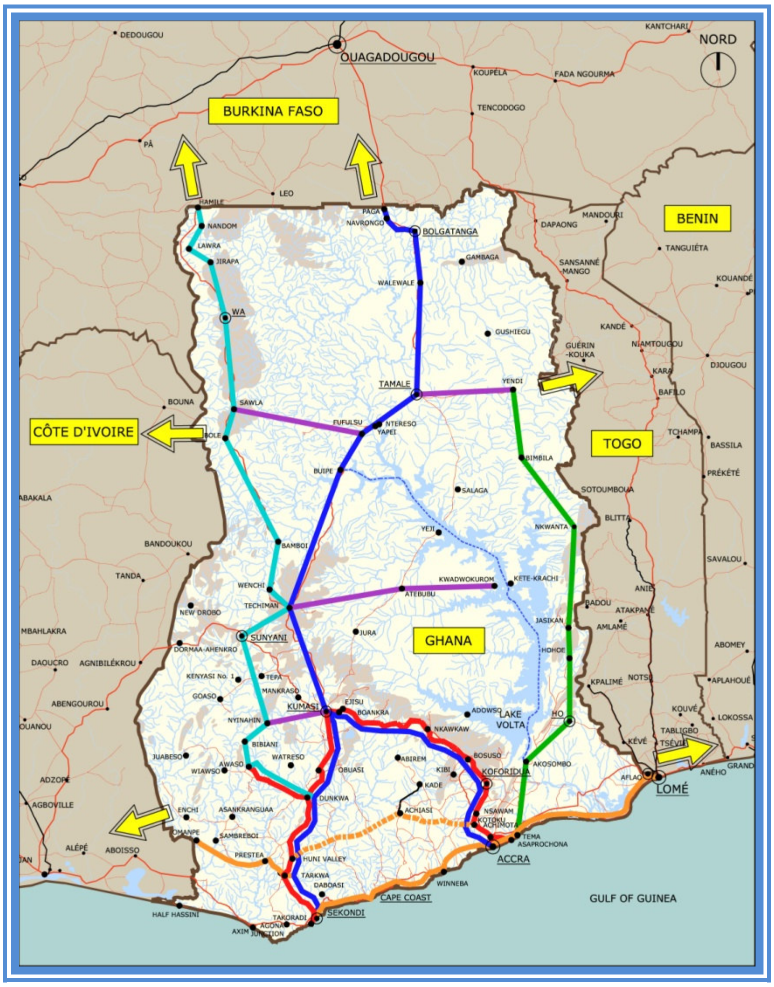
REPUBLIC OF GHANA

Ghana Railway Development Authority
of the Ministry of Transport

PROVISION OF ENGINEERING CONSULTING SERVICES
for the PREPARATION of the

RAILWAY MASTER PLAN OF GHANA



FINAL REPORT

TEAM group

December 2013

TEAM Engineering SpA Roma

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LIST OF ACRONYMS AND ABBREVIATIONS

ACRONYM	EXTENDED NAME	ACRONYM	EXTENDED NAME
AADT	Annual Average Daily Traffic	**ICT**	Information and Communication Technology
ACS	Africa Coastal Services	**IDA**	International Development Association
ADM	Add-Drop Multiplexer	**IFC**	International Finance Corporation
ADT	Average Daily Traffic	**IMF**	International Monetary Fund (United Nations)
AFD	Agencie Francaise de Developpement	**IP**	Internet Protocol
AfDB	African Development Bank	**IR**	Inception Report
AGDP	Agricultural Gross Domestic Product	**IRI**	International Roughness Index
AGI	Association of Ghanaian Industries	**IRR**	Internal Rate of Return
BADEA	Arab Bank for Economic Development in Africa	**ISDN**	Integrated Services Digital Network
BOG	Bank of Ghana	**IT**	Information Technology
BOST	Bulk Oil Storage and Transportation	**ITP**	Integrated Transport Plan
BOT	Build Operate Transfer	**JBIC Japan**	Japan Bank for International Cooperation
BRT	Bus Rapid Transit	**KFW Germany**	Kreditanstalt Für Wiederaufbau (German Development Bank)
BS	Base Station	**KIA**	Kotoka International Airport
CAGD	Controller and Accountant-General's Department	**MCT**	Maersk Container Terminal
CAPEX	CAPital EXpenditure	**MIDA**	Millennium Development Authority
CBA	Cost Benefit Analysis	**MOFA**	Ministry of Food and Agriculture
CFA	Communauté Financière Africaine	**MOFEP**	Ministry of Finance and Economic Planning
CL	Central Line	**MPC**	Monetary Policy Committee
CPI	Consumer Price Index	**NDPC**	National Development Planning Commission
CTC	Centralized Traffic Control	**NGO**	Non-Governmental Organization
CTK	CityLink	**NMT**	Non-Motorized Transport
DACF	Debt-Adjusted Cash Flow	**NPV**	Net Present Value
DCE	District Chief Executive	**O/D**	Origin/Destination
DFR	Draft Final Report.	**OCBN**	Organisation Commune Bénin-Niger des Chemins de Fer et des Transport
DMBs	Deposit Money Banks		
DMR	Digital Mobile Radio	**OPEC**	Organization of the Petroleum Exporting Countries
DMUs	Diesel Multiple Unit	**OPEX**	OPerating EXpenditure
DUR	Department of Urban Roads	**PABX**	Private Automatic Branch eXchange
DWT	Deadweight	**PAX**	Abbreviation for « Passengers »
EIRR	Economic Internal Rate of Return	**PMR**	Private Mobile Radio
EC	European Community	**PPP**	Public Private Partnership
ECOWAS	Economic Community of West African States	**PTM**	Present Transport Model
EIA	Environmental Impact Analysis	**PWDs**	Persons With Disabilities
EIB	European Investment Bank	**RAI**	Rural Access Index
EL	Eastern Line	**RMP**	Railway Master Plan
ERP	Economic Recovery Programme	**RMU**	Regional Maritime University
ETSI	European Telecommunications Standards Institute	**RORO**	Roll On – Roll Off
FTM	Future transport Model.	**RRPs**	Railway Rehabilitation Projects
GACL	Ghana Airports Company Limited	**RTG**	Rubber Tired Gantry
GAP	Good Agricultural Practices	**SDH**	Synchronous Digital Hierarchy
GCAA	Ghana Civil Aviation Authority	**STC**	State Transport Company
GDP	Gross Domestic Product	**STM**	Synchronous Transfer Mode
GHA	Ghana Highway Authority,	**STS**	Ship-to-Shore
GHATIG	Ghana Trade and Investment Gateway Program	**TAH**	Trans-African Highway
GhIE	Ghana Institution of Engineers	**TBT**	Tema Bonded Terminal
GIR	Gross International Reserves	**TCT**	Tema Container Terminal
GJT	Golden Jubilee Terminal	**TETRA**	TErrestrial Trunked RAdio
GLSS	Ghana Living Standard Surveys	**TEU**	Twenty-foot Equivalent Unit

ACRONYM	EXTENDED NAME	ACRONYM	EXTENDED NAME
GMA	Ghana Maritime Authority	**TON/TONNE**	Metric ton
GNI	Gross National Income	**TOR**	Terms of Reference
GPHA	Ghana Ports and Harbours Authority	**TRANSCAD**	Transportation Model
GRC /GRCL	Ghana Railway Company	**TRP**	Transport Recovery Programme
GPRTU	Ghana Private Road Transport Union	**TWI**	Trade Weighted Index
GRC/GRCL	Ghana Railway Company Limited	**UIC**	Union International des Chemins de Fer (International Railway Union)
GRDA	Ghana Railway Development Authority	**UNDP**	United Nations Development Program
GSA	Ghana Shippers Authority	**USAID**	United States Agency for International Development
GSGDA	Ghana Shared Growth and Development Agenda	**VHF**	Very High Frequency
GSM	Global System for Mobile (Communication)	**VLTC**	Volta Lake Transport Company
GSS	Ghana Statistical Service	**VLTS**	Volta Lake Transport System
GUTP	Ghana Urban Transport Project	**VOC**	Vehicle Operating Costs
IBRD	International Bank for Reconstruction and Development	**WL**	Western Line

PREFACE

This Final Report takes into consideration the comments relating to the Draft Final Report received by the Client and, in particular, that referting to the "Central Line".

In the Study presented in the "Inception Report", due to the scarse traffic demand and lack of economic return, the "Central Line" was not included in the plan for "Expanding Ghana's Rail Network".

Following the comments and the Client's request to take into account that, in any case, the "Central Line" is an existing line and for social reasons should not be abandoned, the Consultant has taken this specific request into consideration.

The section of the Accra-Kotoku-Huni Valley-Tarkwa railway line that includes the "Central Line" has been considered and analised as an alternative (Alternative 2) of the Accra-Takoradi-Tarkwa section (Alternative 1) of the Trans-ECOWAS corridor (Phase 4).

During the elaboration of the Economic Feasibility Study, sensitivity tests were carried out regarding the economic feasibility of both entire phases and for single lines (see paragraph 5.2.8).

Furthermore, sensitivity tests were developed and introduced in the elaboration of the Financial Analysis of the Master Plan (see paragraph 6.2.7).

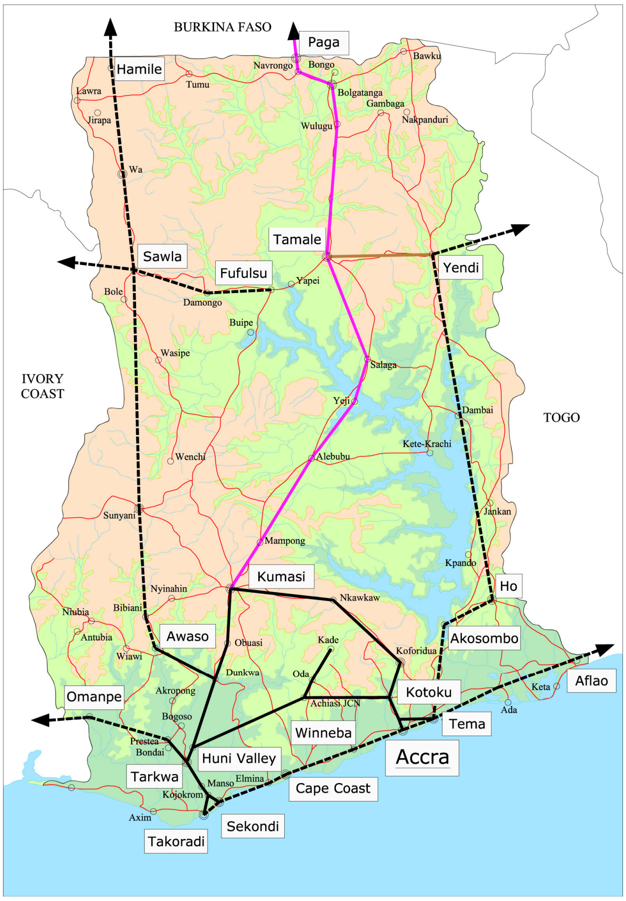
DOCUMENT ORGANISATION

Vol. 1	**FINAL REPORT**
Vol. 2	**ANNEX 1: INCEPTION REPORT ABSTRACT (Chapters 2-3-4-5-6)**
Vol. 3	**ANNEX 2: ENVIRONMENTAL & SOCIAL MANAGEMENT FRAMEWORK**
Vol. 4	**ANNEX 3: URBAN TRANSPORT ISSUE**
Appendix	***COMMENTS ON DRAFT REPORT & ANSWERS***

1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

With reference to the socio-economic situation and the existing railway network in Ghana, which were diffusely described and analysed in the Inception Report elaborated during the 1st Phase of the Study and are integrally referred to here, this 2nd Phase (Study Phase) has been elaborated with the following methodology:

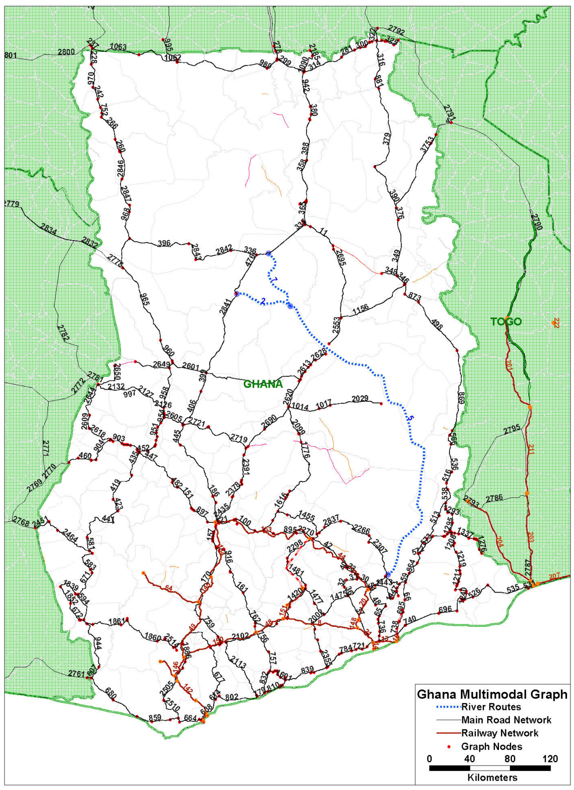


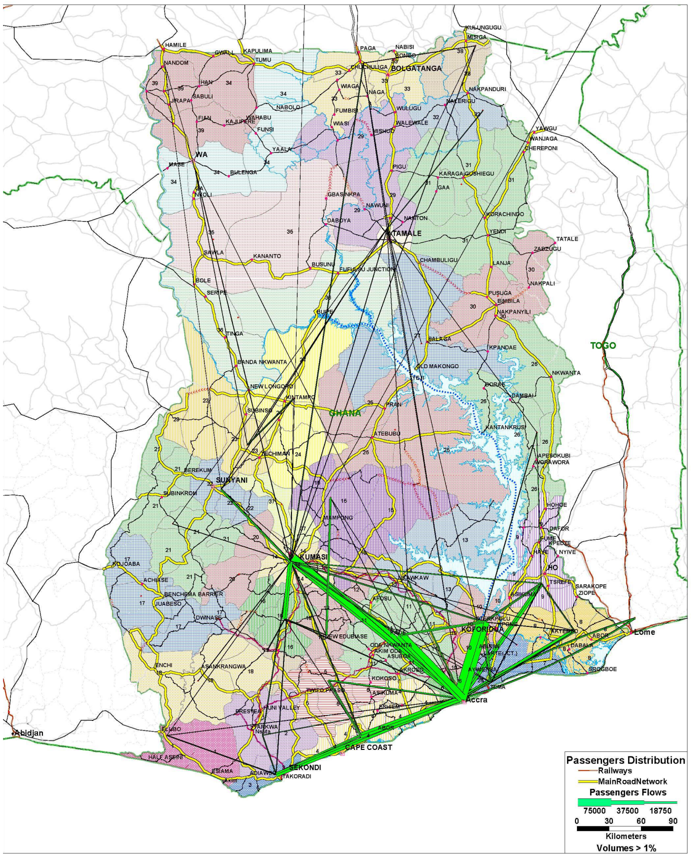
- **Evolution of the demand** for freight and passenger transport in Ghana with a timeframe that goes from today to 2015, year in which it is hypothesised to start the infrastructural interventions; successive developments up to 2030, year in which approximately half of the Project will have been realised, and 2047 when the foreseen interventions will be concluded;

- **Definition and characterisation of the railway network** that is the subject of the investments, which ranges from some existing narrow gauge lines that are obsolete and not in use, to the construction of new standard gauge lines and in this way achieve a total of approximately 4000km that covers the country from North to South. These lengths are foreseen to be carried out in phases lasting 33 years;

- **Assignment of the transport demand** to the various timeframes on the multi-modal graph showing the means of transport available in Ghana: road, rail, sea and water courses as well as air;

- **Analysis of freight and passenger rail traffic on the various lines of the network and identification of the operational methodology and composition of the fleet of Rolling Stock, including locomotives;**





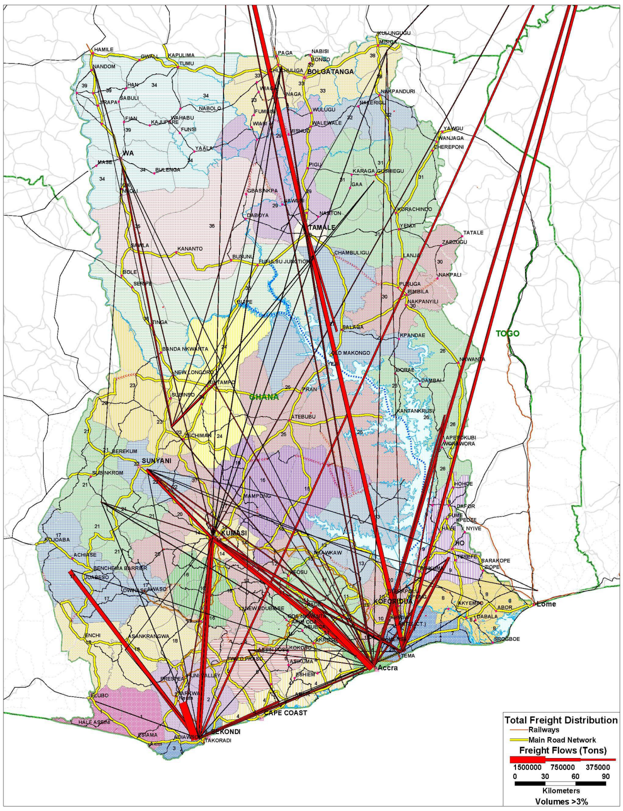
- **Environmental feasibility:** With the drafting of the Environmental and Social Management Framework (ESMF), to be attached to the Master Plan;

- **Economical Analysis** of the interventions with the evaluation of the induced benefits and main economic factors relating to the various time scenarios for a period of 30 years, from the start of operations of the various scenarios;

- **Financial Analysis** of the investments;

- **Proposals for financing and possible PPP**

  Considerations on the profitability and usefulness of the design interventions and the benefits derived for the socio-economic development of the entire country. Analyses in terms of feasibility and returns for both GRDA, the owner of the infrastructure, and eventual management companies operating the railway in PPP, in prevision of a possible division of responsibility between the Owner of the infrastructure and the transport operators.



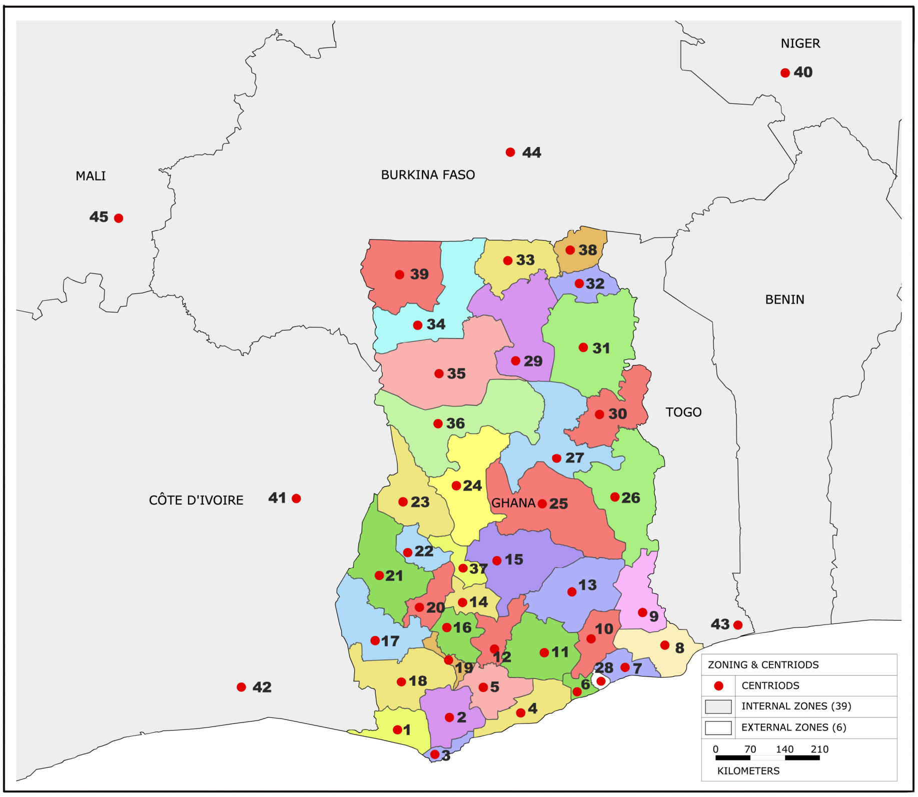
1.2 EVOLUTION OF TRANSPORT DEMAND

The country covers an area of approximately 238,000sq.km, with a population of approximately 25 million inhabitants. The per capita gross income in 2010 was approximately 1300 US$. The annual development increase in the various sectors is between 6 and 8%.

A further economic growth is foreseen that will bring the per capita income to approximately US$ 3000 by 2020. This improvement is due to, besides the economic growth in the various sectors, the new contribution from the oil and gas sectors and from the mining industry in the Southeast and Southwest of the country (see Chapter 2 of the Inception Report, here as Annex 1).

The current overall freight traffic for the entire country for 2008 was approximately 28.2 million tons/year; passenger traffic was approximately 0.64 million passengers/day. Both these figures almost exclusively refer to road transport.

Starting from this scenario, the existing O/D matrix for freight and passengers has been analysed, which was studied and elaborated in the I.T.P. (Integrated Transport Plan) by the French engineering company Egis BCEOM and which referred to 2008; it was then up-dated according to the factors of growth and socio-economic development in the country at the various timeframes of the Project and with reference to the zoning of the country model (45 zones of which 39 within the country and 6 outside (see chapter 5 of the Inception Report – Annex 1). A forecast has also been included for future development of the mining settlements indicated above and the agricultural centre of Brong-Ahafo in the central region of the country (middle belt).



The following table gives the global values of traffic demand in Ghana for a certain period of time, that will then be assigned to the means of transport at the various timeframes.

Year	Scenario	Freight Traffic in mill.tons/year	Passenger Traffic in mill. pax/day
2008	Current	28.25	0.64
2015	Start of interventions	36.25	0.73
2030	During interventions	65.98	0.99
2047	End of interventions	128.57	1.38

The import-export traffic of goods from the ports of Tema and Takoradi completes the picture, having a total flow of respectively 14.0 and 4.0 mill.tons/year and a container traffic of 750,000 and 53,000 TEU.

1.3 THE FUTURE RAILWAY TRANSPORT NETWORK

The current transport system in Ghana depends mainly on the road network, made up of approximately 67,000km of main and secondary roads, of which approximately 12,800km are main arteries but of which only 3800km are paved. Another, more limited, contribution that has grown in recent years, is water transport that takes place along the Volta Lake between the ports of Akosombo in the South and Buipe and Yapei in the North (see chapter 3 of the Inception Report).

The existing railway network is made up of three lines: **Western**, **Eastern** and **Central** that together with some branch lines extend for approximately 940km. Built during the colonial period, they are narrow (Cape) gauge, single track lines and were used for both freight and passenger traffic. Over the years this railway network has deteriorated, together with the rolling stock, due to lack of maintenance and is currently in a state of disrepair and is not able to guarantee reliable and safe transport.

For some years now the Government has given prior importance to the necessity for the rehabilitation, extension and development of the entire national network to take into account the necessities of northern Ghana, the bordering countries and the objectives of Ecowas, identifying a plan for a new railway network (see chapter 4 of the Inception Report).

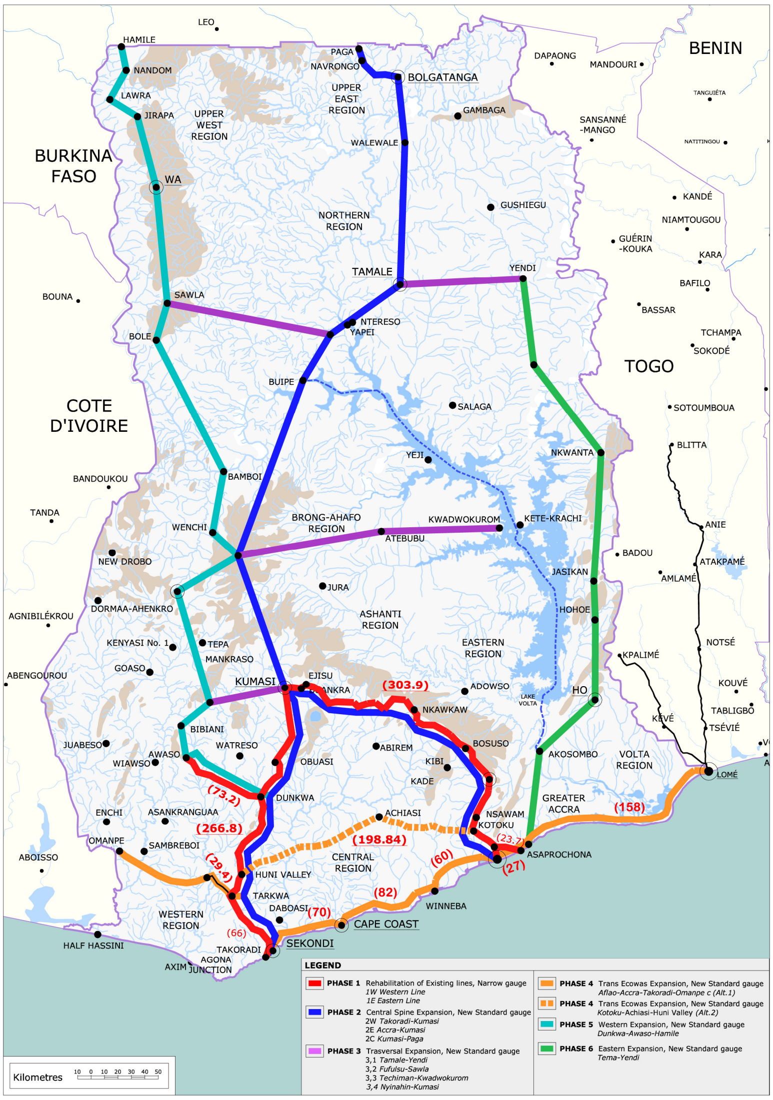
With this as a basis, the following phases have been identified for the rehabilitation and extension of the network as indicated below:

1st Phase: Rehabilitation of the Existing Lines

- Only two of the three existing lines are rehabilitated: the Western Line (Takoradi-Awaso-Kumasi) and the Eastern Line (Accra-Tema-Kumasi) for a total of approximately 668km including branches to Awaso and Prestea). The Central Line is not very attractive for freight and passenger traffic, which should be substituted in successive phases by the foreseen Coastal Line.
- The lines remain narrow gauge, but will be modernised and adapted to the new technical standards for all the infrastructures, but with sleepers conditioned for a subsequent transformation of the lines to standard gauge.
- The traffic assignments indicate that the Western Line has a higher potential for freight traffic, and in particular that of the mines, whereas the Eastern Line is more suited for passenger transport.
- On the basis of the surveys and verifications carried out, it is proposed to undertake repairs on the limited number of the current rolling stock fleet that it is still technically possible to rehabilitate, without purchasing any new vehicles, thus avoiding any unnecessary expenses in view of the future changeover of the lines to standard gauge.

2nd Phase: Extension of the Central Corridor

- Doubling of the track of the two lines rehabilitated in the 1st Phase and the conversion to standard gauge of the previously modernised track, thus creating two modern lines with double track on the routes with a high demand for freight and passenger traffic.
- Construction of the new standard gauge single track line that runs from Kumasi to Tamale and Paga in the North.
- This phase covers approximately 1161km.



3rd Phase: Extension of the Transversal Links

- Construction of transversal links, always with standard gauge single tracks, for the stretches Tamale-Yendi, Fufulsu-Sawla, Techiman-Kwadwokurom and Nyinahin-Kumasi for a total of approximately 484km.

4th Phase: Extension of the Trans-ECOWAS Line

- This is mainly a coastal line, with standard gauge single track, that runs from Aflao (near the border with Togo) westwards to Tema-Accra-Cape Coast – Takoradi - Tarkwa-Omanpe for a total of approximately 498km.

5th Phase: Extension of the Western Line

- Extension northwards of the original Western Line to reach and connect the future mines.
- The line starts from Dunkwa-Awaso and extends towards Techiman, Sawla and Hamile for a total of approximately 729km

6th Phase: Extension of the Eastern Line

- This is the new route to the East of Ghana, near the border with Togo, that from Tema reaches the river port of Akosombo and then heads towards Ho and Yendi to the North, for a total of approximately 468km.

In effect, in the 1st Phase, 668km of the original narrow gauge line are rehabilitated and in the following 5 phases the network is extended by a further 3340km of new lines and the 1st phase will be converted to standard gauge. In 33 years a total of **4008km** of lines will be realised for an investment of **US$21,508 million**.

As will be illustrated below, to this should be added the further investments on the part of the management company operating under a PPP, for the rehabilitation and purchase of the freight and passenger rolling stock, evaluated in **US$53** and **US$1200 million** respectively.

- The **main technical characteristics** of the line infrastructures are:

  - For standard gauge lines:
    - Minimum planimetric curve radii of 1500m on the flat and 1200m in hilly terrain:
    - 5‰ maximum gradients on the flat, 10‰ in hilly terrain and exceptionally 15‰; maximum axle load 25 ton;
    - Permanent way on ballast with 60kg/m rails, elastic fastenings and prestressed concrete sleepers (those for the rehabilitation of narrow gauge with a length of 2.60m, predisposed for the successive transformation to standard gauge).
    - Maximum speed for passenger trains: 120 and 160km/h respectively for local and express trains.
    - Maximum speed for freight trains: 80 and 100 km/h, for light commercial loads and heavy mine transport.

  - For the stations:

    Adoption of European railway standards (in line with UIC recommendations) for the stops, secondary and main stations, in regard to the dimensions and equipment of the spaces dedicated to passengers (concourse, waiting rooms, toilets), to commercial premises and operational service premises (ticket office, technical installations premises, premises for personnel). In any case for the comfort of passengers, cantilevered roofs will be foreseen along the boarding and disembarking platforms and pedestrian under and overpasses, equipped also with elevators for access to the train platforms (where applicable).

  - For signalling and telecommunications

    Adoption of a network for long distance data transmission for every type of communication (voice, video, service data, various signals) based on SDH (Synchronous Digital Hierarchy) technology. The installation is foreseen with optic fibre cables along each railway line and the installation of signal regenerators in each station. Completion of the network with the DMR (Digital Mobile Radio) radio communication system, with a frequency band dedicated for use on the railway network, reserved for land-train service communication and for personnel in service along the line. The system is new generation, simple, efficient, produced by numerous industries and low cost. It foresees the use of BS (Base Station) repeaters installed at 60-80km distances, depending on the topography of the terrain along the lines.

    Adoption of a signalling system based on the use of a new generation axle counting system. This system has been adopted by several railway companies all over the world; it is simple (no track circuits and insulating joints on the track), is a modular system that is easily expandable and is centralised in each station for the control of the occupation of the various stretches of the track, and is not expensive.

- **Train operations** are foreseen as follows:

  - For the rehabilitated narrow gauge lines and with rehabilitated rolling stock:
    - Freight trains comprising 30 wagons with a useful capacity of 30 ton/ea. i.e. the maximum capacity of a train is 900tons with a maximum load of 16 tons/axle and maximum speed of 60km/h and a commercial speed of 45 km/h.
    - Passenger trains comprising 10 wagons with 65 pass/wagon, i.e. with a capacity of 650 pass/train and maximum speed of 70 km/h and commercial speed of 50km/h.

- <u>For new standard gauge lines with new rolling stock:</u>
    - Freight trains comprising 40 wagons with a useful capacity of 50ton/ea. i.e. the maximum capacity of a train is 2000tons, with a maximum load of 25tons/axle and maximum speed of 80-100km/h and commercial speed of 60-70km/h.
    - Passenger trains comprising 12 wagons with 100 pass/wagon, i.e. with a capacity of 1200 pass/train and maximum speed of 120-160km/h and commercial speed of 80-100km/h.

N.B. In effect, operations will be carried out on the various lines with a composition that is suitable for the effective transport demand.

As a general rule, freight transport with 2000 tons/train will use double traction for mining traffic; commercial traffic will be characterised by a lower utility coefficient, and will reasonably reach 1600-1800 ton/train with single or double traction, according to the gradient of the lines. Lastly, for passenger trains with a utility coefficient of 70-90%, trains with 800-1050 passengers will be reached.

1.4 ASSIGNMENT OF TRANSPORT DEMAND

The “graph” of the **transport offer** model has been up-dated. In particular, the data characteristics of the new railway network have been up-dated and added. The entire model has been “calibrated” carefully with up-to-date information on the various means of transport (see chapter 6 of the Inception Report.

For the assignment of the **transport demand**, represented by the up-dated O/D matrix, the model takes into account, among other things, the various parameters that characterize the transport offer among which for example: transportation time, commercial speeds, tariffs, road conditions, petrol cost, etc.. The model permits the assignment of traffic using the TransCAD software, already described in detail in Chapter 6 of the Inception Report. The assignments have been made for Phase 0 scenario without realising the Project, and for the 6 phases of the railway network project, described in the previous paragraphs.

The results of the assignments of goods and passenger traffic along the main routes of the road network in 2015, in the corridors of interest for Phase 0 without the Project, and analogously still on the road network without the project in 2030 and 2047, are summarised in the following tables 1-1, 1-2 and 1-3.

Table 1 - 1 Without the Project

	Year 2015					
Main road corridors	**goods (average weight)**			**passengers (average weight)**		
	northbound	southbound	total	northbound	southbound	total
	(mil.ton./y)	(mil.ton./y)	(mil.ton./y)	$10^3 \cdot$ pax/d	$10^3 \cdot$ pax/d	$10^3 \cdot$ pax/d
Western	2.18	1.29	3.47	14.5	14.8	29.3
Eastern	3.67	3.43	7.10	50.0	50.0	100.0
Kumasi-Paga	2.89	3.88	6.76	11.0	11.0	22.0
Ecowas Corridor	0.63	0.87	1.50	23.0	23.0	46.0
Western Expansion	0.75	0.57	1.33	4.0	4.0	8.0
Eastern Expansion	0.24	0.36	0.60	6.2	6.1	12.3
Transversal Expansio	0.09	0.23	0.32	2.0	2.1	4.1
		Total	***21.1***		*Total*	***221.7***

Table 1 - 2 Without the Project

	Year 2030					
Main road corridors	goods (average weight)			passengers (average weight)		
	northbound	southbound	total	northbound	southbound	total
	(mil.ton./y)	(mil.ton./y)	(mil.ton./y)	$10^3 \cdot$ pax/d	$10^3 \cdot$ pax/d	$10^3 \cdot$ pax/d
Western	3.86	2.28	6.13	19.6	19.9	39.5
Eastern	6.62	6.19	12.80	67.7	67.6	135.3
Kumasi-Paga	5.19	6.94	12.14	15.3	15.3	30.6
Ecowas Corridor	1.12	1.56	2.68	30.8	30.8	61.7
Western Expansion	1.34	1.04	2.38	5.6	5.6	11.1
Eastern Expansion	0.43	0.65	1.08	7.8	7.8	15.6
Tranversal Expansion	0.21	0.61	0.82	2.0	2.1	4.1
		Total	***38.0***		*Total*	***297.8***

Table 1 - 3 Without the Project

	Year 2047					
Main road corridors	goods (average weight)			passengers (average weight)		
	northbound	southbound	total	northbound	southbound	total
	(mil.ton./y)	(mil.ton./y)	(mil.ton./y)	$10^3 \cdot$ pax/d	$10^3 \cdot$ pax/d	$10^3 \cdot$ pax/d
Western	7.51	4.43	11.94	27.3	27.9	55.2
Eastern	12.89	12.05	24.93	94.3	94.2	188.5
Kumasi-Paga	10.12	13.53	23.64	20.8	20.8	41.6
Ecowas Corridor	2.19	3.04	5.23	43.4	43.4	86.8
Western Expansion	2.62	2.03	4.65	7.5	7.5	15.0
Eastern Expansion	0.84	1.26	2.10	11.6	11.6	23.2
Transversal Expansio	0.40	1.20	1.60	3.8	4.0	7.8
		Total	***74.1***		*Total*	***418.2***

A comparison of the three tables shows how the freight and passenger traffic would increase on the roads should the Project not be carried out, as a result of the evolution of traffic demand over the years.

With the realization of the Project, the results of the assignment of freight and passenger traffic, from Phase 1 to Phase 6, are summarized for the various reference years in the following Tables 1 - 4 and 1 - 5.

Table 1 - 4 With the Project (Freight)

Railway Lines	Freight traffic (average weight) in mill.ton/year								
	2015			2030			2047		
	Northb.	Southb.	Total	Northb.	Southb.	Total	Northb.	Southb.	Total
Phase 1-Rehabilitation									
Western	0.60	1.36	1.96						
Eastern	1.00	1.05	2.05						
Phase 2-Central Corr.									
Western				0.95	2.70	3.66	2.10	5.79	7.89
Eastern				3.02	3.56	6.58	5.22	5.75	10.97
Kumasi-Paga				5.51	2.34	7.85	9.42	3.98	13.40
Phase 2-Transvers.links							East/West	West/East	
Sum of links							2.51	4.38	6.88
Phase 4-Ecowas Ext.							0.43	0.12	0.55
							Northb.	Southb.	
Phase 5-Western L. Ext.							1.80	1.85	3.66
Phase 6-Eastern L. Ext.							2.47	3.08	5.55

Table 1 - 5 With the Project (Passengers)

Railway Lines	Passenger traffic (average weight) in '000 pass/day								
	2015			2030			2047		
	Northb.	Southb.	Total	Northb.	Southb.	Total	Northb.	Southb.	Total
Phase 1-Rehabilitation									
Western	2.5	2.5	5.0						
Eastern	20.6	19.1	39.7						
Phase 2-Central Corr.									
Western				5.3	5.3	10.6	8.0	8.0	15.9
Eastern				48.7	48.5	97.1	64.5	66.1	130.6
Kumasi-Paga				15.1	14.9	29.9	18.1	18.1	36.2
Phase 2-Transvers.links							East/West	West/East	
Sum of links							9.6	9.6	19.2
Phase 4-Ecowas Ext.							18.6	19.8	38.4
							Northb.	Southb.	
Phase 5-Western L. Ext.							5.0	4.9	9.9
Phase 6-Eastern L. Ext.							12.0	12.0	24.0

The assignments made with and without the realization of the Project, from Phase 1 to Phase 6, indicate that the railway traffic absorbs a significant amount of road traffic. The allocation coefficients of the traffic between the various means of transport are the following:

Table 1 - 6 Freight Traffic

	a) tot.Tab.1	b) tot.Tab.4	c) % dren.	a) tot.Tab.2	b) tot.Tab.4	c) % dren.	a) tot.Tab.3	b) tot.Tab.4	c) % dren.
Phase 1 -rehabilitation									
Western	3.47	1.96	56%						
Eastern	7.10	2.05	29%						
Phase2 -Central Corridor									
Western	3.47			6.13	3.66	60%	11.94	7.89	66%
Eastern	7.10			12.80	6.58	51%	24.93	10.97	44%
Kumasi-Paga	6.76			12.14	7.85	65%	23.64	13.40	57%
							A	**32.26**	**66%**
Phase 3 -Transv. Links									
Total links	0.32			0.82			1.60	6.88	430%
Phase 4 -Ext. Ecowas Line	1.50			2.68			5.23	0.55	11%
Phase 5 -Ext.Western Line	1.33			2.38			4.65	3.66	79%
Phase 6 -Ext. Easter Line	0.6			1.08			2.10	5.55	264%
							B	**16.64**	**34%**
							A+B	**48.90**	**100%**

a) is the total bi-directional freight traffic in the scenarios **Without the Project** at the timeframes of 2015, 2030 and 2047 shown in the Tables 1 - 1, 1 - 2 and 1 – 3.

b) is the total bi-directional freight traffic in the scenarios **With the Project** at the timeframes of 2015, 2030 and 2047 shown in Table 1 - 4.

c) is the b/a percentage of the total bi-directional freight traffic absorbed by **rail from road** at the timeframes of 2015, 2030 and 2047.

Table 1 - 7 Passenger Traffic

	Total passenger traffic north and southbound (average weight) in '000 pass/day and % absorbed from road								
Railway lines	**2015**			**2030**			**2047**		
	d) tot.Tab.1	e) tot.Tab.5	f) % dren.	d) tot.Tab.2	e) tot.Tab.5	f) % dren.	d) tot.Tab.3	e) tot.Tab.5	f) % dren.
Phase 1 -rehabilitation									
Western	29.3	5.00	17%						
Eastern	100.0	39.70	40%						
Phase2 -Central Corridor									
Western	29.3			39.50	10.60	27%	55.20	15.90	29%
Eastern	100.0			135.20	97.50	72%	188.50	130.60	69%
Kumasi-Paga	22.0			30.60	29.90	98%	41.60	36.20	87%
							C	**182.70**	**67%**
Phase 3 -Transv. Links									
Total links	4.1			4.10			7.80	19.20	246%
Phase 4 -Ext. Ecowas L.	46.0			61.70			86.80	38.40	44%
Phase 5 -Ext.Western L.	8.0			11.10			15.00	9.90	66%
Phase 6 -Ext. Eastern L.	12.3			15.60			23.20	24.00	103%
							D	**91.50**	**33%**
							C+D	**274.20**	**100%**

d) is the total bi-directional passenger traffic in the scenarios **Without the Project** at the timeframes of 2015, 2030 and 2047 shown in Tables 1 - 1, 1 - 2 and 1 - 3.

e) is the total bi-directional passenger traffic in the scenarios **With the Project** at the timeframes of 2015, 2030 and 2047 shown in Table 1 - 5.

f) is the e/d percentage of the total bi-directional passenger traffic absorbed by rail from road at the timeframes of 2015, 2030 and 2047.

The percentages of freight traffic absorbed by rail vary for some line (phases 1, 2 and 4) between 11% and 65%, whereas for the others (phases 3, 5 and 6) where new traffic is generated above all, the percentages are obviously very high.

The percentages of passenger traffic absorbed by rail are also significant for the various lines, even if to a slightly lesser degree than for freight

1.5 ANALYSIS OF ASSIGNED RAILWAY TRAFFIC

The assignment of the model to the various time frames results in the macrovalues of the freight and passenger traffic along the various stretches of line, shown in the tables in the previous paragraphs. For freight, some values are unbalanced in the two directions. For example, for the Kumasi-Paga line the northbound direction is busier whereas for the Takoradi-Kumasi line the southbound line is busier. Whereas for passengers, the traffic is well balanced in both directions.

It is further pointed out that both the freight and passenger traffic (see points A, B, C and D, Tables 1-6 and 1-7) of the the entire country is mainly in the Central Corridor (Spine) – Phase 2, where approximately two thirds of the total traffic is concentrated. This railway corridor represents, therefore, the fundamental rail axis of Ghana.

Given the long period of time that has been studied, over the years the plan must remain well balanced and up-to-date: some sections of the line, such as the Kumasi-Tamale on the Central Corridor, may need to be double tracked.

From the traffic flows it has been possible to carry out a first evaluation of the trains (freight and passengers) necessary to carry out the operations of the entire network. Taking into account the type of operations envisaged, indicated at the end of the previous paragraph 1.3, that is presumed can be effected for approximately 20h/day in order to leave 4h during the night to carry out the maintenance of the line, it has been possible to dimension the total fleet of rolling stock, including a percentage of vehicles to be foreseen for maintenance and reserves.

Below is the composition of the fleet.

		freight wag.	pax wagons	locomotive	total	cost in Mil.US$
1st Phase	Narrow gauge	330	132	29	**491**	**53**
2nd-6th Phase	Standard gauge	3344	1122	177	**4643**	**1200**
1st-6th Phase	*Total*	3674	1254	206	**5134**	**1253**

Thus on approx. 4000km of new network, 4643 vehicles will be operating with the following incidence of vehicle per km of line

freight wagons	0.84
wagons	0.28
locomotives	0.04
	1.16 veh/km

The allocation of the rolling stock and the composition of the trains for the various lines will be calibrated in more detail during operations, according to the effective transport demand and, in any case, will be equilibrated for approximately 2/3 of the Central Corridor.

1.6 ECONOMICAL ANALYSIS OF THE INTERVENTIONS

- The study has been carried out according to a classical Cost-Benefit Analysis to evaluate the economic feasibility of the foreseen investments, comparing them with the return that they will have in respect of the social benefits they produce.
- The economical analysis is based on the comparison of the following two cases:
  - The first case, called **"without project"** is considered the normal evolution of the existing situation;
  - The second case, called **"with project"** takes into consideration the rehabilitation of the existing lines and the construction of new railway lines according to the plan.

  The analysis is generally conducted for a period of 30 years starting from the beginning of operations of the various lines.
- The analysis has a discontinuous characteristic, because the flow of costs and benefits may be produced at different times. For this reason, a discount rate must be used to take into account the depreciation of the currency. The discount rate in the analysis has been assumed to be 12%.

  Taking into account that for these types of projects the assumed value is high, a sensitivity test has also been carried out with a value of 7%, in order to evaluate the NPV with a more realistic rate.
- The indicators used have been:
  - The **Net Present Value (NPV)** represents the sum of all discounted costs and benefits. This value reflects the return on the investment. If this value is negative, the costs

prevail over the benefits and therefore the project is not financially or economically feasible.

- The **Internal Rate of Return (IRR)** represents the discount rate with which the benefits are equal to the costs, i.e. when the NPV is annulled. The IRR can be compared, for example, with the current interest rate or with a certain minimum rate for determined types of investments. The higher the IRR , the more the Project would be profitable.

- The **costs** used in the economical analysis, in the various phases of the Project were:
  - The investment over the years for the cost of the **infrastructure**, the financial value of which is approximately US$21,500 mill., that has been reduced with a corrective factor of 0.8 to approximately US$17,200 mill. (deducting taxes, duties and excise) to obtain the **economic value**.
  - The investment over the years for the cost of **rolling stock** to be rehabilitated and purchased new, the financial value of which is approximately US$1253 million, which has not been reduced. As they are imported industrial products, no deductions have been considered, as the economic value is practically the same as the financial value;
  - The **operating costs (VOC)** per vehicle/km, as an average cost of the various categories and types that travel on roads under various conditions.
  - The **cost of maintenance and operations of the infrastructures** and the lines.
  - The **cost of maintenance and operations of the trains (ROC),** both freight and passenger. The cost per ton-km has also been calculated for heavy and standard trains and the cost per passenger-km on the basis of international experience and taking into account the local conditions.
- The **benefits** that have been evaluated and quantified in the economic analysis in the various phases of the project are as follows:
  - A **saving in transport costs** for passengers due to the lower cost of transportation by rail and for the financial operators in the various business sectors;
  - A **saving on road maintenance** due to the reduced traffic and less damage as a consequence of the fewer heavy vehicles in circulation:
  - A **saving due to the fewer road accidents** that will occur as a consequence of the reduced road traffic.

Lastly, a residual economic value has been calculated for the infrastructures equal to 70% of the investment value.

- The results of the **economic feasibility** analysis with a 12% discount rate are summarised below:
  - For the network, passing from Phase 1 to Phase 6, the IRR value varies between approximately 31% and 15%, gradually decreasing as the network is implemented. Even if the NPV is high and varies between US$2125 million and US$487 million;
  - For the single sections of line, that represent the increase of the Project made during a phase in respect of the previous phase, the IRR value is lower and varies between approximately 7% and 11%, according to their importance. The NPV is negative and varies between –US$348 million and –US$11 million;
- The results of the **sensitivity test** with a discount rate of 7% are the following:
  - For the network, the IRR value remains the same (approx. 31% - 15%), whereas the NPV increases considerably and varies between US$295 and US$4299;

- For the single sections of line, the IRR value remains the same (approx. 7% and 11%), whereas the NPV increases considerably, becomes positive and varies between US$335 million and US$7 million.

- Sensitivity tests have also been added with a discount rate of 12% for cost variations of +5%/10% or for reductions of traffic benefits always of -5%, -10% (see paragraph 5.2.8).

The economic indicators show good values for the IRR and NPV indexes that demonstrate the good economic feasibility and convenience of the Project.

1.7 FINANCIAL ANALYSIS OF THE INVESTMENTS

- The study analysed the financial investments of all 6 phases of the Master Plan (US$21.508 million for the infrastructures and US$1254 million for the rolling stock), the costs for the maintenance and operations of the trains and infrastructures and the revenue from the transport tariffs (freight and passengers). The investments have been hypothesised with a cover from the **public sector** (80% equity and 20% loan) for the **infrastructures** and from the **private sector** (30% equity and 70% loan) for the **rolling stock.**

  The financial analysis was conducted for a relatively long period (2015-2070) with several years of cover from the start of operations of the last stretch of line (2048) up to the end of the analysis.

  Taking into consideration the bank interest rate for the loans and the 12% discount rate adopted for the investments, the financial indicators give a negative NPV equal to –US$3631 and a low IRR equal to 3.6%. These values are not sufficient to attract capital from the private sector for the realisation of the Project. The Project, therefore, does not appear financially feasible.

- To complete the study, the Financial Analysis for the single phases and for the single railway sections of the network have been added, in analogy with the Economic Study (see paragraph 6.2.5) and the same **sensitivity tests** were made for cost variations of +5%, +10% or for a reduction of the revenue of -5%, -10% (see paragraph 6.2.6).

- Bearing in mind that the Central Corridor – Phase 2 is the fundamental transport axis, a financial analysis has been elaborated specifically for this line, applying the PPP concept, that foresees the separation between the ownership of the infrastructure and the train operations. It has been hypothesised that the realisation and financing of the infrastructure (approx. US$6528 million) will be paid for by the **public sector** (GRDA) and the purchase and financing of the rolling stock (approx. US$ 715 million) will be paid for by the **private sector** (investor). The maintenance and operations of the infrastructure will also remain the responsibility of the public sector, against payment for the “concessioning” of the lines to the private parties that operate the line. The private party is responsible for the costs of maintenance and operations of the rolling stock.

  In this case, the Project is valid and financially feasible: for the private sector the NPV is positive and equal to US$709 million with a high IRR equal to approximately **23.2**%; for the public a still negative NPV is reached equal to -2269 and with a low IRR equal to approximately **2.8**%, but there is the opportunity and financial advantage of being able to amply repay the costs of maintenance and operations of the line infrastructures with the revenue from the sale of “concessions” to a private company.

1.8 FINAL CONSIDERATIONS

- The **Economic Analysis** shows that the Project is very positive financially both for the profitability and for the benefits induced with reference to the promotion of the socio-economic development in general. This is demonstrated by the NPV and IRR economic indexes for both 12% and 7% discount rates.
- The **Financial Analysis** has shown the financial inconvenience of the entire project in regard to eventual private investors, because the capital is not remunerative. Whereas, the adoption of a PPP type procedure for a line such as Central Corridor - Phase 2 with a high transport demand, is valid and feasible for a private investor because it gives a profit on the invested capital. The GRDA public sector has the great advantage of not having economic costs for the maintenance and operation of the infrastructure.

  Lastly, it is strongly advised to make **long term monitoring interventions** and periodically revise the Master Plan to update it with the requirements that may arise, bearing in mind the vast length of time taken into consideration; such as, for example, verifying the necessity of converting to double track the Kumasi-Tamale stretch in the Central Corridor.

2. PROJECT SCENARIOS OF THE REHABILITATION AND EXPANSION OF GHANA'S RAILWAY NETWORK

2.1 REHABILITATION AND EXPANSION OF RAIL LINES

On the basis of analyses of the current transport system and the proposed development plan of the Government of Ghana to expand the existing railway infrastructures, a definition has been made for the "New Railway Network" in a future scenario. This scenario foresees the infrastructures and services that will be necessary to satisfy the growing demand for mobility in Ghana.

The New Railway Network will be realized by Rehabilitation and Expanding of Exsisting lines (see figure 2.1). The new railway network will be developed in successive phases on the basis of the priorities identified for the traffic demand and reorganization. It is of strategic importance in the development plans for the Ghanaian Railways and accompanies important interventions for the reorganization of transport and the requalification of the areas to be crossed: stations, regional and urban railway services, routes dedicated to the transport of mineral products. On a supranational level, the new network constitutes a fundamental aspect of the Trans-ECOWAS Network, and also an important link to the northern, landlocked countries.

The Proposed Expansion of National Railway Network runs along several corridors in a north-south and east-west direction and, besides linking the main cities, also connects both existing and potential mineral deposits with the two important Ports in the country (Takoradi and Tema).

The New Railway Network is comprised mainly of three north-south routes (Western Expansion and Eastern Expansion), a coastal line running in a East-west direction (Trans Ecowas Expansion) and four transversal connections.

The expansion of the National Railway Network will be realized by the construction of new standard gauge lines to ensure a more complete transportation service for the whole country. Rehabilitation and this expansion will be developed in 6 phases interventions(see figure 2.3).

In relation to traffic assignment, the following phases have been identified for the **Rehabilitatiion** and **Expansion** of the existing Railway Network:

Phase 1- Rehabilitation of Existing Lines

- 1 W Western Line (340km)
- 1 E Eastern Line (327.6 km)

Phase 2- Central Spine Expansion

- 2 W Takoradi - Kumasi (266 km)
- 2 E Accra - Kumasi (300 km)
- 2 C Kumasi - Paga (595 km)

Phase 3- Transversal Expansion

- 3.1 Tamale - Yendi (102 km)
- 3.2 Fufulsu - Sawla (126 km)
- 3.3 Techiman - Kwadwokurom (198 km)
- 3.4 Nyinahin - Kumasi (58 km)

Phase 4- Trans-ECOWAS Expansion

Aflao - Accra - Takoradi - Omanpe (498 km)

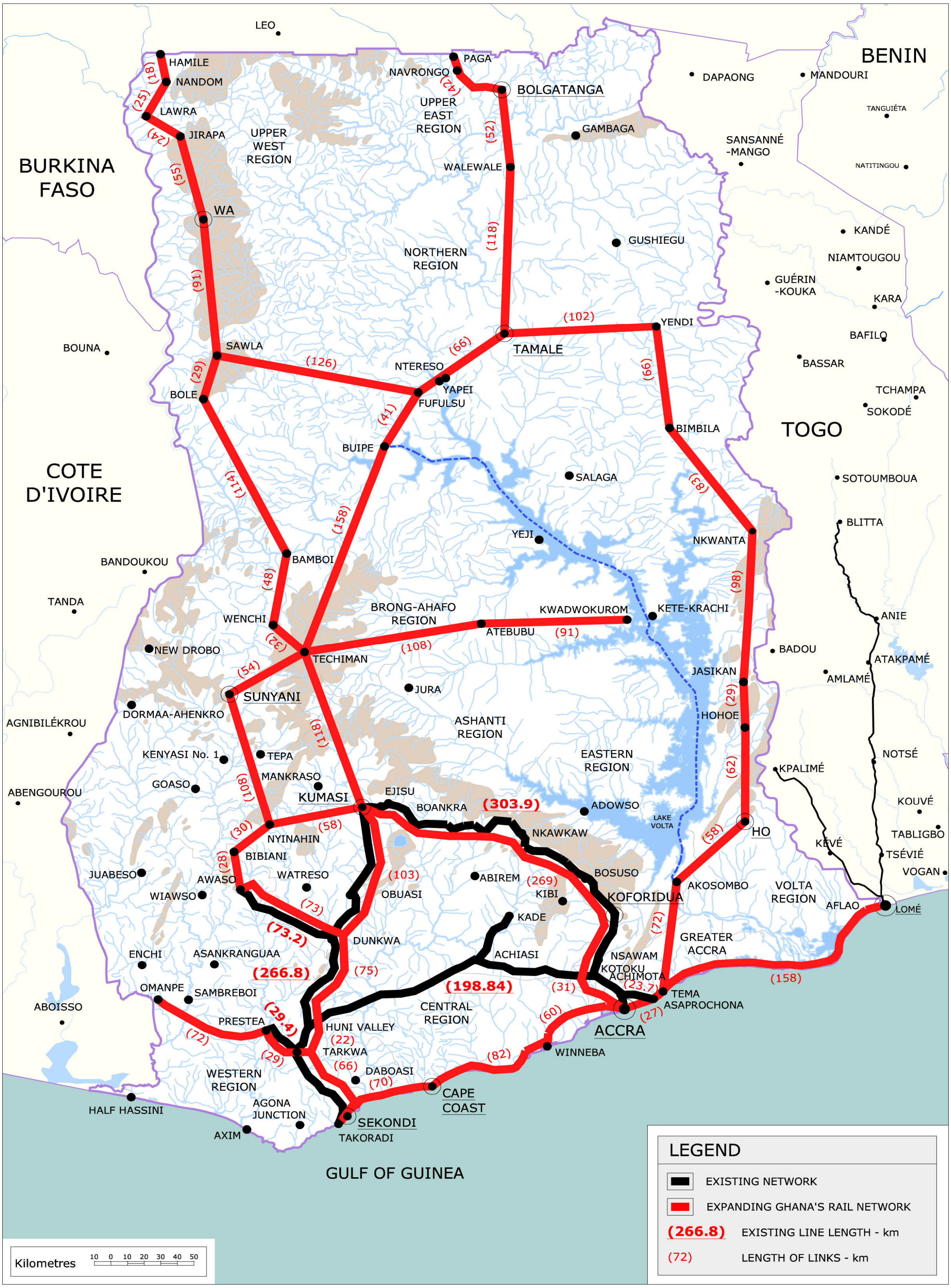
Phase 5- Western Expansion

Dunkwa - Awaso - Hamile (729 km)

Phase 6- Eastern Expansion

Tema - Yendi Tamale (468 km).

Figure 2 - 1 Schematic Map of Proposed New Rail Network



2.1.1 Phase 1 - Rehabilitation of Western and Eastern Lines

Only two of the three existing lines are expected to be rehabilitated in this 1st Phase:

the **Western Line (1W):** Takoradi-Kumasi and Dunkwa-Awaso lines; and
the **Eastern Line (1E):** Accra-Kumasi and Achimota-Tema lines.

The traffic assignment shows that the Western Line has a greater tendency for goods transportation, in particular traffic related to the mines, while the Eastern Line has more passenger traffic. The **Central Line,** however, is unappealing for both goods and passenger traffic and, as such, could not be – in principle- considered as a positive section within the framework of a Master Plan for the future development of an efficient railway network at national level, which will be oriented towards an East-West connection shifted South, along the coastline (see Figures 2 - 2, 2 – 3, and further argumentations at following paragraph 2-1-4).

This rehabilitation involves the civil works (tracks, stations, buildings, etc.), the signalling and communication systems and rolling stock (locomotives, coaches, etc.).

The Rehabilitation and Modernization of the existing infrastructure will consist in:

- Increasing the minimum curve radii;
- Decrease the maximum gradients compensated in the direction of trains loaded with minerals;
- Increase the axle load
- Reinforce the permanent way;
- Reconstruct existing bridges and culvers due to the increase in axle load;
- Lengthen passing loop lengths in stations and junctions to be compatible with the forecasted lengths of the trains.

The objectives of the Rehabilitation are to:

- increase line capacity;
- increase average speed/reduce travel time;
- increase passenger comfort,
- increase efficiency/reduce maintenance costs.

To date, the performance and design criteria chosen by the GRDA for rehabilitating and improving the existing rail network results as being a combination of the design standards of the two Scenarios (Scenario 1 and Scenario 2) proposed by Bonifica in the Final Report of “Feasibility Study of the Western Corridor Infrastructure” August 2010. In fact, for the restructuring of the Western Line, GRDA recently adopted a dual gauge sleeper from Scenario 1, incorporing the specification for Scenario 2 (ie. Axle load of 21 tons and speed of 120 km/h).

The following Chapter 3 describes the programme and design criteria to be applied in the implementation of the rehabilitation programmes described above.

Figure 2 - 2 Existing Lines to be Rehabilitated

The following table shows the length of the existing rail lines that will be rehabilitated and the total length of the relative routes.

Table 2 - 1 Rehabilitation of Existing Rail Lines

PHASE 1	
Western Line (1 W)	
1- Takoradi - Kumasi	266,8
2- Dunkwa - Awaso	73,2
	340.0
Eastern Line (1 E)	
Accra - Kumasi	303,9
Achimota - Tema	23.70
	327.60
Total Km	**667.6**

2.1.2 Phase 2 - Central Spine Expansion

Phase 2 involves the doubling of the two lines restructured in Phase 1, by constructing the standard gauge lines: **Takoradi-Kumasi (2 W)** and **Accra-Kumasi (2 E)** and the conversion to standard gauge of the previously restructured track. Furthermore, the new standard gauge line from **Kumasi to Tamale and Paga (2C)** will also be constructed for a total of 1161 km (see Figure 2.3) .

2.1.3 Phase 3 - Transversal Expansion

Phase 3 involves the construction of the single track, standard gauge, transversal lines for the routes **Tamale-Yendi (3.1)**, **Fufulsu-Sawla (3.2)**, **Techiman-Kwadwokurom (3.3)** and **Nyinahin–Kumasi (3.4)**, for a total of approximately 484 km (see Figure 2.3).

2.1.4 Phase 4 - Trans-ECOWAS Expansion

Phase 4 sees the construction of two single track, standard gauge lines. The first section of the line starts from Aflao, near the border with Togo and heads west, mainly along the coast of the Gulf of Guinea, connecting the important cities of Tema, Accra, Cape Coast and Takoradi. The second section starts at Tarkwa and ends at Omanpe, near the border with the Cote D'Ivoire. The two stretches have a total length of approximately 498 km (see Figure 2 - 3).

This solution, for a line of such primary importance as the Trans-ECOWAS (which should assure the direct connection with the neighbouring states East (Togo) and West (Ivory Coast)) has been preferred to a sub-parallel option running along the existing NG Central Line (from Tarkwa to Kotoku, via Achiasi), for the following reasons:

- along the coast, the cities of Cape Coast, the capital of Central Region, and Winneba, the second most important town of the region, are met and connected. Both towns host University and High School facilities, as well as socio-cultural activities;
- along the coast, both tourism and fishing activities are developed. On the other hand,
- the Central Line, being NG, has a rather winding alignment, running almost parallel to the coast, at a distance of 60-70 Km. The crossed land is less densely populated and mainly dedicated to agriculture;
- due to said tortuosity of the alignment, more difficult and costly would its rehabilitation be, so much so, that the relevant cost could be expected to be equivalent to that of the newly

constructed coastal line;

- with the proposed route along the coast, the railway distance between Accra and Takoradi, will be about 110 Km shorter (210Km rather than 320Km)

However, should the Client prefer, for other reasons (beyond the technical-economical argumentations orienting the Consultant's choice) to choose the route following the Central Line (shown as a dotted line as an Alternative 2, if we call Alternative 1 the one developed in the Master Plan study), this is clearly possible; noting, however, than in the Economic Analysis, the benefits related to passengers and freight traffic will be lower.

Nonetheless, given the magnitude of the new railway system comprised in the study, dealing with a network measuring approx. 4000Km, it can be concluded that choosing one or the other alternative will not actually have a sensible impact on the overall results of the study.

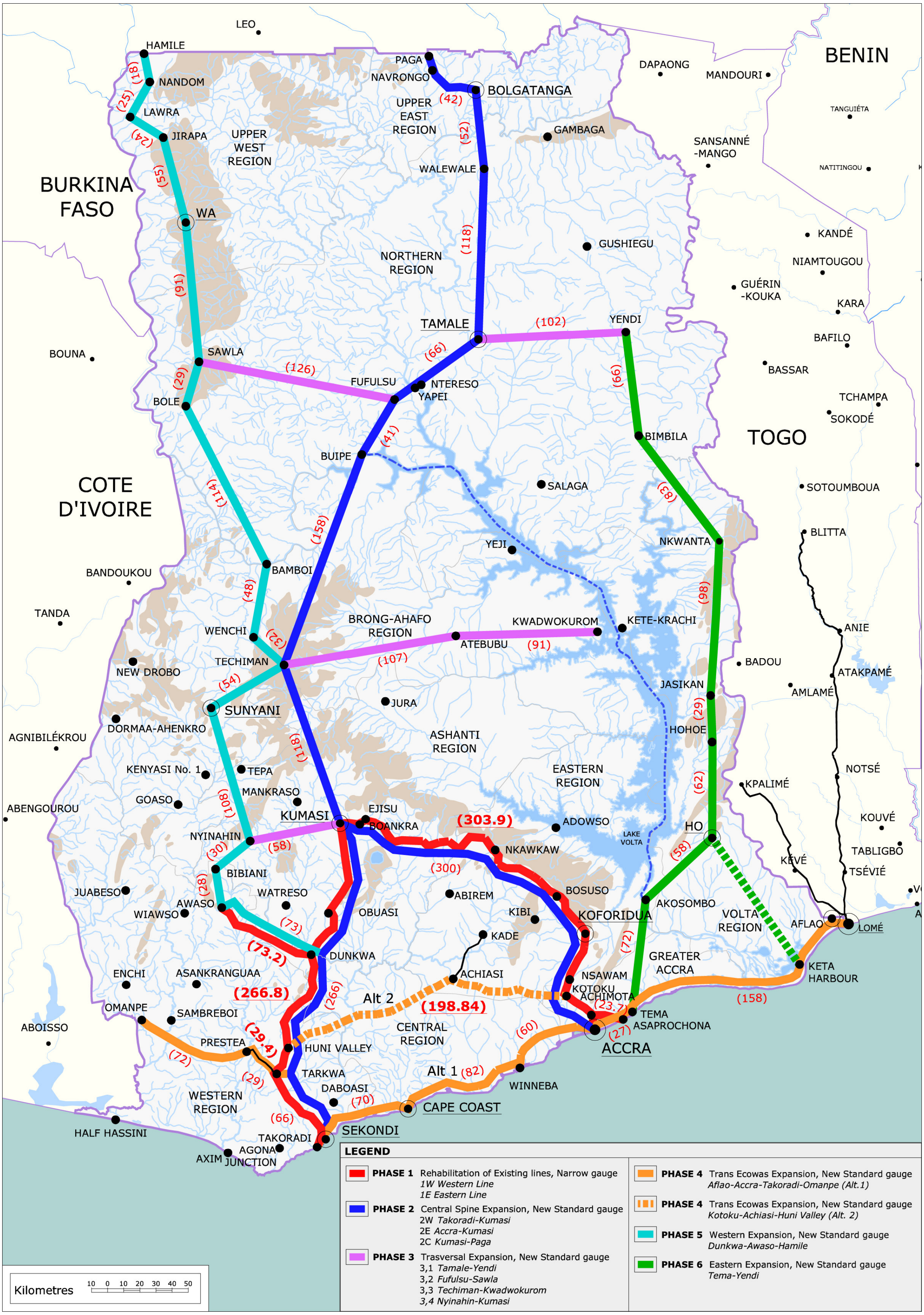
2.1.5 Phase 5 - Western Expansion

Phase 5 sees the construction of a single, standard gauge line that extends the original Western Line northwards to reach and connect the future mines. The line starts from Dunkwa-Awaso and extends as far as Techiman, Sawia and Hamile for a total of 729 km (see Figure 2 - 3).

2.1.6 Phase 6 - Eastern Expansion

Phase 6 sees the construction of a single, standard gauge line heading east, near the border with Togo, that from Tema reaches the river port of Akosombo and then heads towards Ho and Yendi in the North, for a total length of 468 km (see Figure 2 - 3). A possible extension in this Phase could be represented by Ho-Keta branch to serve a new harbour in Keta Lagoon: this initiative being supported by the Volta Foundation and a group of private investors in anticipation of substancial oil discoveries in the Accra-Keta basin.

Figure 2 - 3 Phases of Expansion of New Lines



The following Table 2 - 2 shows the length of the new standard gauge lines and the total length of the relative routes, whereas Fig. 2 - 4 is a preliminary GANTT Programme of the implementation of the various phases and sub-phases.

As can be seen, the programme extends from year 2015 (taken as a starting preference point) to year 2047, this extension originates from the results of the traffic assignment studies, combined with the benefit/cost analysis, which provided indications on the priorities of the various phases and the optimum years of completion (i.e. opening to traffic and starting of revenues).

Regarding the duration of each phase, this has been hypothesized based on a reasonable rate of progress of the construction works (generally in the range of 30 to 48 km/year. Attention has also been taken in the distribution of the sub-phases, in order to limit to a reasonable extent the superimposition in each year of excessive works (and, consequently, the simultaneous use of too many contractors), as well as the necessary annual budget to be made available for the construction.

Table 2 - 2 Expansion of Ghana's Rail Network Lengths

PHASES AND SECTIONS	LENGTH
PHASE 2: Central Spine Expansion	**Km**
2 W: Takoradi - Kumasi	266,0
2 E: Accra - Kumasi	300,0
2 C: Kumasi - Techiman	118,0
Techiman - Buipe	158,0
Buipe - Fufulsu	41,0
Fufulsu - Tamale	66,0
Tamale - Walewale	118,0
Walewale - Bolgatanga	52,0
Bolgatanga - Paga	42,0
Total Phase 2: km	***1161,0***
PHASE 3: Transversal Expansion	
Transversal Expansion	
3.1: Tamale - Yendi	102,0
3.2: Fufulsu - Sawla	126,0
3.3: Techiman- Atebubu - Kwadwokurom	198,0
3.4: Nyinahin - Kumasi	58,0
Total Phase 3: km	***484,0***
PHASE 4 : Trans ECOWAS Expansion	
Trans Ecowas along Coastal line	
Aflao - Tema	158,0
Tema - Accra	27,0
Accra - Winneba	60,0
Winneba - Cape Coast	82,0
Cape Coast - Takoradi	70,0
Tarkwa - Prestea	29,0
Prestea - Omanpe	72,0
Total Phase 4: km	***498,0***
PHASE 5: Western Expansion	
Western Expansion	
Dunkwa - Awaso	73,0
Awaso - Bibiani	28,0
Bibiani - Nyinahin	30,0
Nyinahin - Sunyani	108
Sunyani - Techiman	54,0
Techiman - Wenchi	32,0
Wenchi - Bamboi	48,0
Bamboi -Bole	114,0
Bole - Sawla	29,0
Sawla - Wa	91,0
Wa - Jirapa	55,0
Jirapa - Lawra	24,0
Lawra - Nandom	25,0
Nandom - Hamile	18,0
Total Phase 5: km	***729,0***
PHASE 6: Eastern "B" Expansion	
Eastern "B" Expansion	
Tema - Akosombo	72,0
Akosombo - Ho	58,0
Ho - Hohoe	62,0
Hohoe - Jasikan	29,0
Jasikan - Nkwanta	98,0
Nkwanta - Bimbila	83,0
Bimbila - Yendi	66,0
Total Phase 6: km	***468,0***
TOTAL Overall Total Length Km	**3340,0**

2.2 MAGNITUDE AND IMPLEMENTATION PROGRAMME OF THE INTERVENTIONS

An implementation programme has been elaborated regarding the rehabilitation of the existing narrow gauge lines, approximatly 667 km (2015 - 2018), and the constrution of new standard gauge lines, approximatly 3340 km (2017 - 2039) for a total length of 4007 km (see Figure 2 - 4)

Figure 2 - 4 Implementation Programme

	Lines	Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
		L	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
		Km	Rehabilitation				Construction new lines -Standard gauge																												
A	**PHASE 1: Rehabilitation of existing line**	**667.6**																																	
	1W - Western Line	***340***	1	1	1	1																													
	1- Takoradi - Tarkwa - Dunkwa - Kumasi	266.8																																	
	2- Dunkwa - Awaso	73.2																																	
	1E - Eastern Line	***327.6***	1	1	1	1	1																												
	1- Accra - Kumasi	303.9																																	
	2- Achimota - Tema	23.7																																	
B	**PHASE 2: Eastern "A" Expansion**	**1161**																																	
	2W-Takoradi-Kumasi	266					1	1	1	1	1	1																							
	2E- Accra - Kumasi	300						1	1	1	1	1	1	1																					
	2C Kumasi - Techiman - Tamale	383							1	1	1	1	1	1	1	1	1																		
	Tamale - Paga	212											1	1	1	1	1																		
C	**PHASE 3: Transversal Expansions**	**484**																																	
	1- Tamale - Yendi	102																			1	1	1												
	2- Fufulsu - Sawla	126																1	1	1															
	3- Techiman - Atebubu - Kwadwokurom	198																1	1	1	1	1													
	4- Nyinahin - Kumasi	58																			1	1													
D	**PHASE 4: Trans Ecowas Expansion**	**498**																																	
	1- Aflao - Tema - Accra	185																						1	1	1	1								
	2- Accra - Takoradi	212																				1	1	1	1	1									
	3- Tarkwa - Omanpe	101																							1	1	1								
E	**PHASE 5: Western Expansion**	**729**																																	
	1- Dunkwa - Awaso	73																									1	1							
	2- Awaso - Techiman	220																										1	1	1	1	1			
	3- Techiman - Sawla	223																							1	1	1	1	1						
	4- Sawla - Hamile	213																										1	1	1	1	1			
F	**PHASE 6: Eastern "B" Expansion**	**468**																																	
	1- Tema - Ho	130																													1	1	1		
	2- Ho - Yendi	338																											1	1	1	1	1	1	1
	Total New Construction Km	***3,340***	No. Years (new constr.)		0	0	1	2	3	3	3	3	3	3	2	2	2	2	2	2	3	4	2	2	4	4	4	4	4	3	4	4	2	1	1
	Grand Total (Rehabilitation + New Construction) Km	**4007.6**																																	

3. SPECIFICATIONS/PERFORMANCE AND DESIGN CRITERIA FOR THE IMPLEMENTATION OF THE MASTER PLAN

3.1 RAILWAY WORKS

3.1.1 Rehabilitation

Below are the **Performance** and **Design Criteria** for the **Rehabilitation and Improving** of Ghana's existing railway network (about 667.6 km), as well as the bases for estimating costs:

- Gauge:

Pre-stressed dual gauge concrete sleepers, initially set for narrow gauge 1067mm, will be used. They will enable convertion to standard gauge 1435mm to take place on the same sleepers at a future date.

- Axle Load and Design Speed:

The axle load is 22 tons and miximum speed is 120 km/h.

- Horizontal Alignment:
  - Maximum super-elevation (e): 15mm
  - Minimum radius of horizontal curve: 900m-1500m

- Vertical Alignment:
  - Maximum grade: 1.25%
  - Minimum radius for vertical curves: 4000m

- Crossing Loop Length:

The crossing loop length has been fixed to allow two trains of 900m to pass each other.

- Typical Cross Section:

The proposed railway typical cross section on flat and sloping terrain consists of a single rail track with a gauge of 1067mm, with **rails type 60UNI** fixed to the pre-stressed reinforced concrete sleepers with the following dimensions 190X300X2300mm. The sleepers will be placed on top of 300mm thick ballast. The sleepers shall be constructed in such a way that the rail track can be easily modified to accommodate a line gauge of 1435mm in the future.

3.1.2 Construction of New Lines

Below are the proposed **Performance** and **Design Criteria** for the **New Standard Gauge Line**, as well as the bases for estimating costs.

- **Formation:**

Width :
- In fill: 7.00m
- In cut: 7.00 + ditches
- On bridges: net between parapets 6.00 m

Slopes:
- In fill: 5/3 up to 2/1 (horizontal/vertical)
  Protection: topsoiling (15cm thick) + wickerworks and seeding + drainage channel on one side

- In cut: variable according to soil characteristics;
  Protection: in common soil seeding with wickerworks and topsoiling where necessary.

<u>Sub-ballast:</u>

Course of granular material, average thickness 25cm

❖ **<u>Structures:</u>**

<u>Bridges & viaducts:</u>

Various standard spans will be foreseen, according to the height of the piers: approx. 9, 15, 25 and 30m.

<u>Loads:</u>

To be assumed for the calculations: according to U.I.C. codes and/or British Standards.

<u>Back filling:</u>

For abutments and culverts, by means of granular material.

<u>Speeds:</u>

- Open line
  - Passenger Express Trains: 160 km/h
  - Passenger Local Trains: 120 km/h

❖ **<u>Axle loads:</u>**

Design value: 22-25 t

❖ **<u>Planimetric curves:</u>**

- Minimum Radii
  - In flat terrain: = 1,500 m
  - In hilly terrain: = 1,200 m
    (max. possible speed 160 km/h)
  - In exceptionally hilly terrain: = 900 m
    (max. possible speed 140 km/h)
  - In branch lines & junctions: = 500 m
    (max. possible speed 100 km/h)
  - In stations: 250 m, exceptionally up to 190 m (max. possible speed resp. 43 and 38 km/h)
- Cant
  - Centrifugal acceleration admitted 0.6 m/sec^2
  - Cant (h) according to various train speeds, with the following restrictions:
    - h = 150 mm on main track
    - h = 0 for other station tracks

❖ **<u>Vertical alignment:</u>**

- Gradients:
  - Maximum in flat terrain 5‰
  - In hilly terrain 10‰
  - In exceptionally hilly terrain 16‰ corrected
  - In stations 1.25‰

No vertical transition curves are to be designed for differences of contiguous gradients > 1,5‰.

Note: ‰ = per thousand

❖ **Ballast profile:**

- Minimum thickness under sleeper on the vertical of the rail.
  - Main line and crossing tracks: 0.30 m
  - Sidings and service tracks: 0.20 m
  - On bridges: 0.25 m
- Total width at the top (at sleeper level) 3.44 m
- Inclination of the slopes (horizontal/vertical) 4/3

❖ **Track:**

- Rails
  - 60 UIC, conforming to code 861-3
  - Steel of "normal quality" as defined by UIC Code 860-0
  - 50 UIC, normal quality, in the yards of loco depots, workshops, maintenance centres, steel factories and the like.
- Sleepers
  - Prestressed concrete sleepers B 70W-60 type with the following dimensions:
  - Length (bottom level) 2,600 mm
  - Width (maximum) 300 mm
  - Height (under rail) 210 mm
- Fastenings
  - Elastic type. (e.g. Pandrol or Vossloh type).

3.2 DESIGN CRITERIA FOR THE STATIONS OF THE GHANA RAILWAY NETWORK

3.2.1 Dimensioning and Equipment of the Functional Elements

3.2.1.1 Scope

Stations represent the elements that, throughout the country, permit access to rail transportation, especially in regard to passenger services.

This document defines the criteria on which their design is based in order to favour accessibility, safety and comfort for passengers, a homogeneity of standard dimensions and equipment of the functional elements.

These guide lines cannot, however, be considered complete and will be correlated to successive regulations, as well as to legal prescriptions and specific standards, regarding civil constructions and town planning.

Materials, construction techniques, technological installations (that must, in any case, correspond to criteria of durability, economy and maintainability) and the relative regulations, will also be deferred to successive design phases.

Moreover, the architectural characteristics of the building complexes are not taken into consideration and, except in particular cases where it is deemed necessary to restructure an existing station, they should foresee standardized and homogeneous solutions for insertion in the territorial environment.

3.2.1.2 Definitions and Abbreviations

Station: Service premises, within a well defined area, in which the train circulation is regulated by crossings and/or rights of way. The station is dedicated to commercial services giving access to passenger and/or goods transport, as well as to other activities connected to the use of rolling stock.

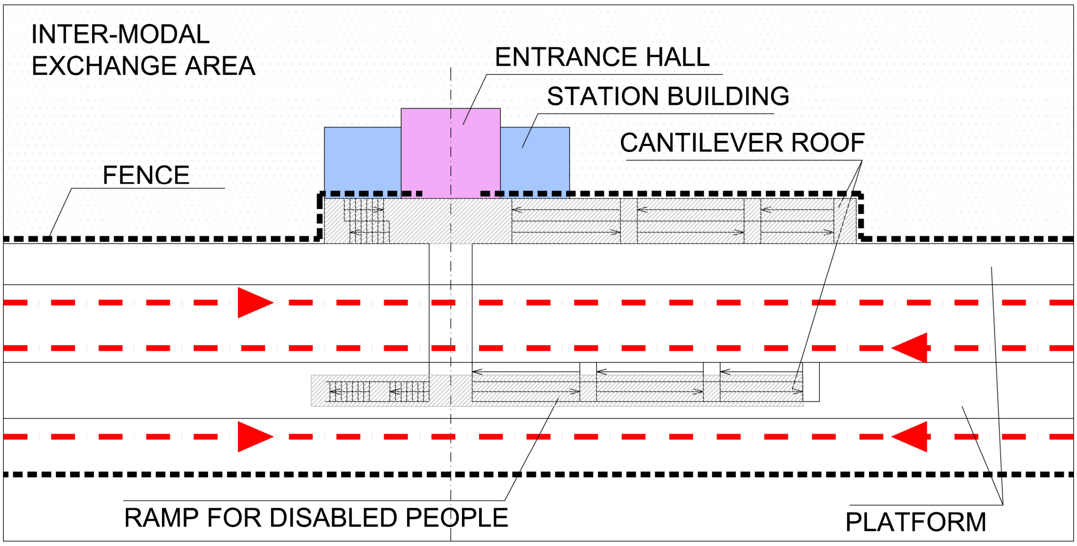
S.B.	Station Building / Passenger Building
A.S.B.	Auxiliary Services Building
T.B.	Technological Building
T.R.	Transformer room
p/d	Average number of passengers boarding and disembarking on a week day
P/D	Total number of passengers foreseen on a week day
R.s.	Running surface
M.P.O.	Minimum profile of the obstacles

3.2.1.3 Methodology for Dimensioning and Classification in Function of Configuration and Types of Access

The dimensioning standards and functional equipment of the main services to be foreseen in the new Stations should be in proportion with the forecasted passenger traffic and related to the specific local contexts in respect of the following main configurations [1] and typologies that have been identified.

3.2.1.4 Main Configurations of Installations in function of the Forecasted Passenger Traffic and Type of Line (for stations on single or double track lines)

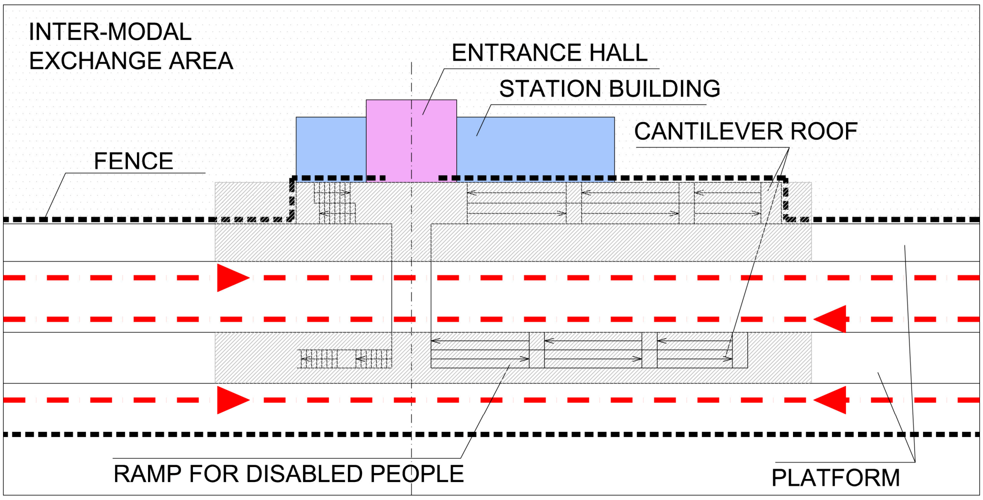
Type 1



[1] The configurations under examination refer to "transit" installations, in terms of their position in respect of the line, as they are the most common. Other possible configurations relating to the position (terminal stations, branch lines, island, crossing, etc.) can be evaluated by analogy.

Type 1 installations are directed towards services for low level passenger traffic (<200 p/d or < 400 p/d)

Type 2



Type 2 installations are directed towards services for short, medium and long distances with passenger traffic of 200 p/d or 400 p/d.

3.2.1.5 Main Types of Access to the Station

A) Accesses at track level

B) Accesses at a lower level than the track (stations located on embankment or viaduct)

C) Accesses at a higher level than the track (stations located in cut)

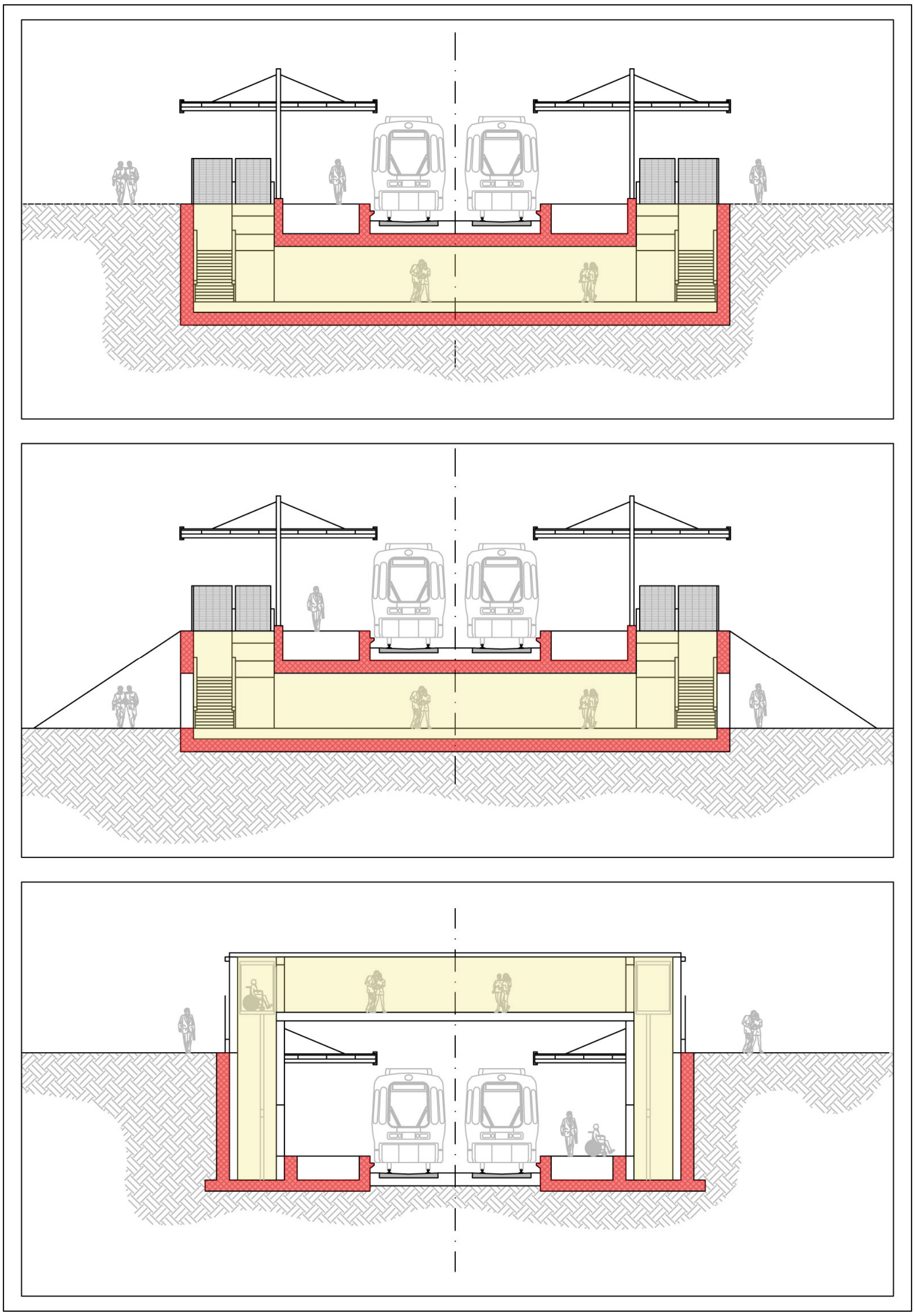


Figure 3 - 1 From top to bottom: Indicative Examples of A, B and C Access Types

3.2.1.6 <u>Characteristics of the Functional Elements</u>

➢ <u>General</u>

❖ **Location based on the characteristics of the line**

The new stations will preferably be located on flat, straight stretches in order to limit inconveniences for passengers when boarding or disembarking from the train.

- **Accessibility**

The new stations should overcome any architectural and sensory barriers according to these guide lines and the specifications indicated below.

At least one route that is completely accessible from the entrance or from interchange points, if present, should connect all the main services of the station as far as the tracks, allowing use by passengers with motor or sensory handicaps. This route, with the exception of doors that are subject to specific regulations, must in any case have a net width of no less than 1.60m and a height free from obstacles of no less than 2.30m.

- **Finishing materials**

The finishing materials must conform to proven standards of durability and strength and must allow easy maintenance and cleaning operations, and the removal of any stains or dirt (also through the use of preventive anti-graffiti treatment).

- External Forecourt: Inter-modal Exchange Area

A) STATIONS LOCATED IN AN URBAN CONTEXT OR NEAR MINOR SETTLEMENTS

Inter-modal exchange areas will usually be located near the stations, according to specific agreements with the Local Authorities. These areas will comprise: parking facilities for cars, motorcycles and bicycles, routes within the interchange area, kiss-and-ride[2] and taxi lanes, green areas, street furniture and lighting systems.

The number of parking places will be for spatial distribution in the quantity required and will be linked to specific local situations, town planning standards for sparial distributon and forecasted passenger flow in function of the other existing means of transport (buses, trams, metro, etc.) and on the available area.

B) STATIONS LOCATED IN AN EXTRA-URBAN CONTEXT AWAY FROM ANY SETTLEMENT

Near the stations, there will usually be parking facilities for cars, motorcycles ad bicycles, internal access routes, pedestrian routes, green areas, street furniture and lighting.

As far as dimensioning is concerned, as there are no specific town planning standards and in the absence of any indications from the Local Authorities, it is deemed useful to prescribe at least 40 sq.m of parking area for every 100 sq.m of gross built-up pavement area (excluding the road formation), to which should be added 1 sq.m for every 10 cu.m of construction.

27 sq.m is calculated for every parking place, including manoeuvring spaces.

For example, with an **S.B.** of 500 sq.m and 2 platforms, with an overall area of 2000 sq.m (length 250 m and width 4.00m) and an cubic area of 2000 cu.m, for the parking facilities we have:

2500sq.m x 0.4 = 1000 sq.m; 2000 cu.m / 10= 200 sq.m

1000 + 200 =1200 sq.m

Dedicating 80% of the area to cars and the remaining 20% to motorcycles and bicycles, we will have 960 sq.m / 27 sq.m = approx. 35 parking places.

For both the above station locations, as a rule, the following should be present:

- Accesses and eventual routes connected to other means of transport
- parking places for private cars
- parking places for handicapped people (1 every 50 places and at least 2)

[2] *Term used for a passenger drop-off area*

- parking places for motorcycles
- parking places for bicycles
- kiss-and-ride and taxi spaces or lanes near the entrance
- Entry and space for emergency vehicles

As far as the organization of the green areas, pedestrian paving and street furniture are concerned, they should be limited to the extent strictly necessary for the use of the station, with design solutions that optimize the use of the areas.

➢ Internal Yard

A) STATION PLATFORMS

❖ **Equipment**

As a rule, each track should be served by a single platform for passenger use.

Eventual service platforms will be forbidden to passengers.

❖ **Dimensioning**

For dimensioning purposes, in relation to the flow of passengers, indicatively the value of 1 sq.m/passenger can be considered. These areas are defined net of the safety area (between the yellow line and the edge of the platform).

❖ **Height of the platform**

As a rule, platforms for passenger use will be at a height of 550mm above the running surface.

Eventual service platforms will have a height of 250mm.

❖ **Length of the platforms**

Platforms for passenger service will, as a rule, have a standard length of 350 m, in function of the type of traffic adopted, with trains composed of 12 passenger coaches.

❖ **Width of the platforms**

The continuous width is in proportion to the forecasted passenger flow, the dimensions of the safety strip (according to the line speed) and to the size of the fixed obstacles and their relative distances from the yellow line. For the installation configurations identified by these guidelines, points 3.2.1.7.1/3.2.1.7.2 indicate the minimum continuous widths.

It is preferable that the continuous width should be used for the entire longitudinal length, taking into due account the areas dedicated to stairs/ramps/elevators and fixed obstacles (pillars, piles, etc.), for which the minimum clearances indicated below are valid.

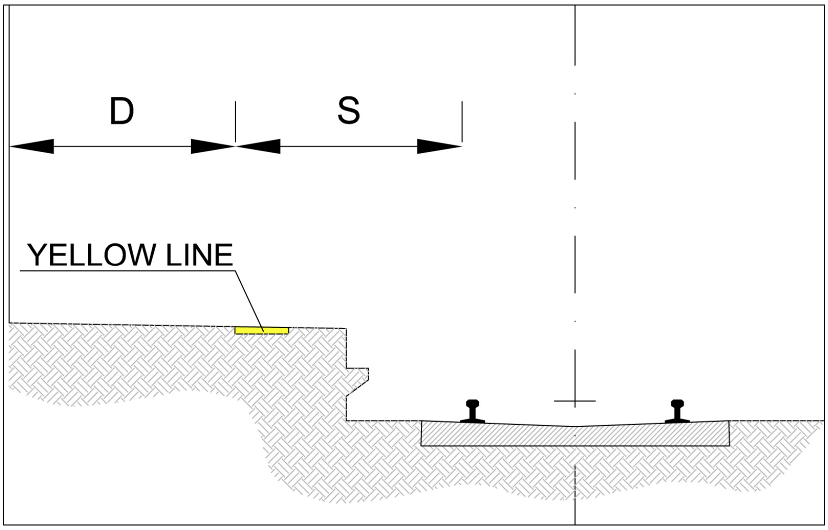
On side platforms, it is preferable to find solutions with space (fence side) for elements such as stairs and ramps. Eventual narrowing of the width, only possible at the end of the platforms, must in any case respect the minimum dimensions fixed by the specific regulations and allow, inside the safety strip and net of the area dedicated to eventual fixed obstacles, a minimum width of 1.60m for the transit for passengers.

❖ **Minimum distance between the yellow line (inside edge of platform border) and the fixed obstacle (D):**

- Obstacle with maximum length (measured parallel to track) of 1.00 m, D1 = 0.90 m
- Obstacle with maximum length (measured parallel to track) of 10.00 m, D2 =1.20 m
- Obstacle with length superior (measured parallel to track) to 10.00 m, D3 =1.60 m

These distances take into account the European regulations relating to public routes that overcome architectural barriers.

Distance between the yellow line and the inside edge of the nearest rail (S) (edge of service step at a height of 250mm from the running surface for H550 platforms or H250 platform edge): in function of the line speed.



- **Accessibility characteristics (architectural and sensorial barriers)**

The platforms should conform to the guide lines that are adopted during successive design phases and be equipped with:

- Paving with anti-slip characteristics
- Tactile routes and tactile maps for the blind [3]
- Tactile yellow line to indicate the safety strip and the edge of the platform (to be positioned in conformity with the note quoted in the previous point)

B) ROUTES AND ACCESSES INSIDE THE STATION

Further to 3.2.1.6.1 relating to accessibility (overcoming architectural and sensorial barriers), the routes and accesses for both the public and for service, must conform to the regulations for escape routes for fire prevention safety.

The width of the routes, in proportion to the passenger flow, should be multiples of M (M = 60 cm), with a minimum for a single module of 80 cm.

Inside the routes, eventual lighting devices or other protrusions (e.g. transversal flag-type signs and/or from the ceiling) must be located at a height from the floor that is not less than 2.30m in areas frequented by the public and 2.20m in other areas.

Emergency exits should have a height of not less than 2.10m and a width that is suitable to the flows and characteristics that correspond to the regulations mentioned above.

[3] As a rule, the tactile routes must be positioned in a way that is not contiguous with the tactile yellow safety line, and as much as possible towards the inside of the platform.

C) STRUCTURES THAT OVERCOME A DIFFERENCE IN LEVEL

❖ **Stairs**

Stairs are to be foreseen for all the station types (one stair for each platform and for every underpass or overhead gangway).

The width of the stairs, in proportion with the flows, will be multiples of M (M = 60cm) and in any case not inferior to 180 cm. Lower widths (minimum 120 cm) could only be allowed for installations with low passenger frequency.

The dimensions and the characteristics of the steps, landings and handrails must conform to the regulations for overcoming architectural and sensorial barriers (tactile codes) and for escape routes for fire prevention safety.

❖ **Ramps**

Access ramps for the disabled in wheelchairs are to be installed for all types of stations (one ramp for each platform and for every underpass and overhead gangway).

The width of the ramps, in proportion to the flows, will be multiples of M (M = 60cm) and, in any case, not less than 180 cm. Lower widths could only be allowed for installations with low passenger frequency.

❖ **Rising platforms and elevators**

For station types equipped with overhead gangways (e.g. stations in cut) and only in cases where the effective difference in level to be overcome advises against the use of ramps (extremely long route), rising platforms or elevators could be installed.

The presence of elevators means the installation of alarm systems with intercommunication and CCTV connections with control posts in the station or in other localities.

Rising platforms and elevators should conform to the specific technical and operational regulations and to regulations for overcoming architectural and sensory barriers.

At least two sides of the external walls and the cabin of these elevators should be transparent.

D) UNDERPASSES

Underpasses for the use of passengers may be for the specific use of the station, or, on the basis of conventions with the Municipality, for a promiscuous use (connections with the tracks and urban connections through direct accesses to spaces outside the station). In the second case, they should foresee systems of separation (gates) to be suitably located for when the railway installations are closed.

The width of the underpasses, in proportion with the flows, must be multiples of M (M = 60cm) and, in any case, no less than 3.00m.

The net height from floor to ceiling should not be less than 2.50 m.

The location of installations and lighting, advertising boards, signs, etc., should allow a fluid and safe transit of passengers across a “corridor free from obstacles” with a height of not less than 2.30 m and a minimum width of 2.40m. Fixed and variable signs disposed longitudinally along the walls of the underpass tunnel should be positioned at a height from the floor that is not less than 2.10m.

The underpasses should conform to regulations for overcoming architectural and sensorial barriers and for escape routes for fire prevention safety.

E) OVERHEAD GANGWAYS

Eventual overhead gangways which, due to the particular conformation of the station (e.g. in cut with access from above) are necessary in substitution of underpasses (Access type C, 3.2.1.5) when it is not possible to introduce an alternative route, will be positioned with a minimum height from the running surface to the intrados of the foreseen horizontal structure in function of the gabarit.

The width, according to the flow of passengers, should be multiples of M (M = 60 cm) and in any case, no less than 3.00m.

The roof must have a minimum height from the floor of 2.30m.

The location of station installations and lighting, advertising boards, signs, etc., should allow the smooth and safe transit of passengers through a “corridor free from obstacles” with a height of no less than 2.30m and a minimum width of 2.40m. Fixed and variable signs positioned horizontally along the walls of the gangway should be at a height of not less than 2.10m from the floor. The sides should have a protection, in order to prevent objects being thrown, with an overall height of not less than 2.00m. The protection should have closed surfaces (blind or transparent) for a minimum height of 1.00m from the floor and in the case they are equipped above with open elements (e.g. grilles), the latter will have a mesh that is no greater than 30 x 30mm.

The overhead gangways must conform to the regulations regarding overcoming architectural and sensorial barriers and for escape routes for fire prevention safety.

F) STRUCTURES FOR THE PROTECTION OF PASSENGERS

❖ **Cantilevered roofs**

The roofs will be long enough to generally cover the access and waiting areas, as well as the stairs and ramps in the event of underpasses (where specified in part IV).

The maximum length, according to the conformation of these areas, should not exceed 70.00m. The cantilevered roofs will preferably be modular in order to allow eventual successive lengthening.

The dimensions regarding the height of the intrados of the roof from the running surface and its projection from the edge of the platform, should respect the allowed clearance.

G) FENCING AND STATION ACCESSES

The stations will be protected from intruders by a suitable fence around the boundaries, with a height from the level of the external paving that is no less than 1.80m.

Accesses for both the public and personnel should allow a safe exit for all users, in conformity with the regulations for overcoming architectural and sensorial barriers and escape routes for fire prevention safety, and will be equipped with gates for the closure of the station when not in operation and to allow the entry of emergency vehicles.

H) PASSENGER BUILDING, AUXILIARY SERVICES BUILDING, TECHNOLOGICAL BUILDING, OTHER BUILDINGS.

❖ **Passenger Buildings**

For the dimensioning of the waiting areas in the Passenger Building, the areas indicated in point 3.2.1.7 have been identified, for the configurations under examination, on the basis of the forecasted traffic during peak times, by adopting the following procedures:

- 40% of passengers present in the morning time band (7:00 – 9:00)

- 20% of passengers present in the afternoon time band (13:00 – 15:00)

- 20% of passengers present in the evening time band (18:00 – 20:00)

- 20% of passengers present in the remaining times.

For small stations, the presence of people who are not passengers is negligible.

Considering that passengers remain in the station for an average of 20', the total number of passengers during peak (P) time is:

P = (P x 0.40) : 6

Giving the standard of 1.00 sq.m per passenger, the area (S) is obtained which is sub-divided according to the type of waiting, in the concourse (60%) and on the platform (40%).

For example, with a total of 2000 passengers per day (p/d)

P =	(2000 x 0.40) : 6 = 133
S total =	133 sq.m
S concourse =	133 x 0.6= 79.80 sq.m
S waiting on platform =	33 x 0.4 = 53.20 sq.m.

Main types of **S.B.** in function of their position in respect of the internal yard.

- **S.B.** lateral (platform area on transit or terminal line)
- **S.B.** bridge (platform area on transit line)
- **S.B.** underground (platform area on transit or terminal line)
- **S.B.** on viaduct (platform area on transit or terminal line)
- **S.B.** terminus (platform area on terminal line)

❖ **Technological buildings** and **Transformer Rooms**, where necessary will be modular and be dimensioned according to the necessities illustrated in 3.2.1.7

❖ **Auxiliary services Buildings** and **Other Buildings** to be dedicated to specific functions and activities for: logistics, railway operations, transport companies, different types of transport, police, etc., are to be considered specific design elements.

I) TOILETS

The number and size of toilet facilities must be in proportion with the passengers foreseen at peak time.

Facilities should be provided within the buildings or in a separate structure, all in accordance with the available space and within the design restrictions.

Adequate male, female and handicapped toilets should be provided as shown in the following schedule.

Table 3 - 1 Sizing of Toilet Facilities

Passengers	(n°)	100	250	500	750	1000	1500	2000
Standard value	(m2/pass)	0,15	0,14	0,13	0,12	0,11	0,10	0,09
Surface	(rn2)	15	35	65	90	110	150	180
Water closet	(n°)	2 _ 4	4	8	10	12	14	18
Lavatory	(n°)	2 _ 4	4	8	10	12	14	18
Handicap toilet	(n°)	1	1	1	1	1	2	2

J) LIGHTING

❖ **Access areas, internal areas**

- The minimum lighting at floor level should not be lower than 100 Lux.
- The minimum lighting at floor level in the underpasses and on the connecting stairs and ramps should not be lower than 120 Lux.

❖ **Area under cantilevered roof**

- The minimum lighting at floor level should not be lower than 70 Lux.

❖ **Open areas**

- In the sections of station pavement and other public areas in the open, the average lighting at floor level should not be lower than 20 Lux and not exceed 50 Lux, with in any case a minimum value of no less than 10 Lux.
- In the direction that the trains travel, any intense lighting that may interfere with the driving or operating signals must be avoided.

❖ **S.B. and other Buildings**

In those cases that foresee their presence (3.2.1.7), these buildings must conform with the guide lines that will be adopted in the successive design phases.

In all cases emergency lighting must be foreseen.

K) FIXED MESSAGE SIGNS

The type and location of signs with fixed messages giving directions, information or for safety and prohibition, shall conform to the specific instructions that will be used in successive design phases, as well as to the fire prevention signs according to the current national regulations.

L) VARIABLE SIGNS AND PUBLIC ADDRESS SYSTEM

The type and location of the signs for variable visual information (only for the main stations) and the public address system will conform to the specific instructions that will be assumed during successive design phases.

M) FURNISHINGS

These should foresee :

- Seats and ischiatic support for internal waiting areas (S.B.) according to the furnishing scheme, that should be equipped with armrests or dividing elements between seats and be attached to the floor with small fixtures

- Seats and ischiatric support for waiting areas under the cantilevered roof, according to the furnishing scheme, that should be attached to the floor with small fixtures.
- Seats in the external waiting area; further seating or benches could be foreseen in continuity with the architectural furnishing scheme.
- Rubbish bins (of the type for common or differentiated collection), coordinated with the urban furnishing scheme.
- Adverting furnishings: spaces allocated for advertising signs.

N) TURNSTILES THAT CONTROL ACCESS

The transport company may request the use of turnstiles in stations.

Therefore, in the configurations indicated in 3.2.1.7, suitable, protected spaces should be allocated for their eventual successive installation.

The turnstiles should be sufficient for the flow of passengers and, in any case, not less than 3 per access and 3 per exit of which one, in each direction, with the dimensions and characteristics suitable for disabled passengers in wheelchairs. The positioning of the turnstiles should not interfere with transit flow in an emergency or the entry of emergency vehicles.

O) FIRE PREVENTION

The typologies considered in the following 3.2.1.7., should foresee for fire prevention, all or part of the installations listed below, dimensioned according to a functional fire prevention design, emergency and evacuation plan.

1. inside the buildings and/or car parks, manual fire extinguishing systems, either fixed or portable, with a fire prevention hydraulic circuit;

2. inside the technological premises, manual fire extinguishing and local and remote fire alarm systems;

3. emergency and safety lighting systems;

4. signs indicating the fire fighting equipment, the escape routes and access for rescue and emergency vehicles;

5. Remote intercom system connected to the nearest control post, to raise the alarm.

P) ENERGY SAVING

In the situations where buildings are present, care must be taken to save energy through the following design interventions:

- Use and integration of bioclimatic technologies for energy supply (photovoltaic installations for the production of electricity and the use of solar heating for the production of hot water);
- Control of energy use through devices to limit consumption;
- Insulation with low conductivity materials, use of highly insulating materials, reduction of thermal bridges;
- Interventions to control in-coming radiation and shading in summer by creating a system of natural cross ventilation, by inserting windows on the opposite wall of the rooms, and doors with transom windows, shutters and sun screens.

Also for the cantilevered roofs, on the basis of their location in advantageous sunny conditions, they can be used in coordination with photovoltaic panels.

3.2.1.7 Dimensioning and Equipment of the Functional Elements for each Configuration and Access Typology

- Class 1A/1B/1C: Station with Low Frequency on a Single or Double Track
  - **Configuration 1 Access types A-B-C**

a. Inter-modal exchange area (point 3.2.1.6.2)

b. Side platform(s) with a continuous minimum width of 3.50m with suitable widening for waiting, access, stairs and ramp areas [4] and Island platform(s) with a continuous minimum width of 7,20 m (both to be increased in function of the safety factor according to the speed).

c. Cantilever roof partially covering the width of each platform and long enough to protect the fixed stairs and ramps (max 70.00m), with areas (in special climatic conditions) with side facings, equipped with seats, arrivals/departures notice board, lighting, loudspeaker system, rubbish bins.

d. Fencing and access gates.

e. Structures, routes and equipment accessible for handicapped passengers.

f. Tactile routes and maps for the blind

g. Fixed message signs.

h. Identification of station entrance with location name on the station building

i. Station Illumination.

j. Bicycle racks

k. CCTV according to specific programmes controlled from a command post.

l. Underpass (cases 1A and 1B) served by covered stairs and ramps or covered aerial footbridge (case 1C) served by covered stairs and ramps or rising platforms or elevators

m. Technological Building or part of the Station Building dedicated to equipment and premises for the railway operations, according to the requirements of the line and installations, agreed with the Management of the competent Operations and Infrastructures Departments. Usually premises are required for : Electricity supply, MT/BT, Generators, UPS, ACC Switchboards (Computerized Central Command Unit) or ACEI (Signalling Ralway Interlocking), Operations Manager (manned) + toilets, Signalling and Communication.

   On the basis of the equipment, the technological premises should include air conditioning systems, ventilation, fire detection and extinguishing systems.

   Indicatively, the area to be designed is approximately 120 - 200 sq.m.

n. Section of the Station Building containing:

   - Concourse-waiting area equipped with arrival/departure boards, notice and information bulletin boards, loudspeaker system, seating, rubbish bins, arrangements for ticket issue and stamping machines, arrangements for drink distributors.
   - Connections to successively install toilets and storage rooms

[4] *In the case when, for unavailability of extra area in respect of the platform limits (fencing edge), the stairs and ramps may be located inside the pavement area, these should be dimensioned with a suitably increased continuous width (ex. 5.00m), in order to satisfy the regulatory distances indicated in part III.1.3.1 (Minimum distance between yellow line and fixed obstacle).*

Overall area of approx. 80 sq.m (concourse-waiting area approx. 50 sq.m., toilets approx. 15 sq.m., storeroom approx. 15 sq.m).

➢ <u>Class 2A/2B/2C: Station on a Single of Double Track Line</u>

❖ **Configuration 2 Access types A-B-C**

a. Inter-modal exchange point (point III.1.2)

b. Side platforms(s) with a continuous minimum width of 3.50m with suitable widening for waiting, access, stairs and ramp areas [5] and Island platform(s) with a continuous minimum width of 7.20 m (both to be increased in function of the safety factor according to the speed).

c. Cantilever roof partially covering the width of each platform and long enough to protect the fixed stairs and ramps (max 70.00m), with areas (in special climatic conditions) with side facings, equipped with seats, arrivals/departures notice board, lighting, public address system, rubbish bins.

d. Fencing and access gates.

e. Structures, routes and equipment accessible for handicapped passengers.

f. Tactile routes and maps for the blind

g. Fixed message signs.

h. Identification of station entrance with location name in single letters on the station building

i. Station Illumination.

j. Bicycle racks covered by roofs

k. CCTV according to specific programmes controlled from command post.

l. Underpass (cases 2A and 2B) served by covered stairs and ramps or covered aerial footbridge (case 2C) served by covered stairs and ramps or rising platforms or elevators

m. Technological Building for equipment and premises for railway operations according to the requirements of the line and installations, agreed with the Managements of the Operations and Maintenance Departments

   Usually premises are required for : Electricity supply, MT/BT, Generators, UPS, ACC Switchboards or ACEI, Operations Manager (manned) + toilets, Signalling and Communication.

   On the basis of the equipment, the technological premises should foresee air conditioning systems, ventilation, fire detection and extinguishing systems.

   Indicatively, the area to be foreseen is between approx. 200 and 300 sq.m.

   As an alternative to the insertion of a Technological Building, the above premises can be contained in dedicated spaces located inside the Station Buildings, or if present for other needs, in the Auxiliary Service Buildings.

n. Station Building containing:

[5] *In the case when, for unavailability of extra area in respect of the platform limits, the stairs and ramps may be located inside the pavement area, these should be dimensioned with a suitably increased continuous width (ex. 5.00m), in order to satisfy the regulatory distances indicated in part III.1.3.1 (Minimum distance between yellow line and fixed obstacle).*

- Concourse-waiting area equipped with arrival/departure boards, LED notice and information bulletin boards, loudspeaker system, seating, rubbish bins, arrangements for ticket issue and stamping machines, arrangements for drink distributors, heating/air conditioning systems according to climatic conditions.
- Area, approx. 90 sq.m. (for locations with more than 1000 p/d, foresee a further 4sq.m every 100 p/d for the concourse-waiting area).
- Premises for the ticket office (back office, management and cash desk, dressing rooms and toilets), as requested and quantified by the Transport company, with air conditioning systems
- Area, indicatively 30 sq.m.

  - Arrangements for commercial units (bar, ticket seller, tobacconist, newspapers)
- Area, approx. 30 sq.m.

  - Toilets with access near the commercial unit.
- Area, approx. 30 sq.m.

  - Arrangements in turnstile area for access control to the pavements (only if requested by Transport company).
  - Storage rooms
- Area, approx. 30 sq.m.

➢ Auxiliary Services Building

Located according to operational necessities, to house functions and activities agreed with the Management of the Operations and Maintenance Departments.

Usually, premises and store rooms are requested for maintenance, checking, waiting rooms for mechanical staff and reserves, dining room, dressing rooms and toilets for personnel and suppliers, Police (Railway Police) offices, premises for technological equipment and others.

3.2.1.8 Method for the Requalification of the Existing Stations

In the overall picture of the requalification of the main existing stations of the Ghana Railway Network, besides what has already been stated for the design of the new stations, the following objectives should be followed:

- **Improvement** of the general imagine of the stations, intended as the link between the railway infrastructure and the urban reality with which they interact.
- **Redefinition** of the functional areas inside the Passenger Buildings, taking also the criteria of profitability into account.
- **Standardization** of some environments and support elements and recurrent furnishing schemes, relating to the services offered to the consumers and which, due to the changing functional needs and environmental quality, most require an architectural reorganization and re-examination (concourse, arrivals and departures, commercial areas, waiting rooms and areas; ticket office and toilets; lighting systems, loud speaker and public address system; the structures and regulations for overcoming the architectural barriers; railway signs, advertising and commercial signs; platform furniture.

- **Reconstruction** of those diffused and recognizable homogeneous characteristics that in the past distinguished the network stations and which, together with the station signs and the colour of the trains constituted the “Corporate identity” of the Railway Company.

Particular care must be given to the redefinition of the functional areas inside the Passenger Buildings, that should be sub-divided between:

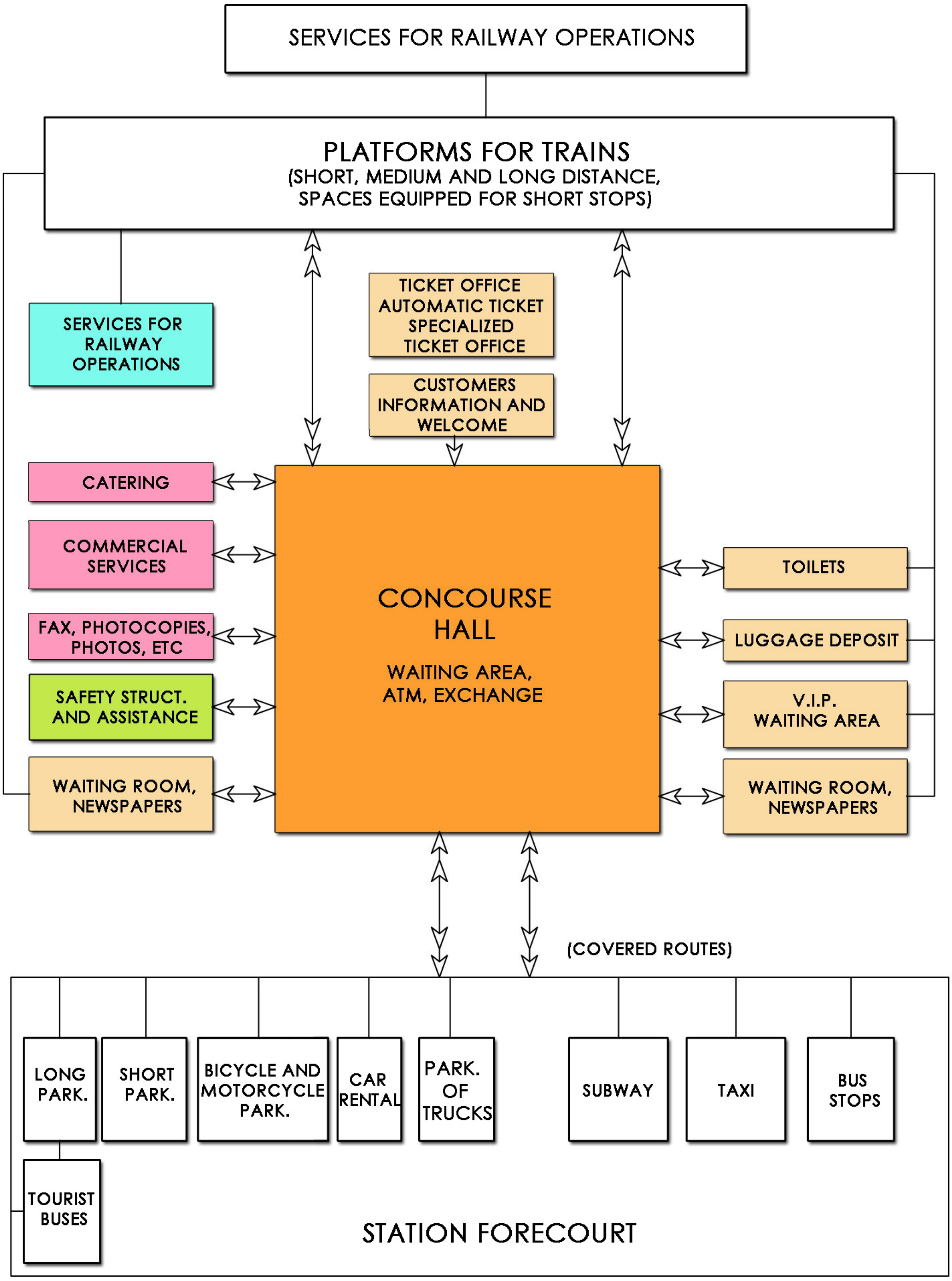
- Spaces and equipment in direct support of passengers (spaces relating to the arrival and departure of trains, boarding and disembarking of passengers; means and structures for the movement of passengers; means and structures for the movement and deposit of luggage; spaces and equipment for passenger information and directions; spaces and services for catering and toilets for the public).
    - The area dedicated to direct support is considered to be equal to 50% of the S.B.
- Indirect support spaces and equipment (commercial facilities, tourism agencies, offices, etc.). The area dedicated to indirect support is considered to be 30% of the S.B.
- Spaces and equipment for Railway Operations (offices; deposits; toilets for personnel; technical premises for transport operations; command centres; technological centres; technical premises for electro-mechanical installations; catering facilities for personnel.
    - The area dedicated to Railway Operations is considered to be 20% of the S.B.

Below are some examples of the functional distribution of activities inside the Passenger Buildings.

CONCOURSE HALL TYPOLOGIES AND AGGREGATIVE ANALYSIS OF COMPATIBLE ACTIVITIES

FUNCTIONS AGGREGATION SCHEME

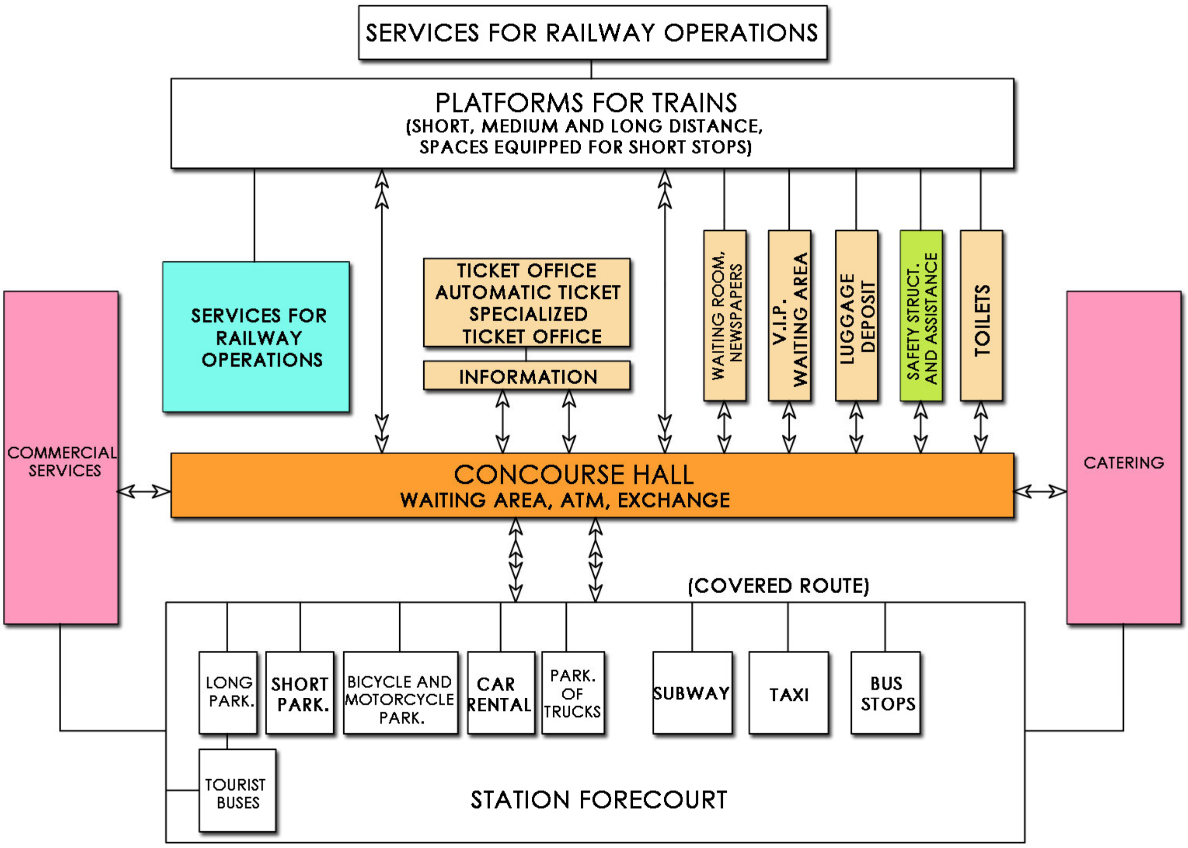
SCHEME A



CONCOURSE HALL TYPOLOGIES AND AGGREGATIVE ANALYSIS OF COMPATIBLE ACTIVITIES

FUNCTIONS AGGREGATION SCHEME

SCHEME B



3.3 TELECOMMUNICATIONS AND SIGNALLING

3.3.1 Communications

Wireless technology is the future of communication. Since 2005, throughout the world, wireless is exceeding wire line systems and the use of wireless communication is growing. This is due to the evolution of these technologies and the reduced prices due to the availability of components, large scale production and vendor competitiveness. Therefore, all over the world, any plans for the future must be based on wireless technology.

Of course, communication cannot be only radio, but an efficient network based on optic fibres must be used.

A railway network operation must rely on an efficient and complete range of information: voice, data services, ISDN services, video, signalling safe data, etc: all the stations long the line must be connected with a central dispatcher and between stations signal data and block information shall be exchanged in an efficient and reliable system.

The long distance system used today and available from different vendors, is based on SDH technologies .This system uses optical fibres to transmit digital data at different speeds, so that there are different solutions available, based on the total traffic requirements for any specific network.

The modularity of the system permits the configuration of the network and delivery of hardware with the best economical solution. A last but no less important aspect, is that the interfaces between the various levels of equipment are standardized, so that different vendors may supply any type of multiplex. This means competitiveness and lower prices.

In conclusion, Ghana Railway must install a complete long distance communication network laying optical cables along the railway lines with a minimum number of 16 fibres. (The fibres that are not used for the railway may be rented to telecommunication operators).

In each station long the line an optical regenerator shall be installed: the proper level (STM -4 is used for 622 Mbit/sec; STM-1 for 155 Mbit/sec ecc.) according to the bit rate used for data on the line and ADM multiplex used as terminal add/drop. The ADM must be able to have 100% capacity add/drop at a level of 2Mbit/s.

The 2 Mbit/sec is the lowest level of the hierarchy and shall be characterized by the possibility of greater flexibility in regard to the various types of hardware, so that different **data services** such as: G.703, 64 Kbit/sec , V24/V28,V35,X21/V11 etc., **ISDN services,** voice **Analog services** 2/4 wires, 2/4 wires leased line, 2–wire , 2-wire 25 Hz signalling must be provided.

Once the backbone, that is the SDH communication network, is installed is the right time to chose the wireless system based on radio communication. Railways in the past have used their own radio in the range of 457-467 MHz, according to a special frequency plan that is exclusive for railways. For a developing country, the use of such band and proprietary networks could, at the moment, be competitive versus a more modern technology, such as GSM.

More recently, the professional environment has undergone changes whereby, in many cases the old operational models are no longer applicable. This has meant that the operational requirements required from communication equipment have evolved and the traditional analogue service is no longer able to completely meet the users' needs. It is, therefore, appropriate that a more sophisticated service be made available to meet these needs. This raises the necessity for a technology enhancement that allows the PRM model (which, for many aspects, remains very attractive) to support the basic and enhanced features and facilities that existing and future users will require.

ETSI have made a specification named EN 360 390-1,2,3 for a new generation of digital PMR radio that is designated to operate within the existing channel rasters or spacing used in land mobile frequency bands in accordance with the ECC Decision on harmonized frequencies. The ETSI specification provides three tiers of DMR equipment:

- Tier I equipment is for the lowest-cost "digital PMR 446" application
- Tier II is for professional market offering peer-to-peer mode and repeater mode
- Tier III is for trunked operation.

The DMR (Digital Mobile Radio) over-the-air protocol from ETSI provides professional users in both the conventional (both single-site and multi-site) and systems (for example, trunking or multisite operation) markets, with the DMR protocol that has the following key characteristics over and above the existing features and facilities the users are familiar with:

→ Low signalling latency

→ Duplex speech where required, also enabling access to PTSN where desired

→ Reverse channel signalling to support the operation of applications during speech sessions

→ Selectable "politeness" channel access algorithms to avoid interference with currently established communications

→ Flexible arrangements for supplier choice of vocoder

→ Compatibility with the existing harmonized regulation for PMR licensed spectrum bands with no requirement to change them. Thus the spectrum planning may be continued unchanged

→ Possibility to apply improved battery saving technique

→ Capability for data transfers (consistent with narrow-band operation)

So DMR is now the best choice for future investment in a Radio Network, especially if the radio base station will adopt the multicast technology due to the lower cost, the multivendors available and the possibility to change from analogue to digital in steps. considering that the MS (Mobile station) are switched over from FM to digital. Moreover, DMR uses 12.5 KHz spacing and in one carrier allows communication of 2 channel at the same time.

DMR equipment is available from:

- Motorola
- Hytera
- Kirisun
- Selex Elsag
- Sepura
- Tait Communications

The price of a DMR Radio Network is actually 1/10 of the TETRA system, due to the fact that TETRA needs a wide band radio link to connect the BS, whereas DMR can be connected with a 2 Mbit channel using an IP protocol available from the SDH backbone.

Digital systems give the possibility of a soft, easy and seamless migration from analogue communication to a digital network. So professional Mobile Radio Users must chose for a future solution their own proprietary network, which may start with analogue technique but can evolve to the digital.

3.3.2 Signalling

A modern signalling system must guarantee safety, modularity and easy modification of the equipment following any changes of the rail (schematic plan of the stations). Today, relay-based interlocking has been abandoned due to the cost of the relays, that will increase year by year and the amount of work necessary to make the logic which is by cable connection of the various relays.

All over the world, for over 20 years, computer-based interlocking is used to renew old station equipment or for new stations. All the big signalling companies produce and install computer interlocking. Computer interlocking does not follow common specifications, so every vendor uses a proprietary design which, in general, has different modularity from other vendors. So when interlocking should be used for small stations, some signalling companies propose a centralised interlocking system, which operates distributed stations using the backbone communication network. This system is more economical than having single equipment, requires fewer staff and has the advantage of giving the performance of a CTC (Centralised Traffic Control) of the fail-safe type.

Regarding the Track Vacancy Detection, two systems are used: track circuits or axle counting.

Generally, track circuits are based on a phase relay working at 50 Hz or 25 Hz depending on the type of electrical traction system. Where industrial 50 Hz is used (16/25 KV) for locomotives, using relays working at 25 Hz avoids interference with the return traction current on the rail. For Ghana, where electrical traction is not projected, both types of relays (European type at 50 Hz or Asian working at 25 Hz) can be used. Of course, the 25 Hz type cannot use power at 50 Hz and so needs a proper generator, which could be more expensive.

Recently, different European signalling companies have designed an Axle Counting System which has a centralised equipment module that can control all the station tracks for small stations and also the line block with the adjacent stations. This new way of detecting vacancy of the track has the advantage of being immune to electrical interference, it does not require insulated joints on the rail and guarantees detection of the track circuits (secondary in the station), which could be rusty due to lack of use, and not guarantee detection from track relays.

As the signalling must also provide a line block, if an axle counting system is not used, it is necessary to use a semi-automatic block which requires that all the stations must be manned with a dispatcher because to give “line free”, the local dispatcher must control that a train entering the station has not lost any cars along the line.

In conclusion, the proposed solution consists of computer interlocking for the stations (single or multi-station), axle counting for vacancy detection of the station track and for the automatic block of the line.

Due to the maximum speed foreseen for the new network, a special radio system such as GSMR is not needed. Nevertheless, a radio system must be available to connect loco drivers to the dispatcher (centralised and local), for staff in the yard, for work on the line and for any operations which cannot be based on fixed telephone equipment.

This type of service may be provided, as said before, by using proprietary radio network on UHF railway band (457-467 MHz). The radio system may start as standard analogue FM or start with a new DMR Digital Network, because the cost for such modern technology is comparable with the old PMR analogue network.

For the Ghana Railway System, the use of TETRA is not suggested because it is more expensive and the performance of this system is not needed (the TETRA system was studied for the ETCS /train system level 2. The performance is similar to GSM).

3.4 ROLLING STOCK

3.4.1 Considerations on the Typical Train Size

Some assumptions have been made in the study concerning the transport capacity of the rail system.

These assumptions are related to the size of trains to be operated, in terms of maximum transport performance. The real transport flows will, in the real situation, be affected by a load factor, which can be estimated, as a realistic minimum, as 40-50% for passenger trains amd 60-70% for freight trains.

These load factors are mainly due, for passenger trains, to peak and off-peak hours (during the day) and peak and off-peak days (during the year); for freight trains this is mainly due to the need to also transport empty wagons during regular operations, as it is not realistic to think of transporting only loaded wagons.

Said that, in terms of transport capacity, the standard freight train has been assumed as a 2000 tons mass train, composed of 40 wagons and one (or two) locomotives, as described below. The standard passenger train has been assumed to have a formation of 12 coaches and one locomotive. In terms of maximum transport capacity, such a train is suitable for 1200 passengers.

3.4.1.1 Freight Trains

A freight train of 2000 tons total mass can be hauled by one diesel-electric locomotive with 20 tons/axle, AC/AC system (power inverter and asynchronous traction motors), with a power rate of around 3000 HP and CoCo type bogies (two bogies 3 motorized axles each) only on a flat railway line, at a maximum speed of around 100 km/h.

In the case that the railway line has some gradients with a length exceeding 1 km, it is necessary to utilize double traction.

This condition means two locomotives at the head of the train, with only one driver. The second locomotive is controlled by the driver of the first one, through a wired or radio remote control system.

Utilizing double traction, a freight train of 2000 tons total mass can be hauled at a speed of around 40 km/h on a 12 per thousand gradient.

For steeper gradients the speed is reduced to values normally not considered compatible with ordinary operations.

In this case three or more locomotives could be utilized, two at the head of the train and one at the tail (for more than three, one or more locomotives should be “interposed”). The alternative is to cut the train into smaller trains, for the steep gradient route.

The locomotive pushing the train from the back can be controlled by the driver of the first locomotive through a remote control using a radio system (i.e. Locotrol)

The total length of the freight train (40 wagons) is around 820 m in single traction and 840 m in double traction.

The stations and crossing points module required is, therefore, around 900 m length.

3.4.1.2 Passenger Trains

A passenger train with 12 coaches and 1 locomotive has a total mass of around 700 tons.

It is recommend to utilize the same type of locomotive as for freight trains, for standardization reasons.

This train can be hauled on a maximum gradient of 4 per thousand, at a maximum speed of around 100 km/h. On a 12 per thousand gradient the same passenger train can run at a speed of around 60 km/h.

For higher gradients or when a higher speed is required, it is necessary to utilize a double traction, in the same condition as per the freight trains.

The total length of the passenger train (12 coaches) is around 350 m in single traction.

3.4.2 Present Situation of Rolling Stock and Maintenance Facilities in General

3.4.2.1 Rolling Stock

On the basis of data collected and the surveys, the situation of the existing rolling stock can be summarized as follows.

Generally speaking, the situation is quite poor in terms of reliability, availability for operations and maintenance conditions.

From a technical point of view, most of the existing rolling stock is quite outdated, corresponding to a “state of the art” of around 25 years ago.

Only few locomotives (GM, Henschel and Alstom) are 6 axles, are less than 20 years old and have sufficient adherent mass for heavy freight trains.

GM and Henschel locomotives are, however. not very powerful, having around 1600 HP.

Alstom locomotives have around 2500 HP rated power.

Serious problems affecting fleet availability come from lack of spare parts and suitable maintenance tools and equipment. The skill of maintenance staff has been verified as being fairly adequate, but without proper spare parts and inadequate facilities; they cannot give much support to the train operations than they presently do.

Passenger coaches also need major maintenance interventions, especially the interiors and on-board equipment (lighting, toilets, doors, windows, etc…).

In the case of utilization for commuter and suburban services, these interventions could be simpler and less expensive, but for long distance services it is necessary to foresee major rehabilitation and refurbishment works.

A similar situation applies for wagons. The existing fleet is, in theory, formed by some hundred wagons, of 5 main types. A large part of them need, however, extensive repair and overhaul and cannot be currently available for operation.

3.4.2.2 Maintenance Depots & Workshops

The general impression concerning rolling stock maintenance infrastructures is that many plants exist, each of them on quite large areas, in terms of yards and buildings, with a size that far exceeds needs. This may be for “historical” reasons, dating back to a time when rail operations were more frequent and the rolling stock fleet (tractive and hauled) much more numerous.

Only some Depot and Workshop have been visited, but, on the basis of the surveys, our opinion is that a large part of them is outdated and in poor condition in terms of civil structures and industrial equipment, machinery, maintenance tools and spare parts availability.

Resources in general (equipment, staff, spare parts) seem therefore to be spread rather than concentrated in a few specialized sites.

3.4.3 Rolling Stock Improvement Options

Improvement options and relevant conditions have been considered for :

1. Refurbishment and/or Procurement of Main Line Locomotives
2. Refurbishment and/or Procurement of Passenger coaches
3. Rehabilitation and Modernization of Maintenance Depots & Workshops

As a general consideration, we can say again that the existing rolling stock fleet is quite old and in poor condition. For this reason, it can be estimated that for no more than half of the existing fleet is it convenient to foresee refurbishment works.

3.4.3.1 Improvement Options for Locomotives

➢ Refurbishment of Main Line Locomotives

All the existing locomotivess are around 20 years old or older.

A possible option, as an alternative to procuring new locomotives, is their refurbishment.

A complete refurbishment is expected to cost from US$700,000 to 1 million (around 1/3 to half the price of a new locomotive, depending on the equipment to be replaced or overhauled).

The complete refurbishment of a main line locomotive could include, as its main technical content:

→ Installation of a new diesel engine (more efficient in terms of fuel consumption and more environmentally friendly in terms of exhaust gases emissions)

→ Installation of a new electric main generator

→ General overhaul and upgrade of other major equipment, including
  - Bogie frame, wheelsets and transmission
  - Pneumatic and braking systems
  - Traction motors
  - Auxiliary systems
  - Driving cabs
  - Coupling system
  - Car body

The refurbishment could be carried out in Ghana, under a contract of technical assistance with the suppliers of the new equipment to be installed on the locomotives, with the supervision of a main contractor responsible for design and system integration.

The main contractor should propose as well supply tools and machinery for the workshop where the refurbishment will be carried out and training of the staff involved in the activities.

This option will permit the use of existing facilities and also employ and train local manpower, especially with the view for future maintenance needs.

The contract should also include a stock of spare parts suitable to guarantee support to the fleet for at least 3-4 years of operation.

In the case of refurbishment of existing locomotives, the option of purchasing power supply wagons (generators) to supply the air conditioning systems of new long distance passenger coaches should be considered.

For the refurbishment option, it is also necessary to take into account its effect on the current rail operations, which will be negatively affected by the reduction of available locomotives.

In fact, an intensive refurbishment programme would put at least 3 to 4 units out of service at the same time, considering a lead time for refurbishment of around 3 to 4 months

- Procurement or Leasing of New Main Line Locomotives

An alternative option to refurbishing existing locomotives is to purchase new locos on the international market.

This option is clearly more expensive, since the price of one such type of locomotive is between US$2 mln and 2.5 mln, depending on the type and quantity to be ordered.

It should be taken into consideration that new locomotives will be more efficient in terms of fuel consumption and exhaust emission and, in particular, they will be equipped with modern traction equipment, suitable to improve traction performance (with the same power rate) and reduce maintenance costs to half of the costs of a locomotive of the existing fleet, designed with AC/DC transmission (DC traction motors).

New locomotives should be equipped with:

→ AC/AC transmission, with microprocessor control per each axle

→ CoCo bogies

→ Asynchronous traction motors

→ Diesel engine with low emission exhaust system

→ Power rate around 3000 HP

→ Starting effort > 300 kN

→ Max speed 120 km/h

→ Max axle load 20 tons

It is recommended that the contract for procurement of new locomotives shall include technical assistance for at least the first year of operation, or better still, for three years.

The supplier should also propose and supply:

→ tools and machinery for maintenance

→ staff training

→ maintenance manuals

→ spare parts for three years operation

Another possible option could be the leasing of locomotives, at a price estimated at around 1000 USD per day, including running maintenance costs.

3.4.3.2 Refurbishment or Procurement of New Passenger Coaches

Existing coaches are not adequate, in terms of technical characteristics, comfort, interiors, facilities, etc. for long distance passenger services aimed at being competitive with road and air transport.

The condition of most of the existing coaches is not, in the Consultant's view, such to consider it a realistic option to refurbish them, so the only proposed option is the procurement of new coaches.

In case it is necessary to consider the option of refurbishment. it is quite clear that the achievable technical and passenger comfort level will not be, in terms of comfort, the same as a modern tourist bus.

Existing coaches could, however, be refurbished for operation in commuter services, where reduced travel times can be considered compatible with a lower level of equipment and interior fittings.

The cost of a new coach on the international market could be considered between 500,000 and 800,000 USD, depending on the on-board equipment and the quantity to be ordered.

Refurbishment can cost from 1/3 to a half, depending on the type of interventions.

Refurbishment could be carried out in Ghana, under a contract for technical assistance with the suppliers of the new equipment to be installed on the coaches, with the supervision of a main contractor responsible for design and system integration.

3.4.3.3 Refurbishment or Procurement of New Wagons

Existing wagons are, in general, in poor condition and need major works for the following main areas:

→ car body

→ bogie frame

→ wheelsets

→ brake system

→ coupling system

The cost of a new wagon on the international market could be considered between 50,000 and 100,000 USD, depending on the type of wagon; the lower price being for flat wagons and higher for tank wagons.

Refurbishment can cost from 1/3 to a half, depending on the type of intervention.

The refurbishment could be carried out in Ghana, under a contract for technical assistance with the suppliers of the new equipment to be installed on the wagons.

3.4.4 Rehabilitation of Maintenance Depots and Workshops

The concept of rolling stock maintenance facilities has to be revised on the basis of the fleet size and the type of operation (origin-destination of trains, number of passengers and freight trains, operating schedule, etc..)

Maintenance operations can be divided into three main levels, defined as follows.

Each level can be assigned to an equivalent level maintenance facility, to be appropriately located along the network.

Level 0	Servicing
Level 1	Depot Workshop Service and Maintenance
Level 2	Main Workshop Maintenance

Each of these levels requires different resources in terms of:

→ Organization

→ Skilled staff

→ Spare parts

→ Tools

→ Infrastructure facilities and equipment

The main characteristics of the three levels are described below.

3.4.4.1 Level 0 - Servicing (Station Areas)

Level 0 Servicing operations are normally carried out at each end of the train route

The operations can be done on station tracks on train arrival or before leaving, depending on service needs.

Level 0 operations require the availability of one or two technical operators, skilled for routine checks and controls and for minor repairs.

For minor maintenance operations, it is necessary to have available a small store for spare parts and consumables (i.e. lamps, relays, filters, etc..) and a kit of transportable tools.

Cleaning and restocking of on-board supplies are not to be considered the responsibility of the technical staff, but are normally carried out by a different team, equipped with specific equipment.

Refuelling of diesel locomotives is one of the tasks for Level 0 operations.

Main operations assigned to Level 0 Servicing are the following:

→ Restocking of onboard supplies

→ Technical checks (on track)

→ Functional controls by driver's cab

→ Low level repairs and small parts replacement (in case of need)

→ Interior cleaning

→ Windscreen cleaning

3.4.4.2 Level 1 - Depot Workshop Service and Maintenance

Level 1 Service and Maintenance operations are normally carried out every three or four weeks or on a km basis.

The operations are normally done in a Depot Workshop, on the basis of a schedule defined by the train management staff according to the maintenance manual and the train operating conditions.

Level 1 operations require the availability of a specialized Depot Workshop, located in a suitable area possibly close to a train terminal station.

The **Depot Workshop** shall be equipped with the following main facilities:

→ Parking tracks

→ Rolling stock external and underframe washing installation

→ Equipment for cleaning, washing and restoring coach toilets

→ Shed equipped with tracks specialized in rolling stock interior deep cleaning. The shed shall be equipped with electric power, water, compressed air, aspiration system, internal transport system…

→ Shed equipped with tracks for rolling stock maintenance and components replacement. The shed shall be equipped with electric power, water, compressed air, aspiration system, internal transport system, cranes, ordinary and special equipment and tools

→ Shed equipped with tracks specialized for rolling stock checkout and final testing

→ Shed (or part of a shed) dedicated to storage of spare parts and components in stock and to be sent to main workshop for major repair

Some of the Depots of the network shall have an underfloor wheel lathe, for reprofiling wheels without removing the wheelsets from the vehicle. The quantity and location of this equipment depends of the fleet size and the railway network extension.

Level 1 operations require the availability of a complete technical staff, skilled for checks, controls, ordinary scheduled preventive maintenance, components replacement and repairs.

Administrative and Management Staff are also necessary.

Cleaning is not to be considered the responsibility of the technical staff, but is normally carried out by a different team, equipped with specific equipment.

The main operations assigned to Level 1 **Service and Maintenance** are the following:

→ Interior deep cleaning

→ External and underframe complete washing and cleaning

→ Toilet treatment and restore to service (clean water tanks refilling)

→ Restocking of onboard supplies

→ Locomotive complete refuelling (including sand, windscreen water, oil, ….)

→ Technical checks (to be done on track with central pit)

→ Functional controls by driver’s cab

→ Repair and parts replacement (when necessary)

→ Wheelsets grinding (when necessary)

→ Wheelsets and bogies replacement (when necessary)

→ All the Preventive maintenance scheduled for Level 1 operations (tasks and their frequency are according to the maintenance manual)

3.4.4.3 Level 2 – Main Workshop Maintenance

Level 2 Maintenance operations are normally carried out in a specialized workshop,

Two main types of intervention are carried out in the workshop:

→ Preventive heavy maintenance interventions

→ Components overhaul and repair

Preventive heavy maintenance operation frequency and their technical content are defined in the maintenance manual. Normally, the main workshop performs the complete overhaul and refurbishment of the different types of rolling stock (locomotives, passenger coaches, wagons) and their components.

Components overhaul and repair is done for the Main Workshop itself and for the Depots. When a component has to be stripped in a depot because of a serious breakdown, it is sent to the workshop for repair and return.

A serious breakdown means a breakdown requiring special equipment and staff specialized in the component disassembly, fault isolation and repair.

Level 2 operations require the availability of a specialized workshop, serving the entire rolling stock fleet and located in a suitable area connected to the line where the trains operate.

The **Main Workshop** shall be equipped with the following main facilities:

- → Parking tracks
- → Rolling stock external and underframe pressure washing installation
- → Equipment for treatment, washing and restore toilets
- → Bogie replacement installation (for single bogie and for all the bogies of a vehicle)
- → Shed equipped with tracks specialized for train coupling and uncoupling
- → Shed equipped with tracks specialized for rolling stock final testing
- → Shed equipped with tracks for rolling stock maintenance and components replacement. The shed shall be equipped with electric power, water, compressed air, aspiration system, internal transport system, cranes, ordinary and special equipment and tools
- → Sheds (or areas of a shed) dedicated to the revision and repair of stripped components. The areas shall be equipped with electric power, water, compressed air, dust and smoke aspiration system, internal transport system, cranes, ordinary and special equipment and tools, welding equipment, components painting equipment, complete vehicle body sanding and painting equipment, work benches, machine tools, testing facilities, wheels disassembling and assembling, axles machining and testing, traction motors rewinding, gearboxes repair, brake system components control and repair, axle boxes control and repair, suspension components and dampers control and repair, signaling and safety on board systems control and repair, bogie frame control and repair, ….
- → Shed dedicated to storage of spare parts and components in stock and to be sent back to Depot Workshops following major repair.

Level 2 operations require the availability of a complete technical staff, skilled for checks, controls, ordinary scheduled preventive maintenance, components replacement and repairs.

An Administrative and a Management staff is also necessary.

The **main operations** assigned to Level 2 Maintenance are the following:

- → Repair of broken down components sent to the Main Workshop by the Depots
- → General overhaul of rolling stock
- → Car body heavy repair and re-painting
- → Electrical, pneumatic and hydraulic systems overhaul and parts replacement
- → Wheels and axles disassembling and replacement
- → Bogies disassembling and overhaul
- → Traction motors and gears disassembling and overhaul
- → Air compressor disassembling and overhaul
- → Main electrical machines and components disassembling and overhaul
- → Toilets overhaul
- → All the Preventive heavy maintenance scheduled operations on rolling stock and single components (different levels and frequency, according to the maintenance manual)

On the basis of the above described maintenance of the rolling stock, the various types of workshops necessary for the three levels of maintenance of the fleet forecasted for both the rehabilitated lines (Phase 1) and all the new lines, have been positioned along the lines (see Figures 3 – 2 and 3 - 3)

Figure 3 - 2 Locations for Maintenance of Rehabilitated Narrow Gauge Rail Lines

Figure 3 - 3 Location for Maintenance of both Rehabilitated and New Rail Lines

4. TRAFFIC SIMULATIONS

4.1 INTRODUCTION

The traffic volumes simulations for freight and passengers have been operated through the ***TransCAD*** model (see Chapter 6 of Annex 1), assigning the freight and passenger transport demand (ITP O/D matrices) on the Multi-modal graph. In particular the ITP matrices have been updated with additional information (see transport demand forecast in Chapter 5), while, for lack of project data, the Volta Lake transport is supposed in the future to absorb the entire traffic in petroleum products, which is excluded from the present ITP matrices.

The Assignment model assigns traffic flows between Origins and Destinations according to minimum generalized cost of transport, which includes transport operating costs and time spent along the routes. It is assumed that cargo and passengers will chose the most convenient route from the cost and time point of view. The transport cost for freight and passenger on road and railway are shown in Chapter 5.

As indicated in Chapter 2, the Master Plan Project phases adopted are the following:

- **Phase 0: Without Project Scenario:** Cargo & Passengers**;**
- **Phase 1: Rehabilitation of Existing lines NG:**
  - 1W Western line:
  - 1E Eastern line;
- **Phase 2: Central Spine Expansion SG:**
  - 2W Western line,
  - 2E Eastern line
  - 2C Kumasi-Paga line;
- **Phase 3 - Transversal Expansions SG:**
  - 3.1 Tamale – Yendi,
  - 3.2 Fufulsu - Sawla,
  - 3.3 Techiman - Kwadwokurom,
  - 3.4 Nyinahin - Kumasi;
- **Phase 4 - Trans-ECOWAS Expansion SG: Aflao-Accra-Takoradi-Omanpe line;**
- **Phase 5 – Western Expansion SG: Dunkwa-Awaso-Hamile line;**
- **Phase 6 – Eastern Expansion SG:** Tema-Yendi-Tamale line.

In order to establish the priority of each of the possible rail project to be included in the Master Plan, a preliminary assignment of all the phases and sub-phases has been operated at year 2015, assigning the freight and passenger transport demand and comparing these simulations with the "without project" scenarios. Sub-phases 1W and 1E of the rehabilitation of existing lines and sub-phases 2W and 2E of the Central Spine Expansion have been analyzed and assigned as independent projects, while, starting with the phase 2C Kumasi – Paga, all the other phases and sub-phases have been analyzed as incremental projects to the previous phases. On the basis of the preliminary assignments at year 2015, the Optimal Opening Year (OOY) has been determined for each phase or sub-phase (see implementation programme…).

Main traffic simulation at national level has been then operated midway of the Master Plan period (year 2030), when the Central Spine Expansion is supposed to enter in operation.

The last main traffic simulation has been made at the conclusion of the MP period at year 2047, when the phase 6 (Eastern Expansion) will enter into operation.

Following are the detailed traffic volume simulations for year 2015, 2030 and 2047 for cargo and passengers, in accordance with the various phases and sub-phases established. Cargo traffic are presented as annual traffic volume, weighted average on the length of the corridors, while the passenger traffic are presented as daily weighted averages for each corridor.

4.2 PRELIMINARY TRAFFIC SIMULATIONS AT YEAR 2015

4.2.1 Without Project Scenario

The Without Project scenario represents the volumes of traffic that will happen along the road system of Ghana at year 2015, in absence of any railway project. Following are the results of the traffic assignments "without project" both ways for Freight and Passengers at year 2015 along the main road corridors of the country, parallel to the railway projects under study:

- **Freight**

Below are shown, both as a graph and relevant quantities table, the freight traffic flows along the main road corridors, parallel to the railway projects in the "without project" scenarios.

Figure 4 - 1 Freight Traffic 2015 – Without Project

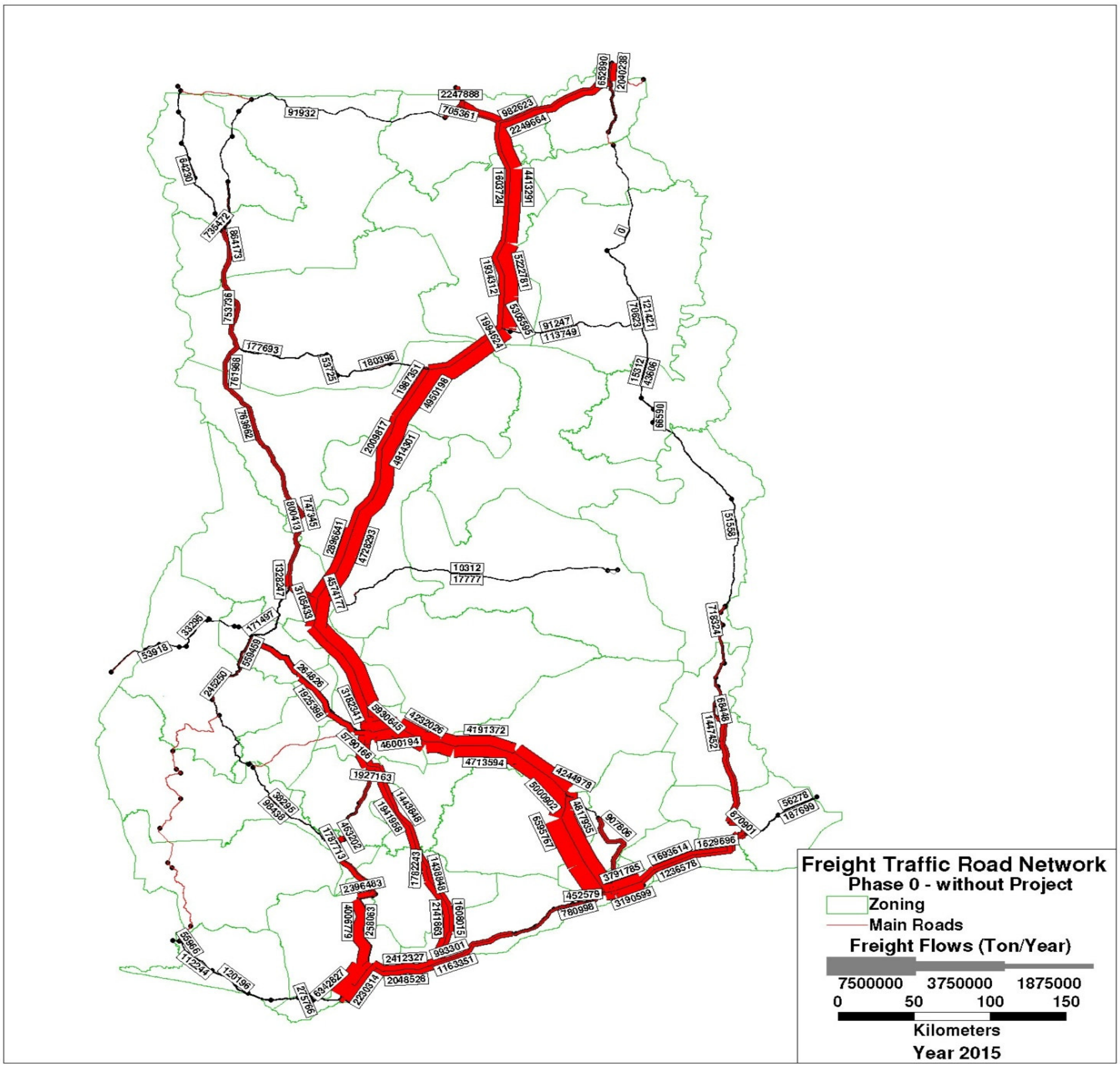


Table 4 - 1 Freight Traffic Flows – Year 2015

MAIN ROADS CORRIDORS	LENGTH (km)	FREIGHT Average Northbound (Ton)	Southbound (Ton)	Total (Ton)
Western	470	2,181,011	1,288,037	***3,469,049***
Eastern	376	3,666,797	3,431,464	***7,098,261***
Kumasi - Paga	584	2,885,086	3,876,616	***6,761,702***
Ecowas Corridor	411	627,463	871,650	***1,499,113***
Western Expansion	568	752,765	573,882	***1,326,647***
Eastern Expansion	603	236,913	358,124	***595,037***
Transversal 1 – Tamale-Yendi	99	20,030	86,655	***106,685***
Transversal 2 – Fufulsu-Sawla	146	36,482	105,432	***141,914***
Transversal 3 – Techiman-Kwadwokurom	224	17,777	10,312	***28,089***
Transversal 4 – Nyinahin-Kumasi	78	16,980	29,645	***46,625***

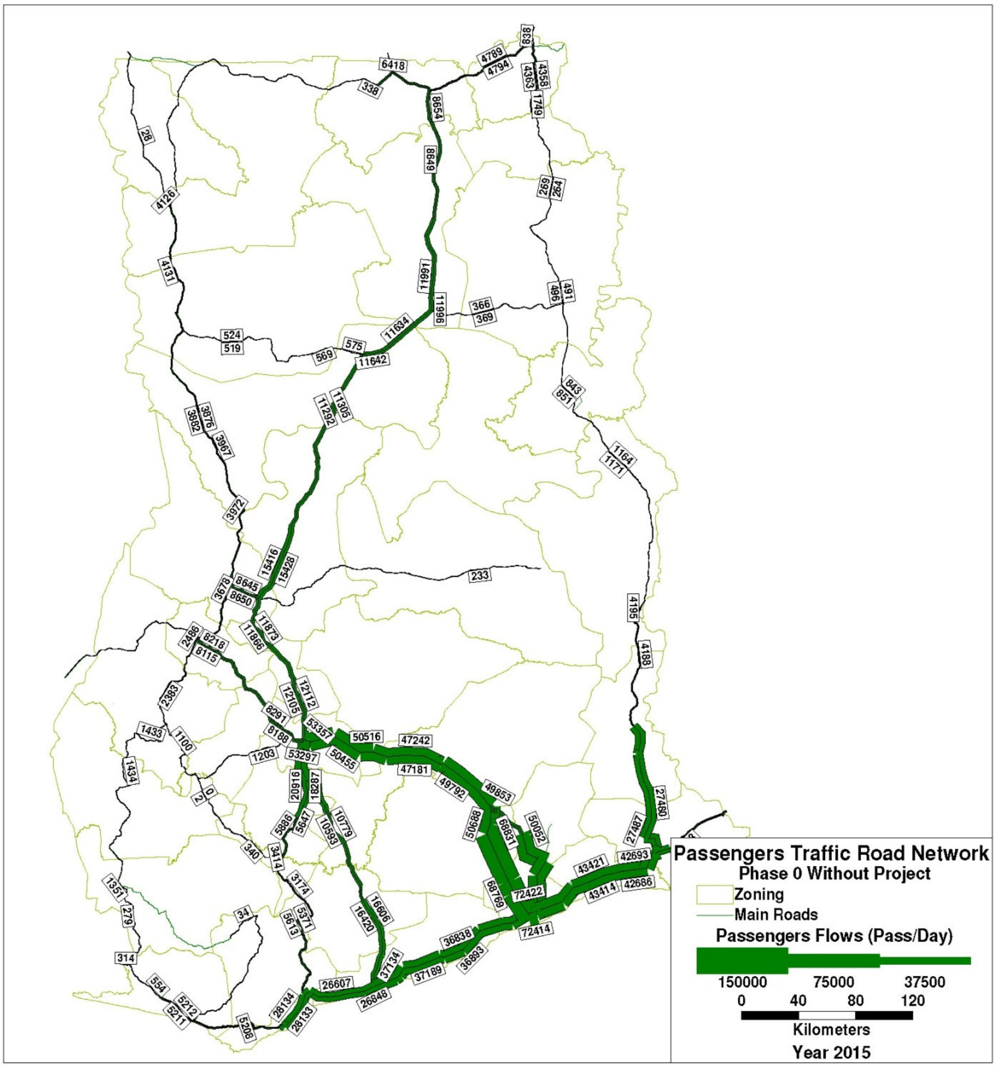
❖ Passengers

Below are shown the passengers traffic flows along the main road corridors, parallel to the railway projects in the "without project" scenarios.

Table 4 - 2 Passengers/day Traffic Flows – Year 2015

MAIN ROADS CORRIDORS	LENGTH (km)	PASSENGERS Average		
		Northbound (Pass/Day)	Southbound (Pass/Day)	Total (Pass/Day)
WESTERN	470	14,517	14,815	***29,332***
EASTERN	376	50,035	50,009	***100,044***
KUMASI PAGA	584	11,029	11,033	***22,062***
ECOWAS CORRIDOR	411	23,004	23,001	***46,006***
WESTERN EXPANSION	568	3,988	3,995	***7,983***
EASTERN EXPANSION	603	6,160	6,159	***12,319***
TRANSVERSAL 1 – TAMALE-YENDI	99	369	367	***735***
TRANSVERSAL 2 – FUFULSU-SAWLA	146	322	326	***648***
TRANSVERSAL 3 – TECHIMAN-KWADWOKUROM	224	233	233	***465***
TRANSVERSAL 4 – NYINAHIN-KUMASI	78	1,102	1,203	***2,306***

Figure 4 - 2 Passengers Traffic 2015 – Without Project



In the "without Project" scenario, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 3.5 million tons/year and about 30,000 passengers/daily;
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 7.0 million tons/year and about 100,000 passengers/daily;
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 6.7 million tons/year and 22,000 passenger/day;
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.5 million tons/year and 46,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla is around 150,000 tons/year and 700 passengers/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 1.3 million tons/year and 8,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.6 million tons/year and 12,500 passengers/day.

4.2.2 Phase 1 - Rehabilitation of Existing NG Lines

Phase 1 is the combination of the rehabilitation of the existing lines NG of the Western and Eastern railways.

❖ **1W – Western NG line**

Following are the results of the traffic assignments for Cargo and Passengers at year 2015 for the Western Railway NG. In the case of rehabilitation of the Western NG line, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 2.4 million tons/year and about 26,000 passengers/daily. The new railway will absorb 2.0 million tons/year and 6,000 passengers/day. The rehabilitation of the Western line NG is able to divert 1.1 million tons from the parallel road corridor and attract 0.9 million tons from other itineraries, while for passengers the new railway line attracts 4,000 passengers from the parallel road and 2,000 from other road itineraries.
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 7.0 million tons/year and about 100,000 passengers/daily;
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 6.7 million tons/year and 22,000 passenger/day;
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.3 million tons/year and 46,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla is around 150,000 tons/year and 700 passengers/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 1.3 million tons/year and 8,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.6 million tons/year and 12,500 passengers/day.

Table 4 - 3 Freight – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	1,474,657	903,439	***2,378,096***	487,582	1,518,666	2,006,248
Eastern	3,626,423	3,400,143	***7,026,567***	0	0	0
Kumasi Paga	2,885,086	3,880,637	***6,765,723***	0	0	0
Ecowas Corridor	642,838	678,554	***1,321,392***	0	0	0
Western Expansion	735,376	560,281	***1,295,657***	0	0	0
Eastern Expansion	236,913	358,124	***595,037***	0	0	0
Transversal 1 – Tamale-Yendi	20,030	86,655	***106,685***	0	0	0
Transversal 2 – Fufulsu-Sawla	36,482	105,432	***141,914***	0	0	0
Transversal 3 – Techiman-Kwadwokurom	17,777	10,312	***28,089***	0	0	0
Transversal 4 – Nyinahin-Kumasi	29	775	***804***	0	0	0

Figure 4 - 3 Freight Traffic 2015 – Phase 1W Western Railway Project

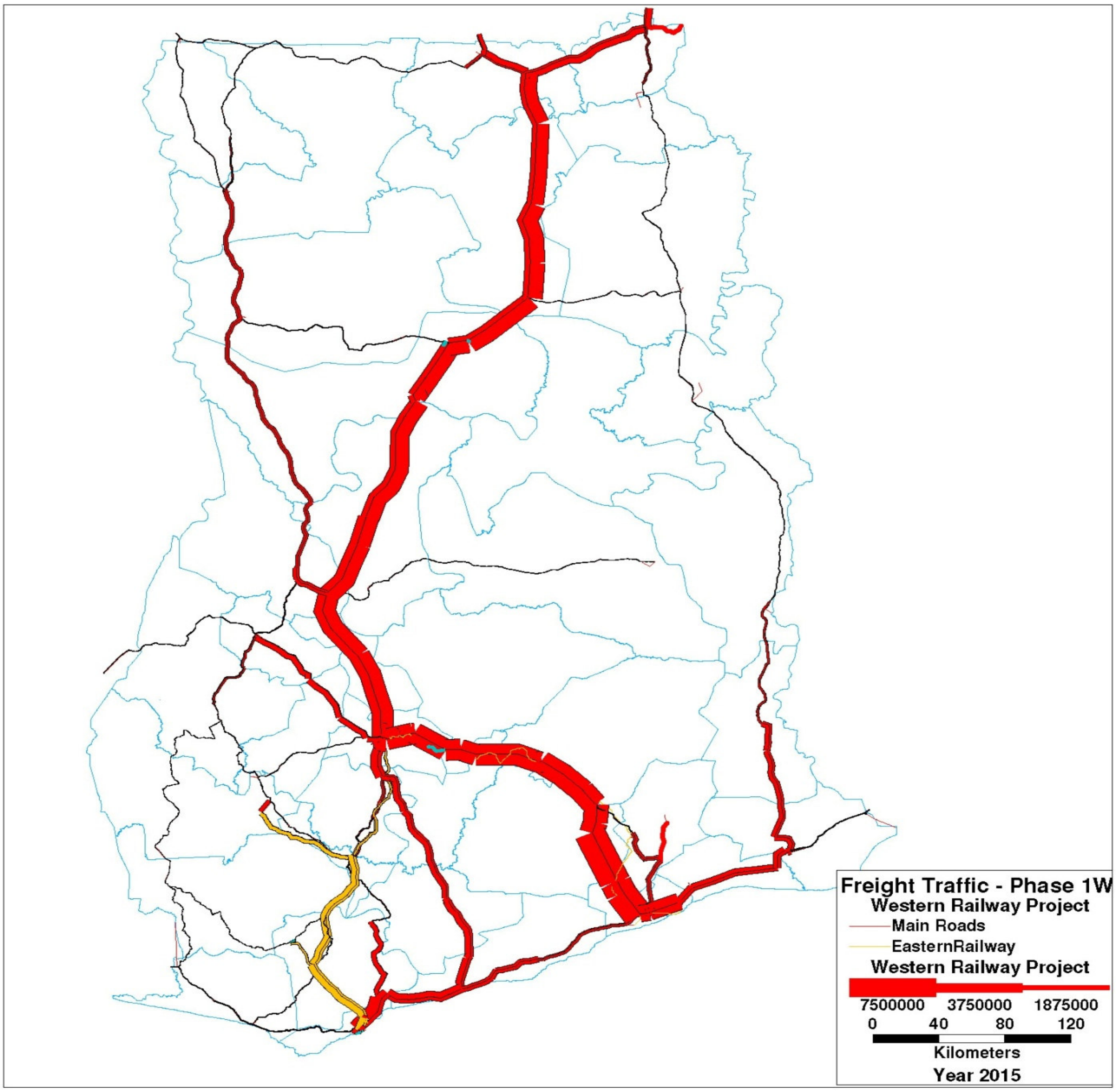
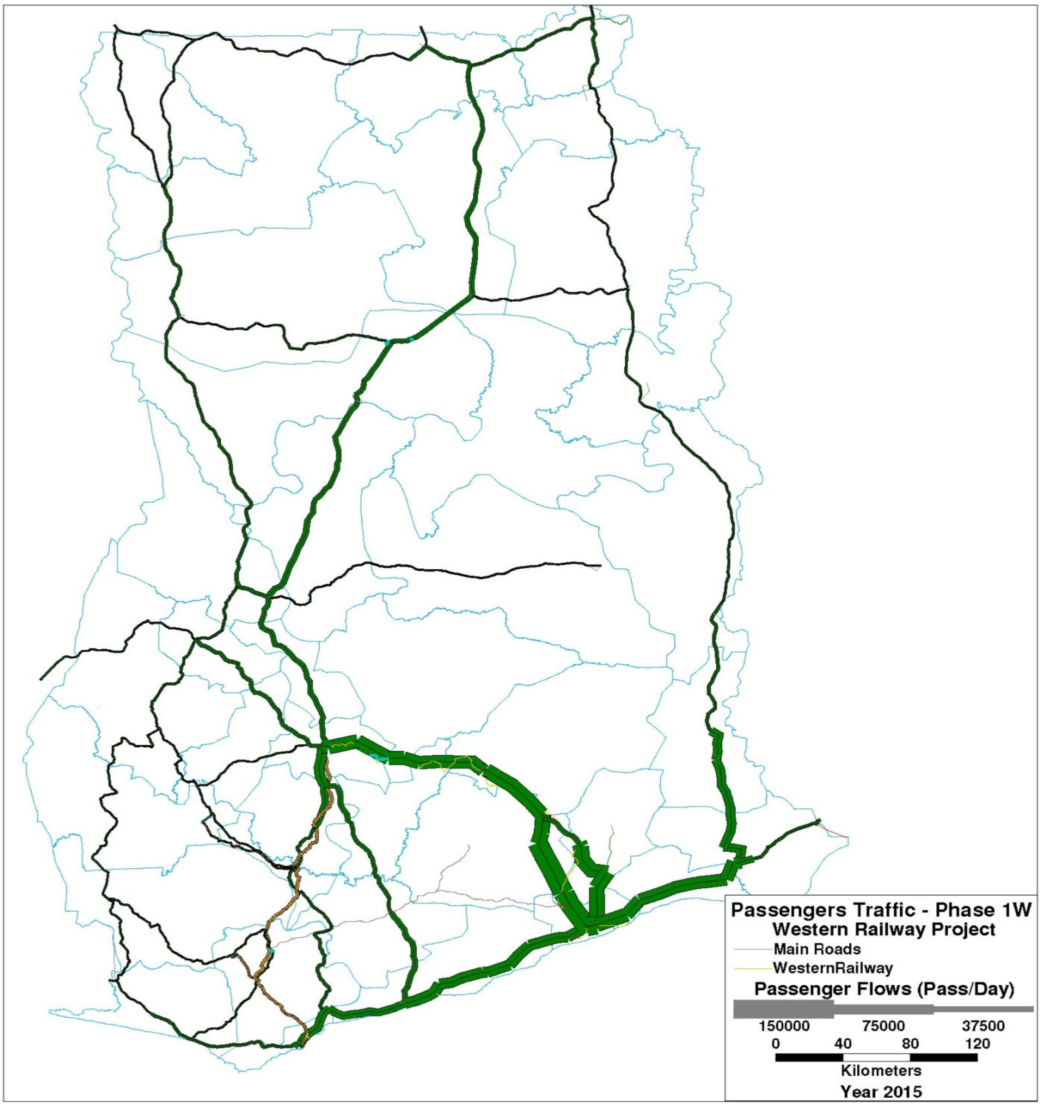


Table 4 - 4 Passengers – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	ToT. Average (Pass/Day)
WESTERN	12,840	13,176	26,016	2,960	3,006	5,967
EASTERN	49,981	49,945	99,926	0	0	0
KUMASI PAGA	11,032	11,037	22,069	0	0	0
ECOWAS CORRIDOR	22,952	22,952	45,904	0	0	0
WESTERN EXPANSION	3,952	3,959	7,911	0	0	0
EASTERN EXPANSION	6,160	6,159	12,319	0	0	0
TRANSVERSAL 1 – TAMALE-YENDI	369	367	735	0	0	0
TRANSVERSAL 2 – FUFULSU-SAWLA	322	326	648	0	0	0
TRANSVERSAL 3 – TECHIMAN-KWADWOKUROM	233	233	465	0	0	0
TRANSVERSAL 4 – NYINAHIN-KUMASI	0	103	103	0	0	0

Figure 4 - 4 Passengers Traffic 2015 – Phase 1W Western Railway Project



❖ **Eastern NG Railway**

Following are the results of the traffic assignments for Cargo and Passengers at year 2015 for the Eastern Railway NG

In the case of rehabilitation of the Eastern NG line, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 3.5 million tons/year and about 30,000 passengers/daily
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4 Accra – Koforidua then Kumasi present a weighted average of about 6.0 million tons/year and about 63,000 passengers/daily. The new railway will absorb 1.6 million tons/year and 54,000 passengers/day. The rehabilitation of the Eastern line NG is able to divert 1.0 million tons from the parallel road corridor and attract 0.6 million tons from other itineraries, while for passengers the new railway line attracts 37,000 passengers from the parallel road and 17,000 from other road itineraries.
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 6.7 million tons/year and 22,000 passenger/day;
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.3 million tons/year and 46,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla is around 140,000 tons/year and 700 passengers/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 1.3 million tons/year and 8,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.6 million tons/year and 12,500 **passengers**/day.

Figure 4 - 5 Freight Traffic 2015 – Phase 1E Eastern Railway Project

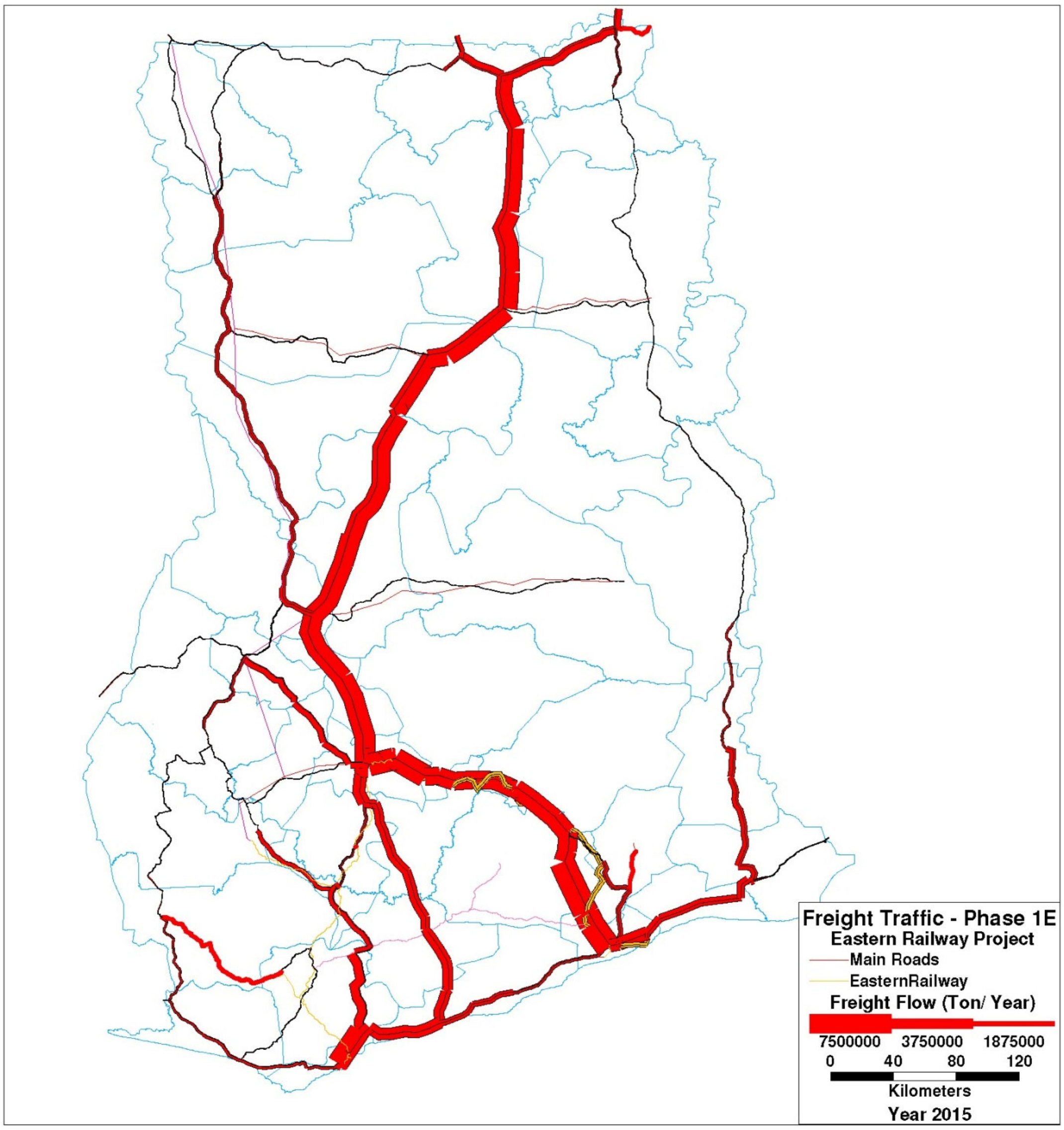


Table 4 - 5 Freight – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	2,180,863	1,288,024	3,468,887	0	0	0
Eastern	3,133,634	2,878,991	6,012,625	772,259	848,886	1,621,146
Kumasi Paga	2,885,086	3,876,615	6,761,702	0	0	0
Ecowas Corridor	627,331	871,549	1,498,880	0	0	0
Western Expansion	752,765	573,882	1,326,647	0	0	0
Eastern Expansion	236,912	358,125	595,037	0	0	0
Transversal 1 – Tamale-Yendi	20,030	86,656	106,685	0	0	0
Transversal 2 – Fufulsu-Sawla	36,482	105,432	141,914	0	0	0
Transversal 3 – Techiman-Kwadwokurom	17,777	10,312	28,089	0	0	0
Transversal 4 – Nyinahin-Kumasi	16,980	29,645	46,625	0	0	0

Figure 4 - 6 Passengers Traffic 2015 – Phase 1E Eastern Railway Project

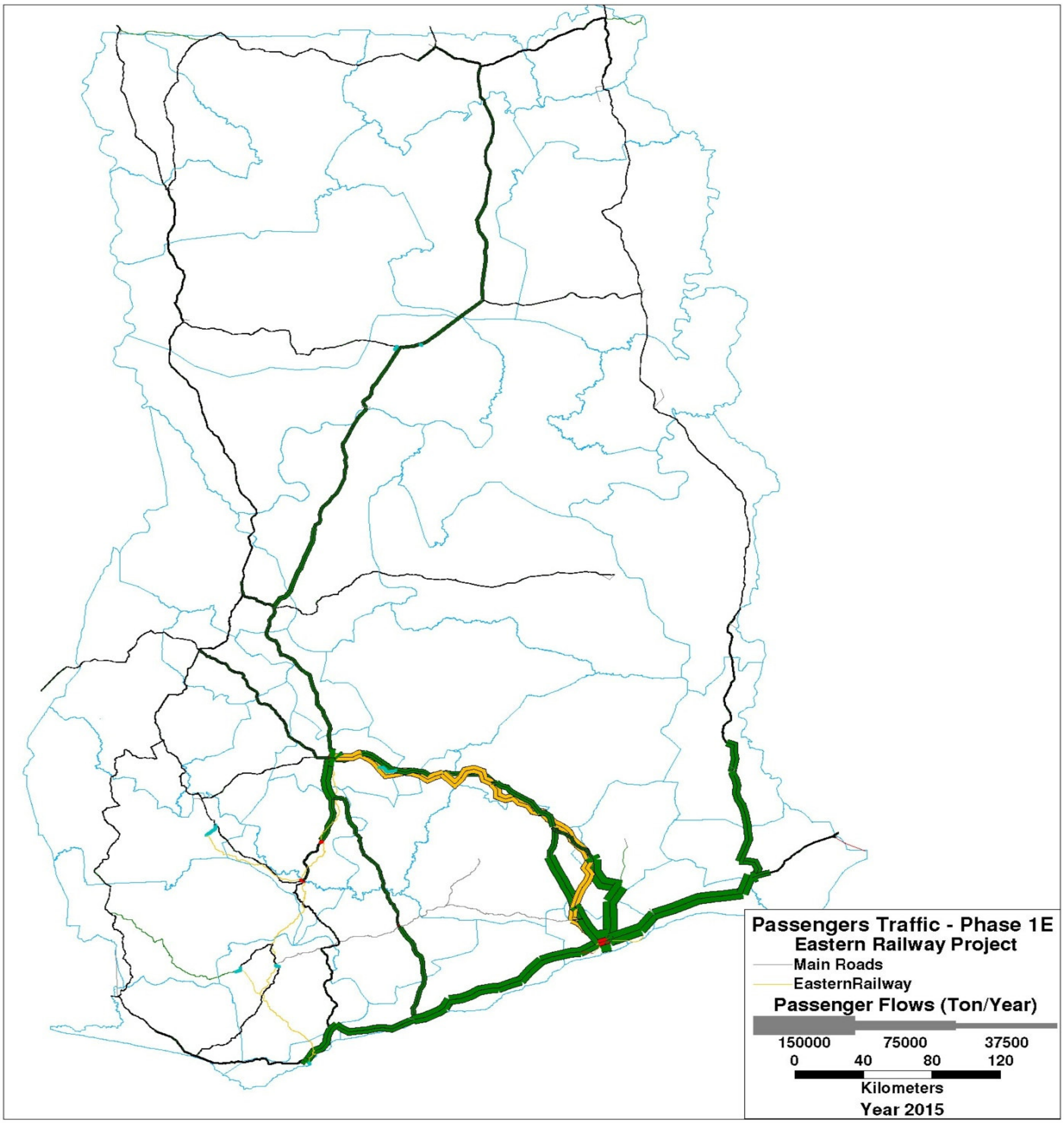


Table 4 - 6 Passengers – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	14,507	14,814	29,321	0	0	0
Eastern	31,709	31,655	63,364	26,872	26,883	53,755
Kumasi Paga	11,062	11,067	22,130	0	0	0
Ecowas Corridor	22,987	22,986	45,972	0	0	0
Western Expansion	3,988	3,994	7,983	0	0	0
Eastern Expansion	6,124	6,122	12,246	0	0	0
Transversal 1 – Tamale-Yendi	381	373	754	0	0	0
Transversal 2 – Fufulsu-Sawla	322	325	648	0	0	0
Transversal 3 – Techiman-Kwadwokurom	233	233	465	0	0	0
Transversal 4 – Nyinahin-Kumasi	1,102	1,203	2,306	0	0	0

Phase 1 Rehabilitation of Existing NG Lines

Considering the Phase 1 as the combination of rehabilitation NG of the Western plus Eastern railways, the results of the traffic assignments for Cargo and Passengers at year 2015 are similar to the sum of the previous ones but additional traffic due to the combined effect on the rail network.

In the case of rehabilitation of the Western and Eastern NG lines, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 2.1 million tons/year and about 25,000 passengers/daily. The new Western railway will attract 2.0 million tons/year and 5,000 passengers/daily.
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 6.0 million tons/year and about 78,000 passengers/daily. The new railway will absorb 2.0 million tons/year and 40,000 passengers/day.
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 6.7 million tons/year and 24,000 passenger/day;
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.2 million tons/year and 46,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla is around 150,000 tons/year and 700 passengers/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 1.3 million tons/year and 8,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.6 million tons/year and 12,500 passengers/day.

Figure 4 - 7 Freight Traffic 2015 – Phase 1

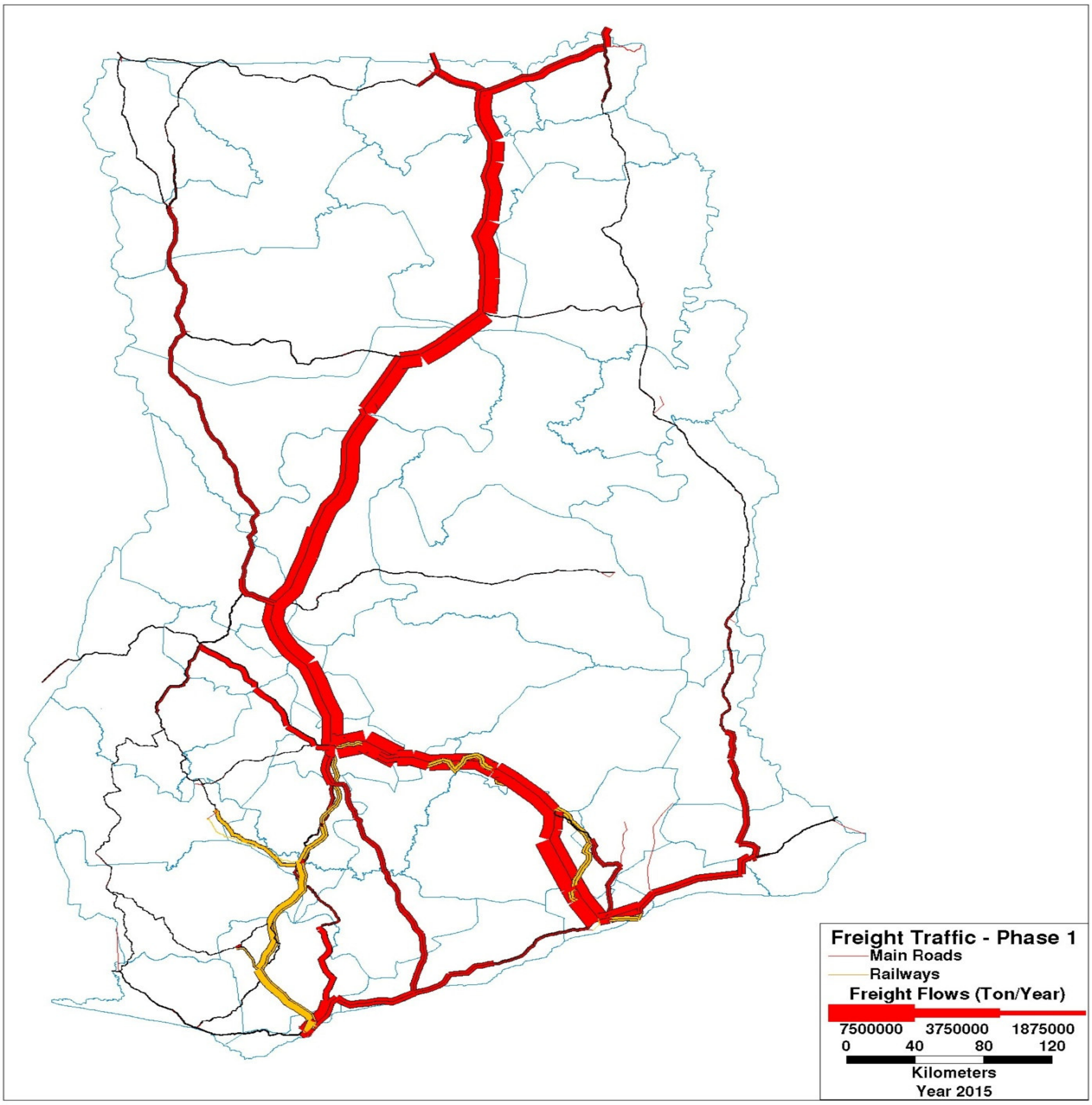


Table 4 - 7 Freight – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
WESTERN	1,268,879	818,129	2,087,008	603,978	1,354,668	1,958,647
EASTERN	3,145,195	2,889,385	6,034,580	996,382	1,050,437	2,046,818
KUMASI PAGA	2,885,086	3,880,637	6,765,723	0	0	0
ECOWAS CORRIDOR	610,814	652,342	1,263,156	0	0	0
WESTERN EXPANSION	742,910	565,712	1,308,621	0	0	0
EASTERN EXPANSION	236,913	358,124	595,037	0	0	0
TRANSVERSAL 1 – TAMALE-YENDI	20,030	86,655	106,685	0	0	0
TRANSVERSAL 2 – FUFULSU-SAWLA	36,482	105,432	141,914	0	0	0
TRANSVERSAL 3 – TECHIMAN-KWADWOKUROM	17,777	10,312	28,089	0	0	0
TRANSVERSAL 4 – NYINAHIN-KUMASI	0	853	853	0	0	0

Figure 4 - 8 Passengers Traffic 2015 – Phase 1

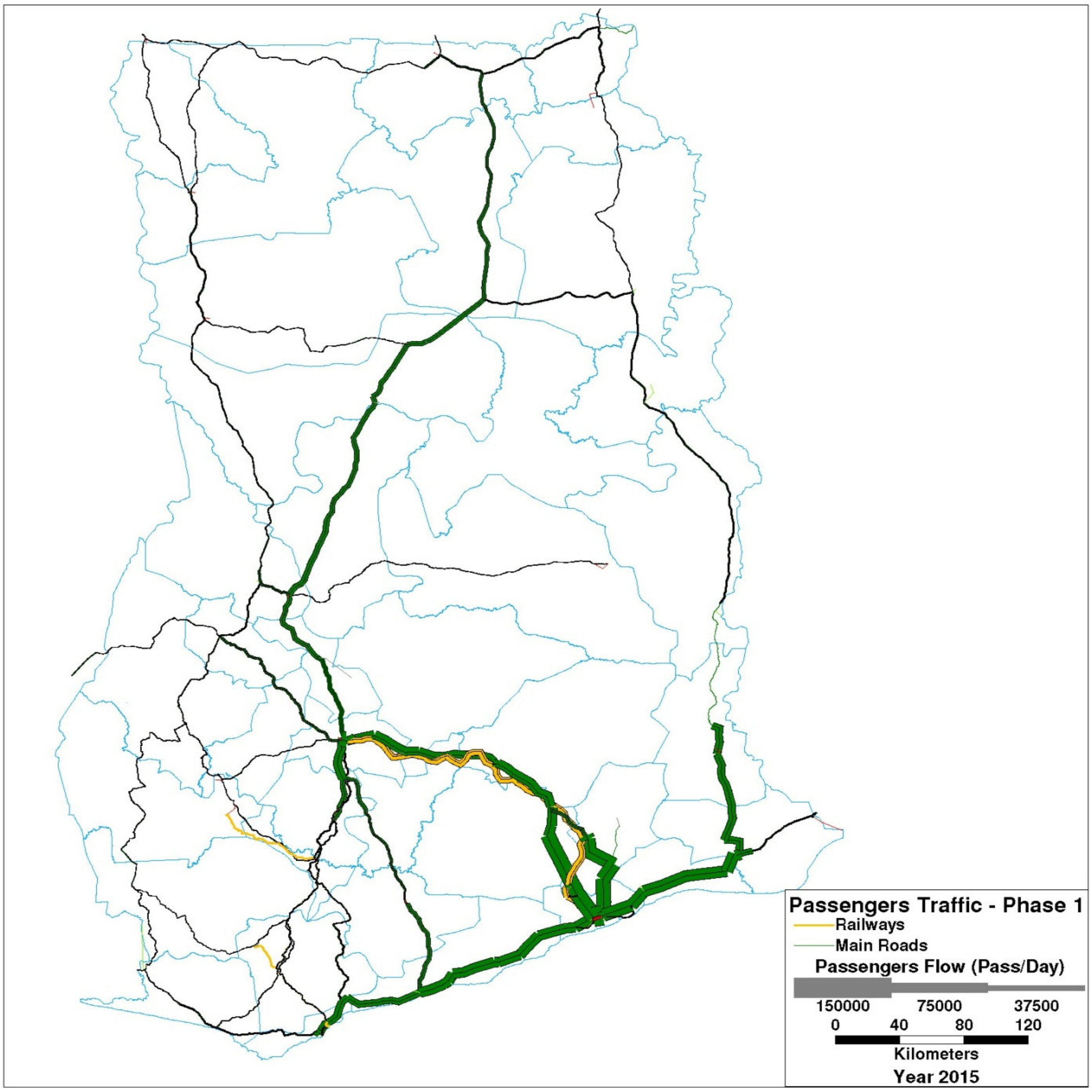


Table 4 - 8 Passengers – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	12,517	12,826	25,343	2,505	2,528	5,033
Eastern	37,902	39,714	77,616	20,630	19,100	39,730
Kumasi Paga	12,060	12,012	24,071	0	0	0
Ecowas Corridor	22,731	22,858	45,590	0	0	0
Northwestern	4,043	4,094	8,137	0	0	0
North Eastern	6,455	6,455	12,910	0	0	0
Transversal 1 – Tamale-Yendi	4,260	4,259	8,519	0	0	0
Transversal 2 – Fufulsu-Sawla	321	325	646	0	0	0
Transversal 3 – Techiman-Kwadwokurom	233	233	465	0	0	0
Transversal 4 – Nyinahin-Kumasi	1,096	1,194	2,290	0	0	0

4.2.3 Phase 2 - Central Spine Expansion

Phase 2 is the combination of full rehabilitation SG of the Western, Eastern lines and the new line Kumasi - Paga.

❖ **Western SG Line**

In the case of rehabilitation of the Western line SG, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 1.4 million tons/year and about 22,000 passengers/daily. The new Western railway will attract 3.2 million tons/year and 11,500 passengers/daily.
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 7.0 million tons/year and about 100,000 passengers/daily.
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 6.7 million tons/year and 22,000 passenger/day;
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.3 million tons/year and 46,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla is around 150,000 tons/year and 700 passengers/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 1.3 million tons/year and 8,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.6 million tons/year and 12,500 passengers/day.

Figure 4 - 9 Freight Traffic 2015 – Phase 2W Western Railway Project

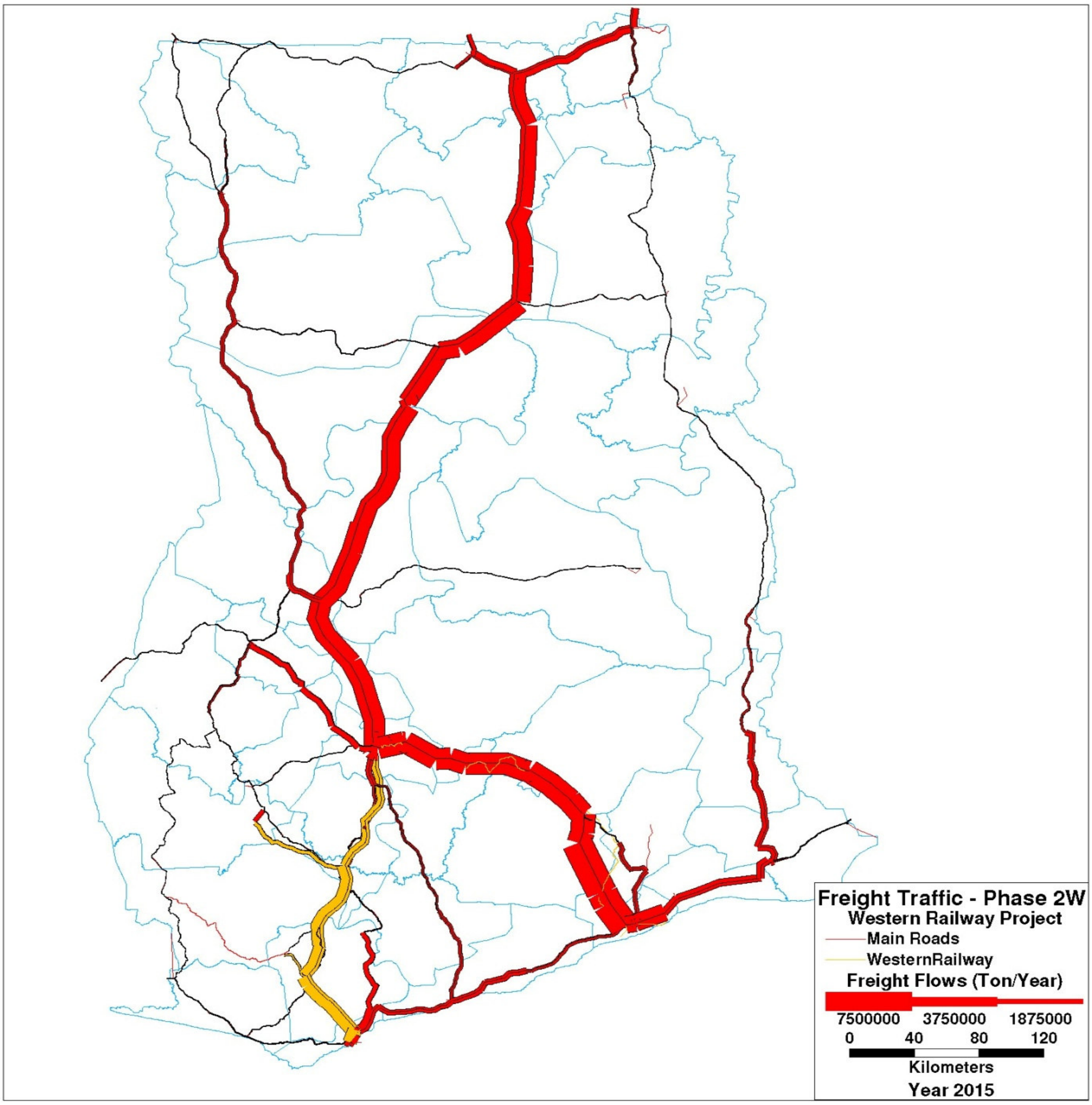


Table 4 - 9 Freight – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	855,982	533,213	1,389,195	977,908	2,226,412	3,204,320
Eastern	3,632,246	3,404,550	7,036,796	0	0	0
Kumasi Paga	2,885,086	3,880,637	6,765,723	0	0	0
Ecowas Corridor	640,098	676,143	1,316,241	0	0	0
Western Expansion	741,878	565,431	1,307,309	0	0	0
Eastern Expansion	236,913	358,124	595,037	0	0	0
Transversal 1 – Tamale-Yendi	20,030	86,655	106,685	0	0	0
Transversal 2 – Fufulsu-Sawla	36,482	105,432	141,914	0	0	0
Transversal 3 – Techiman-Kwadwokurom	17,777	10,312	28,089	0	0	0
Transversal 4 – Nyinahin-Kumasi	65	839	904	0	0	0

Figure 4 - 10 Passengers Traffic 2015 – Phase 2W Western Railway Project

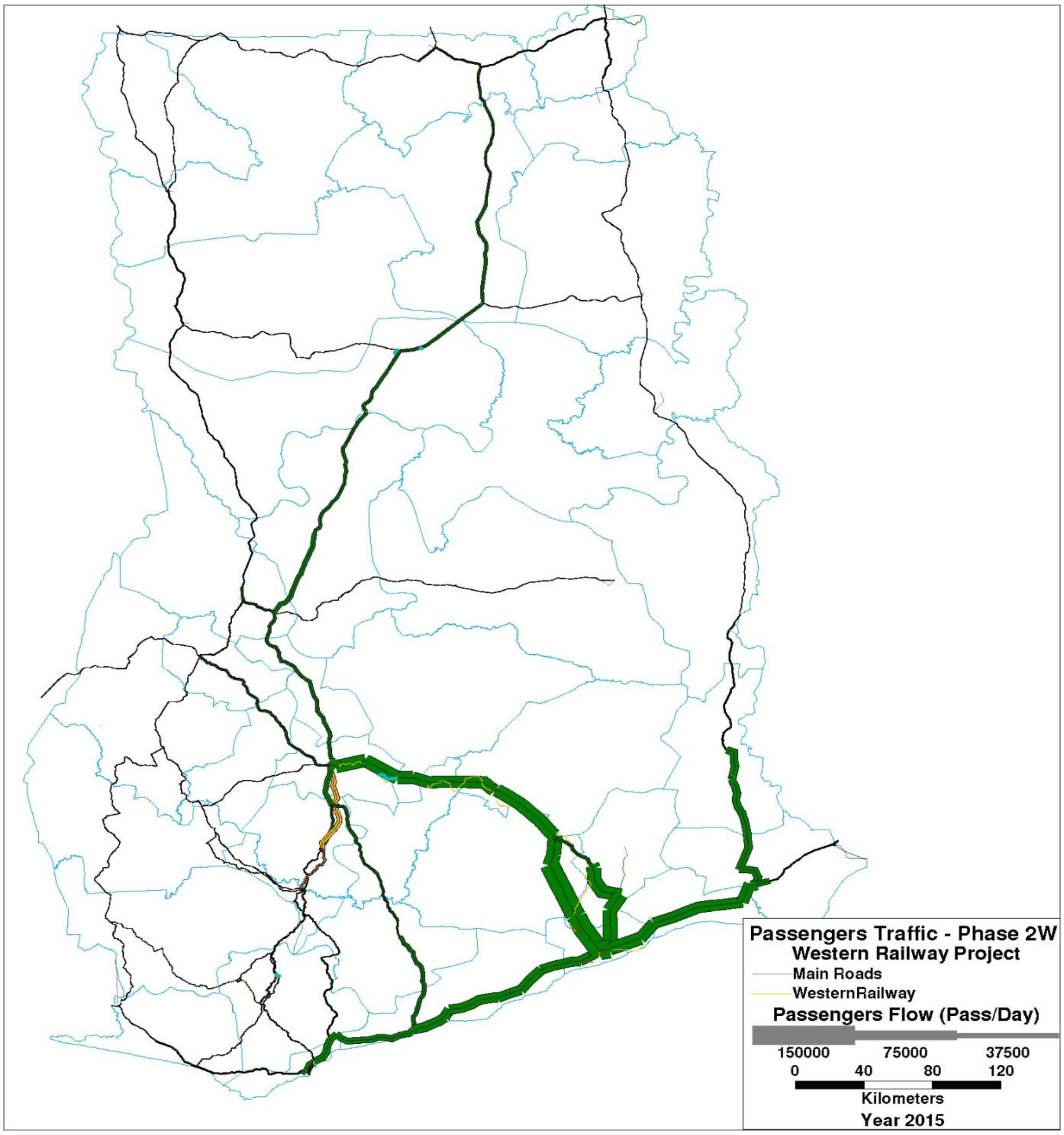


Table 4 - 10 Passengers – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
WESTERN	11,005	11,207	22,212	5,655	5,771	11,425
EASTERN	50,068	50,036	100,104	0	0	0
KUMASI PAGA	11,032	11,037	22,069	0	0	0
ECOWAS CORRIDOR	22,902	22,901	45,803	0	0	0
WESTERN EXPANSION	3,953	3,959	7,912	0	0	0
EASTERN EXPANSION	6,160	6,159	12,319	0	0	0
TRANSVERSAL 1 – TAMALE-YENDI	369	367	735	0	0	0
TRANSVERSAL 2 – FUFULSU-SAWLA	322	326	648	0	0	0
TRANSVERSAL 3 – TECHIMAN-KWADWOKUROM	233	233	465	0	0	0
TRANSVERSAL 4 – NYINAHIN-KUMASI	0	103	103	0	0	0

❖ 2E – Eastern SG Railway

Following are the results of the traffic assignments for Cargo and Passengers at year 2015 for the Eastern Railway SG

In the case of rehabilitation of the Eastern lines SG, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 3.5 million tons/year and about 30,000 passengers/daily.
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 5.0 million tons/year and about 52,000 passengers/daily. The new railway will absorb 3.2 million tons/year and 70,000 passengers/day.
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 6.7 million tons/year and 23,000 passenger/day;
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.5 million tons/year and 46,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla is around 150,000 tons/year and 700 passengers/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 1.3 million tons/year and 8,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.6 million tons/year and 12,000 passengers/day.

Figure 4 - 11 Freight Traffic 2015 – Phase 2E Eastern Railway Project

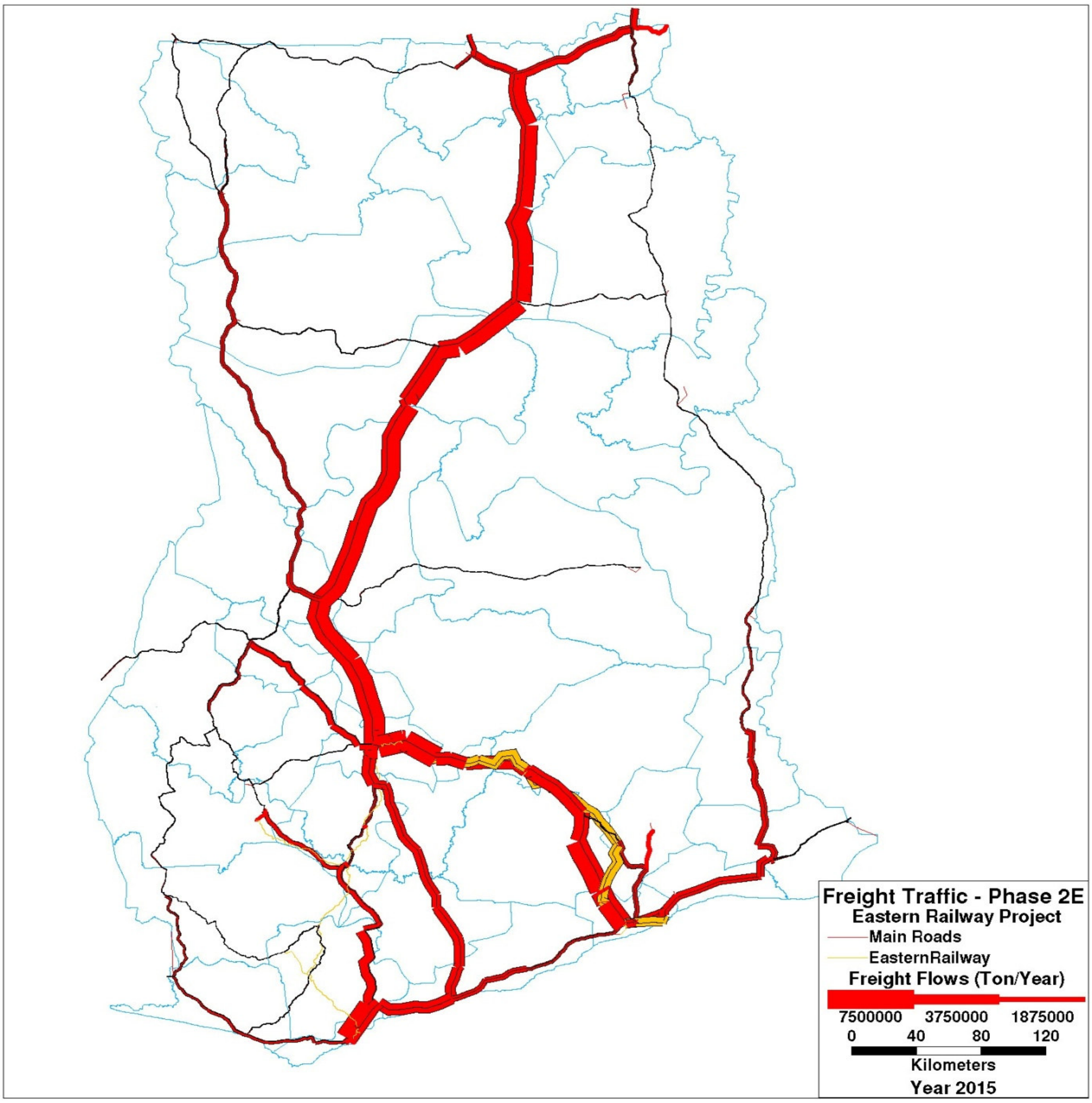


Table 4 - 11 Freight – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	2,180,734	1,288,012	3,468,745	0	0	0
Eastern	2,606,549	2,300,517	4,907,066	1,496,747	1,778,032	3,274,779
Kumasi Paga	2,885,086	3,876,616	6,761,702	0	0	0
Ecowas Corridor	627,216	871,462	1,498,678	0	0	0
Western Expansion	752,765	573,882	1,326,647	0	0	0
Eastern Expansion	236,913	358,124	595,037	0	0	0
Transversal 1 – Tamale-Yendi	20,030	86,655	106,685	0	0	0
Transversal 2 – Fufulsu-Sawla	36,482	105,482	141,914	0	0	0
Transversal 3 – Techiman-Kwadwokurom	17,777	10,312	28089	0	0	0
Transversal 4 – Nyinahin-Kumasi	16,980	29,645	46,625	0	0	0

Figure 4 - 12 Passengers Traffic 2015 – Phase 2E Eastern Railway Project

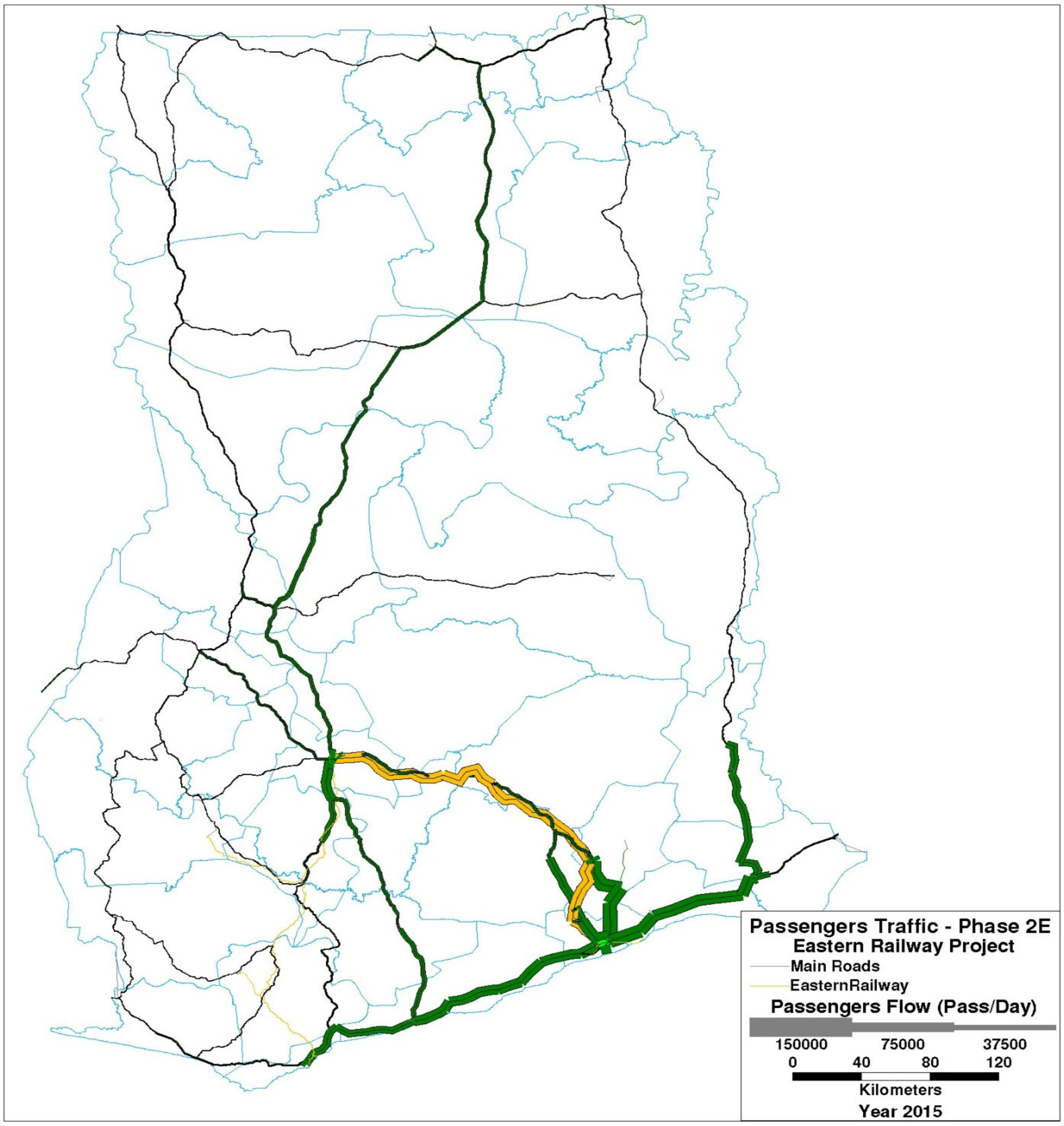


Table 4 - 12 Passengers – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	14,501	14,800	29,301	0	0	0
Eastern	26,201	26,270	52,472	35,067	34,923	69,991
Kumasi Paga	11,292	11,291	22,583	0	0	0
Ecowas Corridor	22,924	23,106	46,031	0	0	0
Western Expansion	3,988	3,995	7,983	0	0	0
Eastern Expansion	5,874	5,875	11,749	0	0	0
Transversal 1 – Tamale-Yendi	432	438	870	0	0	0
Transversal 2 – Fufulsu-Sawla	322	326	648	0	0	0
Transversal 3 – Techiman-Kwadwokurom	233	233	465	0	0	0
Transversal 4 – Nyinahin-Kumasi	1,102	1,203	2,306	0	0	0

4.2.4 Phase 2A - Eastern + Western SG

Phase 2A is the combination of rehabilitation SG of the Western plus Eastern railways. The results of the traffic assignments for Cargo and Passengers at year 2015 for the Phase 2 (Eastern plus Western Railway SG) are similar to the sum of the previous ones but additional traffic due to the combined effect on the rail network.

In the case of rehabilitation of the Western and Eastern lines SG, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 2.7 million tons/year and about 25,000 passengers/daily. The new Western railway will attract 1.5 million tons/year and 5,000 passengers/daily.
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 4.8 million tons/year and about 58,000 passengers/daily. The new railway will absorb 3.5 million tons/year and 62,000 passengers/day.
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 6.7 million tons/year and 22,000 passenger/day;
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.2 million tons/year and 46,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla is around 150,000 tons/year and 700 passengers/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 1.3 million tons/year and 8,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.6 million tons/year and 12,200 passengers/day.

Figure 4 - 13 Freight Traffic 2015 – Phase 2A

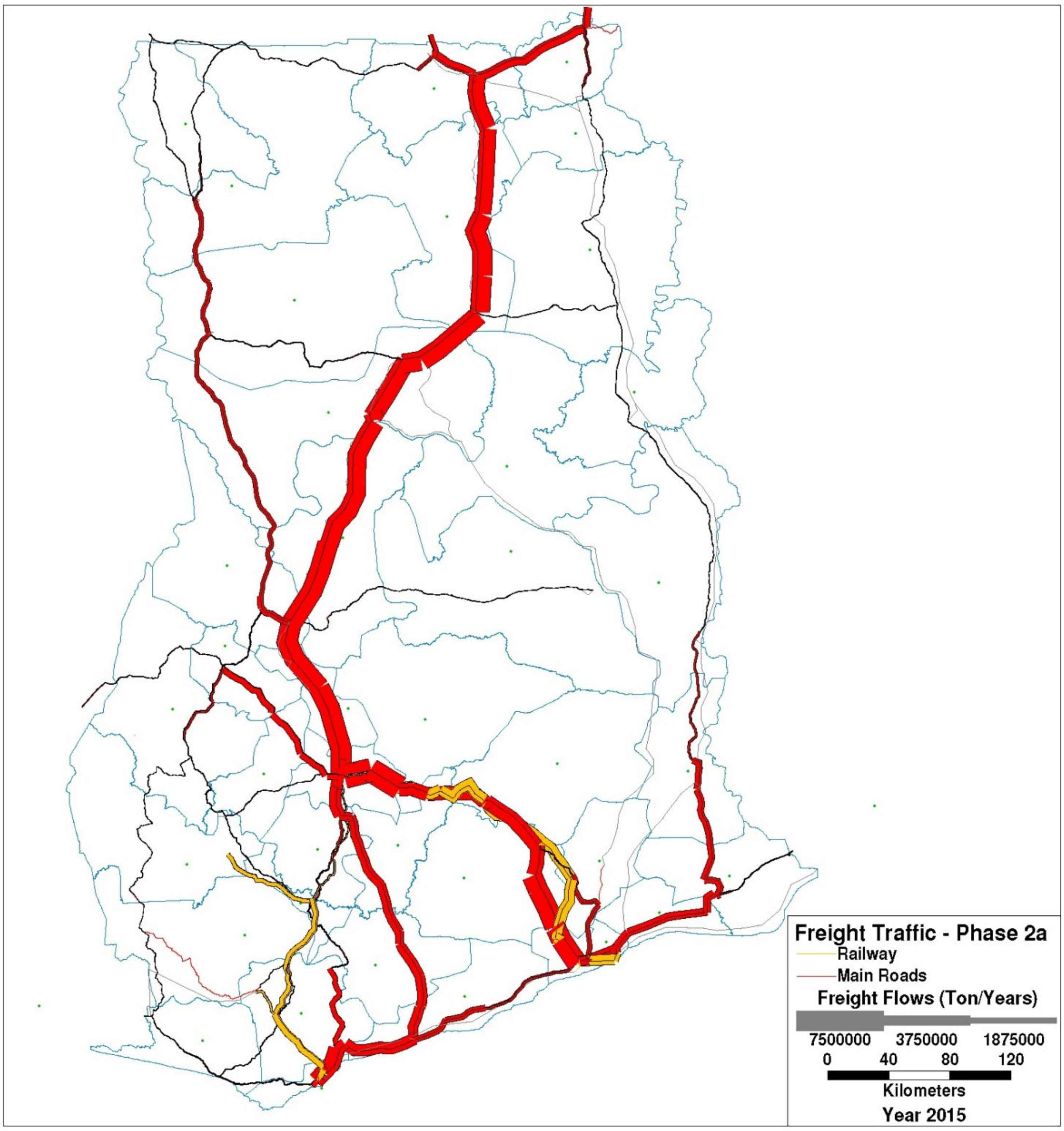


Table 4 - 13 Freight – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	1,611,503	1,118,652	2,730,155	247,772	1,287,129	1,534,900
Eastern	2,570,764	2,265,758	4,836,521	1,627,813	1,918,428	3,546,241
Kumasi Paga	2,885,086	3,880,637	6,765,723	0	0	0
Ecowas Corridor	610,630	652,104	1,262,734	0	0	0
Western Expansion	742,489	564,667	1,307,157	0	0	0
Eastern Expansion	236,913	358,124	595,037	0	0	0
Transversal 1 – Tamale-Yendi	20,030	86,655	106,685	0	0	0
Transversal 2 – Fufulsu-Sawla	36,482	105,432	141,914	0	0	0
Transversal 3 – Techiman-Kwadwokurom	17,777	10,312	28,089	0	0	0
Transversal 4 – Nyinahin-Kumasi	49	853	902	0	0	0

Figure 4 - 14 Passengers Traffic 2015 – Phase 2A

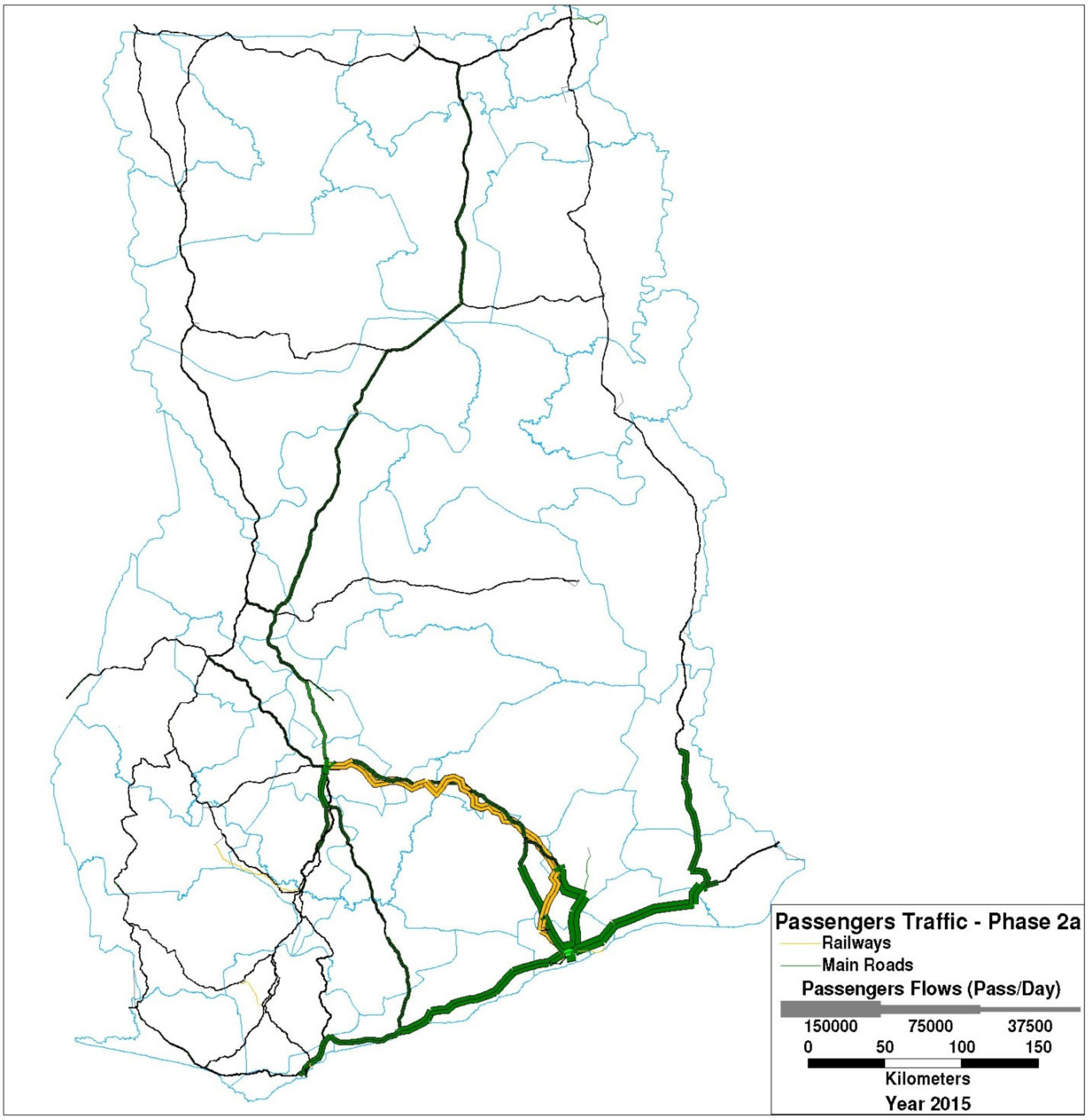


Table 4 - 14 Passengers – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	12,509	12,820	25,330	2,507	2,532	5,040
Eastern	28,948	28,902	57,850	31,039	31,035	62,074
Kumasi Paga	11,092	11,099	22,190	0	0	0
Ecowas Corridor	22,954	22,955	45,909	0	0	0
Western Expansion	3,988	3,994	7,982	0	0	0
Eastern Expansion	6,091	6,087	12,179	0	0	0
Transversal 1 – Tamale-Yendi	394	380	774	0	0	0
Transversal 2 – Fufulsu-Sawla	322	326	648	0	0	0
Transversal 3 – Techiman-Kwadwokurom	233	233	465	0	0	0
Transversal 4 – Nyinahin-Kumasi	1,096	1,194	2,290	0	0	0

❖ **Phase 2C – Kumasi - Paga**

Phase 2C is the extension of the railway line from Kumasi along the Northern Corridor to Techiman, Tamale, Bolgatanga, up to Paga and border to Burkina.

In the case of construction of the Kumasi - Paga SG, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 2.2 million tons/year and about 25,000 passengers/daily. The new Western railway will attract 2.0 million tons/year and 7,000 passengers/daily.
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 4.5 million tons/year and about 52,000 passengers/daily. The new railway will absorb 3.6 million tons/year and 72,000 passengers/day.
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 2.8 million tons/year and 5,000 passenger/day. The new railway will absorb 4.3 million tons/year and 22,000 passengers/day.
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.3 million tons/year and 46,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla is around 190,000 tons/year and 700 passengers/day. Cargo along the transversal Tamale – Yendi is around 180,000 tons/year and 1,500 passengers/day
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 1.3 million tons/year and 8,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.9 million tons/year and 11,400 passengers/day.

Figure 4 - 15 Freight Traffic 2015 – Phase 2C

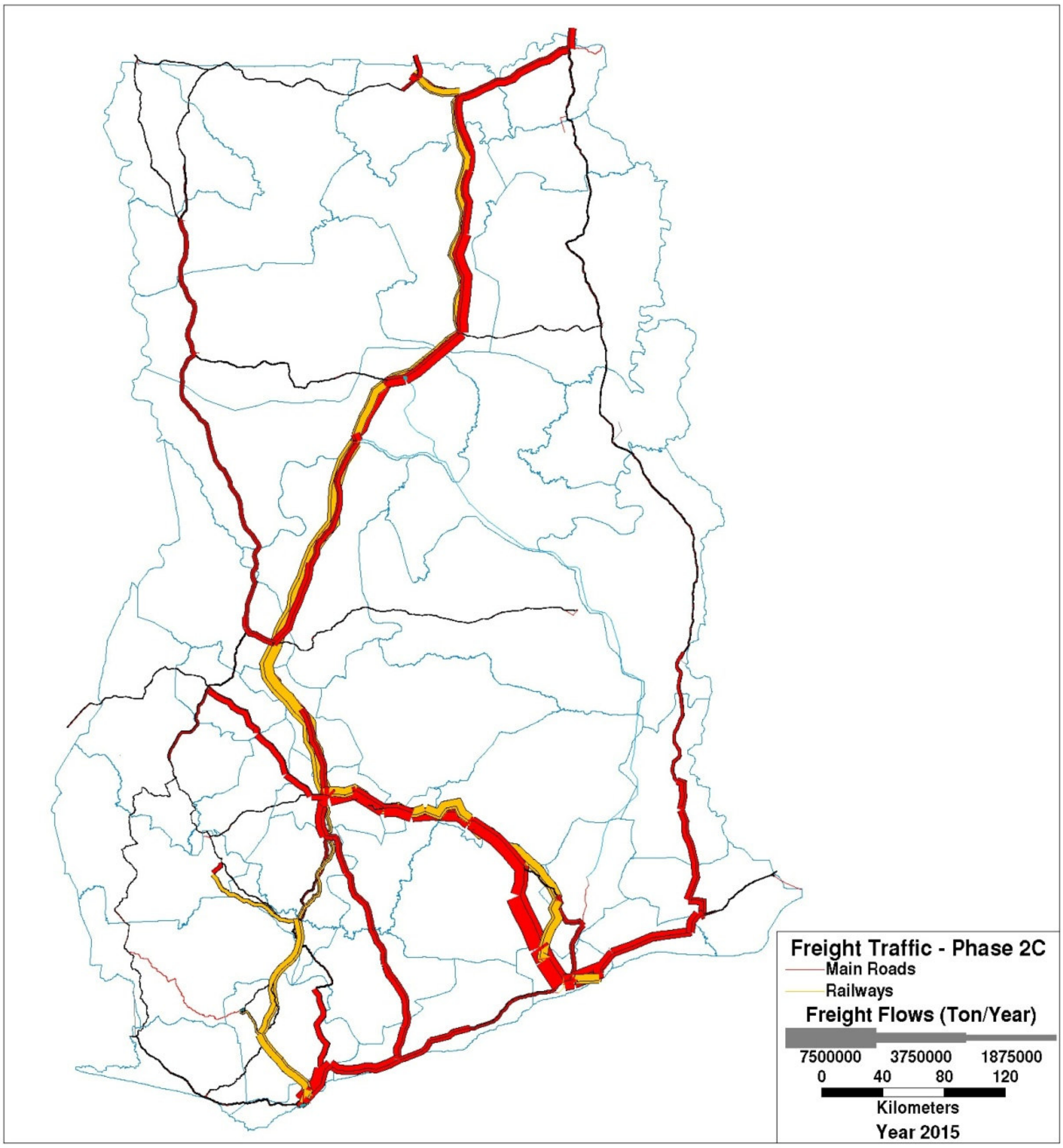


Table 4 - 15 Freight – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
WESTERN	1,416,327	873,898	2,290,225	529,242	1,500,744	2,029,986
EASTERN	2,414,417	2,058,039	4,472,455	1,678,096	1,974,435	3,652,531
KUMASI PAGA	1,402,554	1,460,060	2,862,614	3,059,928	1,297,168	4,357,097
ECOWAS CORRIDOR	660,221	697,753	1,357,974	0	0	0
WESTERN EXPANSION	725,703	577,036	1,302,739	0	0	0
EASTERN EXPANSION	421,762	514,307	936,068	0	0	0
TRANSVERSAL 1 – TAMALE-YENDI	106,444	72,933	179,377	0	0	0
TRANSVERSAL 2 – FUFULSU-SAWLA	77,234	108,447	185,681	0	0	0
TRANSVERSAL 3 – TECHIMAN-KWADWOKUROM	17,777	10,312	28,089	0	0	0
TRANSVERSAL 4 – NYINAHIN-KUMASI	43	853	896	0	0	0

Figure 4 - 16 Passengers Traffic 2015 – Phase 2C

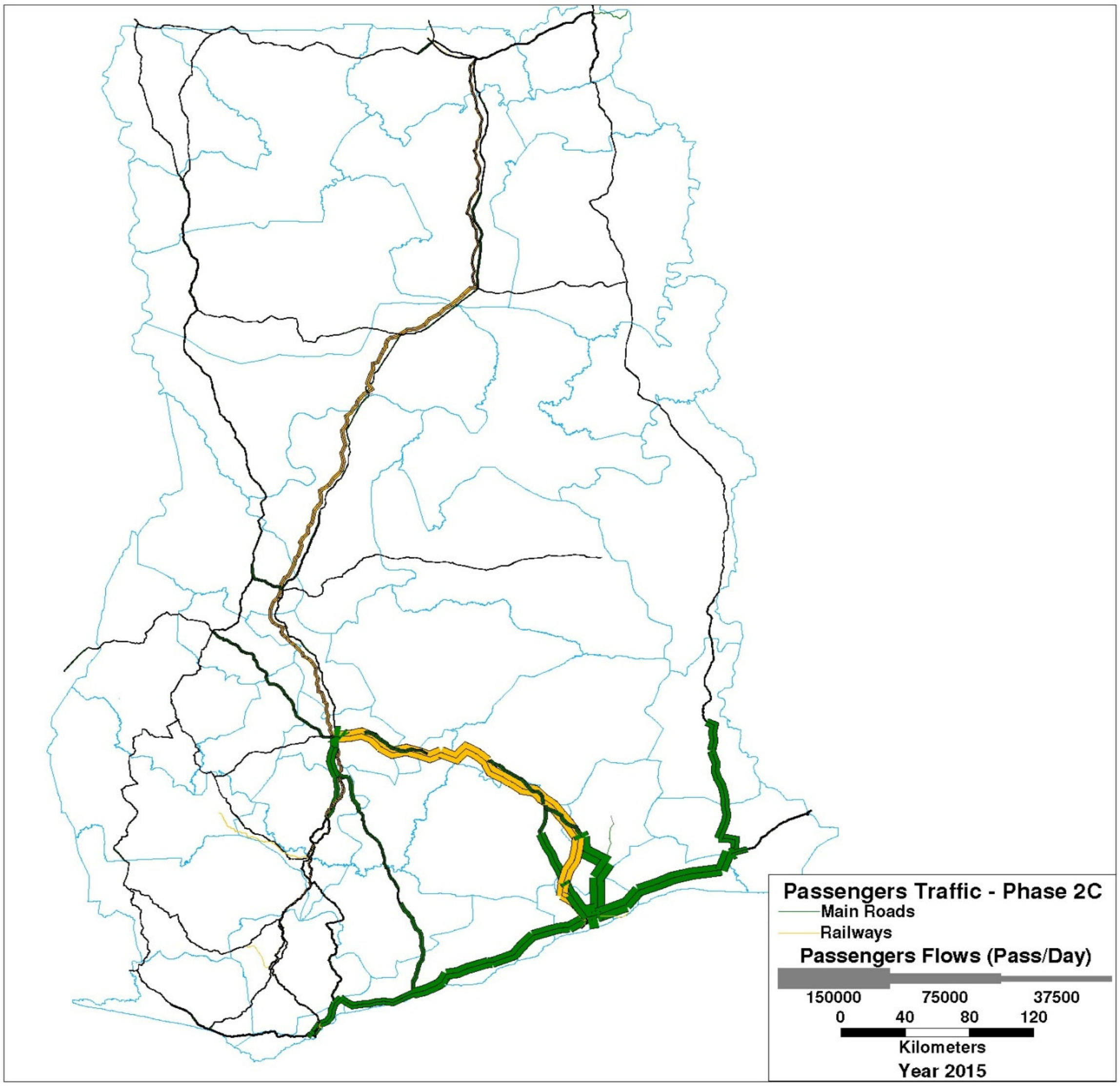


Table 4 - 16 Passengers – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	12,193	12,441	24,634	3,645	3,642	7,287
Eastern	25,855	25,935	51,790	36,149	36,008	72,157
Kumasi Paga	2,508	2,394	4,901	11,195	11,051	22,246
Ecowas Corridor	22,665	22,846	45,511	0	0	0
Western Expansion	3,955	3,984	7,939	0	0	0
Eastern Expansion	5,694	5,694	11,388	0	0	0
Transversal 1 – Tamale-Yendi	714	714	1,427	0	0	0
Transversal 2 – Fufulsu-Sawla	325	329	654	0	0	0
Transversal 3 – Techiman-Kwadwokurom	233	233	465	0	0	0
Transversal 4 – Nyinahin-Kumasi	0	105	105	0	0	0

4.2.5 Phase 3 - Transversal Expansion lines (4)

Phase 3 is the extension of the Northern railway line with 4 transversal lines: Kumasi – Nyinahin, Techiman-Atebubu-Kwadwokurom, Fulfulso-Sawla and Tamale-Yendi.

In the case of construction of the 4 transversal railway lines, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 2.2 million tons/year and about 22,000 passengers/daily. The new Western railway will attract 2.2 million tons/year and 11,000 passengers/daily.
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 4.3 million tons/year and about 48,000 passengers/daily. The new railway will absorb 4.2 million tons/year and 81,000 passengers/day.
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 2.7 million tons/year and 4,000 passenger/day. The new railway will absorb 5.3 million tons/year and 26,000 passengers/day.
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.3 million tons/year and 44,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla road is around 128,000 tons/year and 500 passengers/day. The new railway will absorb 1.1 million tons/year and 6,700 passengers/day. Cargo along the transversal Tamale – Yendi road is around 31,000 tons/year and 700 passengers/day, the new railway will absorb 0.5 million/year and 700 passenger/day.
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 0.9 million tons/year and 11,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.65 million tons/year and 6,000 passengers/day.

Figure 4 - 17 Freight Traffic 2015 – Phase 3

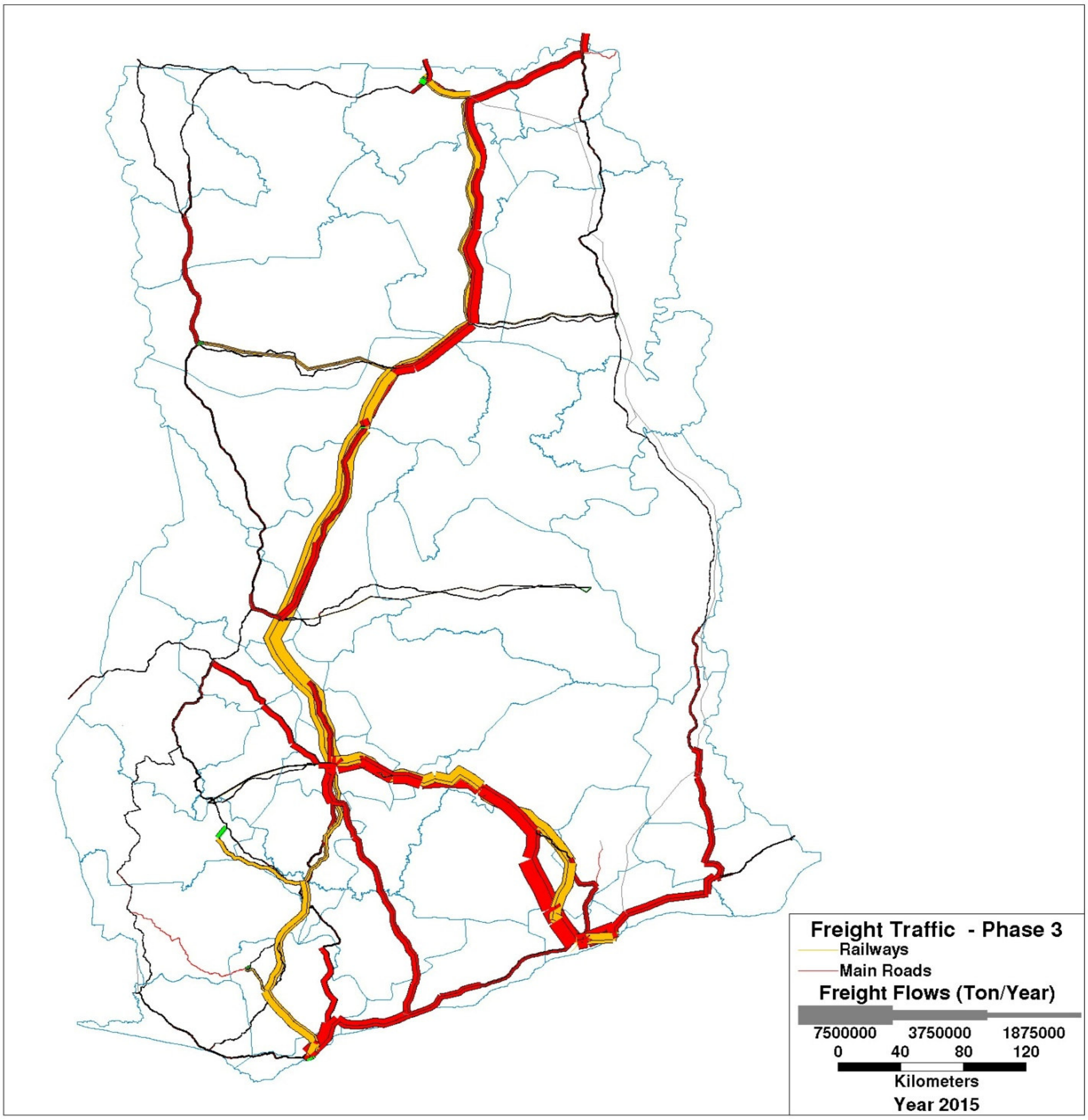


Table 4 - 17 Freight – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	1,362,763	868,401	2,231,165	590,104	1,595,332	2,185,436
Eastern	2,366,581	1,998,367	4,364,948	1,985,845	2,255,309	4,241,154
Kumasi Paga	1,351,554	1,360,065	2,711,619	3,484,237	1,796,861	5,281,098
Ecowas Corridor	613,114	666,145	1,279,259	0	0	0
Western Expansion	531,197	379,561	910,758	0	0	0
Eastern Expansion	240,555	409,560	650,115	0	0	0
Transversal 1 – Tamale-Yendi	11,055	20,006	31,061	111,932	368,562	480,494
Transversal 2 – Fufulsu-Sawla	31,432	96,429	127,860	569,854	522,069	1,091,924
Transversal 3 – Techiman-Kwadwokurom	7	6	14	17,770	10,306	28,075
Transversal 4 – Nyinahin-Kumasi	22,981	109,440	132,421	183,461	132,857	316,318

Figure 4 - 18 Passengers Traffic 2015 – Phase 3

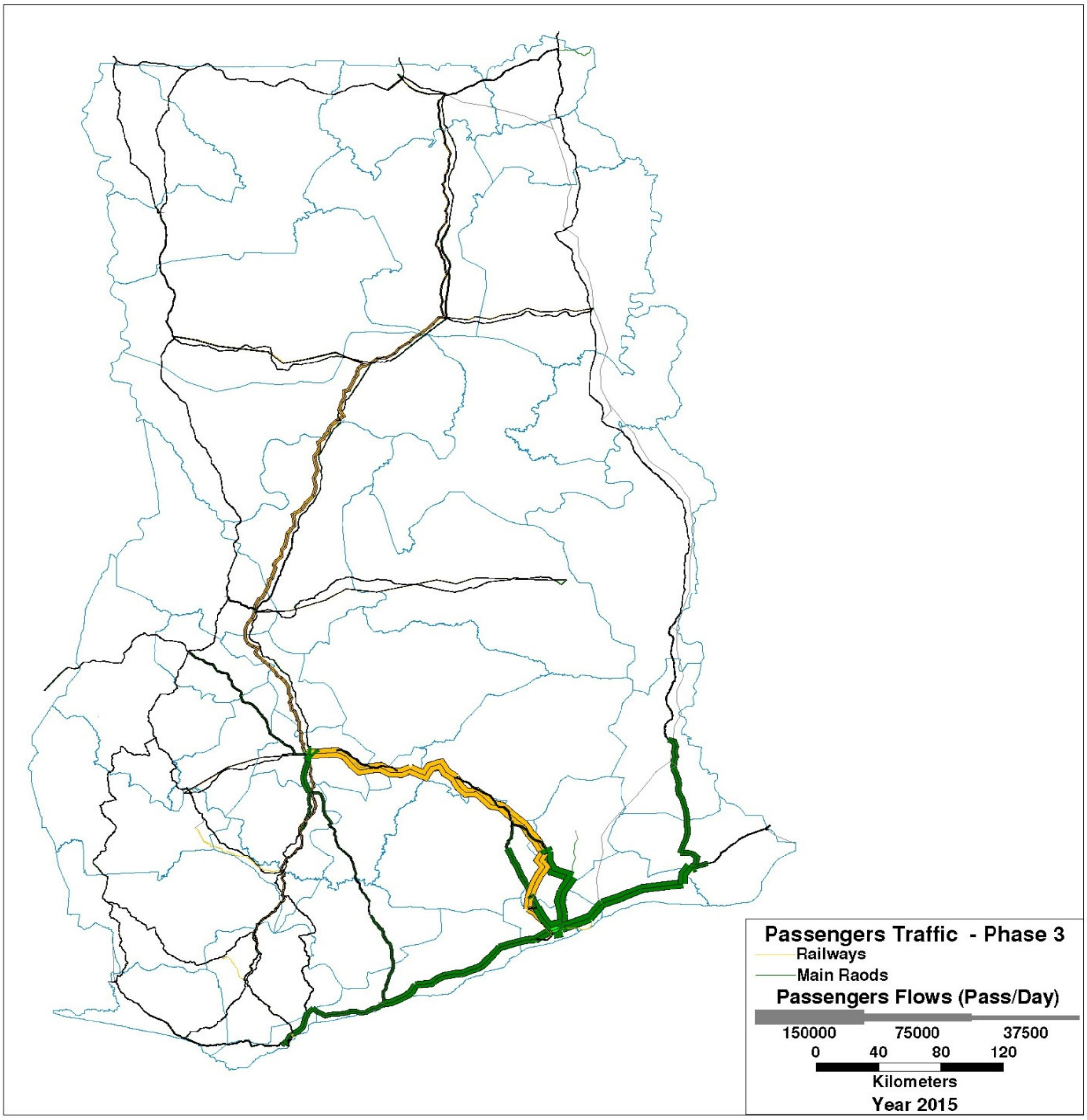


Table 4 - 18 Passengers – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	10,879	10,958	21,837	5,576	5,438	11,014
Eastern	24,055	24,202	48,256	40,579	40,429	81,008
Kumasi Paga	2,045	2,015	4,060	12,963	12,922	25,885
Ecowas Corridor	22,096	22,279	44,376	0	0	0
Western Expansion	2,758	2,822	5,580	0	0	0
Eastern Expansion	5,693	5,693	11,386	0	0	0
Transversal 1 – Tamale-Yendi	354	354	709	358	358	715
Transversal 2 – Fufulsu-Sawla	246	248	494	3,418	3,292	6,709
Transversal 3 – Techiman-Kwadwokurom	0	0	0	233	233	465
Transversal 4 – Nyinahin-Kumasi	0	81	81	1,017	904	1,921

4.2.6 Phase 4 - Trans-ECOWAS Corridor

Phase 4 is the implementation of the East – West Ecowas connection between Aflao to Elubo, passing along the coastline.

In the case of construction of the Trans-Ecowas railway line, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 2.2 million tons/year and about 13,000 passengers/daily. The new Western railway will attract 2.2 million tons/year and 17,000 passengers/daily.
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 4.3 million tons/year and about 44,000 passengers/daily. The new railway will absorb 4.3 million tons/year and 82,000 passengers/day.
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 2.7 million tons/year and 4,000 passenger/day. The new railway will absorb 5.3 million tons/year and 27,000 passengers/day.
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.1 million tons/year and 30,000 passengers/day. The new railway will absorb 125,000 tons/year and 26,000 passengers/day.
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla road is around 127,000 tons/year and 500 passengers/day. The new railway will absorb 1.1 million tons/year and 8,200 passengers/day. Cargo along the transversal Tamale – Yendi road is around 31,000 tons/year and 700 passengers/day, the new railway will absorb 0.5 million/year and 700 passenger/day.
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 0.9 million tons/year and 5,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.65 million tons/year and 11,400 passengers/day.

Figure 4 - 19 Freight Traffic 2015 – Phase 4

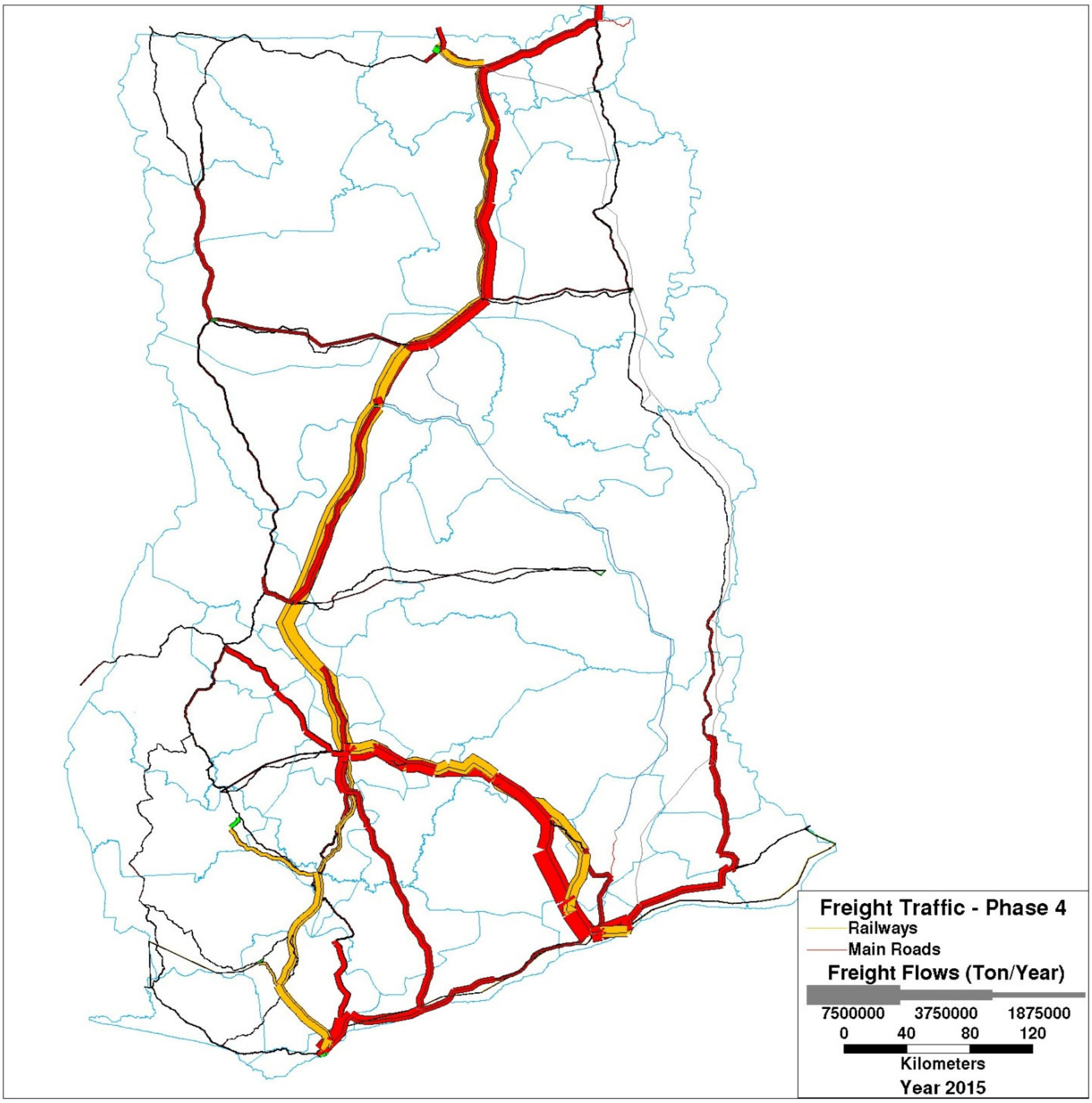


Table 4 - 19 Freight – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	1,354,789	862,454	2,217,243	582,306	1,607,287	2,189,593
Eastern	2,327,494	1,960,480	4,287,974	2,043,767	2,297,045	4,340,812
Kumasi Paga	1,360,391	1,372,983	2,733,374	3,474,423	1,806,584	5,281,007
Ecowas Corridor	576,798	577,932	1,154,730	88,478	36,133	124,611
Western Expansion	522,208	376,398	898,606	0	0	0
Eastern Expansion	240,546	409,560	650,106	0	0	0
Transversal 1 – Tamale-Yendi	11,055	20,006	31,061	111,898	368,561	480,460
Transversal 2 – Fufulsu-Sawla	31,432	96,428	127,860	569,854	522,069	1,091,924
Transversal 3 – Techiman-Kwadwokurom	7	6	14	17,770	10,306	28,075
Transversal 4 – Nyinahin-Kumasi	22,979	109,442	132,421	183,461	132,859	316,319

Figure 4 - 20 Passengers Traffic 2015 – Phase 4

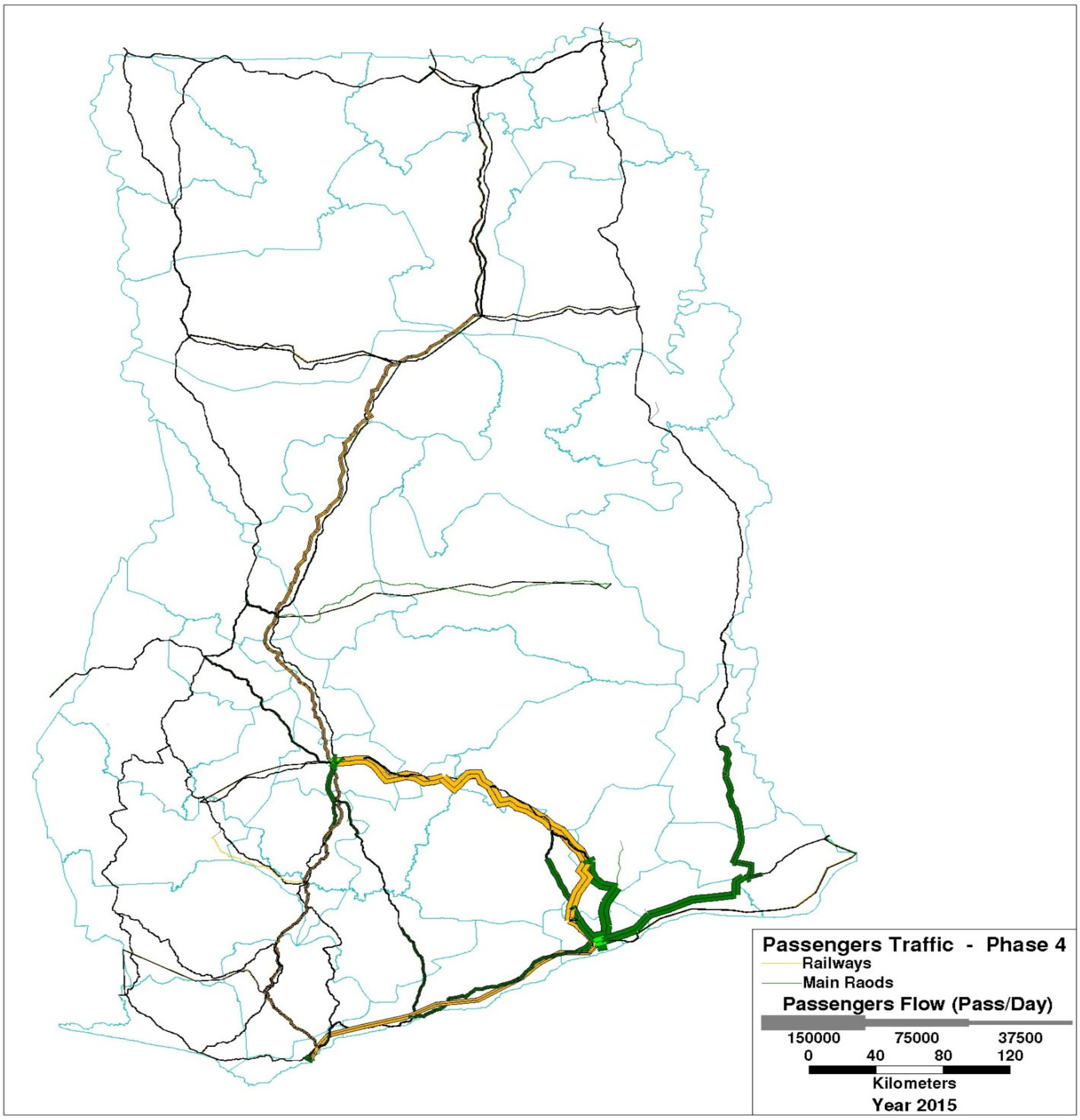


Table 4 - 20 Passengers – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	6,260	6,743	13,003	8,468	8,164	16,632
Eastern	22,192	21,683	43,875	40,749	41,238	81,987
Kumasi Paga	1,877	1,852	3,729	13,454	13,368	26,823
Ecowas Corridor	14,370	14,670	29,040	12,949	12,641	25,590
Western Expansion	2,504	2,530	5,034	0	0	0
Eastern Expansion	5,689	5,692	11,381	0	0	0
Transversal 1 – Tamale-Yendi	307	351	658	410	371	782
Transversal 2 – Fufulsu-Sawla	248	248	496	4,160	4,101	8,261
Transversal 3 – Techiman-Kwadwokurom	0	0	0	233	233	465
Transversal 4 – Nyinahin-Kumasi	0	81	81	949	834	1,784

4.2.7 Phase 5 - Western Expansion

Phase 5 is the extension of the North-Western corridor from Nyinahin along the transversal line to Sunyani, Techiman, Bole, Wa and Hamile (border Burkina),

In the case of construction of the Western Expansion railway line, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 2.1 million tons/year and about 17,000 passengers/daily, The new Western railway will attract 2.2 million tons/year and 11,000 passengers/daily,
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 3.8 million tons/year and about 44,000 passengers/daily, The new railway will absorb 5.0 million tons/year and 85,000 passengers/day,
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 2.2 million tons/year and 4,000 passenger/day, The new railway will absorb 5.0 million tons/year and 24,000 passengers/day,
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.1 million tons/year and 30,000 passengers/day, The new railway will absorb 131,000 tons/year and 24,000 passengers/day,
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla road is around 97,000 tons/year and 500 passengers/day, The new railway will absorb 160,000 tons/year and 1,000 passengers/day, Cargo along the transversal Tamale – Yendi road is around 31,000 tons/year and 700 passengers/day, the new railway will absorb 0.6 million/year and 800 passenger/day, Cargo along the transversal Nyinahin -Kumasi road is around 124,000 tons/year and 70 passengers/day, the new railway will absorb 1,0 million/year and 3,200 passenger/day,
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 0.5 million tons/year and 3,000 passengers/day, The new railway will absorb 1.2 million tons/year and 5,500 passengers/day,
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.7 million tons/year and 11,400 passengers/day.

Figure 4 - 21 Freight Traffic 2015 – Phase 5

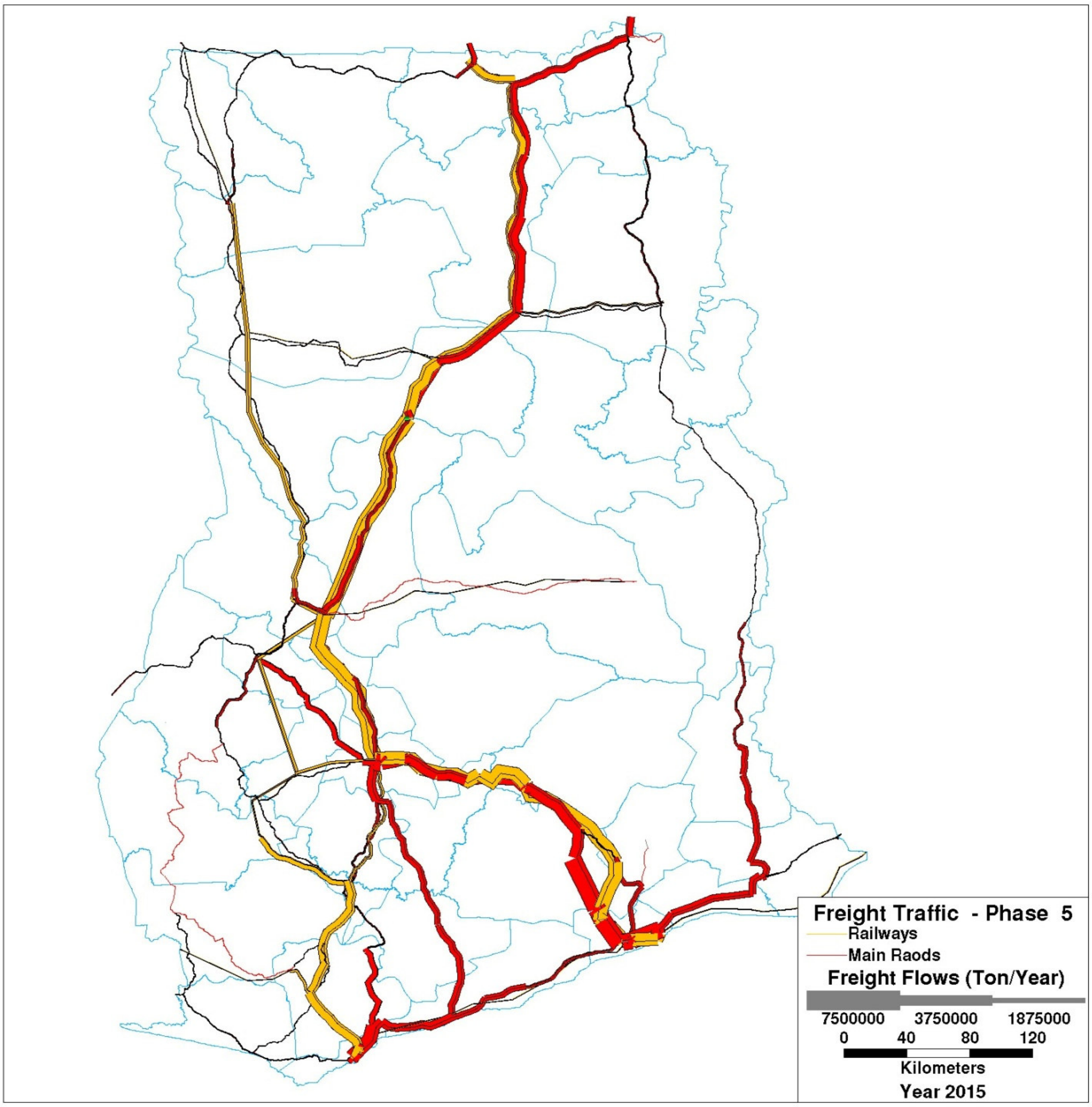


Table 4 - 21 Freight – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	1,294,477	810,944	2,105,422	574,521	1,643,018	2,217,539
Eastern	2,121,987	1,761,814	3,883,801	2,389,190	2,628,776	5,017,966
Kumasi Paga	1,146,199	1,090,475	2,236,674	3,336,275	1,720,753	5,057,028
Ecowas Corridor	576,427	576,055	1,152,483	96,214	35,442	131,656
Western Expansion	300,393	168,786	469,178	694,554	522,433	1,216,987
Eastern Expansion	281,433	412,386	693,819	0	0	0
Transversal 1 – Tamale-Yendi	10,986	20,002	30,988	273,165	379,701	652,866
Transversal 2 – Fufulsu-Sawla	30,636	66,819	97,455	119,716	40,430	160,147
Transversal 3 – Techiman-Kwadwokurom	0	0	0	17,777	10,312	28,089
Transversal 4 – Nyinahin-Kumasi	22,561	101,026	123,587	140,075	840,104	980,179

Figure 4 - 22 Passengers Traffic 2015 – Phase 5

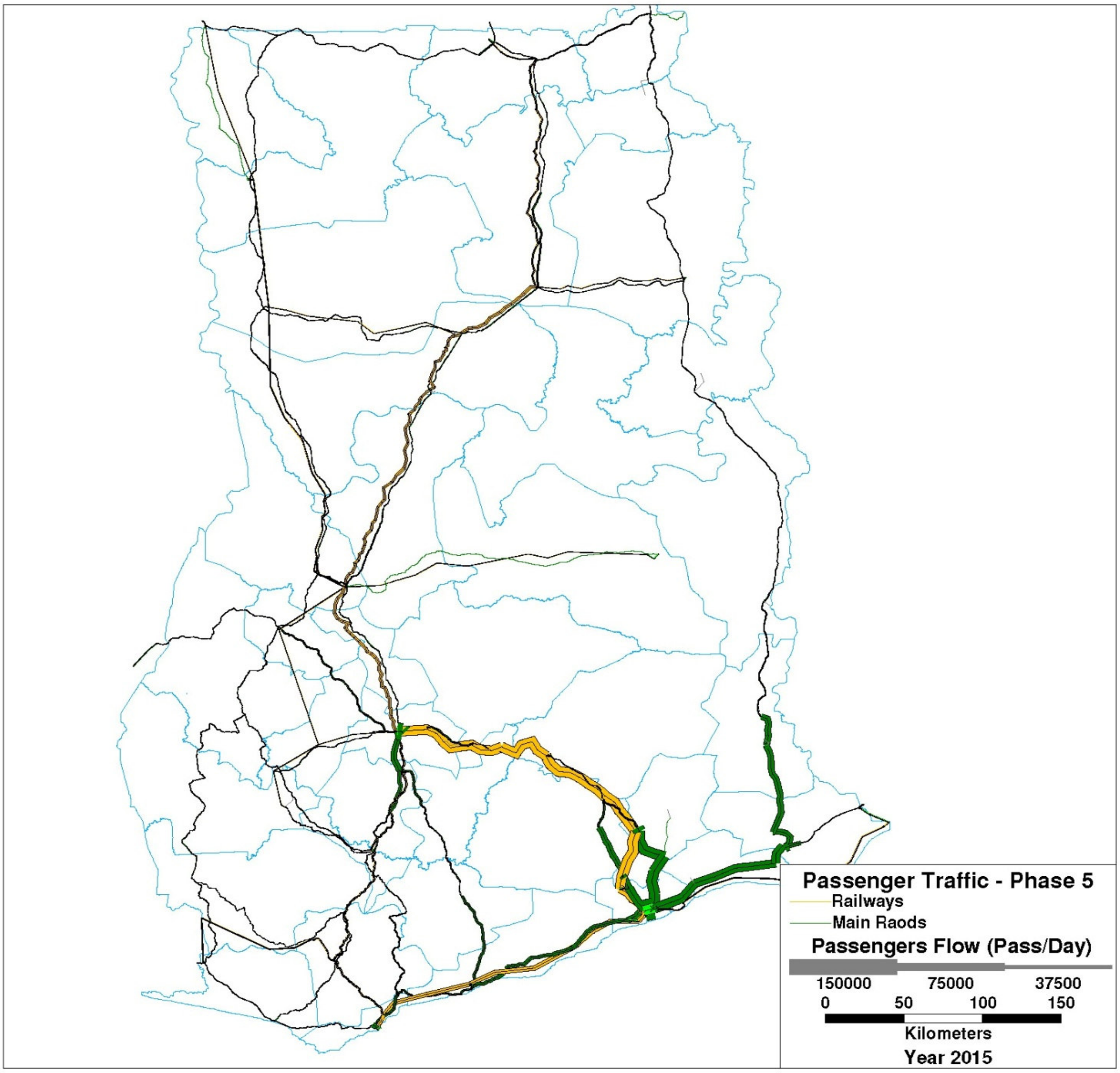


Table 4 - 22 Passengers – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	8,245	8,572	16,816	5,404	5,293	10,696
Eastern	22,193	21,692	43,886	42,153	42,658	84,811
Kumasi Paga	1,860	1,833	3,693	11,916	11,895	23,811
Ecowas Corridor	14,389	14,689	29,078	12,112	12,330	24,442
Western Expansion	1,309	1,375	2,685	2,689	2,724	5,413
Eastern Expansion	5,689	5,692	11,381	0	0	0
Transversal 1 – Tamale-Yendi	307	351	658	410	371	782
Transversal 2 – Fufulsu-Sawla	248	248	496	496	473	970
Transversal 3 – Techiman-Kwadwokurom	0	0	0	233	233	465
Transversal 4 – Nyinahin-Kumasi	0	70	70	1,915	1,330	3,245

4.2.8 Phase 6 – Eastern Expansion

Phase 6 is the extension of the North- East Corridor from Tema, Akosombo, Ho and Yendi,

In the case of construction of the Eastern Expansion railway line, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 2.1 million tons/year and about 14,000 passengers/daily, The new Western railway will attract 2.2 million tons/year and 14,000 passengers/daily, Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 3.8 million tons/year and about 43,000 passengers/daily, The new railway will absorb 3.1 million tons/year and 81,000 passengers/day;
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 2.1 million tons/year and 4,000 passenger/day, The new railway will absorb 3.8 million tons/year and 20,000 passengers/day;
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 1.0 million tons/year and 21,000 passengers/day, The new railway will absorb 156,000 tons/year and 25,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla road is around 102,000 tons/year and 500 passengers/day, The new railway will absorb 26,000 tons/year and 1,000 passengers/day, Cargo along the transversal Tamale – Yendi road is around 180,000 tons/year and 10 passengers/day, the new railway will absorb 1.6 million/year and 5,000 passenger/day, Cargo along the transversal Nyinahin-Kumasi road is around 130,000 tons/year and 70 passengers/day, the new railway will absorb 0.3 million/year and 3,000 passenger/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 0.5 million tons/year and 3,000 passengers/day, The new railway will absorb 1.0 million tons/year and 5,500 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 0.5 million tons/year and 3,700 passengers/day, The new railway will absorb 1.6 million tons/year and 13,000 passengers/day,

Figure 4 - 23 Freight Traffic 2015 – Phase 6

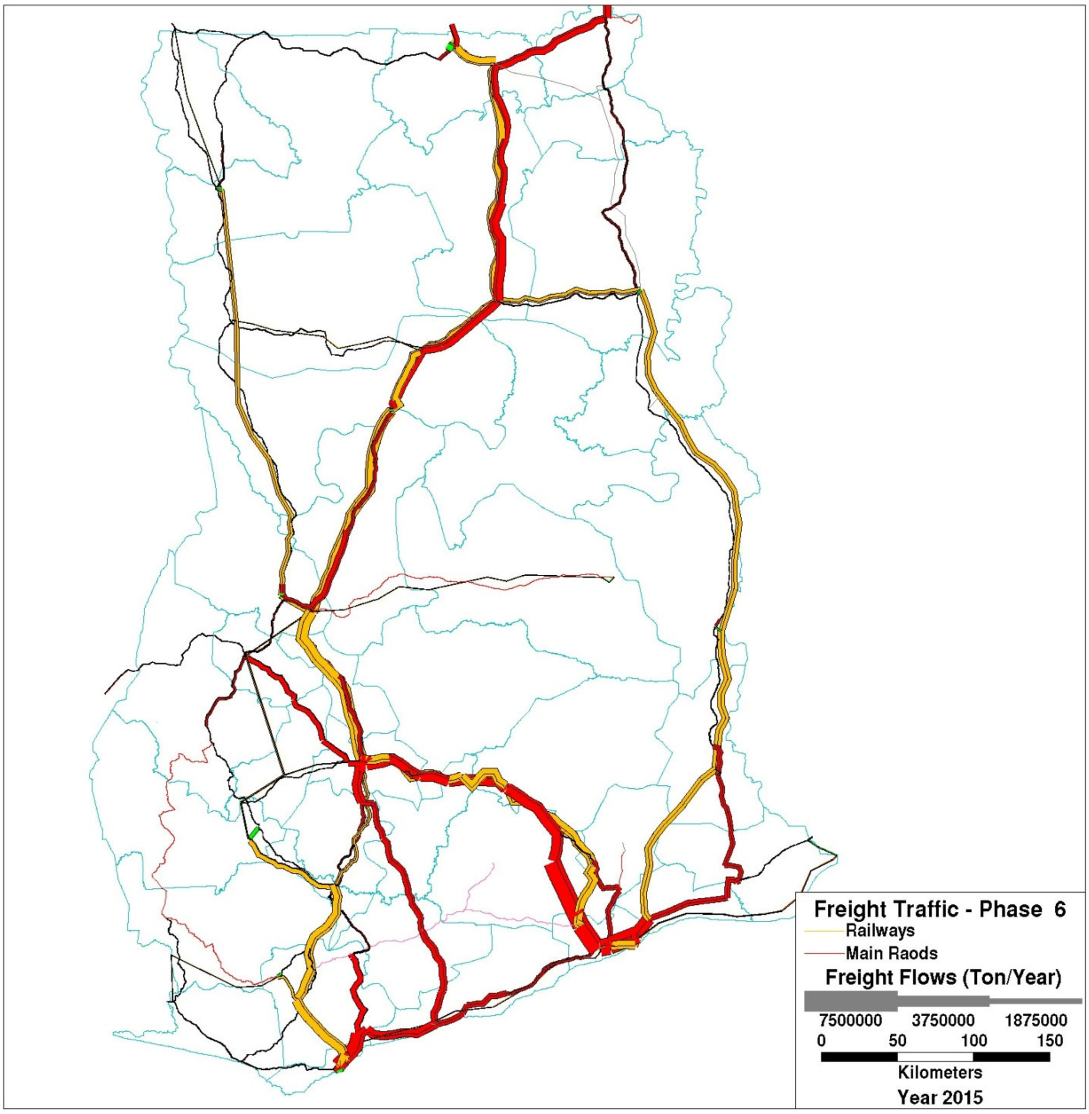


Table 4 - 23 Freight – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	1,292,556	809,033	2,101,588	598,008	1,649,975	2,247,983
Eastern	2,061,710	1,709,717	3,771,427	1,487,283	1,640,014	3,127,298
Kumasi Paga	1,106,956	1,046,579	2,153,534	2,685,453	1,135,468	3,820,920
Ecowas Corridor	539,644	544,391	1,084,036	123,395	33,564	156,959
Western Expansion	291,502	167,275	458,777	513,807	528,069	1,041,876
Eastern Expansion	259,237	281,922	541,160	703,168	877,773	1,580,941
Transversal 1 – Tamale-Yendi	147,348	28,793	176,141	522,952	1,111,706	1,634,658
Transversal 2 – Fufulsu-Sawla	32,188	70,120	102,307	20,688	5,894	26,583
Transversal 3 – Techiman-Kwadwokurom	0	0	0	17,777	10,312	28,089
Transversal 4 – Nyinahin-Kumasi	22,915	106,254	129,169	153,713	119,285	272,998

Figure 4 - 24 Passengers Traffic 2015 – Phase 6

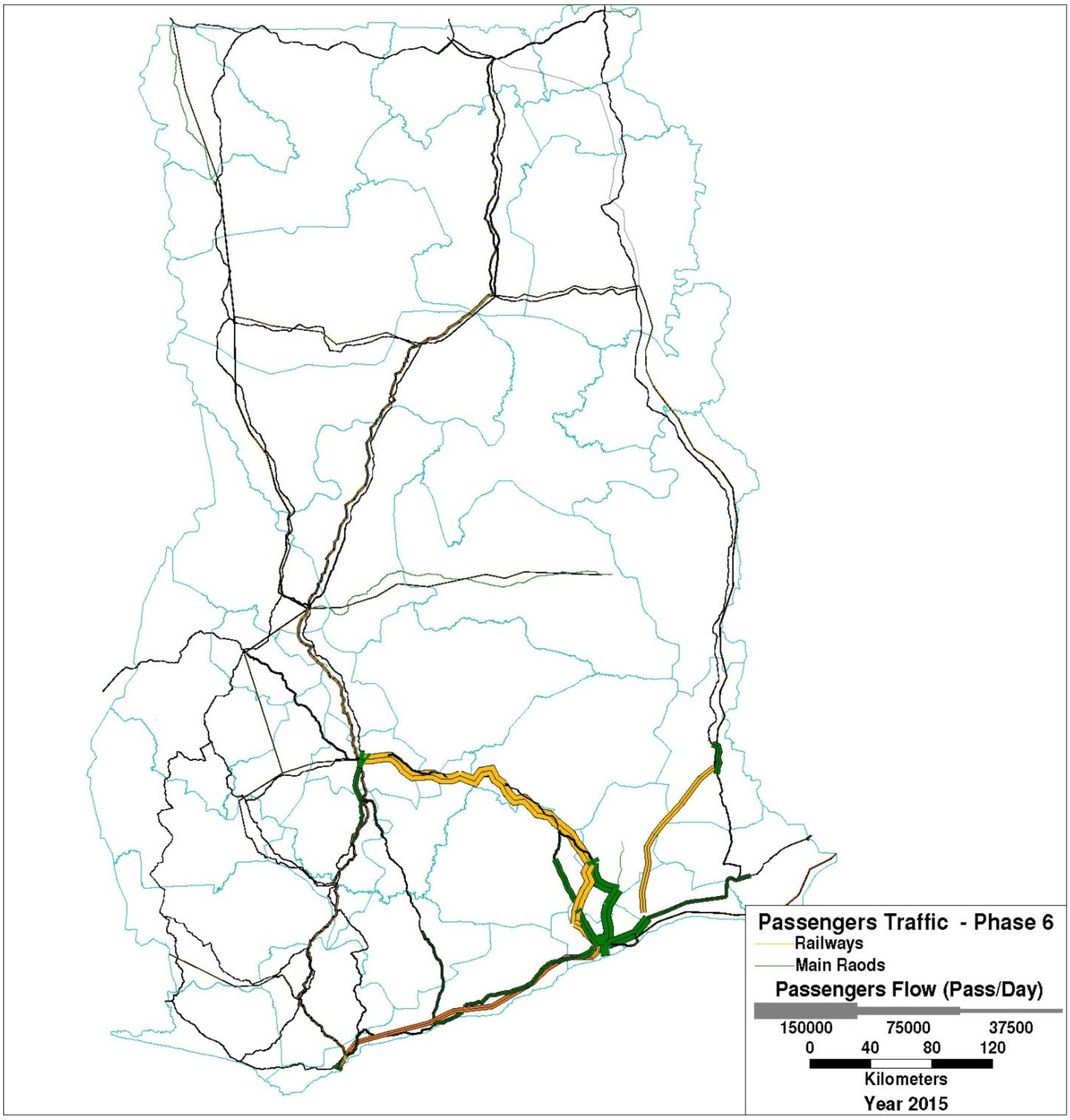


Table 4 - 24 Passengers – Year 2015

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	6,890	7,114	14,005	7,147	7,035	14,181
Eastern	21,970	21,328	43,298	40,221	40,927	81,148
Kumasi Paga	1,857	1,830	3,687	10,006	9,979	19,986
Ecowas Corridor	10,223	10,496	20,718	11,934	12,198	24,132
Western Expansion	1,272	1,338	2,610	2,690	2,723	5,413
Eastern Expansion	1,855	1,855	3,710	6,260	6,260	12,520
Transversal 1 – Tamale-Yendi	4	4	8	2,457	2,456	4,912
Transversal 2 – Fufulsu-Sawla	243	243	486	511	488	998
Transversal 3 – Techiman-Kwadwokurom	0	0	0	233	233	465
Transversal 4 – Nyinahin-Kumasi	0	67	68	1,910	1,292	3,202

4.3 TRAFFIC ASSIGNMENT AT YEAR 2030

4.3.1 Without Project Scenario

Following are the results of the traffic assignments " without project" both ways for Cargo and Passengers at year **2030:**

In the "without project" scenario at year 2030, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10 Takoradi – Kumasi present a weighted average of about 6.1 million tons/year and about 39,000 passengers/daily;
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4 Accra – Koforidua then Kumasi present a weighted average of about 13.0 million tons/year and about 135,000 passengers/daily;
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 12.1 million tons/year and 30,000 passenger/day;
- Trans-ECOWAS corridor: Cargo along the RN1 Aflao – Omanpe is 2.6 million tons/year and 62,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla road is around 255,000 tons/year and 1000 passengers/day. Cargo along the transversal Tamale – Yendi road is around 200,000 tons/year and 1400 passengers/day. Cargo along the transversal Nyinahin-Kumasi road is around 330,000 tons/year and 1200 passengers/day. Cargo along the transversal Techiman-Kwadwokurom road is around 50,000 tons/year and 600 passengers/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 2.4 million tons/year and 11,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 1.1 million tons/year and 15,000 passengers/day.

Figure 4 - 25 Freight Traffic 2030 – Without Project

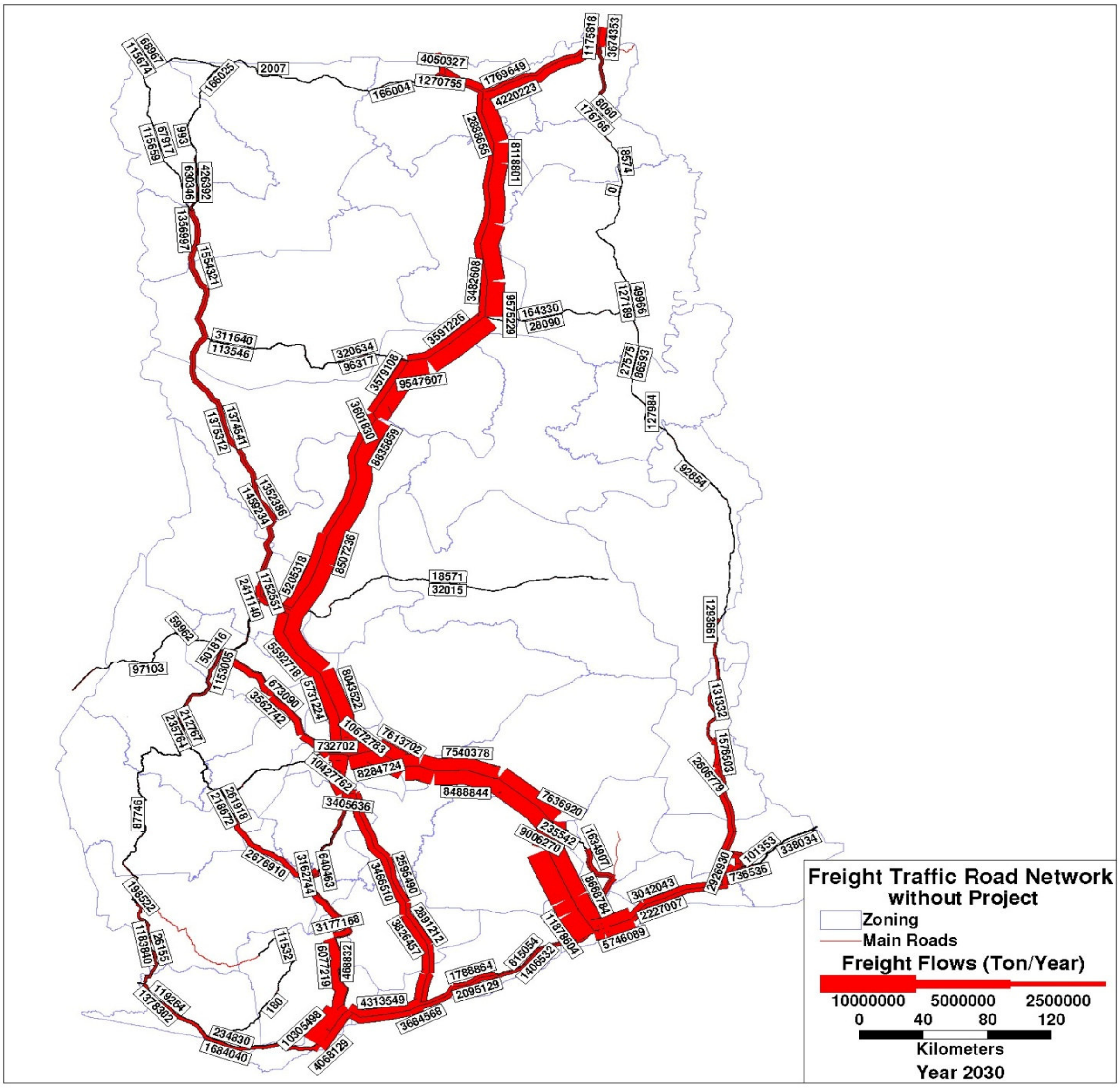


Table 4 - 25 Freight – Year 2030

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	3,857,216	2,274,846	6,132,063	0	0	0
Eastern	6,614,930	6,185,644	12,800,574	0	0	0
Kumasi Paga	5,193,730	6,944,243	12,137,973	0	0	0
Ecowas Corridor	1,122,645	1,561,965	2,684,610	0	0	0
Western Expansion	1,342,651	1,042,265	2,384,916	0	0	0
Eastern Expansion	430,833	648,928	1,079,760	0	0	0
Transversal 1 – Tamale-Yendi	36,342	156,078	192,420	0	0	0
Transversal 2 – Fufulsu-Sawla	65,776	189,996	255,772	0	0	0
Transversal 3 – Techiman-Kwadwokurom	32,015	18,571	50,586	0	0	0
Transversal 4 – Nyinahin-Kumasi	71,898	248,918	320,816	0	0	0

Figure 4 - 26 Passenger Traffic 2030 – Without Project

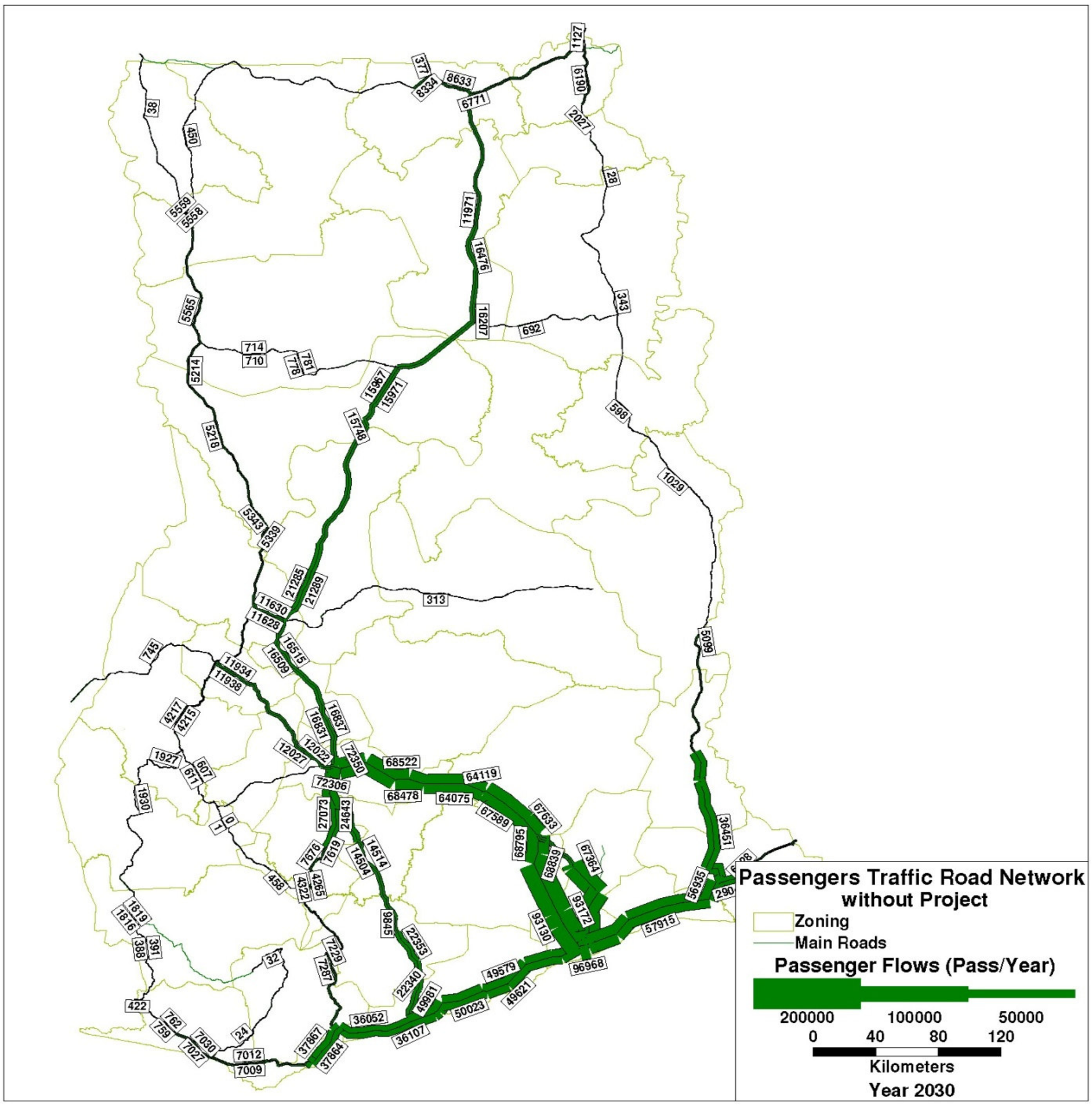


Table 4 - 26 Passengers/day – Year 2030

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	19,596	19,876	39,472	0	0	0
Eastern	67,669	67,631	135,300	0	0	0
Kumasi Paga	15,285	15,287	30,573	0	0	0
Ecowas Corridor	30,848	30,845	61,694	0	0	0
Western Expansion	5,552	5,550	11,102	0	0	0
Eastern Expansion	7,803	7,803	15,606	0	0	0
Transversal 1 – Tamale-Yedi	692	692	1,384	0	0	0
Transversal 2 – Fufulsu-Sawla	441	443	884	0	0	0
Transversal 3 – Techiman-Kwadwokurom	313	313	626	0	0	0
Transversal 4 – Nyinahin-Kumasi	607	611	1,218	0	0	0

4.3.2 Phase 2 - Central Spine Expansion at Year 2030

In the case of construction of the Phase 2 – Central Expansion: eastern + Western + Kumasi - Paga SG, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 4.1 million tons/year and about 35,000 passengers/daily, The new Western railway will attract 3.6 million tons/year and 10,500 passengers/daily,
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 8.0 million tons/year and about 70,000 passengers/daily, The new railway will absorb 6.5 million tons/year and 92,000 passengers/day,
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 5.1 million tons/year and 6,500 passenger/day, The new railway will absorb 7.8 million tons/year and 30,000 passengers/day,
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 2.4 million tons/year and 61,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla is around 335,000 tons/year and 800 passengers/day. Cargo along the transversal Tamale – Yendi is around 300,000 tons/year and 2,000 passengers/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 2.3 million tons/year and 11,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 1.7 million tons/year and 15,000 passengers/day.

Figure 4 - 27 Multimodal Freight Traffic 2030 – Phase 2

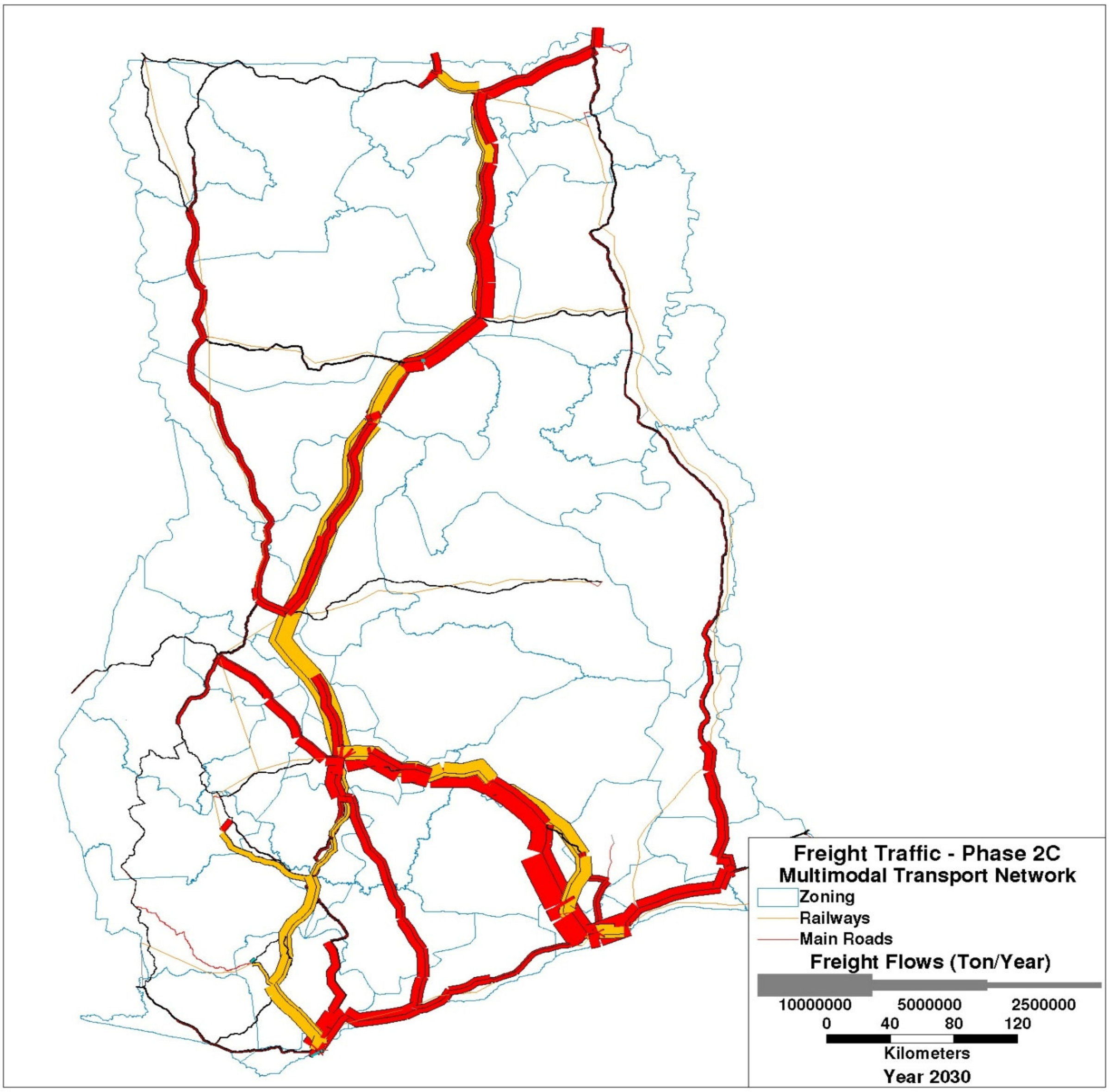


Table 4 - 27 Freight – Year 2030

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
WESTERN	2,550,725	1,573,841	4,124,566	953,135	2,702,756	3,655,890
EASTERN	4,348,228	3,706,411	8,054,639	3,022,156	3,555,846	6,578,002
KUMASI PAGA	2,525,920	2,629,486	5,155,406	5,510,758	2,336,127	7,846,885
ECOWAS CORRIDOR	1,189,020	1,256,614	2,445,634	0	0	0
WESTERN EXPANSION	1,306,950	1,039,209	2,346,160	0	0	0
EASTERN EXPANSION	759,569	926,237	1,685,806	0	0	0
TRANSVERSAL 1 – TAMALE-YENDI	191,700	131,348	323,048	0	0	0
TRANSVERSAL 2 – FUFULSU-SAWLA	139,094	195,306	334,400	0	0	0
TRANSVERSAL 3 – TECHIMAN-KWADWOKUROM	32,015	18,571	50,586	0	0	0
TRANSVERSAL 4 – NYINAHIN-KUMASI	78	1,536	1,614	0	0	0

Figure 4 - 28 Railway Freight Traffic 2030 – Phase 2C

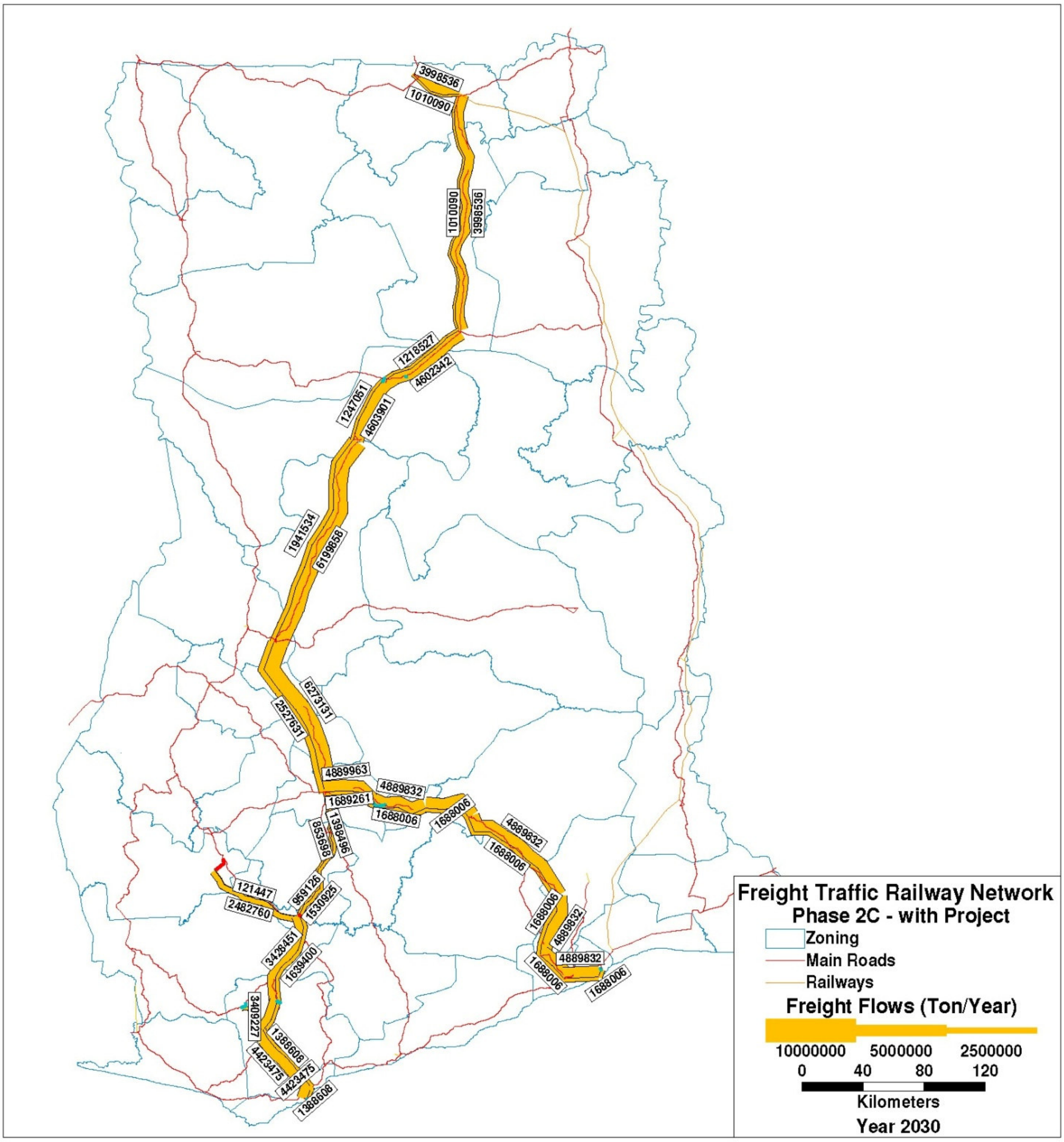


Figure 4 - 29 Road Freight Traffic 2030 – Phase 2C

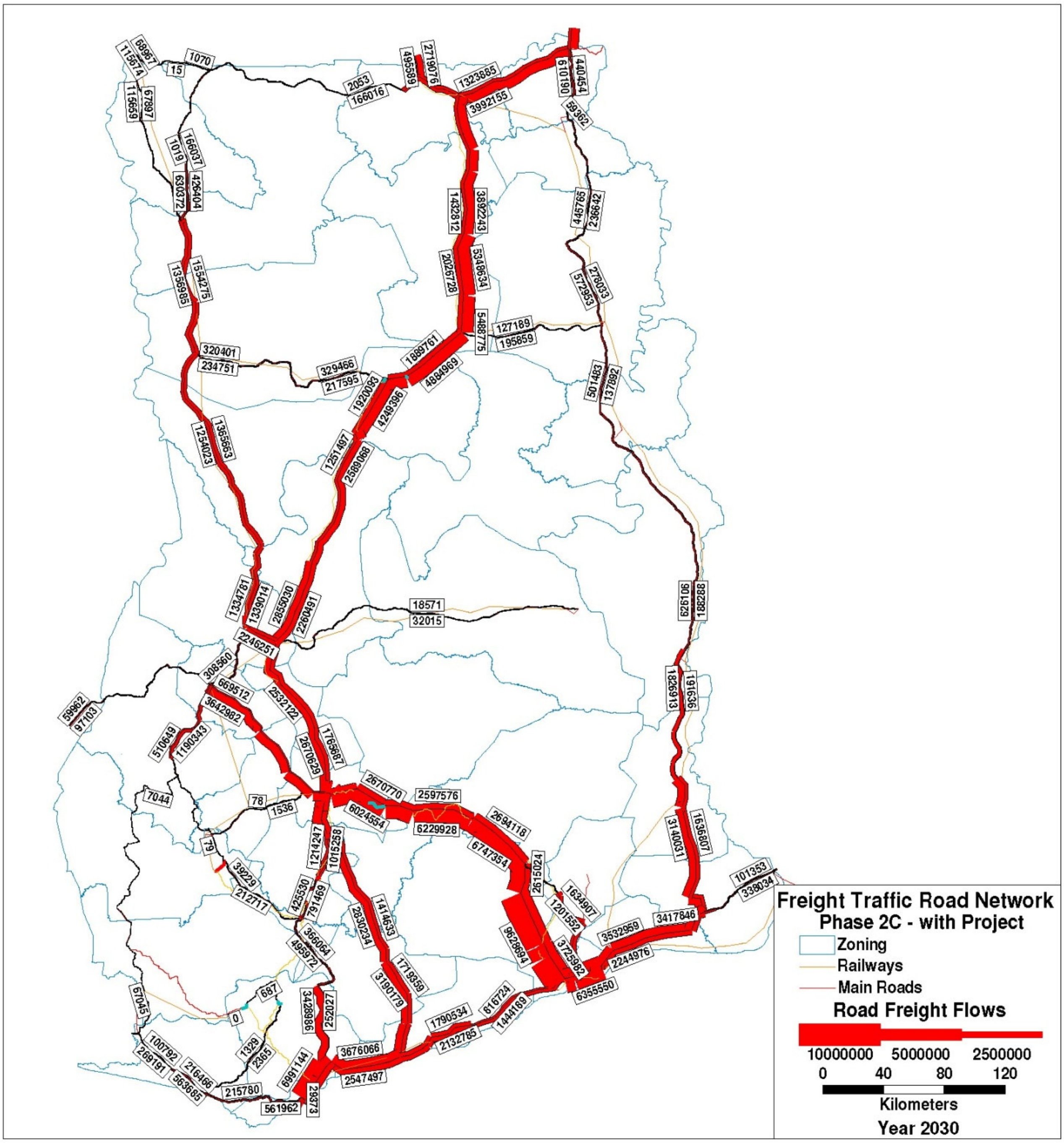


Figure 4 - 30 Multimodal Passenger Traffic 2030 – Phase 2

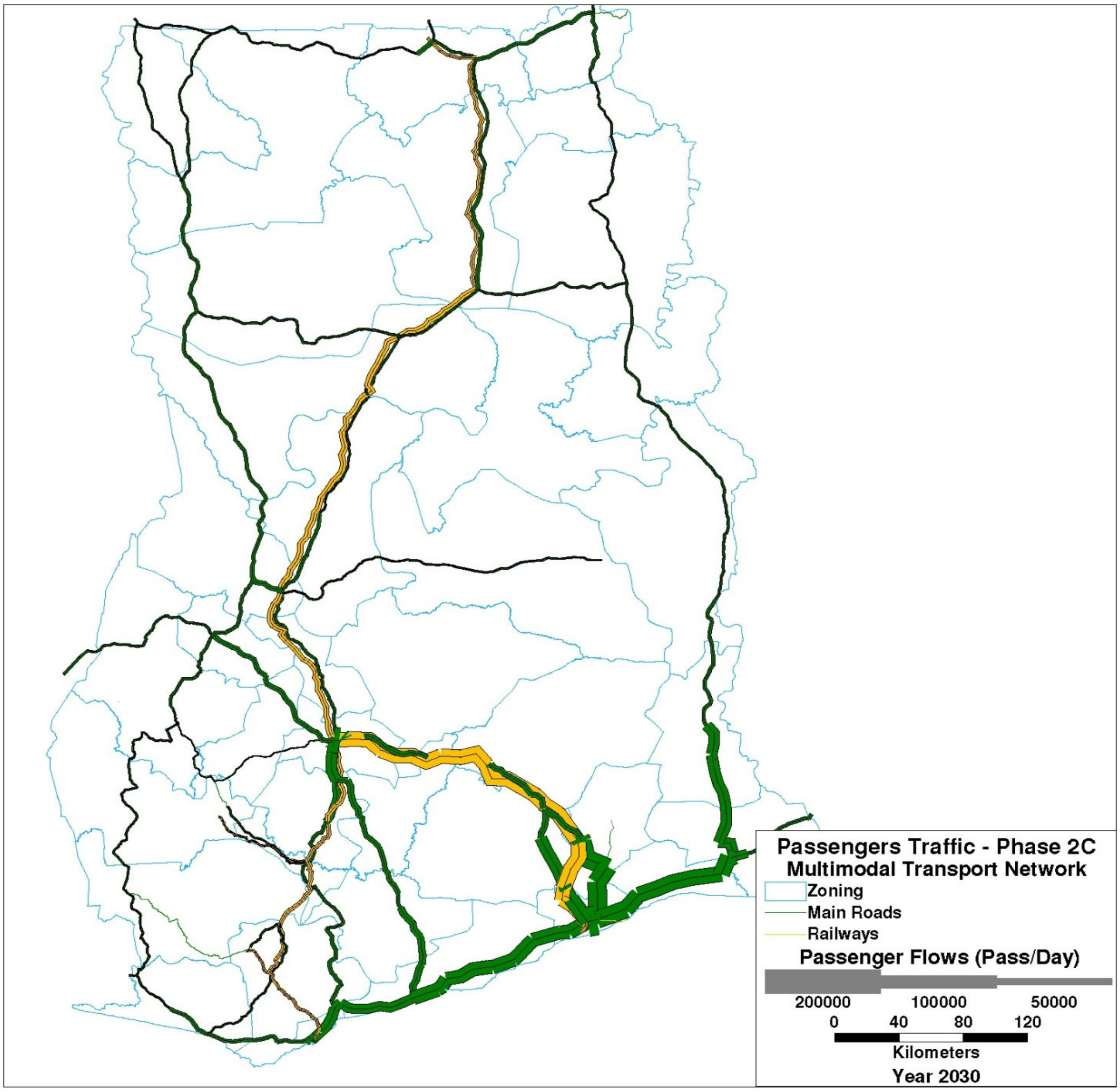


Table 4 - 28 Passengers – Year 2030

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
WESTERN	16,405	16,738	33,143	5,283	5,278	10,561
EASTERN	34,794	34,903	69,698	48,655	48,465	97,120
KUMASI PAGA	3,375	3,222	6,597	15,067	14,874	29,941
ECOWAS CORRIDOR	30,503	30,747	61,250	0	0	0
WESTERN EXPANSION	5,327	5,366	10,693	0	0	0
EASTERN EXPANSION	7,664	7,663	15,327	0	0	0
TRANSVERSAL 1 – TAMALE-YENDI	961	960	1,921	0	0	0
TRANSVERSAL 2 – FUFULSU-SAWLA	438	442	880	0	0	0
TRANSVERSAL 3 – TECHIMAN-KWADWOKUROM	313	313	626	0	0	0
TRANSVERSAL 4 – NYINAHIN-KUMASI	0	141	141	0	0	0

Figure 4 - 31 Railway Passenger Traffic 2030 – Phase 2C

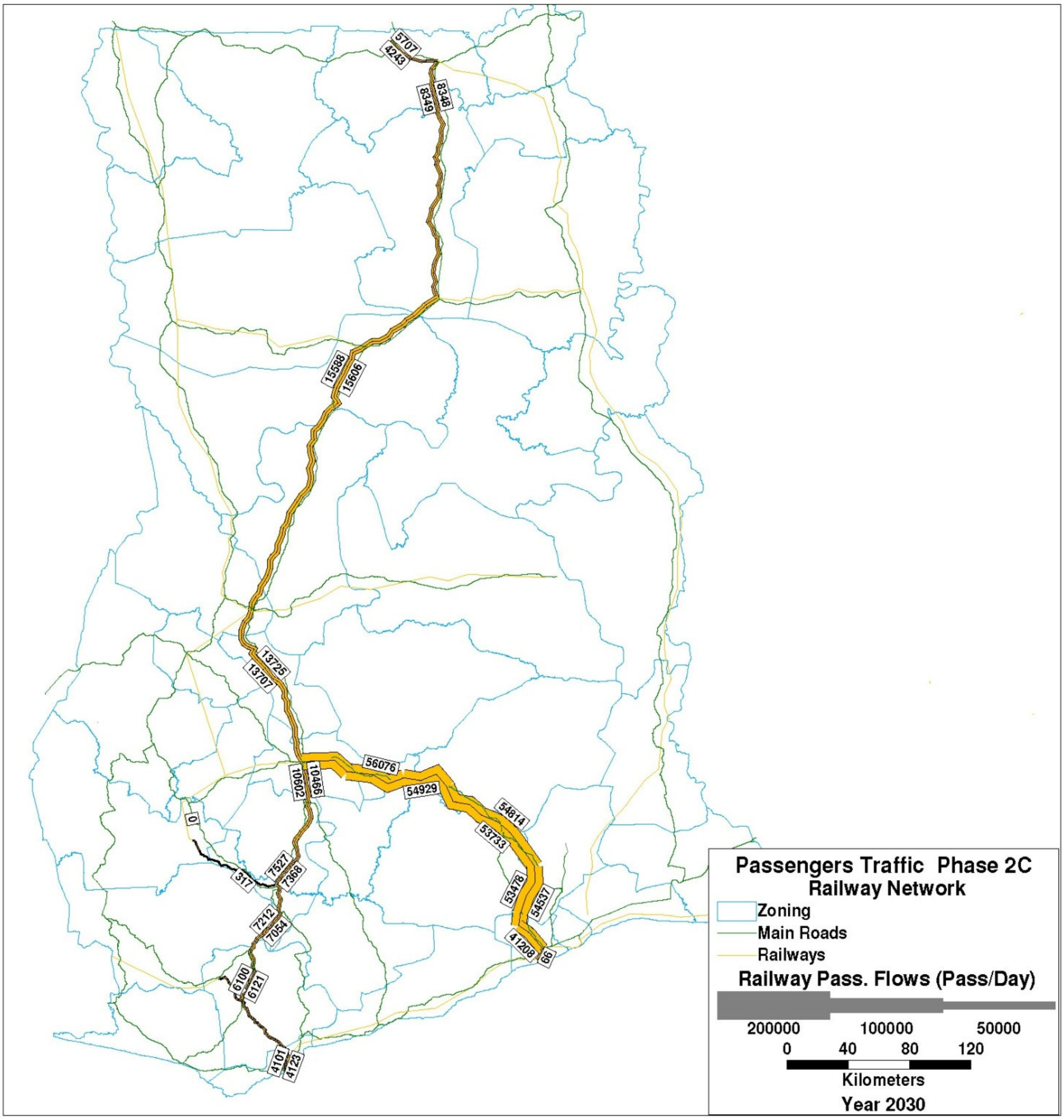
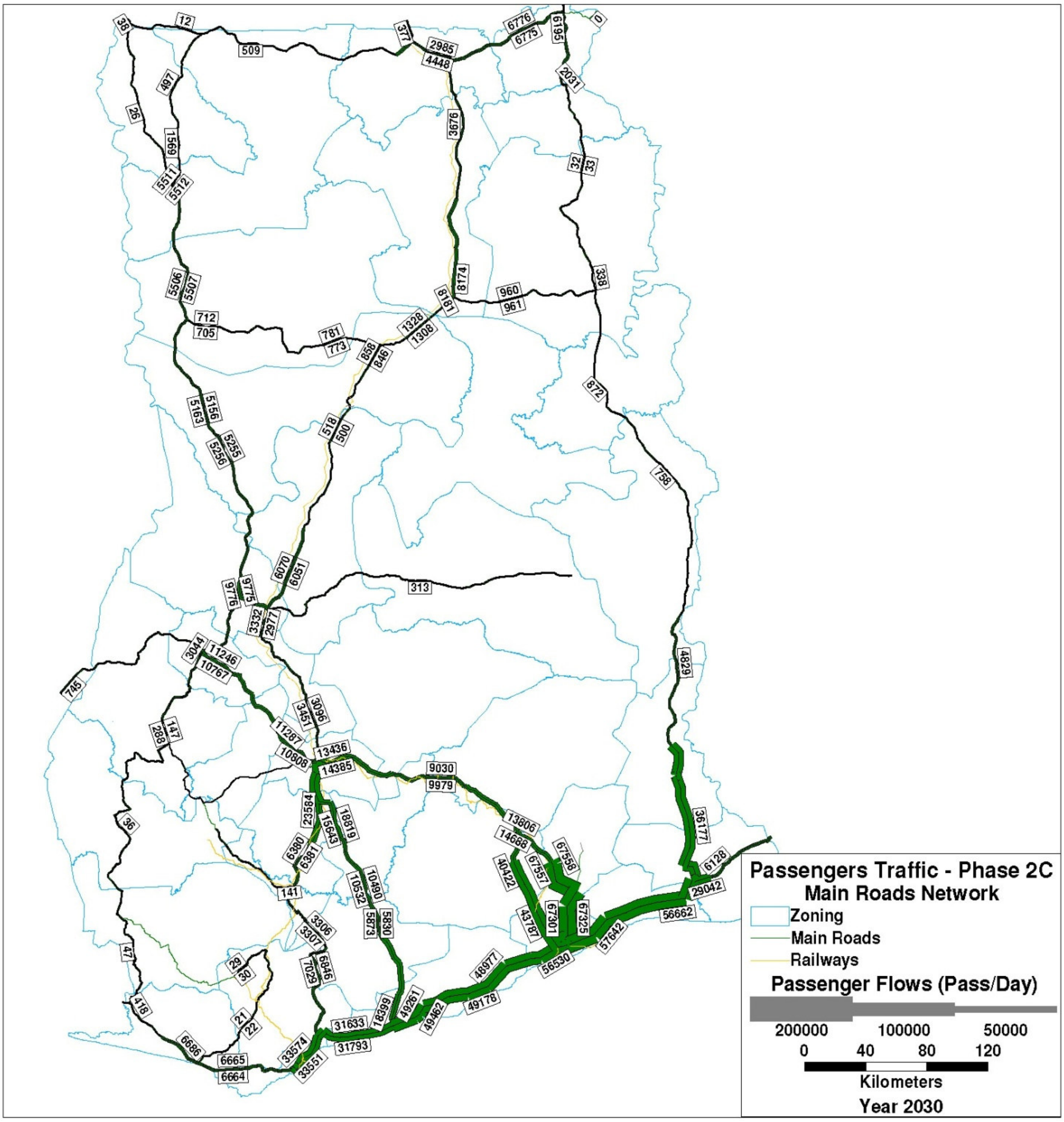


Figure 4 - 32 Road Passenger Traffic 2030 – Phase 2C



4.4 TRAFFIC ASSIGNMENTS AT YEAR 2047

4.4.1 Without Project Scenarios at Year 2047

Following are the results of the traffic assignments " without project" both ways for Cargo and Passengers at year **2047:**

In the "Without Project" scenario at year 2047, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 12.0 million tons/year and about 55,000 passengers/daily;
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 25.0 million tons/year and about 190,000 passengers/daily;
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 24.0 million tons/year and 43,000 passenger/day;
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 5.3 million tons/year and 86,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla is around 0.5 million tons/year and 1,300 passengers/day. Cargo along the transversal Tamale – Yendi is around 375,000 tons/year and 1,400 passengers/day Cargo along the transversal Nyinahin - Kumasi is around 0.6 million tons/year and 4,300 passengers/day. Cargo along the transversal Techiman-Kwadwokurom road is around 100,000 tons/year and 900 passengers/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 4.6 million tons/year and 15,500 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 2.1 million tons/year and 23,000 passengers/day,

Figure 4 - 33 Freight Traffic 2047 – Without Project

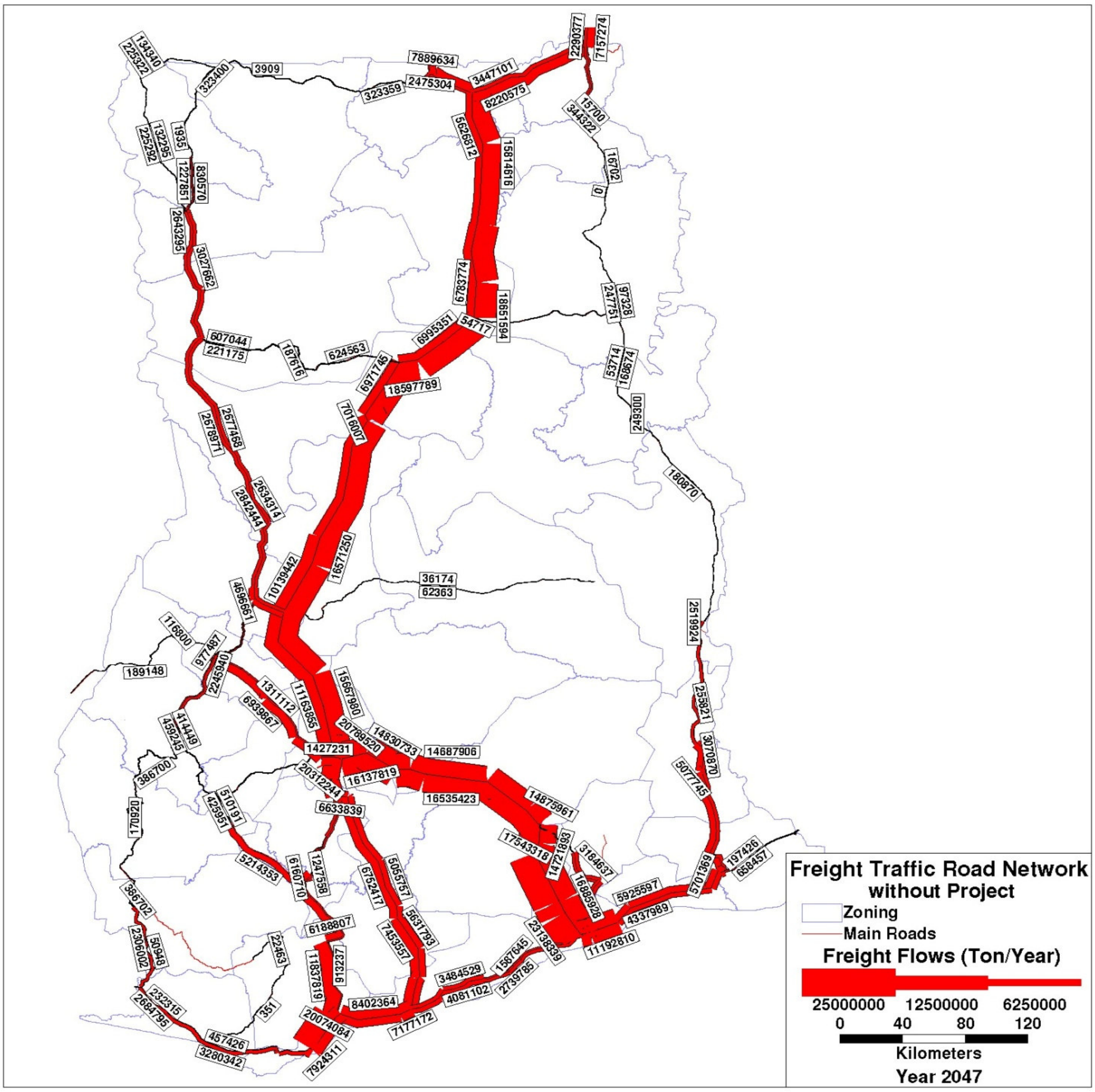


Table 4 - 29 Freight – Year 2047

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	7,513,474	4,431,174	11,944,648	0	0	0
Eastern	12,885,225	12,049,019	24,934,244	0	0	0
Kumasi Paga	10,116,869	13,526,695	23,643,564	0	0	0
Ecowas Corridor	2,186,801	3,042,552	5,229,354	0	0	0
Western Expansion	2,615,351	2,030,228	4,645,578	0	0	0
Eastern Expansion	839,219	1,264,047	2,103,265	0	0	0
Transversal 1 – Tamale-Yendi	70,790	304,026	374,815	0	0	0
Transversal 2 – Fufulsu-Sawla	128,124	370,093	498,217	0	0	0
Transversal 3 – Techiman-Kwadwokurom	62,363	36,174	98,537	0	0	0
Transversal 4 – Nyinahin-Kumasi	140,051	484,867	624,918	0	0	0

Figure 4 - 34 Passenger Traffic 2047 – Without Project

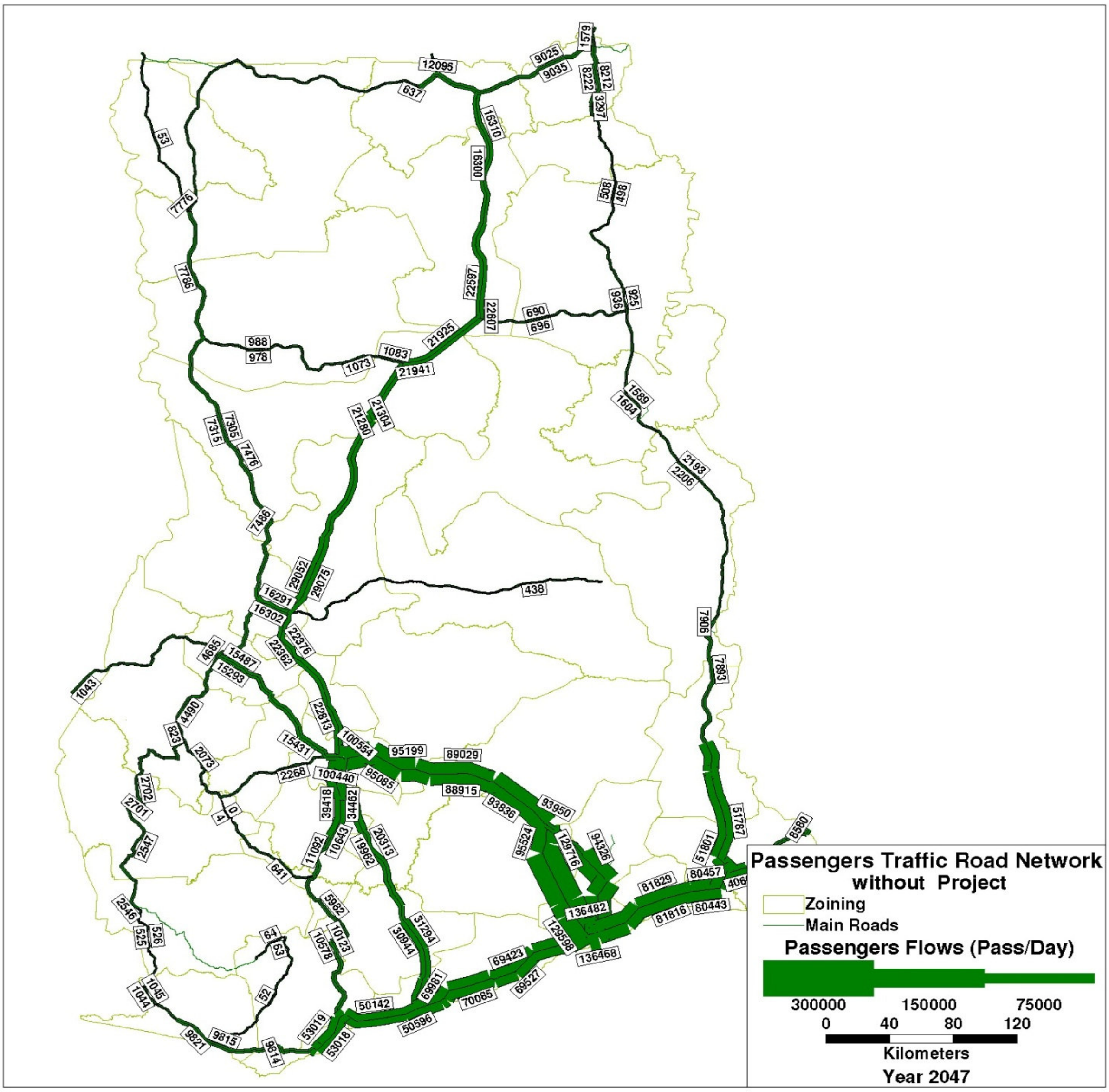


Table 4 - 30 Passengers – Year 2047

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	27,358	27,920	55,278	0	0	0
Eastern	94,292	94,245	188,537	0	0	0
Kumasi Paga	20,785	20,793	41,578	0	0	0
Ecowas Corridor	43,352	43,347	86,699	0	0	0
Western Expansion	7,516	7,528	15,044	0	0	0
Eastern Expansion	11,609	11,608	23,216	0	0	0
Transversal 1 – Tamale-Yendi	696	690	1,386	0	0	0
Transversal 2 – Fufulsu-Sawla	607	614	1,221	0	0	0
Transversal 3 – Techiman-Kwadwokurom	438	438	877	0	0	0
Transversal 4 – Nyinahin-Kumasi	2,077	2,268	4,345	0	0	0

4.4.2 Phase 6 - Year 2047

Phase 6 is the extension of the North- East Corridor from Tema, Akosombo, Ho and Yendi,

In the case of construction of the Eastern Expansion railway line, the traffic volumes are the following:

- Western corridor: Cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi – Kumasi present a weighted average of about 7.4 million tons/year and about 36,000 passengers/daily, The new Western railway will attract 7.9 million tons/year and 16,000 passengers/daily;
- Eastern corridor: Cargo along the RN6: Accra – Kumasi and RN4: Accra – Koforidua then Kumasi present a weighted average of about 13.2 million tons/year and about 123,000 passengers/daily, The new railway will absorb 11.0 million tons/year and 131,000 passengers/day;
- Kumasi-Paga corridor: Cargo along the RN10: Kumasi-Paga is 7.5 million tons/year and 7,600 passenger/day, The new railway will absorb 13.4 million tons/year and 36,000 passengers/day;
- Trans-ECOWAS corridor: Cargo along the RN1: Aflao – Omanpe is 3.8 million tons/year and 43,000 passengers/day, The new railway will absorb 0.5 million tons/year and 38,000 passengers/day;
- Transversal corridors: Cargo along the main transversal Fufulsu – Sawla road is around 0.4 million tons/year and 1,000 passengers/day, The new railway will absorb 93,000 tons/year and 2,000 passengers/day, Cargo along the transversal Tamale – Yendi road is around 0.6 million tons/year and 70 passengers/day, the new railway will absorb 5.7 million/year and 12,000 passenger/day, Cargo along the transversal Nyinahin-Kumasi road is around 0.5 million tons/year and 160 passengers/day, the new railway will absorb 1.0 million/year and 4,500 passenger/day;
- Western expansion corridor: Cargo along the RN12: Dunkwa – Wa – Hamile is 1.6 million tons/year and 5,000 passengers/day, The new railway will absorb 3.6 million tons/year and 10,000 passengers/day;
- Eastern expansion corridor: Cargo along the RN2: Tema – Yendi is 1.9 million tons/year and 8,000 passengers/day, The new railway will absorb 5.5 million tons/year and 24,000 passengers/day.

Figure 4 - 35 Multimodal Freight Traffic 2047 – Phase 6

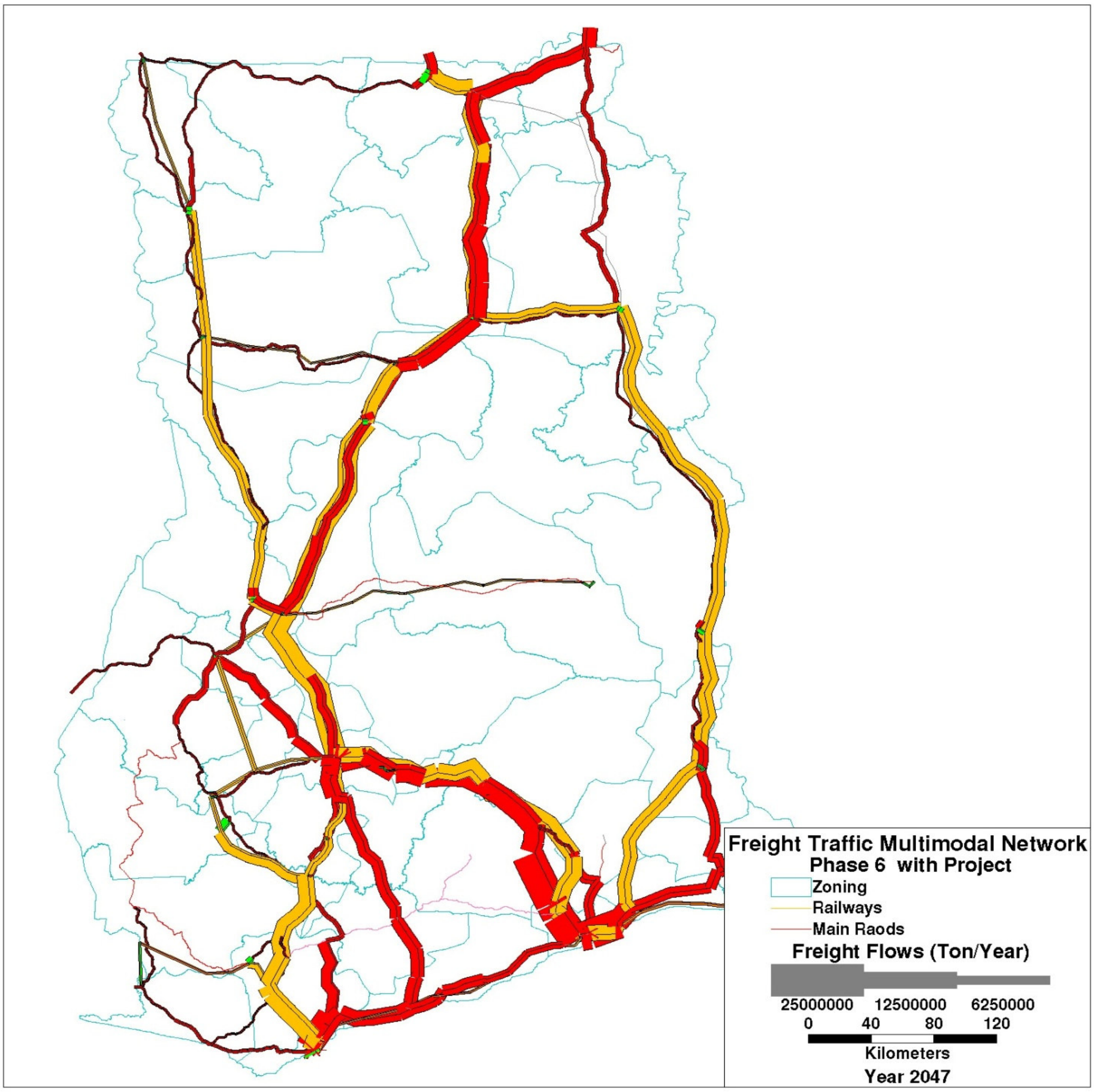


Table 4 - 31 Freight – Year 2047

CORRIDORS	ROAD			RAILWAY		
	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)	Northbound (Ton)	Southbound (Ton)	Total Average (Ton)
Western	4,534,362	2,838,134	7,372,496	2,097,846	5,788,211	7,886,056
Eastern	7,232,601	5,997,788	13,230,388	5,217,478	5,753,266	10,970,744
Kumasi Paga	3,883,265	3,671,459	7,554,724	9,420,726	3,983,287	13,404,013
Ecowas Corridor	1,893,105	1,909,757	3,802,861	432,878	117,743	550,621
Western Expansion	1,022,605	586,811	1,609,417	1,802,465	1,852,497	3,654,962
Eastern Expansion	909,420	989,000	1,898,420	2,466,754	3,079,279	5,546,033
Transversal 1 – Tamale-Yendi	516,904	101,009	617,913	1,834,546	3,899,930	5,734,476
Transversal 2 – Fufulsu-Sawla	112,916	245,984	358,899	72,576	20,677	93,253
Transversal 3 – Techiman-Kwadwokurom	0	0	0	62,363	36,174	98,537
Transversal 4 – Nyinahin-Kumasi	80,387	372,746	453,133	539,234	418,460	957,694

Figure 4 - 36 Railway Freight Traffic 2047 – Phase 6

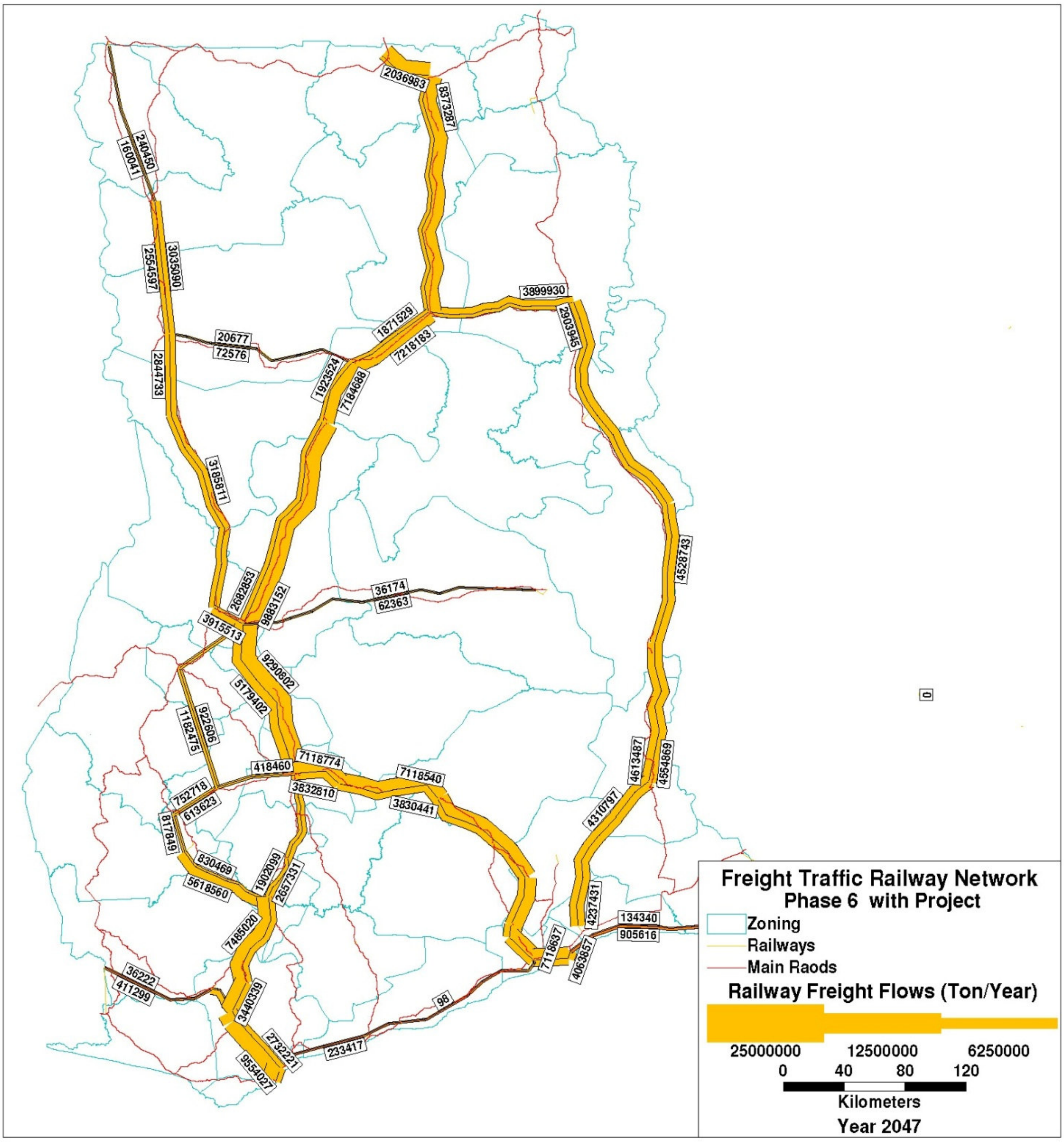
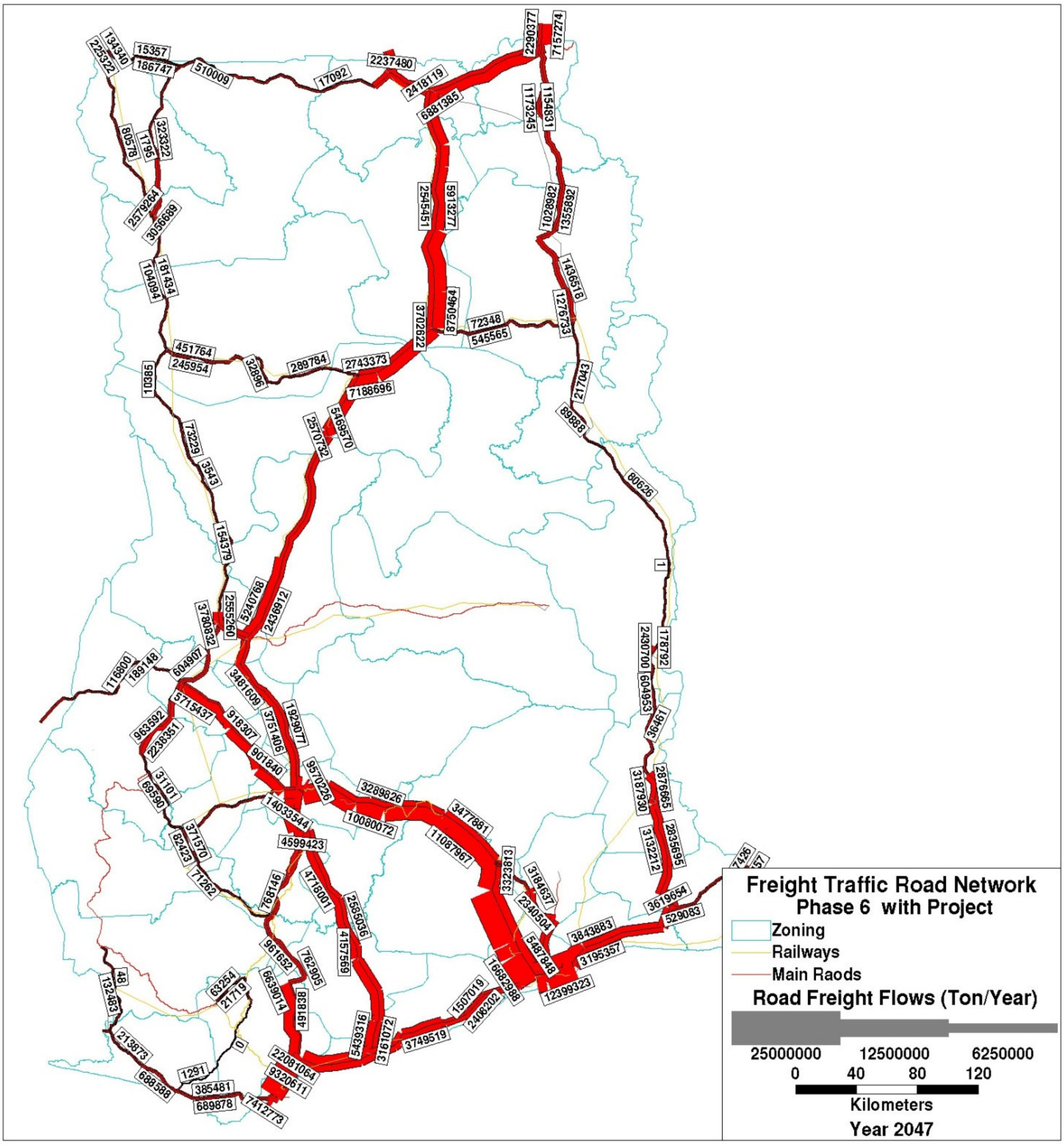


Figure 4 - 37 Road Freight Traffic 2047 – Phase 6



- **Passengers**

Figure 4 - 38 Multimodal Passengers Traffic 2047 – Phase 6

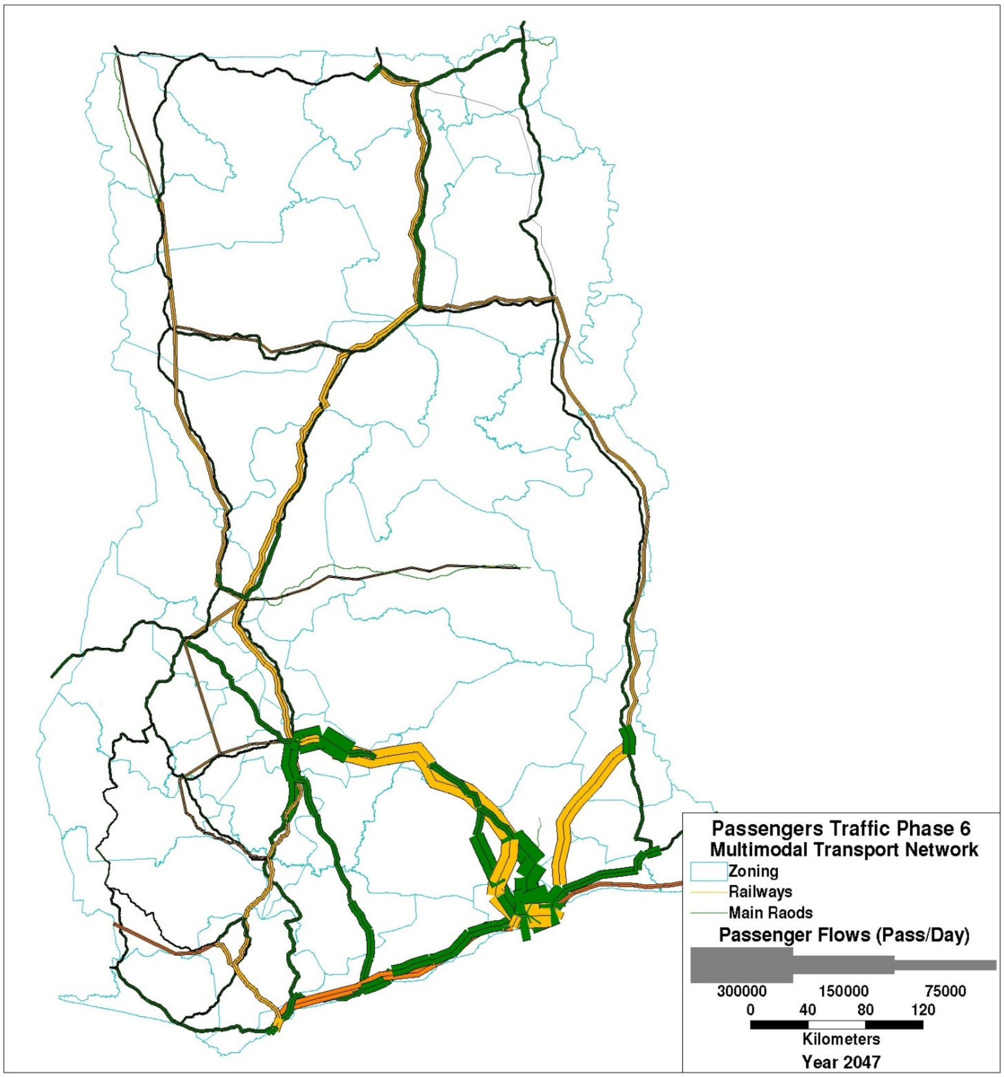


Table 4 - 32 Passengers – Year 2047

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)	Northbound (Pass/Day)	Southbound (Pass/Day)	Total Average (Pass/Day)
Western	17,897	18,606	36,502	7,955	7,977	15,932
Eastern	61,804	61,342	123,146	64,543	66,088	130,631
Kumasi Paga	3,822	3,805	7,627	18,115	18,127	36,242
Ecowas Corridor	21,586	21,804	43,390	18,596	19,790	38,386
Western Expansion	2,656	2,670	5,326	4,991	4,933	9,924
Eastern Expansion	3,926	3,926	7,852	11,984	11,987	23,972
Transversal 1 – Tamale-Yendi	33	37	70	6,045	6,050	12,095
Transversal 2 – Fufulsu-Sawla	457	458	916	961	933	1,894
Transversal 3 – Techiman-Kwadwokurom	0	0	0	438	438	877
Transversal 4 – Nyinahin-Kumasi	1	160	161	2,198	2,173	4,371

Figure 4 - 39 Railway Passengers Traffic 2047 – Phase 6

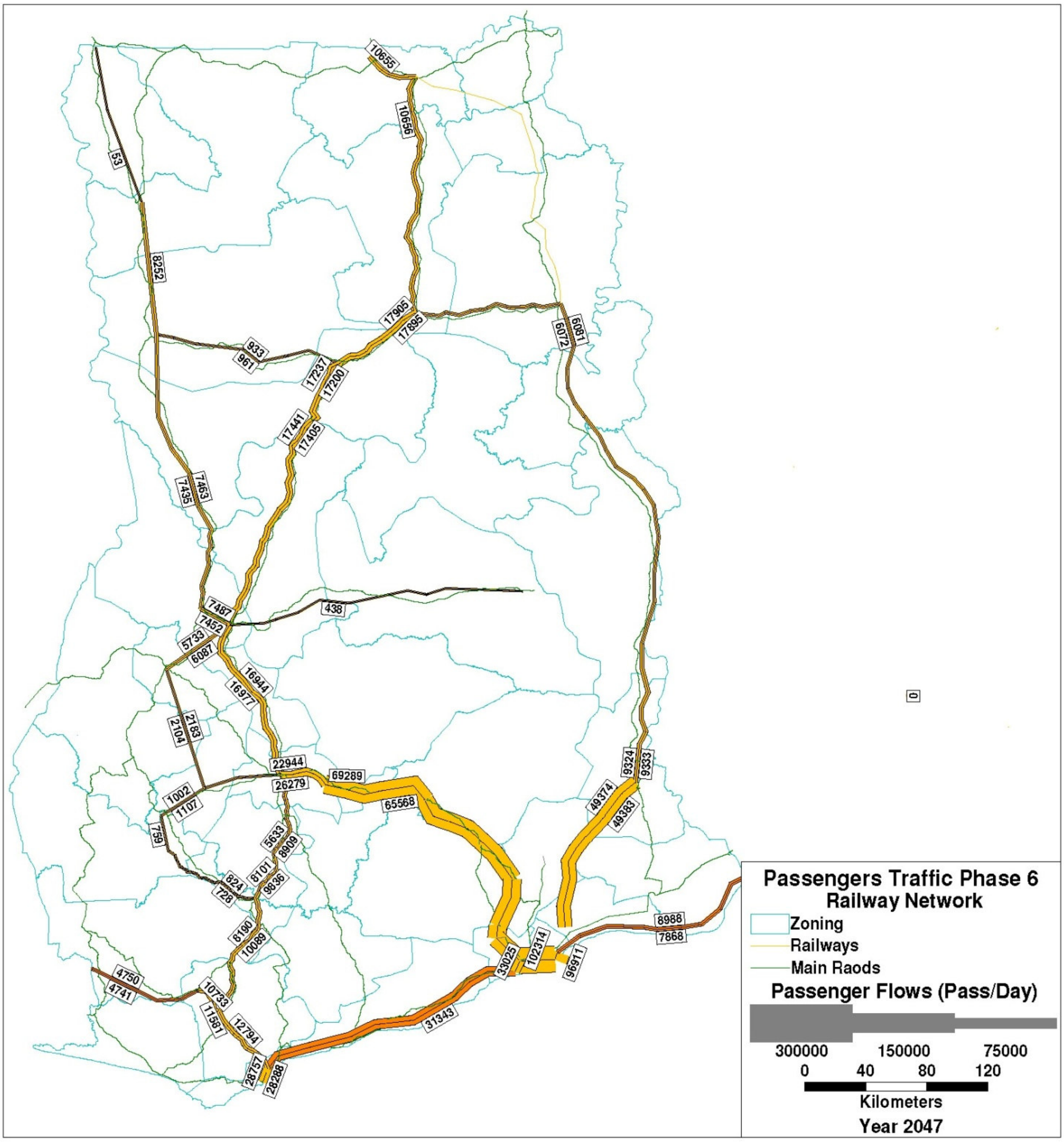
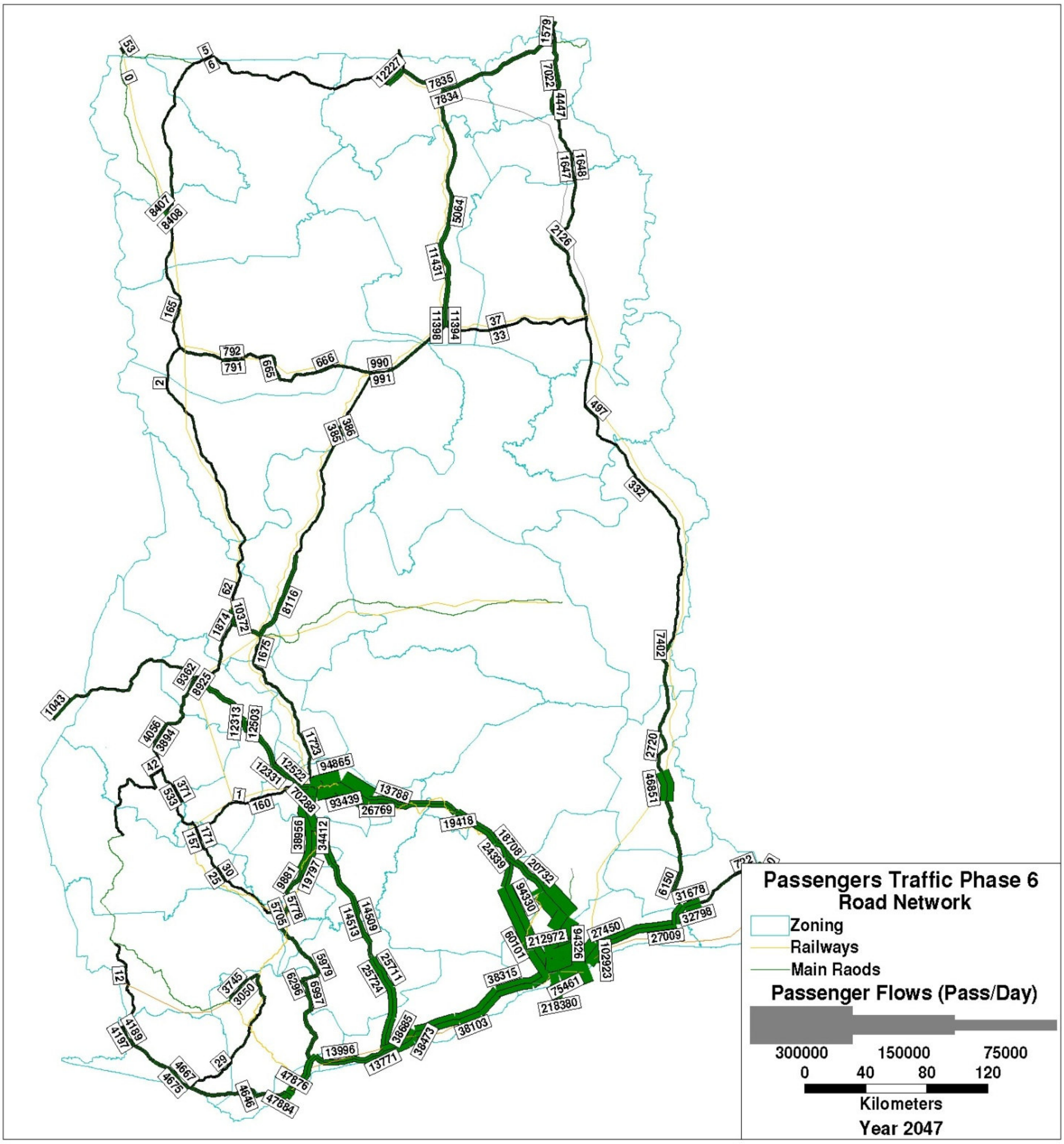


Figure 4 - 40 Road Passengers Traffic 2047 – Phase 6



4.5 CARGO MOBILITY IN THE FUTURE

Cargo mobility in the future along the different transport corridors analyzed are the following:

- Western corridor: In the "Without Project" scenario, cargo along the RN8: Cape Coast – Kumasi and RN10: Takoradi–Kumasi in year 2015 has a weighted average of about 3.5 million tons/year. This volume will rise to 6.1 million tons/year (2030) and 11.9 million tons by year 2047. With the implementation of the Phase 2 projects, these values will be reduced to 2.3 million tons/year (2015), 4.1 million tons/year (2030) and 7.3 million tons/year (2047) along the road, diverting 2.0 million tons/year (2015), 3.6 million tons/year (2030) and 7.9 million tons/year (2047) on to the new railway line SG.
- Eastern corridor: In the "Without Project" scenario, cargo along the RN6: Accra – Kumasi and RN4: Accra–Koforidua-Kumasi at present (2015) has a weighted average of about 7.1 million tons/year. This volume will rise to 12.8 million tons/year (2030) and 24.9 million tons by year 2047. With the implementation of the Phase 2 projects, these values will be reduced to 4.5 million tons/year (2015), 8.0 million tons/year (2030) and 13.2 million tons/year (2047) along the road, diverting 3.6 million tons/year (2015), 6.6 million tons/year (2030) and 10.9 million tons/year (2047) on to the new railway line SG.
- Kumasi-Paga corridor: In the "Without Project" scenario, cargo along the RN10: Kumasi-Paga is 6.7 million tons/year. This volume will rise to 12.1 million tons/year (2030) and 23.6 million tons at year 2047. With the implementation of the Phase 2 projects, these values will be reduced to 2.8 million tons/year (2015), 5.1 million tons/year (2030) and 7.5 million tons/year (2047) along the road, diverting 4.3 million tons/year (2015), 7.8 million tons/year (2030) and 13.4 million tons/year (2047) on to the new railway line SG.
- Trans-ECOWAS corridor: In the "Without Project" scenario, cargo along the RN1: Aflao–Omanpe is 1,5 million tons/year in year 2015. This volume will raise to 2.7 million tons/year (2030) and 5.2 million tons by year 2047. With the implementation of the Phase 6 projects, these values will be reduced to 3.8 million tons/year along the road, while 0.5 million tons/year will be diverted on to the new railway at year 2047.
- Transversal corridors: In the "Without Project" scenario, cargo along the Fufulsu–Sawla road is 150,000 tons/year (2015), 255,000 tons/year (2030) and 500,000 tons/year (2047), along the Tamale–Yendi road: 105,000 tons/year (2015), 190,000 tons/year (2030) and 375,000 tons/year (2047), along the Nyinahin-Kumasi road: 46,000 tons/year (2015), 321,000 tons/year (2030) and 625,000 tons/year (2047). With the implementation of the Phase 6 projects, these values will become at year 2047 to: Fufulsu–Sawla road 360,000 tons/year along the road and 93,000 tons/year by rail, along the Tamale–Yendi road: 618,000 tons/year and 5.7 million tons by rail, along Nyinahin-Kumasi 455,000 tons/year (road) and 0.95 million tons (rail).
- Western expansion corridor: In the "Without Project" scenario, cargo along the RN12: Dunkwa–Wa–Hamile is 1.3 million tons/year (2015), then 2.4 million tons/year (2030) and 4.6 million tons/year (2047). With the implementation of the Phase 6 projects, these values will become 1.6 million tons along the road, while 3.6 million tons will be diverted on to the new railway by year 2047.
- Eastern expansion corridor: In the "Without Project" scenario, cargo along the RN2: Tema–Yendi is 0.6 million tons/year (2015), then 1.1 million tons/year (2030) and 2.1 million tons/year (2047). With the implementation of the Phase 6 projects, these values will become 1.9 million tons along the road, while 5.5 million tons will be diverted on to the new railway by year 2047.

The following tables show the variations of the cargo traffic volumes along the different transport corridors of the country, with the implementation of the different Project phases and their evolution from year 2015 to year 2030 and 2047.

Table 4 - 33 Freight Traffic by Phases – at Year 2015

Freight Traffic at Year 2015		Without Project	Phase - 1W		Phase - 1E		Phase - 1 NG		Phase - 2W		Phase - 2E		Phase - 2		Phase - 2C		Phase - 3		Phase - 4		Phase - 5		Phase - 6	
Num.	Section		With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project	
		Road	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail
		tons/ year	tons/Year		tons/Year		tons/Year		tons/Year		tons/Year		tons/Year		tons/Year		tons/Year		tons/Year		tons/Year		tons/Year	
Western Line	Takoradi-Kumasi	3,469,049	2,378,096	2,006,248	3,468,887	-	2,087,008	1,958,647	1,389,195	3,204,320	3,468,745	-	2,290,225	1,534,900	2,290,225	2,029,986	2,231,165	2,185,436	2,217,243	2,189,593	2,105,422	2,217,539	2,101,588	2,247,983
Eastern Line	Accra-Kumasi	7,098,261	7,026,567	-	6,012,625	1,621,146	6,034,580	2,046,818	7,036,796	-	4,907,066	3,274,779	4,836,521	3,546,241	4,472,455	3,652,531	4,364,948	4,241,154	4,287,974	4,340,812	3,883,801	5,017,966	3,771,427	3,127,298
Kumasi-Paga	Takoradi-Kumasi + Accra-Kumasi	6,761,702	6,765,723	-	6,761,702	-	6,765,723	-	6,765,723	-	6,761,702	-	6,765,723	-	2,862,614	4,357,097	2,711,619	5,281,098	2,733,374	5,281,007	2,236,674	5,057,028	2,153,534	3,820,920
Trans-Ecowas Expansion	Aflao-Accra-Takoradi-Omanpe	1,499,113	1,321,392	-	1,498,880	-	1,263,156	-	1,316,241	-	1,498,678	-	1,262,734	-	1,357,974	-	1,279,259	-	1,154,730	124,611	1,152,483	131,656	1,084,036	156,959
Western Exp	Dunkwa-Awaso-Hamile	1,326,647	1,295,657	-	1,326,647	-	1,308,621	-	1,307,309	-	1,326,647	-	1,307,157	-	1,302,739	-	910,758	-	898,606	-	469,178	1,216,987	458,777	1,041,876
Eastern Exp	Tema-Yendi-Tamale	595,037	595,037	-	595,037	-	595,037	-	595,037	-	595,037	-	595,037	-	936,068	-	650,115	-	650,106	-	693,819	-	541,160	1,580,941
Transversal - 3.1	Tamale-Yendi	106,685	106,685	-	106,685	-	106,685	-	106,685	-	106,685	-	106,685	-	179,377	-	31,061	480,494	31,061	480,460	30,988	652,866	176,141	1,634,658
Transversal - 3.2	Fufulsu-Sawla	141,914	141,914	-	141,914	-	141,914	-	141,914	-	141,914	-	141,914	-	185,681	-	127,860	1,091,924	127,860	1,091,924	97,455	160,147	102,307	26,583
Transversal - 3.3	Techiman-Kwadwokurom	28,089	28,089	-	28,089	-	28,089	-	28,089	-	28,089	-	28,089	-	28,089	-	14	28,075	14	28,075	-	28,089	-	28,089
Transversal - 3.4	Nyinahin-Kumasi	46,625	804	-	46,625	-	853	-	904	-	46,625	-	902	-	896	-	132,421	316,318	132,421	316,319	123,587	980,179	129,169	272,998

Table 4 - 34 Freight Traffic for Phases 2 and 6 at Years 2015 and 2047

Freight Traffic at Year 2030		Phase - 2C		
		Without Project	With Project	
Num.	Section	*Road*	*Road*	*Railway*
		Cargo (tons)	Cargo (tons)	
Western Line	Takoradi-Kumasi	6,132,063	4,124,566	3,655,890
Eastern Line	Accra-Kumasi	12,800,574	8,054,639	6,578,002
Kumasi-Paga	Takoradi-Kumasi + Accra-Kumasi	12,137,973	5,155,406	7,846,885
Trans-ECOWAS Expansion	Aflao-Accra-Takoradi-Omanpe	2,684,610	2,445,634	0
Western Exp.	Dunkwa-Awaso-Hamile	2,384,916	2,346,159	0
Eastern Exp.	Tema-Yendi-Tamale	1,079,760	1,685,806	0
Transversal - 3.1	Tamale-Yendi	192,420	323,047	0
Transversal - 3.2	Fufulsu-Sawla	255,772	334,400	0
Transversal - 3.3	Techiman-Kwadwokurom	50,586	50,586	0
Transversal - 3.4	Nyinahin-Kumasi	320,816	1,614	0

Freight Traffic at Year 2047		Phase - 6		
		Without Project	With Project	
Num.	Section	*Road*	*Road*	*Railway*
		Cargo (tons)	Cargo (tons)	
Western Line	Takoradi-Kumasi	11,944,648	7,372,496	7,886,056
Eastern Line	Accra-Kumasi	24,934,244	13,230,388	10,970,744
Kumasi-Paga	Takoradi-Kumasi + Accra-Kumasi	2,643,564	7,554,724	13,404,013
Trans-ECOWAS Expansion	Aflao-Accra-Takoradi-Omanpe	5,229,354	3,802,861	550,621
Western Exp.	Dunkwa-Awaso-Hamile	4,645,578	1,609,416	3,654,962
Eastern Exp.	Tema-Yendi-Tamale	2,103,265	1,898,419	5,546,033
Transversal - 3.1	Tamale-Yendi	374,815	617,913	5,734,476
Transversal - 3.2	Fufulsu-Sawla	498,217	358,899	93,253
Transversal - 3.3	Techiman-Kwadwokurom	98,537	0	98,537
Transversal - 3.4	Nyinahin-Kumasi	624,918	453,133	957,694

4.6 PASSENGER MOBILITY

Passenger mobility in the future along the different transport corridors analyzed are the following:

- Western corridor: In the "Without Project" scenario, daily passengers volume along the RN8: Cape Coast–Kumasi and RN10: Takoradi–Kumasi present at year 2015 are 29,300. This volume will raise to 39,500 (2030) and 55,300 by year 2047. With the implementation of the Phase 2 projects, these values will be reduced to 25,000 (2015), 33,100 (2030) and 36,500 (2047) along the road, diverting 7,300 (2015), 10,500 (2030) and 16,000 (2047) on to the new railway line SG.
- Eastern corridor: In the "Without Project" scenario, daily passengers volume along the RN6: Accra–Kumasi and RN4: Accra–Koforidua-Kumasi present (2015) a weighted average of about 100,000. This volume will raise to 135,000 (2030) and 190,000 by year 2047. With the implementation of the Phase 2 projects, these values will be reduced to 52,000 (2015), 70,000 (2030) and 123,000 (2047) along the road, diverting 72,000 (2015), 97,000 (2030) and 131,000 (2047) on to the new railway line SG.
- Kumasi-Paga corridor:, In the "Without Project" scenario, daily passengers volume along the RN10: Kumasi-Paga is 22,000 (2015). This volume will raise to 30,500 (2030) and 43,000 at year 2047. With the implementation of the Phase 2 projects, these values will be reduced to 5,000 (2015), 6,600 (2030) and 7,600 (2047) along the road, diverting 22,000 (2015), 30,000 (2030) and 36,000 (2047) on to the new railway line SG.
- Trans-ECOWAS corridor: In the "Without Project" scenario, daily passengers volume along the RN1: Aflao–Omanpe is 46,000 at year 2015. This volume will raise to 61,700 (2030) and 86,400 at year 2047. With the implementation of the Phase 6 projects, these values will be reduced to 43,400 along the road, while 38,400 will be diverted on to the new railway by year 2047.
- Transversal corridors: In the "Without Project" scenario, daily passengers volume along the Fufulsu–Sawla road is 650 (2015), 900 (2030) and 1,250 (2047), along the Tamale–Yendi road: 750 (2015), 1,400 (2030) and 2,000 (2047); along the Nyinahin-Kumasi road: 900 (2015), 1,200 (2030) and 1,700 (2047). With the implementation of the Phase 6 projects, these values will become at year 2047 to: Fufulsu–Sawla route 900 along the road and 1,900 by rail; along the Tamale–Yendi route: 70 and 12,100 by rail: along Nyinahin-Kumasi 160 (road) and 4,400 (rail).
- Western expansion corridor: In the "Without Project" scenario, daily passengers volume along the RN12: Dunkwa–Wa–Hamile is 8,000 (2015), then 11,100 (2030) and 15,500 (2047). With the implementation of the Phase 6 projects, these values will become 5,300 along the road, while 9,900 will be diverted on to the new railway by year 2047.
- Eastern expansion corridor: In the "Without Project" scenario, daily passengers volume along the RN2: Tema–Yendi is 12,300 (2015), then 15,600 (2030) and 21,900 (2047). With the implementation of the Phase 6 projects, these values will become 7,800 along the road, while 24,000 will be diverted on to the new railway by year 2047.

The following tables show the variations of the daily passengers traffic volumes along the different transport corridors of the country, with the implementation of the different project phases and their evolution from year 2015 to year 2030 and 2047.

Table 4 - 35 Passenger Traffic by Phases – at Year 2015

Passengers Traffic at Year 2015			Phase - 1W		Phase - 1E		Phase - 1NG		Phase - 2W		Phase - 2E		Phase - 2		Phase - 2C		Phase - 3		Phase - 4		Phase - 5		Phase - 6	
Num.	Section	Without Project	With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project	
		Road	Road	Rai	Road	Rai	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail
		Passengers (Pass/Day)	Passengers (Pass/Day)		Passengers (Pass/Day)		Passengers (Pass/Day)		Passengers (Pass/Day)		Passengers (Pass/Day)		Passengers (Pass/Day)		Passengers (Pass/Day)		Passengers (Pass/Day)		Passengers (Pass/Day)		Passengers (Pass/Day)		Passengers (Pass/Day)	
Western Line	Takoradi-Kumasi	29,332	26,016	5,967	29,321	0	25,343	5,033	22,212	11,425	29,301	0	25,330	5,040	24,634	7,287	21,837	11,014	13,003	16,632	16,816	10,696	14,005	14,181
Eastern Line	Accra-Kumasi	100,044	99,926	0	63,364	53,755	77,616	39,730	100,104	0	52,472	69,991	57,850	62,074	51,790	72,157	48,256	81,008	43,875	81,987	43,886	84,811	43,298	81,148
Kumasi-Paga	Takoradi-Kumasi + Accra-Kumasi	22,062	22,069	0	22,130	0	24,071	0	22,069	0	22,583	0	22,190	0	4,901	22,246	4,060	25,885	3,729	26,823	3,693	23,811	3,687	19,986
Trans ECOWAS Expansion	Aflao-Accra-Takoradi-Omanpe	46,006	45,904	0	45,972	0	45,590	0	45,803	0	46,031	0	45,909	0	45,511	0	44,376	0	29,040	25,590	29,078	24,442	20,718	24,132
Western Exp	Dunkwa-Awaso-Hamile	7,983	7,911	0	7,983	0	8,137	0	7,912	0	7,983	0	7,982	0	7,939	0	5,580	0	5,034	0	2,685	5,413	2,610	5,413
Eastern Exp	Tema-Yendi-Tamale	12,319	12,319	0	12,246	0	12,910	0	12,319	0	11,749	0	12,179	0	11,388	0	11,386	0	11,381	0	11,381	0	3,710	12,520
Transverasl 3.1	Tamale-Yendi	735	735	0	754	0	8,519	0	735	0	870	0	774	0	1,427	0	709	715	658	782	658	782	8	4,912
Transverasl 3.2	Fufulsu-Sawla	648	648	0	648	0	646	0	648	0	648	0	648	0	654	0	494	6'709	496	8'261	496	970	486	998
Transverasl 3.3	Techiman-Kwadwokurom	465	465	0	465	0	465	0	465	0	465	0	465	0	465	0	0	465	0	465	0	465	0	465
Transverasl 3.4	Nyinahin-Kumasi	911	103	0	900	0	900	0	103	0	912	0	900	0	105	0	81	850	81	820	70	1100	68	3'202

Passengers Traffic at Year 2015		Without Project	Phase - 1W		Phase - 1E		Phase - 1NG		Phase - 2W		Phase - 2E		Phase - 2		Phase - 2C		Phase - 3		Phase - 4		Phase - 5		Phase - 6	
Phase	Section		With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project		With Project	
		Road	Road	Railway	Road	Railway	Road	Railway	Road	Railway	Road	Railway	Road	Railway	Road	Railway	Road	Railway	Road	Railway	Road	Railway	Road	Railway	Road	Railway
		Passengers (Pax/Day)	Passengers (Pax/Day)		Passengers (Pax/Day)		Passengers (Pax/Day)		Passengers (Pax/Day)		Passengers (Pax/Day)		Passengers (Pax/Day)		Passengers (Pax/Day)		Passengers (Pax/Day)		Passengers (Pax/Day)		Passengers (Pax/Day)		Passengers (Pax/Day)	
Western Line	Takoradi-Kumasi	29,332	26,016	5,967	29,321	-	25,343	5,033	22,212	11,425	29,301	-	25,330	5,040	24,634	7,287	21,837	11,014	13,003	16,632	16,816	10,696	14,005	14,181
Eastern Line	Accra-Kumasi	100,044	99,926	-	63,364	53,755	77,616	39,730	100,104	-	52,472	69,991	57,850	62,074	51,790	72,157	48,256	81,008	43,875	81,987	43,886	84,811	43,298	81,148
Kumasi-Paga	Takoradi-Kumasi + Accra-Kumasi	22,062	22,069	-	22,130	-	24,071	-	22,069	-	22,583	-	22,190	-	4,901	22,246	4,060	25,885	3,729	26,823	3,693	23,811	3,687	19,986
Trans ECOWAS Exp.	Aflao-Accra-Takoradi-	46,006	45,904	-	45,972	-	45,590	-	45,803	-	46,031	-	45,909	-	45,511	-	44,376	-	29,040	25,590	29,078	24,442	20,718	24,132
Western Exp.	Dunkwa-Awaso-Hamile	7,983	7,911	-	7,983	-	8,137	-	7,912	-	7,983	-	7,982	-	7,939	-	5,580	-	5,034	-	2,685	5,413	2,610	5,413
Eastern Exp.	Tema-Yendi-Tamale	12,319	12,319	-	12,246	-	12,910	-	12,319	-	11,749	-	12,179	-	11,388	-	11,386	-	11,381	-	11,381	-	3,710	12,520
Transversal - 3.1	Tamale-Yendi	735	735	-	754	-	8,519	-	735	-	870	-	774	-	1,427	-	709	715	658	782	658	782	8	4,912
Transversal - 3.2	Fufulsu-Sawla	648	648	-	648	-	646	-	648	-	648	-	648	-	654	-	494	6,709	496	8,261	496	970	486	998
Transversal - 3.3	Techiman-Kwadwokurom	465	465	-	465	-	465	-	465	-	465	-	465	-	465	-	-	465	-	465	-	465	-	465
Transversal - 3.4	Nyinahin-Kumasi	911	103	-	900	-	900	-	103	-	912	-	900	-	105	-	81	850	81	820	70	1,100	68	3,202

Table 4 - 36 Passenger Traffic for Phases 2 and 6 at Years 2015 and 2047

Passengers Traffic at Year 2030		Phase - 2C		
Num.	Section	Without Project	With Project	
		Road	Road	Railway
		Passengers (Pass/Day)	Passengers (Pass/Day)	
Western Line	Takoradi-Kumasi	39,472	33,143	10,561
Eastern Line	Accra-Kumasi	135,300	69,697	97,120
Kumasi-Paga	Takoradi-Kumasi + Accra-Kumasi	30,573	6,596	29,941
Trans-ECOWAS Expansion	Aflao-Accra-Takoradi-Omanpe	61,694	6,1249	0
Western Exp.	Dunkwa-Awaso-Hamile	11,102	10,692	0
Eastern Exp.	Tema-Yendi-Tamale	15,606	15,326	0
Transversal - 3.1	Tamale-Yendi	1,384	1,921	0
Transversal - 3.2	Fufulsu-Sawla	884	880	0
Transversal - 3.3	Techiman-Kwadwokurom	626	626	0
Transversal - 3.4	Nyinahin-Kumasi	1'218	141	0

Passengers Traffic at Year 2047		Phase - 6		
Num.	Section	Without Project	With Project	
		Road	Road	Railway
		Passengers (Pass/Day)	Passengers (Pass/Day)	
Western Line	Takoradi-Kumasi	55,271	36,502	15,932
Eastern Line	Accra-Kumasi	189,452	123,146	130,631
Kumasi-Paga	Takoradi-Kumasi + Accra-Kumasi	42,809	7,627	36,242
Trans-ECOWAS Expansion	Aflao-Accra-Takoradi-Omanpe	86,386	43,390	38,386
Western Exp.	Dunkwa-Awaso-Hamile	15,546	5,326	9,924
Eastern Exp.	Tema-Yendi-Tamale	21,852	7,852	23,972
Transversal - 3.1	Tamale-Yendi	1,938	70	12,095
Transversal - 3.2	Fufulsu-Sawla	1,238	916	1,894
Transversal - 3.3	Techiman-Kwadwokurom	877	0	877
Transversal - 3.4	Nyinahin-Kumasi	1,706	161	4,371

5. TRAFFIC FORECAST AND ECONOMIC FEASIBILITY

5.1 TRAFFIC FORECAST

The proposed railway, with the ability to safely haul large quantities of goods and significant numbers of people over long distances, meets the requirements of the Ghanaian transport policy, to develop the present railway lines and complement the existing lake and road transportation. The Ghana Railway Network will bind together other rail projects, at various stages of development, throughout the African West Region.

The analysis of the transport demand forecast has been made for passengers and freight traffic, based on existing data and using the TransCAD® model.

5.1.1 Passenger Traffic Forecast

Development of the proposed rail services will cause significant changes in the relationship between modes of transport, especially road.

Passenger traffic forecasts were carried out on a step-by-step basis, using econometric models. There were four main stages:

- **Stage 1** relates to the current situation (2012 in this case). Current traffic is either directly calculated from available data or, if necessary, estimated with appropriate models.
- **Stage 2** concerns the transition from the current situation to the situation in the base year of the project (2015 in this case) without implementing the Project. This corresponds to the "normal" evolution of traffic into the future. Growth in passenger traffic is highly correlated to demographic changes and also to GDP growth.
- **Stage 3** estimates the traffic that will use rail in the project situation in the start year. Competition models were developed to evaluate the rail traffic diverted from other modes. Induced traffic was also estimated.
- **Stage 4** consists of estimating volumes of traffic for the years following the realisation of the different railway lines considered in the Master Plan.

Data on the current situation has been deducted from the Integrated Transportation Plan[6] and updated to year 2012. Basically, the higher the population, the higher the number of trips. Therefore, as population growth plays an important role in traffic forecasting, it has been assumed that passenger traffic growth rate will follow that of population.

Estimated 2015 passenger traffic flows, are described in Traffic Assignment.

The passenger traffic growth rate adopted in this economic feasibility study is 2%.

5.1.2 Freight Traffic Forecast

The forecast was carried out on the basis of tonnage by commodity and origin/destination pairs for each country. The base reference year for the freight forecast was 2015. Traffic diverted from water (lake) or road were identified separately and these figures are used in the economic evaluation of using rail versus water and/or truck.

The freight traffic forecast was developed on the assumption that rail, whether through the National Railway lines or Regional railway lines (like ECOWAS lines), would reach all the traffic generators identified in each country. If rail access is not provided to any of the identified traffic generators, the freight traffic originally identified from that traffic generator point will disappear, diminishing the total

[6] *Integrated Transport Plan for Ghana – Egis BCEOM/Associated Consultants - 2010*

forecast tonnage. These connections, which will be part of national railway networks, are vital for rail to become a viable transportation alternative in the region.

Competitive freight rates were developed per ton-km per commodity and origin/destination pairs based on average freight rates offered by trucking competitors. The freight rates were obtained by other studies and reviewed for comparison purposes.

The potential rail share assumes that lines will link to neighbour countries (Togo, Burkina Faso, Côte d'Ivoire), since this is required for rail to attract the potential traffic. The freight tonnage in base year 2015, considered for this study, is described in Traffic Assignment.

5.1.3 New Production Forecast

It is assumed that primary sector will grow in the next years and especially in the Brong Ahafo Region. Therefore, an additional tonnage of products has been assigned to the model for:

- Timber 35,000 tonnes per year
- Agriculture 14,000 tonnes per year

In the same way the production of mining products will expand over the next years, due to the opening of new sites in the North and the East of the Country. An additional tonnage of mining products has been assigned to the model for:

- Iron 50,000 tonnes per year
- Manganese 300,000 tonnes per year

5.2 ECONOMIC FEASIBILITY

5.2.1 Structure of the Economic Model

Financial and **Economic** Analyses share many common traits. Both involve the development of cash flows over the life of the project and the use of a discount or hurdle rate to test whether the project's impact is positive or negative. Both result in an **internal rate of return (IRR)** and a **net present value (NPV).** The results are tested through **sensitivity analysis**.

The fundamental conceptual difference between the two analyses could be described as follows:

The **financial analysis** is carried out from the point of view of a single entity, and measures the net profit or loss to that entity**. Economic analysis** takes a broader view, in that it seeks to measure the positive or negative impact of the project on the society as a whole.

This major conceptual difference leads to the following differences in the methods and factors used in the two analyses:

Financial transactions, including revenues, are not included in the economic analysis, as these are considered transfer of payments rather than real economic benefits; instead, the analysis measures the resources used and the benefits to users and non-users, in particular.

- Various externalities or spill-over effects are incorporated in the analysis; these are effects of the project on parties other than the railway and its users (passengers and freight shippers).
- Subsidies, direct taxes and import duties are excluded from the analysis; like revenues, these are considered to represent transfer payments rather than true economic costs or benefits.
- A social discount rate (rather than a weighted average cost of capital) is used to develop net present values and to evaluate internal rates of return.
- Shadow prices could be applied to some factors used in the analysis.

This chapter is related to the **economic analysis**.

5.2.2 Implementation Programme

Assuming that years 2012 - 2013 will be dedicated to studies of the Ghana Railway Master Plan and year 2014 is assumed for the assignment of the first construction contracts, the beginning of rehabilitation and / or construction could begin in year 2015. Therefore, the economic analysis is conducted for a period of 30 years of operation, starting from the opening year of the new infrastructure, following the implementation plan presented on the next pag

Ghana Railway Master Plan

IMPLEMENTATION PROGRAMME

	Lines	Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
		L Km	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
			Rehabilitation				Construction new lines -Standard gauge																												
A	**PHASE 1: Rehabilitation of existing line**	**667.6**																																	
	1W - Western Line	***340***	1	1	1	1																													
	1- Takoradi - Tarkwa - Dunkwa - Kumasi	266.8																																	
	2- Dunkwa - Awaso	73.2																																	
	1E - Eastern Line	***327.6***	1	1	1	1	1																												
	1- Accra - Kumasi	303.9																																	
	2- Achimota - Tema	23.7																																	
B	**PHASE 2: Eastern "A" Expansion**	**1161**																																	
	2W-Takoradi-Kumasi	266					1	1	1	1	1	1																							
	2E- Accra - Kumasi	300						1	1	1	1	1	1	1																					
	2C Kumasi - Techiman - Tamale	383							1	1	1	1	1	1	1	1	1																		
	Tamale - Paga	212											1	1	1	1	1																		
C	**PHASE 3: Transversal Expansions**	**484**																																	
	1- Tamale - Yendi	102																			1	1	1												
	2- Fufulsu - Sawla	126																1	1	1															
	3- Techiman - Atebubu - Kwadwokurom	198																1	1	1	1	1													
	4- Nyinahin - Kumasi	58																			1	1													
D	**PHASE 4: Trans Ecowas Expansion**	**498**																																	
	1- Aflao - Tema - Accra	185																						1	1	1	1								
	2- Accra - Takoradi	212																				1	1	1	1	1									
	3- Tarkwa - Omanpe	101																							1	1	1								
E	**PHASE 5: Western Expansion**	**729**																																	
	1- Dunkwa - Awaso	73																									1	1							
	2- Awaso - Techiman	220																										1	1	1	1	1			
	3- Techiman - Sawla	223																							1	1	1	1	1						
	4- Sawla - Hamile	213																										1	1	1	1	1			
F	**PHASE 6: Eastern "B" Expansion**	**468**																																	
	1- Tema - Ho	130																													1	1	1		
	2- Ho - Yendi	338																											1	1	1	1	1	1	1

5.2.3 Economic Analysis Approach

The general approach is based on a widespread methodology, i.e. the **Cost Benefit Analysis (CBA)** that is a well-established methodology for evaluation of investment feasibility in transportation projects.

The economic analysis is based on a comparison between two different cases:

- First case, called "**Without Project**", that considers the normal evolution of the existing situation.
- Second case called "**With Project**", that considers rehabilitation and construction of the new lines.

For the GRMP, the Consultant has developed separate economic analyses, one for each of the six Phases described above and reported hereinafter.

PHASE 1	Rehabilitation of Existing Lines	
	1W	*Western Line*
	1 E	*Eastern Line*
PHASE 2	Central Spine Expansion	
	2W	*Takoradi-Kumasi*
	2E	*Accra-Kumasi*
	2C	*Kumasi-Paga*
PHASE 3	Transversal Expansions	
	3-1	*Tamale-Yendi*
	3-2	*Fufulsu-Sawla*
	3-3	*Techiman-Kwadwokurom*
	3-4	*Nyinahin-Kumasi*
PHASE 4	Trans-ECOWAS Expansion	*Aflao-Accra-Takoradi-Omanpe*
PHASE 5	Western Expansion	*Dunkwa-Awaso-Hamile*
PHASE 6	Eastern Expansion	*Tema-Yendi*

More precisely, the feasibility analysis performed for each phase should be intended as follows:

1. An analysis has been made separately for the rehabilitation of the Western (1W) and of the Eastern (1E) lines (**Phase 1**). Therefore, the results, in terms of IRR and NPV, are directly linked to the single line examined. After that, a cumulate analysis has been made for both of the two lines (1W + 1E), representing the effective analysis of **Phase 1**.
2. In the same way, another analysis has also been carried out separately for the construction of the new Western (2W) and of the new Eastern (2E) lines (**Phase 2**). Therefore, the results, in terms of IRR and NPV, are directly linked to the single line examined. After that, a cumulate analysis has been made for both of the two lines (2A = 2W and 2E) with their results, always in terms of IRR and NPV.
3. Starting from the successive analysis considering the construction of the Kumasi – Paga line (2C), the feasibility analysis is cumulated with the preceding that is, in this case, the analysis of the two lines 2A = 2W and 2E. It means that all costs and benefits are cumulated and, therefore, the resulting IRR and NPV are those of the entire Phase 2 (Central Spine).

This approach has been dictated by the fact that the realisation of the Kumasi – Paga line has a real interest, only if the other two lines (2W and 2E), reaching the main ports of the Country, are considered. In the same way, the following analysis for Phase 3, Phase 4, Phase 5 and Phase 6 are based on the same assumptions. The IRR and NPV of each Phase analysed indicate the level of feasibility of the Railway Network at its stage of development, which is progressively increasing Phase by Phase.

4. However, in order to have an idea of what could be the feasibility of each trunk Railway Line composing the different Phases, specific analyses have also been made.

A summary of the above is presented in the following framework.

ECONOMIC FEASIBILITY ANALYSIS PERFORMED		RESULTS OF THE ECONOMIC FEASIBILITY ANALYSIS IN TERMS OF IRR AND NPV
NAME	DESCRIPTION	INTERPRETATION OF RESULTS
IRR PHASE 1W	separate analysis related to the rehabilitation of existing Western line	*feasibility indicators for the rehabilitation of existing Western line*
IRR PHASE 1E	separate analysis related to the rehabilitation of existing Eastern line	*feasibility indicators for the rehabilitation of existing Eastern line*
IRR PHASE 1(W+E)	cumulated analysis related to the rehabilitation of both Western and Eastern existing lines	*feasibility indicators of Phase 1 (rehabilitation of Western and Eastern lines)*
IRR PHASE 2W	separate analysis related to the construction of new Western line	*feasibility indicators for the construction (to standard gauge) of a new Western line*
IRR PHASE 2E	separate analysis related to the construction of new Eastern line	*feasibility indicators for the construction (to standard gauge) of a new Eastern line*
IRR PHASE 2A (2W+2E)	cumulated analysis related to the construction of both Western and Eastern new lines	*feasibility indicators of Phase 2A (construction of new Western and Eastern lines)*
IRR PHASE 2C	analysis including preceding phase 2A plus the construction of the Kumasi – Paga line	*feasibility indicators related to the realisation of the preceding Phase 2A and to the construction of the Kumasi – Paga line. At this stage, the IRR and NPV indicate the feasibility level of the railway network after the completion of Phase 2C, composed of the new Western and Eastern lines plus the Kumasi – Paga line*
IRR PHASE 3	analysis including preceding phase 2C plus the construction of the Transversal Expansions	*feasibility indicators related to the realisation of the preceding Phase 2C and to the construction of the Transversal Expansions. At this stage, the IRR and NPV indicate the feasibility level of the railway network after the completion of Phase 3, composed of the new Western and Eastern lines plus Kumasi – Paga line and plus the Transversal Expansions*
IRR PHASE 4	analysis including preceding phase 3 plus the construction of the Trans-ECOWAS Expansion line	*feasibility indicators related to the realisation of the preceding Phase 3 and to the construction of the TransEcowas Expansion. At this stage, the IRR and NPV indicate the feasibility level of the railway network after the completion of Phase 4, composed of the new Western and Eastern lines plus Kumasi – Paga line plus the Transversal Expansions and plus the TransEcowas line*
IRR PHASE 5	analysis including preceding phase 4 plus the construction of the Western expansion line	*feasibility indicators related to the realisation of the preceding Phase 4 and to the construction of the Western expansion. At this stage, the IRR and NPV indicate the feasibility level of the railway network after the completion of Phase 5, composed of the new Western and Eastern lines plus Kumasi – Paga line plus the Transversal expansions plus the TransEcowas line and plus the Western expansion line*
IRR PHASE 6	analysis including preceding phase 5 plus the construction of the Eastern expansion line	*feasibility indicators related to the realisation of the preceding Phase 5 and to the construction of the Eastern expansion. At this stage, the IRR and NPV indicate the feasibility level of the railway network after the completion of Phase 6, which represent the entire railway network performed for the Ghana Railway Master Plan*
	ECONOMIC FEASIBILITY ANALYSIS PERFORMED PER LINE	
IRR LINES: 2C, 3, 4, 5, 6	analysis performed for each line composing the whole Railway Master Plan	*IRR and NPV indicators show the feasibility level of each new Railway Line trunk composing the Ghana Railway Master Plan*

5.2.4 Inputs of the Economic Model

The parameters considered in this analysis are those commonly adopted in CBA. Nevertheless, it is important to recall the following points:

1. A basic characteristic of CBA is discounting. This is important as costs and benefit flows do not occur at the same time. That is the reason why a discount rate (expressed in %) is assumed in order to define the yearly depreciation of money value. A discount rate of 12% has been applied in this analysis.

2. The results of this CBA are expressed by means of the traditional indicators that are used in this field. They are:
   - the **Net Present Value (NPV),** that is the sum of all discounted costs and benefits. This sum reflects how much the project will be profitable. If the NPV is negative, clearly the costs prevail over the benefits and the project is not financially or economically feasible
   - the **Internal Rate of Return (IRR),** that is the rate with which the discounted costs equal the discounted benefits, thus giving the ***break-even*** (NPV=0) at that particular rate. The IRR can then be compared with a base line or standard rate; for example, the current interest rate, or a certain minimum rate and if the IRR is higher the project would be profitable.

In order to obtain the above indicators, a basic data collection and classification has been carried out both for costs and benefits.

The different elements considered in the economic analysis are described hereinafter.

5.2.4.1 Infrastructure Investment Costs

In this economic analysis, the project investment costs include the rehabilitation or construction of railway line, acquisition of rolling stock, signalling and buildings (mainly railway stations).

The financial costs have been estimated for each of the six different Phases, analysed and summarised in the following tables.

Table 5 - 1 Infrastructure Investment Costs

PHASES - LINES	L (Km)	FINANCIAL COSTS
PHASE 1: Rehabilitation of existing line	**667.6**	**$2,803,920,000**
1W - Western Line	***340.0***	*1,428,000,000*
1 - Takoradi - Tarkwa - Dunkwa - Kumasi	266.8	
2 - Dunkwa - Awaso	73.2	
1E - Eastern Line	***327.6***	*1,375,920,000*
1 - Accra - Kumasi	303.9	
2 - Achimota - Tema	23.7	
PHASE 2: Eastern "A" Expansion	**1,161**	**$6,501,600,000**
2W -Takoradi-Kumasi	266	*1,489,600,000*
2E - Accra - Kumasi	300	*1,680,000,000*
2C - Kumasi - Techiman - Tamale	383	*2,144,800,000*
- Tamale - Paga	212	*1,187,200,000*
PHASE 3: Transversal Expansions	**484**	**$2,710,400,000**
1 - Tamale - Yendi	102	*571,200,000*
2 - Fufulsu - Sawla	126	*705,600,000*
3 - Techiman - Atebubu - Kwadwokurom	198	*1,108,800,000*
4 - Nyinahin - Kumasi	58	*324,800,000*
PHASE 4: Trans Ecowas Expansion	**498**	**$2,788,800,000**
1 - Aflao - Tema - Accra	185	*1,036,000,000*
2 - Accra - Takoradi	212	*1,187,200,000*
3 - Tarkwa - Omanpe	101	*565,600,000*
PHASE 5: Western Expansion	**729**	**$4,082,400,000**
1 - Dunkwa - Awaso	73	*408,800,000*
2 - Awaso - Techiman	220	*1,232,000,000*
3 - Techiman - Sawla	223	*1,248,800,000*
4 - Sawla - Hamile	213	*1,192,800,000*
PHASE 6: Eastern "B" Expansion	**468**	**$2,620,800,000**
1 - Tema - Ho	130	*728,000,000*
2 - Ho - Yendi	338	*1,892,800,000*
TOTAL INVESTMENT COST (FINANCIAL)	***[Km 4,007.6]***	**$21,507,920,000**

The basic price of the investment, shown in the preceding table, is expressed in **financial value** and, therefore, a conversion factor was adopted in order to correct it to an **economic value** (deducting taxes, levies and duties). Unfortunately, the Consultants could not collect enough information to precisely identify such factor. Consequently, a 0.80 corrective factor was used, only on the basis of the Consultants' experience, and the economic costs of the investment used in the feasibility analysis are presented in the following table.

Table 5 - 2 Infrastructure Economic Investment Costs

PHASES - LINES	L (Km)	ECONOMIC COSTS
PHASE 1: Rehabilitation of existing line	**667.6**	**$2,243,136,000**
1W - Western Line	***340.0***	*1,142,400,000*
1 - Takoradi - Tarkwa - Dunkwa - Kumasi	266.8	
2 - Dunkwa - Awaso	73.2	
1E - Eastern Line	***327.6***	*1,100,736,000*
1 - Accra - Kumasi	303.9	
2 - Achimota - Tema	23.7	
PHASE 2: Eastern "A" Expansion	**1,161**	**$5,201,280,000**
2W -Takoradi-Kumasi	266	*1,191,680,000*
2E - Accra - Kumasi	300	*1,344,000,000*
2C - Kumasi - Techiman - Tamale	383	*1,715,840,000*
- Tamale - Paga	212	*949,760,000*
PHASE 3: Transversal Expansions	**484**	**$2,168,320,000**
1 - Tamale - Yendi	102	*456,960,000*
2 - Fufulsu - Sawla	126	*564,480,000*
3 - Techiman - Atebubu - Kwadwokurom	198	*887,040,000*
4 - Nyinahin - Kumasi	58	*259,840,000*
PHASE 4: Trans Ecowas Expansion	**498**	**$2,231,040,000**
1 - Aflao - Tema - Accra	185	*828,800,000*
2 - Accra - Takoradi	212	*949,760,000*
3 - Tarkwa - Omanpe	101	*452,480,000*
PHASE 5: Western Expansion	**729**	**$3,265,920,000**
1 - Dunkwa - Awaso	73	*327,040,000*
2 - Awaso - Techiman	220	*985,600,000*
3 - Techiman - Sawla	223	*999,040,000*
4 - Sawla - Hamile	213	*954,240,000*
PHASE 6: Eastern "B" Expansion	**468**	**$2,096,640,000**
1 - Tema - Ho	130	*582,400,000*
2 - Ho - Yendi	338	*1,514,240,000*
TOTAL INVESTMENT COST (FINANCIAL)	***[Km 4,007.6]***	**$17,206,336,000**

These infrastructure investment costs have been applied by fixed amount during the period of rehabilitation or construction of each Phase, as follows:

Table 5 - 3 Infrastructure Investment Costs Assignment

YEAR	PHASE 1 W NG	PHASE 1 E NG	PHASE 2 W SG	PHASE 2 E SG	PHASE 2C	PHASE 3	PHASE 4	PHASE 5	PHASE 6	TOTAL
2015	285,600,000	220,147,200								
2016	285,600,000	220,147,200								
2017	285,600,000	220,147,200								
2018	285,600,000	220,147,200								
2019		220,147,200	198,613,333							
2020			198,613,333	192,000,000						
2021			198,613,333	192,000,000	190,648,889					
2022			198,613,333	192,000,000	190,648,889					
2023			198,613,333	192,000,000	190,648,889					
2024			198,613,333	192,000,000	190,648,889					
2025				192,000,000	380,600,889					
2026				192,000,000	380,600,889					
2027					380,600,889					
2028					380,600,889					
2029					380,600,889					
2030						365,568,000				
2031						365,568,000				
2032						365,568,000				
2033						459,648,000				
2034						459,648,000	189,952,000			
2035						152,320,000	189,952,000			
2036							397,152,000			
2037							547,978,667	199,808,000		
2038							547,978,667	199,808,000		
2039							358,026,667	363,328,000		
2040								751,296,000		
2041								587,776,000	216,320,000	
2042								387,968,000	216,320,000	
2043								387,968,000	410,453,333	
2044								387,968,000	410,453,333	
2045									410,453,333	
2046									216,320,000	
2047									216,320,000	
2048										
TOTAL	**1,142,400,000**	**1,100,736,000**	**1,191,680,000**	**1,344,000,000**	**2,665,600,000**	**2,168,320,000**	**2,231,040,000**	**3,265,920,000**	**2,096,640,000**	**17,206,336,000**

NG = Narrow Gauge

SG = Standard Gauge

5.2.4.2 Rolling Stock Investment Costs

In.vestment for rolling stock has been estimated on the basis of the operating plan presented before. Quantities were estimated taking into account additional needs for periodical maintenance stops, failures, etc.

Rolling stock prices are based on the prices of international equipment suppliers. Thus, the investment estimate for new rolling stock, needed at each Phase, is deemed to be already expressed in economic value and presented in the following Tables, with no corrective factor for the purposes of the Economic Feasibility Analysis.

Table 5 - 4 Rolling Stock Estimate Investment

ROLLING STOCK AND INVESTMENT (Million US$)						R.S. Investment made in last 3 years of the construction period of the line.		
PHASE	Wagons		Locos	Total Fleet	INVESTM.			
	Freight	Passengers			Mil. US$	20%	30%	50%
PHASE 1	330	132	29	491	53	10.65	15.97	26.62
PHASE 2	1,056	343	58	1,457	377	75.35	113.02	188.37
PHASE 3	352	304	16	672	214	42.79	64.19	106.99
PHASE 4	528	158	28	714	179	35.84	53.76	89.60
PHASE 5	880	211	53	1,144	287	57.40	86.10	143.50
PHASE 6	528	106	23	657	144	28.71	43.06	71.77
Total standard gauge trains [2-6]	***3,344***	***1,122***	***177***	***4,643***	***1,200***	***240***	***360***	***600***
Total investment Rolling Stock	**3,674**	**1,254**	**206**	5,134	**1,254**	**251**	**376**	**627**

5.2.4.3 Vehicle Operating Costs

Vehicle Operating Costs (VOC) have been calculated by means of the Roads Economic Decision Model, HDM-4 Vehicle Operating Costs Module (RED VOC) in order to estimate Annual Average VOC per vehicle-km travelled for the various categories of vehicles used in Ghana under the different road surface conditions for each type of road facility.

➢ Road Characteristics

Road characteristics comprise the existing road and environmental factors. These include:

- Road surface condition (good, fair, poor)
- Surface type (paved, concrete, unsealed)
- Terrain type (flat, rolling, mountainous)
- Length of road
- Pavement structure and strength
- Altitude and rainfall

Ministry of Transport calibrated values of parameters was used. The following road characteristics according to surface type were used in the model as illustrated in the following table.

Table 5 - 5 Road Characteristics by Surface Type

Carriageway	Width (m)	Speed Limit (km/hour)
Paved	7.0	100
Concrete	6.0	80
Unsealed	5.0	70

Roughness rate according to the types of road surface and conditions modelled is presented in the form of Riding Quality Matrix shown in the following table.

Table 5 - 6 Roughness according to Road Surface Conditions and Surface Type

Road Condition Classes Roughness (IRI)					
Road Type	Road Condition Class				
	Very Good	Good	Fair	Poor	Very Poor
Bituminous	2.0	3.0	5.0	8.0	12.0
Concrete	2.0	3.0	4.0	6.0	22.0
Unsealed	4.0	5.0	7.0	9.0	25.0

Source: *Ministry of Transportation (HDM-4 Calibration for Ghana), March 2007- Consultant elaboration.*

➢ <u>Vehicle Fleet Characteristics</u>

Taking into account the vehicle fleet observed in Ghana, the following categories of vehicles are considered:

1. Cars
2. Taxis
3. Light Buses
4. Medium Buses
5. Heavy Buses
6. Light Trucks
7. Medium Trucks
8. Heavy Trucks
9. Articulated Trucks

Vehicle fleet characteristics, and their utilisation and unit costs are based mostly on values observed by the Ministry of Transport and Ghana Highway Authority and reported in Volume 5 in the Integrated Transport Plan for Ghana (June 2010). Even if these values were calibrated for the model HDM-4, which is used to evaluate main road maintenance and development projects in Ghana, they have been updated for the implementation of the Ghana Railway Master Plan. The characteristics of the vehicle fleet are illustrated in Table 5-7.

Utilization and loading of vehicle are illustrated in Table 5-8. Unit economic costs by type of vehicle, extracted from the output report of the RED-VOC module.

Table 5 - 7 Vehicle Fleet Characteristics

Economic Unit Costs	Car Medium	Taxi	Bus Light	Bus Medium	Bus Heavy	Truck Light	Truck Medium	Truck Heavy	Truck Articulated
New Vehicle Cost ($/vehicle)	22000	20000	33000	80000	180000	22000	75000	78000	155000
Fuel Cost ($/litre for MT, $/MJ for NMT)	0.43	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
Lubricant Cost ($/litre)	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
New Tire Cost ($/tyre)	45.00	55.00	80.00	180.00	180.00	180.00	255.00	255.00	320.00
Maintenance Labor Cost ($/hour)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Crew Cost ($/hour)	0.00	0.40	0.50	0.70	0.70	0.70	0.80	0.90	1.00
Interest Rate (%)	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00

Table 5 - 8 Utilisation and Loading

	Car Medium	Taxi	Bus Light	Bus Medium	Bus Heavy	Truck Light	Truck Medium	Truck Heavy	Truck Articulated
Kilometres Driven per Year (km)	15000	30000	30000	40000	55000	50000	50000	70000	80000
Hours Driven per Year (hr)	500	1300	1300	2000	2000	1720	1720	1720	1720
Service Life (years)	12	12	12	12	12	12	12	12	12
Percent of Time for Private Use (%)	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross Vehicle Weight (tons)	1.20	1.20	3.00	6.00	11.00	6.00	12.00	20.00	30.00

- Vehicle Operating Costs Results

Table 5-10, on the following pages, shows the values of VOC and speeds per category of vehicle, per surface condition and terrain, on a paved road in Ghana.

- VOC Used in the Graph Model

Road vehicle operating costs (VOC) and the relative speeds, retained for their application in the graph model are described in the following Table 5-9. For Car, assumed as the light vehicle for passengers transportation, the VOC retained is the averaged cost between Car Medium, Taxi and Bus Light presented in Table 5-10. For Bus, the VOC retained is the averaged cost between Bus Medium and Bus Heavy of Table 5-10. The VOC for Truck Light is the averaged cost between Truck Light and Truck Medium and for Truck Heavy the VOC retained is the average of Truck Heavy and Truck Articulated VOC shown in Table 5-10.

Table 5 - 9 VOC and Speeds for Different Road Conditions

5 - 9/1 TERRAIN: FLAT - SURFACE: BITUM - CONDITION: FAIR & POOR

AVERAGED VOC for a defined Road Condition Class ($/Veh-km)						
Terrain: A Flat	Road Condition	IRI	Passenger		Freight	
			Car	Bus	Truck Light	Truck Heavy
Bituminous	Fair	5	0.22	0.60	0.39	0.97
	Poor	8	0.24	0.72	0.44	1.08
AVERAGED SPEED for a defined Road Condition Class (Km/h)						
Terrain: A Flat	Road Condition	IRI	Passenger		Freight	
			Car	Bus	Truck Light	Truck Heavy
Bituminous	Fair	5	93.67	84.60	83.73	84.69
	Poor	8	74.47	69.42	70.56	64.67

5 – 9/2 TERRAIN: ROLLING - SURFACE: BITUM - CONDITION: FAIR & POOR

AVERAGED VOC for a defined Road Condition Class ($/Veh-km)						
Terrain: B Rolling	Road Condition	IRI	Passenger		Freight	
			Car	Bus	Truck Light	Truck Heavy
Bituminous	Fair	5	0.22	0.61	0.39	0.98
	Poor	8	0.24	0.72	0.45	1.10
AVERAGED SPEED for a defined Road Condition Class (Km/h)						
Terrain: B Rolling	Road Condition	IRI	Passenger		Freight	
			Car	Bus	Truck Light	Truck Heavy
Bituminous	Fair	5	86.64	77.15	73.90	74.19
	Poor	8	72.70	67.18	66.08	63.35

5 – 9/3 TERRAIN: MOUNTAINOUS - SURFACE: BITUM - CONDITION: FAIR & POOR

AVERAGED VOC for a defined Road Condition Class ($/Veh-km)						
Terrain: C Mountainous	Road Condition	IRI	Passenger		Freight	
			Car	Bus	Truck Light	Truck Heavy
Bituminous	Fair	5	0.22	0.64	0.43	1.11
	Poor	8	0.24	0.76	0.49	1.24
AVERAGED SPEED for a defined Road Condition Class (Km/h)						
Terrain: C Mountainous	Road Condition	IRI	Passenger		Freight	
			Car	Bus	Truck L	Truck H
Bituminous	Fair	5	75.21	65.08	58.75	60.73
	Poor	8	68.24	61.02	55.58	57.39

Table 5 - 10 Typical Vehicle Operating Costs and Speeds for Different Road Condition classes

Typical Vehicle Operating Costs for Different Road Condition Classes

Road Terrain & Type	Road Condition	Roughness (IRI)	Car Medium ($/veh-km)	Taxi ($/veh-km)	Bus Light ($/veh-km)	Bus Medium ($/veh-km)	Bus Heavy ($/veh-km)	Truck Light ($/veh-km)	Truck Medium ($/veh-km)	Truck Heavy ($/veh-km)	Truck Articulated ($/veh-km)	Vehicle Fleet ($/veh-km)
Terrain: **A**	Very Good	2	0.18	0.18	0.25	0.39	0.69	0.21	0.49	0.64	1.11	0.34
Flat	Good	3	0.18	0.18	0.26	0.39	0.70	0.21	0.50	0.65	1.12	0.34
Road: X	**Fair**	**5**	**0.19**	**0.19**	**0.27**	**0.43**	**0.78**	**0.23**	**0.55**	**0.71**	**1.23**	**0.37**
Bituminous	**Poor**	**8**	**0.20**	**0.20**	**0.30**	**0.50**	**0.93**	**0.25**	**0.62**	**0.77**	**1.38**	**0.41**
	Very Poor	12	0.24	0.24	0.35	0.60	1.16	0.29	0.74	0.90	1.65	0.49

Typical Vehicle Speeds for Different Road Condition Classes

Road Terrain & Type	Road Condition	Roughness (IRI)	Car Medium (km/hr)	Taxi (km/hr)	Bus Light (km/hr)	Bus Medium (km/hr)	Bus Heavy (km/hr)	Truck Light (km/hr)	Truck Medium (km/hr)	Truck Heavy (km/hr)	Truck Articulated (km/hr)	Vehicle Fleet (km/hr)
Terrain: **A**	Very Good	2	100.5	100.5	90.3	88.1	85.4	84.6	88.5	86.0	88.0	94.0
Flat	Good	3	100.3	100.3	90.0	87.7	85.3	84.1	88.2	86.0	87.7	93.7
Road: X	**Fair**	**5**	**97.1**	**97.1**	**86.9**	**84.9**	**84.3**	**81.6**	**85.9**	**85.0**	**84.3**	**90.9**
Bituminous	**Poor**	**8**	**75.9**	**75.9**	**71.5**	**70.8**	**68.1**	**69.3**	**71.8**	**68.2**	**61.2**	**72.8**
	Very Poor	12	51.9	51.9	50.7	50.6	46.1	50.3	50.8	46.1	41.0	50.5

Table 5 – 10 *cont'd*

Typical Vehicle Operating Costs for Different Road Condition Classes												
Road Terrain & Type	**Road Condition**	**Roughness (IRI)**	**Car Medium ($/veh-km)**	**Taxi ($/veh-km)**	**Bus Light ($/veh-km)**	**Bus Medium ($/veh-km)**	**Bus Heavy ($/veh-km)**	**Truck Light ($/veh-km)**	**Truck Medium ($/veh-km)**	**Truck Heavy ($/veh-km)**	**Truck Articulated ($/veh-km)**	**Vehicle Fleet ($/veh-km)**
Terrain: **B**	Very Good	2	0.18	0.18	0.25	0.38	0.70	0.21	0.50	0.66	1.10	0.34
Rolling	Good	3	0.18	0.18	0.25	0.39	0.70	0.21	0.51	0.66	1.11	0.34
Road: X	**Fair**	**5**	**0.19**	**0.19**	**0.27**	**0.43**	**0.79**	**0.23**	**0.56**	**0.72**	**1.24**	**0.37**
Bituminous	**Poor**	**8**	**0.21**	**0.21**	**0.30**	**0.50**	**0.94**	**0.26**	**0.64**	**0.79**	**1.40**	**0.42**
	Very Poor	12	0.24	0.24	0.35	0.60	1.17	0.29	0.75	0.92	1.67	0.49

Typical Vehicle Speeds for Different Road Condition Classes												
Road Terrain & Type	**Road Condition**	**Roughness (IRI)**	**Car Medium (km/hr)**	**Taxi (km/hr)**	**Bus Light (km/hr)**	**Bus Medium (km/hr)**	**Bus Heavy (km/hr)**	**Truck Light (km/hr)**	**Truck Medium (km/hr)**	**Truck Heavy (km/hr)**	**Truck Articulated (km/hr)**	**Vehicle Fleet (km/hr)**
Terrain: **B**	Very Good	2	92.2	92.2	81.3	78.4	78.2	74.5	76.4	79.2	70.4	84.2
Rolling	Good	3	92.0	92.0	81.1	78.2	78.1	74.2	76.2	79.2	70.3	84.1
Road: X	**Fair**	**5**	**90.3**	**90.3**	**79.4**	**76.7**	**77.6**	**72.8**	**75.0**	**78.7**	**69.7**	**82.6**
Bituminous	**Poor**	**8**	**74.6**	**74.6**	**68.9**	**67.5**	**66.9**	**65.1**	**67.1**	**67.2**	**59.5**	**70.3**
	Very Poor	12	51.8	51.8	50.4	50.1	46.1	49.5	50.2	46.1	41.0	50.2

Table 5 – 10 *cont'd*

Typical Vehicle Operating Costs for Different Road Condition Classes												
Road Terrain & Type	**Road Condition**	**(IRI)**	**Car Medium ($/veh-km)**	**Taxi ($/veh-km)**	**Bus Light ($/veh-km)**	**Bus Medium ($/veh-km)**	**Bus Heavy ($/veh-km)**	**Truck Light ($/veh-km)**	**Truck Medium ($/veh-km)**	**Truck Heavy ($/veh-km)**	**Truck Articulated ($/veh-km)**	**Vehicle Fleet ($/veh-km)**
Terrain: **C**	Very Good	2	0.18	0.18	0.25	0.40	0.75	0.23	0.56	0.74	1.27	0.37
Mountainous	Good	3	0.18	0.18	0.26	0.40	0.76	0.23	0.56	0.75	1.28	0.37
Road: X	**Fair**	**5**	**0.19**	**0.19**	**0.27**	**0.44**	**0.84**	**0.25**	**0.61**	**0.81**	**1.40**	**0.40**
Bituminous	**Poor**	**8**	**0.21**	**0.21**	**0.31**	**0.52**	**1.00**	**0.28**	**0.70**	**0.90**	**1.58**	**0.45**
	Very Poor	12	0.24	0.24	0.36	0.63	1.22	0.32	0.82	1.02	1.84	0.53

Typical Vehicle Speeds for Different Road Condition Classes												
Road Terrain & Type	**Road Condition**	**Roughness (IRI)**	**Car Medium (km/hr)**	**Taxi (km/hr)**	**Bus Light (km/hr)**	**Bus Medium (km/hr)**	**Bus Heavy (km/hr)**	**Truck Light (km/hr)**	**Truck Medium (km/hr)**	**Truck Heavy (km/hr)**	**Truck Articulated (km/hr)**	**Vehicle Fleet (km/hr)**
Terrain: **C**	Very Good	2	78.7	78.7	70.3	65.7	65.7	60.1	59.1	67.3	54.9	70.0
Mountainous	Good	3	78.7	78.7	70.2	65.6	65.6	59.8	58.9	67.2	54.8	69.9
Road: X	**Fair**	**5**	**78.1**	**78.1**	**69.4**	**64.9**	**65.3**	**59.1**	**58.4**	**67.0**	**54.5**	**69.3**
Bituminous	**Poor**	**8**	**70.5**	**70.5**	**63.7**	**60.4**	**61.6**	**55.7**	**55.4**	**62.8**	**52.0**	**63.8**
	Very Poor	12	51.5	51.5	49.4	48.4	45.8	46.4	46.5	45.9	40.4	48.8

5.2.4.4 Rail Operating Costs

Rail Operating Costs (ROC) have been estimated in order to subsequently determine the volume of passenger and of freight traffic diverted from road mode to rail mode.

The main categories of Railways **operating expenditure (OPEX)** are summarised under the headings **freight** and **passenger**. Unit costs have been developed for each of the main cost components. These are generally either traffic-related (per train kilometre, train hour or gross tonne kilometres) or operation size related (as number of staff). The costs are based on international practice, while wage rates and fuel cost are based on local conditions.

➢ Freight Operating Expenditures

Freight has been divided into two categories for mining activities and general freight operation.

Locomotive crew costs and fuel costs are directly related to the size of the transport task. Most other costs relate to the size of the operation (and thus only indirectly to the task). Locomotive and wagon maintenance is assumed to be on a time based cycle.

➢ Passenger Operating Expenditures

The main passenger service costs are directly related to the number of train kilometres and train hours operated.

➢ Other Operations

Other operating costs are assumed to be only indirectly related to the transport task. The number of Staff per Station, in the Operation Control Centre and in Workshops has been established based on the expected size of the operation. They will be relatively invariant over a range of activity.

5.2.4.5 Quantified Project Benefits

In order to evaluate the feasibility of the Project implementation, different categories of benefits have been evaluated, which mainly concern:

1) Reduction in transportation costs for the users, by travelling by rail instead of road.
2) Savings in road maintenance costs, as a reduction of damages caused by the heavy loads of trucks.
3) Savings in road accidents, as a result of a minor volume of traffic on the road network.

➢ Savings in Transportation Costs

It is clear that there is a difference in cost between railways and road transportation, with a lower cost for rail mode. The higher and better use of railways transportation will directly improve the condition of transport for all the population and, more particularly, for the economic operators, in all sectors of activities. The decrease of transportation costs, in situations of free entry in the public transport market, will stimulate competition for transport services and hence the decrease of fares. This advantage can be considered accruing directly to the different classes of the population.

The reduction in transportation costs represents the principal category of benefits generated by the realisation of the Project and is calculated by the comparison of the “Without Project” situation and the “With Project” situation represented step-by-step, by incrementing the realisation of Railway Network Phase after Phase, following the forecasted implementation plan.

The “Without Project” situation is represented, on the modal graph, by the existence of a road network assuring the total transportation service, apart from reduced traffic of mining products on the existing Western Line, and the Volta Lake transportation infrastructure. It should be recalled that transport service on the Volta Lake is essentially dedicated to petroleum product transportation and, in the absence of more detailed information, it is assumed that the same transportation service will continue, without affecting, for our analysis purpose, future assignment of the intermodal traffic flows.

The overall transportation costs in the “Without Project” situation has been evaluated for the year 2015 and separately for Freight and Passengers categories. Then the **generalised transportation cost** (as a factor representing the utility of the path as perceived by travellers) has been determined, at the same year 2015, including successively the different Phases of the Railways Network implementation. The elaboration of these costs are presented in detail, with the relative calculation explanation, in Annex 1 (paragraph 6.1) and summarised in Table 5 -11 below.

Table 5 - 11 Multimodal Generalised Transportation Costs (US $)

2015 BASE YEAR	GENERALISED TRANSPORTATION COSTS	
PHASES	FREIGHT	PASSENGERS
Without Project (base case)	747,607,107	4,086,616
With Project - Phase 1 W	350,624,721	2,574,569
With Project - Phase 1 E	356,734,150	2,748,656
With Project - Phase 1 (W + E)	347,765,458	2,789,632
With Project - Phase 2 W	351,356,156	2,545,839
With Project - Phase 2 E	356,575,803	2,608,599
With Project - Phase 2 A (2W + 2E)	349,131,710	2,536,416
With Project - Phase 2 C	321,342,351	2,666,981
With Project - Phase 3	320,337,608	2,585,172
With Project - Phase 4	319,368,333	2,440,344
With Project - Phase 5	303,578,888	2,433,282
With Project - Phase 6	301,982,326	2,346,570

As can be seen, from the numbers reported in the table, the total transportation cost amount, both for Freight and Passengers, is decreasing phase after phase, demonstrating the positive impact of the Railway Network implementation.

By difference of these costs, all regarding the “Without Project” base case, we obtain the transportation costs savings, i.e. the project benefits in the basic 2015 year. Then, the benefits have been projected for the following years by application of the same constant value growth rate of **4% for Freight** and **2% for Passengers**.

In effect, it is generally accepted that the freight traffic growth rate is close to the economic growth rate, while passenger traffic growth rate is similar to the population growth rate.

The different flows of benefits are presented in the following Table 5-12. Bold font years and relative figures are those of the opening year of the railway lines.

Table 5 - 12 Benefits in Transportation Costs

PHASE 1 W			
YEARS	BENEFITS		TOTAL BENEFITS
	FREIGHT	PASSENGERS	
2015	396,982,386	1,512,046	398,494,432
2016	412,861,681	1,542,287	414,403,968
2017	429,376,148	1,573,133	430,949,281
2018	446,551,194	1,604,596	448,155,790
2019	**464,413,242**	**1,636,688**	**466,049,930**
2020	482,989,772	1,669,421	484,659,193
2021	502,309,363	1,702,810	504,012,173
2022	522,401,737	1,736,866	524,138,603
2023	543,297,807	1,771,603	545,069,410
2024	565,029,719	1,807,035	566,836,754
2025	587,630,908	1,843,176	589,474,084
2026	611,136,144	1,880,040	613,016,184
2027	635,581,590	1,917,640	637,499,230
2028	661,004,853	1,955,993	662,960,847
2029	687,445,048	1,995,113	689,440,161
2030	714,942,849	2,035,015	716,977,865
2031	743,540,563	2,075,716	745,616,279
2032	773,282,186	2,117,230	775,399,416
2033	804,213,473	2,159,575	806,373,048
2034	836,382,012	2,202,766	838,584,778
2035	869,837,293	2,246,821	872,084,114
2036	904,630,785	2,291,758	906,922,542
2037	940,816,016	2,337,593	943,153,609
2038	978,448,657	2,384,345	980,833,001
2039	1,017,586,603	2,432,032	1,020,018,635
2040	1,058,290,067	2,480,672	1,060,770,739
2041	1,100,621,670	2,530,286	1,103,151,955
2042	1,144,646,536	2,580,891	1,147,227,428
2043	1,190,432,398	2,632,509	1,193,064,907
2044	1,238,049,694	2,685,160	1,240,734,853
2045	1,287,571,682	2,738,863	1,290,310,544
2046	1,339,074,549	2,793,640	1,341,868,189
2047	1,392,637,531	2,849,513	1,395,487,044
2048	1,448,343,032	2,906,503	1,451,249,535

PHASE 1 E			
YEARS	BENEFITS		TOTAL BENEFITS
	FREIGHT	PASSENGERS	
2015	390,872,957	1,337,960	392,210,917
2016	406,507,875	1,364,719	407,872,594
2017	422,768,190	1,392,014	424,160,204
2018	439,678,918	1,419,854	441,098,772
2019	457,266,075	1,448,251	458,714,325
2020	**475,556,718**	**1,477,216**	**477,033,933**
2021	494,578,986	1,506,760	496,085,746
2022	514,362,146	1,536,895	515,899,041
2023	534,936,632	1,567,633	536,504,265
2024	556,334,097	1,598,986	557,933,083
2025	578,587,461	1,630,966	580,218,426
2026	601,730,959	1,663,585	603,394,544
2027	625,800,197	1,696,857	627,497,054
2028	650,832,205	1,730,794	652,562,999
2029	676,865,494	1,765,410	678,630,903
2030	703,940,113	1,800,718	705,740,831
2031	732,097,718	1,836,732	733,934,450
2032	761,381,627	1,873,467	763,255,093
2033	791,836,892	1,910,936	793,747,828
2034	823,510,367	1,949,155	825,459,522
2035	856,450,782	1,988,138	858,438,920
2036	890,708,813	2,027,901	892,736,714
2037	926,337,166	2,068,459	928,405,625
2038	963,390,652	2,109,828	965,500,480
2039	1,001,926,278	2,152,025	1,004,078,303
2040	1,042,003,330	2,195,065	1,044,198,395
2041	1,083,683,463	2,238,966	1,085,922,429
2042	1,127,030,801	2,283,746	1,129,314,547
2043	1,172,112,033	2,329,421	1,174,441,454
2044	1,218,996,515	2,376,009	1,221,372,524
2045	1,267,756,375	2,423,529	1,270,179,905
2046	1,318,466,630	2,472,000	1,320,938,630
2047	1,371,205,295	2,521,440	1,373,726,735
2048	1,426,053,507	2,571,869	1,428,625,376
2049	1,483,095,648	2,623,306	1,485,718,954

Table 5-12 *Cont'd*

PHASE 1 (W+E)			
YEARS	BENEFITS		TOTAL BENEFITS
	FREIGHT	PASSENGERS	
2015	399,841,649	1,296,984	401,138,633
2016	415,835,315	1,322,923	417,158,239
2017	432,468,728	1,349,382	433,818,110
2018	449,767,477	1,376,370	451,143,847
2019	467,758,176	1,403,897	469,162,073
2020	**486,468,503**	**1,431,975**	**487,900,478**
2021	505,927,243	1,460,614	507,387,858
2022	526,164,333	1,489,827	527,654,160
2023	547,210,906	1,519,623	548,730,530
2024	569,099,343	1,550,016	570,649,358
2025	591,863,316	1,581,016	593,444,332
2026	615,537,849	1,612,636	617,150,485
2027	640,159,363	1,644,889	641,804,252
2028	665,765,738	1,677,787	667,443,524
2029	692,396,367	1,711,343	694,107,710
2030	720,092,222	1,745,569	721,837,791
2031	748,895,911	1,780,481	750,676,391
2032	778,851,747	1,816,090	780,667,837
2033	810,005,817	1,852,412	811,858,229
2034	842,406,050	1,889,460	844,295,510
2035	876,102,292	1,927,250	878,029,541
2036	911,146,383	1,965,795	913,112,178
2037	947,592,239	2,005,110	949,597,349
2038	985,495,928	2,045,213	987,541,141
2039	1,024,915,765	2,086,117	1,027,001,882
2040	1,065,912,396	2,127,839	1,068,040,235
2041	1,108,548,892	2,170,396	1,110,719,288
2042	1,152,890,847	2,213,804	1,155,104,651
2043	1,199,006,481	2,258,080	1,201,264,561
2044	1,246,966,740	2,303,242	1,249,269,982
2045	1,296,845,410	2,349,307	1,299,194,717
2046	1,348,719,226	2,396,293	1,351,115,519
2047	1,402,667,995	2,444,219	1,405,112,214
2048	1,458,774,715	2,493,103	1,461,267,818
2049	1,517,125,704	2,542,965	1,519,668,669

PHASE 2 W			
YEARS	BENEFITS		TOTAL BENEFITS
	FREIGHT	PASSENGERS	
2015	396,250,951	1,540,776	397,791,728
2016	412,100,989	1,571,592	413,672,581
2017	428,585,029	1,603,024	430,188,053
2018	445,728,430	1,635,084	447,363,514
2019	463,557,567	1,667,786	465,225,353
2020	482,099,870	1,701,141	483,801,012
2021	501,383,865	1,735,164	503,119,029
2022	521,439,219	1,769,868	523,209,087
2023	542,296,788	1,805,265	544,102,053
2024	563,988,660	1,841,370	565,830,030
2025	**586,548,206**	**1,878,198**	**588,426,404**
2026	610,010,134	1,915,762	611,925,896
2027	634,410,540	1,954,077	636,364,617
2028	659,786,961	1,993,158	661,780,120
2029	686,178,440	2,033,022	688,211,461
2030	713,625,577	2,073,682	715,699,259
2031	742,170,600	2,115,156	744,285,756
2032	771,857,425	2,157,459	774,014,883
2033	802,731,722	2,200,608	804,932,329
2034	834,840,990	2,244,620	837,085,610
2035	868,234,630	2,289,512	870,524,142
2036	902,964,015	2,335,303	905,299,318
2037	939,082,576	2,382,009	941,464,585
2038	976,645,879	2,429,649	979,075,528
2039	1,015,711,714	2,478,242	1,018,189,956
2040	1,056,340,183	2,527,807	1,058,867,989
2041	1,098,593,790	2,578,363	1,101,172,153
2042	1,142,537,541	2,629,930	1,145,167,472
2043	1,188,239,043	2,682,529	1,190,921,572
2044	1,235,768,605	2,736,179	1,238,504,784
2045	1,285,199,349	2,790,903	1,287,990,252
2046	1,336,607,323	2,846,721	1,339,454,044
2047	1,390,071,616	2,903,655	1,392,975,271
2048	1,445,674,481	2,961,728	1,448,636,209
2049	1,503,501,460	3,020,963	1,506,522,423
2050	1,563,641,518	3,081,382	1,566,722,900
2051	1,626,187,179	3,143,010	1,629,330,189
2052	1,691,234,666	3,205,870	1,694,440,536
2053	1,758,884,053	3,269,988	1,762,154,040
2054	1,829,239,415	3,335,387	1,832,574,802

Table 5-12 ***Cont'd***

PHASE 2 E			
YEARS	BENEFITS		TOTAL BENEFITS
	FREIGHT	PASSENGERS	
2015	391,031,304	1,478,016	392,509,320
2016	406,672,556	1,507,577	408,180,133
2017	422,939,458	1,537,728	424,477,187
2018	439,857,037	1,568,483	441,425,520
2019	457,451,318	1,599,852	459,051,171
2020	475,749,371	1,631,850	477,381,221
2021	494,779,346	1,664,487	496,443,832
2022	514,570,520	1,697,776	516,268,296
2023	535,153,340	1,731,732	536,885,072
2024	556,559,474	1,766,366	558,325,840
2025	578,821,853	1,801,694	580,623,547
2026	601,974,727	1,837,728	603,812,455
2027	**626,053,716**	**1,874,482**	**627,928,198**
2028	651,095,865	1,911,972	653,007,837
2029	677,139,699	1,950,211	679,089,911
2030	704,225,287	1,989,215	706,214,503
2031	732,394,299	2,029,000	734,423,299
2032	761,690,071	2,069,580	763,759,651
2033	792,157,674	2,110,971	794,268,645
2034	823,843,981	2,153,191	825,997,172
2035	856,797,740	2,196,255	858,993,995
2036	891,069,650	2,240,180	893,309,829
2037	926,712,436	2,284,983	928,997,419
2038	963,780,933	2,330,683	966,111,616
2039	1,002,332,170	2,377,297	1,004,709,467
2040	1,042,425,457	2,424,843	1,044,850,300
2041	1,084,122,475	2,473,339	1,086,595,815
2042	1,127,487,374	2,522,806	1,130,010,181
2043	1,172,586,869	2,573,262	1,175,160,132
2044	1,219,490,344	2,624,728	1,222,115,072
2045	1,268,269,958	2,677,222	1,270,947,180
2046	1,319,000,756	2,730,767	1,321,731,523
2047	1,371,760,786	2,785,382	1,374,546,168
2048	1,426,631,218	2,841,090	1,429,472,307
2049	1,483,696,467	2,897,911	1,486,594,378
2050	1,543,044,325	2,955,870	1,546,000,195
2051	1,604,766,098	3,014,987	1,607,781,085
2052	1,668,956,742	3,075,287	1,672,032,029
2053	1,735,715,012	3,136,792	1,738,851,804
2054	1,805,143,612	3,199,528	1,808,343,141
2055	1,877,349,357	3,263,519	1,880,612,876
2056	1,952,443,331	3,328,789	1,955,772,120

PHASE 2 (W+E)			
YEARS	BENEFITS		TOTAL BENEFITS
	FREIGHT	PASSENGERS	
2015	398,475,397	1,550,200	400,025,597
2016	414,414,413	1,581,204	415,995,617
2017	430,990,989	1,612,828	432,603,817
2018	448,230,629	1,645,085	449,875,713
2019	466,159,854	1,677,986	467,837,840
2020	484,806,248	1,711,546	486,517,794
2021	504,198,498	1,745,777	505,944,275
2022	524,366,438	1,780,693	526,147,130
2023	545,341,095	1,816,306	547,157,402
2024	567,154,739	1,852,632	569,007,372
2025	**589,840,929**	**1,889,685**	**591,730,614**
2026	613,434,566	1,927,479	615,362,045
2027	**637,971,948**	**1,966,028**	**639,937,977**
2028	663,490,826	2,005,349	665,496,175
2029	690,030,459	2,045,456	692,075,915
2030	717,631,678	2,086,365	719,718,043
2031	746,336,945	2,128,092	748,465,037
2032	776,190,423	2,170,654	778,361,077
2033	807,238,040	2,214,067	809,452,107
2034	839,527,561	2,258,349	841,785,910
2035	873,108,664	2,303,516	875,412,179
2036	908,033,010	2,349,586	910,382,596
2037	944,354,331	2,396,578	946,750,908
2038	982,128,504	2,444,509	984,573,013
2039	1,021,413,644	2,493,399	1,023,907,043
2040	1,062,270,190	2,543,267	1,064,813,457
2041	1,104,760,997	2,594,133	1,107,355,130
2042	1,148,951,437	2,646,015	1,151,597,453
2043	1,194,909,495	2,698,936	1,197,608,430
2044	1,242,705,874	2,752,914	1,245,458,789
2045	1,292,414,109	2,807,973	1,295,222,082
2046	1,344,110,674	2,864,132	1,346,974,806
2047	1,397,875,101	2,921,415	1,400,796,516
2048	1,453,790,105	2,979,843	1,456,769,948
2049	1,511,941,709	3,039,440	1,514,981,149
2050	1,572,419,377	3,100,229	1,575,519,606
2051	1,635,316,152	3,162,233	1,638,478,386
2052	1,700,728,799	3,225,478	1,703,954,277
2053	1,768,757,950	3,289,988	1,772,047,938
2054	1,839,508,268	3,355,787	1,842,864,056
2055	1,913,088,599	3,422,903	1,916,511,502
2056	1,989,612,143	3,491,361	1,993,103,504

Table 5-12 *Cont'd*

PHASE 2C			
YEARS	BENEFITS		TOTAL BENEFITS
	FREIGHT	PASSENGERS	
2015	426,264,756	1,419,634	427,684,390
2016	443,315,346	1,448,027	444,763,373
2017	461,047,960	1,476,988	462,524,948
2018	479,489,878	1,506,527	480,996,406
2019	498,669,473	1,536,658	500,206,131
2020	518,616,252	1,567,391	520,183,644
2021	539,360,902	1,598,739	540,959,641
2022	560,935,339	1,630,714	562,566,052
2023	583,372,752	1,663,328	585,036,080
2024	606,707,662	1,696,595	608,404,257
2025	630,975,969	1,730,526	632,706,495
2026	656,215,007	1,765,137	657,980,144
2027	682,463,608	1,800,440	684,264,047
2028	709,762,152	1,836,449	711,598,601
2029	738,152,638	1,873,177	740,025,816
2030	**767,678,744**	**1,910,641**	**769,589,385**
2031	798,385,893	1,948,854	800,334,747
2032	830,321,329	1,987,831	832,309,160
2033	863,534,182	2,027,588	865,561,770
2034	898,075,550	2,068,139	900,143,689
2035	933,998,572	2,109,502	936,108,074
2036	971,358,514	2,151,692	973,510,207
2037	1,010,212,855	2,194,726	1,012,407,581
2038	1,050,621,369	2,238,620	1,052,859,990
2039	1,092,646,224	2,283,393	1,094,929,617
2040	1,136,352,073	2,329,061	1,138,681,134
2041	1,181,806,156	2,375,642	1,184,181,798
2042	1,229,078,402	2,423,155	1,231,501,557
2043	1,278,241,538	2,471,618	1,280,713,156
2044	1,329,371,200	2,521,050	1,331,892,250
2045	1,382,546,048	2,571,471	1,385,117,519
2046	1,437,847,890	2,622,901	1,440,470,790
2047	1,495,361,805	2,675,359	1,498,037,164
2048	1,555,176,277	2,728,866	1,557,905,143
2049	1,617,383,329	2,783,443	1,620,166,772
2050	1,682,078,662	2,839,112	1,684,917,774
2051	1,749,361,808	2,895,894	1,752,257,702
2052	1,819,336,280	2,953,812	1,822,290,093
2053	1,892,109,732	3,012,888	1,895,122,620
2054	1,967,794,121	3,073,146	1,970,867,267
2055	2,046,505,886	3,134,609	2,049,640,495
2056	2,128,366,121	3,197,301	2,131,563,423
2057	2,213,500,766	3,261,247	2,216,762,013
2058	2,302,040,797	3,326,472	2,305,367,269
2059	2,394,122,429	3,393,002	2,397,515,430

PHASE 3			
YEARS	BENEFITS		TOTAL BENEFITS
	FREIGHT	PASSENGERS	
2015	427,269,499	1,501,444	428,770,943
2016	444,360,279	1,531,473	445,891,752
2017	462,134,690	1,562,102	463,696,792
2018	480,620,078	1,593,344	482,213,422
2019	499,844,881	1,625,211	501,470,092
2020	519,838,676	1,657,715	521,496,391
2021	540,632,223	1,690,870	542,323,093
2022	562,257,512	1,724,687	563,982,199
2023	584,747,812	1,759,181	586,506,993
2024	608,137,725	1,794,364	609,932,089
2025	632,463,234	1,830,252	634,293,485
2026	657,761,763	1,866,857	659,628,620
2027	684,072,234	1,904,194	685,976,428
2028	711,435,123	1,942,278	713,377,401
2029	739,892,528	1,981,123	741,873,651
2030	769,488,229	2,020,746	771,508,975
2031	800,267,758	2,061,161	802,328,919
2032	832,278,469	2,102,384	834,380,852
2033	865,569,607	2,144,431	867,714,039
2034	900,192,392	2,187,320	902,379,712
2035	936,200,087	2,231,066	938,431,154
2036	**973,648,091**	**2,275,688**	**975,923,779**
2037	1,012,594,015	2,321,202	1,014,915,216
2038	1,053,097,775	2,367,626	1,055,465,401
2039	1,095,221,686	2,414,978	1,097,636,664
2040	1,139,030,554	2,463,278	1,141,493,831
2041	1,184,591,776	2,512,543	1,187,104,319
2042	1,231,975,447	2,562,794	1,234,538,241
2043	1,281,254,465	2,614,050	1,283,868,515
2044	1,332,504,643	2,666,331	1,335,170,974
2045	1,385,804,829	2,719,658	1,388,524,486
2046	1,441,237,022	2,774,051	1,444,011,073
2047	1,498,886,503	2,829,532	1,501,716,035
2048	1,558,841,963	2,886,122	1,561,728,085
2049	1,621,195,642	2,943,845	1,624,139,486
2050	1,686,043,467	3,002,722	1,689,046,189
2051	1,753,485,206	3,062,776	1,756,547,982
2052	1,823,624,614	3,124,032	1,826,748,646
2053	1,896,569,599	3,186,512	1,899,756,111
2054	1,972,432,383	3,250,243	1,975,682,625
2055	2,051,329,678	3,315,247	2,054,644,925
2056	2,133,382,865	3,381,552	2,136,764,417
2057	2,218,718,180	3,449,183	2,222,167,363
2058	2,307,466,907	3,518,167	2,310,985,074
2059	2,399,765,583	3,588,530	2,403,354,114
2060	2,495,756,207	3,660,301	2,499,416,508
2061	2,595,586,455	3,733,507	2,599,319,962
2062	2,699,409,913	3,808,177	2,703,218,090
2063	2,807,386,310	3,884,341	2,811,270,650
2064	2,919,681,762	3,962,028	2,923,643,789
2065	3,036,469,032	4,041,268	3,040,510,300

Table 5-12 ***Cont'd***

PHASE 4			
YEARS	BENEFITS		TOTAL BENEFITS
	FREIGHT	PASSENGERS	
2015	428,238,774	1,646,272	429,885,045
2016	445,368,325	1,679,197	447,047,522
2017	463,183,057	1,712,781	464,895,839
2018	481,710,380	1,747,037	483,457,417
2019	500,978,795	1,781,978	502,760,773
2020	521,017,947	1,817,617	522,835,564
2021	541,858,665	1,853,970	543,712,634
2022	563,533,011	1,891,049	565,424,060
2023	586,074,332	1,928,870	588,003,202
2024	609,517,305	1,967,447	611,484,752
2025	633,897,997	2,006,796	635,904,793
2026	659,253,917	2,046,932	661,300,849
2027	685,624,074	2,087,871	687,711,945
2028	713,049,037	2,129,628	715,178,665
2029	741,570,998	2,172,221	743,743,219
2030	771,233,838	2,215,665	773,449,503
2031	802,083,192	2,259,979	804,343,170
2032	834,166,519	2,305,178	836,471,697
2033	867,533,180	2,351,282	869,884,462
2034	902,234,507	2,398,307	904,632,815
2035	938,323,888	2,446,273	940,770,161
2036	975,856,843	2,495,199	978,352,042
2037	1,014,891,117	2,545,103	1,017,436,220
2038	1,055,486,761	2,596,005	1,058,082,766
2039	1,097,706,232	2,647,925	1,100,354,157
2040	**1,141,614,481**	**2,700,884**	**1,144,315,365**
2041	1,187,279,060	2,754,901	1,190,033,962
2042	1,234,770,223	2,809,999	1,237,580,222
2043	1,284,161,032	2,866,199	1,287,027,231
2044	1,335,527,473	2,923,523	1,338,450,996
2045	1,388,948,572	2,981,994	1,391,930,566
2046	1,444,506,515	3,041,634	1,447,548,148
2047	1,502,286,775	3,102,466	1,505,389,242
2048	1,562,378,246	3,164,516	1,565,542,762
2049	1,624,873,376	3,227,806	1,628,101,182
2050	1,689,868,311	3,292,362	1,693,160,673
2051	1,757,463,044	3,358,209	1,760,821,253
2052	1,827,761,565	3,425,373	1,831,186,939
2053	1,900,872,028	3,493,881	1,904,365,909
2054	1,976,906,909	3,563,758	1,980,470,668
2055	2,055,983,186	3,635,034	2,059,618,219
2056	2,138,222,513	3,707,734	2,141,930,247
2057	2,223,751,414	3,781,889	2,227,533,303
2058	2,312,701,470	3,857,527	2,316,558,997
2059	2,405,209,529	3,934,677	2,409,144,206
2060	2,501,417,910	4,013,371	2,505,431,281
2061	2,601,474,626	4,093,638	2,605,568,265
2062	2,705,533,612	4,175,511	2,709,709,123
2063	2,813,754,956	4,259,021	2,818,013,977
2064	2,926,305,154	4,344,202	2,930,649,356
2065	3,043,357,360	4,431,086	3,047,788,446
2066	3,165,091,655	4,519,707	3,169,611,362
2067	3,291,695,321	4,610,102	3,296,305,423
2068	3,423,363,134	4,702,304	3,428,065,437
2069	3,560,297,659	4,796,350	3,565,094,009

PHASE 5			
YEARS	BENEFITS		TOTAL BENEFITS
	FREIGHT	PASSENGERS	
2015	444,028,219	1,653,334	445,681,553
2016	461,789,348	1,686,400	463,475,748
2017	480,260,922	1,720,128	481,981,050
2018	499,471,359	1,754,531	501,225,889
2019	519,450,213	1,789,621	521,239,834
2020	540,228,221	1,825,414	542,053,635
2021	561,837,350	1,861,922	563,699,272
2022	584,310,844	1,899,161	586,210,005
2023	607,683,278	1,937,144	609,620,422
2024	631,990,609	1,975,887	633,966,496
2025	657,270,234	2,015,404	659,285,638
2026	683,561,043	2,055,712	685,616,755
2027	710,903,485	2,096,827	713,000,311
2028	739,339,624	2,138,763	741,478,387
2029	768,913,209	2,181,539	771,094,747
2030	799,669,737	2,225,169	801,894,907
2031	831,656,527	2,269,673	833,926,199
2032	864,922,788	2,315,066	867,237,854
2033	899,519,699	2,361,367	901,881,067
2034	935,500,487	2,408,595	937,909,082
2035	972,920,507	2,456,767	975,377,274
2036	1,011,837,327	2,505,902	1,014,343,229
2037	1,052,310,820	2,556,020	1,054,866,840
2038	1,094,403,253	2,607,140	1,097,010,393
2039	1,138,179,383	2,659,283	1,140,838,666
2040	1,183,706,558	2,712,469	1,186,419,027
2041	1,231,054,821	2,766,718	1,233,821,539
2042	1,280,297,014	2,822,053	1,283,119,066
2043	1,331,508,894	2,878,494	1,334,387,388
2044	1,384,769,250	2,936,064	1,387,705,314
2045	**1,440,160,020**	**2,994,785**	**1,443,154,805**
2046	1,497,766,421	3,054,681	1,500,821,101
2047	1,557,677,078	3,115,774	1,560,792,852
2048	1,619,984,161	3,178,090	1,623,162,250
2049	1,684,783,527	3,241,651	1,688,025,179
2050	1,752,174,868	3,306,484	1,755,481,353
2051	1,822,261,863	3,372,614	1,825,634,477
2052	1,895,152,337	3,440,066	1,898,592,404
2053	1,970,958,431	3,508,868	1,974,467,299
2054	2,049,796,768	3,579,045	2,053,375,813
2055	2,131,788,639	3,650,626	2,135,439,265
2056	2,217,060,184	3,723,639	2,220,783,823
2057	2,305,742,592	3,798,111	2,309,540,703
2058	2,397,972,296	3,874,074	2,401,846,369
2059	2,493,891,187	3,951,555	2,497,842,742
2060	2,593,646,835	4,030,586	2,597,677,421
2061	2,697,392,708	4,111,198	2,701,503,906
2062	2,805,288,417	4,193,422	2,809,481,838
2063	2,917,499,953	4,277,290	2,921,777,243
2064	3,034,199,951	4,362,836	3,038,562,787
2065	3,155,567,949	4,450,093	3,160,018,042
2066	3,281,790,667	4,539,095	3,286,329,762
2067	3,413,062,294	4,629,877	3,417,692,171
2068	3,549,584,786	4,722,474	3,554,307,260
2069	3,691,568,177	4,816,924	3,696,385,101
2070	3,839,230,904	4,913,262	3,844,144,166
2071	3,992,800,141	5,011,527	3,997,811,668
2072	4,152,512,146	5,111,758	4,157,623,904
2073	4,318,612,632	5,213,993	4,323,826,625
2074	4,491,357,137	5,318,273	4,496,675,410

Table 5-12 ***Cont'd***

PHASE 6			
YEARS	BENEFITS		TOTAL BENEFITS
	FREIGHT	PASSENGERS	
2015	445,624,781	1,740,046	447,364,826
2016	463,449,772	1,774,847	465,224,619
2017	481,987,763	1,810,344	483,798,106
2018	501,267,273	1,846,551	503,113,824
2019	521,317,964	1,883,482	523,201,446
2020	542,170,683	1,921,151	544,091,834
2021	563,857,510	1,959,574	565,817,084
2022	586,411,810	1,998,766	588,410,576
2023	609,868,283	2,038,741	611,907,024
2024	634,263,014	2,079,516	636,342,530
2025	659,633,535	2,121,106	661,754,641
2026	686,018,876	2,163,528	688,182,404
2027	713,459,631	2,206,799	715,666,430
2028	741,998,016	2,250,935	744,248,951
2029	771,677,937	2,295,954	773,973,890
2030	802,545,054	2,341,873	804,886,927
2031	834,646,857	2,388,710	837,035,567
2032	868,032,731	2,436,484	870,469,215
2033	902,754,040	2,485,214	905,239,254
2034	938,864,202	2,534,918	941,399,120
2035	976,418,770	2,585,617	979,004,386
2036	1,015,475,521	2,637,329	1,018,112,849
2037	1,056,094,541	2,690,076	1,058,784,617
2038	1,098,338,323	2,743,877	1,101,082,200
2039	1,142,271,856	2,798,755	1,145,070,610
2040	1,187,962,730	2,854,730	1,190,817,460
2041	1,235,481,239	2,911,824	1,238,393,064
2042	1,284,900,489	2,970,061	1,287,870,550
2043	1,336,296,508	3,029,462	1,339,325,970
2044	1,389,748,369	3,090,051	1,392,838,420
2045	1,445,338,304	3,151,852	1,448,490,156
2046	1,503,151,836	3,214,889	1,506,366,725
2047	1,563,277,909	3,279,187	1,566,557,096
2048	**1,625,809,026**	**3,344,771**	**1,629,153,796**
2049	1,690,841,387	3,411,666	1,694,253,053
2050	1,758,475,042	3,479,900	1,761,954,942
2051	1,828,814,044	3,549,498	1,832,363,541
2052	1,901,966,605	3,620,487	1,905,587,093
2053	1,978,045,270	3,692,897	1,981,738,167
2054	2,057,167,080	3,766,755	2,060,933,836
2055	2,139,453,764	3,842,090	2,143,295,854
2056	2,225,031,914	3,918,932	2,228,950,846
2057	2,314,033,191	3,997,311	2,318,030,501
2058	2,406,594,518	4,077,257	2,410,671,775
2059	2,502,858,299	4,158,802	2,507,017,101
2060	2,602,972,631	4,241,978	2,607,214,609
2061	2,707,091,536	4,326,818	2,711,418,354
2062	2,815,375,198	4,413,354	2,819,788,552
2063	2,927,990,206	4,501,621	2,932,491,827
2064	3,045,109,814	4,591,654	3,049,701,467
2065	3,166,914,206	4,683,487	3,171,597,693
2066	3,293,590,775	4,777,156	3,298,367,931
2067	3,425,334,406	4,872,699	3,430,207,105
2068	3,562,347,782	4,970,153	3,567,317,935
2069	3,704,841,693	5,069,557	3,709,911,250
2070	3,853,035,361	5,170,948	3,858,206,309
2071	4,007,156,775	5,274,367	4,012,431,142
2072	4,167,443,046	5,379,854	4,172,822,900
2073	4,334,140,768	5,487,451	4,339,628,219
2074	4,507,506,399	5,597,200	4,513,103,599
2075	4,687,806,655	5,709,144	4,693,515,799
2076	4,875,318,921	5,823,327	4,881,142,248
2077	5,070,331,678	5,939,793	5,076,271,471

- <u>Savings in Road Maintenance</u>

Road pavements deteriorate mainly as a result of traffic loading. The rate of pavement deterioration is directly affected by the standards of maintenance applied to repair defects on the pavement surface (such as cracking, ravelling, potholes, etc.), or to preserve the structural integrity of the pavement (for example, surface treatments, overlays, etc.). Consequently, in addition to the capital costs of road construction, the total costs that are incurred by road agencies will depend on the standards of maintenance and improvement applied to road networks.

It is obvious, that a reduction of traffic flows (especially of heavy trucks) on the road network leads to a lower rate of deterioration of the road pavement and, therefore, to lower maintenance cost of the facility.

In order to estimate the probable savings in terms of maintenance costs on the road network, after the modal redistribution of traffic on the rail and road networks, the following assumptions have been made.

Assuming a mean cost of construction in Ghana of 1.0 million US$ per kilometre, for a new asphalted road and a ratio of 2.5% of the preceding cost for the annual maintenance of the road, the maintenance cost per km and per year is: US$25,000. It has been successively considered that the realisation of the new lines at standard gauge will attract more traffic from the road mode and the total road maintenance costs will be less than those related to the rehabilitation of the existing lines at narrow gauge. It is therefore assumed that the savings in road maintenance will be of US$2000 per km and per year in Phase 1 and, successively, of US$3750 per km in the other Phases.

Calculation is based on changes of the road freight traffic related to the Eastern Railway Line. The estimation of road maintenance savings has been done as follows

<u>ROAD FREIGHT TRAFFIC RELATED TO THE EASTERN LINE</u>

9,300,000	Ton	Without project (present situation)
7,800,000	Ton	Narrow Gauge project realisation (Phase 1)
6,300,000	Ton	Standard Gauge project realisation (Phase 2)

<u>PERCENTAGE OF DECREASE</u>

16%	Narrow Gauge project
32%	Standard Gauge project

- **ASSUMING THE FOLLOWING PERCENTAGES (HALF VALUES CALCULATED)**

8%	Narrow Gauge project
15%	Standard Gauge project

Assuming a mean construction cost, for Ghana, of	**US$ 1,000,000**	**/ KM**
and a periodic **maintenance in percent of construction cost**, of	**2.5%**	
then**, Maintenance Cost per KM per year**	**US$ 25,000**	**/ KM**

- **SAVINGS WILL BE:**

For the road network <u>versus NARROW gauge rail rehabilitation</u>:

25,000 x 8% = ***US$ 2,000 /KM/YR***

For the road network <u>versus STANDARD gauge rail construction</u>:

25,000 x 15% = ***US$ 3,750 /KM/YR***

Based on the preceding assumptions, the savings in road maintenance, per Phase and accumulated for the economic analysis, are detailed in the following Table 5-13.

Table 5 - 13 Estimates in Road Maintenance Savings per Phase

ESTIMATE IN ROAD MAINTENANCE SAVINGS PER PHASE				US$/KM/YEAR
PHASES - SECTIONS	LENGTH (Km)			
	Partial	Total		
PHASE 1: Rehabilitation of existing line		**667.6**		
1W - Western Line	***340.0***		PHASE 1 WESTERN	**680,000**
1 - Takoradi - Tarkwa - Dunkwa - Kumasi	266.8	***1W***	*533,600*	
2 - Dunkwa - Awaso	73.2		*146,400*	
1E - Eastern Line	***327.6***		PHASE 1 EASTERN	**655,200**
1 - Accra - Kumasi	303.9	***1E***	*607,800*	
2 - Achimota - Tema	23.7		*47,400*	
PHASE 2: Eastern "A" Expansion		**1,161**		
2W -Takoradi-Kumasi	266		PHASE 2 W	**1,143,900**
2E - Accra - Kumasi	300		PHASE 2 E	**1,172,400**
2C - Kumasi - Techiman - Tamale	383		PHASE 2 C	**2,231,250**
- Tamale - Paga	212			
PHASE 3: Transversal Expansions		**484**	PHASE 3: TRANSVERSAL	**1,815,000**
1 - Tamale - Yendi	102			
2 - Fufulsu - Sawla	126			
3 - Techiman - Atebubu - Kwadwokurom	198			
4 - Nyinahin - Kumasi	58			
PHASE 4: Trans Ecowas Expansion		**498**	PHASE 4: TRANS ECOWAS	**1,867,500**
1 - Aflao - Tema - Accra	185			
2 - Accra - Takoradi	212			
3 - Tarkwa - Omanpe	101			
PHASE 5: Western Expansion		**729**	PHASE 5: WESTERN	**2,733,750**
1 - Dunkwa - Awaso	73			
2 - Awaso - Techiman	220			
3 - Techiman - Sawla	223			
4 - Sawla - Hamile	213			
PHASE 6: Eastern "B" Expansion		**468**	PHASE 6: EASTERN B	**1,755,000**
1 - Tema - Ho	130			
2 - Ho - Yendi	338			

➢ <u>Savings in Road Accident Casualties</u>

As the number of road accidents could increase with increase in traffic, the road accident rate should diminish with the modal shift of part of road traffic to rail. Therefore, it has been evaluated what would be the savings in costs of reduced road casualties that could be assigned to the realisation of the National Railways Network, in Ghana.

Statistics for years 2008, 2009 and 2010 on accidents and casualties on the Accra to Kumasi road are as follows.

Table 5 - 14 Accident Data 2008 - 2010 Accra - Kumasi Road (243 km)

	ACCIDENTS PER YEAR				CASUALTIES PER YEAR			
	TOTAL	FATAL	SERIOUS	SLIGHT	**TOTAL**	FATAL	SERIOUS	SLIGHT
2008	**1,038**	125	194	254	**1,450**	152	393	905
2009	**1,175**	181	210	319	**2,032**	236	589	1,207
2010	**1,090**	161	178	286	**1,665**	215	526	924
AVERAGES	***1,101***	***156***	***194***	***286***	***1,716***	***201***	***503***	***1,012***

Source: Ghana Highway Authority

After comparing this data with volumes of passengers on the road, the following estimate of the number of people travelling by road and by rail, after the implementation of the existing Eastern Line railway has been established.

Table 5 - 15 Road Passenger Traffic related to the Eastern Line

5-15/1 **BASE TransCAD** **Per 365 days / year**

108,000	Pax/Day	**39,420,000**	Pax/Year	**Without project**
58,000	Pax/Day	**21,170,000**	Pax/Year	**Narrow Gauge project**
42,000	Pax/Day	**15,330,000**	Pax/Year	**Standard Gauge project**

The resulting annual road passenger traffic decrease is:

5-15/2	**PERCENTAGE OF ROAD TRAFFIC DECREASE**			
46%	(A-B)=	18,250,000	Person	**For Narrow Gauge project**
61%	(A-C)	24,090,000	Person	**For Standard Gauge project**

5-15/3 **CASUALTIES PER YEAR IN % OF TODAY ROAD TRAFFIC**

FATAL	SERIOUS	SLIGHT
0.00051%	0.00128%	0.00257%

5-15/4 **No. OF RELATIVE CASUALTIES (*5-15/3 * 5-15/2*)**

FATAL	SERIOUS	SLIGHT	
93	233	469	For Narrow Gauge project
123	307	618	For Standard Gauge project

5-15/5 NUMBER OF RELATIVE CASUALTIES PER 243 km (*5-15/4 : 243)*

FATAL	SERIOUS	SLIGHT	
0.38	0.96	1.93	For Narrow Gauge project
0.51	1.26	2.55	For Standard Gauge project

4-15/6 THE SAVING COST PER KM-YEAR IS (*5-15/5 * 5-15/7*)

FATAL	SERIOUS	SLIGHT	TOTAL US$	
38,294	114,922	19,281	**172,497**	For Narrow Gauge project
50,549	151,696	25,450	**227,695**	For Standard Gauge project

5-15/7 ACCIDENTS COST

The cost for 1 person injured is estimated for:	FATAL	SERIOUS	SLIGHT
at US$:	100,000	120,000	10,000

Based on the preceding data, the estimates in road accident savings per Phase, have been calculated and the results are shown in the following Table 5-16.

Table 5 - 16 Estimates in Road Accidents Savings per Phases

PHASES and Sections	Length (Km)		PHASE	Total (US$)
	partial	Total		
PHASE 1: Rehabilitation of existing line				
Western Line		***340.0***	PHASE 1 W	**58,648,834**
1 - Takoradi - Tarkwa - Dunkwa - Kumasi	266.8			
2 - Dunkwa - Awaso	73.2			
Eastern Line		***327.6***	PHASE 1 E	**56,509,877**
1 - Accra - Kumasi	303.9			
2 - Achimota - Tema	23.7			
PHASE 2: Eastern "A" Expansion		***566***		
1a -Takoradi-Kumasi	266		PHASE 2W	**60,566,996**
1b - Accra - Kumasi	300		PHASE 2E	**68,308,642**
PHASE 2C Eastern "A" Expansion		***595***	PHASE 2C	**135,478,807**
2 - Kumasi - Techiman - Paga	383			
3 - Tamale - Paga	212			
PHASE 3: Transversal		***484***	PHASE 3	**110,204,609**
1 - Tamale - Yendi	102			
2 - Fufulsu - Sawla	126			
3 - Techiman - Atebubu - Kwadwokurom	198			
4 - Nyinahin - Kumasi	58			
PHASE 4: Trans Ecowas		**498**	PHASE 4	**113,392,346**
1 - Aflao - Tema - Accra	185			
2 - Accra - Takoradi	212			
3 - Tarkwa - Omanpe	101			
PHASE 5: Western Expansion		**729**	PHASE 5	**165,990,000**
1 - Dunkwa - Awaso	73			
2 - Awaso - Techiman	220			
3 - Techiman - Sawla	223			
4 - Sawla - Hamile	213			
PHASE 6: Eastern "B" Expansion		**468**	PHASE 6	**106,561,481**
1 - Tema - Ho	130			
2 - Ho - Yendi	338			

5.2.4.6 Other Non-Quantified Benefits

There will be a better opportunity for local people to be employed during rehabilitation and construction phases of the railway network, for a relatively long period, and also for the subsequent operation and maintenance activities. The number of employment opportunities created represents a real benefit for the community and should be retained, even if in qualitative terms, in the final decision for the Project realisation.

5.2.5 Economic Feasibility Analysis

Based on the preceding assumptions the economic feasibility has been conducted for each Phase in order to determine their respective feasibility. Phases 1 and 2 have been analysed separately both for the Western and Eastern existing lines, while the other phases have been evaluated in a increasing order.

It should be highlighted that the main category of benefits, represented by savings in transportation costs, is increasing phase after phase due to the progressive assignment of the growing traffic on the multimodal network (i.e. road and rail). That means that at the end of introducing Phase 6 into TransCAD model, the derived benefits are those produced by the existence of the entire new Railways Network and not only those related to the Phase 6 realisation. This procedure is necessarily the same for each Phase introduced in the model. Therefore, the project costs should be considered incrementally in the same way.

5.2.5.1 Economic Investment Plan for the Infrastructure

In consideration of what has just been exposed, the investment cost streams to be considered in the economic analysis are presented in Table 5 -17 on the following page.

5.2.5.2 Economic Investment Plan for the Rolling Stock

Estimated investment in rolling stock is applied in the last three years of the total period forecasted for the construction of the relative phase. The costs are applied at 20%, 30% and 50% of their total, respectively along the three-year period considered. These costs are presented in Table 5 - 18.

Table 5 - 17 Economic Investment Plan per Phase for the Economic Feasibility

	YEAR	PHASE 1 W	PHASE 1 E	PHASE 2 W	PHASE 2 E	PHASE 2C	TOT CUMUL 2	PHASE 3	TOT CUMUL 2+3	PHASE 4	TOT 2+3+4	PHASE 5	TOT 2+3+4+5	PHASE 6	TOT 2+3+4+5+6
	2015	285,600,000	220,147,200												
	2016	285,600,000	220,147,200												
	2017	285,600,000	220,147,200												
	2018	285,600,000	220,147,200												
1W	**2019**		220,147,200	198,613,333			198,613,333		198,613,333		198,613,333		198,613,333		**198,613,333**
1E	**2020**			198,613,333	192,000,000		390,613,333		390,613,333		390,613,333		390,613,333		**390,613,333**
	2021			198,613,333	192,000,000	190,648,889	581,262,222		581,262,222		581,262,222		581,262,222		**581,262,222**
	2022			198,613,333	192,000,000	190,648,889	581,262,222		581,262,222		581,262,222		581,262,222		**581,262,222**
	2023			198,613,333	192,000,000	190,648,889	581,262,222		581,262,222		581,262,222		581,262,222		**581,262,222**
	2024			198,613,333	192,000,000	190,648,889	581,262,222		581,262,222		581,262,222		581,262,222		**581,262,222**
2W	**2025**				192,000,000	380,600,889	572,600,889		572,600,889		572,600,889		572,600,889		**572,600,889**
	2026				192,000,000	380,600,889	572,600,889		572,600,889		572,600,889		572,600,889		**572,600,889**
2E	**2027**					380,600,889	380,600,889		380,600,889		380,600,889		380,600,889		**380,600,889**
	2028					380,600,889	380,600,889		380,600,889		380,600,889		380,600,889		**380,600,889**
	2029					380,600,889	380,600,889		380,600,889		380,600,889		380,600,889		**380,600,889**
2C	**2030**							365,568,000	365,568,000		365,568,000		365,568,000		**365,568,000**
	2031							365,568,000	365,568,000		365,568,000		365,568,000		**365,568,000**
	2032							365,568,000	365,568,000		365,568,000		365,568,000		**365,568,000**
	2033							459,648,000	459,648,000		459,648,000		459,648,000		**459,648,000**
	2034							459,648,000	459,648,000	189,952,000	649,600,000		649,600,000		**649,600,000**
	2035							152,320,000	152,320,000	189,952,000	342,272,000		342,272,000		**342,272,000**
3	**2036**									397,152,000	397,152,000		397,152,000		**397,152,000**
	2037									547,978,667	547,978,667	199,808,000	747,786,667		**747,786,667**
	2038									547,978,667	547,978,667	199,808,000	747,786,667		**747,786,667**
	2039									358,026,667	358,026,667	363,328,000	721,354,667		**721,354,667**
4	**2040**											751,296,000	751,296,000		**751,296,000**
	2041											587,776,000	587,776,000	216,320,000	**804,096,000**
	2042											387,968,000	387,968,000	216,320,000	**604,288,000**
	2043											387,968,000	387,968,000	410,453,333	**798,421,333**
	2044											387,968,000	387,968,000	410,453,333	**798,421,333**
5	**2045**													410,453,333	**410,453,333**
	2046													216,320,000	**216,320,000**
	2047													216,320,000	**216,320,000**
6	**2048**														
	2049														
	2050														
	TOTAL	**1,142,400,000**	**1,100,736,000**	**1,191,680,000**	**1,344,000,000**	**2,665,600,000**		**2,168,320,000**		**2,231,040,000**		**3,265,920,000**		**2,096,640,000**	**17,206,336,000**

Table 5 - 18 Rolling Stock Investment Streams

Open.Year /Phase	YEAR	1 W NG	1 E NG	2 W	2 E	2C	TOT 2W+2E+2 C	PHASE 3	TOT 2+3	PHASE 4	TOT 2+3+4	PHASE 5	TOT 2+3+4+5	PHASE 6	TOT 2+3+4+5+6
	2015														
	2016	5,324,830													
	2017	7,987,245	5,324,830												
	2018	13,312,075	7,987,245												
1W	**2019**		13,312,075												
1E	**2020**														
	2021														
	2022			18,836,500			**18,836,500**		**18,836,500**		**18,836,500**		**18,836,500**		**18,836,500**
	2023			28,254,750			**28,254,750**		**28,254,750**		**28,254,750**		**28,254,750**		**28,254,750**
	2024			47,091,250	18,836,500		**65,927,750**		**65,927,750**		**65,927,750**		**65,927,750**		**65,927,750**
2W	**2025**				28,254,750		**28,254,750**		**28,254,750**		**28,254,750**		**28,254,750**		**28,254,750**
	2026				47,091,250		**47,091,250**		**47,091,250**		**47,091,250**		**47,091,250**		**47,091,250**
2E	**2027**					37,673,000	**37,673,000**		**37,673,000**		**37,673,000**		**37,673,000**		**37,673,000**
	2028					56,509,500	**56,509,500**		**56,509,500**		**56,509,500**		**56,509,500**		**56,509,500**
	2029					94,182,500	**94,182,500**		**94,182,500**		**94,182,500**		**94,182,500**		**94,182,500**
2C	**2030**								**0**		**0**		**0**		**0**
	2031								**0**		**0**		**0**		**0**
	2032								**0**		**0**		**0**		**0**
	2033							42,794,000	**42,794,000**		**42,794,000**		**42,794,000**		**42,794,000**
	2034							64,191,000	**64,191,000**		**64,191,000**		**64,191,000**		**64,191,000**
	2035							106,985,000	**106,985,000**		**106,985,000**		**106,985,000**		**106,985,000**
3	**2036**										**0**		**0**		**0**
	2037									35,840,000	**35,840,000**		**35,840,000**		**35,840,000**
	2038									53,760,000	**53,760,000**		**53,760,000**		**53,760,000**
	2039									89,600,000	**89,600,000**		**89,600,000**		**89,600,000**
4	**2040**												**0**		**0**
	2041												**0**		**0**
	2042											57,398,000	**57,398,000**		**57,398,000**
	2043											86,097,000	**86,097,000**		**86,097,000**
	2044											143,495,000	**143,495,000**		**143,495,000**
5	**2045**													28,708,000	**28,708,000**
	2046													43,062,000	**43,062,000**
	2047													71,770,000	**71,770,000**
6	**2048**														
	2049														
TOTAL		**26,624,150**	**26,624,150**	**94,182,500**	**94,182,500**	**188,365,000**		**213.970,000**		**179,200,000**		**286,990,000**		**143,540,000**	**1,200,430,000**

5.2.5.3 Economic Maintenance Costs Plan

The unit cost for maintenance and operation of the infrastructure, comprising the Railways lines, signalling and stations, has been estimated in US $ 37,000 per km and per year.

As for the preceding costs, those related to the maintenance of the infrastructure have been accumulated phase by phase for a correct evaluation of the economic feasibility of the project. Maintenance cost flows are presented in the following Table 5 -19.

Table 5 - 19 Maintenance Economic Costs and First Year of Application

PHASE / LINES	KM	PHASES	TOTAL COST	CUMULATED TOTAL	1st YEAR OF APPLICATION
PHASE 1 Western Line	***340***	**1W**	12,580,000	**12,580,000**	**2019**
1 - Takoradi - Tarkwa - Dunkwa - Kumasi	266.8				
2 - Dunkwa - Awaso	73.2				
PHASE 1 Eastern line	***327.6***	**1E**	12,121,200	**12,121,200**	**2020**
1 - Accra - Kumasi	303.9				
2 - Achimota - Tema	23.7				
PHASE 2	KM				
1a -Takoradi-Kumasi	266	**2W**	9,842,000	**9,842,000**	**2025**
1b - Accra - Kumasi	300	**2E**	11,100,000	**11,100,000**	**2027**
2 - Kumasi - Techiman - Paga	383	**2C**	22,015,000	**42,957,000**	**2030**
3 - Tamale - Paga	212				
PHASE 3	KM	**3**	17,908,000	**60,865,000**	**2036**
1 - Tamale - Yendi	102				
2 - Fufulsu - Sawla	126				
3 - Techiman - Atebubu - Kwadwokurom	198				
4 - Nyinahin - Kumasi	58				
PHASE 4	KM	**4**	18,426,000	**79,291,000**	**2040**
1 - Aflao - Tema - Accra	185				
2 - Accra - Takoradi	212				
3 - Tarkwa - Omanpe	101				
PHASE 5	KM	**5**	26,973,000	**106,264,000**	**2045**
1 - Dunkwa - Awaso	73				
2 - Awaso - Techiman	220				
3 - Techiman - Sawla	223				
4 - Sawla - Hamile	213				
PHASE 6	KM	**6**	17,316,000	**123,580,000**	**2048**
1 - Tema - Ho	130				
2 - Ho - Yendi	338				

5.2.6 Residual Value of the Infrastructure

The residual value of each Phase analysed has been estimated in 70% of the total investment costs of the Infrastructure.

5.2.7 Economic Analysis Results

A first analysis has been made in order to determine the Optimal Opening Year of each Phase. On the basis of the results obtained, a new analysis has been carried out, and the results in terms of IRR and NPV are presented in Table 5-20 for the Phases and in Table 5-21 for the Railways Lines. Obviously, the analysis and therefore, the results are the same for Phase 1 and Phase 2W and 2E.

The tables containing the detailed analysis of each Phase and of the Railways Lines are presented in Annex 2 (paragraph 6.2).

Table 5 - 20 Phases Economic Feasibility Analysis Results

PHASES			IRR	NPV (at 12%) US $
Phase 1	Rehabilitation of Existing Lines			
	1W	Western Line	31.44%	2,125,120,924
	1E	Eastern Line	29.56%	1,931,018,548
PHASE 1 (W+E)			*21.62%*	*1,691,269,856*
Phase 2	Central Spine Expansion			
	2W	Takoradi-Kumasi	28.57%	1,355,043,268
	2E	Accra-Kumasi	25.81%	1,114,896,343
PHASE 2A (2W+2E)			*20.73%*	*1,074,672,176*
	2C	2A + Kumasi-Paga	16.13%	726,432,125
Phase 3	Transversal Expansions	2C + Transversal expansions	15.17%	603,157,466
Phase 4	Trans Ecowas Expansion	3 + Aflao-Accra-Takoradi-Omanpe line	14.69%	526,316,028
Phase 5	Western Expansion	4 + Dunkwa-Awaso-Hamile	14.60%	515,670,294
Phase 6	Eastern Expansion	5 + Tema-Yendi	14.45%	487,281,870

The results indicated in the preceding table demonstrate the excellent degree of feasibility of the different incremental phases of the whole railway network. All the IRR are over 14% going from 31,44% to about 21% (Phase 2A) and 14.45% following the railway network completion.

Table 5 - 21 Railways Lines Economic Feasibility Analysis Results

LINES ANALYSED	LINES IDENTIFICATION	REFERENCE TO PHASE	IRR	NPV (at 12%) US $
NORTH-LINE OF CENTRAL SPINE EXPANSION	Kumasi - Techiman - Tamale - Paga	2C	7.03%	-348,240,051
TRANSVERSAL EXPANSIONS LINES	1- Tamale - Yendi 2- Fufulsu - Sawla 3- Techiman - Atebubu - Kwadwokurom 4- Nyinahin - Kumasi	3	8.44%	-123,274,659
TRANS ECOWAS EXPANSION LINE	Aflao - Tema - Accra - Takoradi and Tarkwa - Omanpe	4	7.96%	-76,841,439
WESTERN EXPANSION LINE	Dunkwa - Awaso - Techiman - Sawla - Hamile	5	10.86%	-10,645,734
EASTERN EXPANSION LINE	Tema - Ho - Yendi	6	8.26%	-28,388,424

As can be noted, the values of the feasibility indicators are lower for the single Railways trunk lines analysed separately, which is normal as the single line does not benefit from all the advantages generated by the Railways Network. However, it could be considered that an IRR of 7% is quite a considerable result for the realisation of a Railway Infrastructure.

5.2.8 Sensitivity Test

In order to see what will be the NPV with a lower discount rate, another analysis has been performed taking into account a discount rate of 7%. Even if this alternative analysis represents a sensitivity test, it could be considered that the results are very realistic and perfectly suited to the social and governmental characteristics of the Ghana Railways Master Plan.

It results that all the NPV of the different Phases have had a very high increase, also becoming positive for the single lines analysis.

The results of this sensitivity analysis are presented in the following Tables 5-22 and 5-23.

Four sensitivity tests were carried out, with a discount rate of 12%, for a cost increase of +5% and +10% or for a reduction of traffic benefits always of -5% or -10%, both for the single phases of the network and for the single sections of the line.

The results are as follows:

- For the **single phases,** the IRR value has an insignificant reduction of approx. 1%÷2% (see Table 5-21)
- For the **single sections** of the line, the IRR value is reduced by the same values indicated above (see Table 5-25)

Table 5 - 22 Phases Sensitivity Test Results

PHASES			IRR	NPV (at 7%) US $
Phase 1	Rehabilitation of Existing Lines			
	1W	Western Line	31.44%	5,525,550,918
	1E	Eastern Line	29.56%	5,281,027,287
PHASE 1 (W+E)			*21,62%*	*5.286.933.748*
Phase 2	Central Spine Expansion			
	2W	Takoradi-Kumasi	28.57%	4,651,584,907
	2E	Accra-Kumasi	25.81%	4,298,859,162
PHASE 2A (2W+2E)			*20,73%*	*4.522.416.043*
	2C	Kumasi-Paga	16.13%	4,529,092,931
Phase 3	Transversal Expansions	2C + Transversal expansions	15.17%	4,769,092,172
Phase 4	Trans Ecowas Expansion	3 + Aflao-Accra-Takoradi-Omanpe line	14.69%	4,875,850,824
Phase 5	Western Expansion	4 + Dunkwa-Awaso-Hamile	14.60%	5,210,976,929
Phase 6	Eastern Expansion	5 + Tema-Yendi	14.45%	5,294,598,224

Table 5 - 23 Railways Lines Sensitivity Test Results

LINES ANALYSED	LINES IDENTIFICATION	REFERENCE TO PHASE	IRR	NPV (at 7%) US $
NORTH-LINE OF CENTRAL SPINE EXPANSION	Kumasi - Techiman - Tamale - Paga	2C	7.03%	6,676,889
TRANSVERSAL EXPANSIONS LINES	1- Tamale - Yendi 2- Fufulsu - Sawla 3- Techiman - Atebubu - Kwadwokurom 4- Nyinahin - Kumasi	3	8.44%	239,999,241
TRANS ECOWAS EXPANSION LINE	Aflao - Tema - Accra - Takoradi and Tarkwa - Omanpe	4	7.96%	106,758,651
WESTERN EXPANSION LINE	Dunkwa - Awaso - Techiman - Sawla - Hamile	5	10.86%	335,126,105
EASTERN EXPANSION LINE	Tema - Ho - Yendi	6	8.26%	83,621,295

Table 5 - 24 Results of the Sensitivity Tests for the Economic Feasibility of all Phases

WITH REFERENCE TO ECONOMIC FEASIBILITY ECONOMIC ANALYSIS RESULTS					TEST 1: +5% INVESTMENT COSTS RESULTS		TEST 2: +10% INVESTMENT COSTS RESULTS		TEST 3: -5% REDUCTION OF BENEFITS		TEST 4: -10% REDUCTION OF BENEFITS	
PHASES			IRR	NPV (12%) US $	IRR	NPV (12%) US $	IRR	NPV (12%) US $	IRR	NPV (12%) US $	IRR	NPV (12%) US $
Phase 1	**Rehabilitation of Existing Lines**											
	1W	Western Line	31.44%	2,125,120,924	30.49%	2,091,047,212	29.61%	2,056,973,501	30.51%	1,993,597,256	29.55%	1,862,073,588
	1 E	Eastern Line	29.56%	1,931,018,548	28.73%	1,899,810,157	27.96%	1,868,601,767	28.74%	1,810,811,188	27.91%	1,690,603,828
		PHASE 1 (W + E)	***21.62%***	***1,691,269,856***	***20.92%***	***1,625,915,310***	***20.27%***	***1,560,560,765***	***20.97%***	***1,557,709,865***	***20.30%***	***1,424,149,875***
Phase 2	**Central Spine Expansion**											
	2W	Takoradi-Kumasi	28.57%	1,355,043,268	27.85%	1,334,611,922	27.17%	1,314,180,577	27.84%	1,270,908,147	27.08%	1,186,773,026
	2E	Accra-Kumasi	25.81%	1,114,896,343	25.19%	1,095,300,172	24.60%	1,075,704,001	25.18%	1,043,319,387	24.53%	971,742,431
		PHASE 2 (W + E)	***20.73%***	***1,074,672,176***	***20.13%***	***1,034,572,191***	***19.57%***	***994,472,206***	***20.15%***	***988,651,002***	***19.55%***	*902,629,828*
	2C	Kumasi-Paga	16.13%	726,432,125	15.60%	657,163,027	15.11%	587,893,929	15.63%	632,561,126	15.12%	538,690,127
Phase 3	**Transversal Expansions**		15.17%	603,157,466	14.64%	522,601,189	14.15%	442,044,912	14.68%	506,327,693	14.18%	409,497,920
	3-1	Tamale-Yendi										
	3-2	Fufulsu-Sawla										
	3-3	Techiman-Kwadwokurom										
	3-4	Nyinahin-Kumasi										
Phase 4	**Trans-ECOWAS Expansion**		14.69%	526,316,028	14.16%	438,932,866	13.66%	351,549,704	14.20%	427,993,366	13.70%	329,670,705
		Aflao-Accra-Takoradi-Omanpe										
Phase 5	**Western Expansion**		14.60%	515,670,294	14.04%	421,751,786	13.52%	327,833,278	14.09%	412,566,316	13.57%	309,462,339
		Dunkwa-Awaso-Hamile										
Phase 6	**Eastern Expansion**		14.45%	487,281,870	13.89%	390,435,352	13.36%	293,588,835	13.93%	383,275,307	13.41%	279,268,745
		Tema-Yendi										

Table 5 - 25 Results of the Sensitivity Tests for the Economic Feasibility of the Single Lines

WITH REFERENCE TO ECONOMIC FEASIBILITY RESULTS ECONOMIC-ANALYSIS OF THE RAILWAYS LINES					TEST 1: +5% INVESTMENT COSTS ANALYSIS RESULTS			TEST 2: +10% INVESTMENT COSTS ANALYSIS RESULTS			TEST 3: -5% REDUCTION OF BENEFITS			TEST 3: -10% REDUCTION OF BENEFITS		
LINES ANALYSED	LINES IDENTIFICATION	REF TO PHASE	IRR	NPV	REF TO PHASE	IRR	NPV	REF TO PHASE	IRR	NPV	REF TO PHASE	IRR	NPV	REF TO PHASE	IRR	NPV
WESTERN LINE REHABILITATION	Takoradi - Kumasi	1W	31.44%	2,125,120,924	1W	30.49%	2,091,047,212	1W	29.61%	2,056,973,501	1W	30.51%	1,993,597,256	1W	29.55%	1,862,073,588
EASTERN LINE REHABILITATION	Accra - Kumasi	1 E	29.56%	1,931,018,548	1 E	28.73%	1,899,810,157	1 E	27.96%	1,868,601,767	1 E	28.74%	1,810,811,188	1 E	27.91%	1,690,603,828
WESTERN AND EASTERN LINES REHABILITATION	Takoradi- Kumasi + Accra-Kumasi	1W+ 1E	21.62%	1,691,269,856	1W+ 1E	20.92%	1,625,915,310	1W+ 1E	20.27%	1,560,560,765	1W+ 1E	20.97%	1,557,709,865	1W+ 1E	20.30%	1,424,149,875
NEW WESTERN LINE CONSTRUCTION	Takoradi - Kumasi	2W	28.57%	1,355,043,268	2W	27.85%	1,334,611,922	2W	27.17%	1,314,180,577	2W	27.84%	1,270,908,147	2W	27.08%	1,186,773,026
NEW EASTERN LINE CONSTRUCTION	Accra - Kumasi	2E	25.81%	1,114,896,343	2E	25.19%	1,095,300,172	2E	24.60%	1,075,704,001	2E	25.18%	1,043,319,387	2E	24.53%	971,742,431
NEW WESTERN AND EASTERN LINES CONSTRUCTION	Takoradi - Kumasi + Accra - Kumasi	2W+ 2E	20.73%	1,074,672,176	2W+ 2E	20.13%	1,034,572,191	2W+ 2E	19.57%	994,472,206	2W+ 2E	20.15%	988,651,002	2W+ 2E	19.55%	902,629,828
NORTH-LINE OF CENTRAL SPINE EXPANSION	Kumasi - Techiman - Tamale - Paga	2C	7.03%	-348,240,051	2C	6.81%	-377,409,164	2C	6.60%	-406,578,277	2C	6.88%	-356,089,876	2C	6.72%	-363,939,702
TRANSVERSAL EXPANSIONS LINES	1- Tamale - Yendi 2- Fufulsu - Sawla 3- Techiman - Atebubu - Kwadwokurom 4- Nyinahin - Kumasi	3	8.44%	-123,274,659	3	8.23%	-134,561,838	3	8.04%	-145,849,017	3	8.30%	-126,233,433	3	8.15%	-129,192,206
TRANS ECOWAS EXPANSION LINE	Aflao - Tema - Accra - Takoradi/Tarkwa-Omanpe	4	7.96%	-76,841,439	4	7.75%	-83,668,323	4	7.55%	-90,495,208	4	7.82%	-78,334,327	4	47.69%	-79,827,215
WESTERN EXPANSION LINE	Dunkwa - Awaso - Techiman - Sawla - Hamile	5	10.86%	-10,645,734	5	10.34%	-17,181,080	5	9.91%	-23,716,426	5	10.44%	-15,427,050	5	510.05%	-20,208,367
EASTERN EXPANSION LINE	Tema - Ho - Yendi	6	8.26%	-28,388,424	6	8.04%	-31,316,434	6	7.83%	-34,244,443	6	8.11%	-29,291,009	6	67.96%	-30,193,594

6. FINANCIAL ANALYSIS

LIST OF ACRONYMS AND ABBREVIATIONS

ACRONYMS	EXTENDED NAME	ACRONYMS	EXTENDED NAME
AfDB	African Development Bank	**NASDAQ**	National Association of Security Dealers Automated Quotation
BADEA	Banque Arabe de Développement Economique en Afrique	**NIC**	National Insurance Commission
BOST	Bulk Oil Storage and Transportation	**NPV**	Net Present Value
BOT	Build Operate and Transfer	**NTV**	New Passengers Transport
CADFund	China-Africa Development Fund	**O/D**	Origin/Destination
CBA	Cost Benefit Anaysis	**OECD**	Organisation for Economic Co-operation and Development
CF	Cash Funds	**pax / train**	Passenger per train
CIC	China Investment Corporation	**PAU**	PPP Advisory Unit
DFID	Department for International Development	**Pax**	Passenger
DMU	Diesel Multiple Unit	**pax/km**	Passenger per kilometre
DP	Development Partner	**PFA**	Project and Financial Analysis
DRC	Democratic Republic of Congo	**PFI**	Public Finance Initiative
EIB	European Investment Bank	**PID**	Public Investment Division
EXIMBank	Export-Import Bank in China	**PIDG**	Private Infrastructure Development Group
FGN	Federal Government of Nigeria	**PPIAF**	Public-Private Infrastructure Advisory Facility
GDP	Gross Domestic Product	**PPI**	Public Private Initiative
GRDA	Ghana Railways Development Authority	**PPP**	Public Private Partnership
GHA	Ghana Highway Authority	**PRC**	PPP Resource Center
GoG	Government of Ghana	**PSO**	Passenger Service Obligation
GPHA	Ghana Ports and Harbours Authority	**ROT**	Rehabilitate, Operate and Transfer
GRCL	Ghana Railway Company Limited	**SADC**	Southern African Development Community
GRDA	Ghana Railway Development Authority	**SME**	Small & Medium Enterprise
GRF	General Revenue Fund	**SPV**	Special Purpose Vehicle
GSA	Ghana Shippers Authority	**SSA**	Sub-Saharian Africa
HO.RE.CA	HOtel REstaurants and CAtering	**SSNIT**	Social Security and National Insurance Trust
IBRD	International Bank for Reconstruction and Development	**SWF**	Sovereign Wealth Fund
IDA	International Development Bank	**TACs**	Track Access Charges
IFC	International Finance Corporation	**TOC**	Train Operating Company
InfraCo	Infrastructure Company	**Tot**	Total
ITP	Integrated Transport Plan	**UK**	United Kingdom
IRR	Internal Rate of Return	**US$**	United States Dollars
KfW	Kreditanstalt fuer Wiederaufbau	**VfM**	Value for money
MMT	Multi Modal Transport	**VGF**	Viability Gap Fund
MoFEP	Ministry of Finance and Economic Planning	**VLTC**	Volta Lake Transport Company
MoRH	Ministry of Roads and Highways	**WEO**	World Economic Output

6.1 EXECUTIVE SUMMARY

This second part of the Draft Final Report concerns the Financial Analysis and the funding procedure suggestions for the implementation of the Railway Master Plan.

The Financial Analysis (Chapter 6.2), examines the financial investment, operating expenses and the operative revenues of the total of the 6 phases of the Master Plan, according to the priority programme derived from the economic analysis (see Chapter 5.2)). The analysis is conducted from the public sector point of view and includes the investment costs for infrastructure and rolling stock, the maintenance and operative costs and the revenues coming from tariffs of transport services (freight and passengers). Investment expenses are supposed to be covered by the **public sector** (80% equity and 20% loan), while rolling stock expenses by the **private sector** (30% equity and 70% loan). The financial analysis is conducted over a long period (2015 – 2070) to give sufficient (23 years) operating time for the last phase to enter into operation (2048); it gives a positive **Financial Rate of Return**, equal to **3.6%,** while the NPV at 12% discount rate is naturally negative.

The suggested funding procedures, according to the National Transport Policy, are based on the private sector participation for the extent possible. The **PPP Prospectus** introduces the PPP concepts, the experiences in Ghana, the application in the railway sector and in Africa and then presents a proposal package for funding phases 1 and 2 of the Railway Master Plan (Chapter 6.4). Given the huge amounts needed for railway investments, the principle followed is to take the maximum advantage of the possible interest of the private sector, in partnership with the Government agencies.

In fact, the following suggestions are presented:

- Railway rehabilitation works for Phase 1: Rehabilitation of the existing Western and Eastern lines. According to the majority of such experiences in Africa, rehabilitation of existing railways can be the object of a **vertical concession** to a private entity, to be responsible for the construction and operation of the railway for a given period of time (minimum 15 years) and collecting revenues directly from freight and passenger tariffs.

  Mining companies could be interested in the rehabilitation of the Western Line, while Freight Carriers could be interested in the Eastern Line. The concession should guarantee the access of other private operators at agreed terms.

  This proposal has to take into consideration that the present state of the existing lines is very deteriorated and the investment cost is quite high. On the other hand, recently the Government of Ghana has received a line of credit from the China Development Bank (CDB) that will be partly devoted to rehabilitate (dual gauge) the Western line. In the definition of the Plan of Action of the Master Plan, this line of credit should be taken into consideration.

- New railway construction for Phase 2: Central Spine Expansion. In this case, it is not considered possible to attract private investors for a vertical concession, given the difficulty for the private sector to recover the huge infrastructure investments. But once the infrastructure construction is implemented by the public sector (through equity and loans and/or grants), the private sector will be certainly attracted to a management concession for railway operations, railway stations real estate upgrading and supply chain improvement.

  A possibility to partially involve the private sector in the financing of the infrastructure construction should be studied anyway, defining the Viability Gap Fund (VGF), i.e. the level of the public participation to make the private contribution profitable.

Railway Operation Concession for Phase 2: Central Spine Expansion. The possibility to apply a railway operation concession for the Central Spine Expansion has been explored building a preliminary business plan for the infrastructure company (InfraCo) to remain in public hands and for a Private Operator providing freight and passenger services.

The analysis shows positive results for the InfraCo, which will be able to manage and maintain properly the infrastructure with the revenues obtained from the private operators Track Access Charges (TACs) and for the Private Operator that will recover from tariffs (23.2% rate of return) the operative expenses and the TACs to be paid to the InfraCo. This analysis confirms the viability of PPP arrangements for the railway operation in the Central Spine Expansion.

- PPP safeguards: the closing of a PPP arrangement, however, requires that: (i) the right legal and institutional environment is set up before starting the bid, (ii) that each project is soundly prepared in terms of clear responsibility and risks, optimal tariff and subsidy structure, in order to ensure concrete Value for Money (VfM) for the public sector and financial profitability for the private operators; (iii) that access and competition between operators is assured in the project life; (iv) that Public Sector Obligations (PSO) especially for passenger services, are guaranteed and made convenient for the private operator, and (v) that a possible private contribution for the infrastructure investment is defined by the Viability Gap Fund (VGF).
- Sources of financing: finally a list of known sources of funds is listed for rising public resources, borrowing from foreign or local financing. This list is only indicative and does not represent all the funding possibilities. The private sector will certainly find and offer new and effective sources of funding.

6.2 FINANCIAL ANALYSIS OF MASTER PLAN

6.2.1 Proposed Railway Investment of the Ghana Railways Master Plan

Table 6-1 provides the amounts of proposed infrastructure investments for the 6 phases of the Master Plan, while in Table 6-2 the chronogram and the investments by year are summarised and in table 6-3 the investments in rolling stock.

Table 6- 1 Summary of Proposed Railway Investments

PHASES - LINES	L (Km)	FINANCIAL COSTS (US$)
PHASE 1: Rehabilitation of existing line	**667.6**	**$2,803,920,000**
1W - Western Line	***340.0***	*1,428,000,000*
1 - Takoradi - Tarkwa - Dunkwa - Kumasi	266.8	
2 - Dunkwa - Awaso	73.2	
1E - Eastern Line	***327.6***	*1,375,920,000*
1 - Accra - Kumasi	303.9	
2 - Achimota - Tema	23.7	
PHASE 2: Eastern "A" Expansion	**1,161**	**$6,501,600,000**
2W -Takoradi-Kumasi	266	*1,489,600,000*
2E - Accra - Kumasi	300	*1,680,000,000*
2C - Kumasi - Techiman - Tamale	383	*2,144,800,000*
- Tamale - Paga	212	*1,187,200,000*
PHASE 3: Transversal Expansions	**484**	**$2,710,400,000**
1 - Tamale - Yendi	102	*571,200,000*
2 - Fufulsu - Sawla	126	*705,600,000*
3 - Techiman - Atebubu - Kwadwokurom	198	*1,108,800,000*
4 - Nyinahin - Kumasi	58	*324,800,000*
PHASE 4: Trans Ecowas Expansion	**498**	**$2,788,800,000**
1 - Aflao - Tema - Accra	185	*1,036,000,000*
2 - Accra - Takoradi	212	*1,187,200,000*
3 - Tarkwa - Omanpe	101	*565,600,000*
PHASE 5: Western Expansion	**729**	**$4,082,400,000**
1 - Dunkwa - Awaso	73	*408,800,000*
2 - Awaso - Techiman	220	*1,232,000,000*
3 - Techiman - Sawla	223	*1,248,800,000*
4 - Sawla - Hamile	213	*1,192,800,000*
PHASE 6: Eastern "B" Expansion	**468**	**$2,620,800,000**
1 - Tema - Ho	130	*728,000,000*
2 - Ho - Yendi	338	*1,892,800,000*
TOTAL INVESTMENT COST (FINANCIAL)	***[Km 4,007.6]***	**$21,507,920,000**

(as Table 5-1 in Chapter 5)

Table 6- 2 Ghana Railway Master Plan: Implementation Programme and Related Investments

Lines	Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	
	L	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	
	Km	Rehabilitation				Construction new lines -Standard gauge																													
PHASE 1: Rehabilitation of existing line	667.6																																		
1W - Western Line	*340*	1	1	1	1																														
1E - Eastern Line	*327.6*	1	1	1	1	1																													
PHASE 2: Eastern "A" Expansion	1161																																		
PHASE 3: Transversal Expansions	484																																		
PHASE 4: Trans Ecowas Expansion	498																																		
PHASE 5: Western Expansion	729																																		
PHASE 6: Eastern "B" Expansion	468																																		
Total New Construction Km	*3,340*																																		
nd Total (Rehabilitation + New Construction) Km	4007.6																																		
Yearly investment at constant rate (million US$)																																			TOTAL m$
REHABILITATION		632	632	632	632	275	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*2,804*
NEW CONSTRUCTION		-	-	-	-	248	488	727	727	727	727	716	716	476	476	476	457	457	457	575	812	428	496	935	935	902	939	1005	755	998	998	513	270	270	*18,704*
TOTAL YEARLY INVESTMENT (m$)		632	632	632	632	523	488	727	727	727	727	716	716	476	476	476	457	457	457	575	812	428	496	935	935	902	939	1005	755	998	998	513	270	270	21,508

(as described from the Implementation Plan, under para 5.2.2. of Part 1)

Table 6- 3 Investment in Rolling Stock (US$)

YEAR	1 W NG	1 E NG	2 W	2 E	2C	PHASE 3	PHASE 4	PHASE 5	PHASE 6	TOT
2015										
2016	5,324,830									5,324,830
2017	7,987,245	5,324,830								13,312,075
2018	13,312,075	7,987,245								21,299,320
2019		13,312,075								13,312,075
2020										-
2021										-
2022			18,836,500							18,836,500
2023			28,254,750							28,254,750
2024			47,091,250	18,836,500						65,927,750
2025				28,254,750						28,254,750
2026				47,091,250						47,091,250
2027					37,673,000					37,673,000
2028					56,509,500					56,509,500
2029					94,182,500					94,182,500
2030										-
2031										-
2032										-
2033						42,794,000				42,794,000
2034						64,191,000				64,191,000
2035						106,985,000				106,985,000
2036										-
2037							35,840,000			35,840,000
2038							53,760,000			53,760,000
2039							89,600,000			89,600,000
2040										-
2041										-
2042								57,398,000		57,398,000
2043								86,097,000		86,097,000
2044								143,495,000		143,495,000
2045									28,708,000	28,708,000
2046									43,062,000	43,062,000
2047									71,770,000	71,770,000
2048										-
2049										-
2050										-
TOT	***26,624,150***	***26,624,150***	***94,182,500***	***94,182,500***	***188,365,000***	***213,970,000***	***179,200,000***	***286,990,000***	***143,540,000***	***1,253,678,300***

6.2.2 Funding Sources

There are essentially 3 options for financing these investments:

1. Government of Ghana (GoG) funds the entire rehabilitation and new constructions investment directly;
2. Government of Ghana (GoG) obtains a loan through conventional means;
3. Private investment (equity or commercial loans).

Option 1 is very onerous, given that Ghana's commitment to fund the completion of all the 6 Phases of the Master Plan means a total investment of 22.76 billion US$ over a period of 33 years, i.e. about 700 million US$ per year, corresponding to 2% of the 2010 Ghana GDP. This is a huge investment, even for a country with a high development potential such as Ghana, mainly due to the growing importance of the crude oil sector, which is boosting the country's economy: according to the Ghanaian Government, the country could expand its reserves by up to 5 billion barrels of oil within a few years.

Private investors would not be interested in new railway construction and, in principle, in the restructuring of the existing railway lines given its current status, but mining companies could be interested, especially in the restoring and refurbishment of the Western Line, given its importance for minerals transport, or freight carriers on the Eastern railway for the import of containerised goods through the Tema Port facilities. In any event, it would take at least two years to secure such investment, through an international concession bid and this delay would cause the existing lines to deteriorate even further.

For **new railway construction** there is scope to obtain a loan/grant for rehabilitation/ construction from multi-lateral sources such as the World Bank or the African Development Bank, or through bi-lateral arrangements with countries such as China, Japan, India, or the U.S. Such loans could be used for new constructions financing, but they will be difficult to activate for **rehabilitation works** financing because:

- these institutions will need to undertake detailed appraisal studies which could take more than a year to complete, and at least another 6 months to finalize the loan
- the investments are urgently required to restore the railway's operating capability, and a delay could lead to the shut-down of operations.

The **rolling stock** should, instead, be financed as much as possible by private investment. Ghana has great potential for direct foreign investment, given its market size and natural resources, mainly of crude oil (besides gold, other minerals, cocoa, etc.). Private investors, generally, have greater access to private equity markets and therefore will be able to develop creative financing arrangements. As well, international private investors will also have access to their country's export support credits which will lower financing costs and make investment more attractive.

➢ Projects that are financially viable would be attractive to private investors subject to the following conditions:

1. Investors must be convinced that projects are **technically feasible** and **financially viable**. Projects must exhibit that sufficient cash flow can be generated from revenues to cover the project's cost of capital.
2. Investors will seek to achieve a 20-25% return on investment, and will expect the Government to agree to contractual mechanisms to guarantee this level of return. Contractual arrangements must also provide for a **fair sharing of risk and reward** between the investor and the Government.

3. A legislative and regulatory **environment conducive to investment and rail operations** must be in place. The regulatory environment should provide a level "playing field" for modal competition and not favour one mode over another. Rail Operators must have the ability to set tariffs and fares without Government interference, or in the event that restrictions are necessary, then the Government should be prepared to subsidise rail operators.
4. Subsidy programmes must be also available where the investor is required to construct and operate services that are not financially viable in the event that the Government does not fund them directly.
5. The bidding process must be transparent and competitive.

- A specific model to explore the financial impact of the proposed investments has been developed. The following assumptions were used for funding the annual financial requirements:

(i) That the Government of Ghana would directly fund the cost of all the Infrastuctures of the Master Plan.

(ii) For purposes of public financing, a 20% loan has been assumed, while the 80% will be financed directly by the Government.

(iii) Loan terms for Government have been set at 6%, with a 15 year term. It is conceivable that other terms could be arranged.

(iv) Rolling stock would be financed by private sector investments. It should be noted, however, that the financial feasibility of each project has not yet been established and, therefore, there is the very real possibility that the Government would have to finance some of the projects that were not attractive to the private sector.

(v) For purposes of private financing, the Consultants have assumed a 70%/30% loan/equity ratio, which is the standard in railway transactions.

(vi) Loan terms for private sector financing have been set at 7%, with a 15 year term.

(vii) All the values of investment costs are in US$ at constant prices (no inflation rate has been considered).

Table 6-4 (following pages) and the accompanying chart (Fig. 6-1, next page) present the indicative annual financial cost of these investments. Note that Government provision of an operating subsidy is not necessary, because the revenues are able to repay the operative expenditures, but in the first 15 years there will be a cash deficit (to be funded by Government and/or private investors), due to repayment and interests of loans.

Figure 6 - 1 Indicative Annual Financial Requirements (million US $)

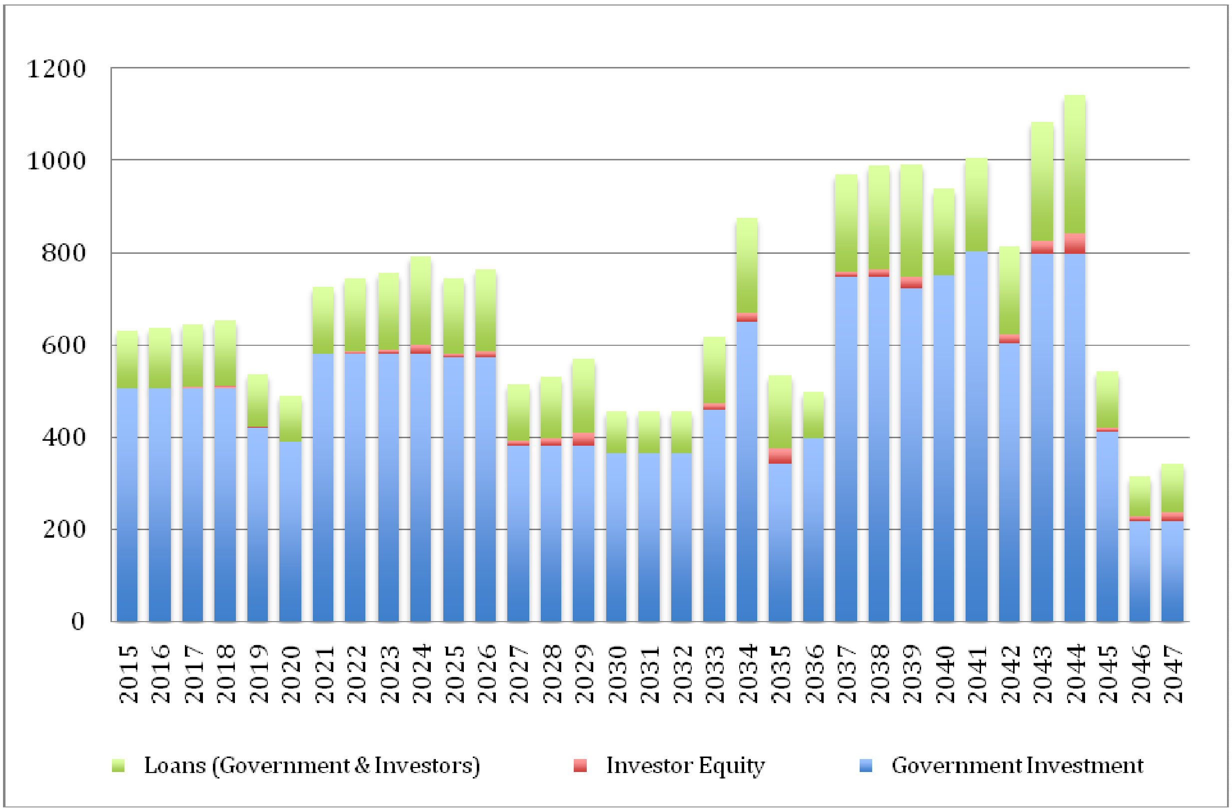


Table 6- 4 Sources of Funds - All Master Plan Investments ($US)

	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
0.1	Infrastructures	632,184,000	632,184,000	632,184,000	632.184.000	523,450,667	488,266,667	726,577,778	726,577,778	726,577,778	726,577,778	715,751,111	715,751,111	475,751,111	475,751,111
0.2	Rolling stock		5,324,830	13,312,075	21.299.320	13,312,075	-	-	18,836,500	28,254,750	65,927,750	28,254,750	47,091,250	37,673,000	56,509,500
0	***Total Investment***	***632,184,000***	***637,508,830***	***645,496,075***	***653.483.320***	***536,762,742***	***488,266,667***	***726,577,778***	***745,414,278***	***754,832,528***	***792,505,528***	***744,005,861***	***762,842,361***	***513,424,111***	***532,260,611***
1	Government Investment	5 05,747,200	505,747,200	505,747,200	505.747.200	418,760,533	390,613,333	581,262,222	581,262,222	581,262,222	581,262,222	572,600,889	572,600,889	380,600,889	380,600,889
2	Investor Equity	-	1,597,449	3,993,623	6.389.796	3,993,623	-	-	5,650,950	8,476,425	19,778,325	8,476,425	14,127,375	11,301,900	16,952,850
3	Government Debt	126,436,800	126,436,800	126,436,800	126.436.800	104,690,133	97,653,333	145,315,556	145,315,556	145,315,556	145,315,556	143,150,222	143,150,222	95,150,222	95,150,222
4	Investor Debt	-	3,727,381	9,318,453	14.909.524	9,318,453	-	-	13,185,550	19,778,325	46,149,425	19,778,325	32,963,875	26,371,100	39,556,650
5	Interest on Loans (Government & Investors)	7,586,208	15,107,408	22,664,120	30.219.314	35,646,025	39,611,180	46,069,571	52,939,520	59,692,034	67,658,036	72,903,571	78,360,436	79,683,896	81,231,770
6	Repayment of Loans (Principal)	5,432,074	11,338,403	17,823,089	24.923.163	31,298,754	37,388,256	45,891,957	55,431,801	65,812,932	77,875,980	89,541,141	102,442,675	113,811,550	126,403,714
7	Operating Subsidy														
Total Annual Cash Requirement (1+2+5+6+7)		***518,765,482***	***533,790,460***	***550,228,032***	***567,279,474***	***489.698.935***	***467,612,769***	***673,223,750***	***695,284,493***	***715,243,613***	***746,574,563***	***743,522,026***	***767,531,375***	***585,398,235***	***605,189,223***

Table 6-4 continued

	Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28
		2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
0.1	Infrastructures	475,751,111	456,960,000	456,960,000	456,960,000	574,560,000	812,000,000	427,840,000	496,440,000	934,733,333	934,733,333	901,693,333	939,120,000	1,005,120,000	755,360,000
0.2	Rolling stock	94,182,500	-	-	-	42,794,000	64,191,000	106,985,000	-	35,840,000	53,760,000	89,600,000	-	-	57,398,000
0	***Total Investment***	***569,933,611***	***456,960,000***	***456,960,000***	***456,960,000***	***617,354,000***	***876,191,000***	***534,825,000***	***496,440,000***	***970,573,333***	***988,493,333***	***991,293,333***	***939,120,000***	***1,005,120,000***	***812,758,000***
1	Government Investment	380,600,889	365,568,000	365,568,000	365,568,000	459,648,000	649,600,000	342,272,000	397,152,000	747,786,667	747,786,667	721,354,667	751,296,000	804,096,000	604,288,000
2	Investor Equity	28,254,750	-	-	-	12,838,200	19,257,300	32,095,500	-	10,752,000	16,128,000	26,880,000	-	-	17,219,400
3	Government Debt	95,150,222	91,392,000	91,392,000	91,392,000	114,912,000	162,400,000	85,568,000	99,288,000	186,946,667	186,946,667	180,338,667	187,824,000	201,024,000	151,072,000
4	Investor Debt	65,927,750	-	-	-	29,955,800	44,933,700	74,889,500	-	25,088,000	37,632,000	62,720,000	-	-	40,178,600
5	Interest on Loans (Government & Investors)	83,847,251	80,722,165	77,614,929	74,554,482	75,094,160	79,527,850	81,102,557	77,889,533	81,765,981	86,402,977	92,289,779	94,267,728	97,011,749	99,611,054
6	Repayment of Loans (Principal)	140,823,675	140,340,452	139,430,132	137,859,153	137,784,850	143,203,490	148,606,908	147,080,809	148,797,639	150,407,335	149,945,970	150,396,202	149,991,770	154,666,314
7	Operating Subsidy	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Annual Cash Requirement (1+2+5+6+7)		***633.526.565***	***586,630,617***	***582,613,061***	***577,981,635***	***685,365,210***	***891,588,640***	***604,076,966***	***622,122,341***	***989,102,287***	***1,000,724,979***	***990,470,415***	***995,959,931***	***1,051,099,518***	***875,784,769***

Table 6-4 continued

Year	29	30	31	32	33	34	35	36	37	38	39	40	41	42

		2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056
0.1	Infrastructures	998,026,667	998,026,667	513,066,667	270,400,000	270,400,000									
0.2	Rolling stock	86,097,000	143,495,000	28,708,000	43,062,000	71,770,000									
0	***Total Investment***	***1,084,123,667***	***1,141,521,667***	***541,774,667***	***313,462,000***	***342,170,000***	***-***	***-***	***-***	***-***	***-***	***-***	***-***	***-***	***-***
1	Government Investment	798,421,333	798,421,333	410,453,333	216,320,000	216,320,000									
2	Investor Equity	25,829,100	43,048,500	8,612,400	12,918,600	21,531,000									
3	Government Debt	199,605,333	199,605,333	102,613,333	54,080,000	54,080,000	-								
4	Investor Debt	60,267,900	100,446,500	20,095,600	30,143,400	50,239,000									
5	Interest on Loans (Government & Investors)	106,241,643	115,300,362	112,598,289	107,296,659	103,082,587	91,710,416	80,569,736	70,083,381	60,047,834	50,003,392	40,682,462	32,225,283	24,837,089	18,149,657
6	Repayment of Loans (Principal)	161,064,697	166,550,937	172,614,779	177,384,246	183,272,543	179,524,071	169,010,120	162,463,692	162,276,272	150,317,642	136,258,235	119,260,927	107,310,243	93,299,688
7	Operating Subsidy	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Annual Cash Requirement (1+2+5+6+7)		***1.091.556.773***	***1,123,321,133***	***704.278.801***	***513,919,505***	***524,206,130***	***271,234,487***	***249,579,856***	***232,547,073***	***222,324,106***	***200,321,033***	***176,940,696***	***151,486,210***	***132,147,332***	***111,449,345***

Table 6-4 continued							
	Year	**43**	**44**	**45**	**46**	**47**	**TOTAL**
		2057	**2058**	**2059**	**2060**	**2061**	**2013-2061**
0.1	Infrastructures	0	0	0	0	0	21,507,920
0.2	Rolling stock	0	0	0	0	0	1,253,678
0	***Total Investment***	***-***	***-***	***-***	***-***	***-***	***22,761,598***
1	Government Investment	-	-	-	-	-	17,206,336
2	Investor Equity	-	-	-	-	-	376,103
3	Government Debt	-	-	-	-	-	4,301,584
4	Investor Debt	-	-	-	-	-	877,575
5	Interest on Loans (Government & Investors)	12,285,442	7,292,822	3,680,104	1,842,331	676,041	2,909,681
6	Repayment of Loans (Principal)	798,197,718	57,021,330	29,053,646	18,119,677	10,408,158	5,179,159
7	Operating Subsidy						
Total Annual Cash Requirement (1+2+5+6+7)		***12.285.442***	***7,292,822***	***3,680,104***	***1,842,331***	***676,041***	***25,671,279***

6.2.3 Financial Statements

Note that the Master Plan financial analysis is from the perspective of a single investor who invests in all projects. This is because it is not possible to assess the financial viability of individual projects at this point in time. In fact, this requires a feasibility study to be conducted, which will include a detailed traffic study and forecast, and the development of operating cost projections. A more detailed exercise has been carried out only for the "Phase 2 - Central Spine Expansion" (see the next paragraph 6.4.4). Assumptions concerning the timing of investments associated with a specific project have been already presented in 6.2.1.

Both projected operative costs and projected revenues have been calculated on the basis of unitary values referred to freight (**opex** per ton/km and **fare** per ton/km) and passengers (**opex** per pax/km and **revenue** per pax/km), as synthesized in the following table (values are expressed in US$). Fares have been determined, according to experiences in similar countries. Obviously, the projected fare value is quite higher than the current one (0.034 versus an average of 0.015 US$ per pax/km), but the level of service will be completely different.

Finally, maintenance and operation of the infrastructure costs have been considered, and calculated on the basis of an average cost of *41,100 US$/km per year*.

Table 6- 5 Opex and Fares (US$)

FARES	FREIGHT	ton/km	0.083
	PAX	pax/km	0.034
OPEX	FREIGHT	ton/km	0.0126
	PAX	pax/km	0.0324

The traffic expected for the whole period of analysis (till year 2070) derives from the hypotheses of Master Plan phasing presented in Table 6-2, which are the same as those already considered for the economic evaluation purposes.

In the following Table 6-6, traffic, revenues and operative expenditures are presented, distinguishing between freight and passenger traffic.

Table 6- 6 Traffic (000 ton-km or pax-km), Revenues and Operative Expenditures (000 US$)

		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
TRAFFIC	FREIGHT	797,919	1,626,531	1,691,592	1,759,255	1,829,626	1,902,811	1,978,923	2,058,080	2,696,754	2,804,624	2,916,809	8,065,039
	PAX	2,196	7,085	7,227	7,371	7,519	7,669	7,822	7,979	8,141	8,304	8,470	20,804
REVENUE	FREIGHT	65,860	134,253	139,623	145,208	151,017	157,057	163,340	169,873	222,589	231,493	240,752	665,686
	PAX	75	242	246	251	256	262	267	272	278	283	289	709
	TOT	***65,935***	***134,495***	***139,870***	***145,460***	***151,273***	***157,319***	***163,606***	***170,145***	***222,867***	***231,776***	***241,041***	***666,395***
OPEX	FREIGHT	10,073	20,533	21,354	22,208	23,096	24,020	24,981	25,980	34,043	35,404	36,820	101,809
	PAX	71	230	234	239	244	248	253	258	264	269	274	674
	TOT	***10,144***	***20,762***	***21,588***	***22,447***	***23,340***	***24,269***	***25,234***	***26,239***	***34,306***	***35,673***	***37,095***	***102,483***

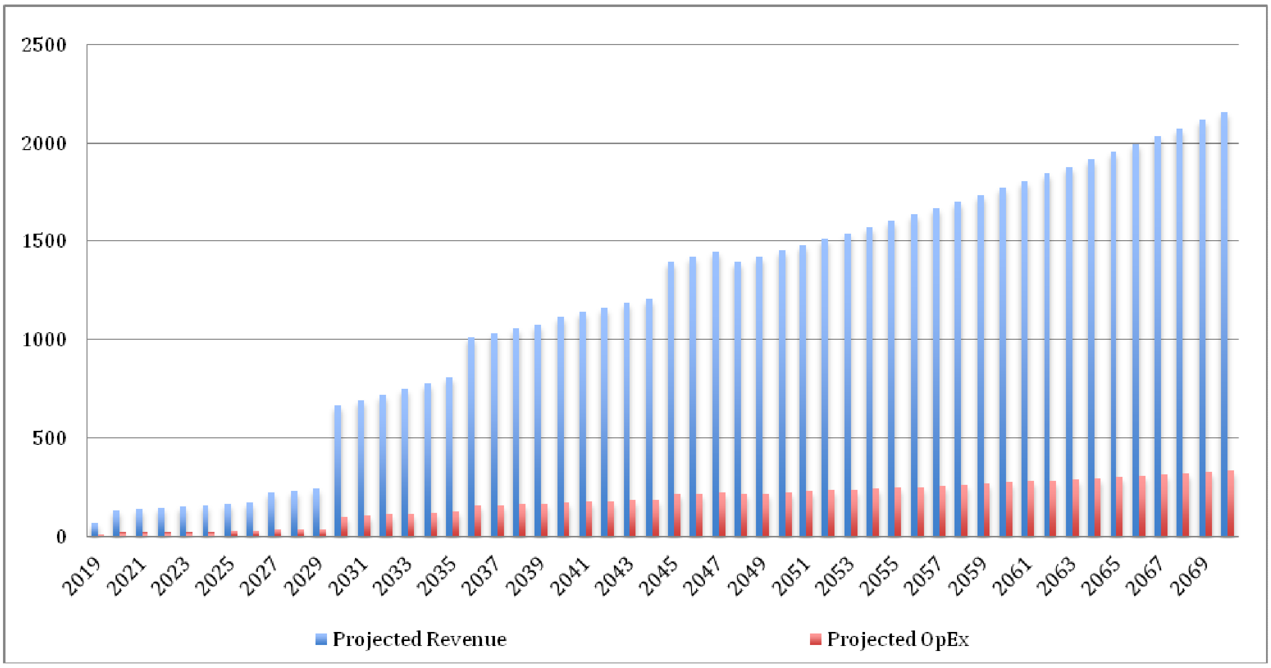
Table 6-6 (cont'd)		2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
TRAFFIC	FREIGHT	8,387,641	8,723,146	9,072,072	9,434,955	9,812,353	12,496,585	12,996,449	13,516,307	14,056,959	14,308,748	14,881,098	15,476,342
	PAX	21,220	21,645	22,078	22,519	22,970	27,049	27,590	28,142	28,705	53,639	54,712	55,806
REVENUE	FREIGHT	692,313	720,006	748,806	778,758	809,909	1,031,464	1,072,723	1,115,632	1,160,257	1,181,040	1,228,281	1,277,412
	PAX	724	738	753	768	783	922	941	960	979	1,829	1,866	1,903
	TOT	***693,037***	***720,744***	***749,559***	***779,526***	***810,692***	***1,032,387***	***1,073,664***	***1,116,591***	***1,161,236***	***1,182,869***	***1,230,147***	***1,279,315***
OPEX	FREIGHT	105,882	110,117	114,521	119,102	123,866	157,751	164,061	170,623	177,448	180,627	187,852	195,366
	PAX	687	701	715	729	744	876	894	912	930	1,738	1,772	1,808
	TOT	***106,569***	***110,818***	***115,237***	***119,832***	***124,610***	***158,627***	***164,955***	***171,535***	***178,378***	***182,364***	***189,624***	***197,174***

Table 6-6 (cont'd)		2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
TRAFFIC	FREIGHT	16,095,396	16,739,212	17,847,336	18,561,230	19,303,679	21,716,185	22,584,832	23,488,226	24,427,755	25,404,865	26,421,059	27,477,902
	PAX	56,922	58,061	58,525	59,696	60,889	80,677	82,290	83,936	85,615	87,327	89,074	90,855
REVENUE	FREIGHT	1,328,509	1,381,649	1,473,113	1,532,038	1,593,320	1,792,447	1,864,145	1,938,711	2,016,259	2,096,909	2,180,786	2,268,017
	PAX	1,941	1,980	1,996	2,036	2,076	2,751	2,806	2,862	2,919	2,978	3,037	3,098
	TOT	***1,330,450***	***1,383,629***	***1,475,109***	***1,534,074***	***1,595,396***	***1,795,198***	***1,866,951***	***1,941,573***	***2,019,179***	***2,099,887***	***2,183,823***	***2,271,115***
OPEX	FREIGHT	203,181	211,308	225,296	234,308	243,680	274,135	285,100	296,504	308,364	320,699	333,527	346,868
	PAX	1,844	1,881	1,896	1,934	1,972	2,613	2,666	2,719	2,773	2,829	2,885	2,943
	TOT	***205,024***	***213,189***	***227,192***	***236,242***	***245,653***	***276,748***	***287,766***	***299,223***	***311,138***	***323,528***	***336,412***	***349,811***

Table 6-6 (cont'd)		2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070
TRAFFIC	FREIGHT	28,577,018	29,720,099	30,908,902	32,145,259	33,431,069	34,768,312	36,159,044	37,605,406	39,109,622	40,674,007	42,300,967	43,993,006	45,752,726	47,582,835	49,486,149	51,465,595
	PAX	92,672	94,526	96,416	98,345	100,312	102,318	104,364	106,451	108,580	110,752	112,967	115,226	117,531	119,882	122,279	124,725
REVENUE	FREIGHT	2,358,738	2,453,087	2,551,211	2,653,259	2,759,390	2,869,765	2,984,556	3,103,938	3,228,096	3,357,220	3,491,508	3,631,169	3,776,415	3,927,472	4,084,571	4,247,954
	PAX	3,160	3,223	3,288	3,354	3,421	3,489	3,559	3,630	3,703	3,777	3,852	3,929	4,008	4,088	4,170	4,253
	TOT	***2,361,898***	***2,456,311***	***2,554,499***	***2,656,613***	***2,762,810***	***2,873,254***	***2,988,115***	***3,107,568***	***3,231,798***	***3,360,996***	***3,495,361***	***3,635,098***	***3,780,423***	***3,931,560***	***4,088,741***	***4,252,207***
OPEX	FREIGHT	360,742	375,172	390,179	405,786	422,018	438,898	456,454	474,713	493,701	513,449	533,987	555,347	577,560	600,663	624,689	649,677
	PAX	3,002	3,062	3,123	3,186	3,250	3,314	3,381	3,448	3,517	3,588	3,659	3,733	3,807	3,883	3,961	4,040
	TOT	***363,745***	***378,234***	***393,302***	***408,972***	***425,267***	***442,213***	***459,835***	***478,161***	***497,218***	***517,037***	***537,646***	***559,079***	***581,368***	***604,546***	***628,650***	***653,717***

In the following chart, the comparison between **projected revenues** and **operative expenditures,** over the whole period of analysis, is presented; from the very first years, projected revenue will be able to cover the Opex.

Figure 6 - 2 Projected Revenues and Operative Expenditures (million US$)



6.2.4 Financial Results for the whole Railway Network

The main assumptions of the financial analysis are: Government Debt: 20% - Investor equity: 30% - Investor loan: 70% - Gov Interest rate: 6% - Private interest rate: 7% - Taxes : 24% - Discount Rate: 12%.

It must be underlined that the following items have not been included in the analysis: Interest Earned on Cash Balances, Financing Fees, Development Costs, Dividends, Concession Fees, Withholding Tax, Grace Period, Inflation, since these are usually retained at Business Plan level.

The **net present value** (at 12% discount rate) of all the investments is **negative** and equal to -3.631 million US$, while the IRR is positive even if low and equal to **3.6**%. Taken on their own, some projects will be viable and some will not. Based on this analysis, however, the forecasted revenue base will not be sufficient to support all projects. Since it can be assumed that the private sector will not invest in a non-viable project, Government intervention will be required in order for a non-viable project to proceed. Because trade-offs with other required investments are necessary, before decisions can be made, it will be necessary to determine if financially non-viable projects are justifiable in terms of other criteria (social, economic, environmental, etc), which will require a study that will assess the complete spectrum of costs and benefits.

The following Table 6-7 combines the financial results for all Phases.

Table 6- 7 Indicative Financial Statements – All Master Plan Investments ($US)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Projected Revenue	0	0	0	0	65,934,824	134,494,911	139,869,876	145,459,742	151,273,105	157,318,901	163,606,427	170,145,349
Projected OpEx	0	0	0	0	10,143,667	20,762,046	21,587,937	22,446,773	23,339,868	24,268,592	25,234,367	26,238,674
Maintenance and operative structure					13,974,000	27,438,360	27,438,360	27,438,360	27,438,360	27,438,360	27,438,360	27,438,360
Depreciation & Amortization	0	12,643,680	25,300,728	38,096,010	51,015,180	61,071,366	69,540,083	82,609,407	96,362,742	110,287,060	125,778,796	138,768,146
Net Operating Profit	**0**	**-12,643,680**	**-25,300,728**	**-38,096,010**	**-9,198,022**	**25,223,140**	**21,303,496**	**12,965,202**	**4,132,135**	**-4,675,110**	**-14,845,096**	**-22,299,830**
Interest on CapEx	-7,586,208	-15,107,408	-22,664,120	-30,219,314	-35,646,025	-39,611,180	-46,069,571	-52,939,520	-59,692,034	-67,658,036	-72,903,571	-78,360,436
Net Income Before Tax	**-7,586,208**	**-27,751,088**	**-47,964,848**	**-68,315,324**	**-44,844,047**	**-14,388,041**	**-24,766,075**	**-39,974,318**	**-55,559,899**	**-72,333,147**	**-87,748,667**	**-100,660,266**
Tax	0	0	0	0	0	0	0	0	0	0	0	0
Net Income After Tax	**-7,586,208**	**-27,751,088**	**-47,964,848**	**-68,315,324**	**-44,844,047**	**-14,388,041**	**-24,766,075**	**-39,974,318**	**-55,559,899**	**-72,333,147**	**-87,748,667**	**-100,660,266**
CASH FLOW												
Opening Balance	0	-13,018,282	-26,445,811	-40,487,210	-55,142,478	-25,127,621	9,295,070	-1,117,949	-12,796,712	-25,010,089	-39,922,066	-51,511,012
Sources of Funds												
Net Income	-7,586,208	-27,751,088	-47,964,848	-68,315,324	-44,844,047	-14,388,041	-24,766,075	-39,974,318	-55,559,899	-72,333,147	-87,748,667	-100,660,266
Plus:												
Depreciation & Amortization	0	12,643,680	25,300,728	38,096,010	51,015,180	61,071,366	69,540,083	82,609,407	96,362,742	110,287,060	125,778,796	138,768,146
Cash flows from operations	-7,586,208	-15,107,408	-22,664,120	-30,219,314	6,171,133	46,683,325	44,774,008	42,635,090	40,802,843	37,953,913	38,030,129	38,107,880
Add CapEx												
Government Investment	505,747,200	505,747,200	505,747,200	505,747,200	418,760,533	390,613,333	581,262,222	581,262,222	581,262,222	581,262,222	572,600,889	572,600,889
Investor Equity	0	1,597,449	3,993,623	6,389,796	3,993,623	0	0	5,650,950	8,476,425	19,778,325	8,476,425	14,127,375
Loans (Government & Investors)	126,436,800	130,164,181	135,755,253	141,346,324	114,008,586	97,653,333	145,315,556	158,501,106	165,093,881	191,464,981	162,928,547	176,114,097
Total	***624,597,792***	***622,401,422***	***622,831,955***	***623,264,006***	***542,933,874***	***534,949,992***	***771,351,786***	***788,049,368***	***795,635,371***	***830,459,441***	***782,035,990***	***800,950,241***
Application of Funds												
Total investments	632,184,000	637,508,830	645,496,075	653,483,320	536,762,742	488,266,667	726,577,778	745,414,278	754,832,528	792,505,528	744,005,861	762,842,361
Repayments of loans (Principal)	5,432,074	11,338,403	17,823,089	24,923,163	31,298,754	37,388,256	45,891,957	55,431,801	65,812,932	77,875,980	89,541,141	102,442,675
Total	***637,616,074***	***648,847,233***	***663,319,164***	***678,406,483***	***568,061,496***	***525,654,922***	***772,469,735***	***800,846,079***	***820,645,460***	***870,381,508***	***833,547,002***	***865,285,036***
Cash Surplus / (Deficit) - Closing Balance	-13,018,282	-26,445,811	-40,487,210	-55,142,478	-25,127,621	9,295,070	-1,117,949	-12,796,712	-25,010,089	-39,922,066	-51,511,012	-64,334,795
Net Present Value & Internal Rate of												
Net income	-7,586,208	-27,751,088	-47,964,848	-68,315,324	-44,844,047	-14,388,041	-24,766,075	-39,974,318	-55,559,899	-72,333,147	-87,748,667	-100,660,266
Plus: Depreciation & Amortization	0	12,643,680	25,300,728	38,096,010	51,015,180	61,071,366	69,540,083	82,609,407	96,362,742	110,287,060	125,778,796	138,768,146
Cash flows from operations	-7,586,208	-15,107,408	-22,664,120	-30,219,314	6,171,133	46,683,325	44,774,008	42,635,090	40,802,843	37,953,913	38,030,129	38,107,880
Minus:												
Gov Investment and Investor equity	505,747,200	507,344,649	509,740,823	512,136,996	422,754,156	390,613,333	581,262,222	586,913,172	589,738,647	601,040,547	581,077,314	586,728,264
Principal repayments	5,432,074	11,338,403	17,823,089	24,923,163	31,298,754	37,388,256	45,891,957	55,431,801	65,812,932	77,875,980	89,541,141	102,442,675
Working capital requirements	0	0	0	0	1,978,045	4,034,847	4,196,096	4,363,792	4,538,193	4,719,567	4,908,193	5,104,360
Net Free Cashflow	**-518,765,482**	**-533,790,460**	**-550,228,032**	**-567,279,474**	**-449,859,822**	**-385,353,111**	**-586,576,267**	**-604,073,676**	**-619,286,930**	**-645,682,181**	**-637,496,519**	**-656,167,420**

Table 6-7 (cont'd)	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Projected Revenue	222,866,811	231,775,931	241,041,305	666,395,189	693,036,808	720,743,808	749,558,798	779,526,093	810,691,779	1,032,386,582	1,073,663,597	1,116,591,325
Projected OpEx	34,306,249	35,673,225	37,094,773	102,483,102	106,568,947	110,817,957	115,236,652	119,831,814	124,610,497	158,627,104	164,954,663	171,534,974
Maintenance and operative structure	27,438,360	27,438,360	27,438,360	51,892,860	51,892,860	51,892,860	57,071,460	57,071,460	67,593,060	71,785,260	71,785,260	71,785,260
Depreciation & Amortization	152,408,293	160,446,791	169,225,436	179,645,039	184,651,031	189,583,918	194,443,812	203,722,590	218,593,413	227,552,248	232,222,945	247,393,448
Net Operating Profit	**8,713,909**	**8,217,556**	**7,282,736**	**332,374,189**	**349,923,970**	**368,449,073**	**382,806,874**	**398,900,229**	**399,894,808**	**574,421,970**	**604,700,729**	**625,877,642**
Interest on CapEx	- 79,683,896	- 81,231,770	- 83,847,251	- 80,722,165	- 77,614,929	- 74,554,482	- 75,094,160	- 79,527,850	- 81,102,557	- 77,889,533	- 81,765,981	-
Net Income Before Tax	**- 70,969,987**	**- 73,014,214**	**- 76,564,515**	**251,652,024**	**272,309,041**	**293,894,591**	**307,712,714**	**319,372,379**	**318,792,251**	**496,532,438**	**522,934,748**	**539,474,665**
Tax	-	-	-	- 60,396,486	- 65,354,170	- 70,534,702	- 73,851,051	- 76,649,371	- 76,510,140	- 119,167,785	- 125,504,339	-
Net Income After Tax	**- 70,969,987**	**- 73,014,214**	**- 76,564,515**	**191,255,538**	**206,954,871**	**223,359,889**	**233,861,663**	**242,723,008**	**242,282,111**	**377,364,653**	**397,430,408**	**410,000,745**
CASH FLOW	-	-	-	-	-	-	-	-	-	-	-	-
Opening Balance	- 64,334,795	- 32,373,244	- 38,971,137	- 48,162,754	230,560,125	252,175,770	275,084,654	290,520,625	303,242,108	312,268,616	457,836,092	480,855,714
Sources of Funds	-	-	-	-	-	-	-	-	-	-	-	-
Net Income	- 70,969,987	- 73,014,214	- 76,564,515	191,255,538	206,954,871	223,359,889	233,861,663	242,723,008	242,282,111	377,364,653	397,430,408	410,000,745
Plus:	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation & Amortization	152,408,293	160,446,791	169,225,436	179,645,039	184,651,031	189,583,918	194,443,812	203,722,590	218,593,413	227,552,248	232,222,945	247,393,448
Cash flows from operations	81,438,306	87,432,577	92,660,921	370,900,577	391,605,902	412,943,807	428,305,475	446,445,598	460,875,524	604,916,900	629,653,353	657,394,193
Add CapEx	-	-	-	-	-	-	-	-	-	-	-	-
Government Investment	380,600,889	380,600,889	380,600,889	365,568,000	365,568,000	365,568,000	459,648,000	649,600,000	342,272,000	397,152,000	747,786,667	747,786,667
Investor Equity	11,301,900	16,952,850	28,254,750	-	-	-	12,838,200	19,257,300	32,095,500	-	10,752,000	16,128,000
Loans (Government & Investors)	121,521,322	134,706,872	161,077,972	91,392,000	91,392,000	91,392,000	144,867,800	207,333,700	160,457,500	99,288,000	212,034,667	224,578,667
Total	***594,862,417***	***619,693,188***	***662,594,532***	***827,860,577***	***848,565,902***	***869,903,807***	***1,045,659,475***	***1,322,636,598***	***995,700,524***	***1,101,356,900***	***1,600,226,687***	***1,645,887,527***
Application of Funds	-	-	-	-	-	-	-	-	-	-	-	-
Total investments	513,424,111	532,260,611	569,933,611	456,960,000	456,960,000	456,960,000	617,354,000	876,191,000	534,825,000	496,440,000	970,573,333	988,493,333
Repayments of loans (Principal)	113,811,550	126,403,714	140,823,675	140,340,452	139,430,132	137,859,153	137,784,850	143,203,490	148,606,908	147,080,809	148,797,639	150,407,335
Total	***627,235,661***	***658,664,325***	***710,757,286***	***597,300,452***	***596,390,132***	***594,819,153***	***755,138,850***	***1,019,394,490***	***683,431,908***	***643,520,809***	***1,119,370,973***	***1,138,900,668***
Cash Surplus / (Deficit) - Closing Balance	- 32,373,244	- 38,971,137	- 48,162,754	230,560,125	252,175,770	275,084,654	290,520,625	303,242,108	312,268,616	457,836,092	480,855,714	506,986,858
Net Present Value & Internal Rate of	-	-	-	-	-	-	-	-	-	-	-	-
Net income	- 70,969,987	- 73,014,214	- 76,564,515	191,255,538	206,954,871	223,359,889	233,861,663	242,723,008	242,282,111	377,364,653	397,430,408	410,000,745
Plus: Depreciation & Amortization	152,408,293	160,446,791	169,225,436	179,645,039	184,651,031	189,583,918	194,443,812	203,722,590	218,593,413	227,552,248	232,222,945	247,393,448
Cash flows from operations	81,438,306	87,432,577	92,660,921	370,900,577	391,605,902	412,943,807	428,305,475	446,445,598	460,875,524	604,916,900	629,653,353	657,394,193
Minus:	-	-	-	-	-	-	-	-	-	-	-	-
Gov Investment and Investor equity	391,902,789	397,553,739	408,855,639	365,568,000	365,568,000	365,568,000	472,486,200	668,857,300	374,367,500	397,152,000	758,538,667	763,914,667
Principal repayments	113,811,550	126,403,714	140,823,675	140,340,452	139,430,132	137,859,153	137,784,850	143,203,490	148,606,908	147,080,809	148,797,639	150,407,335
Working capital requirements	6,686,004	6,953,278	7,231,239	19,991,856	20,791,104	21,622,314	22,486,764	23,385,783	24,320,753	30,971,597	32,209,908	33,497,740
Net Free Cashflow	**-430,962,037**	**-443,478,154**	**-464,249,633**	**-154,999,731**	**-134,183,334**	**-112,105,660**	**-204,452,339**	**-389,000,975**	**-86,419,637**	**29,712,494**	**-309,892,860**	**-290,425,548**

Table 6-7 (cont'd)	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062
Projected Revenue	**2,019,178,604**	**2,099,887,358**	**2,183,823,294**	**2,271,115,477**	**2,361,898,133**	**2,456,310,855**	**2,554,498,822**	**2,656,613,018**	**2,762,810,467**	**2,873,254,473**	**2,988,114,870**	**3,107,568,288**
Projected OpEx	311,137,615	323,527,652	336,412,180	349,810,958	363,744,533	378,234,274	393,302,403	408,972,033	425,267,198	442,212,896	459,835,122	478,160,912
Maintenance and operative structure	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760
Depreciation & Amortization	332,707,796	325,100,875	317,693,731	310,479,987	303,453,510	-	-	-	-	-	-	-
Net Operating Profit	**1,233,883,432**	**1,309,809,071**	**1,388,267,623**	**1,469,374,773**	**1,553,250,329**	**1,936,626,821**	**2,019,746,659**	**2,106,191,225**	**2,196,093,509**	**2,289,591,817**	**2,386,829,988**	**2,487,957,617**
Interest on CapEx	- 60,047,834	- 50,003,392	- 40,682,462	- 32,225,283	- 24,837,089	- 18,149,657	- 12,285,442	- 7,292,822	- 3,680,104	- 1,842,331	- 676,041	-
Net Income Before Tax	**1,173,835,598**	**1,259,805,679**	**1,347,585,161**	**1,437,149,489**	**1,528,413,241**	**1,918,477,164**	**2,007,461,217**	**2,098,898,403**	**2,192,413,405**	**2,287,749,486**	**2,386,153,948**	**2,487,957,617**
Tax	- 281,720,544	- 302,353,363	- 323,420,439	- 344,915,877	- 366,819,178	- 460,434,519	- 481,790,692	- 503,735,617	- 526,179,217	- 549,059,877	- 572,676,947	-
Net Income After Tax	**892,115,055**	**957,452,316**	**1,024,164,722**	**1,092,233,612**	**1,161,594,063**	**1,458,042,645**	**1,525,670,525**	**1,595,162,787**	**1,666,234,188**	**1,738,689,609**	**1,813,477,000**	**1,890,847,789**
CASH FLOW	-	-	-	-	-	-	-	-	-	-	-	-
Opening Balance	**1,006,682,084**	**1,062,546,578**	**1,132,235,550**	**1,205,600,219**	**1,283,452,672**	**1,357,737,330**	**1,364,742,957**	**1,446,472,807**	**1,538,141,457**	**1,637,180,542**	**1,720,569,932**	**1,803,068,842**
Sources of Funds	-	-	-	-	-	-	-	-	-	-	-	-
Net Income	**892,115,055**	**957,452,316**	**1,024,164,722**	**1,092,233,612**	**1,161,594,063**	**1,458,042,645**	**1,525,670,525**	**1,595,162,787**	**1,666,234,188**	**1,738,689,609**	**1,813,477,000**	**1,890,847,789**
Plus:	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation & Amortization	332,707,796	325,100,875	317,693,731	310,479,987	303,453,510	-	-	-	-	-	-	-
Cash flows from operations	1,224,822,850	1,282,553,191	1,341,858,454	1,402,713,599	1,465,047,573	1,458,042,645	1,525,670,525	1,595,162,787	1,666,234,188	1,738,689,609	1,813,477,000	1,890,847,789
Add CapEx	-	-	-	-	-	-	-	-	-	-	-	-
Government Investment	-	-	-	-	-	-	-	-	-	-	-	-
Investor Equity	-	-	-	-	-	-	-	-	-	-	-	-
Loans (Government & Investors)	-	-	-	-	-	-	-	-	-	-	-	-
Total	**1,224,822,850**	**1,282,553,191**	**1,341,858,454**	**1,402,713,599**	**1,465,047,573**	**1,458,042,645**	**1,525,670,525**	**1,595,162,787**	**1,666,234,188**	**1,738,689,609**	**1,813,477,000**	**1,890,847,789**
Application of Funds	-	-	-	-	-	-	-	-	-	-	-	-
Total investments	-	-	-	-	-	-	-	-	-	-	-	-
Repayments of loans (Principal)	162,276,272	150,317,642	136,258,235	119,260,927	107,310,243	93,299,688	79,197,718	57,021,330	29,053,646	18,119,677	10,408,158	-
Total	**162,276,272**	**150,317,642**	**136,258,235**	**119,260,927**	**107,310,243**	**93,299,688**	**79,197,718**	**57,021,330**	**29,053,646**	**18,119,677**	**10,408,158**	-
Cash Surplus / (Deficit) - Closing Balance	**1,062,546,578**	**1,132,235,550**	**1,205,600,219**	**1,283,452,672**	**1,357,737,330**	**1,364,742,957**	**1,446,472,807**	**1,538,141,457**	**1,637,180,542**	**1,720,569,932**	**1,803,068,842**	**1,890,847,789**
Net Present Value & Internal Rate of	-	-	-	-	-	-	-	-	-	-	-	-
Net income	**892,115,055**	**957,452,316**	**1,024,164,722**	**1,092,233,612**	**1,161,594,063**	**1,458,042,645**	**1,525,670,525**	**1,595,162,787**	**1,666,234,188**	**1,738,689,609**	**1,813,477,000**	**1,890,847,789**
Plus: Depreciation & Amortization	332,707,796	325,100,875	317,693,731	310,479,987	303,453,510	-	-	-	-	-	-	-
Cash flows from operations	1,224,822,850	1,282,553,191	1,341,858,454	1,402,713,599	1,465,047,573	1,458,042,645	1,525,670,525	1,595,162,787	1,666,234,188	1,738,689,609	1,813,477,000	1,890,847,789
Minus:	-	-	-	-	-	-	-	-	-	-	-	-
Gov Investment and Investor equity	-	-	-	-	-	-	-	-	-	-	-	-
Principal repayments	162,276,272	150,317,642	136,258,235	119,260,927	107,310,243	93,299,688	79,197,718	57,021,330	29,053,646	18,119,677	10,408,158	-
Working capital requirements	60,575,358	62,996,621	65,514,699	68,133,464	70,856,944	73,689,326	76,634,965	79,698,391	82,884,314	86,197,634	89,643,446	93,227,049
Net Free Cashflow	**1,001,971,220**	**1,069,238,929**	**1,140,085,520**	**1,215,319,208**	**1,286,880,386**	**1,291,053,631**	**1,369,837,842**	**1,458,443,066**	**1,554,296,228**	**1,634,372,298**	**1,713,425,396**	**1,797,620,740**

Table 6-7 (cont'd)	2063	2064	2065	2066	2067	2068	2069	2070
Projected Revenue	3,231,798,419	3,360,996,304	3,495,360,622	3,635,098,003	3,780,423,338	3,931,560,115	4,088,740,759	4,252,206,994
Projected OpEx	497,218,380	517,036,768	537,646,485	559,079,155	581,367,668	604,546,228	628,650,408	653,717,202
Maintenance and operative structure	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760	141,449,760
Depreciation & Amortization	-	-	-	-	-	-	-	-
Net Operating Profit	**2,593,130,279**	**2,702,509,776**	**2,816,264,378**	**2,934,569,088**	**3,057,605,910**	**3,185,564,126**	**3,318,640,591**	**3,457,040,032**
Interest on CapEx	-	-	-	-	-	-	-	-
Net Income Before Tax	**2,593,130,279**	**2,702,509,776**	**2,816,264,378**	**2,934,569,088**	**3,057,605,910**	**3,185,564,126**	**3,318,640,591**	**3,457,040,032**
Tax	- 622,351,267	- 648,602,346	- 675,903,451	- 704,296,581	- 733,825,418	- 764,535,390	- 796,473,742	- 829,689,608
Net Income After Tax	**1,970,779,012**	**2,053,907,429**	**2,140,360,927**	**2,230,272,507**	**2,323,780,492**	**2,421,028,736**	**2,522,166,849**	**2,627,350,424**
CASH FLOW	-	-	-	-	-	-	-	-
Opening Balance	**1,890,847,789**	**1,970,779,012**	**2,053,907,429**	**2,140,360,927**	**2,230,272,507**	**2,323,780,492**	**2,421,028,736**	**2,522,166,849**
Sources of Funds	-	-	-	-	-	-	-	-
Net Income	1,970,779,012	2,053,907,429	2,140,360,927	2,230,272,507	2,323,780,492	2,421,028,736	2,522,166,849	2,627,350,424
Plus:	-	-	-	-	-	-	-	-
Depreciation & Amortization	-	-	-	-	-	-	-	-
Cash flows from operations	1,970,779,012	2,053,907,429	2,140,360,927	2,230,272,507	2,323,780,492	2,421,028,736	2,522,166,849	2,627,350,424
Add CapEx	-	-	-	-	-	-	-	-
Government Investment	-	-	-	-	-	-	-	-
Investor Equity	-	-	-	-	-	-	-	-
Loans (Government & Investors)	-	-	-	-	-	-	-	-
Total	**1,970,779,012**	**2,053,907,429**	**2,140,360,927**	**2,230,272,507**	**2,323,780,492**	**2,421,028,736**	**2,522,166,849**	**2,627,350,424**
Application of Funds	-	-	-	-	-	-	-	-
Total investments	-	-	-	-	-	-	-	-
Repayments of loans (Principal)	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-
Cash Surplus / (Deficit) - Closing Balance	**1,970,779,012**	**2,053,907,429**	**2,140,360,927**	**2,230,272,507**	**2,323,780,492**	**2,421,028,736**	**2,522,166,849**	**2,627,350,424**
Net Present Value & Internal Rate of	-	-	-	-	-	-	-	-
Net income	**1,970,779,012**	**2,053,907,429**	**2,140,360,927**	**2,230,272,507**	**2,323,780,492**	**2,421,028,736**	**2,522,166,849**	**2,627,350,424**
Plus: Depreciation & Amortization	-	-	-	-	-	-	-	-
Cash flows from operations	**1,970,779,012**	**2,053,907,429**	**2,140,360,927**	**2,230,272,507**	**2,323,780,492**	**2,421,028,736**	**2,522,166,849**	**2,627,350,424**
Minus:	-	-	-	-	-	-	-	-
Gov Investment and Investor equity	-	-	-	-	-	-	-	-
Principal repayments	-	-	-	-	-	-	-	-
Working capital requirements	**96,953,953**	**100,829,889**	**104,860,819**	**109,052,940**	**113,412,700**	**117,946,803**	**122,662,223**	**127,566,210**
Net Free Cashflow	**1,873,825,060**	**1,953,077,540**	**2,035,500,108**	**2,121,219,567**	**2,210,367,792**	**2,303,081,933**	**2,399,504,626**	**2,499,784,215**
NPV	**-3,630,619,493**							
IRR	**3,6%**							

6.2.5 Financial Results for the Single Railway Trunk Lines and Sensitivity Test

Coherently with the Economic Analysis, the Financial Analysis has also been conducted for each single phase and for each single railway trunk line.

Table 6- 8 Phases Financial Feasibility Analysis Results

PHASES			IRR	NPV (at 12%) US $
Phase 1	Rehabilitation of Existing Lines			
	1W	Western Line	5.0%	-632,784,560
	1E	Eastern Line	4.0%	-641,330,830
PHASE 1 (W+E)			*5.0%*	*-1,196,404,226*
Phase 2	Central Spine Expansion			
	2W	Takoradi-Kumasi	7.2%	-536,095,460
	2E	Accra-Kumasi	5.6%	-598,847,326
PHASE 2A (2W+2E)			*5.8%*	*-1,214,639,421*
	2AC	2A + Kumasi-Paga	8.0%	-1,357,327,237
Phase 3	Transversal Expansions	2C + Transversal expansions	8.0%	-1,473,967,547
Phase 4	Trans Ecowas Expansion	3 + Aflao-Accra-Takoradi-Omanpe line	7.2%	-1,758,005,542
Phase 5	Western Expansion	4 + Dunkwa-Awaso-Hamile	6.4%	-1,971,274,486
Phase 6	Eastern Expansion	5 + Tema-Yendi	6.1%	-2,033,315,361

The results indicated in the preceding table demonstrate a variable degree of feasibility for the different incremental Phases of the whole railway network, although the Net Present Value (at *12%*) of all the Phases is negative. The IRR range from 4% for the Eastern Line (1E) to 8% for 2A + Kumasi-Paga (2AC) and Phase 3.

It has to be noted that IRR values are always higher than those obtained for the entire Railway Network (3.6%): this is because in the second case rehabilitation costs for the Western and Eastern Lines have also been considered.

Table 6- 9 Railways Lines Financial Feasibility Analysis Results

LINES ANALYSED	LINES IDENTIFICATION	REFERENCE TO PHASE	IRR	NPV (at 12%) US $
NORTH-LINE OF CENTRAL SPINE EXPANSION	Kumasi - Techiman - Tamale - Paga	2C	10.9%	-142,687,815
TRANSVERSAL EXPANSIONS LINES	1- Tamale - Yendi 2- Fufulsu - Sawla 3- Techiman - Atebubu – Kwadwokurom 4- Nyinahin - Kumasi	3	4.7%	-355,399,235
TRANS ECOWAS EXPANSION LINE	Aflao - Tema - Accra - Takoradi and Tarkwa – Omanpe	4	-9.6%	-329,331,164
WESTERN EXPANSION LINE	Dunkwa - Awaso - Techiman - Sawla - Hamile	5	-8.1%	-302,568,358
EASTERN EXPANSION LINE	Tema - Ho - Yendi	6	-8.6%	-131,185,768

As can be noted, the values of the feasibility indicators are lower for the single railway trunk lines analysed separately, which is normal as the single line does not benefit from all the advantages generated by the railways network. Only the “Kumasi-Techiman-Tamale–Paga” gives an acceptable IRR of 10.9%.

6.2.6 Sensitivity Test

In order to verify how the results of the Financial Analysis vary as a consequence of changes in the values of **cost** (+5%; +10%) and **revenues** (-5%; -10%). Variations of IRR value are not significant and always lower than 1%.

The results of this Sensitivity Analysis are presented in the following Table 6-10.

Table 6-10 Railways Lines – Financial Feasibility Analysis Results and Sensitivity Test

	BASE		5C		10C		5R		10R	
	NPV	IRR	NPV	IRR	NPV	IRR	NPV	IRR	NPV	IRR
1W	-632.784.560	5,0%	-692.957.153	4,7%	-751.195.774	4,3%	-660.698.940	4,5%	-687.889.388	4,2%
1E	-641.330.830	4,0%	-695.190.045	3,8%	-749.493.260	3,5%	-663.145.703	3,7%	-685.415.787	3,4%
1WE	-1.196.404.226	5,0%	-1.308.464.678	4,6%	-1.421.218.749	4,3%	-1.248.653.833	4,6%	-1.301.705.727	4,3%
2W	-536.095.460	7,2%	-587.912.096	6,9%	-639.728.733	6,7%	-565.873.071	6,9%	-595.650.683	6,5%
2E	-598.847.326	5,6%	-648.326.557	5,4%	-697.805.789	5,1%	-622.113.158	5,3%	-645.378.990	4,9%
2A	-1.214.639.421	5,8%	-1.274.175.816	5,7%	-1.333.712.210	5,5%	-1.260.684.595	5,5%	-1.306.729.768	5,2%
2C	-142.687.815	10,9%	-226.183.962	10,4%	-309.680.108	9,8%	-219.049.571	10,3%	-295.411.326	9,7%
2AC	-1.357.327.237	8,0%	-1.561.704.569	7,7%	-1.733.994.840	7,4%	-1.511.821.228	7,6%	-1.634.228.157	7,2%
3A	-355.399.235	4,7%	-384.805.772	4,3%	-414.212.308	4,0%	-367.035.810	4,3%	-378.672.385	4,0%
3	-1.473.967.547	8,0%	-1.809.016.295	6,8%	-2.008.624.686	6,4%	-1.751.241.490	6,7%	-1.893.075.076	6,2%
4A	-329.331.164	-9,6%	-346.861.972	-10,1%	-364.392.779	-10,6%	-330.395.413	-10,1%	-331.459.662	-10,7%
4	-1.791.822.750	7,2%	-2.007.840.287	6,7%	-2.223.857.823	6,3%	-1.942.436.116	6,6%	-2.093.049.482	6,1%
5A	-302.568.358	-8,1%	-319.192.919	-8,6%	-335.817.481	-9,0%	-304.064.501	-8,6%	-305.560.645	-9,1%
5	-1.971.274.486	6,4%	-2.070.378.495	6,2%	-2.301.782.710	5,8%	-2.005.081.285	6,1%	-2.171.188.290	5,5%
6A	-131.185.768	-8,6%	-138.561.460	-9,1%	-145.937.153	-9,6%	-132.002.172	-9,1%	-132.818.576	-9,7%
6	-2.033.315.361	6,1%	-2.270.256.814	5,7%	-2.508.521.738	5,3%	-2.194.852.623	5,6%	-2.357.713.355	5,1%
All MP	**-3.630.619.493**	**3,6%**	**-3.886.691.699**	**3,3%**	**-4.142.763.904**	**3,1%**	**-3.719.417.261**	**3,3%**	**-3.808.215.028**	**2,9%**

6.3 PUBLIC-PRIVATE-PARTNERSHIP PROSPECTUS

6.3.1 Introduction

This prospectus intends to introduce the PPP concepts and the suggested financing procedures to be applied in the implementation of the Ghana Railway Master Plan.

From the results of the Financial Analysis conducted in the previous paragraph, it appears clear that:

1. The huge amounts needed for the construction or re-construction of the railway infrastructures and the uncertainties of the market do not allow, in general, the involvement of private financing for a vertical integrated railway concession;
2. Nonetheless mining companies could be interested in the rehabilitation of the existing Western Railway line at narrow gauge, considering their need to transport their own mineral products to the port of Takoradi for export, while freight carriers could be interested in the rehabilitation of the Eastern line, to transport their containers;
3. Private investment can be anyway attracted for management and operation of the new railway lines, providing railway services along the most demanded lines, once the construction has been implemented with public resources.

The following paragraphs illustrate the PPP concepts, Ghana activity in the PPP procedures, PPP forms in the Railway sector, Railway concession experiences in Africa and conclude with a proposal package for the implementation of the priority interventions of the Ghana Railway Master Plan, accompanied with the suggested legal and institutional safeguards and the possible sources of funding to be activated.

6.3.2 PPP Concepts

Transport infrastructures and services are “public goods” traditionally provided by public authorities with public funds, but the recent constraints in public finances matched with the huge increase of transport demand are urgently asking for innovative approaches in the provision and financing of transport infrastructures.

The challenge is now to combine optimally the strengths and resources of the public sector with those of the private sector in order to effectively and efficiently provide transport services to the customers. In the last two decades, in fact, there has been a worldwide trend to involve the private sector in the provision of transport infrastructure and transport services, producing a wide range of models for private sector participation, that differ in the extent and functions of private sector involvement and the repayment method.

While developed and industrialised countries are using the private sector participation mostly for the extension and refurbishment of existing infrastructures, in developing countries, recently experiencing an explosive increase in transport demand, the private investors are asked to participate massively in the reconstruction of old or abandoned infrastructures, bringing foreign exchange and expertise for the construction and management of the transport infrastructure.

A PPP is a contractual arrangement between a public entity and the private sector, with clear agreement on shared objectives for the provision of public infrastructure and services traditionally provided by the public sector. The form of a PPP arrangement is varied and can include: simple contracted out-sourcing arrangements funded by the public sector, management contracts to operate a facility, forming a public-private joint venture, concession contract for the construction and management of the infrastructure. The PPP contract should set out which party assumes the financial, technical and operational risks of the project: usually the private sector performs part or all of a Government service function and assumes the associated risks for a significant period of time and, in return, receives a benefit/financial remuneration from service tariffs, user charges and/or Government budget.

The benefits of a well implemented PPP, in comparison with the traditional form, include, to a greater or lesser degree: the accelerated construction of infrastructure and delivery of services on time and within budget, innovative design, technology and financing structures, increased domestic and international investments, risk sharing between Government and private sector, reduction in the initial public capital outlay, economic growth, increased employment, technology transfer and improved operation and maintenance of public infrastructures.

The capital investment can be provided by the Government, the private partner or a combination of the two; the cost of providing the service is borne generally by the private sector while the cost of using the service may be borne exclusively by the users of the service, shared between the user and taxpayer, or falls wholly on the taxpayer. Setting up a PPP can also involve the transfer of assets to a specific PPP company (Special Purpose Vehicle - SPV), or ownership is retained by the Government, while the PPP company is responsible for the repair/ maintenance and the provision of services. Government subsidies may be provided in the form of one-time grants. revenue subsidies (subventions), tax breaks or annual revenues for a fixed period. The newly created assets usually revert to the public sector at the end of the PPP contract or are assigned to the project (SPV) at no cost or under some form of lease or maintenance agreement (e.g. when major rail or road infrastructures remain in the public domain).

Although PPPs may result in investors obtaining a higher rate of return on their (often leveraged) investment than the Government would pay if funding came from a bond or loan, PPPs can be beneficial to the public sector. In fact:

(i) construction costs may be lower if the private partner is given appropriate incentives to avoid cost overruns,

(ii) the private sector financing removes the burden of direct debt on the public sector (although there is an implicit long term public liability off the balance sheet),

(iii) project delivery can be quicker than that possible through Government budget procedures,

(iv) costs and revenues are ring-fenced with the formation of a separate PPP company, authority or other form of agency,

(v) management and operation of the project is also removed from the restrictions and inherent inefficiencies of annual Government budget,

(vi) the private sector is geared up to quicker responses to changing circumstances than is the public sector.

6.3.3 Ghana Policy in PPP

The Government of Ghana (GoG) is currently facing big challenges in infrastructure development and public service delivery to accommodate the huge increase of service demand occurred in the last years. Given the limited budget resources, the country's huge deficit in infrastructure cannot be met by the public sector alone through budget allocations, but should encourage the use of Public-Private Partnership (PPP) as a means of leveraging public resources with private sector resources and expertise ìn order to close the infrastructure gap and deliver efficient public infrastructure and services for the growth of the country.

The ***National Transport Policy (2008)*** document has set up a blueprint for the sustainable development of the Ghana transportation system. The transportation system is meant to ensure economic growth and poverty reduction and bring Ghana to become a Middle Income Country and a Transportation Hub of West Africa by year 2015. The financing of a national transportation system (as indicated by the ***Policy***) should be based on ***the use of private***

sector resources for those transport infrastructures and services that provide commercial returns (almost all freight transport operations and a number of financially viable passenger operations), while the. Government will continue to "***invest***" in transport infrastructure and "***subsidise***" transport services where they provide mainly social and environmental benefits important to users and to the country.

Since 2008, GoG has shown a solid commitment to develop Public Private Partnership procedures for infrastructure financing, launching in October 2011 the ***National Policy on Public Private Partnership*** and undertaking a set of legislative, policy and institutional reforms to address many of the identified environment weaknesses: *Ghana PPP Diagnostic Study* (2010), *Establishment of a PPP Resource Center* (PRC) and *PPP Capacity Building*, supported by the World Bank and the Public-Private Infrastructure Advisory Facility (PPIAF). The Government also proceeded to establish the Public Investment Division (PID) within the Ministry of Finance and Economic Planning (MoFEP) to take a lead role in the PPP Program in Ghana. The Public Investment Division, led by a Director, is comprised of four units including a Project and Financial Analysis Unit (PFA Unit) with gate-keeping and upstream investment appraisal responsibilities and a PPP Advisory Unit (PAU) with technical specialists to support line ministries and agencies in the development and management of prospective PPP transactions that satisfy GoG public investment priorities.

Even if GoG has shown a solid commitment to develop Public Private Partnership (PPP) for infrastructure financing, it is still actually lagging behind other Sub-Saharan African countries in terms of private sector investment in infrastructures. Ghana has not attracted as much private finance of infrastructure as Benin, DRC, Kenya, Nigeria, Senegal, Tanzania and Uganda, while the most successful country in this regard has been Mozambique, which captured in excess of 3.5 percent of GDP. Private sector participation in Ghana has been mainly in the form of divestures and concentrated in the telecom and energy sectors.

Most recently, GoG initiated but did not finalise a BOT (Build Operate and Transfer) concession process for the Accra – Kumasi National Road NR6. The road was going to be financed through 2007 Eurobonds, but the turmoil in the international financial markets and the withdrawal/non-availability of private sector interest were the reasons for this PPP failure. Development of NR6 has then continued with public funds and the ITP has identified NR6 for priority investment consideration.

Also, GSA (Ghana Shippers Authority) has launched through the Ministry of Transport, a tender for the *Development of an Inland Port at Boankra, in the Ashanti Region, on a Build, Operate and Transfer (BOT) basis,* in order to find a Private Managing Operator. Fourteen reputable organisations participated and 6 were retained in the short list to be invited to make an offer.

Also the railway sector has been the object of different PPP proposal letters from different organisations, such as Kampac Oil (for the rehabilitation of the Central and Western railway lines), GPK (development of Accra – Tema suburban rail), Globalex Company Limited (for rehabilitation and expansion of the national railway network), African Rail AS (for the Eastern Corridor railway reconstruction), Montmontaza Group (for the construction of rail network), Railmark Inc. USA (for railway system re-development). None of these letters has developed into PPP agreements.

In terms of public loans, a China Commercial Bank (CDB) line of credit is now ensuring to GoG 3 billion US$ for various projects, including the financing of part of the Western Line rehabilitation at dual gauge standard. The credit foresees two tranches of 1.5 million with a tenor of 15 years and 5 years grace, and an interest rate of Libor (6 months) plus 2.95%. The financing of the Western Line should amount to a total of 425 million US$.

6.3.4 PPP in Railway Sector

The possibility to introduce private participation in the railway sector is mostly based on the completion of a **railway restructuring** process. Railway restructuring involves a complex of reforms that have been or are going to be introduced in many railway organisations, in terms of creation of new organisations (un-bundling), revised accounting methods, liberalisation through the introduction of competition, privatization, de-monopolization and regulatory reform, in order to create better managed, more commercially-responsive and market-led railway organisations.

Typical railway problems in different countries are still: chronic financial deficits, growing operating subsidies, lack of a sound fare structure, low productivity, low service quality, poorly maintained assets and poor management of the railway infrastructure and services. These problems are interrelated and cause a **vicious circle**: no market response, declining revenues, increased deficits, decreased subsidies, asset and service deterioration, market losses, etc. The best way to align consumer needs and demand, with the provision of railway services, in a manner which promotes economic and financial sustainability is through ***competition and public-private partnership***. Policymakers in many countries have concluded, therefore, that the solution to this myriad of problems is likely to be found in creating a competitive 'market based' railway industry.

6.3.4.1 Railway restructuring process

Railway restructuring involves introducing, to varying extents, competition and private participation in the financing, operation, management and, possibly, although not necessarily, the ownership of the railways. Substantial cost savings can be achieved by creating competition and private participation (PPP) in the supply of the railway infrastructure facilities and train services. Many countries are, therefore, seeking economic reforms aimed at creating a competitive market-based transport industry.

Competition is the most important mechanism for maximising consumer benefits, and for limiting monopoly power. Its essence is rivalry and freedom to enter a market. Competition serves the public interest by inducing suppliers to become more efficient and to offer a greater choice of products and services at lower prices.

Competition (between different public or private entities) can be created in basically two ways:

i) launching a concession tender for the exclusive (or not) use of the railway infrastructure (here the issue is also the duration of the concession); or

ii) creating competition between different railway operators in the use of infrastructure, tendering the single track access timing.

Following is the presentation of the different forms of PPP applied in the railway sector, as outlined by the Bonifica 2010 Report (following paragraph 6.3.4.2), whereas, under the subsequent paragraph 6.3.4.3 , the Consultant has presented its own elaboration of Summary Sheets synthetically describing the schematic Models of the most common PPP interventions in the railway field.

6.3.4.2 Traditional Forms of involving the Private Sector in Railway Sector

State-owned Railway companies, in the long and widespread experience of sharing the costs for renovating, improving and developing their networks, have entered into a number of arrangements with the private sector involving service contracts, lease arrangements and outsourcing of activities such as catering, track maintenance, train and station cleaning, weed control, station and depot maintenance, rolling stock provision and rolling stock maintenance. Many are simple contracts but a number do incorporate performance-based payment regimes linked to performance targets that transfer performance risk to the supplier. These arrangements tend to be short to medium term arrangements and require to be funded and managed by the Railway Company. They may add private sector competencies to improve the overall operations of the railway but they do not solve the problem of inadequate cash to fund activities or improving general management capabilities.

- Vertical Concession (BOT/ROT)

After a considerable decline in traffic, traffic transfers to road, mismanagement and budget restraints over the last 30 years, many state railways adopted the concession approach. In a railway vertical concession, the public authority grants a private party the right to build, operate and maintain the public assets and retain the revenues for a specified period (usually 20-30 years). The contract typically requires the concessionaire to invest in building (BOT), rehabilitate (ROT), extending or modernising the railway infrastructure, which revert to the authority at the expiry of the contract period. The operating company arranges its own finance, which does not appear on the authority's account. The private party recoups its investment, operating, and financing costs and its profit by charging members of the public or users of the services. Thus a key feature is that the private party usually assumes the risk of demand for use of the asset, in addition to the risks of design, finance, construction, and operation. This demand risk can however be shared with the public authority, for example, by underwriting a minimum level of usage. User charges may be either prescribed in the PPP contract or set by the concessionaire.

- Franchise

Franchises are a subset of vertical concession in which the private sector takes over existing public infrastructure, operating and maintaining it under a fixed-term contract, often with an obligation to upgrade it. They are common in the rail sector (UK originally awarded 27 franchises to train operating companies). The private party often pays an initial lump sum of money to the public authority to acquire the franchise. Clearly the dividing line between franchises and concessions is not precise. If a project involves a high level of initial investment in new or upgraded infrastructure, it may be called a concession, whereas if it involves a limited level of initial investment (even if there are long-term maintenance requirements), it may be called a franchise.

- Affermage/Leasing

Affermage is a type of leasing arrangement (similar to a concession) under which an operator takes over and runs public infrastructure and collects revenue from customers, but does not undertake and finance new investment. The operator either makes a specified lease payment to the contracting authority (under a simple lease), or shares revenues according to a predetermined formula (under an affermage).

- Availability-Based PPPs

Availability-based PPPs are also similar to a vertical concession, in that they involve the private party designing, financing, building or rebuilding, and subsequently operating and maintaining the necessary infrastructure. However, in this case, the public authority (as opposed to the user) makes payments to the private party, as, when, and to the extent that a public service (not an asset) is made available. Hence the demand or usage risk remains with the public authority.

- Unbundled concessions

The concessions awarded so far have generally been 'vertically integrated concessions' in that the concessionaire takes over the infrastructure management, operation and maintenance activities and train operations (passenger/freight services, rolling stock and rolling stock maintenance). Other models, particularly in the UK, Scandinavia and Europe 'unbundle' this vertical arrangement, separating the infrastructure management side from train operations. With vertical separation the Government usually sets up a specific company to manage, maintain and operate the infrastructure (permanent way, signalling etc) and concessions train service operations to separate private and/or state owned train operating companies.

The mix is very wide from one state company running infrastructure (InfraCo) and another state company running services, to Government owned Infraco and train operator competing with private sector operators, all private train operators, etc. The European Union railway directives require all railways to separately account for the two areas, infrastructure and operation and most EU countries have already split the activities into two divisions of the railway company or formed two separate companies.

6.3.4.3 PPP Models

The following models of PPP Contracts and their basic characteristics applicable (to a various extent and with possible combinations) to railway restructuring and developing projects are shown in the following pages:

- Model 1 – Concession
- Model 2 – Franchise
- Model 3 – BOT (Build-Operate-Transfer)
- Model 4 – BROT (Build-Rehabilitate-Operate-Transfer)
- Model 5 – Management Contracts
- Model 6 - Service Contracts

Model 1 - Concession

Model : **Concession Contracts**

Level of involvement/Risk by Private Sector: Low – Med. – **High**

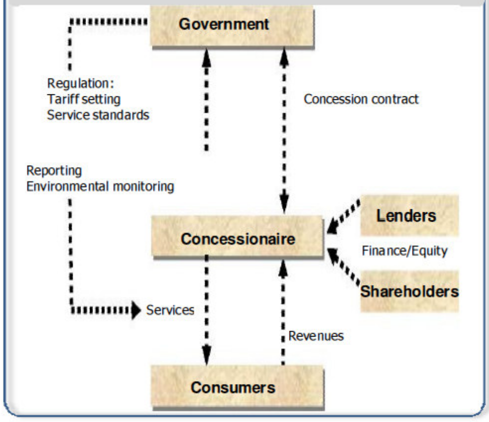
GENERAL

Description	Government gives the operation and maintenance, construction and rehabilitation of the infrastructure facility to a concessionaire. Concession generally involves an existing infrastructure
Scope	Responsibility for all operations and for financing and execution of specific investments (and working capital)
Characteristics	The Public sector's role shifts from being the service provider to regulating price and quality of services The government may choose to provide financing support to help the concessionaire fund its capital expenditure

SPECIFIC ASPECTS

Compensation Terms	All or part of Tariff Revenues
Ownership of Capital Assets	Public
O&M Responsibility	Private
Commercial Risk	Private
Overall level of Risk assumed by Priv. Sector	High
Duration of Contracts	25-30 years

STRUCTURE



PROS & CONS

PROS	Improves operational and commercial efficiency The concessionaire is able to prioritize and innovate as it deems most effective
CONS	- Regulatory capacity of the Government in relation to tariffs and permormance monitoring - last years of concessions may be critical for maintenance

CASES

General cases	- Many infrastructures in the transport infrastructure sector (motorways, airports, railways). - e.g.: DBFO (Design, Build, Finance, Operate) concession for Dunaujvaros Motorway, Hungary - 2004 -
Specific cases (railways)	- Examples in Argentina, Brazil, Burkina Faso, Chile, Ivory Coast, Mexico... - In U.K. The London Underground Ltd PPP is an example in which the private sector are paid in relation to performance (availability, capability, ambience)

Model 2 - Franchise

Model : **Franchise Contracts**

Level of involvement/Risk by Private Sector — Low / Med. / High

GENERAL	Description	The concessionarire will be a franchisee when his service will have to comply with strict standards and qualitative constraints/parameters set by the Contracting Authority (Franchisor)
	Scope	As for the concession
	Characteristics	Under the franchise agreement the concessionaire provide services that are fully specified by the franchising authority

SPECIFIC ASPECTS	Compensation Terms	All or part of Tariff Revenues
	Ownership of Capital Assets	Public
	O&M Responsibility	Private
	Commercial Risk	Public
	Overall level of Risk assumed by Priv. Sector	Private
	Duration of Contracts	25-30 years

PROS & CONS	PROS	Quality standards are usually well defined
	CONS	Contractual aspects may take longer

CASES	*General cases*	Popular in urban bus or rail service
	Specific cases (railways)	Franchise agreement in U.K. for railways passanger traffic (U.K., 2005)

Model 3 – BOT

[Build-Operate-Transfer]

Model : **BOT Contracts**

Level of involvement/Risk by Private Sector — Low / Med. / **High**

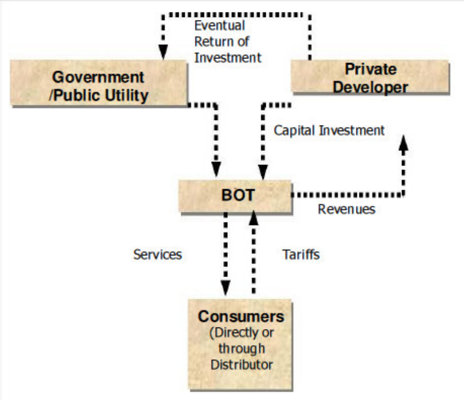
GENERAL

Description	Specialized concession in which a private firm or consortium finances or develops a new infrastructure project according to performance standards set by government. BOT or DBOT (including design) arrangements generally involve a greenfield investment
Scope	Investment in and operation of a specific major component
Characteristics	Standards and service quality parameters set by Contracting Authority

SPECIFIC ASPECTS

Compensation Terms	Mostly fixed, partly variable related to production parameters
Ownership of Capital Assets	Public
O&M Responsibility	Private
Commercial Risk	Private
Overall level of Risk assumed by Priv. Sector	High
Duration of Contracts	Normally up to 50 yrs

STRUCTURE



PROS & CONS

PROS	Way of attracting private financing to construction or renovation of infrastructure
CONS	Limited competition to the initial bidding process Safeguards for long term commitment

CASES

General cases	- BOT is a common form of PPP in all sectors in Asian countries (Port and road projects) - In Europe the N31 road (2003) is an example of DBFM (Design, Built, Finance, Manage) which does not involve ownership transfer of the asset - The construction of the Suez Canal was awarded under BOT concession, involving private equity (99 years concession)
Specific cases (railways)	Railway connections and Stations. E.g.: Arlanda express (Stockholm) - 42 km connection to the main airport (40 years, 1999)

Model 4 – BROT
[*Build-Rehabilitate-Operate-Transfer*]

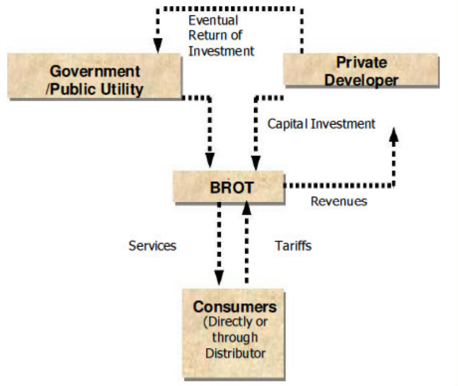
Model : **BROT Contracts**

Level of involvement/Risk by Private Sector: Low – Med. – **High**

GENERAL		
	Description	BOT concept applied to an add-on to an existing facility or completes a partially built facility and rehabilitates existing assets
	Scope	Investment in and operation of a specific major component
	Characteristics	Standards and service quality parameters set by Contracting Authority

SPECIFIC ASPECTS		
	Compensation Terms	Mostly fixed, partly variable related to production parameters
	Ownership of Capital Assets	Public
	O&M Responsibility	Private
	Commercial Risk	Private
	Overall level of Risk assumed by Priv. Sector	High
	Duration of Contracts	Varies

STRUCTURE



PROS & CONS		
	PROS	Way of attracting private financing to construction or renovation of infrastructure
	CONS	Limited competition to the initial bidding process Safeguards for long term commitment

CASES		
	General cases	BROT is a popular form of PPP in the water sector
	Specific cases (railways)	Railway connections and Stations (e.g.: redevelopment of Melbourne's Spencer Street Station, 2002)

Model 5 – Management Contracts

Model : **Management Contracts**

Level of involvement/Risk by Private Sector: Low — Med. — High

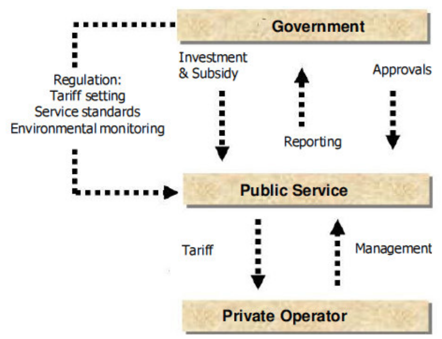
GENERAL

Description	Government hires a private company to carry out the management and operation of a public service/enterprise
Scope	Management of the entire operation or a major component
Characteristics	Private sector interacts with Customers, Tariffs set by Public Sector

SPECIFIC ASPECTS

Compensation Terms	Fixed fee + performance incentives
Ownership of Capital Assets	Public
O&M Responsibility	Private
Commercial Risk	Public
Overall level of Risk assumed by Priv. Sector	Minimal/Moderate
Duration of Contracts	2-5 years

STRUCTURE



PROS & CONS

PROS	Interim solution for preparation for more intense private participation
CONS	If Private is paid through incentives: potential risk of inflation of reported achievements or low maintenance (in order to increase profits)

CASES

General cases	Frequently used in health care
Specific cases (railways)	Overall Assets Maintenance of rolling stock: normally performed by the same vendors/suppliers

Model 6 – Service Contracts

Model : **Service Contracts**

Level of involvement/Risk by Private Sector: Low – Med. – High

GENERAL	Description	Government hires a *private company* to carry out one or more services
	Scope	Multiple contracts for a variety of support services (ticketing, catering, cleaning,…)
	Characteristics	Suitable when service is clearly defined and level of demand reasonably certain

SPECIFIC ASPECTS	Compensation Terms	Unit Prices / Predetermined fee
	Ownership of Capital Assets	Public
	O&M Responsibility	Public
	Commercial Risk	Public
	Overall level of Risk assumed by Priv. Sector	Minimal
	Duration of Contracts	1-3 years

PROS & CONS	PROS	- Improving efficiency of public company - Promotes local private sector development - Technology Transfer - Development of managerial capacity
	CONS	Potential Administration complexity of multiple contracts

CASES	*General cases*	Variety of support services in many fields
	Specific cases (railways)	Maintenance of part of facilities (railway systems, stations,…)

6.3.4.4 PPP Policies

Generally speaking, Public and Private partners have distinct objectives, therefore the Partnership may not be "easy".

In any case, for important capital intensive infrastructures/projects (such as a railway), the **Public Partner plays an important financial role**, in ways to be determined case by case. However, apart from its financial support, the Public Authority will always have a determinant role to guarantee the success of a PPP agreement on railways.

From international experience, it is possible to identify some key PPP Conditions for Success (which are further dealth with on following Chapter 6.5):

- Create sufficient **incentives** so that profit seeking by Private partner does not affect the broader public interest / quality of services provided.
- Evolve a **legal and regulatory framework for the railway sector**, defining, among other things, general maintenance standards, safety levels, service standards, tariff limits, Public Service Obligation scheme.
- Conceive carefully **structured contracts** (affordable & bankable) with equitable risk sharing. In any case, the Public Authority should also introduce mechanisms for periodic review of specific contractual terms during the life of contract.
- Plan and regularly implement adequate **public control** to assure the provision of quality services.
- Introduce mechanisms for **Periodic audit of the concession** (or other PPP Model contract). The audit should be conducted by an independent auditor.

It is also fundamental that PPP initiatives are taken in the context of a **long term strategic transport network development plan** that is stable and predictable.

Last but not least, in order to successfully revitalise the railway network, it is imperative to associate to the fundamental role played by a specific PPP, an effective set of actions by the Public Authorities to promote and enhance the use of railways for both freight and passenger transport with respect to road transport.

6.3.4.5 Railway Restructuring in Ghana

The Government of Ghana is carrying out a railway restructuring process and has already produced (Railway Act 779/2008) the unbundling of the railway infrastructure (land, stations, permanent way, etc) from rolling stock and other train transport services. The Government will continue to own the railway infrastructure through the Ghana Railway Development Authority (GRDA) while the provision of rail service, and the ownership of rolling stock may be provided by private sector operators. The Ghana Railway Development Authority is then the landlord of rail infrastructure in Ghana, mandated to promote the development of railways and railway services. Until private sector operators are brought on board, the existing Ghana Railway Company Limited (GRCL), subject to transitional arrangements with the GRDA, will continue to operate the railway services.

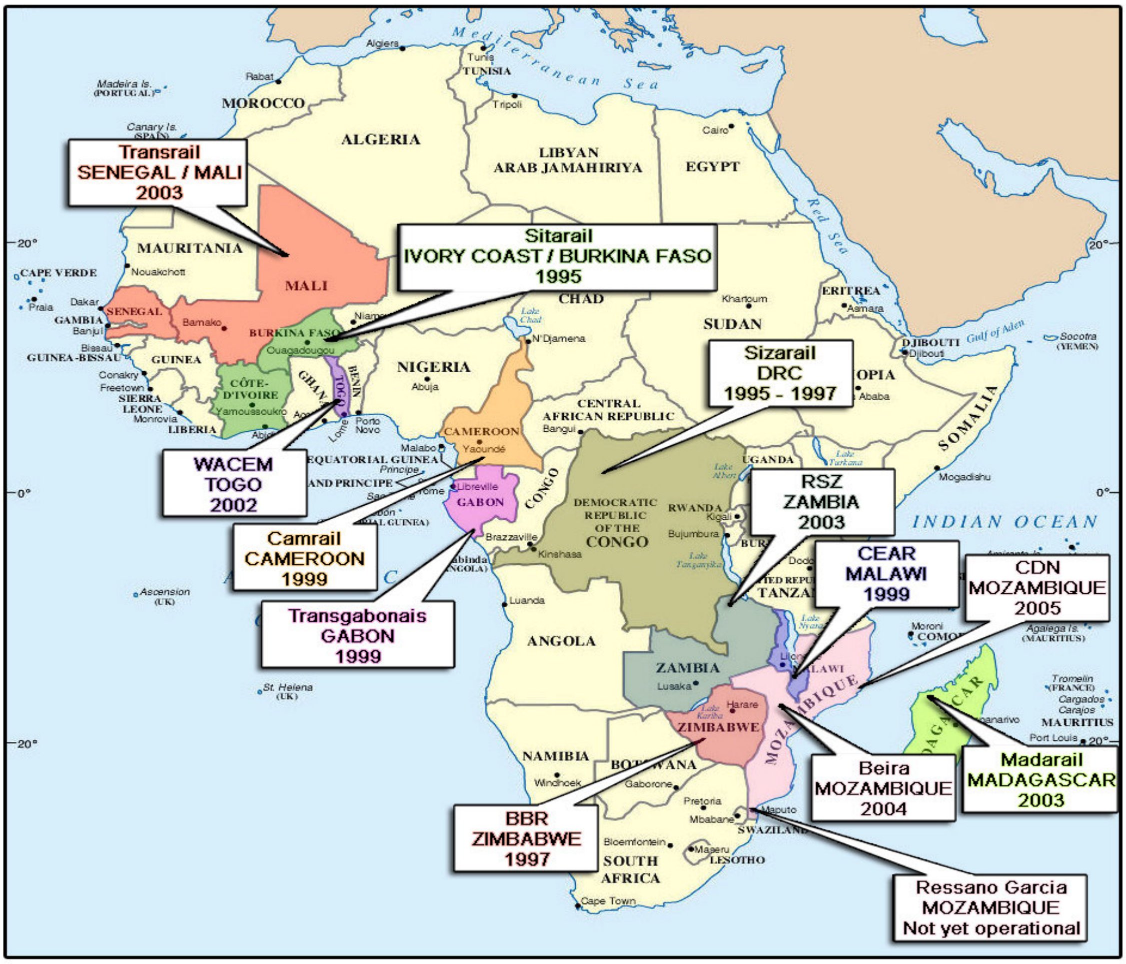
6.3.5 Railway Concessions Experiences in Africa

African concessions have predominantly followed the vertically integrated format with the concessionaire taking over everything including responsibility for investment (i.e. Camrail, Malawi, Mali, etc). The Sitarail concession (Ivory Coast/Burkina Faso) however does represent a different type of model: the railway companies of the two countries (SICF and SCFB) retain full ownership of infrastructure and assets during the concession period and acting as Landlords lease the assets to the operator SITARAIL. The operator maintains the leased assets during the concession and can invest in new assets and equipment if desired; generally, however, the landlords are responsible for investments in the infrastructure. Technically this model is an Affermage. The operator pays usage and rental fees for the concession and assets.

Experiences of vertical concessions in Africa are connected with the rehabilitation of colonial railway lines for freight purposes. In general, **African railways are essentially a freight business** because private operators are not keen on passenger traffic uncertainties. Passenger trains clutter up the tracks and generate little revenue. Also, because the track has often not been maintained, rail speeds are low so optimum track usage is vital. For financial reasons, this results in prioritising freight. The railways tend to be single track, not conducive to intensive passenger traffic. Freight rail PPPs, especially heavy freight, have been the only real successes, like, for example, in West Africa the railways to transport iron ore and minerals from the interior to the coast. There could also be space for passenger transport, but separating long distance rail from commuter rail, as commuter rail holds more potential for PPPs.

Figure 6 - 3 Railway Concessions Awarded in Africa Since 1990

(*re-drafted, after R.Bullock: Results of Railway Privatization in Africa - WB 2009)*



Analysing the recent experiences of railway concessions in Africa, a technical report prepared in 2009 for the Southern African Development Community (SADC) has observed that railway concessions in the region have generally been characterized by “declining performance”, deteriorating infrastructures and “massive retrenchments” in investment. New guidelines for railway concessions in Africa, ask for: (i) Separating rail infrastructure from operations, with clear track usage fee determination and Regulatory Body; (ii) Establishing the rules for open access to all qualified operators both for freight and passenger trains; (iii) examine possibilities of pooling equipment – both wagons and locomotives – including a rail leasing company owned by the SADC States and (iv) establish minimum standards of passenger service and set full compensation parameters to operators of PSO (Public Service Obligation) passenger trains.

6.4 PROPOSAL FOR FINANCING THE RAILWAY MASTER PLAN

As shown in the financial analysis, the implementation of the Ghana Railway Master Plan will require huge investments for existing railway rehabilitation/reconstruction and the construction of new railway lines and will also need substantial investments for restoring and construction of new railway stations, the purchase of the necessary rolling stock, restore and construct maintenance workshops, logistic platforms and machinery for cargo handling.

The adoption of PPP procedures is meant to reduce the overall capital burden of the railway master plan, bestowing all possible revenue generating activity to the private sector. As already mentioned, Government of Ghana has already unbundled the railway infrastructure (land, stations, permanent way, etc) from rolling stock and other train services equipment, envisaging in general terms a future railway environment for unbundled concession or affermage/leasing models, similar to the Sitarail. Nonetheless, a vertical integrated concession could be pursued in the rehabilitation of the existing lines: mining transport along the Western Line and freight transport (mostly import/export and transit traffic containers) along the Eastern Line.

The Government will then continue to own the railway infrastructure through the Ghana Railway Development Authority (GRDA) while the provision of rail service and the ownership of rolling stock is to be provided by private sector operators. The GRDA could actually become a Regulatory Body, conferring the railway infrastructure to an InfraCo (public company) and assuring the competition in the railway usage for different private or public train operator companies. GRC could be one of the railway operators, or/and eventually offering workshop services for rolling stock maintenance.

Following is a package proposal to finance the priority interventions identified in the Railway Master Plan. i.e. Phase 1: Rehabilitation of the Eastern and Western railway lines (2015-2019) and Phase 2: Construction of new railway lines Eastern, Western and Kumasi-Paga (2019-2029):

- Vertical integrated concession for the rehabilitation of Eastern and Western lines (Phase 1)
- Construction with public funds of the new lines of Phase 2 (Eastern, Western and Kumasi-Paga)
- Private Railway Operators to provide transport services (freight and passengers), for Phase 2;
- Private investors, Real Estate operators to invest in restoring/developing railway stations;
- National or International Carriers/Operators to invest in the development of freight ports, logistic platforms and handling machinery.

6.4.1 Vertical Integrated Concession for Rehabilitation of Eastern & Western Railways - Phase 1

The rehabilitation of existing infrastructures is an interest to the major users (mining companies, national agricultural exporters, international carriers, etc.) because they do not have any “traffic risk”, since they are transporting mostly their products, whose amounts they know very well.

So the concession for the rehabilitation of the existing railway alignment (Eastern and Western lines) should be granted through a bid to these major users (mostly mining companies or freight carriers). The Government should, in any case, try to extract the highest possible value from the concession, negotiating comprehensive “mining development agreements” rather than simple “mining licenses” and acting to guarantee also the possibility of passenger train services accompanied by PSO (Passenger Service Obligation) contributions.

The infrastructure to be built may foresee a dual gauge standard, in order to foresee the possibility to convert the railway line to standard gauge after a certain number of years. An important issue is which party will be responsible for developing the railway infrastructure and how can the infrastructure be shared with other freight or passenger users. There are three primary models for financing and developing freight-related transport infrastructure (as per IFC Handshake Issue 7):

- ***Public entity:*** Rarely seen since the 1980s - Government can choose to finance shared-use infrastructure and gain from its broader benefits - Too costly for most emerging market Governments - Historically dependent on concessional financing - Little donor appetite, especially for single-user projects which are commercially viable - Governments may lack expertise to design, build, and operate the assets. Actually a decision seems to have already been taken for the rehabilitation of the Western line (Dual gauge through public funds).

- ***Mining/Freight Company:*** The most popular model since the 1990s and the most pragmatic approach - Project financing - Incentive to maintain good quality infrastructure - Efficiencies from an integrated value chain - Creates economic gains if Government regulates assets as multi-modal and/or multi-user - Creates barriers of entry for mid-tier and smaller mining companies - Creates unnecessary duplications in most cases if multi-modal and/or multi-user approach is not imposed by regulators.
- ***Third-party private sector company:*** Facilitates asset pooling - Allows the use of project financing and integrated construction management - Limits barriers to entry and fosters core-business competition - Can be more complex to structure and requires Government PPP know-how - Difficult to attract strong private sector players due to market and geopolitical uncertainties - Requires the mining company to give up some of its equity returns to the third party provider.

6.4.2 Construction of the Railway Infrastructure for the Central Spine – Phase 2

The interest of private partners for building new railway infrastructure is very limited worldwide and especially in Sub-Saharian Africa for the high risk perceived by the private investors. But special interest can be shown by foreign states and sovereign wealth funds with other business interests that depend heavily on the railway. These lenders often have significantly lower rate-of-return requirements as their loans are often politically motivated, or they are able to leverage synergies with other businesses they may own such as mines, oil and agricultural products.

Some African Governments with significant natural resources are starting to consider partnerships with cash-rich foreign Governments with a deep thirst for minerals and a knowledge of railway operations. There have been numerous recent examples of foreign consortia/companies committing to upgrade rail infrastructure in exchange for mineral or oil rights, as for example in Congo Brazzaville.

The past years of rail concessions in Africa have yielded initial benefits for many economies and the model continues to evolve. Given the huge demand for raw material in Asia, and the necessary infrastructure development plans in many African countries, the trends toward increased risk sharing and bidders with other special interest outside the rail business is likely to continue.

Ghana’s public finances are insufficient to meet huge infrastructure expenses (as in the case of new railway infrastructures), so a substantial element of GoG development expenditure is to be provided by Development Partners. The PPP process of a new railway should be initiated by a public investment (direct or loan) for the construction of the new railway line, in order to attract railway operators to run trains, to attract investors in logistic platforms and operations, to attract real estate investors in investing in restoring the major stations buildings and the surroundings with commercial purposes.

Chapter 6.6 shows a list of possible international or national funding sources.

6.4.2.1 Central Spine Railway Operations

GRDA is oriented towards establishing a system of competition in rail services, separating rail services from infrastructure and possibly licensing in the future multiple rail operators to provide services over the same rail network. Private operators will negotiate for network space (‘train paths’) and provide shippers with loading, unloading, train assembly, and transport services on a ‘for-hire’ basis. Private operators invest in locomotives and rolling stock and sell services to shippers or local communities for suburban and commuter passenger services. Governments usually forbid differential pricing for infrastructure access (all operators pay according to the same access charge formula).

The unbundling reform could open up the railway market in Ghana to private rail operators who compete with state-owned operators for freight and passenger markets. Other private operators own or lease rolling stock that they manage for their customers, but they do not operate trains. GRCL could participate as railway operator in competition with the private operators or constitute a service oriented structure eventually offering workshop services for rolling stock maintenance.

The potential to attract private operators lies in the type and technical performance of the rail infrastructure to be efficient, modern, safe and fast in order to cope with both the increasing transport of goods and cargo and an high passenger volumes, especially between the main cities (Accra – Kumasi) coupled with an increasing commuters traffic in the surrounding metropolitan areas, such as Accra – Tema or Ejisu-Kumasi. Also the commercial speed, the maximum axle load as well the quality and ancillary services along the railway corridor are directly related to the overall capacity and elasticity of the railway to compete with the road sector.

As the retrenchment continues in the public sector worldwide, private sector investors are likely to play an important role in operating fast train systems. PPPs for fast passenger trains in Italy provide a good example of private operator: NTV (*Nuovo Trasporto Viaggiatori* – New Passengers Transport) recently entered the Rome – Milan fast passenger business, offering good quality transport and fast services at reduced costs in comparison with the state-owned ReteItalia operator. Fast passenger trains could have an important role on the Eastern Line between Accra and Kumasi, where presently there is a daily demand of 35,000 passengers that will grow to 47,000 by year 2030. A confortable and affordable train service would certainly be preferred to air or road transport.

In emerging markets, like Ghana, PPPs offer advantages that are not as apparent in developed nations. High growth rates mean that an investment in capital for certain projects may provide a very high return. Thus private funds assembled more quickly could result in more significant economic growth over the long term than expenditures generated from public revenues or loans from international organizations, which often require a longer development time. Moreover, developing countries that lack public-sector expertise in rail construction can use PPPs to gain access to construction and management tools not currently available to them. PPPs cost more than Government-sponsored alternatives in many cases, but they provide an infusion of technical knowledge that may not be available without private sector involvement.

To ensure success, however, effective PPPs require strong legal systems, lack of corruption, and strong enabling institutions. Emerging markets must pay close attention to these components to avoid even greater risks than developed countries if they bring in private investors without ensuring that an effective Regulatory Framework and Regulatory Body is in place first.

6.4.2.2 Central Spine Railway Stations

Under the scenario of a modern railway construction between the important cities of Ghana, Private investors and Real Estate operators will have the opportunity to invest in restoring/developing railway stations to guarantee the transport services and use part of the buildings for commercial purposes.

Under this scenario, the renovation/construction of the railway network, seems to be a very attractive opportunity for the building sector and real estate developers in all the cities and towns traversed by the rail. For the private sector, it is a tremendous opportunity to get involved with the development of a national railway infrastructure first of all in the re-construction of the stations and ancillary buildings almost abandoned along the existing railway lines and then in the new stations to be built and for the urban renovation and requalification of the urban areas near the stations.

All over the world the new concept of railway stations is linked to their capacity to host rather complex functions. The stations (from the smallest towns to the metropolitan cities) are intended as commercial centers, combined with office spaces together with hotels and restaurants. The opportunity for the real estate and building sector is, for the most important stations along the national railway network, to be ready for the construction on a modern standard base following the pace of the railway modernisation.

The challenge is not an easy task. First of all because these buildings and stations must generally host very different functions and therefore need a sound architectural and technological design. Then, as future urban hubs, they will be meeting places and points of attraction for a wide variety of medium to high value activities and services; thus, they must be easily accessible by public and private urban transport.

The profitability of the stations is naturally more related to the commercial and real estate incomes than from the (relatively) small business linked to the railway sector. These opportunities are not just connected to the buildings and premises pertaining to the stations, but involve all the surrounding areas. Thus giving new life to a large part of the cities, paving the way for a widespread renovation of neglected urban areas as the rail station are now.

This situation is evident in Accra and in Kumasi and in all the main stations traversed by the Eastern or Western railways. But these areas and buildings are still part of the city centers and the renovation of the railways can facilitate and boost the renovation of the existing real estate. It happened in all the city of Europe, USA, as well as India and Latin America. The real estate investors can find a lot of opportunities and, together with a sound urban planning practice able to drive the change and the direction of the intervention that must be coherent with the objectives of the urban development, they may pursue the quality of the space, the renovation of the neglected areas that is the theme of the Ghana Urban Renewal in the coming years together with the improving of the infrastructure mobility.

The business opportunities deriving from railway station areas and nearby buildings appear in this situation to be highly profitable for different types of investors:

- the pension funds looking for rentable investment able to protect the saving and pensions of their clients;
- the business community looking for commercial and office spaces in areas where the flux of the people is huge and quite constant throughout the year;
- the hotel industries, the restaurants and related services (HO.RE.CA) for the travellers and commuters;
- the professional, SME's and handicraft activities that can grow and develop in a modern and vibrant environment;
- the Public Administration that can find profitable locations near the people they serve.

This scenario is based on a railway able to serve annually millions of citizens and commuters.

The more efficient, safe, fast and reliable is the railway, the more the station has to be comfortable, spacious, smart, clean, and safe, that means that the capacity to attract investor for the renovation of the stations and areas around are directly linked to the type and quality of the railway constructed.

6.4.2.3 Investing in the Supply Chain of the Central Spine

Private logistic operators or international carriers could be interested in developing the various services of the main inland ports of the country. For example many bidders participated in the BOT management of Boankra inland port, where the basic infrastructure has been already provided, while National carriers or main national shippers could be interested to invest in the logistic platforms and machinery of the main stations along the future railway network.

Minor Logistics Operators could be involved in the different activities of an inland port, like consolidation and distribution, temporary storage, custom clearance, connection between transport modes, allowing agglomeration of institutions (both private and public) which facilitates the interactions between different stakeholders along the supply chain.

The capacity to attract national and international logistic operators in the main stations and inland ports, is strictly linked to the future development of Ghana as a whole and to the increasing volume of traffic (goods) direct to the inland neighboring countries . The possibility to avoid any delay in the Port of Tema as well the concrete opportunity throughout the railway to alleviate and overcome the congestion due to the increasing import and export activities is of paramount importance for the freight operators. Moreover, the opportunity to ease the customs clearance operations directly in a logistic multimodal platform in Boankra inland port, is the main reason that could attract logistic operators and all the ancillary professional services and business activities. These circumstances coupled with an interesting and favorable business environment as well as the price and service delivery (predictability of time of arrival at the destination) are key arguments to attract freight operators to invest and operate in Ghana inland ports.

It can be assumed that the logistic operators will also be attracted by the opportunity to add value to the goods transported both by rail and trucks if they have the possibilities to incorporate more work and operations. Activities such as grouping, picking, sorting as well as final delivery, "the last miles" are of paramount importance. What is important to capture high traffic volumes from road to rail is not the speed, but the **predictability** and **safety** of transport on the new railway.

6.5 PPP PROCEDURE SAFEGUARDS

Policy, planning, and regulation aspects play a critical role in the implementation of PPP projects in the railway sector. Following are some of the key safeguards to be operated in order to solve important issues that arise from the interface between the public and private sectors in railway concessions.

6.5.1 Sound PPP Project preparation

One of the primary reasons for delays in PPP projects is the lack of adequate upstream project development and preparation. Thorough upstream analysis of PPP projects is critical to a project's success.

Both **prefeasibility studies** and **full-feasibility studies** are needed to analyze the technical, financial, environmental, and social aspects of the single project. These studies further address issues such as: if the project is in line with the sector policy; if it achieves value for money (VfM); the responsibilities of the different parties; optimal risk allocation; tariff structure; structure of any Government subsidy or other fiscal support needed (also in terms of Government assets), in addition to the key terms of the PPP contract.

Such sophisticated analysis is associated with **legal, technical,** and **financial advisors.** Commonly, the related costs can reach up to 10 percent of the total cost of the project, a cost that is arguably justified in the light of the expected efficiency gains from PPPs and thus Governments need to internalize these costs as they embark on PPPs as a means for infrastructure provision.

6.5.2 Assuring Competitive Access

In situations of vertical integration, where the railway operator owns the track, operates the track, and operates trains on the track, monopoly pricing can restrict access to private operators. This challenge can be managed through regulation, by requiring the incumbent to allow third party access at set rates. Not as easy as it sounds perhaps, but getting it right allows for significant growth of private sector participation, increased competition, and resulting efficiency gains. Where a railway is being operated by a private operator, the terms for competing access will need to be specifically addressed in the concession or operating agreement. Clear requirements are critical, especially those that stipulate whether the operator is required to provide access to third parties, on what terms, and whether its own operations can take priority.

These challenges increase where there is cross-border potential (a particular issue for land-locked countries that need transit services to sea ports).

6.5.3 Exclusive or Shared Use

An obvious but critical point: the Government must define a railway's end-use during the conceptualization of new railways or the expansion of an existing one. This definition will affect specifications, which are often difficult to change once the railway has been built. For example, if Government wants the railway to carry passengers, the track, route and station specifications will need to reflect this. In contrast, if the track is to be used for heavy minerals, it will need to be constructed to manage the load.

In determining capacity, Governments need to predict future need and specify in the contract how to manage increases in demand. Planning for future traffic loads is particularly important in the case of minerals transportation. Often, a dedicated track laid by a mining company is not designed to allow for increased loads from other mines or for passenger transport. If the Government has envisaged shared use, then it will need to specify this before the track is laid. If connectivity with neighboring countries is necessary, then compatible gauge must be used. Other technical standards, such as signalling and safety, should also be considered.

6.5.4 Appropriate Risk Allocation

While PPPs can bring private sector finance, experience, and efficiency to infrastructure service provision at a better VfM than traditional public procurement, the Government's contribution to the "partnership" often gives rise to fiscal commitments. Under a PPP, the Government almost always bears some risk or provides some support that gives rise to an ongoing fiscal commitment. These Government contributions are needed to mobilize private investment in a way that achieves Value for Money (VfM) by ensuring that projects are financially viable and by allocating risks well between public and private parties. The fiscal commitments that the Government commonly accept under a PPP can be categorized into two types: (i) *direct,* where the value and timing of the payment are known (such as annuity or availability payments); and (ii) *contingent,* where the value or timing of the payment depends on some uncertain future event (such as shadow tolls or output-based subsidies, guarantees on particular risk variables such as demand, exchange rate tariff setting; termination payment commitments, and debt guarantees.) The task of risk assessment and risk allocation is a sophisticated and detailed process that requires tailored skills and expertise. Risk assessment is inherently challenging. For instance on *greenfield* transport projects, demand risk is extremely difficult to transfer entirely to the private party given that traffic and demand forecasts cannot be based on any existing trends. Furthermore, the exercise of risk quantification is commonly constrained by the availability of objective data on which cost estimates can be based over the 25-30 years of the project.

6.5.5 Public Sector Obligations

Contracts must assure investors that pre-agreed government obligations will be met on time. Timely provision of land, access roads, and connectivity to other transport modes will significantly impact the viability of railways. This is also achieved through a robust compensation mechanism and/or other remedies.

6.5.6 Regulatory Risk

Given the monopolistic nature of public sector involvement in railways, and railways' important place in a nation's infrastructure, they tend to be heavily regulated. From an investor's perspective, it is important that such regulation is fair, transparent, and predictable. Investors will look for assurances that regulatory risk is mitigated. In particular, investors prefer to see an independent regulator—or at least one that is shielded from government interference in favour of road, a new subsidy for bus routes, or a reduction in taxes for truck freight.

6.5.7 Balancing Capital Costs And Tariffs

Much of the railway infrastructure requires significant upfront capital investment to bring it to a point at which a viable flow of commercial returns can be realised. This high cost need to be then balanced against users "willingness to pay" and broader national and social equity considerations that militate against high tariff structure. This is made more difficult when demand levels are so low that it would require a prohibitively high tariff to reach break-even (this being the "ability to pay" challenge).

6.5.8 Viability Gap Fund (VGF)

Frequently the Government is asked to provide public finance (VGF) to close a PPP project. The VGF entity should be established according to the amount able to make the project bankable on the basis of the Net Present Value (NPV) and Financial Rate of Return, from the private point of view. In Africa, the absence of deep financial and capital markets able to finance these substantial costs over the extended period needed, pose particular problems. Private investors have frequently highlighted that this is often one of the most overriding factors discouraging entry into the market and, as such, requires particular attention.

6.6 SOURCES OF FINANCING

There are many factors that limit Africa's ability to draw on long-term local and foreign currency financing for infrastructure. First, most African countries have low or sometimes nonexistent sovereign credit ratings. which limits the public sector's ability to use private investors. Second, most local financial markets have limited capacity to finance infrastructure projects: PPP projects are high risk, local long-term resource markets are shallow and infrastructure projects require substantial credit enhancement provided mostly by official agencies to attract long term debt. Third, PPP projects tend to have longer payback and build-out periods and are more susceptible to political and regulatory interference. In the light of these constraints the PPP projects implemented in Africa to date have typically been small relative to those in other regions.

Ghana is already aware of the multiple approaches that can be, and have been, used to fund projects. The Railway Master Plan funding strategy should focus on readily available financial sources that offer long term credits with concessionary interest rates and grace periods before repayment commences. Borrowing/financing should be matched to the lives of the assets invested in. Efforts should be made to link long term users (e.g. mining companies) of public assets with commitments in terms of tariffs, quantities, etc. linked to underlying operational and amortisation costs (e.g. ports, rail track operators). If this cannot be achieved, the next best solution is to involve multilateral institutions with concessionary, long term finance.

Following is a listing of general possible sources of funds for transport infrastructures taken from the ITP (2010) and integrated with additional information from World Bank (2011 - Toward Better Infrastructure). The sources are divided into raising public resources, international and local sources, accessible by the Government and the private partner of the PPP.

6.6.1 Raising Public Resources

6.6.1.1 GoG Consolidated Fund

GoG provides funds from its own resources to directly finance investment. These funds, obtained from taxable sources, are already stretched and fully committed. To finance the ITP strategy GoG could review existing programmes and identify lower priority investment projects (transport sector or otherwise) which could be deferred, with the CF (Cash Funds) switched to funding these strategic priority projects.

6.6.1.2 Sale of Public Assets to Private Shareholder

As a source of funds the sale of public assets is useful, and often results in the removal of annual operating losses from the national accounts. The sale of Ghana Telecoms to Vodafone (an international, publicly listed company) is an example of how a poor performing institution and public liability can be transformed, with the Government retaining a shareholding (in this case 30%) but with no other financial obligations. The funds generated from the sale were applied to different GoG purposes. All future expansion and funding lies with the new institution, as much as possible internally and organically (public shareholders may be called upon for further capital contributions through rights issues in the future, but this can be declined).

6.6.1.3 Trade and Supplier Credits

Trade and supplier credits are tied to the procurement and supply of goods and services, e.g. BOST's purchase of pipelines. Either suppliers or foreign trade banks provide credit or credit guarantee that spread the cost of procurement over up to five years. This is a useful, if restricted form of funding, but necessarily does not match the life cycle of the purchases with the period of credit available.

6.6.1.4 Revenue Generation Public Companies

Few existing transport sector operations have their own direct revenues. Most are subject to external regulation of one form or another (VLTC, MMT, etc). Some agencies have no independent revenues (e.g. GHA). By contrast the GPHA is expected to generate repayments from the revenues earned or levied on its operations. Agreements to borrow are expected to be entered into on the basis that the funds borrowed are deployed on revenue generating activities (meeting various financial and economic benchmarks agreed by GoG, GPHA and the lenders). GPHA fees and charges do, to some extent, reflect international levels in fees and charges, thus generating sufficient forex to repay the international financing costs incurred. As a national monopoly these fees and charges are subject to GoG monitoring. The main competitive pressure, however, comes from the charges levied by regional ports to which cargoes can be diverted. Given the public nature of transport operations, revenue generation on full cost recovery principles has proved difficult to implement but remains an area where the raising of additional funds for projects should be explored.

6.6.1.5 Charges Revenues

Hypothecated revenues are raised and linked to specific spending purposes. The tariff, fee or charge is often a user charge, to ensure that those who benefit meet the costs of providing the service. In theory the funds accrue to the spending institution. In practice, in most countries, the Treasury ensures that the funds are accounted for through the Central Bank and MoFEP where they are often temporarily or permanently diverted, and setting the user charge remains an issue of policy. The Fuel Levy is specifically designed to fund road maintenance and is channelled through the GRF. Although intended to be increased every year, as part of an overall agreement with DPs who are funding road construction, rehabilitation and maintenance, the revenues have fallen well below what is required. Some funds have been diverted to non-transport purposes. As a user charge the levy is well below the underlying cost of road maintenance and could prove to be a significant source of revenue. It is being supplemented by road tolls, which have just been increased for the first time in over a decade. The yield of both these revenues is significant but is not a foreseeable source of investment funding in the near future.

6.6.1.6 Long Term User Agreements

In the case of GRDA and the railway operations, a case can be made for entering into long term revenue and tariff agreements with the principal or major users of the rail system (as is the case of the Western rail corridor). The commitment of major freight users can also be ensured if they are required to provide the capital for customized wagons for their specific freight. In the case of Ghana Managanese and Bauxite Companies, they are almost entirely privately owned and in a better position to raise finance to invest in dedicated wagons and other equipment.

This approach ensures the viability of parallel public investments in rail track, etc but only if the asset owner repairs and maintains the facilities. This requires the ring-fencing of the finances of the dedicated rail link, and full autonomy of the asset owner from Government interventions. Tariff negotiations need to be mutually agreed, and open to arbitration arrangements if not resolved amicably. A potential user of the Eastern rail corridor is Maersk, which could finance container rolling stock and take over the operations management, with infrastructure remaining with GRDA.

6.6.2 Borrowing from Foreign Sources

Ghana is at an early stage in accessing international capital markets. In 2007 Ghana accessed international capital markets through its Eurobond borrowing with a 10 year USD denominated bond at a commercial 8.5% interest rate. This was targeted to finance the energy, road (Accra/Kumasi and Nsawam/Kumasi highways) and rail transport sub-sectors. In addition to the high rate of interest and short borrowing period (compared to multilateral institutional borrowings), Ghana has incurred a substantial increased Cedi liability of nearly 50% through the depreciation of the Cedi against the USD. This additional cost can in theory be recovered through user charges (energy sector) but only through public revenues (transport sector). Such exchange depreciation risk could also exists with multi-lateral debt expressed in foreign currencies. With the public policy control of tariffs, charges and levies, the additional liability usually falls on the GoG rather than the beneficiaries (institutions and users).

6.6.2.1 International Commercial Banks

Self-accounting state institutions are able to access domestic and foreign banks for short and longer term funding, based on their ability to repay from internally generated funds (GPHA, GHA, BOST, etc), but nearly always with underlying GoG guarantees on the borrowing. Few, if any, public sector projects can generate rates of return able to cover this level of cost.

Bank borrowing should be limited to short term operational/cash flows needs, not for investment funding. International banks have represented a limited financing option for the infrastructure projects of African countries. When coming into play, banks propose only short-term financing that is enhanced by risk mitigating instruments from institutional organizations in order to reduce political and commercial risks. Furthermore, these banks cannot lend in local currencies, and the exchange risk borne under a foreign currency loan blocks the access of PPP projects with local currency revenue to international financing.

6.6.2.2 Private Sector Funding

Private sector equity involvement in projects may be part of a package of funding, but the principle financing will come from loans and similar sources. Foreign syndicated bank loans are the most likely source for large scale projects, although the duration of the loans may be well less than the life of the assets involved. Domestic banks are prepared to provide bridging loans, working capital and lines of credit in support of foreign domiciled bank syndicated loans. The main problem with domestic bank financing lies with high domestic interest rates which limit the use of short term debt financing of local currency for project costs and working capital.

Full economic cost recovery is required for private sector involvement, which conflicts with public policy practice that tends to direct, regulate or otherwise constrain the setting of user charges, tariffs and prices. The private sector requires political and legal certainty over the right to establish full cost recovery charges, fees, tariffs, etc without government limitation, restriction or oversight. Where commercial viability is not evident the private sector will require the assumption of risk by, and appropriate financial indemnities from, GoG. The expropriation of assets is also an issue but this can be dealt with by the multilateral institutions. For instance, IFC offers partial risk guarantees to lenders. Their judicious use can attract private sector capital that would otherwise not be available.

6.6.2.3 Donor Infrastructure Funds

The development community has made available a number of funds/facilitates geared towards supporting infrastructure financing. The growth of private infrastructure funds over the last decade in Africa has been damaged by the drying up of liquidity as a result of the financial crisis. A World Bank study on infrastructure funds and facilities in Africa reports an inventory of 45 infrastructure funds that operate in Africa. The total value of capital raised or targeted by these funds is about US$18.9 billion. The information available indicates that investors have committed about US$10 billion of this total to 2009. Most of the infrastructure funds are equity funds, but some provide debt or *mezzanine finance*

Listed below are facilities that have supported different aspects of the PPP projects in Africa, including support for technical preparations and financing or providing the relevant enhancing instruments.

- *The EU-Africa Infrastructure Trust Fund* supports Africa's efforts to identify and address the missing links in existing networks, harmonize transport policies, develop integrated water management, develop cross-border and regional energy infrastructure.

- *Private Infrastructure Development Group (PIDG)* is a coalition of donors mobilizing private sector investment to assist developing countries in providing infrastructure vital to boost their economic development and combat poverty. Current members are: the UK Department for International Development (DFID), the Swiss State Secretariat for Economic Affairs, the Netherlands Ministry of Foreign Affairs, the Swedish International Development Cooperation Agency, the International Finance Corporation (IFC)/World Bank, the Austrian Development Agency, Irish Aid, and KfW.

6.6.3 Development Partner Finance Availability

The ideal funding source is Development Partner (DP) grant based, resulting in no annual principal or interest payments chargeable to the Consolidated Fund. DP funding (the major source of Ghana's development funding) is subject to policies and strategies of DP national governments – usually in agreement with the recipient government. Funding may be restricted to specific economic sectors or sub-sectors, to new investment rather than rehabilitation or reconstruction, or to specific goals (e.g. Millennium targets).

DP funding is coordinated through the Ghana – Joint Assistance Strategy which covers 95% of development partner assistance. DPs outside this arrangement include China. Most DP assistance is linked to specific accountability, transparency, and good governance issues and requirements, clearly impacting on the financing of projects. Millennium Development Goals, poverty reduction, gender and HIV/AIDs issues have also been introduced into the economic/financial analyses, in addition to Environmental Assessment and Impact requirements. However the economic/financial analyses are the critical determinants for projects to proceed. None of Ghana's DPs have specific transport sector commitments to providing funds outside the current plans although several have expressed the intention to continue assisting Ghana in principle in the transport sector.

■ *Multilateral Institutions*: Important lenders are multilateral institutions, where the money is lent directly to GoG and then on-lent to the implementing institution. The funding is considered to be a MoFEP responsibility, rather than MoRH (in the case of GHA). GoG remains liable for repayment whether or not the beneficiary institution has to generate funds to repay GoG. In the case of GHA, GHA does not have independent sources of funding to repay GoG.

The extent of foreign exchange risk on sovereign debt is reflected in the source of funding. If the foreign lending originates with multilateral institutions, e.g. IDA, then interest rates are often at a concessionary, sub-market level, with generous grace (5 years) and repayment periods (as much as 30 years). Credits are preferable to loans from these institutions (IDA/IBRD/EIB/AfDB/BADEA/IFC, etc). GoG determines whether or not the foreign exchange risk is handed on to the beneficiary institution. In the case of GHA, the risk falls directly on public revenues, whether or not it is formally allocated to GHA. In the case of GPHA, the risk can, and is, formally a liability of GPHA to be paid to GoG and borne through the amortisation payments.

■ *Bi-lateral Funding – Grants*: Bi-lateral funding – country to country – has generally been replaced by multilateral and joint development partner arrangements to ensure coordination of investments and avoidance of duplication of efforts. Much bilateral funding is in the form of direct grants or the supply of vehicles and equipment to specific projects. It may also take the form of budget support to a specific sector, sometimes pooled with funds from other DPs.

■ *Tied Bi-lateral Funding with Concessions*: China announced a US10 billion investment plan in Africa for 2010-12 which might involve one or more of the above approaches. Tied bilateral funding may depend upon parallel agreements on mineral or other concessions. The long term nature of such arrangements is often reflected in long term loans (20 years plus) at market (e.g. 5-8%) or concessionary interest rates and five year principal grace periods, tied to China suppliers of infrastructure and operating equipment, and Chinese construction contractors.

6.6.4 Sovereign Wealth Funds and Other Public Entities

Another potentially significant source of equity and/or debt capital for core infrastructure is Sovereign Wealth Funds (SWFs). Sovereign Funds tend to focus on private sector investment (e.g. Norway's Oil Fund) or are channelled through multilateral institutions rather than directly to governments.

The total assets of SWFs that have strategic interests in Africa include funds from the Middle East, China, and India which have become important players in African infrastructure projects. There is substantial appetite from SWFs in Africa to support foreign country mineral and raw material requirements, as seen with China's successful efforts in locking up deals in the oil and gas sector and in providing substantial transport infrastructure funding. Middle East SWFs are also active in both the physical and social infrastructure sectors. One expects these trends to continue in the near future, but they may slow down initially as some of the SWFs restructure their portfolios and investment strategies damaged by the global financial crisis. Several of the SWFs had considerable losses in their global financial sector investments as a result of the crisis but remain active exploring infrastructure opportunities in Africa. Some of the SWFs and Public Entities active in Africa are described below:

■ *China-Africa Development Fund (CADFund)*: introduced in 2007, CAD Fund is essentially an equity fund, investing in Chinese enterprises with operations in Africa in the fields of agriculture and manufacturing industries, infrastructure (electric power and energy, transportation, telecommunications, and water), and natural resources (oil, gas, minerals). Currently more than 30 percent of the projects tendered by the World Bank and AfDB have been completed by Chinese contractors, of which a significant share is supported by the CAD Fund. In January 2010, Nasdaq reported that CAD Fund invested nearly US$540 million to support 27 projects in Africa that are expected to lead to total investments of about US$3.6 billion by Chinese companies in the continent.

■ *China Investment Corporation (CIC):* established in 2007, CIC is a wholly state-owned Chinese investment institution with the mission of making long-term investments that maximise risk-adjusted financial returns for the benefit of its shareholders. CIC and the CAD Fund together are the lead SWF investing in infrastructure in Africa.

■ *Export-Import Bank (EXIMBank) in China:* although not a SWF, EXIMbank China is a government-owned policy bank, acting as an alternative mechanism by which foreign governments finance infrastructure development in Africa. Through providing concessional loans, China EXIMBank is supporting about 300 projects in Africa, more than 79 percent of which are in infrastructure. Based on World Bank figures, it is estimated that Chinese financial commitments to African infrastructure projects rose from less than US$1 billion per year in 2001–03 to around US$1.5 billion per year in 2004–05, reached at least US$7 billion in 2006—China's official "Year of Africa"—then trailed back to US$4.5 billion in 2007. The two largest beneficiary sectors are power (mainly hydropower) and transport (mainly railroads).

■ *Dubai International Capital—Dubai's SWF* has made public its plan to invest less in developed western markets and more in local and emerging markets. It is mentioned by Nigerian financial sector observers that Dubai International Capital was contemplating, and may already have executed, a Memorandum of Understanding with the FGN to invest US$1.5 billion in the Nigerian infrastructure sector. It is unclear whether this initiative is separate from a US$16 billion agreement by Dubai World Corporation to develop oil and gas industry infrastructure in the Niger delta, announced in January 2009. By September 2009, there were indications that a Middle Eastern SWF may have committed US$700 million to one or more projects in Nigeria's telecom sector and was still actively interested in the oil, gas, and mining sectors.

6.6.5 Borrowing Local Resources

While mobilizing foreign financing for private infrastructure is important, a number of factors highlight that it is critical to develop a local market for PPPs. A primary factor demonstrated during the recent financial crisis is the volatility of international finance. Based on the World Economic Output (WEO) Report (April 2010), it is estimated that foreign banks decreased their total loan exposure to SSA by around 15 percent (US$14.4 billion) during the period from September 2008 to June 2009. Other reasons that underline the importance of developing a local market for private infrastructure financing are: (i) the foreign exchange risk associated with borrowings in hard currency against local currency revenue streams from PPP projects; (ii) high cost of international finance resulting from high country risk premiums and foreign exchange hedging; (iii) the importance of using infrastructure investments to improve the long-term capacity of local financial markets; and finally (iv) financing smaller projects that would not attract international finance.

6.6.5.1 Local Commercial Banks

The size of local commercial banks is small relatively to the levels of financing required for large infrastructure projects. A great segment of the population in Africa is extremely poor and does not have sufficient financial resources that enable significant savings. Additionally, banks have a limited capacity to provide long-term infrastructure financing as a result of the asset-liability mismatch between long-term financing required for infrastructure and short-term deposits. Long term resources can originate from customers' long-term deposits or from resources provided by equity markets or through bond issuances. The availability of long-term resources for banks is a prerequisite for awarding long-term loans. The lack of long-term finance puts pressure on project developers to repeatedly refinance. With an average PPP concession duration being 25-30 years, commercial banks are not able to raise such tenors from their deposits that are of short-term nature and are commonly tied for only one year across all the sample countries.

6.6.5.2 Pension Funds

Pension funds in countries with fully funded pension systems are a potential investor for infrastructure financing. The risk-averse, long-term nature of pension funds fits with the long-term nature of infrastructure cash flows. The increasing role of the pension industry in financing infrastructure is regarded as a win-win situation. On the one hand, pension funds offer local long-term financing, particularly crucial when capital markets are underdeveloped. On the other hand, infrastructure investments offer pension funds long-term yields, higher and stable returns that are linked to inflation, and risk diversification. However, there are common challenges to mobilising pensions, some of which are associated with particular features of infrastructure projects. Pension funds typically require listed securities with good credit rating (for example, must achieve at least a local "A").

For *Ghana* the following benchmarks are the *target* asset allocations for the SSNIT, currently the main provider of pensions in Ghana: listed equity (27 percent), unlisted equity (4 percent), corporate bonds (5 percent), government bonds (3 percent), municipal bonds (1 percent), corporate lending (12 percent), sovereign lending (8 percent), municipal lending (1 percent), syndications (2 percent), treasury (15 percent), study loans (2 percent), alternative investments real estate (15 percent), private equity (3 percent), Economically Targeted Investments (2 percent)). SSNIT is among the nine investors of the Pan African Infrastructure Fund, which was established in 2007 to play a critical role in assisting African economies to meet the capital requirements in financing infrastructure investments.

A recent OECD study examining the role of governments in responding to infrastructure challenges specifically highlighted the role of the private sector. Notably, the OECD presented 17 principal policy recommendations, including: (i) encouraging investment by pension funds and other large institutional investors, and (ii) examining the legal and regulatory framework conditions with a view to encouraging the emergence of fresh sources of capital and new business models for infrastructure. Furthermore, the *OECD Guidelines for Pension Fund Asset Management* (2006) can be read to be broadly supportive of pension fund investment in infrastructure.

6.6.5.3 Insurance Funds

Similar to pension funds, infrastructure investments fit with the payout schedule of life insurance policies. The data is scarce on country experiences in mobilizing insurance funds for infrastructure financing. The size of the life insurance industry is small in relation to pension funds for the anglophone sample countries, contrary to the francophone sample. In *Ghana,* NIC (National Insurance Commission) provides guidelines on investment mixes for the industry to ensure that investments of insurance companies are adequately spread. For the life insurance companies, the guidelines stipulate the following investment ceilings: up to 30 percent in listed stocks, 20 percent in unlisted stocks (10 percent for nonlife insurance companies), 20 percent in mutual funds, 10-30 percent in investment properties (0-20 percent for nonlife), and up to 10 percent in investments approved by NIC. Furthermore, the guidelines stipulate that at any point in time, the ratio of investments to total assets should not be less than 55 percent (that is at least 55 percent of the total assets of the company must be in direct investments, the latter defined as assets that directly earn cash income or appreciate in value over time).

6.6.5.4 Local Capital Market

While long-term domestic financing —often available only in local capital markets— is well suited for infrastructure projects, to date this market is limited in Africa and Ghana's domestic bond market is not significant. Africa has been less successful in raising project finance in capital markets through corporate bonds compared to other developing regions. Generally, only a few developing countries are equipped with local capital markets that can provide such financing consistently and in significant amounts. These countries are characterized by having larger economies than almost all African countries. Furthermore, their financial markets are sophisticated enough to provide currency forwards and interest rate swaps.

6.7 CASE STUDY: CENTRAL SPINE EXPANSION

6.7.1 Introduction

After the presentation of the Financial Plan of the complete Ghana Railway Master Plan, a Case Study has been conducted on the Central Spine Expansion (Phase 2), in order to verify the financial viability of an unbundled concession for train operations (freight and passengers).

The objective of the case study is to verify:

1. The capability of Infrastructure company (GRDA or other public InfraCo) to manage and properly maintain the railway infrastructure year by year, with the revenues from Track Access Charges (TACs) deriving from the railway operators;
2. The Profitability of the railway operators in managing the railway transport services, spending for the track access charges, purchase/leasing/maintaining the rolling stock, operating the services in comparison with the tariff revenues from freight and passenger transport.

In the following paragraphs, the Consultant has focused on the implementation of the three new railway sections (Western, Eastern and Kumasi–Paga) of the Central Spine Expansion at Standard Gauge in order to build up the preliminary business plans of the various entities involved (InfraCo, Passenger and Freight Operators, etc.).

The case study starts with the definition of the **future traffic volumes** using the new railways, then consequently the train **operational plan** is defined and finally the **financial analysis** of the specific Phase 2 is presented.

6.7.2 Modal Split according to Tariffs

According to the Economic Analysis priorities, the following implementation calendar has been established for the three Phase 2 railway sections:

RAILWAY Section	Length (km)	Opening Year
WESTERN	266	**2025**
EASTERN	300	**2027**
KUMASI - PAGA	595	**2030**

According to the traffic forecast based on ITP O/D matrices, at year 2030, the estimated traffic flows along the three sections are shown in the following tables 6-11, 6-12 respectively for Freight and Passengers. The **modal split** between road and rail is based on the relative road/rail transport operational cost (Table 6-13).

Table 6- 11 Freight – Year 2030

CORRIDORS	ROAD			RAILWAY		
	Northbound (Tons)	Southbound (Tons)	Total Average (Tons)	Northbound (Tons)	Southbound (Tons)	Total Average (Tons)
WESTERN	2,550,725	1,573,841	4,124,566	953,135	2,702,756	3,655,890
EASTERN	4,348,228	3,706,411	8,054,639	3,022,156	3,555,846	6,578,002
KUMASI PAGA	2,525,920	2,629,486	5,155,406	5,510,758	2,336,127	7,846,885

Table 6- 12 Passengers – Year 2030

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pax/Day)	Southbound (Pax/Day)	Total Average (Pax/Day)	Northbound (Pax/Day)	Southbound (Pax/Day)	Total Average (Pax/Day)
WESTERN	16,405	16,738	33,143	5,283	5,278	10,561
EASTERN	34,794	34,903	69,698	48,655	48,465	97,120
KUMASI PAGA	3,375	3,222	6,597	15,067	14,874	29,941

While it is considered that freight traffic will not be subjected to variations if the rail and road transport tariffs are introduced, the passenger traffic is considered highly elastic towards the relative values of road and railway tariffs applied.

In order to adjust the passenger modal split to the road/rail tariffs, a logit formula has been applied to estimate the modal share of passengers between road and railway, given the following tariffs per pax/km.

Table 6- 13 Passenger Transport Tariff

Passengers Transport Mode	Unit Tariff US $ Pax /Km
Railway	0.034
Road	0.042

The Logit model applied is the same kind used in the ITP 2010. For example, the railway share is obtained by the following formula:

$$P_{Train} = \frac{e^{\gamma * TFrail}}{e^{\gamma * TFrail} + e^{\gamma * TFroad}}$$

Where TF*rail* and *TEroad* are the tariffs applied from origin to destination by rail and road and γ is a factor depending on the type of competition between the two modes of transport. γ is assumed as equal to 0.2, according to the modal split formula used by the ITP.

Considering the said values of TF*rail* and TF*road* and γ, the logit formula gives the following passenger volume share between the road and railway transport for the three corridors considered.

Table 6- 14 Passengers Modal share

Corridor	Road	Railway
Western	79.0%	21.0%
Eastern	71.5%	28.5%
Kumasi Paga	36.5%	63.5%

Passenger traffic flows in the different corridors, by road and rail in different years are then:

Table 6- 15 Passengers with Tariffs – Year 2030

CORRIDORS	ROAD			RAILWAY		
	Northbound (Pax/Day)	Southbound (Pax/Day)	Total Average (Pax/Day)	Northbound (Pax/Day)	Southbound (Pax/Day)	Total Average (Pax/Day)
WESTERN	16,803	17,136	33,939	4,514	4,509	9,023
EASTERN	59,672	59,684	119,357	23,776	23,683	47,459
KUMASI PAGA	6,765	6,568	13,333	11,677	11,527	23,204

6.7.3 Operational Plan of the Eastern Railway

Operational Plan of Phase 2

A preliminary operational plan for Phase 2 was developed in order to evaluate the amount of rolling stock to be acquired by the future operators of the line.

The estimation of the rolling stock that is necessary for the railway operations along the Western, Eastern and Kumasi – Paga line was carried out on the basis of the traffic evaluations and, at the same time, on the basis of some operating aspects that are linked with the possible characteristics of the lines.

The scenario that was considered is the “2C” and the rolling stock was estimated until year 2047. It is important to emphasize that the approach that was followed here is a simplified one, due to the fact that at this level (general Master Plan) no specific details can be analysed. Specific feasibility studies for each of the considered lines will define the actual magnitude of the necessary rolling stock and will give more specific information about its technical characteristics.

The traffic flows that were considered for the estimation of the rolling stock are those presented in the next four tables.

Table 6- 16 Rail traffic at year 2015, Scenario 2C

RAILWAY LINES SCENARIO 2C - 2015		Freight flows average values			Passenger flows average values		
	LENGTH	AB_Rail	BA_Rail	ToT. Average	AB_Rail	BA_Rail	ToT. Average
	(km)	(Ton / year)			(Pax / day)		
Western Railway Line	266	529,242	1,500,744	2,029,986	2,318	2,318	4,637
Eastern Railway Line	300	1,678,096	1,974,435	3,652,531	17,387	17,387	34,774
Kumasi-Paga Railway Line	595	0	0	0	0	0	0

Table 6- 17 Rail traffic at year 2027, Scenario 2C

RAILWAY LINES SCENARIO 2C - 2027		Freight flows average values			Passenger flows average values		
	LENGTH	AB_Rail	BA_Rail	ToT. Average	AB_Rail	BA_Rail	ToT. Average
	(km)	(Ton / year)			(Pax / day)		
Western Railway Line	266	910,745	2,582,555	3,493,300	2,940	2,940	5,880
Eastern Railway Line	300	2,887,750	3,397,705	6,285,455	22,051	22,051	44,101
Kumasi-Paga Railway Line	595	0	0	0	0	0	0

Table 6- 18 Rail traffic at year 2030, Scenario 2C

RAILWAY LINES SCENARIO 2C - 2030	LENGTH	Freight flows average values			Passenger flows average values		
		AB_Rail	BA_Rail	ToT. Average	AB_Rail	BA_Rail	ToT. Average
	(km)	(Ton / year)			(Pax / day)		
Western Railway Line	266	953,135	2,702,756	3,655,890	4,511	4,511	9,023
Eastern Railway Line	300	3,022,156	3,555,846	6,578,002	23,730	23,730	47,459
Kumasi Paga Railway Line	595	5,510,758	2,336,127	7,846,885	11,602	11,602	23,204

Table 6- 19 Rail traffic at year 2047, Scenario 2C

RAILWAY LINES SCENARIO 2C - 2047	LENGTH	Freight flows average values			Passenger flows average values		
		AB_Rail	BA_Rail	ToT. Average	AB_Rail	BA_Rail	ToT. Average
	(km)	(Ton / year)			(Pax / day)		
Western Railway Line	266	1,334,618	3,784,511	5,119,129	6,317	6,317	12,634
Eastern Railway Line	300	4,231,749	4,979,043	9,210,792	33,227	33,227	66,454
Kumasi Paga Railway Line	595	7,716,392	3,271,142	10,987,534	16,245	16,245	32,491

In order to estimate the amount of trains that is necessary to carry out a service satisfying the above demand of transport, the Consultant made some hypotheses about commercial speeds, time necessary in order to load / unload trains and possible train compositions. Such hypotheses are basically the same already presented in other parts of this report, with the exception of commercial speeds, that were reduced in order to maintain a conservative approach.

The methodology adopted is the same for freight and passenger trains, but some distinctions were made. Basically, three different categories of trains were identified:

- Passenger trains;
- "General cargo" freight trains, i.e. trains composed by traditional bulk freight wagons or (more probably) by spine cars equipped for carrying intermodal containers;
- "Specific cargo" freight trains, i.e. trains carrying specific categories of freights that require the use of specific wagons (as an example, tank wagons for specific liquids, side-discharging wagons for coarse-grained goods.

While passenger traffic is generally equally distributed on both ways (at least on a day-by-day basis), the same is not valid for freight traffic. Freight traffic is indeed influenced by the fact that production, distribution and consumption of goods is not homogeneously distributed, and this is often the consequence of a directional unbalancing of demand. The effect of this is that it is not possible to avoid the presence of empty or semi-empty wagons that steal, anyhow, capacity from the railway line. Of course, this is a drawback that is present also inside other transport modes, and not only inside the rail mode.

The distinction between "general" and "specific cargo" arises from the fact that for the first case it is partially possible to compensate the unbalanced demand by using the same wagons for different categories of goods; while for the second case this is not generally possible.

Considering that "specific cargo" traffic flows are mostly mono-directional for each product category, it is really very difficult to imagine a bi-directional use of rolling stock: as an example, a tank wagon used for fuel transport cannot be used in order to transport other liquids, and one can hardly imagine a market were the same kind of fuel is transported in both directions.

The result is that:

for “general cargo” the critical value is given by the higher traffic flow between the two directions; this means that in the (less critical) opposite direction the goods will be transported by the same wagons travelling towards the more critical direction. Part of these wagons will come back empty.

On the basis of the above hypotheses, the estimation of the necessary rolling stock was based on the evaluation of the time that is needed for a train to run from the first terminal of each line (terminal “A”) and reach the opposite terminal (terminal “B”) at the other end of the line, wait for the time that is necessary for unloading and loading, run again from “B” to “A”, waiting again for unloading and loading in order to be finally ready for a new cycle.

Failing any detailed information about the composition of the freight flows, the Consultant made the hypothesis of 50% / 50% distribution between the two aforementioned categories of freight trains. It is worth remembering that from the technical point of view, nothing prevents that freight trains with a mixed composition may exist, but the hypothesis of a separate traffic was made in order to facilitate the estimation.

The full run cycle time (T_C) for a train is, therefore, given by:

$$T_C = 2 \times (T_V + T_G)$$

where:

- T_V is the travel time between “A” and “B” , and
- T_G is the time needed for a train to be unloaded/loaded and/or the other technical operations that are necessary in order to reverse it

The number of trains for each direction is given by the ratio:

$$N_T = F_C / C$$

where:

- FC is the flow defined as above (on the basis of the considerations made about the possibility of using or not the same freight wagons for bi-directional traffic)
- C is the capacity of each train, in terms of seats for passenger trains or tons for freight trains

The values of N_T were rounded to the upper integer value, being inadvisable at this level of analysis the introduction of “flexible compositions”.

As regards **time of operation**, the following assumptions were made:

- A daily time of operation of 20 hours (in order to reserve at least 4 hours for maintenance operations)
- A load/unload time of 3 hours for freight and 2 hours for passenger trains
- A commercial speed of 50 and 70 km/h respectively for freight and passenger trains (lower than those considered in other parts of this study)

As regards **capacities**, the following hypotheses were made:

- “general cargo” freight trains: locomotive + 40 wagons per train, with an overall capacity of 1600 tons
- “specific cargo” freight trains: locomotive + 40 wagons per train, with an overall capacity of 1800 tons

Passenger trains: 1050 pax / train, corresponding to a train composition made up of a locomotive + 12 coaches with 88 passengers each.

It should be emphasised that the above compositions are not at full capacity; even if the same compositions were considered in other parts of this study. This is also a conservative approach.

The above hypotheses were adopted in order to evaluate a possible program of operation on the basis of the aforementioned premises. The result was a rough graphical timetable, that cannot be probably adopted as a final timetable when the lines will be opened but that can give an estimation of the amount of rolling stock needed.

The result of the rolling stock estimation is presented in the next tables.

Table 6- 20 Required amount of rolling stock, years 2015 and 2027, Scenario 2C

(WR = Western Railway, ER = Eastern Railway, KP = Kumasi – Paga)

	Year 2015				Year 2027			
	WR	ER	KP	Total	WR	ER	KP	Total
Rolling stock								
Freight (without spares)								
locomotives	6	9	0	15	7	11	0	18
freight wagons	240	360	0	600	280	440	0	720
Incl. for spares:	*10%*	*10%*	*10%*		*10%*	*10%*	*10%*	
Freight (with spares)								
locomotives	**7**	**10**	**0**	**17**	**8**	**12**	**0**	**20**
freight wagons	**264**	**396**	**0**	**660**	**308**	**484**	**0**	**792**
Passenger (without spares)								
locomotives	3	12	0	15	3	15	0	18
passenger coaches	36	144	0	180	36	180	0	216
Incl. for spares:	*10%*	*10%*	*10%*		*10%*	*10%*	*10%*	
Passenger (with spares)								
locomotives	**3**	**13**	**0**	**16**	**3**	**17**	**0**	**20**
passenger coaches	**40**	**158**	**0**	**198**	**40**	**198**	**0**	**238**

Table 6- 21 Required amount of rolling stock, years 2030 and 2047, Scenario 2C

(WR = Western Railway, ER = Eastern Railway, KP = Kumasi – Paga)

	Year 2030				Year 2047			
	WR	ER	KP	Total	WR	ER	KP	Total
Rolling stock								
Freight (without spares)								
locomotives	7	12	23	42	9	15	31	55
freight wagons	280	480	920	1680	360	600	1240	2200
Incl. for spares:	*10%*	*10%*	*10%*		*10%*	*10%*	*10%*	
Freight (with spares)								
locomotives	**8**	**13**	**25**	**46**	**10**	**17**	**34**	**61**
freight wagons	**308**	**528**	**1012**	**1848**	**396**	**660**	**1364**	**2420**
Passenger (without spares)								
locomotives	4	12	14	30	5	21	18	44
passenger coaches	48	144	168	360	60	252	216	528
Incl. for spares:	*10%*	*10%*	*10%*		*10%*	*10%*	*10%*	
Passenger (with spares)								
locomotives	**4**	**13**	**15**	**32**	**6**	**23**	**20**	**49**
passenger coaches	**53**	**158**	**185**	**396**	**66**	**277**	**238**	**581**

The above values imply a linear growth of the demand for rolling stock between each time horizon and the next one, in parallel with the growth of traffic demand. This was the criterion adopted by the financial CBA for the estimation of investments that are necessary year by year.

The above tables also consider an increase of 10% of the basic amount of rolling stock in order to have spare stock to be used to allow extra maintenance and face failures and/or possible peaks of traffic demand.

Sample timetables for the Western Railway (at 2015 time horizon) are presented in the following tables. These tables present a daily startup of activities at 4:00 in the morning, in order to take into account the presence of the maintenance interval. As already said, these timetables were prepared in order to estimate the amount of rolling stock and not for a detailed operational plan.

This is the reason why all the tables present simultaneous departures at 4:00 hours (which, from the strictly operational point of view would not be realistic). When the actual train operations will be defined in more detail, this and other aspects can be better specified.

Table 6- 22 Theoretical Timetable for the Western Railway, Year 2015, General Cargo Trains

		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		etc.
	km	b1	b3	b1	b3	b1	b3	b1	b3	b1	b3	b1	b3	
Start	*0*	04:00	14:00	04:00	14:00	04:00	14:00	04:00	14:00	04:00	14:00	04:00	14:00	…
End	*266*	11:33	21:33	11:33	21:33	11:33	21:33	11:33	21:33	11:33	21:33	11:33	21:33	…
		b2	b4	b2	b4	b2	b4	b2	b4	b2	b4	b2	b4	
End	*266*	15:33	01:33	15:33	01:33	15:33	01:33	15:33	01:33	15:33	01:33	15:33	01:33	…
Start	*0*	23:07	09:07	23:07	09:07	23:07	09:07	23:07	09:07	23:07	09:07	23:07	09:07	…
Ready	*0*	03:07	13:07	03:07	13:07	03:07	13:07	03:07	13:07	03:07	13:07	03:07	13:07	…

Table 6- 23 Theoretical Timetable for the Western Railway, Year 2015, Specific Cargo Trains

		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		etc.
	km	s1	s3	s5	s1	s3	s5	s1	s3	s5	s1	s3	s5	
Start	*0*	04:00	14:00	04:00	14:00	04:00	14:00	04:00	14:00	04:00	14:00	04:00	14:00	…
End	*266*	11:33	21:33	11:33	21:33	11:33	21:33	11:33	21:33	11:33	21:33	11:33	21:33	…
		b2	b4	b2	b4	b2	b4	b2	b4	b2	b4	b2	b4	
End	*266*	15:33	01:33	15:33	01:33	15:33	01:33	15:33	01:33	15:33	01:33	15:33	01:33	…
Start	*0*	23:07	09:07	23:07	09:07	23:07	09:07	23:07	09:07	23:07	09:07	23:07	09:07	…
Ready	*0*	03:07	13:07	03:07	13:07	03:07	13:07	03:07	13:07	03:07	13:07	03:07	13:07	…

Table 6- 24 Theoretical Timetable for the Western Railway, Year 2015, Passenger Trains

		Monday			Tuesday			Wednesday			Thursday			etc.
	km	s1	s3	s5	s1	s3	s5	s1	s3	s5	s1	s3	s5	
Start	*0*	04:00	10:40	17:20	04:00	10:40	17:20	04:00	10:40	17:20	04:00	10:40	17:20	…
End	*266*	09:40	16:20	23:00	09:40	16:20	23:00	09:40	16:20	23:00	09:40	16:20	23:00	…
		s2	s4	s6	s2	s4	s6	s2	s4	s6	s2	s4	s6	
End	*266*	11:40	18:20	01:00	11:40	18:20	01:00	11:40	18:20	01:00	11:40	18:20	01:00	…
Start	*0*	17:20	24:00	06:40	17:20	24:00	06:40	17:20	24:00	06:40	17:20	24:00	06:40	…
Ready	*0*	19:20	02:00	08:40	19:20	02:00	08:40	19:20	02:00	08:40	19:20	02:00	08:40	…

The above tables present a “start” and an “end” that represent the two ends of the line, which are mutually reversible from the operational point of view. For this reason, no place name was specified in the above tables.

6.7.4 Central Spine Financial Analysis

6.7.4.1 Objective of the analysis

The objective of the analysis is the financial evaluation of the “Central Spine”, in the hypothesis of splitting the operation of railway services and the infrastructure management (railway network). Therefore, two analyses have been elaborated: one from the point of view of the private company which will operate the railway services and one from the point of view of the Ghana Railways Development Authority (GRDA), i.e. the public body that will take charge of the infrastructure.

6.7.4.2 Financial Requirements of Phase 2 - Central Spine

Table 6-25 provides a complete summary of the investments for infrastructures, by line, by year and type.

Table 6- 25 Summary of Proposed Investments - Central Spine

Lines	L Km	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total Cost (m$/km)
		1	2	3	4	5	6	7	8	9	10	11	
		Construction new lines -Standard gauge											
1 - Takoradi - Tarkwa - Dunkwa - Kumasi	266.8	249	249	249	249	249	249						**1,494.1**
1 - Accra - Kumasi	303.9		243	243	243	243	243	243	243				**1,701.8**
2C - Kumasi - Techiman - Tamale	383			238	238	238	238	238	238	238	238	238	**2,144.8**
Tamale - Paga	212							237	237	237	237	237	**1,187.2**
Total Central Spine	**1,165.7**	**249**	**492**	**730**	**730**	**730**	**730**	**718**	**718**	**475**	**475**	**475**	**6,528**

Table 6-26 provides a complete summary of the investments for rolling stock, by year and type of service (freight and passengers), determined according to the plan of services for freight and passengers described in Table 6-2. The total cost of the rolling stock, which will be funded by the private company operating the railways service in the future, will be of 1270 milion US$ over a period of 22 years. The total amount of the investment will be of 7798 milion US$.

Table 6-26 Rolling Stock Investments for the Central Spine Expansion

Year	Freight Locos	Freight wagons	Passenger Locos	Passenger coaches	Investment "B" (USD x 10^6)
2025	20	770	19	231	*258.82*
2026	20	781	20	235	*3.77*
2027	20	792	20	238	*3.77*
2028	29	1,144	24	291	*81.09*
2029	37	1,496	28	343	*81.09*
2030	46	1,848	32	396	*81.09*
2031	47	1,882	33	407	*12.09*
2032	48	1,915	34	418	*12.09*
2033	49	1,949	35	429	*12.09*
2034	50	1,983	36	440	*12.09*
2035	50	2,016	37	450	*12.09*
2036	51	2,050	38	461	*12.09*
2037	52	2,084	39	472	*12.09*
2038	53	2,117	40	483	*12.09*
2039	54	2,151	41	494	*12.09*
2040	55	2,184	42	505	*12.09*
2041	56	2,218	43	516	*12.09*
2042	57	2,252	44	527	*12.09*
2043	57	2,285	45	537	*12.09*
2044	58	2,319	46	548	*12.09*
2045	59	2,353	47	559	*12.09*
2046	60	2,386	48	570	*12.09*
2047	61	2,420	49	581	*12.09*
Year 2047 total fleet : 3111					**715.10**

6.7.5 Funding Sources

A specific model to explore the financial impact of the proposed investments has been developed. The following assumptions were used for funding the financial annual requirements:

1. Infrastructures; will be fully financed by GRDA: **20% of loan** has been assumed, while 80% will be financed directly by the Government.
2. Rolling stock: will be fully financed by the private operator: a **70%/30%** loan/equity ratio, which is the standard in railway transactions, has been assumed.

Tables 6-27 and 6-28 (following page) present the indicative annual financial cost of these investments, respectively from the GRDA (infrastructure) and the private operator. The total investment will be of **7,243 milion US$:** 6,528 for infrastructures (GRDA) and 715 million US$ for rolling stock (private operator).

Note that Government provision of an operating subsidy is not necessary because the revenues are able to repay the operative expenditures, but:

- For GRDA: in the first 6 years there will be a cash deficit (to be funded by GRDA), due to investment financing;
- For private operator: in the first 5 years there will be a cash deficit (to be funded by private operator), due to a negative net operating profit.

Table 6-27 Indicative Annual Financial Requirements – InfraCo ($US)

	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
0.1	Infrastructures	249,013,333	492,133,333	730,444,444	730,444,444	730,444,444	730,444,444	718,871,111	718,871,111	475,751,111	475,751,111	475,751,111			
0.2	Rolling stock														
0	***Total Investment***	**249,013,333**	**492,133,333**	**730,444,444**	**730,444,444**	**730,444,444**	**730,444,444**	**718,871,111**	**718,871,111**	**475,751,111**	**475,751,111**	**475,751,111**	**-**	**-**	**-**
1	Government Investment	199,210,667	393,706,667	584,355,556	584,355,556	584,355,556	584,355,556	575,096,889	575,096,889	380,600,889	380,600,889	380,600,889	-	-	-
2	InvestorEquity	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	Government Debt	49,802,667	98,426,667	146,088,889	146,088,889	146,088,889	146,088,889	143,774,222	143,774,222	95,150,222	95,150,222	95,150,222	-	-	-
4	InvestorDebt	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	InterestonLoans (Government&Investors)	2,988,160	8,765,380	17,140,910	25,116,469	32,668,059	39,770,241	46,257,171	52,245,113	54,786,688	56,892,942	58,537,755	53,984,429	49,157,902	44.041.784
6	Repaymentof Loans(Principal)	2,139,660	6,496,721	13,162,907	20,229,064	27,719,190	35,658,724	43,975,186	52,790,635	60,045,989	67,736,665	75,888,782	80,442,109	85,268,635	90.384.753
7	OperatingSubsidy														
TotalAnnualCash Requirement(1+2+5+6+7)		**204.338.487**	**204,338,487**	**408,968,769**	**614,659,373**	**629,701,089**	**644,742,805**	**659,784,521**	**665,329,245**	**680,132,636**	**495,433,566**	**505,230,496**	**515,027,426**	**134,426,537**	**134,426,537**

Table 6-27 (cont'd)

	Year	15	16	17	18	19	20	21	22	23	24	25	TOTAL
		2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	
0.1	Infrastructures												**6,527,920,000**
0.2	Rolling stock												**-**
0	***Total Investment***	-	-	-	-	-	-	-	-	-	-	-	**6,527,920,000**
1	Government Investment	-	-	-	-	-	-	-	-	-	-	-	**5,222,336,000**
2	InvestorEquity	-	-	-	-	-	-	-	-	-	-	-	**-**
3	GovernmentDebt	-	-	-	-	-	-	-	-	-	-	-	**1,305,584,000**
4	InvestorDebt	-	-	-	-	-	-	-	-	-	-	-	**-**
5	InterestonLoans (Government&Investors)	38,618,699	32,870,228	27,084,519	21,559,724	16,605,944	12,257,441	8,550,530	5,523,707	3,203,479	1,632,240	554,543	**710,814,058**
6	Repaymentof Loans(Principal)	95,807,839	96,428,489	92,079,916	82,562,995	72,475,059	61,781,847	50,447,042	38,670,474	26,187,311	17,961,619	9,242,387	**1,305,584,000**
7	OperatingSubsidy	-	-	-	-	-	-	-	-	-	-	-	**-**
TotalAnnualCash Requirement(1+2+5+6+7)		**134.426.537**	**129,298,717**	**119,164,435**	**104,122,720**	**89,081,004**	**74,039,288**	**58,997,572**	**44,194,181**	**29,390,790**	**19,593,860**	**9,796,930**	**7,238,734,058**

Table 6-28 Indicative Annual Financial Requirements – Private Operator ($US)

		Year 1 2019	Year 2 2020	Year 3 2021	Year 4 2022	Year 5 2023	Year 6 2024	Year 7 2025	Year 8 2026	Year 9 2027	Year 10 2028	Year 11 2029	Year 12 2030	Year 13 2031	Year 14 2032
0.1	Infrastructures														
0.2	Rolling stock							258,816,667	3,771,667	3,771,667	81,093,333	81,093,333	81,093,333	12,085,882	12,085,882
0	**Total Investment**	**-**	**-**	**-**	**-**	**-**	**-**	**258,816,667**	**3,771,667**	**3,771,667**	**81,093,333**	**81,093,333**	**81,093,333**	**12,085,882**	**12,085,882**
1	Government Investment	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Investor Equity	-	-	-	-	-	-	77,645,000	1,131,500	1,131,500	24,328,000	24,328,000	24,328,000	3,625,765	3,625,765
3	Government Debt	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Investor Debt	-	-	-	-	-	-	181,171,667	2,640,167	2,640,167	56,765,333	56,765,333	56,765,333	8,460,118	8,460,118
5	Interest on Loans (Government & Investors)	-	-	-	-	-	-	12,682,017	12,362,152	11,999,606	15,380,152	18,561,059	21,528,352	20,885,714	20,133,070
6	Repayment of Loans (Principal)	-	-	-	-	-	-	7,209,658	7,819,399	8,471,821	11,323,804	14,375,425	17,640,660	19,212,174	20,893,693
7	Operating Subsidy														
	Total Annual Cash Requirement (1+2+5+6+7)	**-**	**-**	**-**	**-**	**-**	**-**	**97,536,675**	**21,313,051**	**21,602,927**	**51,031,956**	**57,264,484**	**63,497,013**	**43,723,653**	**44,652,528**

Table 6-28 (cont'd)

		Year 15 2033	Year 16 2034	Year 17 2035	Year 18 2036	Year 19 2037	Year 20 2038	Year 21 2039	Year 22 2040	Year 23 2041	Year 24 2042	Year 25 2043	Year 26 2044	Year 27 2045	Year 28 2046
0.1	Infrastructures														
0.2	Rolling stock	12,085,882	12,085,882	12,085,882	12,085,882	12,085,882	12,085,882	12,085,882	12,085,882	12,085,882	12,085,882	12,085,882	12,085,882	12,085,882	12,085,882
0	**Total Investment**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**
1	Government Investment	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Investor Equity	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765
3	Government Debt	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Investor Debt	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118
5	Interest on Loans (Government & Investors)	19,262,720	18,266,424	17,135,366	15,860,113	14,430,570	12,835,938	11,064,661	9,104,373	8,334,261	7,465,511	6,491,219	5,819,982	5,473,014	5,473,014
6	Repayment of Loans (Principal)	22,692,919	24,618,090	26,678,024	28,882,153	31,240,571	33,764,078	36,464,231	19,461,719	20,870,830	22,378,579	18,049,219	13,416,803	8,460,118	8,460,118
7	Operating Subsidy	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total Annual Cash Requirement (1+2+5+6+7)	**45,581,404**	**46,510,279**	**47,439,155**	**48,368,030**	**49,296,906**	**50,225,781**	**51,154,656**	**32,191,857**	**32,830,856**	**33,469,855**	**28,166,202**	**22,862,549**	**17,558,896**	**17,558,896**

Table 6-28 (cont'd)

		Year 29 2047	Year 30 2048	Year 31 2049	Year 32 2050	Year 33 2051	Year 34 2052	Year 35 2053	Year 36 2054	Year 37 2055	Year 38 2056	Year 39 2057	Year 40 2058	Year 41 2059	Year 42 2060
0.1	Infrastructures														
0.2	Rolling stock	12,085,882													
0	**Total Investment**	**12,085,882**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
1	Government Investment	-	-	-	-	-									
2	Investor Equity	3,625,765	-	-	-	-									
3	Government Debt	-	-	-	-	-	-								
4	Investor Debt	8,460,118	-	-	-	-									
5	Interest on Loans (Government & Investors)	5,473,014	4,880,806	4,312,164	3,768,739	3,252,295	2,764,722	2,308,040	1,884,411	1,496,150	1,145,731	835,805	569,204	348,964	178,327
6	Repayment of Loans (Principal)	8,460,118	8,123,450	7,763,217	7,377,766	6,965,334	6,524,032	6,051,839	5,546,593	5,005,979	4,427,522	3,808,573	3,146,297	2,437,663	1,679,424
7	Operating Subsidy	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total Annual Cash Requirement (1+2+5+6+7)	**17,558,896**	**13,004,256**	**12,075,381**	**11,146,505**	**10,217,630**	**9,288,754**	**8,359,879**	**7,431,004**	**6,502,128**	**5,573,253**	**4,644,377**	**3,715,502**	**2,786,626**	**1,857,751**

Table 6-28 (cont'd)

		Year 43 2061	Year 44 2062	Year 45 2063	Year 46 2064	Year 47 2065	Year 48 2066	Year 49 2067	Year 50 2068	Year 51 2069	Year 52 2070	**Total**
0.1	Infrastructures	-	-	-	-	-						
0.2	Rolling stock	-	-	-	-	-						**715,100,000**
0	**Total Investment**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**715,100,000**
1	Government Investment	-	-	-	-	-						
2	Investor Equity	-	-	-	-	-						**214,530,000**
3	Government Debt	-	-	-	-	-						**-**
4	Investor Debt	-	-	-	-	-						**500,570,000**
5	Interest on Loans (Government & Investors)	60,768	-	-	-	-	-	-	-	-	-	**323,828,429**
6	Repayment of Loans (Principal)	868,108	-	-	-	-						**500,570,000**
7	Operating Subsidy											
	Total Annual Cash Requirement (1+2+5+6+7)	**928,875**										**1,038,928,429**

6.7.6 Financial Statements

6.7.6.1 Infrastructure - GRDA

For the financial analysis conducted from the Infrastructure point of view (GRDA or other InfraCo), on the basis of similar experiences, the cost of the maintenance and operation of the infrastructures has been calculated on the basis of the average cost of 41,100 US$/km per year.

Projected revenue is related to the Track Access Charges that the private operator will pay for the use of the railway network. Such charge has been determined in 220 million US$ for the first year of operation (2025) and it will increase until 420 US$ million in 2035.

6.7.6.2 Private Operator

Both projected operative costs and projected revenues have been calculated on the basis of unitary values referred to freight (opex per ton/km and fare per ton/km) and passengers (opex per pax/km and revenue per pax/km), as synthesised in the following table (values are expressed in US$). Fares have been determined, according to similar experiences in analogous countries. The values (0.091 US$ per ton/km and 0.037 US$ per pax/km) are a little higher than the ones used for the Master Plan assessment (respectively 0.083 and 0.034), but coherent with an higher than the average level of service.

In the operative expenditures are also included the track access charges that the private operator will pay for the use of the railway network.

Table 6- 29 Track Access Charges (US$)

FARES	FREIGHT	ton/km	0,091
	PAX	pax/km	0,037
OPEX	FREIGHT	ton/km	0,0126
	PAX	pax/km	0,0324

The traffic expected for all the period of the analysis (until the year 2070) derives from the hypothesis of Central Spine phasing presented in Table 6-2, which are the same ones already considered for the economic evaluation purposes.

In the following Table 6-30, traffic, revenues and operative expenditures are presented, distinguishing between freight and passenger traffic.

Table 6-30 Traffic (000 ton-km or pax-km), Revenues and Operative Expenditures (000 US$) - Private Operator

		2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
TRAFFIC	FREIGHTS	1,978,923	2,058,080	2,696,754	2,804,624	2,916,809	8,065,039	8,226,340	8,390,867	8,558,684	8,729,858	8,904,455
	PAX	7,822	7,979	16,457	16,786	17,639	32,423	33,071	33,733	34,407	35,096	35,797
REVENUE	FREIGHTS	180,082	187,285	245,405	255,221	265,430	733,919	748,597	763,569	778,840	794,417	810,305
	PAX	289	295	609	621	653	1,200	1,224	1,248	1,273	1,299	1,325
	TOT	***180,371***	***187,580***	***246,013***	***255,842***	***266,082***	***735,118***	***749,821***	***764,817***	***780,113***	***795,716***	***811,630***
OPEX	FREIGHTS	24,981	25,980	34,043	35,404	36,820	101,809	103,845	105,922	108,041	110,202	112,406
	PAX	253	258	533	544	571	1,050	1,071	1,093	1,115	1,137	1,160
	TOT	***25,234***	***26,239***	***34,576***	***35,948***	***37,392***	***102,859***	***104,917***	***107,015***	***109,155***	***111,338***	***113,565***

Table 6.30 (cont'd)		2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
TRAFFIC	FREIGHTS	9,082,544	9,264,195	9,449,479	9,638,468	9,831,237	10,027,862	10,228,419	10,432,988	10,641,648	10,854,481	11,071,570
	PAX	36,513	37,244	37,988	38,748	39,523	40,314	41,120	41,942	42,781	43,637	44,510
REVENUE	FREIGHTS	826,511	843,042	859,903	877,101	894,643	912,535	930,786	949,402	968,390	987,758	1,007,513
	PAX	1,351	1,378	1,406	1,434	1,462	1,492	1,521	1,552	1,583	1,615	1,647
	TOT	***827,862***	***844,420***	***861,308***	***878,534***	***896,105***	***914,027***	***932,308***	***950,954***	***969,973***	***989,372***	***1,009,160***
OPEX	FREIGHTS	114,654	116,947	119,286	121,671	124,105	126,587	129,119	131,701	134,335	137,022	139,762
	PAX	1,183	1,206	1,231	1,255	1,280	1,306	1,332	1,359	1,386	1,414	1,442
	TOT	***115,836***	***118,153***	***120,516***	***122,927***	***125,385***	***127,893***	***130,451***	***133,060***	***135,721***	***138,435***	***141,204***

Table 6.30 (cont'd)		2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058
TRAFFIC	FREIGHTS	11,293,002	11,744,722	12,214,511	12,703,091	13,211,215	13,739,663	14,289,250	14,860,820	15,455,252	16,073,463	16,716,401	17,385,057
	PAX	45,400	46,308	47,234	48,179	49,142	50,125	51,128	52,150	53,193	54,257	55,342	56,449
REVENUE	FREIGHTS	1,027,663	1,068,770	1,111,520	1,155,981	1,202,221	1,250,309	1,300,322	1,352,335	1,406,428	1,462,685	1,521,192	1,582,040
	PAX	1,680	1,713	1,748	1,783	1,818	1,855	1,892	1,930	1,968	2,008	2,048	2,089
	TOT	***1,029,343***	***1,070,483***	***1,113,268***	***1,157,764***	***1,204,039***	***1,252,164***	***1,302,213***	***1,354,264***	***1,408,396***	***1,464,693***	***1,523,240***	***1,584,129***
OPEX	FREIGHTS	142,557	148,260	154,190	160,358	166,772	173,443	180,381	187,596	195,100	202,904	211,020	219,461
	PAX	1,471	1,500	1,530	1,561	1,592	1,624	1,656	1,689	1,723	1,758	1,793	1,829
	TOT	***144,028***	***149,760***	***155,720***	***161,918***	***168,364***	***175,067***	***182,037***	***189,285***	***196,823***	***204,661***	***212,813***	***221,289***

Table 6.30 (cont'd)		2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070
TRAFFIC	FREIGHTS	18,080,459	18,803,678	19,555,825	20,338,058	21,151,580	21,997,643	22,877,549	23,792,651	24,744,357	25,734,131	26,763,497	27,834,037
	PAX	57,578	58,729	59,904	61,102	62,324	63,571	64,842	66,139	67,462	68,811	70,187	71,591
REVENUE	FREIGHTS	1,645,322	1,711,135	1,779,580	1,850,763	1,924,794	2,001,786	2,081,857	2,165,131	2,251,736	2,341,806	2,435,478	2,532,897
	PAX	2,130	2,173	2,216	2,261	2,306	2,352	2,399	2,447	2,496	2,546	2,597	2,649
	TOT	***1,647,452***	***1,713,308***	***1,781,797***	***1,853,024***	***1,927,100***	***2,004,138***	***2,084,256***	***2,167,578***	***2,254,233***	***2,344,352***	***2,438,075***	***2,535,546***
OPEX	FREIGHTS	228,239	237,369	246,863	256,738	267,007	277,688	288,795	300,347	312,361	324,855	337,849	351,363
	PAX	1,865	1,902	1,941	1,979	2,019	2,059	2,100	2,143	2,185	2,229	2,274	2,319
	TOT	***230,104***	***239,271***	***248,804***	***258,717***	***269,026***	***279,747***	***290,896***	***302,489***	***314,546***	***327,084***	***340,123***	***353,683***

6.7.7 Financial Results

It must be underlined that, coherently with the previous assessment of the whole Master Plan, the following items have not been included in the analysis:

- Interest Earned on Cash Balances
- Financing Fees
- Development Costs
- Dividends
- Concession Fees
- Withholding Tax
- Grace Period
- Inflation.

The main assumptions are:

- Government Debt: 20%
- Investor equity: 30%
- Investor loan: 70%
- Gov Interest rate: 6%
- Privates interest rate: 7%
- Tax : 24%.
- Discount rate: 12%

For the analysis conducted from the GRDA point of view, the net present value of all the investments is negative and equal to -2,269 million US$, while the IRR is positive even if low and equal to **2.8**%.

For the analysis conducted from the Private Operator point of view, the net present value of all the investments is positive and equal to 709 million US$, while the IRR is positive even if low and equal to **23.2**%.

Tables 6-31 and 6-32 combine the financial results for Railway Infrastructure (GRDA) and Private Operator, respectively.

Table 6-31 Indicative Financial Statement – InfraCo ($US)

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Projected Revenue	0	0	0	0	0	0	220,000,000	240,000,000	260,000,000	280,000,000	300,000,000	320,000,000
Projected OpEx												0
Maintenance and operative structure	0	0	0	0	0	0	10,932,600	10,932,600	23,262,600	23,262,600	23,262,600	47,717,100
Depreciation & Amortization	0	4,980,267	14,723,328	29,037,750	43,065,884	56,813,455	70,286,075	83,257,776	95,970,043	103,565,664	111,009,373	118,304,208
Net Operating Profit	**0**	**-4,980,267**	**-14,723,328**	**-29,037,750**	**-43,065,884**	**-56,813,455**	**138,781,325**	**145,809,624**	**140,767,357**	**153,171,736**	**165,728,027**	**153,978,692**
Interest on CapEx	-2,988,160	-8,765,380	-17,140,910	-25,116,469	-32,668,059	-39,770,241	-46,257,171	-52,245,113	-54,786,688	-56,892,942	-58,537,755	-53,984,429
Net Income Before Tax	**-2,988,160**	**-13,745,647**	**-31,864,238**	**-54,154,220**	**-75,733,943**	**-96,583,696**	**92,524,154**	**93,564,511**	**85,980,669**	**96,278,794**	**107,190,272**	**99,994,264**
Tax	0	0	0	0	0	0	-22,205,797	-22,455,483	-20,635,361	-23,106,911	-25,725,665	-23,998,623
Net Income After Tax	**-2,988,160**	**-13,745,647**	**-31,864,238**	**-54,154,220**	**-75,733,943**	**-96,583,696**	**70,318,357**	**71,109,029**	**65,345,309**	**73,171,883**	**81,464,606**	**75,995,640**
CASH FLOW												
Opening Balance	0	-5,127,820	-15,262,102	-30,303,818	-45,345,533	-60,387,249	-75,428,965	96,629,247	101,576,170	101,269,362	109,000,882	116,585,198
Sources of Funds												
Net Income	-2,988,160	-13,745,647	-31,864,238	-54,154,220	-75,733,943	-96,583,696	70,318,357	71,109,029	65,345,309	73,171,883	81,464,606	75,995,640
Plus:												
Depreciation & Amortization	0	4,980,267	14,723,328	29,037,750	43,065,884	56,813,455	70,286,075	83,257,776	95,970,043	103,565,664	111,009,373	118,304,208
Cash flows from operations	-2,988,160	-8,765,380	-17,140,910	-25,116,469	-32,668,059	-39,770,241	140,604,432	154,366,804	161,315,351	176,737,547	192,473,979	194,299,848
Add CapEx												
Government Investment	199,210,667	393,706,667	584,355,556	584,355,556	584,355,556	584,355,556	575,096,889	575,096,889	380,600,889	380,600,889	380,600,889	0
Investor Equity	0	0	0	0	0	0	0	0	0	0	0	0
Loans (Government & Investors)	49,802,667	98,426,667	146,088,889	146,088,889	146,088,889	146,088,889	143,774,222	143,774,222	95,150,222	95,150,222	95,150,222	0
Total	***246,025,173***	***483,367,953***	***713,303,534***	***705,327,975***	***697,776,386***	***690,674,204***	***859,475,543***	***873,237,916***	***637,066,462***	***652,488,659***	***668,225,090***	***194,299,848***
Application of Funds												
Total investments	249,013,333	492,133,333	730,444,444	730,444,444	730,444,444	730,444,444	718,871,111	718,871,111	475,751,111	475,751,111	475,751,111	0
Repayments of loans (Principal)	2,139,660	6,496,721	13,162,907	20,229,064	27,719,190	35,658,724	43,975,186	52,790,635	60,045,989	67,736,665	75,888,782	80,442,109
Total	***251,152,994***	***498,630,055***	***743,607,352***	***750,673,509***	***758,163,635***	***766,103,169***	***762,846,297***	***771,661,746***	***535,797,101***	***543,487,776***	***551,639,893***	***80,442,109***
Cash Surplus / (Deficit) - Closing Balance	-5,127,820	-15,262,102	-30,303,818	-45,345,533	-60,387,249	-75,428,965	96,629,247	101,576,170	101,269,362	109,000,882	116,585,198	113,857,739
Net Present Value & Internal Rate of												
Net income	-2,988,160	-13,745,647	-31,864,238	-54,154,220	-75,733,943	-96,583,696	70,318,357	71,109,029	65,345,309	73,171,883	81,464,606	75,995,640
Plus: Depreciation & Amortization	0	4,980,267	14,723,328	29,037,750	43,065,884	56,813,455	70,286,075	83,257,776	95,970,043	103,565,664	111,009,373	118,304,208
Cash flows from operations	-2,988,160	-8,765,380	-17,140,910	-25,116,469	-32,668,059	-39,770,241	140,604,432	154,366,804	161,315,351	176,737,547	192,473,979	194,299,848
Minus:												
Gov Investment and Investor equity	199,210,667	393,706,667	584,355,556	584,355,556	584,355,556	584,355,556	575,096,889	575,096,889	380,600,889	380,600,889	380,600,889	0
Principal repayments	2,139,660	6,496,721	13,162,907	20,229,064	27,719,190	35,658,724	43,975,186	52,790,635	60,045,989	67,736,665	75,888,782	80,442,109
Working capital requirements	0	0	0	0	0	0	6,600,000	7,200,000	7,800,000	8,400,000	9,000,000	9,600,000
Net Free Cashflow	**-204,338,487**	**-408,968,769**	**-614,659,373**	**-629,701,089**	**-644,742,805**	**-659,784,521**	**-485,067,642**	**-480,720,719**	**-287,131,527**	**-280,000,007**	**-273,015,691**	**104,257,739**

Table 6-31(cont'd)	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Projected Revenue	**340,000,000**	**360,000,000**	**380,000,000**	**400,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**
Projected OpEx	-	-	-	-	-	-	-	-	-	-	-	-
Maintenance and operative structure	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100
Depreciation & Amortization	115,938,124	113,619,361	111,346,974	109,120,034	106,937,634	104,798,881	102,702,903	100,648,845	98,635,868	96,663,151	94,729,888	92,835,290
Net Operating Profit	**176,344,776**	**198,663,539**	**220,935,926**	**243,162,866**	**265,345,266**	**267,484,019**	**269,579,997**	**271,634,055**	**273,647,032**	**275,619,749**	**277,553,012**	**279,447,610**
Interest on CapEx	- 49,157,902	- 44,041,784	- 38,618,699	- 32,870,228	- 27,084,519	- 21,559,724	- 16,605,944	- 12,257,441	- 8,550,530	- 5,523,707	- 3,203,479	- 1,632,240
Net Income Before Tax	**127,186,874**	**154,621,755**	**182,317,227**	**210,292,637**	**238,260,747**	**245,924,295**	**252,974,052**	**259,376,614**	**265,096,502**	**270,096,042**	**274,349,533**	**277,815,369**
Tax	- 30,524,850	- 37,109,221	- 43,756,135	- 50,470,233	- 57,182,579	- 59,021,831	- 60,713,773	- 62,250,387	- 63,623,160	- 64,823,050	- 65,843,888	- 66,675,689
Net Income After Tax	**96,662,025**	**117,512,534**	**138,561,093**	**159,822,404**	**181,078,168**	**186,902,464**	**192,260,280**	**197,126,227**	**201,473,341**	**205,272,992**	**208,505,645**	**211,139,681**
CASH FLOW	-	-	-	-	-	-	-	-	-	-	-	-
Opening Balance	**113,857,739**	**127,331,513**	**140,747,142**	**154,100,228**	**172,513,950**	**195,935,885**	**209,138,350**	**222,488,124**	**235,993,225**	**249,662,167**	**263,265,669**	**277,048,222**
Sources of Funds	-	-	-	-	-	-	-	-	-	-	-	-
Net Income	**96,662,025**	**117,512,534**	**138,561,093**	**159,822,404**	**181,078,168**	**186,902,464**	**192,260,280**	**197,126,227**	**201,473,341**	**205,272,992**	**208,505,645**	**211,139,681**
Plus:	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation & Amortization	115,938,124	113,619,361	111,346,974	109,120,034	106,937,634	104,798,881	102,702,903	100,648,845	98,635,868	96,663,151	94,729,888	92,835,290
Cash flows from operations	212,600,148	231,131,895	249,908,067	268,942,439	288,015,802	291,701,345	294,963,183	297,775,072	300,109,210	301,936,143	303,235,533	303,974,971
Add CapEx	-	-	-	-	-	-	-	-	-	-	-	-
Government Investment	-	-	-	-	-	-	-	-	-	-	-	-
Investor Equity	-	-	-	-	-	-	-	-	-	-	-	-
Loans (Government & Investors)	-	-	-	-	-	-	-	-	-	-	-	-
Total	**212,600,148**	**231,131,895**	**249,908,067**	**268,942,439**	**288,015,802**	**291,701,345**	**294,963,183**	**297,775,072**	**300,109,210**	**301,936,143**	**303,235,533**	**303,974,971**
Application of Funds	-	-	-	-	-	-	-	-	-	-	-	-
Total investments	-	-	-	-	-	-	-	-	-	-	-	-
Repayments of loans (Principal)	85,268,635	90,384,753	95,807,839	96,428,489	92,079,916	82,562,995	72,475,059	61,781,847	50,447,042	38,670,474	26,187,311	17,961,619
Total	**85,268,635**	**90,384,753**	**95,807,839**	**96,428,489**	**92,079,916**	**82,562,995**	**72,475,059**	**61,781,847**	**50,447,042**	**38,670,474**	**26,187,311**	**17,961,619**
Cash Surplus / (Deficit) - Closing Balance	127,331,513	140,747,142	154,100,228	172,513,950	195,935,885	209,138,350	222,488,124	235,993,225	249,662,167	263,265,669	277,048,222	286,013,352
Net Present Value & Internal Rate of	-	-	-	-	-	-	-	-	-	-	-	-
Net income	**96,662,025**	**117,512,534**	**138,561,093**	**159,822,404**	**181,078,168**	**186,902,464**	**192,260,280**	**197,126,227**	**201,473,341**	**205,272,992**	**208,505,645**	**211,139,681**
Plus: Depreciation & Amortization	115,938,124	113,619,361	111,346,974	109,120,034	106,937,634	104,798,881	102,702,903	100,648,845	98,635,868	96,663,151	94,729,888	92,835,290
Cash flows from operations	212,600,148	231,131,895	249,908,067	268,942,439	288,015,802	291,701,345	294,963,183	297,775,072	300,109,210	301,936,143	303,235,533	303,974,971
Minus:	-	-	-	-	-	-	-	-	-	-	-	-
Gov Investment and Investor equity	-	-	-	-	-	-	-	-	-	-	-	-
Principal repayments	85,268,635	90,384,753	95,807,839	96,428,489	92,079,916	82,562,995	72,475,059	61,781,847	50,447,042	38,670,474	26,187,311	17,961,619
Working capital requirements	10,200,000	10,800,000	11,400,000	12,000,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000
Net Free Cashflow	**117,131,513**	**129,947,142**	**142,700,228**	**160,513,950**	**183,335,885**	**196,538,350**	**209,888,124**	**223,393,225**	**237,062,167**	**250,665,669**	**264,448,222**	**273,413,352**

Table 6.31 (cont'd)	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Projected Revenue	**420.000.000**	**420.000.000**	**420.000.000**	**420.000.000**	**420.000.000**	**420.000.000**	**420.000.000**	**420.000.000**	**420.000.000**	**420.000.000**	**420.000.000**	**420.000.000**
Projected OpEx	-	-	-	-	-	-	-	-	-	-	-	-
Maintenance and operative structure	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100
Depreciation & Amortization	90,978,584	89,159,013	87,375,833	85,628,316	83,915,750	82,237,435	80,592,686	78,980,832	77,401,216	75,853,191	74,336,127	72,849,405
Net Operating Profit	**281,304,316**	**283,123,887**	**284,907,067**	**286,654,584**	**288,367,150**	**290,045,465**	**291,690,214**	**293,302,068**	**294,881,684**	**296,429,709**	**297,946,773**	**299,433,495**
Interest on CapEx	- 554,543	-	-	-	-	-	-	-	-	-	-	-
Net Income Before Tax	**280,749,772**	**283,123,887**	**284,907,067**	**286,654,584**	**288,367,150**	**290,045,465**	**291,690,214**	**293,302,068**	**294,881,684**	**296,429,709**	**297,946,773**	**299,433,495**
Tax	- 67,379,945	- 67,949,733	- 68,377,696	- 68,797,100	- 69,208,116	- 69,610,912	- 70,005,651	- 70,392,496	- 70,771,604	- 71,143,130	- 71,507,225	- 71,864,039
Net Income After Tax	**213,369,827**	**215,174,154**	**216,529,371**	**217,857,484**	**219,159,034**	**220,434,554**	**221,684,563**	**222,909,572**	**224,110,080**	**225,286,579**	**226,439,547**	**227,569,456**
CASH FLOW	-	-	-	-	-	-	-	-	-	-	-	-
Opening Balance	**286,013,352**	**295,106,025**	**304,333,167**	**303,905,204**	**303,485,800**	**303,074,784**	**302,671,988**	**302,277,249**	**301,890,404**	**301,511,296**	**301,139,770**	**300,775,675**
Sources of Funds	-	-	-	-	-	-	-	-	-	-	-	-
Net Income	**213,369,827**	**215,174,154**	**216,529,371**	**217,857,484**	**219,159,034**	**220,434,554**	**221,684,563**	**222,909,572**	**224,110,080**	**225,286,579**	**226,439,547**	**227,569,456**
Plus:	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation & Amortization	90,978,584	89,159,013	87,375,833	85,628,316	83,915,750	82,237,435	80,592,686	78,980,832	77,401,216	75,853,191	74,336,127	72,849,405
Cash flows from operations	304,348,411	304,333,167	303,905,204	303,485,800	303,074,784	302,671,988	302,277,249	301,890,404	301,511,296	301,139,770	300,775,675	300,418,861
Add CapEx	-	-	-	-	-	-	-	-	-	-	-	-
Government Investment	-	-	-	-	-	-	-	-	-	-	-	-
Investor Equity	-	-	-	-	-	-	-	-	-	-	-	-
Loans (Government & Investors)	-	-	-	-	-	-	-	-	-	-	-	-
Total	**304,348,411**	**304,333,167**	**303,905,204**	**303,485,800**	**303,074,784**	**302,671,988**	**302,277,249**	**301,890,404**	**301,511,296**	**301,139,770**	**300,775,675**	**300,418,861**
Application of Funds	-	-	-	-	-	-	-	-	-	-	-	-
Total investments	-	-	-	-	-	-	-	-	-	-	-	-
Repayments of loans (Principal)	9,242,387	-	-	-	-	-	-	-	-	-	-	-
Total	**9,242,387**	-	-	-	-	-	-	-	-	-	-	-
Cash Surplus / (Deficit) - Closing Balance	295,106,025	304,333,167	303,905,204	303,485,800	303,074,784	302,671,988	302,277,249	301,890,404	301,511,296	301,139,770	300,775,675	300,418,861
Net Present Value & Internal Rate of	-	-	-	-	-	-	-	-	-	-	-	-
Net income	213,369,827	215,174,154	216,529,371	217,857,484	219,159,034	220,434,554	221,684,563	222,909,572	224,110,080	225,286,579	226,439,547	227,569,456
Plus: Depreciation & Amortization	90,978,584	89,159,013	87,375,833	85,628,316	83,915,750	82,237,435	80,592,686	78,980,832	77,401,216	75,853,191	74,336,127	72,849,405
Cash flows from operations	304,348,411	304,333,167	303,905,204	303,485,800	303,074,784	302,671,988	302,277,249	301,890,404	301,511,296	301,139,770	300,775,675	300,418,861
Minus:	-	-	-	-	-	-	-	-	-	-	-	-
Gov Investment and Investor equity	-	-	-	-	-	-	-	-	-	-	-	-
Principal repayments	9,242,387	-	-	-	-	-	-	-	-	-	-	-
Working capital requirements	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000
Net Free Cashflow	**282,506,025**	**291,733,167**	**291,305,204**	**290,885,800**	**290,474,784**	**290,071,988**	**289,677,249**	**289,290,404**	**288,911,296**	**288,539,770**	**288,175,675**	**287,818,861**

Table 6.31 (cont'd)	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066
Projected Revenue	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**	**420,000,000**
Projected OpEx	-	-	-	-	-	-	-	-	-	-	-	-
Maintenance and operative structure	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100	47,717,100
Depreciation & Amortization	71,392,417	69,964,568	68,565,277	67,193,971	65,850,092	-	-	-	-	-	-	-
Net Operating Profit	**300,890,483**	**302,318,332**	**303,717,623**	**305,088,929**	**306,432,808**	**372,282,900**	**372,282,900**	**372,282,900**	**372,282,900**	**372,282,900**	**372,282,900**	**372,282,900**
Interest on CapEx	-	-	-	-	-	-	-	-	-	-	-	-
Net Income Before Tax	**300,890,483**	**302,318,332**	**303,717,623**	**305,088,929**	**306,432,808**	**372,282,900**	**372,282,900**	**372,282,900**	**372,282,900**	**372,282,900**	**372,282,900**	**372,282,900**
Tax	- 72,213,716	- 72,556,400	- 72,892,230	- 73,221,343	- 73,543,874	- 89,347,896	- 89,347,896	- 89,347,896	- 89,347,896	- 89,347,896	- 89,347,896	- 89,347,896
Net Income After Tax	**228,676,767**	**229,761,932**	**230,825,393**	**231,867,586**	**232,888,934**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**
CASH FLOW	-	-	-	-	-	-	-	-	-	-	-	-
Opening Balance	**300,418,861**	**300,069,184**	**299,726,500**	**299,390,670**	**299,061,557**	**298,739,026**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**
Sources of Funds	-	-	-	-	-	-	-	-	-	-	-	-
Net Income	**228,676,767**	**229,761,932**	**230,825,393**	**231,867,586**	**232,888,934**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**
Plus:	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation & Amortization	71,392,417	69,964,568	68,565,277	67,193,971	65,850,092	-	-	-	-	-	-	-
Cash flows from operations	300,069,184	299,726,500	299,390,670	299,061,557	298,739,026	282,935,004	282,935,004	282,935,004	282,935,004	282,935,004	282,935,004	282,935,004
Add CapEx	-	-	-	-	-	-	-	-	-	-	-	-
Government Investment	-	-	-	-	-	-	-	-	-	-	-	-
Investor Equity	-	-	-	-	-	-	-	-	-	-	-	-
Loans (Government & Investors)	-	-	-	-	-	-	-	-	-	-	-	-
Total	**300,069,184**	**299,726,500**	**299,390,670**	**299,061,557**	**298,739,026**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**
Application of Funds	-	-	-	-	-	-	-	-	-	-	-	-
Total investments	-	-	-	-	-	-	-	-	-	-	-	-
Repayments of loans (Principal)	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-	-	-
Cash Surplus / (Deficit) - Closing Balance	**300,069,184**	**299,726,500**	**299,390,670**	**299,061,557**	**298,739,026**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**
Net Present Value & Internal Rate of	-	-	-	-	-	-	-	-	-	-	-	-
Net income	**228,676,767**	**229,761,932**	**230,825,393**	**231,867,586**	**232,888,934**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**	**282,935,004**
Plus: Depreciation & Amortization	71,392,417	69,964,568	68,565,277	67,193,971	65,850,092	-	-	-	-	-	-	-
Cash flows from operations	300,069,184	299,726,500	299,390,670	299,061,557	298,739,026	282,935,004	282,935,004	282,935,004	282,935,004	282,935,004	282,935,004	282,935,004
Minus:	-	-	-	-	-	-	-	-	-	-	-	-
Gov Investment and Investor equity	-	-	-	-	-	-	-	-	-	-	-	-
Principal repayments	-	-	-	-	-	-	-	-	-	-	-	-
Working capital requirements	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000	12,600,000
Net Free Cashflow	**287,469,184**	**287,126,500**	**286,790,670**	**286,461,557**	**286,139,026**	**270,335,004**	**270,335,004**	**270,335,004**	**270,335,004**	**270,335,004**	**270,335,004**	**270,335,004**

Table 6.31 (cont'd)	2067	2068	2069	2070
Projected Revenue	420,000,000	420,000,000	420,000,000	420,000,000
Projected OpEx	-	-	-	-
Maintenance and operative structure	47,717,100	47,717,100	47,717,100	47,717,100
Depreciation & Amortization	-	-	-	-
Net Operating Profit	372,282,900	372,282,900	372,282,900	372,282,900
Interest on CapEx	-	-	-	-
Net Income Before Tax	372,282,900	372,282,900	372,282,900	372,282,900
Tax	- 89,347,896	- 89,347,896	- 89,347,896	- 89,347,896
Net Income After Tax	282,935,004	282,935,004	282,935,004	282,935,004
CASH FLOW	-	-	-	-
Opening Balance	282,935,004	282,935,004	282,935,004	282,935,004
Sources of Funds	-	-	-	-
Net Income	282,935,004	282,935,004	282,935,004	282,935,004
Plus:	-	-	-	-
Depreciation & Amortization	-	-	-	-
Cash flows from operations	282,935,004	282,935,004	282,935,004	282,935,004
Add CapEx	-	-	-	-
Government Investment	-	-	-	-
Investor Equity	-	-	-	-
Loans (Government & Investors)	-	-	-	-
Total	282,935,004	282,935,004	282,935,004	282,935,004
Application of Funds	-	-	-	-
Total investments	-	-	-	-
Repayments of loans (Principal)	-	-	-	-
Total	-	-	-	-
Cash Surplus / (Deficit) - Closing Balance	282,935,004	282,935,004	282,935,004	282,935,004
Net Present Value & Internal Rate of	-	-	-	-
Net income	282,935,004	282,935,004	282,935,004	282,935,004
Plus: Depreciation & Amortization	-	-	-	-
Cash flows from operations	282,935,004	282,935,004	282,935,004	282,935,004
Minus:	-	-	-	-
Gov Investment and Investor equity	-	-	-	-
Principal repayments	-	-	-	-
Working capital requirements	12,600,000	12,600,000	12,600,000	12,600,000
Net Free Cashflow	270,335,004	270,335,004	270,335,004	270,335,004
NPV	-2,268,759,479			
IRR	2,8%			

Table 6-32 Indicative Financial Statements – Railway Operator ($US)

	2025	2026	2027	2028	2029	2030	2031	2032
Projected Revenue	180,371,427	187,580,496	246,013,487	255,841,848	266,082,220	735,118,189	749,820,552	764,816,963
Track Access Charges	220,000,000	240,000,000	260,000,000	280,000,000	300,000,000	320,000,000	340,000,000	360,000,000
Projected OpEx	25,234,367	26,238,674	34,575,624	35,947,987	37,391,771	102,859,471	104,916,661	107,014,994
Maintenance and operative structure								
Depreciation & Amortization	0	0	0	12,940,833	12,482,375	12,046,840	15,499,164	18,778,873
Net Operating Profit	**-64,862,940**	**-78,658,178**	**-48,562,138**	**-73,046,973**	**-83,791,926**	**300,211,878**	**289,404,727**	**279,023,097**
Interest on CapEx	0	0	-12,682,017	-12,362,152	-11,999,606	-15,380,152	-18,561,059	-21,528,352
Net Income Before Tax	**-64,862,940**	**-78,658,178**	**-61,244,154**	**-85,409,125**	**-95,791,532**	**284,831,726**	**270,843,668**	**257,494,744**
Tax	0	0	0	0	0	-68,359,614	-65,002,480	-61,798,739
Net Income After Tax	**-64,862,940**	**-78,658,178**	**-61,244,154**	**-85,409,125**	**-95,791,532**	**216,472,112**	**205,841,188**	**195,696,006**
CASH FLOW								
Opening Balance		-64,862,940	-78,658,178	-68,453,813	-80,287,691	-91,780,978	217,195,147	206,964,927
Sources of Funds								
Net Income	-64,862,940	-78,658,178	-61,244,154	-85,409,125	-95,791,532	216,472,112	205,841,188	195,696,006
Plus:								
Depreciation & Amortization	0	0	0	12,940,833	12,482,375	12,046,840	15,499,164	18,778,873
Cash flows from operations	-64,862,940	-78,658,178	-61,244,154	-72,468,292	-83,309,157	228,518,951	221,340,352	214,474,878
Add CapEx								
Government Investment	0	0	0	0	0	0	0	0
Investor Equity	0	0	77,645,000	1,131,500	1,131,500	24,328,000	24,328,000	24,328,000
Loans (Government & Investors)	0	0	181,171,667	2,640,167	2,640,167	56,765,333	56,765,333	56,765,333
Total	***-64,862,940***	***-78,658,178***	***197,572,512***	***-68,696,625***	***-79,537,490***	***309,612,285***	***302,433,686***	***295,568,212***
Application of Funds								
Total investments	0	0	258,816,667	3,771,667	3,771,667	81,093,333	81,093,333	81,093,333
Repayments of loans (Principal)	0	0	7,209,658	7,819,399	8,471,821	11,323,804	14,375,425	17,640,660
Total	***0***	***0***	***266,026,325***	***11,591,066***	***12,243,488***	***92,417,137***	***95,468,759***	***98,733,994***
Cash Surplus / (Deficit) - Closing Balance	-64,862,940	-78,658,178	-68,453,813	-80,287,691	-91,780,978	217,195,147	206,964,927	196,834,218
Net Present Value & Internal Rate of Return								
Net income	-64,862,940	-78,658,178	-61,244,154	-85,409,125	-95,791,532	216,472,112	205,841,188	195,696,006
Plus: Depreciation & Amortization	0	0	0	12,940,833	12,482,375	12,046,840	15,499,164	18,778,873
Cash flows from operations	-64,862,940	-78,658,178	-61,244,154	-72,468,292	-83,309,157	228,518,951	221,340,352	214,474,878
Minus:								
Gov Investment and Investor equity	0	0	77,645,000	1,131,500	1,131,500	24,328,000	24,328,000	24,328,000
Principal repayments	0	0	7,209,658	7,819,399	8,471,821	11,323,804	14,375,425	17,640,660
Working capital requirements	5,411,143	5,627,415	7,380,405	7,675,255	7,982,467	22,053,546	22,494,617	22,944,509
Net Free Cashflow	**-70,274,082**	**-84,285,593**	**-153,479,218**	**-89,094,446**	**-100,894,945**	**170,813,602**	**160,142,310**	**149,561,709**

Table 6-32 (cont'd)	2033	2034	2035	2036	2037	2038	2039	2040
Projected Revenue	**780,113,303**	**795,715,569**	**811,629,880**	**827,862,478**	**844,419,727**	**861,308,122**	**878,534,284**	**896,104,970**
Track Access Charges	380,000,000	400,000,000	420,000,000	420,000,000	420,000,000	420,000,000	420,000,000	420,000,000
Projected OpEx	109,155,294	111,338,400	113,565,168	115,836,471	118,153,201	120,516,265	122,926,590	125,385,122
Maintenance and operative structure	-	-	-	-	-	-	-	-
Depreciation & Amortization	21,894,596	21,404,160	20,938,246	20,495,628	20,075,141	19,675,678	19,296,188	18,935,673
Net Operating Profit	**269,063,413**	**262,973,009**	**257,126,466**	**271,530,379**	**286,191,386**	**301,116,179**	**316,311,506**	**331,784,176**
Interest on CapEx	- 20,885,714	- 20,133,070	- 19,262,720	- 18,266,424	- 17,135,366	- 15,860,113	- 14,430,570	- 12,835,938
Net Income Before Tax	**248,177,699**	**242,839,938**	**237,863,746**	**253,263,954**	**269,056,020**	**285,256,067**	**301,880,936**	**318,948,237**
Tax	- 59,562,648	- 58,281,585	- 57,087,299	- 60,783,349	- 64,573,445	- 68,461,456	- 72,451,425	- 76,547,577
Net Income After Tax	**188,615,051**	**184,558,353**	**180,776,447**	**192,480,605**	**204,482,575**	**216,794,611**	**229,429,512**	**242,400,660**
CASH FLOW	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Opening Balance	**196,834,218**	**191,297,473**	**185,068,820**	**179,021,774**	**188,358,143**	**197,879,692**	**207,588,136**	**217,485,129**
Sources of Funds	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Net Income	**188,615,051**	**184,558,353**	**180,776,447**	**192,480,605**	**204,482,575**	**216,794,611**	**229,429,512**	**242,400,660**
Plus:	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Depreciation & Amortization	21,894,596	21,404,160	20,938,246	20,495,628	20,075,141	19,675,678	19,296,188	18,935,673
Cash flows from operations	210,509,647	205,962,513	201,714,693	212,976,233	224,557,716	236,470,289	248,725,700	261,336,333
Add CapEx	-	-	-	-	-	-	-	-
Government Investment	-	-	-	-	-	-	-	-
Investor Equity	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765
Loans (Government & Investors)	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118
Total	**222,595,529**	**218,048,396**	**213,800,575**	**225,062,116**	**236,643,598**	**248,556,171**	**260,811,582**	**273,422,215**
Application of Funds	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total investments	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**	**12,085,882**
Repayments of loans (Principal)	19,212,174	20,893,693	22,692,919	24,618,090	26,678,024	28,882,153	31,240,571	33,764,078
Total	**31,298,056**	**32,979,576**	**34,778,801**	**36,703,973**	**38,763,906**	**40,968,035**	**43,326,453**	**45,849,960**
Cash Surplus / (Deficit) - Closing Balance	**191,297,473**	**185,068,820**	**179,021,774**	**188,358,143**	**197,879,692**	**207,588,136**	**217,485,129**	**227,572,255**
Net Present Value & Internal Rate of Return	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Net income	**188,615,051**	**184,558,353**	**180,776,447**	**192,480,605**	**204,482,575**	**216,794,611**	**229,429,512**	**242,400,660**
Plus: Depreciation & Amortization	21,894,596	21,404,160	20,938,246	20,495,628	20,075,141	19,675,678	19,296,188	18,935,673
Cash flows from operations	210,509,647	205,962,513	201,714,693	212,976,233	224,557,716	236,470,289	248,725,700	261,336,333
Minus:	-	-	-	-	-	-	-	-
Gov Investment and Investor equity	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765
Principal repayments	19,212,174	20,893,693	22,692,919	24,618,090	26,678,024	28,882,153	31,240,571	33,764,078
Working capital requirements	23,403,399	23,871,467	24,348,896	24,835,874	25,332,592	25,839,244	26,356,029	26,883,149
Net Free Cashflow	**164,268,309**	**157,571,588**	**151,047,113**	**159,896,504**	**168,921,335**	**178,123,127**	**187,503,336**	**197,063,341**

Table 6-32 (cont'd)	2045	2046	2047	2048	2049	2050	2051	2052
Projected Revenue	**989,372,295**	**1,009,159,741**	**1,029,342,936**	**1,070,483,057**	**1,113,268,112**	**1,157,763,883**	**1,204,038,786**	**1,252,163,973**
Track Access Charges	420,000,000	420,000,000	420,000,000	420,000,000	420,000,000	420,000,000	420,000,000	420,000,000
Projected OpEx	138,435,306	141,204,012	144,028,092	149,759,802	155,720,192	161,918,398	168,363,920	175,066,638
Maintenance and operative structure	-	-	-	-	-	-	-	-
Depreciation & Amortization	17,386,120	17,121,108	16,869,346	11,991,067	11,995,807	12,000,311	11,400,296	10,830,281
Net Operating Profit	**413,550,870**	**430,834,621**	**448,445,497**	**488,732,188**	**525,552,112**	**563,845,174**	**604,274,571**	**646,267,053**
Interest on CapEx	- 6,491,219	- 5,819,982	- 5,473,014	- 5,473,014	- 5,473,014	- 4,880,806	- 4,312,164	- 3,768,739
Net Income Before Tax	**407,059,651**	**425,014,639**	**442,972,483**	**483,259,174**	**520,079,098**	**558,964,368**	**599,962,407**	**642,498,314**
Tax	- 97,694,316	- 102,003,513	- 106,313,396	- 115,982,202	- 124,818,984	- 134,151,448	- 143,990,978	- 154,199,595
Net Income After Tax	**309,365,334**	**323,011,126**	**336,659,087**	**367,276,973**	**395,260,115**	**424,812,920**	**455,971,429**	**488,298,719**
CASH FLOW	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Opening Balance	**291,018,733**	**308,702,235**	**326,715,431**	**345,068,316**	**370,807,922**	**398,795,804**	**428,689,781**	**459,608,508**
Sources of Funds	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Net Income	**309,365,334**	**323,011,126**	**336,659,087**	**367,276,973**	**395,260,115**	**424,812,920**	**455,971,429**	**488,298,719**
Plus:	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Depreciation & Amortization	17,386,120	17,121,108	16,869,346	11,991,067	11,995,807	12,000,311	11,400,296	10,830,281
Cash flows from operations	**326,751,454**	**340,132,234**	**353,528,434**	**379,268,039**	**407,255,922**	**436,813,231**	**467,371,725**	**499,129,000**
Add CapEx	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Government Investment	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Investor Equity	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	**-**	**-**	**-**
Loans (Government & Investors)	8,460,118	8,460,118	8,460,118	8,460,118	8,460,118	**-**	**-**	**-**
Total	**338,837,336**	**352,218,116**	**365,614,316**	**391,353,922**	**419,341,804**	**436,813,231**	**467,371,725**	**499,129,000**
Application of Funds	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total investments	12,085,882	12,085,882	12,085,882	12,085,882	12,085,882	-	-	-
Repayments of loans (Principal)	18,049,219	13,416,803	8,460,118	8,460,118	8,460,118	8,123,450	7,763,217	7,377,766
Total	**30,135,101**	**25,502,685**	**20,546,000**	**20,546,000**	**20,546,000**	**8,123,450**	**7,763,217**	**7,377,766**
Cash Surplus / (Deficit) - Closing Balance	**308,702,235**	**326,715,431**	**345,068,316**	**370,807,922**	**398,795,804**	**428,689,781**	**459,608,508**	**491,751,233**
Net Present Value & Internal Rate of Return	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Net income	**309,365,334**	**323,011,126**	**336,659,087**	**367,276,973**	**395,260,115**	**424,812,920**	**455,971,429**	**488,298,719**
Plus: Depreciation & Amortization	17,386,120	17,121,108	16,869,346	11,991,067	11,995,807	12,000,311	11,400,296	10,830,281
Cash flows from operations	326,751,454	340,132,234	353,528,434	379,268,039	407,255,922	436,813,231	467,371,725	499,129,000
Minus:	-	-	-	-	-	-	-	-
Gov Investment and Investor equity	3,625,765	3,625,765	3,625,765	3,625,765	3,625,765	-	-	-
Principal repayments	18,049,219	13,416,803	8,460,118	8,460,118	8,460,118	8,123,450	7,763,217	7,377,766
Working capital requirements	29,681,169	30,274,792	30,880,288	32,114,492	33,398,043	34,732,916	36,121,164	37,564,919
Net Free Cashflow	**275,395,302**	**292,814,874**	**310,562,263**	**335,067,665**	**361,771,996**	**393,956,864**	**423,487,345**	**454,186,314**

Table 6-32 (cont'd)	2057	2058	2059	2060	2061	2062	2063	2064
Projected Revenue	**1,523,240,152**	**1,584,128,805**	**1,647,452,185**	**1,713,307,665**	**1,781,796,512**	**1,853,024,043**	**1,927,099,790**	**2,004,137,661**
Track Access Charges	420,000,000	420,000,000	420,000,000	420,000,000	420,000,000	420,000,000	420,000,000	420,000,000
Projected OpEx	212,812,544	221,289,191	230,104,186	239,271,050	248,803,842	258,717,185	269,026,286	279,746,959
Maintenance and operative structure	-	-	-	-	-	-	-	-
Depreciation & Amortization	8,163,634	7,538,821	6,945,249	6,597,987	6,268,088	-	-	-
Net Operating Profit	**882,263,974**	**935,300,793**	**990,402,750**	**1,047,438,628**	**1,106,724,582**	**1,174,306,858**	**1,238,073,504**	**1,304,390,703**
Interest on CapEx	- 1,496,150	- 1,145,731	- 835,805	- 569,204	- 348,964	- 178,327	- 60,768	-
Net Income Before Tax	**880,767,825**	**934,155,062**	**989,566,945**	**1,046,869,424**	**1,106,375,618**	**1,174,128,531**	**1,238,012,736**	**1,304,390,703**
Tax	- 211,384,278	- 224,197,215	- 237,496,067	- 251,248,662	- 265,530,148	- 281,790,847	- 297,123,057	- 313,053,769
Net Income After Tax	**669,383,547**	**709,957,847**	**752,070,878**	**795,620,762**	**840,845,470**	**892,337,683**	**940,889,679**	**991,336,934**
CASH FLOW	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Opening Balance	**633,562,202**	**672,541,202**	**713,069,147**	**755,207,555**	**799,072,452**	**844,675,895**	**890,658,260**	**940,021,572**
Sources of Funds	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Net Income	**669,383,547**	**709,957,847**	**752,070,878**	**795,620,762**	**840,845,470**	**892,337,683**	**940,889,679**	**991,336,934**
Plus:	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Depreciation & Amortization	8,163,634	7,538,821	6,945,249	6,597,987	6,268,088	-	-	-
Cash flows from operations	677,547,181	717,496,668	759,016,128	802,218,749	847,113,557	892,337,683	940,889,679	991,336,934
Add CapEx	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Government Investment	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Investor Equity	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Loans (Government & Investors)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total	**677,547,181**	**717,496,668**	**759,016,128**	**802,218,749**	**847,113,557**	**892,337,683**	**940,889,679**	**991,336,934**
Application of Funds	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total investments	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Repayments of loans (Principal)	5,005,979	4,427,522	3,808,573	3,146,297	2,437,663	1,679,424	868,108	**-**
Total	**5,005,979**	**4,427,522**	**3,808,573**	**3,146,297**	**2,437,663**	**1,679,424**	**868,108**	**-**
Cash Surplus / (Deficit) - Closing Balance	**672,541,202**	**713,069,147**	**755,207,555**	**799,072,452**	**844,675,895**	**890,658,260**	**940,021,572**	**991,336,934**
Net Present Value & Internal Rate of Return	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Net income	**669,383,547**	**709,957,847**	**752,070,878**	**795,620,762**	**840,845,470**	**892,337,683**	**940,889,679**	**991,336,934**
Plus: Depreciation & Amortization	8,163,634	7,538,821	6,945,249	6,597,987	6,268,088	-	-	-
Cash flows from operations	677,547,181	717,496,668	759,016,128	802,218,749	847,113,557	892,337,683	940,889,679	991,336,934
Minus:	-	-	-	-	-	-	-	-
Gov Investment and Investor equity	-	-	-	-	-	-	-	-
Principal repayments	5,005,979	4,427,522	3,808,573	3,146,297	2,437,663	1,679,424	868,108	-
Working capital requirements	45,697,205	47,523,864	49,423,566	51,399,230	53,453,895	55,590,721	57,812,994	60,124,130
Net Free Cashflow	**626,843,998**	**665,545,283**	**705,783,989**	**747,673,222**	**791,221,999**	**835,067,538**	**882,208,578**	**931,212,804**

Table 6-32 (cont'd)

	2069	2070
Projected Revenue	2,438,075,120	2,535,546,186
Track Access Charges	420,000,000	420,000,000
Projected OpEx	340,123,128	353,682,580
Maintenance and operative structure	-	-
Depreciation & Amortization	-	-
Net Operating Profit	1,677,951,992	1,761,863,606
Interest on CapEx	-	-
Net Income Before Tax	1,677,951,992	1,761,863,606
Tax	- 402,708,478	- 422,847,265
Net Income After Tax	1,275,243,514	1,339,016,341
CASH FLOW	-	-
Opening Balance	1,213,923,396	1,275,243,514
Sources of Funds	-	-
Net Income	1,275,243,514	1,339,016,341
Plus:	-	-
Depreciation & Amortization	-	-
Cash flows from operations	1,275,243,514	1,339,016,341
Add CapEx	-	-
Government Investment	-	-
Investor Equity	-	-
Loans (Government & Investors)	-	-
Total	1,275,243,514	1,339,016,341
Application of Funds	-	-
Total investments	-	-
Repayments of loans (Principal)	-	-
Total	-	-
Cash Surplus / (Deficit) - Closing Balance	1,275,243,514	1,339,016,341
Net Present Value & Internal Rate of Return	-	-
Net income	1,275,243,514	1,339,016,341
Plus: Depreciation & Amortization	-	-
Cash flows from operations	1,275,243,514	1,339,016,341
Minus:	-	-
Gov Investment and Investor equity	-	-
Principal repayments	-	-
Working capital requirements	73,142,254	76,066,386
Net Free Cashflow	**1,202,101,260**	**1,262,949,955**
NPV	**709,390,760**	
IRR	**23.2%**	

The Financial Analysis conducted from the InfraCo and Private Operator points of view, confirms the viability of the concession of railway operations to a private organisation. In fact:

- the Infraco will receive sufficient revenues from the Track Access Charges (TACs) paid by the Operators, to run the management and the proper maintenance of the infrastructure;
- the Private Operator will enjoy an attractive 23.2% rate of return from its operative expenses (opex, maintenance of rolling stock, TACs, etc.) through the freight and passenger tariffs during the project life.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 HOW TO IMPLEMENT THE MASTER PLAN

The final scope of the Master Plan is that of prefiguring a programmed development of the Rail Transport (and thence, the rail network and its ancillary facilities), which would strongly contribute to the socio-economic (besides environmental) status of the Country and, ultimately, elevating the role of Ghana within the West African context (ECOWAS), as well as in the whole of Africa.

The Study has identified certain priorities of intervention and suggests the financial solutions (PPP) to be adopted to raise the funding necessary to progressively implement the Plan.

However, other factors and interactions need to be taken into consideration as an essential presupposition to trigger the process, and in particular:

1. The development of an efficient structure having both the technical and organisational capacities and means that are necessary to follow and control the whole development of the Plan.
2. The investment planning and management
3. The realisation of a legal framework creating a favourable context conducive to private investors

7.1.1 Establishing a Master Plan Implementation Office (MPIO)

(i) This office can be created as a dedicated section of GRDA, on the grounds of the full range of responsibilities attributed to the Authority by the introduction of the Act 779, which already include, among others, the task "*to initiate, conduct, promote and encourage studies necessary for the growth and development of railways including the development of Master Plans in accordance with the Schedule to the Act.*"

As per above, the MPIO shall have an efficient structure having both the **technical** and **organisational capacities** and **means** that are necessary to follow and control the whole development of the Plan, thus **ensuring the continuity and regularity of the planned interventions**.

In particular, the MPIO shall **organize**, **follow** and **monitor** all the steps leading to the realization of all the subsequent preliminary and implementation phases, from **Feasibilities**, **Design** (various stages), **Tendering** and **Works Supervisions-**

(ii) Given the length of the time span foreseen for the progressive implementation of the various phases, a **periodical updating of the Plan** has to be expected.

In this regard, it has already been observed that the full validity of the study results also depends on the validity of the assumptions, e.g. on the parallel implementation of the various projects considered in the forecasting exercises for the other transport infrastructures (e.g. Roads, Ports and Harbours, Volta Lake...). Thus, monitoring of the actual progress of these initiatives has to be followed in so far as this can reflect on the said updating.

As a general rule, a prevision of an **updating of the Master Plan every five years** can be expected. However, this can be considered a relatively smooth process if it is effected using the same multimodal transport model constructed for this study.

7.1.2 Investment Planning and Management

- All the investments required for the development of the Plan must be carefully planned and submitted to the appropriate Government entities for approval. This work must begin immediately after the identification of the lines/sections intended to be progressively developed under the Plan, in order to secure the timely financing for the proposed investments. It has to be considered that, in addition to planning, the process of awarding contracts for studies, that are essential prerequisites for the proposals of private investment, must be previously launched.

  In point of fact, besides the general economic/financial feasibility analyzed and established by the Plan, at the large scale typical of a nationwide plan to be developed over quite a long time period, the feasibility of each proposed investment project must be fully established (thence the necessity for specific, fully documented, Feasibility Studies confirming the project's technical and financial viability).

- Financing options will then be developed and assessed by MPIO (or GRDA) that shall be organised and dedicated to the purpose, based on the findings of the specific feasibility or cost/benefit analyses. The results of the entire analyses and recommendations will then be presented to the relevant Authorities for approval.

- Upon approval, GRDA will then manage the tendering of the contracts for the design work and construction, or as the case may be for a private investor/operator to implement the project. In the case of the latter, tendering for construction will not be required, as construction will be the responsibility of the investor

7.1.3 Realisation of a legal framework creating a favourable context conducive to private investors

The importance of this subject has already been dealt with in Chapter 5, as well as with the recommendations. To that end, it is also recalled here in particular, how important it is for Ghana to create an environment that is conducive to market competition among transport modes, and that provides the railway with the commercial freedom in its operations. The new regulatory environment must also be consistent with the option selected for privatization. As a rule, to encourage private sector participation, economic regulation must be minimal and an unobtrusive safety regime established that reflects future operations and technologies.

7.2 CONCLUSION AND RECOMMENDATIONS

➢ ***Government's Commitment***:

The strategies described above depict a development framework that, although diluted over a quarter of a century, requires a very severe commitment for the Government, and for the whole Country. On the other hand, this appears to be the only means to confront in a resolute way the long outstanding problem of endowing the Country with a valid and organic transportation network fit for one of the most important nations on the whole African Continent.

Its implementation has, as a fundamental prerequisite, a STRONG POLITICAL WILL and the creation of a GENERAL CONSENSUS towards its implementation, so as to guarantee the CONTINUITY of this will, independently from the successive changes of the Government Administrations

It is worth noting how the launching of these said strategies would provide the unique occasion for the Nation to realize a modern railway system, functional and harmonically studied in a relatively short period (compared with the generally very long development of a complex railway network); contrary to what has happened in many other Countries where the railway system has developed, or is developing quite slowly, through numerous successive initiatives (often originated by regional interests), that are not co-ordinated and, as such, are often subject to failure.

➢ ***Recommendations for operative actions***

Assuming that the will existing behind the commissioning of this Report preludes a positive and firm decision, regardless of the financing solutions actually found, the following recommendations intend to highlight a number of essential actions that represent a fundamental component of a smooth implementation process, and whose timely programming will contribute to the satisfactory results of the initiatives:

i) Commissioning with no delay the necessary studies and essential propaedeutic activities, e.g.:

- Updated traffic demand study(ies)
- Feasibility studies for the single sections
- Aero-photo-mapping of the areas not covered by recent cartography
- Engineering design

ii) Specific exhortation, based on the Consultant's wide experience in similar contexts, to assure a full commitment by all political/administrative Authorities concerned in order to overcome all the obstacles eventually arising from expectable problems of:

- Land compensation
- Environmental impact
- Social policies
    - *Regularization of interferences with other services and infrastructures*; and last, but not least,
    - *Timeliness and regularity of payments to Contractors and Consultants*.

➢ ***Timeliness of Decisions and Monitoring***

It has already been noted how the process towards the realization of the various phases of the plan will have to consider a number of "technical" intermediate steps, starting from feasibility studies of the single sections and following with the various stages of survey and design, tendering, awarding, construction. On the other hand, the total success of the Plan, based upon an integrated study of all initiatives and steps, fully depends on the synchronization of the interconnected phases. Therefore, it is also necessary to establish an efficient instrument to monitor the course of development, checking all the relevant results in order to be in the position, at any time, to:

- establish the state of the art
- timely intervene if and when a hitch could endanger the achievement of the expected goals.

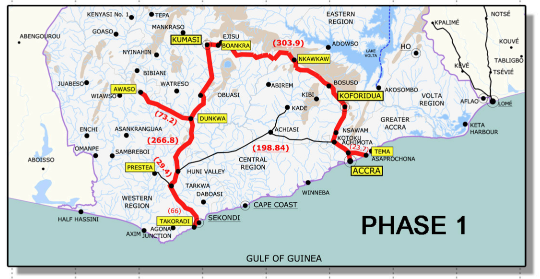
In this respect, the Consultants have deemed it useful to produce a preliminary **Overall Implementation Plan Schedule** showing in detail the execution items of all six phases (at next page). This Overall Implementation Plan would establish a number of milestones which will be technical and operational checking points to be complied with, in order to avoid unpredictable deferment of the whole programme (caused either directly and/or indirectly).

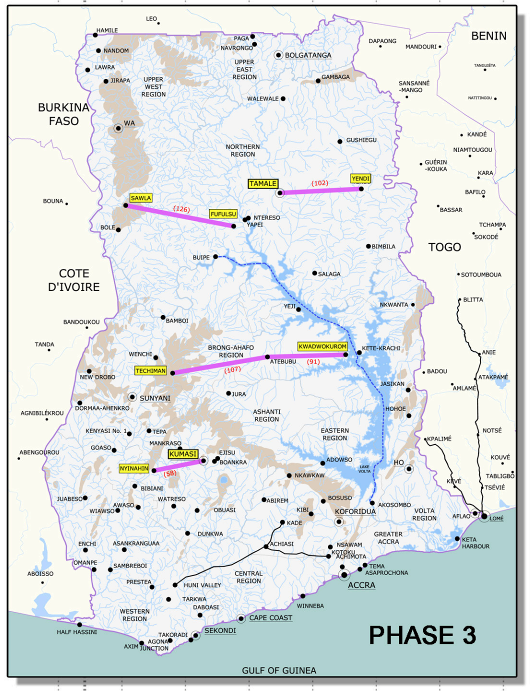
The Consultants recommend that the Government appoints a small **Steering Committee**, comprised of a restricted number of qualified people with strong technical background in management in both the public and private sectors. The Chairman of GRDA would be an ex-office member of the Steering Committee.

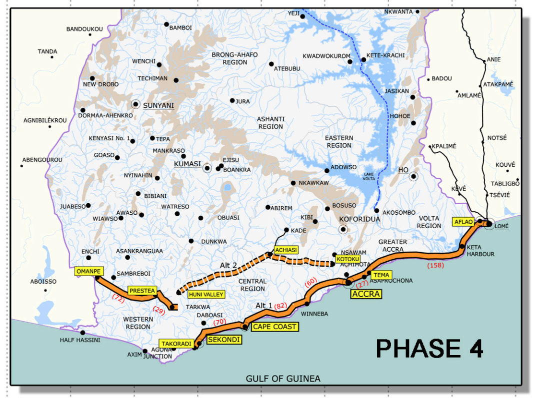
This Committee will keep the Presidency informed of progress, accomplishment and report on any roadblocks to success that may need intervention.

RAILWAY MASTER PLAN OF GHANA

ID	Task Name	Duration	Cost	km (tot)
1	ESTABLISH AN AGENCY, OPERATIONAL CHANGES, TRAINING	7 mo		
2	REHABILITATION, CONSTRUCTION OF NEW S.G. LINES	382.32 mo	mln $21,508	4008
3	PHASE 1: Rehabilitation of Ex. Lines	60 mo	mln $2,804	668
4	1W Western Line	48 mo	mln $1,428	340
5	1E Eastern Line	60 mo	mln $1,376	328
6	PHASE 2: Central Spine Expansion, St gauge	153.5 mo	mln $6,502	1161
7	2W Takoradi - Kumasi - Design	21 mo		
8	Pre-Feasibility/Feasibility Study	5 mo		
9	Surveys & Mapping	4 mo		
10	Design	6 mo		
11	Tender & Awarding	6 mo		
12	2W Takoradi - Kumasi - Construction	70 mo	mln $1,490	266
13	2E Accra - Kumasi - Design	21 mo		
18	2E Accra - Kumasi - Construction	71 mo	mln $1,680	300
19	2C1 Kumasi - Techiman - Tamale - Design	23.82 mo		
24	2C1 Kumasi - Techiman - Tamale - Construction	106 mo	mln $2,145	383
25	2C2 Tamale - Paga - Design	19 mo		
30	2C2 Tamale - Paga - Construction	58 mo	mln $1,187	212
31	PHASE 3: Trasversal Expansion	89.5 mo	mln $2,710	484
32	3.1 Tamale - Yendi - Design	15 mo		
33	Pre-Feasibility/Feasibility Study	3 mo		
34	Surveys & Mapping	2 mo		
35	Design	5 mo		
36	Tendering & Awarding	5 mo		
37	3.1 Tamale - Yendi - Construction	35 mo	mln $571	102
38	3.2 Fufulsu - Sawla - Design	15 mo		
43	3.2 Fufulsu - Sawla - Construction	35 mo	mln $706	126
44	3.3 Techiman - Kwadwokurom - Design	19 mo		
49	3.3 Techiman - Kwadwokurom - Construction	58 mo	mln $1,109	198
50	3.4 Nyinnahin - Kumasi - Design	13 mo		
55	3.4 Nyinnahin - Kumasi - Construction	20 mo	mln $325	58
56	PHASE 4: Trans Ecowas Expansion	84.5 mo	mln $2,789	498
57	4.1- Aflaho - Takoradi - Accra - Project	17 mo		
58	Pre-Feasibility/Feasibility Study	5 mo		
59	Surveys & Mapping	2 mo		
60	Design	4 mo		
61	Tendering & Awarding	6 mo		
62	4.1- Aflaho - Takoradi - Accra - Construction	46 mo	mln $1,036	185
63	4.2- Accra Takoradi - Design	14 mo		
67	4.2- Accra Takoradi - Construction	42 mo	mln $1,187	212
68	4.3- Tarkwa - Omanpe - Design	13 mo		
72	4.3- Tarkwa - Omanpe - Construction	20 mo	mln $566	101
73	PHASE 5: Western Expansion, New Standard Gauge	108.36 mo	mln $4,082	729
74	1- Dunkua - Awaso - Hamile - Project	14 mo		
75	Pre-Feasibility/Feasibility Study	3 mo		
76	Surveys & Mapping	1 mo		
77	Design	4 mo		
78	Tendering & Awarding	6 mo		
79	1- Dunkua - Awaso - Hamile - Construction	16 mo	mln $409	73
80	2- Awaso - Techiman - Design	19 mo		
85	2- Awaso - Techiman - Construction	54 mo	mln $1,232	220
86	3- Techiman - Sawla - Design	19 mo		
91	3- Techiman - Sawla - Construction	54 mo	mln $1,249	223
92	4- Sawla - Hamile - Design	19 mo		
97	4- Sawla - Hamile - Construction	54 mo	mln $1,193	213
98	PHASE 6: Eastern Expansion	97.68 mo	mln $2,621	468
99	1- Tema - Ho - Project	17 mo		
100	Pre-Feasibility/Feasibility Study	4 mo		
101	Surveys & Mapping	2 mo		
102	Design	5 mo		
103	Tendering & Awarding	6 mo		
104	1- Tema - Ho - Construction	30 mo	mln $728	130
105	2- Ho - Yendi - Design	21 mo		
110	2- Ho - Yendi - Construction	74 mo	mln $1,893	338







8. ANNEXES

8.1 ANNEX 1: FREIGHT AND PASSENGERS TRANSPORT COSTS

TRANSPORT COSTS US $			PHASE	0 BASE CASE	2015
WITHOUT PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_TRUCK_	TOT_FLOW	TOT TRSP COST	UNIT TRP COST	TOT_FLOW	TOT TRSP COST
0.42	204,996	**86,242**	0.25	1065	**262**
6.53	204,996	**1,337,680**	3.82	1065	**4,070**
0.02	204,996	**4,592**	0.01	1065	**14**
3.45	192,044	**661,803**	2.02	1353	**2,731**
6.39	98,438	**628,770**	3.74	899	**3,364**
0.12	9,245,880	**1,074,371**	0.07	99636	**6,781**
0.98	9,245,880	**9,035,074**	0.57	99636	**57,028**
0.51	200,018	**101,229**	0.30	22006	**6,523**
0.87	9,096,486	**7,870,279**	0.51	101428	**51,400**
0.28	200,018	**56,425**	0.17	22006	**3,636**
1.16	200,018	**231,721**	0.68	22006	**14,932**
0.31	200,018	**62,446**	0.18	22006	**4,024**
0.58	9,096,486	**5,278,691**	0.34	101428	**34,474**
0.66	11,413,702	**7,526,195**	0.39	137591	**53,140**
1.90	11,413,702	**21,707,721**	1.11	137591	**153,272**
2.43	1,574,985	**3,824,537**	1.42	100105	**142,379**
0.88	1,574,985	**1,379,215**	0.51	100105	**51,345**
0.16	1,574,985	**253,573**	0.09	100105	**9,440**
2.33	9,245,880	**21,571,563**	1.37	99636	**136,155**
0.41	4,460,855	**1,832,965**	0.24	53144	**12,790**
3.02	4,460,855	**13,480,257**	1.77	53144	**94,063**
0.00	7,756,518	**38,007**	0.00	23443	**67**
1.36	7,756,518	**10,533,352**	0.80	23443	**18,646**
0.07	7,756,518	**564,675**	0.04	23443	**1,000**
1.59	8,832,220	**14,052,946**	0.93	100954	**94,082**
0.09	8,832,220	**772,819**	0.05	100954	**5,174**
0.73	8,904,965	**6,507,749**	0.43	94414	**40,413**
2.99	8,904,965	**26,598,241**	1.75	94414	**165,174**
0.67	8,832,220	**5,916,704**	0.39	100954	**39,611**
0.09	7,756,518	**700,414**	0.05	23443	**1,240**
1.96	4,702,611	**9,197,367**	1.15	70099	**80,301**
0.15	11,720,811	**1,755,778**	0.09	106640	**9,357**
0.58	2,242,569	**1,299,793**	0.34	16757	**5,689**
0.02	11,720,811	**254,342**	0.01	106640	**1,355**
0.08	11,720,811	**976,344**	0.05	106640	**5,203**
0.09	11,720,811	**1,000,957**	0.05	106640	**5,334**
0.51	7,756,518	**3,936,433**	0.30	23443	**6,968**
4.67	7,679,610	**35,872,228**	2.74	22965	**62,829**
1.92	2,190,224	**4,199,317**	1.12	16618	**18,662**
0.57	2,190,224	**1,243,390**	0.33	16618	**5,526**
1.14	8,832,220	**10,046,651**	0.67	100954	**67,261**
0.04	8,832,220	**383,318**	0.03	100954	**2,566**
1.89	3,385,806	**6,415,764**	1.11	21060	**23,374**
2.47	3,385,806	**8,373,437**	1.45	21060	**30,506**
0.57	3,376,323	**1,933,282**	0.34	31759	**10,651**
0.00	1,326,289	**6,499**	0.00	41285	**118**
1.42	2,242,569	**3,186,690**	0.83	16644	**13,853**
0.14	2,242,569	**306,111**	0.08	16644	**1,331**
1.80	3,376,323	**6,062,187**	1.05	31759	**33,399**
0.04	3,376,323	**151,259**	0.03	31759	**833**
2.18	1,326,289	**2,890,116**	1.28	41285	**52,693**
2.33	920,445	**2,146,201**	1.37	14440	**19,721**
0.02	102,525	**1,938**	0.01	56	**1**
0.86	102,525	**88,417**	0.51	56	**28**
0.07	102,525	**6,818**	0.04	56	**2**

TRANSPORT COSTS US $			PHASE	0 BASE CASE	2015
WITHOUT PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_TRUCK_	TOT_FLOW	**TOT TRSP COST**	UNIT TRP COST	TOT_FLOW	**TOT TRSP COST**
2.64	91,932	**242,932**	1.55	676	**1,046**
1.42	91,932	**130,507**	0.83	676	**562**
6.83	91,932	**628,340**	4.00	676	**2,706**
3.16	91,932	**290,681**	1.85	676	**1,252**
0.07	102,525	**7,248**	0.04	56	**2**
0.05	102,525	**5,454**	0.03	56	**2**
0.08	1,607,317	**126,014**	0.05	8253	**379**
2.02	1,617,909	**3,266,235**	1.18	8263	**9,770**
2.66	585,962	**1,560,710**	1.56	2394	**3,735**
1.18	102,525	**121,358**	0.69	56	**39**
1.75	102,525	**178,916**	1.02	56	**57**
0.28	102,525	**28,420**	0.16	56	**9**
0.93	102,525	**95,379**	0.54	56	**30**
1.04	102,525	**106,503**	0.61	56	**34**
2.25	102,525	**230,803**	1.32	56	**74**
0.01	2,953,250	**37,211**	0.01	12836	**95**
0.05	2,953,250	**142,642**	0.03	12836	**363**
1.00	1,784,989	**1,791,772**	0.59	560	**329**
0.93	1,168,261	**1,088,469**	0.55	12392	**6,762**
2.08	2,953,250	**6,139,806**	1.22	12836	**15,630**
5.75	3,232,287	**18,578,216**	3.37	9218	**31,031**
2.93	817,904	**2,398,913**	1.72	8411	**14,449**
0.98	2,693,128	**2,635,495**	0.57	1675	**960**
0.04	3,232,287	**113,130**	0.02	9218	**189**
2.62	6,017,015	**15,735,697**	1.53	16938	**25,945**
4.17	7,300,219	**30,451,402**	2.44	23241	**56,781**
0.02	7,300,219	**158,415**	0.01	23241	**295**
0.01	6,017,015	**88,450**	0.01	16938	**146**
0.95	6,017,015	**5,732,410**	0.56	16938	**9,452**
2.98	6,017,015	**17,959,586**	1.75	16938	**29,612**
2.33	1,525,650	**3,555,222**	1.36	7761	**10,593**
4.47	243,275	**1,088,169**	2.62	1046	**2,740**
2.09	1,617,909	**3,378,356**	1.22	8263	**10,106**
1.73	234,122	**404,632**	1.01	1141	**1,155**
2.68	234,122	**627,189**	1.57	1141	**1,791**
0.06	7,157,093	**440,877**	0.04	23621	**852**
0.83	58,918	**48,708**	0.48	1730	**838**
0.71	118,148	**83,613**	0.41	2399	**994**
4.04	58,918	**237,847**	2.36	1730	**4,090**
5.60	118,148	**661,628**	3.28	2399	**7,867**
0.11	7,157,093	**756,505**	0.06	23621	**1,462**
3.03	7,157,093	**21,653,069**	1.77	23621	**41,858**
1.48	7,157,093	**10,621,126**	0.87	23621	**20,532**
0.88	192,044	**168,442**	0.51	1353	**695**
2.79	7,624,933	**21,264,413**	1.63	30777	**50,272**
1.38	7,624,933	**10,536,132**	0.81	30777	**24,909**
3.05	1,547,758	**4,714,006**	1.78	7943	**14,169**
0.39	2,297,064	**902,057**	0.23	14654	**3,371**
0.08	7,679,610	**591,330**	0.05	22965	**1,036**
1.58	2,227,221	**3,521,905**	0.93	16650	**15,421**
1.62	7,679,610	**12,434,057**	0.95	22965	**21,778**
1.88	804,710	**1,515,269**	1.10	4429	**4,885**
3.39	2,190,224	**7,418,947**	1.98	16618	**32,971**
0.86	87,213	**74,846**	0.50	1107	**556**
2.01	353,936	**712,297**	1.18	8067	**9,510**
2.55	804,710	**2,054,907**	1.50	4429	**6,624**

TRANSPORT COSTS US $			PHASE	0 BASE CASE	2015
WITHOUT PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_TRUCK_	TOT_FLOW	**TOT TRSP COST**	UNIT TRP COST	TOT_FLOW	**TOT TRSP COST**
0.98	136,732	**134,476**	0.58	422	**243**
4.83	0	**0**	2.83	273	**772**
0.15	1,547,758	**234,021**	0.09	7943	**703**
1.73	1,547,758	**2,680,407**	1.01	7943	**8,057**
0.44	1,547,758	**682,561**	0.26	7943	**2,052**
0.25	2,190,224	**539,671**	0.14	16618	**2,398**
0.20	87,213	**17,216**	0.12	1107	**128**
1.31	87,213	**114,467**	0.77	1107	**851**
0.76	87,213	**66,055**	0.44	1107	**491**
2.12	87,213	**184,734**	1.24	1107	**1,374**
0.95	87,213	**83,149**	0.56	1107	**618**
0.35	87,213	**30,525**	0.21	1107	**227**
1.87	87,213	**163,245**	1.10	1107	**1,214**
0.08	87,213	**7,265**	0.05	1107	**54**
0.07	87,213	**5,678**	0.04	1107	**42**
0.14	2,297,064	**318,373**	0.08	14654	**1,190**
1.77	353,936	**627,564**	1.04	8067	**8,378**
0.03	2,318,352	**63,291**	0.02	55031	**880**
3.99	2,318,352	**9,253,471**	2.34	55031	**128,653**
0.05	2,318,352	**110,354**	0.03	55031	**1,534**
0.81	786,773	**637,207**	0.47	8447	**4,007**
0.36	786,773	**280,878**	0.21	8447	**1,766**
5.97	118,148	**705,792**	3.50	2399	**8,392**
0.48	786,773	**377,808**	0.28	8447	**2,376**
0.89	786,773	**699,441**	0.52	8447	**4,399**
0.16	2,866,274	**471,502**	0.10	85443	**8,232**
1.10	2,866,274	**3,150,035**	0.64	85443	**55,000**
0.14	2,866,274	**409,304**	0.08	85443	**7,146**
0.59	634,511	**373,093**	0.34	43158	**14,864**
1.44	243,976	**350,789**	0.84	9106	**7,668**
1.40	2,318,352	**3,234,333**	0.82	55031	**44,968**
1.18	786,773	**929,651**	0.69	8447	**5,846**
2.04	786,773	**1,602,656**	1.19	8447	**10,079**
0.99	786,773	**779,849**	0.58	8447	**4,904**
1.03	0	**0**	0.60	273	**165**
0.29	0	**0**	0.17	273	**46**
2.21	0	**0**	1.29	108	**140**
2.11	0	**0**	1.24	108	**134**
0.39	0	**0**	0.23	108	**25**
2.14	0	**0**	1.25	108	**135**
3.97	0	**0**	2.32	125	**289**
1.16	0	**0**	0.68	125	**85**
2.29	168,210	**385,858**	1.34	675	**907**
0.29	168,210	**49,218**	0.17	627	**107**
2.01	8,573,141	**17,241,445**	1.18	55760	**65,682**
4.71	4,264,842	**20,082,716**	2.76	11670	**32,188**
2.14	395,962	**845,379**	1.25	9881	**12,357**
1.13	395,962	**449,021**	0.66	9881	**6,563**
0.65	395,962	**258,326**	0.38	9881	**3,776**
0.28	395,962	**110,315**	0.16	9881	**1,612**
1.36	395,962	**539,657**	0.80	9881	**7,888**
0.01	8,573,141	**84,017**	0.01	55760	**320**
0.17	8,573,141	**1,464,293**	0.10	55760	**5,578**
1.52	395,962	**601,189**	0.89	9881	**8,787**
1.27	2,866,274	**3,637,588**	0.74	85443	**63,512**
0.65	1,574,985	**1,028,623**	0.38	100105	**38,293**

TRANSPORT COSTS US $			PHASE	0 BASE CASE	2015
WITHOUT PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_TRUCK_	TOT_FLOW	TOT TRSP COST	UNIT TRP COST	TOT_FLOW	TOT TRSP COST
1.27	1,574,985	**1,994,404**	0.74	100105	**74,247**
1.34	6,982,385	**9,325,673**	0.78	100003	**78,231**
0.87	2,930,192	**2,541,356**	0.51	86899	**44,144**
0.03	3,522,596	**98,633**	0.02	83514	**1,370**
0.04	3,445,976	**149,555**	0.03	88622	**2,253**
0.07	3,488,007	**234,394**	0.04	56225	**2,213**
0.39	6,933,983	**2,698,706**	0.23	144848	**33,020**
0.98	1,233,576	**1,211,495**	0.58	73681	**42,384**
1.87	11,413,702	**21,348,189**	1.10	137591	**150,734**
0.44	1,233,576	**538,826**	0.26	73681	**18,851**
0.35	1,233,576	**430,888**	0.20	73681	**15,074**
0.11	11,413,702	**1,238,387**	0.06	137591	**8,744**
1.40	3,749,879	**5,260,330**	0.82	32749	**26,908**
1.71	3,749,879	**6,415,292**	1.00	32749	**32,816**
0.14	3,749,879	**540,733**	0.08	32749	**2,766**
3.65	2,250,915	**8,207,512**	2.14	9439	**20,159**
0.50	2,250,915	**1,128,159**	0.29	9439	**2,771**
0.23	3,221,091	**753,091**	0.14	14136	**1,936**
0.51	3,221,091	**1,643,723**	0.30	14136	**4,225**
0.43	2,156,651	**920,890**	0.25	74269	**18,575**
0.28	2,156,651	**600,843**	0.16	74269	**12,119**
2.05	2,156,651	**4,417,253**	1.20	74269	**89,098**
1.55	3,749,879	**5,801,062**	0.91	32749	**29,674**
0.20	1,233,576	**242,644**	0.12	73681	**8,489**
0.94	1,233,576	**1,156,231**	0.55	73681	**40,450**
0.63	4,460,855	**2,816,584**	0.37	53144	**19,654**
0.91	1,233,576	**1,116,510**	0.53	73681	**39,061**
1.21	1,233,576	**1,498,178**	0.71	73681	**52,413**
0.06	1,233,576	**72,534**	0.03	73681	**2,538**
1.23	2,156,651	**2,652,465**	0.72	74269	**53,501**
0.07	1,233,576	**88,941**	0.04	73681	**3,112**
0.15	2,250,915	**341,914**	0.09	9439	**840**
0.05	2,250,915	**122,900**	0.03	9439	**302**
0.87	0	**0**	0.51	3870	**1,980**
3.49	1,525,650	**5,329,095**	2.05	7761	**15,879**
0.88	91,932	**81,084**	0.52	676	**349**
1.78	2,318,352	**4,136,636**	1.05	55031	**57,513**
0.30	243,976	**74,291**	0.18	9106	**1,624**
0.45	2,318,352	**1,049,982**	0.27	55031	**14,598**
1.75	243,976	**426,446**	1.02	9106	**9,322**
0.14	8,904,965	**1,252,929**	0.08	94414	**7,781**
1.37	234,122	**320,723**	0.80	1141	**916**
0.50	1,617,909	**809,764**	0.29	8263	**2,422**
2.13	1,617,909	**3,453,104**	1.25	8263	**10,329**
2.50	2,930,192	**7,320,499**	1.46	86899	**127,159**
6.68	28,089	**187,635**	3.91	465	**1,821**
2.56	1,547,758	**3,966,439**	1.50	7943	**11,922**
0.14	234,122	**33,105**	0.08	1141	**95**
2.99	6,937,549	**20,736,334**	1.75	22851	**40,004**
6.67	6,924,118	**46,181,095**	3.91	22529	**88,009**
0.04	786,773	**31,392**	0.02	8447	**197**
0.67	2,759,811	**1,844,934**	0.39	7752	**3,035**
8.92	28,089	**250,534**	5.22	465	**2,431**
5.46	0	**0**	3.20	113	**360**
6.50	136,732	**888,596**	3.81	36	**137**
4.14	136,732	**566,140**	2.43	149	**360**

TRANSPORT COSTS US $			PHASE	0 BASE CASE	2015
WITHOUT PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_TRUCK_	TOT_FLOW	TOT TRSP COST	UNIT TRP COST	TOT_FLOW	TOT TRSP COST
TOTAL COSTS WITHOUT PROJECT		747.607.107	TOTAL COSTS WITHOUT PROJECT		4.086.616

TRANSPORT COSTS US $			PHASE	1 W-NG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
0.2298	106,685	**24,516**	0.1719	8,519	**1,464**
2.7033	106,685	**288,403**	2.1701	8,519	**18,487**
0.0122	106,685	**1,302**	0.0092	8,519	**78**
2.6369	93,734	**247,166**	1.5153	502	**761**
4.8875	127	**621**	2.8086	48	**135**
0.0636	9,116,214	**579,791**	0.0475	64,103	**3,045**
0.5341	9,116,214	**4,868,970**	0.3996	64,103	**25,616**
0.2765	200,018	**55,305**	0.2069	22,183	**4,590**
0.4698	8,966,819	**4,212,612**	0.3485	65,719	**22,903**
0.1540	200,018	**30,803**	0.1152	22,183	**2,556**
0.6329	200,018	**126,591**	0.4735	22,183	**10,504**
0.1694	200,018	**33,883**	0.1256	22,183	**2,786**
0.3169	8,966,819	**2,841,585**	0.2371	65,719	**15,582**
0.3883	11,284,077	**4,381,607**	0.2901	101,882	**29,556**
1.0393	11,284,077	**11,727,541**	0.7776	101,882	**79,223**
1.3270	1,574,985	**2,090,005**	0.9927	99,673	**98,946**
0.5156	1,574,985	**812,062**	0.3852	99,673	**38,394**
0.0881	1,574,985	**138,756**	0.0659	99,928	**6,585**
0.9666	9,116,214	**8,811,732**	0.7671	64,103	**49,174**
0.1584	3,820,712	**605,201**	0.1281	47,875	**6,133**
1.1655	3,820,712	**4,453,039**	0.9428	47,875	**45,137**
0.2250	7,758,476	**1,745,657**	0.1782	0	**0**
0.7039	8,702,674	**6,125,812**	0.5575	65,501	**36,517**
0.0388	8,702,674	**337,664**	0.0308	65,501	**2,017**
0.2819	8,775,299	**2,473,757**	0.2280	58,953	**13,441**
1.2373	8,775,299	**10,857,677**	0.9933	58,953	**58,558**
0.2990	8,702,674	**2,602,099**	0.2368	65,501	**15,511**
0.0620	845,766	**52,437**	0.0465	15,686	**729**
0.7543	3,858,164	**2,910,213**	0.6102	56,939	**34,744**
0.0622	11,591,226	**720,974**	0.0494	118,708	**5,864**
0.2401	2,308,568	**554,287**	0.1906	19,209	**3,661**
0.0098	11,591,226	**113,594**	0.0077	118,708	**914**
0.0346	11,591,226	**401,056**	0.0274	118,708	**3,253**
0.0378	11,591,226	**438,148**	0.0300	118,708	**3,561**
2.5522	7,681,568	**19,604,898**	1.9094	31,575	**60,290**
0.7396	2,252,039	**1,665,608**	0.5983	16,876	**10,097**
0.2190	2,252,039	**493,197**	0.1771	16,876	**2,989**
0.5044	8,702,674	**4,389,629**	0.3995	65,501	**26,167**
0.0191	8,702,674	**166,221**	0.0151	65,501	**989**
0.7309	2,616,030	**1,912,056**	0.5912	15,915	**9,409**
0.9540	2,616,030	**2,495,692**	0.7717	15,915	**12,282**
0.2372	2,664,711	**632,069**	0.1883	25,862	**4,870**

TRANSPORT COSTS US $				PHASE	1 W-NG	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
0.0031	1,193,454	**3,700**		0.0023	34,041	**78**
0.5888	2,307,764	**1,358,811**		0.4673	16,919	**7,906**
0.0566	2,307,764	**130,619**		0.0450	16,919	**761**
0.7438	2,664,711	**1,982,012**		0.5903	25,862	**15,266**
0.0275	2,664,711	**73,280**		0.0205	25,862	**530**
1.1908	1,193,454	**1,421,165**		0.8909	34,041	**30,327**
1.2118	443,435	**537,354**		0.9066	10,856	**9,842**
0.0101	101,922	**1,029**		0.0075	56	**0**
0.5302	101,922	**54,039**		0.3956	56	**22**
0.0363	101,922	**3,700**		0.0269	56	**2**
1.6252	92,758	**150,750**		1.2127	676	**820**
0.8721	92,758	**80,894**		0.6582	676	**445**
4.0227	93,319	**375,396**		3.0052	676	**2,031**
1.8520	93,319	**172,827**		1.3768	676	**930**
0.0383	101,922	**3,904**		0.0284	56	**2**
0.0289	101,922	**2,946**		0.0214	56	**1**
0.0429	1,606,498	**68,919**		0.0321	8,253	**265**
1.1033	1,616,522	**1,783,509**		0.8254	8,263	**6,820**
1.6381	586,787	**961,216**		1.2223	2,394	**2,926**
0.7279	101,922	**74,189**		0.5432	56	**30**
1.0734	101,922	**109,403**		0.8009	56	**45**
0.1703	102,525	**17,460**		0.1271	56	**7**
2.0097	602	**1,211**		1.4941	0	**0**
0.5721	101,922	**58,310**		0.4269	56	**24**
0.6380	101,922	**65,026**		0.4815	56	**27**
1.3846	101,922	**141,121**		1.0332	56	**58**
0.0244	2,954,637	**72,093**		0.0197	12,836	**253**
0.3867	1,784,989	**690,255**		0.3128	560	**175**
0.5086	1,169,648	**594,883**		0.3805	12,392	**4,715**
0.8019	2,954,637	**2,369,323**		0.6487	12,836	**8,327**
3.1409	3,330,597	**10,461,074**		2.3498	10,069	**23,659**
1.8038	916,215	**1,652,668**		1.3460	9,206	**12,391**
0.5759	2,693,128	**1,550,972**		0.4302	1,675	**721**
0.0190	3,330,597	**63,281**		0.0142	10,069	**143**
1.0087	6,116,712	**6,169,928**		0.8159	17,789	**14,514**
0.3578	7,299,996	**2,611,939**		0.2840	31,646	**8,987**
0.0086	7,299,996	**62,780**		0.0068	31,646	**215**
0.0091	6,116,712	**55,662**		0.0068	17,789	**121**
0.3675	6,116,712	**2,247,892**		0.2973	17,789	**5,289**
1.1514	6,116,712	**7,042,782**		0.9313	17,789	**16,567**
1.4331	1,526,918	**2,188,227**		1.0694	7,761	**8,300**
2.7508	235,867	**648,822**		2.0525	1,040	**2,135**
1.1412	1,616,522	**1,844,775**		0.8537	8,263	**7,054**
1.0631	231,466	**246,072**		0.7933	1,141	**905**
3.1209	22,756	**71,021**		2.3555	680	**1,602**
1.6475	231,466	**381,340**		1.2293	1,141	**1,403**
0.0238	7,255,180	**172,673**		0.0193	24,472	**472**
0.5874	58,918	**34,609**		0.3380	8,383	**2,833**
0.5656	118,148	**66,824**		0.3247	8,208	**2,665**
3.2275	58,918	**190,158**		1.8525	8,383	**15,529**

TRANSPORT COSTS US $			PHASE	1 W-NG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
4.2849	118,148	**506,252**	2.4624	8,208	**20,211**
0.0408	7,255,180	**296,011**	0.0330	24,472	**808**
1.1670	7,255,180	**8,466,796**	0.9440	24,472	**23,102**
0.5725	7,255,180	**4,153,591**	0.4631	24,472	**11,333**
0.7014	93,734	**65,745**	0.4026	502	**202**
1.5237	7,619,073	**11,609,182**	1.1399	39,219	**44,705**
0.7550	7,619,073	**5,752,400**	0.5648	39,219	**22,151**
1.7926	1,560,908	**2,798,084**	1.3392	7,948	**10,644**
0.2147	2,311,733	**496,329**	0.1606	14,665	**2,355**
2.5000	1,631,659	**4,079,149**	0.8000	0	**0**
0.8602	2,243,742	**1,930,067**	0.6381	16,835	**10,742**
0.0220	875,886	**19,270**	0.0164	4,869	**80**
1.3066	2,252,039	**2,942,514**	1.0569	16,876	**17,836**
0.3555	87,213	**31,004**	0.2821	1,107	**312**
1.0996	351,978	**387,035**	0.8227	7,904	**6,503**
1.5029	875,886	**1,316,370**	1.1227	4,869	**5,466**
0.5789	72,959	**42,236**	0.4325	770	**333**
2.9696	3,703	**10,996**	2.2158	2,854	**6,323**
0.0929	1,560,908	**145,008**	0.0701	7,948	**557**
1.0636	1,560,908	**1,660,182**	0.8028	7,948	**6,381**
0.2597	1,560,908	**405,368**	0.1940	7,948	**1,542**
0.0950	2,252,039	**213,944**	0.0768	16,876	**1,296**
0.0818	87,213	**7,134**	0.0649	1,107	**72**
0.5436	87,213	**47,409**	0.4314	1,107	**478**
0.4657	87,213	**40,615**	0.3475	1,107	**385**
1.3013	87,213	**113,490**	0.9216	1,107	**1,020**
0.3676	87,213	**32,059**	0.2974	1,107	**329**
0.1349	87,213	**11,765**	0.1091	1,107	**121**
0.7220	87,213	**62,968**	0.5840	1,107	**647**
0.0321	87,213	**2,800**	0.0260	1,107	**29**
0.0268	87,213	**2,337**	0.0213	1,107	**24**
0.0772	2,311,733	**178,466**	0.0578	14,665	**848**
0.9732	351,978	**342,545**	0.7281	7,904	**5,755**
0.0150	2,318,352	**34,775**	0.0112	52,608	**589**
3.0393	2,318,352	**7,046,168**	1.7381	52,608	**91,437**
0.0258	2,318,352	**59,813**	0.0191	52,608	**1,005**
0.5696	786,773	**448,146**	0.3278	0	**0**
0.2537	786,773	**199,604**	0.1460	0	**0**
4.7758	118,148	**564,251**	2.7412	8,208	**22,500**
0.3672	786,773	**288,903**	0.2110	0	**0**
0.6800	786,773	**535,005**	0.3907	0	**0**
0.0897	2,866,274	**257,105**	0.0671	83,166	**5,580**
0.4554	2,866,274	**1,305,301**	0.3614	83,166	**30,056**
0.0779	2,866,274	**223,283**	0.0583	83,166	**4,849**
0.3213	634,511	**203,868**	0.2404	43,158	**10,375**
0.7858	243,976	**191,717**	0.5879	9,106	**5,353**
1.0621	2,318,352	**2,462,322**	0.6074	52,608	**31,954**
0.9040	786,773	**711,243**	0.5195	0	**0**
1.5588	786,773	**1,226,421**	0.8958	0	**0**
0.7546	786,773	**593,699**	0.4315	0	**0**

TRANSPORT COSTS US $				PHASE	1 W-NG	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
0.6058	3,703	**2,243**		0.4526	2,854	**1,292**
0.1683	3,703	**623**		0.1257	2,854	**359**
1.3594	3,703	**5,034**		1.0144	2,689	**2,727**
1.2988	3,703	**4,809**		0.9691	2,689	**2,606**
0.2385	3,703	**883**		0.1779	2,689	**478**
1.1602	3,703	**4,296**		0.8606	2,689	**2,314**
2.4403	1	**3**		1.8209	576	**1,048**
0.7138	1	**1**		0.5326	576	**307**
0.9503	168,211	**159,851**		0.7542	1,126	**850**
0.1211	168,210	**20,370**		0.0961	627	**60**
0.8333	5,548,962	**4,623,950**		0.6613	50,393	**33,325**
0.0589	1,823,632	**107,412**		0.0466	10,593	**494**
0.8235	395,963	**326,076**		0.6661	10,436	**6,951**
0.6195	395,939	**245,284**		0.4634	10,429	**4,833**
0.2702	395,939	**106,983**		0.2145	10,429	**2,237**
0.1523	395,939	**60,302**		0.1140	10,429	**1,189**
0.7446	395,939	**294,816**		0.5570	10,429	**5,809**
0.0040	5,907,107	**23,628**		0.0032	51,827	**166**
0.0087	517,690	**4,504**		0.0069	1,434	**10**
0.0708	8,573,116	**606,977**		0.0562	56,280	**3,163**
0.0080	2,822,901	**22,583**		0.0064	4,454	**29**
0.6289	395,939	**249,006**		0.4991	10,429	**5,205**
0.0069	3,340,591	**23,050**		0.0051	5,888	**30**
0.1020	3,340,591	**340,740**		0.0761	5,888	**448**
0.5630	2,866,274	**1,613,712**		0.4458	83,166	**37,076**
0.2705	1,574,985	**426,033**		0.2147	99,673	**21,400**
0.5247	1,574,985	**826,395**		0.4164	99,673	**41,504**
0.0645	0	**0**		0.0518	6,526	**338**
0.4838	6,982,385	**3,378,078**		0.4094	91,683	**37,535**
0.3478	2,930,192	**1,019,121**		0.2814	84,623	**23,813**
0.0171	4,038,693	**69,062**		0.0128	76,358	**977**
0.0266	3,667,922	**97,567**		0.0199	87,411	**1,739**
0.0412	3,266,061	**134,562**		0.0308	49,379	**1,521**
0.1612	6,933,983	**1,117,758**		0.1280	149,604	**19,149**
0.4069	1,363,202	**554,687**		0.3230	77,134	**24,914**
0.3023	11,284,077	**3,411,176**		0.2262	104,317	**23,596**
0.1810	1,363,202	**246,740**		0.1437	73,485	**10,560**
0.1895	1,363,202	**258,327**		0.1406	73,485	**10,332**
0.0593	11,284,077	**669,146**		0.0443	104,317	**4,621**
0.5410	2,980,098	**1,612,233**		0.4376	27,468	**12,020**
0.6599	2,980,098	**1,966,567**		0.5338	27,468	**14,662**
0.0555	2,980,098	**165,395**		0.0449	27,468	**1,233**
2.1463	300,607	**645,193**		1.6034	6,201	**9,943**
0.2722	300,607	**81,825**		0.2050	6,201	**1,271**
0.0903	2,451,274	**221,350**		0.0730	8,991	**656**
0.0671	2,451,274	**164,480**		0.0542	8,991	**487**
0.2511	2,286,277	**574,084**		0.1876	74,076	**13,897**
0.1642	2,286,277	**375,407**		0.1226	74,076	**9,082**
1.2057	2,286,277	**2,756,564**		0.9007	74,076	**66,720**
0.5957	2,980,098	**1,775,244**		0.4819	27,468	**13,237**

TRANSPORT COSTS US $			PHASE	1 W-NG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
0.1157	1,363,202	**157,722**	0.0865	73,485	**6,356**
0.5123	1,363,202	**698,368**	0.3833	73,485	**28,167**
0.3888	3,820,712	**1,485,493**	0.2901	47,875	**13,889**
0.4945	1,363,202	**674,103**	0.3699	73,485	**27,182**
0.7146	1,363,202	**974,144**	0.5339	73,485	**39,234**
0.0321	1,363,202	**43,759**	0.0240	73,485	**1,764**
0.6723	2,286,277	**1,537,064**	0.5030	74,076	**37,260**
0.0425	1,363,202	**57,936**	0.0318	73,485	**2,337**
0.0977	300,607	**29,369**	0.0725	6,201	**450**
0.0300	333,233	**9,997**	0.0224	6,594	**148**
0.2646	98,310	**26,013**	0.1997	3,019	**603**
2.1480	1,526,918	**3,279,821**	1.6028	7,761	**12,440**
0.5166	92,758	**47,919**	0.3840	676	**260**
1.3588	2,318,352	**3,150,177**	0.7771	52,608	**40,881**
0.1655	243,976	**40,378**	0.1227	9,106	**1,117**
0.3450	2,318,352	**799,832**	0.1973	52,608	**10,379**
0.9490	243,976	**231,534**	0.7039	9,106	**6,410**
0.0582	8,775,299	**510,722**	0.0467	58,883	**2,750**
0.8423	231,466	**194,964**	0.6285	1,141	**717**
0.2733	1,616,522	**441,796**	0.2045	8,263	**1,690**
1.1663	1,616,522	**1,885,350**	0.8726	8,263	**7,210**
0.9648	2,930,192	**2,827,049**	0.7804	84,623	**66,040**
1.5759	1,560,908	**2,459,835**	1.1759	7,948	**9,346**
0.0871	231,466	**20,161**	0.0650	1,141	**74**
1.1530	6,936,280	**7,997,531**	0.9326	31,298	**29,188**
0.1823	6,910,968	**1,259,869**	0.1353	30,971	**4,190**
0.0245	786,773	**19,276**	0.0183	0	**0**
0.3629	318,580	**115,613**	0.2692	6,667	**1,795**
0.0614	3,340,591	**205,112**	0.0698	5,888	**411**
0.1193	3,340,591	**398,533**	0.1356	5,888	**798**
0.2105	3,340,591	**703,194**	0.2393	5,888	**1,409**
0.0506	3,340,591	**169,034**	0.0575	5,888	**339**
0.2332	1,181,768	**275,588**	0.2651	6,273	**1,663**
0.4703	779,437	**366,569**	0.5346	10,812	**5,780**
0.1649	2,845,980	**469,302**	0.1874	5,888	**1,103**
0.5089	2,846,048	**1,448,354**	0.5785	5,888	**3,406**
0.1603	824,746	**132,207**	0.1823	0	**0**
0.4971	1,631,659	**811,098**	0.5651	0	**0**
0.0558	0	**0**	0.0635	3,651	**232**
0.1663	0	**0**	0.1890	34,848	**6,586**
0.0667	0	**0**	0.0758	41,295	**3,130**
0.2641	0	**0**	0.3002	43,923	**13,186**
0.6450	0	**0**	0.7332	43,995	**32,257**
0.1672	0	**0**	0.1900	6,526	**1,240**
0.0365	0	**0**	0.0415	6,526	**271**
0.3050	0	**0**	0.3467	43,923	**15,228**
3.9317	28,089	**110,436**	2.9372	465	**1,367**
2.5000	3,340,591	**8,351,478**	0.8000	5,888	**4,710**
2.5000	0	**0**	1.5000	6,526	**9,788**
0.0000	0	**0**	0.8000	24,672	**19,737**

TRANSPORT COSTS US $				PHASE	1 W-NG	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
0.0000	0	**0**		0.8000	3,651	**2,921**
0.7197	11,284,077	**8,121,150**		0.5384	110,764	**59,635**
0.0000	0	**0**		0.8000	6,447	**5,157**
0.0000	0	**0**		0.8000	2,435	**1,948**
0.2608	0	**0**		0.2964	43,731	**12,962**
0.0000	0	**0**		0.8000	76	**61**
0.0000	0	**0**		0.8000	264	**211**
3.5000	779,437	**2,728,031**		0.1000	44,375	**4,438**
2.5000	402,331	**1,005,827**		0.8000	4,865	**3,892**
2.5000	32,626	**81,565**		0.8000	397	**317**
2.0300	1,823,632	**3,701,974**		1.6076	10,593	**17,030**
2.5000	70	**175**		0.0000	0	**0**
1.3704	7,299,996	**10,003,914**		1.0876	31,646	**34,418**
3.4382	6,910,968	**23,761,289**		2.5503	30,971	**78,986**
0.2719	98,310	**26,731**		0.2052	3,019	**619**
1.0865	875,886	**951,651**		0.8117	4,869	**3,952**
0.3166	0	**0**		0.3599	43,923	**15,808**
2.9640	69,257	**205,276**		1.9238	2,290	**4,405**
2.5000	824,746	**2,061,866**		0.8000	0	**0**
5.2497	28,089	**147,457**		3.9218	465	**1,825**
3.3566	804	**2,699**		2.5333	2,290	**5,801**
1.5532	24	**37**		1.1603	56	**65**
2.3087	24	**56**		1.7247	56	**97**
1.1773	23	**27**		0.8795	68	**60**
0.8183	23	**19**		0.6113	68	**42**
3.9891	68,454	**273,070**		3.0107	0	**1**
TRANSPORT COSTS PHASE 1W		**351,551,471**		**TRANSPORT COSTS PHASE 1W**		**2,599,326**

TRANSPORT COSTS US $			PHASE	1 E NG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
0.2298	106,685	**24,516**	0.1719	754	**130**
2.7033	106,685	**288,403**	2.1701	754	**1,637**
0.0122	106,685	**1,302**	0.0092	754	**7**
2.6369	93,734	**247,166**	1.5153	928	**1,407**
4.8875	127	**621**	2.8086	474	**1,332**
0.0636	7,388,235	**469,892**	0.0475	40,179	**1,909**
0.5341	7,388,235	**3,946,056**	0.3996	40,179	**16,056**
0.2765	200,018	**55,305**	0.2069	22,004	**4,553**
0.4698	7,238,841	**3,400,807**	0.3485	41,973	**14,628**
0.1540	200,018	**30,803**	0.1152	22,004	**2,535**
0.6329	200,018	**126,591**	0.4735	22,004	**10,419**
0.1694	200,018	**33,883**	0.1256	22,004	**2,764**
0.3169	7,238,841	**2,293,989**	0.2371	41,973	**9,952**
0.3883	9,556,098	**3,710,633**	0.2901	78,136	**22,667**
1.0393	9,556,098	**9,931,653**	0.7776	78,136	**60,759**
1.3270	1,574,985	**2,090,005**	0.9927	100,108	**99,377**
0.5156	1,574,985	**812,062**	0.3852	100,108	**38,562**
0.0881	1,574,985	**138,756**	0.0659	100,107	**6,597**
0.9666	7,388,235	**7,141,468**	0.7671	40,179	**30,822**
0.1584	4,605,230	**729,469**	0.1281	53,409	**6,842**
1.1655	4,605,230	**5,367,396**	0.9428	53,409	**50,354**
0.2250	7,738,920	**1,741,257**	0.1782	24,296	**4,330**
0.7039	8,813,594	**6,203,889**	0.5575	41,644	**23,217**
0.0388	8,813,594	**341,967**	0.0308	41,644	**1,283**
0.2819	7,047,320	**1,986,640**	0.2280	35,096	**8,002**
1.2373	7,047,320	**8,719,649**	0.9933	35,096	**34,861**
0.2990	6,974,695	**2,085,434**	0.2368	41,644	**9,861**
0.0622	758,311	**47,167**	0.0465	11,580	**538**
0.7543	4,666,149	**3,519,676**	0.6102	67,541	**41,214**
0.0622	11,702,147	**727,874**	0.0494	141,442	**6,987**
0.2401	2,507,875	**602,141**	0.1906	18,785	**3,580**
0.0098	11,702,147	**114,681**	0.0077	141,442	**1,089**
0.0346	11,702,147	**404,894**	0.0274	141,442	**3,876**
0.0378	11,702,147	**442,341**	0.0300	141,442	**4,243**
2.5522	7,662,012	**19,554,988**	1.9094	23,818	**45,479**
0.7396	2,405,525	**1,779,126**	0.5983	16,333	**9,772**
0.2190	2,405,525	**526,810**	0.1771	16,333	**2,893**
0.5044	8,813,594	**4,445,577**	0.3995	41,644	**16,637**
0.0191	8,813,594	**168,340**	0.0151	41,644	**629**
0.7309	3,514,875	**2,569,022**	0.5912	21,365	**12,631**
0.9540	3,514,875	**3,353,191**	0.7717	21,365	**16,487**
0.2372	3,485,470	**826,754**	0.1883	31,254	**5,885**
0.0031	1,184,085	**3,671**	0.0023	39,251	**90**
0.5888	2,461,250	**1,449,184**	0.4673	16,479	**7,701**
0.0566	2,461,250	**139,307**	0.0450	16,479	**742**
0.7438	3,485,470	**2,592,493**	0.5903	31,254	**18,450**

TRANSPORT COSTS US $			PHASE	1 E NG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
0.0275	3,485,470	**95,850**	0.0205	31,254	**641**
1.1908	1,184,085	**1,410,009**	0.8909	39,251	**34,968**
1.2118	758,311	**918,922**	0.9066	11,580	**10,498**
0.0101	101,922	**1,029**	0.0075	56	**0**
0.5302	101,922	**54,039**	0.3956	56	**22**
0.0363	101,922	**3,700**	0.0269	56	**2**
1.6252	92,758	**150,750**	1.2127	676	**820**
0.8721	92,758	**80,894**	0.6582	676	**445**
4.0227	93,319	**375,396**	3.0052	676	**2,031**
1.8520	93,319	**172,827**	1.3768	676	**930**
0.0383	101,922	**3,904**	0.0284	56	**2**
0.0289	101,922	**2,946**	0.0214	56	**1**
0.0429	1,606,498	**68,919**	0.0321	8,253	**265**
1.1033	1,616,522	**1,783,509**	0.8254	8,263	**6,820**
1.6381	586,787	**961,216**	1.2223	2,394	**2,926**
0.7279	101,922	**74,189**	0.5432	56	**30**
1.0734	101,922	**109,403**	0.8009	56	**45**
0.1703	102,525	**17,460**	0.1271	56	**7**
2.0097	602	**1,211**	1.4941	0	**0**
0.5721	101,922	**58,310**	0.4269	56	**24**
0.6380	101,922	**65,026**	0.4815	56	**27**
1.3846	101,922	**141,121**	1.0332	56	**58**
0.0244	2,954,637	**72,093**	0.0197	12,836	**253**
0.3867	1,784,989	**690,255**	0.3128	560	**175**
0.5086	1,169,648	**594,883**	0.3805	12,392	**4,715**
0.8019	2,954,637	**2,369,323**	0.6487	12,836	**8,327**
3.1409	3,330,597	**10,461,074**	2.3498	9,642	**22,658**
1.8038	916,215	**1,652,668**	1.3460	8,780	**11,817**
0.5759	2,693,128	**1,550,972**	0.4302	1,675	**721**
0.0190	3,330,597	**63,281**	0.0142	9,642	**137**
1.0087	6,116,712	**6,169,928**	0.8159	17,363	**14,166**
0.3578	7,299,996	**2,611,939**	0.2840	23,355	**6,633**
0.0086	7,299,996	**62,780**	0.0068	23,355	**159**
0.0091	6,116,712	**55,662**	0.0068	17,363	**118**
0.3675	6,116,712	**2,247,892**	0.2973	17,363	**5,162**
1.1514	6,116,712	**7,042,782**	0.9313	17,363	**16,170**
1.4331	1,526,918	**2,188,227**	1.0694	7,758	**8,297**
2.7508	235,867	**648,822**	2.0525	1,043	**2,141**
1.1412	1,616,522	**1,844,775**	0.8537	8,263	**7,054**
1.0631	231,466	**246,072**	0.7933	1,144	**908**
3.1209	1,585,917	**4,949,489**	2.3555	678	**1,598**
1.6475	231,466	**381,340**	1.2293	1,144	**1,407**
0.0238	7,255,180	**172,673**	0.0193	24,046	**464**
0.5874	58,918	**34,609**	0.3380	1,616	**546**
0.5656	118,148	**66,824**	0.3247	2,256	**732**
3.2275	58,918	**190,158**	1.8525	1,616	**2,993**
4.2849	118,148	**506,252**	2.4624	2,256	**5,554**
0.0408	7,255,180	**296,011**	0.0330	24,046	**794**
1.1670	7,255,180	**8,466,796**	0.9440	24,046	**22,700**

TRANSPORT COSTS US $			PHASE	1 E NG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
0.5725	7,255,180	**4,153,591**	0.4631	24,046	**11,136**
0.7014	93,734	**65,745**	0.4026	928	**374**
1.5237	7,619,073	**11,609,182**	1.1399	30,923	**35,249**
0.7550	7,619,073	**5,752,400**	0.5648	30,923	**17,465**
1.7926	1,560,908	**2,798,084**	1.3392	7,939	**10,632**
0.2147	2,311,733	**496,329**	0.1606	14,656	**2,354**
0.8602	2,247,654	**1,933,432**	0.6381	17,295	**11,036**
0.0220	1,049,346	**23,086**	0.0164	4,868	**80**
1.3066	2,405,525	**3,143,059**	1.0569	16,333	**17,262**
0.3555	87,213	**31,004**	0.2821	1,107	**312**
1.0996	371,534	**408,539**	0.8227	7,357	**6,052**
1.5029	1,049,346	**1,577,063**	1.1227	4,868	**5,466**
0.5789	109,610	**63,453**	0.4325	770	**333**
2.9696	154,484	**458,755**	2.2158	2,867	**6,353**
0.0929	1,560,908	**145,008**	0.0701	7,939	**557**
1.0636	1,560,908	**1,660,182**	0.8028	7,939	**6,373**
0.2597	1,560,908	**405,368**	0.1940	7,939	**1,540**
0.0950	2,405,525	**228,525**	0.0768	16,333	**1,254**
0.0818	87,213	**7,134**	0.0649	1,107	**72**
0.5436	87,213	**47,409**	0.4314	1,107	**478**
0.4657	87,213	**40,615**	0.3475	1,107	**385**
1.3013	87,213	**113,490**	0.9216	1,107	**1,020**
0.3676	87,213	**32,059**	0.2974	1,107	**329**
0.1349	87,213	**11,765**	0.1091	1,107	**121**
0.7220	87,213	**62,968**	0.5840	1,107	**647**
0.0321	87,213	**2,800**	0.0260	1,107	**29**
0.0268	87,213	**2,337**	0.0213	1,107	**24**
0.0772	2,311,733	**178,466**	0.0578	14,656	**847**
0.9732	371,534	**361,577**	0.7281	7,357	**5,356**
0.0150	2,318,352	**34,775**	0.0112	54,889	**615**
3.0393	2,318,352	**7,046,168**	1.7381	54,889	**95,402**
0.0258	2,318,352	**59,813**	0.0191	54,889	**1,048**
0.5696	786,773	**448,146**	0.3278	8,305	**2,722**
0.2537	786,773	**199,604**	0.1460	8,305	**1,212**
4.7758	118,148	**564,251**	2.7412	2,256	**6,183**
0.3672	786,773	**288,903**	0.2110	8,305	**1,752**
0.6800	786,773	**535,005**	0.3907	8,305	**3,245**
0.0897	2,866,274	**257,105**	0.0671	85,300	**5,724**
0.4554	2,866,274	**1,305,301**	0.3614	85,300	**30,827**
0.0779	2,866,274	**223,283**	0.0583	85,300	**4,973**
0.3213	634,511	**203,868**	0.2404	43,158	**10,375**
0.7858	243,976	**191,717**	0.5879	9,106	**5,353**
1.0621	2,318,352	**2,462,322**	0.6074	54,889	**33,339**
0.9040	786,773	**711,243**	0.5195	8,305	**4,314**
1.5588	786,773	**1,226,421**	0.8958	8,305	**7,439**
0.7546	786,773	**593,699**	0.4315	8,305	**3,583**
0.6058	154,484	**93,586**	0.4526	2,867	**1,298**
0.1683	154,484	**26,000**	0.1257	2,867	**360**
1.3594	154,484	**210,006**	1.0144	2,702	**2,741**

TRANSPORT COSTS US $			PHASE	1 E NG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
1.2988	154,484	**200,644**	0.9691	2,702	**2,619**
0.2385	154,484	**36,845**	0.1779	2,702	**481**
1.1602	154,484	**179,233**	0.8606	2,702	**2,326**
2.4403	667,591	**1,629,123**	1.8209	558	**1,016**
0.7138	667,591	**476,527**	0.5326	558	**297**
0.9503	835,801	**794,262**	0.7542	1,109	**836**
0.1211	168,210	**20,370**	0.0961	627	**60**
0.8333	7,985,635	**6,654,429**	0.6613	56,267	**37,209**
0.0589	3,509,112	**206,687**	0.0466	10,938	**510**
0.8235	1,063,553	**875,836**	0.6661	10,423	**6,943**
0.6195	1,069,950	**662,834**	0.4634	10,416	**4,827**
0.2702	1,069,950	**289,100**	0.2145	10,416	**2,234**
0.1523	1,069,950	**162,953**	0.1140	10,416	**1,187**
0.7446	1,069,950	**796,685**	0.5570	10,416	**5,802**
0.0040	7,985,635	**31,943**	0.0032	56,267	**180**
0.0708	7,985,635	**565,383**	0.0562	56,267	**3,162**
0.6289	1,069,950	**672,892**	0.4991	10,416	**5,198**
0.5630	2,866,274	**1,613,712**	0.4458	85,300	**38,027**
0.2705	1,574,985	**426,033**	0.2147	100,108	**21,493**
0.5247	1,574,985	**826,395**	0.4164	100,108	**41,685**
0.0645	1,838,899	**118,609**	0.0518	0	**0**
0.4838	5,155,519	**2,494,240**	0.4094	99,913	**40,904**
0.3478	2,930,192	**1,019,121**	0.2814	86,756	**24,413**
0.0171	3,131,042	**53,541**	0.0128	80,650	**1,032**
0.0266	2,760,271	**73,423**	0.0199	91,399	**1,819**
0.0412	2,346,846	**96,690**	0.0308	53,360	**1,644**
0.1612	5,107,117	**823,267**	0.1280	181,500	**23,232**
0.4069	1,252,282	**509,553**	0.3230	73,679	**23,798**
0.3023	9,556,098	**2,888,808**	0.2262	79,167	**17,908**
0.1810	1,252,282	**226,663**	0.1437	73,679	**10,588**
0.1895	1,252,282	**237,307**	0.1406	73,679	**10,359**
0.0593	9,556,098	**566,677**	0.0443	79,167	**3,507**
0.5410	3,878,944	**2,098,508**	0.4376	33,019	**14,449**
0.6599	3,878,944	**2,559,715**	0.5338	33,019	**17,625**
0.0555	3,878,944	**215,281**	0.0449	33,019	**1,483**
2.1463	1,986,108	**4,262,783**	1.6034	6,542	**10,489**
0.2722	1,986,108	**540,619**	0.2050	6,542	**1,341**
0.0903	3,350,119	**302,516**	0.0730	14,440	**1,054**
0.0671	3,350,119	**224,793**	0.0542	14,440	**783**
0.2511	2,175,356	**546,232**	0.1876	74,270	**13,933**
0.1642	2,175,356	**357,194**	0.1226	74,270	**9,106**
1.2057	2,175,356	**2,622,827**	0.9007	74,270	**66,895**
0.5957	3,878,944	**2,310,687**	0.4819	33,019	**15,912**
0.1157	1,252,282	**144,889**	0.0865	73,679	**6,373**
0.5123	1,252,282	**641,544**	0.3833	73,679	**28,241**
0.3888	4,605,230	**1,790,514**	0.2901	53,409	**15,494**
0.4945	1,252,282	**619,253**	0.3699	73,679	**27,254**
0.7146	1,252,282	**894,880**	0.5339	73,679	**39,337**
0.0321	1,252,282	**40,198**	0.0240	73,679	**1,768**

TRANSPORT COSTS US $			PHASE	1 E NG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
0.6723	2,175,356	**1,462,492**	0.5030	74,270	**37,358**
0.0425	1,252,282	**53,222**	0.0318	73,679	**2,343**
0.0977	1,986,108	**194,043**	0.0725	6,542	**474**
0.0300	1,986,108	**59,583**	0.0224	6,542	**147**
0.2646	98,310	**26,013**	0.1997	3,445	**688**
2.1480	1,526,918	**3,279,821**	1.6028	7,758	**12,435**
0.5166	92,758	**47,919**	0.3840	676	**260**
1.3588	2,318,352	**3,150,177**	0.7771	54,889	**42,654**
0.1655	243,976	**40,378**	0.1227	9,106	**1,117**
0.3450	2,318,352	**799,832**	0.1973	54,889	**10,830**
0.9490	243,976	**231,534**	0.7039	9,106	**6,410**
0.0582	7,047,320	**410,154**	0.0467	34,961	**1,633**
0.8423	231,466	**194,964**	0.6285	1,144	**719**
0.2733	1,616,522	**441,796**	0.2045	8,263	**1,690**
1.1663	1,616,522	**1,885,350**	0.8726	8,263	**7,210**
0.9648	2,930,192	**2,827,049**	0.7804	86,756	**67,705**
1.5759	1,560,908	**2,459,835**	1.1759	7,939	**9,335**
0.0871	231,466	**20,161**	0.0650	1,144	**74**
1.1530	6,936,280	**7,997,531**	0.9326	22,996	**21,446**
0.1823	6,910,968	**1,259,869**	0.1353	22,676	**3,068**
0.0245	786,773	**19,276**	0.0183	8,305	**152**
0.3629	2,004,081	**727,281**	0.2692	7,008	**1,886**
0.1575	1,838,899	**289,627**	0.1890	55,835	**10,553**
0.0632	1,838,899	**116,218**	0.0758	58,563	**4,439**
0.2501	0	**0**	0.3002	59,459	**17,850**
0.6108	1,838,899	**1,123,200**	0.7332	59,599	**43,698**
0.1583	1,838,899	**291,098**	0.1900	0	**0**
0.0346	1,838,899	**63,626**	0.0415	0	**0**
0.2889	1,838,899	**531,258**	0.3467	59,459	**20,615**
3.9317	28,089	**110,436**	2.9372	465	**1,367**
2.7000	1,838,899	**4,965,028**	1.5000	0	**0**
0.2000	0	**0**	0.8000	55,834	**44,667**
0.7197	9,556,098	**6,877,524**	0.5384	81,895	**44,092**
0.2000	0	**0**	0.8000	2,728	**2,183**
0.2000	0	**0**	0.8000	1,031	**824**
0.2470	1,838,899	**454,208**	0.2964	59,594	**17,664**
0.2000	0	**0**	0.8000	139	**111**
0.2000	0	**0**	0.8000	5	**4**
2.7000	1,838,899	**4,965,028**	0.0000	0	**0**
4.3500	0	**0**	0.1000	59,459	**5,946**
2.0300	3,509,112	**7,123,498**	1.6076	10,938	**17,584**
1.3704	7,299,996	**10,003,914**	1.0876	23,355	**25,401**
2.7000	0	**0**	0.0000	0	**0**
3.4382	6,910,968	**23,761,289**	2.5503	22,676	**57,830**
0.2719	98,310	**26,731**	0.2052	3,445	**707**
1.0865	1,049,346	**1,140,115**	0.8117	4,868	**3,952**
0.2999	1,838,899	**551,486**	0.3599	59,459	**21,399**
2.9640	46,580	**138,062**	1.9238	2,303	**4,431**
5.2497	28,089	**147,457**	3.9218	465	**1,825**

TRANSPORT COSTS US $				PHASE	1 E NG	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
3.3566	46,625	**156,503**		2.5333	2,306	**5,841**
1.5532	6,397	**9,935**		1.1603	55	**64**
2.3087	6,397	**14,768**		1.7247	55	**95**
1.1773	6,397	**7,531**		0.8795	67	**59**
0.8183	6,397	**5,234**		0.6113	67	**41**
3.9891	46	**184**		3.0107	2	**7**
TRANSPORT COSTS PHASE 1E		**356,734,150**		TRANSPORT COSTS PHASE 1E		**2,426,097**

TRANSPORT COSTS US $			PHASE	2 W-SG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
0.2298	106,685	**24,516**	0.1719	735	**126**
2.7033	106,685	**288,403**	2.1701	735	**1,596**
0.0122	106,685	**1,302**	0.0092	735	**7**
2.0284	93,734	**190,129**	1.5153	988	**1,496**
3.7596	127	**478**	2.8086	533	**1,498**
0.0636	9,131,935	**580,791**	0.0475	99,790	**4,740**
0.5341	9,131,935	**4,877,366**	0.3996	99,790	**39,876**
0.2765	200,018	**55,305**	0.2069	22,099	**4,572**
0.4698	8,982,540	**4,219,997**	0.3485	101,489	**35,369**
0.1540	200,018	**30,803**	0.1152	22,099	**2,546**
0.6329	200,018	**126,591**	0.4735	22,099	**10,464**
0.1694	200,018	**33,883**	0.1256	22,099	**2,776**
0.3169	8,982,540	**2,846,567**	0.2371	101,489	**24,063**
0.3883	11,299,797	**4,387,711**	0.2901	137,652	**39,933**
1.0393	11,299,797	**11,743,879**	0.7776	137,652	**107,039**
1.3270	1,574,985	**2,090,005**	0.9927	100,013	**99,282**
0.5156	1,574,985	**812,062**	0.3852	100,013	**38,525**
0.0881	1,574,985	**138,756**	0.0659	100,013	**6,591**
0.9666	9,131,935	**8,826,928**	0.7671	99,790	**76,549**
0.1584	2,097,247	**332,204**	0.1281	47,782	**6,121**
1.1655	2,097,247	**2,444,341**	0.9428	47,782	**45,049**
1.9404	7,758,476	**15,054,547**	1.5366	24,248	**37,260**
0.7039	8,718,394	**6,136,878**	0.5575	101,115	**56,372**
0.0388	8,718,394	**338,274**	0.0308	101,115	**3,114**
0.2819	8,791,020	**2,478,188**	0.2280	94,567	**21,561**
1.2373	8,791,020	**10,877,129**	0.9933	94,567	**93,934**
0.2990	8,718,394	**2,606,800**	0.2368	101,115	**23,944**
0.0622	763,660	**47,500**	0.0465	25,274	**1,175**
0.7543	2,068,314	**1,560,129**	0.6102	35,996	**21,965**
0.0622	11,606,947	**721,952**	0.0494	106,798	**5,276**
0.2401	2,370,079	**569,056**	0.1906	16,226	**3,093**
0.0098	11,606,947	**113,748**	0.0077	106,798	**822**
0.0346	11,606,947	**401,600**	0.0274	106,798	**2,926**
0.0378	11,606,947	**438,743**	0.0300	106,798	**3,204**
2.1999	7,681,568	**16,898,682**	1.6458	23,770	**39,121**
0.7396	2,313,450	**1,711,027**	0.5983	15,976	**9,559**
0.2190	2,313,450	**506,645**	0.1771	15,976	**2,829**
0.5044	8,718,394	**4,397,558**	0.3995	101,115	**40,396**
0.0191	8,718,394	**166,521**	0.0151	101,115	**1,527**
0.7309	908,286	**663,866**	0.5912	15,818	**9,352**
0.9540	908,286	**866,505**	0.7717	15,818	**12,207**
0.2372	878,882	**208,471**	0.1883	22,009	**4,144**
0.0031	1,189,433	**3,687**	0.0023	16,947	**39**
0.5888	2,369,174	**1,394,970**	0.4673	16,123	**7,534**
0.0566	2,369,174	**134,095**	0.0450	16,123	**726**
0.7438	878,882	**653,712**	0.5903	22,009	**12,992**

TRANSPORT COSTS US $			PHASE	2 W-SG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
0.0275	878,882	**24,169**	0.0205	22,009	**451**
1.1908	1,189,433	**1,416,377**	0.8909	16,947	**15,098**
1.2118	452,026	**547,765**	0.9066	5,141	**4,660**
0.0101	101,922	**1,029**	0.0075	56	**0**
0.5302	101,922	**54,039**	0.3956	56	**22**
0.0363	101,922	**3,700**	0.0269	56	**2**
1.6252	92,758	**150,750**	1.2127	676	**820**
0.8721	92,758	**80,894**	0.6582	676	**445**
4.0227	93,319	**375,396**	3.0052	676	**2,031**
1.8520	93,319	**172,827**	1.3768	676	**930**
0.0383	101,922	**3,904**	0.0284	56	**2**
0.0289	101,922	**2,946**	0.0214	56	**1**
0.0429	1,606,498	**68,919**	0.0321	8,253	**265**
1.1033	1,616,522	**1,783,509**	0.8254	8,263	**6,820**
1.6381	586,787	**961,216**	1.2223	2,394	**2,926**
0.7279	101,922	**74,189**	0.5432	56	**30**
1.0734	101,922	**109,403**	0.8009	56	**45**
0.1703	102,525	**17,460**	0.1271	56	**7**
2.0097	602	**1,211**	1.4941	0	**0**
0.5721	101,922	**58,310**	0.4269	56	**24**
0.6380	101,922	**65,026**	0.4815	56	**27**
1.3846	101,922	**141,121**	1.0332	56	**58**
0.0244	2,954,637	**72,093**	0.0197	12,836	**253**
0.3867	1,784,989	**690,255**	0.3128	560	**175**
0.5086	1,169,648	**594,883**	0.3805	12,392	**4,715**
0.8023	2,954,637	**2,370,505**	0.6487	12,836	**8,327**
3.1409	3,330,597	**10,461,074**	2.3498	9,583	**22,519**
1.8038	916,215	**1,652,668**	1.3460	8,721	**11,738**
0.5759	2,693,128	**1,550,972**	0.4302	1,675	**721**
0.0190	3,330,597	**63,281**	0.0142	9,583	**136**
1.0080	6,116,712	**6,165,646**	0.8159	17,304	**14,118**
0.3578	7,299,996	**2,611,939**	0.2840	23,277	**6,611**
0.0086	7,299,996	**62,780**	0.0068	23,277	**158**
0.0091	6,116,712	**55,662**	0.0068	17,304	**118**
0.3675	6,116,712	**2,247,892**	0.2973	17,304	**5,144**
1.1514	6,116,712	**7,042,782**	0.9313	17,304	**16,115**
1.4331	1,526,918	**2,188,227**	1.0694	7,758	**8,297**
2.7508	235,867	**648,822**	2.0525	1,043	**2,141**
1.1412	1,616,522	**1,844,775**	0.8537	8,263	**7,054**
1.0631	231,466	**246,072**	0.7933	1,144	**908**
3.1209	40,764	**127,220**	2.3555	4	**9**
1.6475	231,466	**381,340**	1.2293	1,144	**1,407**
0.0238	7,255,180	**172,673**	0.0193	23,987	**463**
0.4518	58,918	**26,619**	0.3380	1,694	**573**
0.4351	118,148	**51,406**	0.3247	2,335	**758**
2.4827	58,918	**146,276**	1.8525	1,694	**3,138**
3.2961	118,148	**389,427**	2.4624	2,335	**5,749**
0.0408	7,255,180	**296,011**	0.0330	23,987	**792**

TRANSPORT COSTS US $			PHASE	2 W-SG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
1.1670	7,255,180	**8,466,796**	0.9440	23,987	**22,644**
0.5725	7,255,180	**4,153,591**	0.4631	23,987	**11,108**
0.5396	93,734	**50,579**	0.4026	988	**398**
1.5287	7,619,073	**11,647,277**	1.1399	30,844	**35,159**
0.7550	7,619,073	**5,752,400**	0.5648	30,844	**17,421**
1.7926	1,560,908	**2,798,084**	1.3392	7,939	**10,632**
0.2147	2,311,733	**496,329**	0.1606	14,656	**2,354**
3.0000	1,555,843	**4,667,529**	2.2000	682	**1,500**
0.8602	2,243,742	**1,930,067**	0.6381	17,296	**11,037**
0.0220	929,893	**20,458**	0.0164	4,420	**72**
1.3066	2,313,450	**3,022,753**	1.0569	15,976	**16,885**
0.3555	87,213	**31,004**	0.2821	1,107	**312**
1.0996	351,978	**387,035**	0.8227	7,326	**6,027**
1.5029	929,893	**1,397,536**	1.1227	4,420	**4,963**
0.5789	11,549	**6,686**	0.4325	322	**139**
2.9696	1	**4**	2.2158	219	**485**
0.0929	1,560,908	**145,008**	0.0701	7,939	**557**
1.0636	1,560,908	**1,660,182**	0.8028	7,939	**6,373**
0.2597	1,560,908	**405,368**	0.1940	7,939	**1,540**
0.0950	2,313,450	**219,778**	0.0768	15,976	**1,227**
0.0818	87,213	**7,134**	0.0649	1,107	**72**
0.5436	87,213	**47,409**	0.4314	1,107	**478**
0.4657	87,213	**40,615**	0.3475	1,107	**385**
1.3013	87,213	**113,490**	0.9216	1,107	**1,020**
0.3676	87,213	**32,059**	0.2974	1,107	**329**
0.1349	87,213	**11,765**	0.1091	1,107	**121**
0.7220	87,213	**62,968**	0.5840	1,107	**647**
0.0321	87,213	**2,800**	0.0260	1,107	**29**
0.0268	87,213	**2,337**	0.0213	1,107	**24**
0.0772	2,311,733	**178,466**	0.0578	14,656	**847**
0.9732	351,978	**342,545**	0.7281	7,326	**5,334**
0.0150	2,318,352	**34,775**	0.0112	54,967	**616**
2.3380	2,318,352	**5,420,308**	1.7381	54,967	**95,539**
0.0258	2,318,352	**59,813**	0.0191	54,967	**1,050**
0.4382	786,773	**344,764**	0.3278	8,383	**2,748**
0.1952	786,773	**153,578**	0.1460	8,383	**1,224**
3.6737	118,148	**434,040**	2.7412	2,335	**6,399**
0.2825	786,773	**222,263**	0.2110	8,383	**1,769**
0.5230	786,773	**411,482**	0.3907	8,383	**3,275**
0.0897	2,866,274	**257,105**	0.0671	85,379	**5,729**
0.4554	2,866,274	**1,305,301**	0.3614	85,379	**30,856**
0.0779	2,866,274	**223,283**	0.0583	85,379	**4,978**
0.3213	634,511	**203,868**	0.2404	43,158	**10,375**
0.7858	243,976	**191,717**	0.5879	9,106	**5,353**
0.8170	2,318,352	**1,894,094**	0.6074	54,967	**33,387**
0.6954	786,773	**547,122**	0.5195	8,383	**4,355**
1.1991	786,773	**943,419**	0.8958	8,383	**7,510**
0.5804	786,773	**456,643**	0.4315	8,383	**3,617**

TRANSPORT COSTS US $			PHASE	2 W-SG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
0.6058	1	**1**	0.4526	219	**99**
0.1683	1	**0**	0.1257	219	**28**
1.3594	1	**2**	1.0144	48	**49**
1.2988	1	**2**	0.9691	48	**47**
0.2385	1	**0**	0.1779	48	**9**
1.1602	1	**1**	0.8606	48	**42**
2.4403	1	**3**	1.8209	65	**118**
0.7138	1	**1**	0.5326	65	**35**
0.9503	168,212	**159,851**	0.7542	616	**464**
0.1211	168,210	**20,370**	0.0961	627	**60**
0.8333	3,847,892	**3,206,449**	0.6613	50,295	**33,260**
0.0589	1,851,063	**109,028**	0.0466	10,548	**492**
0.8235	395,963	**326,076**	0.6661	9,941	**6,622**
0.6195	394,537	**244,416**	0.4634	9,910	**4,592**
0.2702	394,537	**106,604**	0.2145	9,910	**2,126**
0.1523	394,537	**60,088**	0.1140	9,910	**1,130**
0.7446	394,537	**293,772**	0.5570	9,910	**5,520**
0.0040	4,332,864	**17,331**	0.0032	51,401	**164**
0.0087	626,125	**5,447**	0.0069	1,869	**13**
0.0708	8,571,714	**606,877**	0.0562	55,789	**3,135**
0.0080	4,377,656	**35,021**	0.0064	4,641	**30**
0.6289	394,537	**248,124**	0.4991	9,910	**4,946**
0.0069	5,003,781	**34,526**	0.0051	6,510	**33**
0.1020	5,003,781	**510,386**	0.0761	6,510	**495**
0.5630	2,866,274	**1,613,712**	0.4458	85,379	**38,062**
0.2705	1,574,985	**426,033**	0.2147	100,013	**21,473**
0.5247	1,574,985	**826,395**	0.4164	100,013	**41,645**
0.4838	6,982,385	**3,378,078**	0.4094	99,992	**40,937**
0.3478	2,930,192	**1,019,121**	0.2814	86,835	**24,435**
0.0171	4,038,693	**69,062**	0.0128	80,667	**1,033**
0.0266	3,667,922	**97,567**	0.0199	91,365	**1,818**
0.0412	3,266,061	**134,562**	0.0308	53,378	**1,644**
0.1612	6,933,983	**1,117,758**	0.1280	144,744	**18,527**
0.4069	1,347,481	**548,290**	0.3230	73,587	**23,769**
0.3023	11,299,797	**3,415,929**	0.2262	137,652	**31,137**
0.1810	1,347,481	**243,894**	0.1437	73,587	**10,574**
0.1895	1,347,481	**255,348**	0.1406	73,587	**10,346**
0.0593	11,299,797	**670,078**	0.0443	137,652	**6,098**
0.5410	1,272,354	**688,344**	0.4376	27,482	**12,026**
0.6599	1,272,354	**839,626**	0.5338	27,482	**14,670**
0.0555	1,272,354	**70,616**	0.0449	27,482	**1,234**
2.1463	326,836	**701,489**	1.6034	5,128	**8,223**
0.2722	326,836	**88,965**	0.2050	5,128	**1,051**
0.0903	743,530	**67,141**	0.0730	8,894	**649**
0.0671	743,530	**49,891**	0.0542	8,894	**482**
0.2511	2,270,556	**570,137**	0.1876	74,179	**13,916**
0.1642	2,270,556	**372,825**	0.1226	74,179	**9,094**
1.2057	2,270,556	**2,737,610**	0.9007	74,179	**66,813**

TRANSPORT COSTS US $			PHASE	2 W-SG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
0.5957	1,272,354	**757,941**	0.4819	27,482	**13,243**
0.1157	1,347,481	**155,904**	0.0865	73,587	**6,365**
0.5123	1,347,481	**690,315**	0.3833	73,587	**28,206**
0.3888	2,097,247	**815,410**	0.2901	47,782	**13,862**
0.4945	1,347,481	**666,329**	0.3699	73,587	**27,220**
0.7146	1,347,481	**962,910**	0.5339	73,587	**39,288**
0.0321	1,347,481	**43,254**	0.0240	73,587	**1,766**
0.6723	2,270,556	**1,526,495**	0.5030	74,179	**37,312**
0.0425	1,347,481	**57,268**	0.0318	73,587	**2,340**
0.0977	326,836	**31,932**	0.0725	5,128	**372**
0.0300	328,848	**9,865**	0.0224	721	**16**
0.2646	98,310	**26,013**	0.1997	3,504	**700**
2.1480	1,526,918	**3,279,821**	1.6028	7,758	**12,435**
0.5166	92,758	**47,919**	0.3840	676	**260**
1.0453	2,318,352	**2,423,374**	0.7771	54,967	**42,715**
0.1655	243,976	**40,378**	0.1227	9,106	**1,117**
0.2654	2,318,352	**615,291**	0.1973	54,967	**10,845**
0.9490	243,976	**231,534**	0.7039	9,106	**6,410**
0.0582	8,791,020	**511,637**	0.0467	94,567	**4,416**
0.8423	231,466	**194,964**	0.6285	1,144	**719**
0.2733	1,616,522	**441,796**	0.2045	8,263	**1,690**
1.1663	1,616,522	**1,885,350**	0.8726	8,263	**7,210**
0.9648	2,930,192	**2,827,049**	0.7804	86,835	**67,766**
1.5759	1,560,908	**2,459,835**	1.1759	7,939	**9,335**
0.0871	231,466	**20,161**	0.0650	1,144	**74**
1.1530	6,936,280	**7,997,531**	0.9326	22,917	**21,373**
0.1823	6,910,968	**1,259,869**	0.1353	22,597	**3,057**
0.0245	786,773	**19,276**	0.0183	8,383	**153**
0.3629	344,809	**125,131**	0.2692	5,585	**1,503**
0.0614	5,003,781	**307,232**	0.0698	6,510	**454**
0.1193	5,003,781	**596,951**	0.1356	6,510	**883**
0.2105	5,003,781	**1,053,296**	0.2393	6,510	**1,558**
0.0506	5,003,781	**253,191**	0.0575	6,510	**374**
0.2332	2,958,141	**689,839**	0.2651	14,726	**3,904**
0.4703	2,646,507	**1,244,652**	0.5346	34,288	**18,330**
0.1649	4,512,869	**744,172**	0.1874	9,708	**1,819**
0.5089	4,515,544	**2,297,960**	0.5785	9,708	**5,616**
0.1603	828,445	**132,800**	0.1823	4,202	**766**
0.4971	1,555,843	**773,410**	0.5651	682	**385**
3.9317	28,089	**110,436**	2.9372	465	**1,367**
3.0000	5,003,781	**15,011,344**	1.0000	6,510	**6,510**
0.7197	11,299,797	**8,132,464**	0.5384	137,652	**74,112**
3.0000	2,646,507	**7,939,522**	1.5000	34,288	**51,432**
3.0000	311,634	**934,902**	1.5000	20,290	**30,435**
3.0000	2,012	**6,035**	1.5000	4,433	**6,650**
2.0300	1,851,063	**3,757,658**	1.6076	10,548	**16,956**
3.0000	2,675	**8,025**	2.0000	0	**0**
1.3708	7,299,996	**10,006,834**	1.0876	23,277	**25,316**

TRANSPORT COSTS US $			PHASE	2 W-SG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT_SC1	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT_SC1	TOT_FLOW	TOT TRSP COST
3.4384	6,910,968	**23,762,671**	2.5503	22,597	**57,628**
0.2719	98,310	**26,731**	0.2052	3,504	**719**
1.0865	929,893	**1,010,329**	0.8117	4,420	**3,588**
2.9640	11,548	**34,228**	1.9238	103	**199**
3.0000	828,445	**2,485,336**	1.0000	4,202	**4,202**
5.2497	28,089	**147,457**	3.9218	465	**1,825**
3.3566	904	**3,035**	2.5333	103	**261**
1.5532	1,426	**2,216**	1.1603	31	**36**
2.3087	1,426	**3,293**	1.7247	31	**54**
1.1773	26	**31**	0.8795	1,085	**954**
0.8183	26	**21**	0.6113	1,085	**663**
3.9891	10,656	**42,509**	3.0107	0	**0**
TRANSPORT COSTS PHASE 2W		360,111,367	TRANSPORT COSTS PHASE 2W		2,640,918

TRANSPORT COSTS US $				PHASE	2E SG	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
0.2296	106,685	**24,493**		0.1719	870	**150**
2.7034	106,685	**288,411**		2.1701	870	**1,887**
0.0122	106,685	**1,304**		0.0092	870	**8**
2.0283	93,734	**190,117**		1.5153	518	**785**
3.7595	127	**478**		2.8086	64	**179**
0.0634	5,513,133	**349,599**		0.0475	21,344	**1,014**
0.5333	5,513,133	**2,939,999**		0.3996	21,344	**8,529**
0.2762	200,018	**55,242**		0.2069	21,854	**4,522**
0.4697	5,363,738	**2,519,240**		0.3485	23,289	**8,116**
0.1539	200,018	**30,792**		0.1152	21,854	**2,518**
0.6322	200,018	**126,453**		0.4735	21,854	**10,348**
0.1695	200,018	**33,899**		0.1256	21,854	**2,745**
0.3167	5,363,738	**1,698,578**		0.2371	23,289	**5,522**
0.3881	7,680,995	**2,981,025**		0.2901	59,452	**17,247**
1.0379	7,680,995	**7,972,059**		0.7776	59,452	**46,230**
1.3252	1,574,985	**2,087,104**		0.9927	100,121	**99,390**
0.5154	1,574,985	**811,766**		0.3852	100,121	**38,567**
0.0879	1,574,985	**138,378**		0.0659	100,258	**6,607**
0.9666	5,513,133	**5,328,829**		0.7671	21,344	**16,373**
0.1585	4,604,633	**729,788**		0.1281	53,408	**6,842**
1.1656	4,604,633	**5,367,114**		0.9428	53,408	**50,354**
1.9434	7,738,920	**15,040,119**		1.5366	24,822	**38,142**
0.7050	8,814,241	**6,214,366**		0.5575	22,813	**12,718**
0.0389	8,814,241	**342,654**		0.0308	22,813	**703**
0.2819	5,172,218	**1,457,945**		0.2280	16,265	**3,709**
1.2369	5,172,218	**6,397,257**		0.9933	16,265	**16,156**
0.2995	5,099,592	**1,527,292**		0.2368	22,813	**5,402**
0.0623	758,909	**47,254**		0.0465	11,580	**538**
0.7544	4,666,796	**3,520,538**		0.6102	67,558	**41,224**
0.0629	11,702,794	**736,457**		0.0494	158,631	**7,836**
0.2395	2,507,875	**600,736**		0.1906	18,785	**3,580**
0.0096	11,702,794	**112,827**		0.0077	158,631	**1,221**
0.0345	11,702,794	**403,863**		0.0274	158,631	**4,346**
0.0379	11,702,794	**444,027**		0.0300	158,631	**4,759**
2.1969	7,662,012	**16,832,537**		1.6458	24,344	**40,066**
0.7395	2,405,525	**1,778,958**		0.5983	16,333	**9,772**
0.2190	2,405,525	**526,738**		0.1771	16,333	**2,893**
0.5054	8,814,241	**4,454,497**		0.3995	22,813	**9,114**
0.0193	8,814,241	**169,956**		0.0151	22,813	**344**
0.7309	3,514,810	**2,568,939**		0.5912	21,289	**12,586**
0.9539	3,514,810	**3,352,812**		0.7717	21,289	**16,428**
0.2372	3,485,406	**826,808**		0.1883	31,263	**5,887**
0.0030	1,184,682	**3,566**		0.0023	39,259	**90**
0.5887	2,461,250	**1,448,938**		0.4673	16,479	**7,701**
0.0566	2,461,250	**139,184**		0.0450	16,479	**742**
0.7439	3,485,406	**2,592,619**		0.5903	31,263	**18,455**

TRANSPORT COSTS US $			PHASE	2E SG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
0.0275	3,485,406	**95,918**	0.0205	31,263	**641**
1.1892	1,184,682	**1,408,783**	0.8909	39,259	**34,976**
1.2102	758,909	**918,413**	0.9066	11,580	**10,498**
0.0103	101,922	**1,046**	0.0075	56	**0**
0.5298	101,922	**53,994**	0.3956	56	**22**
0.0361	101,922	**3,679**	0.0269	56	**2**
1.6233	92,758	**150,569**	1.2127	676	**820**
0.8720	92,758	**80,888**	0.6582	676	**445**
4.0228	93,319	**375,402**	3.0052	676	**2,031**
1.8520	93,319	**172,825**	1.3768	676	**930**
0.0384	101,922	**3,912**	0.0284	56	**2**
0.0289	101,922	**2,944**	0.0214	56	**1**
0.0428	1,606,498	**68,732**	0.0321	8,253	**265**
1.1017	1,616,522	**1,780,903**	0.8254	8,263	**6,820**
1.6362	586,787	**960,072**	1.2223	2,394	**2,926**
0.7271	101,922	**74,111**	0.5432	56	**30**
1.0720	101,922	**109,260**	0.8009	56	**45**
0.1703	102,525	**17,458**	0.1271	56	**7**
2.0098	602	**1,211**	1.4941	0	**0**
0.5715	101,922	**58,245**	0.4269	56	**24**
0.6381	101,922	**65,039**	0.4815	56	**27**
1.3829	101,922	**140,946**	1.0332	56	**58**
0.0373	2,954,637	**110,090**	0.0197	12,836	**253**
0.3918	1,784,989	**699,305**	0.3128	560	**175**
0.5031	1,169,648	**588,443**	0.3805	12,392	**4,715**
0.8022	2,954,637	**2,370,121**	0.6487	12,836	**8,327**
3.1370	3,330,597	**10,448,031**	2.3498	10,053	**23,622**
1.8017	916,215	**1,650,744**	1.3460	9,190	**12,370**
0.5760	2,693,128	**1,551,177**	0.4302	1,675	**721**
0.0199	3,330,597	**66,159**	0.0142	10,053	**143**
1.0079	6,116,712	**6,165,095**	0.8159	17,773	**14,501**
0.3579	7,299,996	**2,612,377**	0.2840	23,881	**6,782**
0.0087	7,299,996	**63,510**	0.0068	23,881	**162**
0.0090	6,116,712	**55,234**	0.0068	17,773	**121**
0.3675	6,116,712	**2,247,708**	0.2973	17,773	**5,284**
1.1513	6,116,712	**7,042,048**	0.9313	17,773	**16,552**
1.4302	1,526,918	**2,183,768**	1.0694	7,758	**8,297**
2.7477	235,867	**648,091**	2.0525	1,043	**2,141**
1.1418	1,616,522	**1,845,742**	0.8537	8,263	**7,054**
1.0587	231,466	**245,044**	0.7933	1,144	**908**
3.1209	1,585,917	**4,949,552**	2.3555	678	**1,598**
1.6456	231,466	**380,903**	1.2293	1,144	**1,407**
0.0238	7,255,180	**172,383**	0.0193	24,457	**472**
0.4511	58,918	**26,580**	0.3380	1,090	**368**
0.4347	118,148	**51,362**	0.3247	1,730	**562**
2.4798	58,918	**146,106**	1.8525	1,090	**2,019**
3.2960	118,148	**389,416**	2.4624	1,730	**4,259**
0.0408	7,255,180	**295,794**	0.0330	24,457	**807**
1.1669	7,255,180	**8,466,360**	0.9440	24,457	**23,087**

TRANSPORT COSTS US $				PHASE	2E SG	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
0.5724	7,255,180	**4,152,865**		0.4631	24,457	**11,326**
0.5388	93,734	**50,503**		0.4026	518	**209**
1.5269	7,619,073	**11,633,212**		1.1399	31,449	**35,849**
0.7541	7,619,073	**5,745,299**		0.5648	31,449	**17,762**
1.7926	1,560,908	**2,798,102**		1.3392	7,939	**10,632**
0.2143	2,311,733	**495,409**		0.1606	14,656	**2,354**
0.8634	2,247,654	**1,940,534**		0.6381	17,295	**11,036**
0.0218	1,049,346	**22,914**		0.0164	4,868	**80**
1.3065	2,405,525	**3,142,890**		1.0569	16,333	**17,262**
0.3555	87,213	**31,008**		0.2821	1,107	**312**
1.0983	371,534	**408,038**		0.8227	7,357	**6,052**
1.5030	1,049,346	**1,577,143**		1.1227	4,868	**5,466**
0.5789	109,610	**63,449**		0.4325	770	**333**
2.9661	154,484	**458,221**		2.2158	2,867	**6,353**
0.0929	1,560,908	**144,977**		0.0701	7,939	**557**
1.0638	1,560,908	**1,660,525**		0.8028	7,939	**6,373**
0.2596	1,560,908	**405,149**		0.1940	7,939	**1,540**
0.0950	2,405,525	**228,621**		0.0768	16,333	**1,254**
0.0818	87,213	**7,132**		0.0649	1,107	**72**
0.5438	87,213	**47,422**		0.4314	1,107	**478**
0.4653	87,213	**40,577**		0.3475	1,107	**385**
1.3012	87,213	**113,480**		0.9216	1,107	**1,020**
0.3677	87,213	**32,072**		0.2974	1,107	**329**
0.1350	87,213	**11,774**		0.1091	1,107	**121**
0.7220	87,213	**62,966**		0.5840	1,107	**647**
0.0321	87,213	**2,802**		0.0260	1,107	**29**
0.0270	87,213	**2,352**		0.0213	1,107	**24**
0.0772	2,311,733	**178,383**		0.0578	14,656	**847**
0.9718	371,534	**361,060**		0.7281	7,357	**5,356**
0.0149	2,318,352	**34,539**		0.0112	54,363	**609**
2.3378	2,318,352	**5,419,890**		1.7381	54,363	**94,488**
0.0258	2,318,352	**59,906**		0.0191	54,363	**1,038**
0.4378	786,773	**344,427**		0.3278	7,779	**2,550**
0.1994	786,773	**156,886**		0.1460	7,779	**1,136**
3.6696	118,148	**433,558**		2.7412	1,730	**4,742**
0.2826	786,773	**222,367**		0.2110	7,779	**1,641**
0.5232	786,773	**411,671**		0.3907	7,779	**3,039**
0.0898	2,866,274	**257,305**		0.0671	84,774	**5,688**
0.4553	2,866,274	**1,305,015**		0.3614	84,774	**30,637**
0.0779	2,866,274	**223,363**		0.0583	84,774	**4,942**
0.3209	634,511	**203,602**		0.2404	43,158	**10,375**
0.7846	243,976	**191,431**		0.5879	9,106	**5,353**
0.8171	2,318,352	**1,894,395**		0.6074	54,363	**33,020**
0.6955	786,773	**547,166**		0.5195	7,779	**4,041**
1.1989	786,773	**943,278**		0.8958	7,779	**6,968**
0.5806	786,773	**456,769**		0.4315	7,779	**3,357**
0.6056	154,484	**93,562**		0.4526	2,867	**1,298**
0.1685	154,484	**26,032**		0.1257	2,867	**360**
1.3579	154,484	**209,781**		1.0144	2,702	**2,741**

TRANSPORT COSTS US $			PHASE	2E SG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
1.2973	154,484	**200,414**	0.9691	2,702	**2,619**
0.2369	154,484	**36,602**	0.1779	2,702	**481**
1.1601	154,484	**179,224**	0.8606	2,702	**2,326**
2.4390	667,591	**1,628,228**	1.8209	558	**1,016**
0.7129	667,591	**475,952**	0.5326	558	**297**
0.9503	835,801	**794,287**	0.7542	1,109	**836**
0.1212	168,210	**20,390**	0.0961	627	**60**
0.8332	7,985,635	**6,653,391**	0.6613	56,267	**37,209**
0.0569	3,508,530	**199,681**	0.0466	10,938	**510**
0.8235	1,063,553	**875,836**	0.6661	10,423	**6,943**
0.6188	1,069,950	**662,128**	0.4634	10,416	**4,827**
0.2703	1,069,950	**289,186**	0.2145	10,416	**2,234**
0.1520	1,069,950	**162,671**	0.1140	10,416	**1,187**
0.7438	1,069,950	**795,780**	0.5570	10,416	**5,802**
0.0041	7,985,635	**32,422**	0.0032	56,267	**180**
0.0708	7,985,635	**565,064**	0.0562	56,267	**3,162**
0.6290	1,069,950	**673,009**	0.4991	10,416	**5,198**
0.5638	2,866,274	**1,616,128**	0.4458	84,774	**37,792**
0.2706	1,574,985	**426,144**	0.2147	100,121	**21,496**
0.5246	1,574,985	**826,253**	0.4164	100,121	**41,690**
0.0645	3,714,649	**239,706**	0.0518	0	**0**
0.4846	3,320,004	**1,608,980**	0.4094	99,389	**40,690**
0.3478	2,930,192	**1,019,004**	0.2814	86,230	**24,265**
0.0172	2,219,094	**38,168**	0.0128	80,389	**1,029**
0.0267	1,848,323	**49,276**	0.0199	91,150	**1,814**
0.0413	1,423,279	**58,753**	0.0308	53,096	**1,635**
0.1612	3,271,602	**527,513**	0.1280	178,123	**22,800**
0.4069	1,251,634	**509,252**	0.3230	79,026	**25,525**
0.3018	7,680,995	**2,317,971**	0.2262	65,045	**14,713**
0.1810	1,251,634	**226,496**	0.1437	73,662	**10,585**
0.1896	1,251,634	**237,335**	0.1406	73,662	**10,357**
0.0592	7,680,995	**454,792**	0.0443	65,045	**2,881**
0.5411	3,878,878	**2,098,783**	0.4376	32,943	**14,416**
0.6596	3,878,878	**2,558,547**	0.5338	32,943	**17,585**
0.0556	3,878,878	**215,743**	0.0449	32,943	**1,479**
2.1461	1,985,526	**4,261,153**	1.6034	6,542	**10,490**
0.2721	1,985,526	**540,222**	0.2050	6,542	**1,341**
0.2198	3,350,054	**736,275**	0.0730	14,364	**1,049**
0.0678	3,350,054	**227,033**	0.0542	14,364	**779**
0.2513	2,174,709	**546,548**	0.1876	74,194	**13,919**
0.1640	2,174,709	**356,600**	0.1226	74,194	**9,096**
1.2055	2,174,709	**2,621,638**	0.9007	74,194	**66,827**
0.5956	3,878,878	**2,310,337**	0.4819	32,943	**15,875**
0.1158	1,251,634	**144,904**	0.0865	73,662	**6,372**
0.5115	1,251,634	**640,208**	0.3833	73,662	**28,235**
0.3883	4,604,633	**1,787,933**	0.2901	53,408	**15,494**
0.4939	1,251,634	**618,215**	0.3699	73,662	**27,247**
0.7148	1,251,634	**894,693**	0.5339	73,662	**39,328**
0.0321	1,251,634	**40,162**	0.0240	73,662	**1,768**

TRANSPORT COSTS US $			PHASE	2E SG	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
0.6716	2,174,709	**1,460,439**	0.5030	74,194	**37,320**
0.0424	1,251,634	**53,114**	0.0318	73,662	**2,342**
0.0977	1,985,526	**193,906**	0.0725	6,542	**474**
0.0298	1,985,526	**59,161**	0.0224	6,542	**147**
0.2645	98,310	**25,998**	0.1997	3,034	**606**
2.1457	1,526,918	**3,276,309**	1.6028	7,758	**12,435**
0.5166	92,758	**47,919**	0.3840	676	**260**
1.0451	2,318,352	**2,422,887**	0.7771	54,363	**42,245**
0.2063	243,976	**50,342**	0.1227	9,106	**1,117**
0.2653	2,318,352	**614,989**	0.1973	54,363	**10,726**
1.0184	243,976	**248,466**	0.7039	9,106	**6,410**
0.0583	5,172,218	**301,489**	0.0467	16,190	**756**
0.8415	231,466	**194,781**	0.6285	1,144	**719**
0.2731	1,616,522	**441,521**	0.2045	8,263	**1,690**
1.1647	1,616,522	**1,882,793**	0.8726	8,263	**7,210**
0.9647	2,930,192	**2,826,786**	0.7804	86,230	**67,294**
1.5742	1,560,908	**2,457,228**	1.1759	7,939	**9,335**
0.0903	231,466	**20,901**	0.0650	1,144	**74**
1.1529	6,936,280	**7,996,838**	0.9326	23,522	**21,937**
0.1824	6,910,968	**1,260,560**	0.1353	23,202	**3,139**
0.0245	786,773	**19,284**	0.0183	7,779	**142**
0.3629	2,003,499	**727,070**	0.2692	7,008	**1,886**
0.0000	3,714,649	**0**	0.1890	58,469	**11,051**
0.0000	3,714,649	**0**	0.0758	73,274	**5,554**
0.0000	0	**0**	0.3002	78,892	**23,683**
0.0000	3,714,649	**0**	0.7332	79,036	**57,949**
0.0000	3,714,649	**0**	0.3467	78,892	**27,352**
3.9754	28,089	**111,663**	2.9372	465	**1,367**
0.0000	0	**0**	1.5000	53,050	**79,575**
0.0000	0	**0**	1.5000	5,419	**8,128**
0.7189	7,680,995	**5,522,052**	0.5384	79,850	**42,991**
0.0000	0	**0**	1.5000	14,805	**22,207**
0.0000	0	**0**	1.5000	5,593	**8,390**
0.0000	3,714,649	**0**	0.2964	78,867	**23,376**
0.0000	0	**0**	1.5000	147	**221**
0.0000	0	**0**	1.5000	171	**257**
0.0000	0	**0**	1.5000	78,892	**118,338**
2.0355	3,508,530	**7,141,596**	1.6076	10,938	**17,584**
1.3708	7,299,996	**10,007,053**	1.0876	23,881	**25,972**
3.4382	6,910,968	**23,761,565**	2.5503	23,202	**59,171**
0.2718	98,310	**26,717**	0.2052	3,034	**623**
1.0864	1,049,346	**1,140,056**	0.8117	4,868	**3,952**
0.0000	3,714,649	**0**	0.3599	78,892	**28,393**
2.9640	46,580	**138,062**	1.9238	2,303	**4,431**
5.2497	28,089	**147,457**	3.9218	465	**1,825**
3.3566	46,625	**156,502**	2.5333	2,306	**5,841**
1.5532	6,397	**9,935**	1.1603	55	**64**
2.3087	6,397	**14,768**	1.7247	55	**95**
1.1752	6,397	**7,517**	0.8795	67	**59**

TRANSPORT COSTS US $				PHASE	2E SG	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC2	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC2	TOT_FLOW	TOT TRSP COST
0.8183	6,397	**5,234**		0.6113	67	**41**
0.8686	46	**40**		3.0107	2	**7**
TRANSPORT COSTS PHASE 2E		**336,256,900**		**TRANSPORT COSTS PHASE 2E**		**2,572,265**

TRANSPORT COSTS US $				PHASE 2C	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC 2B	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT 2B	TOT_FLOW	TOT TRSP COST
0.2298	179,377	**41,221**	0.1719	1,427	**245**
2.7033	179,377	**484,910**	2.1701	1,427	**3,097**
0.0122	179,377	**2,188**	0.0092	1,427	**13**
2.0284	472,523	**958,465**	1.5153	502	**761**
3.7596	378,916	**1,424,573**	2.8086	48	**135**
0.0636	5,242,514	**333,424**	0.0475	21,172	**1,006**
0.5341	5,242,514	**2,800,027**	0.3996	21,172	**8,460**
0.2765	200,018	**55,305**	0.2069	21,719	**4,494**
0.4698	5,093,120	**2,392,748**	0.3485	23,251	**8,103**
0.1540	200,018	**30,803**	0.1152	21,719	**2,502**
0.6329	200,018	**126,591**	0.4735	21,719	**10,284**
0.1694	200,018	**33,883**	0.1256	21,719	**2,728**
0.3169	5,093,120	**1,614,010**	0.2371	23,251	**5,513**
0.3883	7,415,377	**2,879,391**	0.2901	59,414	**17,236**
1.0393	7,415,377	**7,706,802**	0.7776	59,414	**46,200**
1.3270	1,574,985	**2,090,005**	0.9927	100,029	**99,299**
0.5156	1,574,985	**812,062**	0.3852	100,029	**38,531**
0.0881	1,574,985	**138,756**	0.0659	100,392	**6,616**
0.9666	5,242,514	**5,067,414**	0.7671	21,172	**16,241**
0.1584	3,455,724	**547,387**	0.1281	47,124	**6,037**
1.1655	3,455,724	**4,027,646**	0.9428	47,124	**44,429**
1.9404	2,463,329	**4,779,844**	1.5366	4,864	**7,474**
0.7039	4,828,204	**3,398,573**	0.5575	20,684	**11,531**
0.0388	4,828,204	**187,334**	0.0308	20,684	**637**
0.2819	4,901,599	**1,381,761**	0.2280	14,136	**3,223**
1.2373	4,901,599	**6,064,749**	0.9933	14,136	**14,041**
0.2990	4,828,974	**1,443,863**	0.2368	20,684	**4,898**
0.0622	858,133	**53,376**	0.0465	14,500	**674**
0.7543	3,562,398	**2,687,117**	0.6102	55,298	**33,743**
0.0622	7,716,757	**479,982**	0.0494	156,502	**7,731**
0.2401	2,437,399	**585,219**	0.1906	16,493	**3,143**
0.0098	7,716,757	**75,624**	0.0077	156,502	**1,205**
0.0346	7,716,757	**267,000**	0.0274	156,502	**4,288**
0.0378	7,716,757	**291,693**	0.0300	156,502	**4,695**
2.1999	2,386,421	**5,249,888**	1.6458	4,688	**7,716**
0.7396	2,394,575	**1,771,028**	0.5983	16,327	**9,768**
0.2190	2,394,575	**524,412**	0.1771	16,327	**2,891**
0.5044	4,828,204	**2,435,346**	0.3995	20,684	**8,263**
0.0191	4,828,204	**92,219**	0.0151	20,684	**312**
0.7309	2,357,024	**1,722,749**	0.5912	15,622	**9,236**
0.9540	2,357,024	**2,248,601**	0.7717	15,622	**12,055**
0.2372	2,327,619	**552,111**	0.1883	25,608	**4,822**
0.0031	1,237,965	**3,838**	0.0023	32,654	**75**
0.5888	2,436,502	**1,434,613**	0.4673	16,388	**7,658**
0.0566	2,436,502	**137,906**	0.0450	16,388	**737**
0.7438	2,327,619	**1,731,283**	0.5903	25,608	**15,117**
0.0275	2,327,619	**64,010**	0.0205	25,608	**525**
1.1908	1,237,965	**1,474,169**	0.8909	32,654	**29,091**
1.2118	675,756	**818,882**	0.9066	9,515	**8,627**
0.0101	101,922	**1,029**	0.0075	38	**0**
0.5302	101,922	**54,039**	0.3956	38	**15**

TRANSPORT COSTS US $			PHASE	2C	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC 2B	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT 2B	TOT_FLOW	TOT TRSP COST
0.0363	101,922	**3,700**	0.0269	38	**1**
1.6252	92,760	**150,754**	1.2127	738	**895**
0.8721	92,760	**80,896**	0.6582	738	**486**
4.0227	93,322	**375,408**	3.0052	756	**2,272**
1.8520	93,322	**172,833**	1.3768	756	**1,041**
0.0383	101,922	**3,904**	0.0284	38	**1**
0.0289	101,922	**2,946**	0.0214	38	**1**
0.0429	1,606,496	**68,919**	0.0321	8,190	**263**
1.1033	1,616,519	**1,783,506**	0.8254	8,183	**6,754**
1.6381	586,790	**961,221**	1.2223	2,332	**2,850**
0.7279	101,922	**74,189**	0.5432	38	**21**
1.0734	101,922	**109,403**	0.8009	38	**30**
0.1703	102,525	**17,460**	0.1271	56	**7**
2.0097	603	**1,211**	1.4941	18	**27**
0.5721	101,922	**58,310**	0.4269	38	**16**
0.6380	101,922	**65,026**	0.4815	38	**18**
1.3846	101,922	**141,121**	1.0332	38	**39**
9.5000	2,781,112	**26,420,566**	2.2000	7,393	**16,264**
0.0244	1,689,799	**41,231**	0.0197	5,523	**109**
0.3867	1,784,989	**690,255**	0.3128	560	**175**
0.5086	1,169,651	**594,884**	0.3805	12,472	**4,746**
0.8023	1,689,799	**1,355,726**	0.6487	5,523	**3,583**
3.1409	2,951,808	**9,271,335**	2.3498	10,069	**23,659**
1.8038	583,385	**1,052,310**	1.3460	9,206	**12,391**
0.5759	2,693,128	**1,550,972**	0.4302	1,675	**721**
0.0190	2,951,808	**56,084**	0.0142	7,231	**103**
1.0080	2,956,814	**2,980,468**	0.8159	5,463	**4,457**
0.3578	3,761,767	**1,345,960**	0.2840	1,959	**556**
0.0086	4,212,777	**36,230**	0.0068	12,157	**83**
0.0091	2,956,814	**26,907**	0.0068	5,463	**37**
0.3675	2,956,814	**1,086,629**	0.2973	5,463	**1,624**
1.1514	2,956,814	**3,404,476**	0.9313	5,463	**5,088**
1.4331	1,454,618	**2,084,614**	1.0694	7,668	**8,200**
2.7508	308,256	**847,951**	2.0525	1,053	**2,162**
1.1412	1,616,519	**1,844,772**	0.8537	8,183	**6,986**
1.0631	303,763	**322,931**	0.7933	1,154	**916**
3.1209	139,897	**436,603**	2.3555	680	**1,603**
1.6475	303,763	**500,450**	1.2293	1,154	**1,419**
0.0238	4,095,277	**97,468**	0.0193	12,147	**234**
0.4518	355,022	**160,399**	0.3380	1,295	**438**
0.4351	452,204	**196,754**	0.3247	1,127	**366**
2.4827	355,022	**881,413**	1.8525	1,295	**2,400**
3.2961	452,204	**1,490,510**	2.4624	1,127	**2,775**
0.0408	4,095,277	**167,087**	0.0330	12,147	**401**
1.1670	4,095,277	**4,779,188**	0.9440	12,147	**11,466**
0.5725	4,095,277	**2,344,546**	0.4631	12,147	**5,625**
0.5396	472,523	**254,973**	0.4026	502	**202**
1.5287	2,840,467	**4,342,222**	1.1399	9,006	**10,266**
0.7550	2,840,467	**2,144,552**	0.5648	9,006	**5,087**
1.7926	1,484,664	**2,661,408**	1.3392	7,809	**10,458**
0.2147	2,235,451	**479,951**	0.1606	14,526	**2,333**
3.0000	1,446,024	**4,338,071**	2.2000	0	**0**
0.8602	2,106,861	**1,812,322**	0.6381	16,846	**10,750**
0.0220	944,500	**20,779**	0.0164	4,449	**73**

TRANSPORT COSTS US $				PHASE	2C	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC 2B	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT 2B	TOT_FLOW	TOT TRSP COST
1.3066	2,394,575	**3,128,752**		1.0569	16,327	**17,256**
0.3555	87,213	**31,004**		0.2821	1,107	**312**
1.0996	426,319	**468,780**		0.8227	7,535	**6,199**
1.5029	944,500	**1,419,490**		1.1227	4,449	**4,994**
0.5789	4,764	**2,758**		0.4325	354	**153**
2.9696	3,911	**11,615**		2.2158	249	**551**
0.0929	1,484,664	**137,925**		0.0701	7,809	**547**
1.0636	1,484,664	**1,579,088**		0.8028	7,809	**6,269**
0.2597	1,484,664	**385,567**		0.1940	7,809	**1,515**
0.0950	2,394,575	**227,485**		0.0768	16,327	**1,254**
0.0818	87,213	**7,134**		0.0649	1,107	**72**
0.5436	87,213	**47,409**		0.4314	1,107	**478**
0.4657	87,213	**40,615**		0.3475	1,107	**385**
1.3013	87,213	**113,490**		0.9216	1,107	**1,020**
0.3676	87,213	**32,059**		0.2974	1,107	**329**
0.1349	87,213	**11,765**		0.1091	1,107	**121**
0.7220	87,213	**62,968**		0.5840	1,107	**647**
0.0321	87,213	**2,800**		0.0260	1,107	**29**
0.0268	87,213	**2,337**		0.0213	1,107	**24**
0.0772	2,235,451	**172,577**		0.0578	14,526	**840**
0.9732	426,319	**414,893**		0.7281	7,535	**5,487**
0.0150	2,652,409	**39,786**		0.0112	53,760	**602**
2.3380	2,652,409	**6,201,331**		1.7381	53,760	**93,441**
0.0258	2,652,409	**68,432**		0.0191	53,760	**1,027**
0.4382	1,120,829	**491,147**		0.3278	7,176	**2,352**
0.1952	1,120,829	**218,786**		0.1460	7,176	**1,048**
3.6737	452,204	**1,661,262**		2.7412	1,127	**3,089**
0.2825	1,120,829	**316,634**		0.2110	7,176	**1,514**
0.5230	1,120,829	**586,194**		0.3907	7,176	**2,804**
0.0897	3,144,364	**282,049**		0.0671	84,201	**5,650**
0.4554	3,144,364	**1,431,943**		0.3614	84,201	**30,430**
0.0779	3,144,364	**244,946**		0.0583	84,201	**4,909**
0.3213	634,511	**203,868**		0.2404	43,158	**10,375**
0.7858	243,976	**191,717**		0.5879	9,106	**5,353**
0.8170	2,652,409	**2,167,018**		0.6074	53,760	**32,654**
0.6954	1,120,829	**779,424**		0.5195	7,176	**3,728**
1.1991	1,120,829	**1,343,986**		0.8958	7,176	**6,428**
0.5804	1,120,829	**650,529**		0.4315	7,176	**3,096**
0.6058	3,911	**2,369**		0.4526	249	**113**
0.1683	3,911	**658**		0.1257	249	**31**
1.3594	3,911	**5,317**		1.0144	84	**85**
1.2988	3,911	**5,080**		0.9691	84	**81**
0.2385	3,911	**933**		0.1779	84	**15**
1.1602	3,911	**4,538**		0.8606	84	**72**
2.4403	37,228	**90,847**		1.8209	75	**136**
0.7138	37,228	**26,573**		0.5326	75	**40**
0.9503	205,438	**195,228**		0.7542	626	**472**
0.1211	168,210	**20,370**		0.0961	627	**60**
0.8333	5,373,162	**4,477,456**		0.6613	49,855	**32,969**
0.0589	2,043,936	**120,388**		0.0466	10,328	**481**
0.8235	433,190	**356,732**		0.6661	9,940	**6,621**
0.6195	431,853	**267,533**		0.4634	9,908	**4,591**
0.2702	431,853	**116,687**		0.2145	9,908	**2,125**
0.1523	431,853	**65,771**		0.1140	9,908	**1,130**

TRANSPORT COSTS US $				PHASE	2C	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC 2B	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT 2B	TOT_FLOW	TOT TRSP COST
0.7446	431,853	**321,557**		0.5570	9,908	**5,519**
0.0040	5,736,934	**22,948**		0.0032	51,287	**164**
0.0087	397,322	**3,457**		0.0069	1,551	**11**
0.0708	8,533,862	**604,197**		0.0562	55,783	**3,135**
0.0080	2,829,921	**22,639**		0.0064	4,534	**29**
0.6289	431,853	**271,592**		0.4991	9,908	**4,945**
0.0069	3,227,243	**22,268**		0.0051	6,085	**31**
0.1020	3,227,243	**329,179**		0.0761	6,085	**463**
0.5630	3,144,364	**1,770,277**		0.4458	84,201	**37,537**
0.2705	1,574,985	**426,033**		0.2147	100,029	**21,476**
0.5247	1,574,985	**826,395**		0.4164	100,029	**41,652**
0.0645	3,652,440	**235,582**		0.0518	0	**0**
0.4838	6,139,484	**2,970,282**		0.4094	98,847	**40,468**
0.3478	3,208,282	**1,115,840**		0.2814	85,657	**24,104**
0.0171	3,619,910	**61,900**		0.0128	80,098	**1,025**
0.0266	3,249,139	**86,427**		0.0199	90,810	**1,807**
0.0412	2,841,943	**117,088**		0.0308	52,802	**1,626**
0.1612	6,091,082	**981,882**		0.1280	178,163	**22,805**
0.4069	1,255,405	**510,824**		0.3230	78,364	**25,312**
0.3023	7,415,377	**2,241,669**		0.2262	65,105	**14,727**
0.1810	1,255,405	**227,228**		0.1437	72,931	**10,480**
0.1895	1,255,405	**237,899**		0.1406	72,931	**10,254**
0.0593	7,415,377	**439,732**		0.0443	65,105	**2,884**
0.5410	2,726,092	**1,474,816**		0.4376	27,313	**11,952**
0.6599	2,726,092	**1,798,948**		0.5338	27,313	**14,579**
0.0555	2,726,092	**151,298**		0.0449	27,313	**1,226**
2.1463	478,658	**1,027,344**		1.6034	4,932	**7,908**
0.2722	478,658	**130,291**		0.2050	4,932	**1,011**
0.0903	2,197,268	**198,413**		0.0730	8,697	**635**
0.0671	2,197,268	**147,437**		0.0542	8,697	**471**
0.2511	2,178,480	**547,016**		0.1876	73,353	**13,761**
0.1642	2,178,480	**357,706**		0.1226	73,353	**8,993**
1.2057	2,178,480	**2,626,593**		0.9007	73,353	**66,069**
0.5957	2,726,092	**1,623,933**		0.4819	27,313	**13,162**
0.1157	1,255,405	**145,250**		0.0865	72,931	**6,309**
0.5123	1,255,405	**643,144**		0.3833	72,931	**27,954**
0.3888	3,455,724	**1,343,585**		0.2901	47,124	**13,671**
0.4945	1,255,405	**620,798**		0.3699	72,931	**26,977**
0.7146	1,255,405	**897,112**		0.5339	72,931	**38,938**
0.0321	1,255,405	**40,299**		0.0240	72,931	**1,750**
0.6723	2,178,480	**1,464,592**		0.5030	73,353	**36,896**
0.0425	1,255,405	**53,355**		0.0318	72,931	**2,319**
0.0977	478,658	**46,765**		0.0725	4,932	**358**
0.0300	479,676	**14,390**		0.0224	5,317	**119**
0.2646	280,479	**74,215**		0.1997	3,019	**603**
2.1480	1,454,618	**3,124,520**		1.6028	7,668	**12,290**
0.5166	92,760	**47,920**		0.3840	738	**284**
1.0453	2,652,409	**2,772,563**		0.7771	53,760	**41,777**
0.1655	243,976	**40,378**		0.1227	9,106	**1,117**
0.2654	2,652,409	**703,949**		0.1973	53,760	**10,607**
0.9490	243,976	**231,534**		0.7039	9,106	**6,410**
0.0582	4,901,599	**285,273**		0.0467	16,018	**748**
0.8423	303,763	**255,860**		0.6285	1,154	**726**
0.2733	1,616,519	**441,795**		0.2045	8,183	**1,673**

TRANSPORT COSTS US $				PHASE	2C	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC 2B	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT 2B	TOT_FLOW	TOT TRSP COST
1.1663	1,616,519	**1,885,347**		0.8726	8,183	**7,140**
0.9648	3,208,282	**3,095,350**		0.7804	85,657	**66,847**
1.5759	1,484,664	**2,339,682**		1.1759	7,809	**9,183**
0.0871	318,736	**27,762**		0.0650	1,154	**75**
1.1530	3,425,698	**3,949,830**		0.9326	1,266	**1,180**
0.1823	3,404,330	**620,609**		0.1353	757	**102**
0.0245	1,120,829	**27,460**		0.0183	7,176	**131**
0.3629	496,631	**180,227**		0.2692	5,361	**1,443**
0.0614	3,227,243	**198,153**		0.0698	6,085	**425**
0.1193	3,227,243	**385,010**		0.1356	6,085	**825**
0.2105	3,227,243	**679,335**		0.2393	6,085	**1,456**
0.0506	3,227,243	**163,299**		0.0575	6,085	**350**
0.2332	1,382,637	**322,431**		0.2651	11,006	**2,918**
0.4703	1,250,563	**588,140**		0.5346	15,612	**8,346**
0.1649	2,770,006	**456,774**		0.1874	6,085	**1,140**
0.5089	2,813,998	**1,432,043**		0.5785	10,550	**6,103**
0.1603	786,950	**126,148**		0.1823	0	**0**
0.4971	1,446,024	**718,818**		0.5651	0	**0**
0.0558	0	**0**		0.0635	5,589	**355**
0.1663	3,652,440	**607,401**		0.1890	59,503	**11,246**
0.0667	3,652,440	**243,618**		0.0758	74,566	**5,652**
0.2641	3,653,210	**964,813**		0.3002	82,466	**24,756**
0.6450	3,652,440	**2,355,824**		0.7332	80,652	**59,134**
0.1672	3,652,440	**610,688**		0.1900	0	**0**
0.0365	3,652,440	**133,314**		0.0415	0	**0**
0.3050	3,652,440	**1,113,994**		0.3467	82,466	**28,591**
0.7947	4,886,751	**3,883,501**		0.7947	20,382	**16,198**
3.9317	28,089	**110,436**		2.9372	465	**1,367**
1.0399	4,520,626	**4,700,999**		1.0947	23,177	**25,372**
0.4180	3,232,122	**1,351,027**		0.4559	23,177	**10,567**
0.3376	3,248,826	**1,096,804**		0.3331	23,177	**7,720**
1.1265	2,781,112	**3,132,923**		1.1924	12,406	**14,793**
0.2394	2,781,112	**665,798**		0.2697	7,393	**1,994**
3.0000	3,227,243	**9,681,730**		1.0000	6,085	**6,085**
8.3000	3,652,440	**30,315,253**		1.5000	0	**0**
0.0000	0	**0**		1.5000	53,914	**80,871**
0.0000	0	**0**		1.5000	5,589	**8,383**
0.7197	7,415,377	**5,336,847**		0.5384	80,167	**43,162**
0.0000	0	**0**		1.5000	15,063	**22,594**
0.0000	0	**0**		1.5000	5,691	**8,536**
0.2608	3,652,440	**952,556**		0.2964	80,256	**23,788**
0.0000	0	**0**		1.5000	2,105	**3,157**
0.0000	0	**0**		1.5000	398	**597**
6.0000	770	**4,619**		0.0000	0	**0**
3.0000	0	**0**		1.5000	86,990	**130,485**
3.0000	182,377	**547,130**		1.5000	5,024	**7,535**
3.0000	1,018	**3,054**		1.5000	470	**705**
2.0300	2,043,936	**4,149,189**		1.6076	10,328	**16,603**
3.0000	43,992	**131,976**		2.0000	4,653	**9,305**
4.0000	366,126	**1,464,503**		2.2000	6,591	**14,501**
7.5000	451,010	**3,382,575**		2.2000	10,772	**23,697**
1.3708	3,761,767	**5,156,630**		1.0876	1,959	**2,130**
3.4384	2,132,530	**7,332,490**		2.5503	757	**1,929**
0.2719	280,479	**76,262**		0.2052	3,019	**619**

TRANSPORT COSTS US $				PHASE	2C	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC 2B	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT 2B	TOT_FLOW	TOT TRSP COST
1.0865	944,500	**1,026,200**		0.8117	4,449	**3,611**
5.0000	1,271,800	**6,359,000**		2.2000	0	**0**
6.5000	16,704	**108,575**		0.0000	0	**0**
0.3166	3,652,440	**1,156,363**		0.3599	82,466	**29,679**
2.9640	853	**2,528**		1.9238	105	**202**
3.0000	786,950	**2,360,851**		0.0000	0	**0**
5.2497	28,089	**147,457**		3.9218	465	**1,825**
3.3566	896	**3,008**		2.5333	105	**266**
1.5532	2,051	**3,186**		1.1603	32	**38**
2.3087	2,051	**4,735**		1.7247	32	**56**
1.1773	382	**449**		0.8795	3,169	**2,787**
0.8183	382	**312**		0.6113	3,169	**1,937**
3.9891	44	**174**		3.0107	0	**0**
TRANSPORT COSTS PHASE 2C		**347,762,917**		TRANSPORT COSTS PHASE 2C		**2,426,874**

TRANSPORT COSTS US $				PHASE 3	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC3	TOT_FLOW	TOT TRSP COST	VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST
0.2298	31,061	**7,138**	0.1719	709	**122**
2.7033	31,061	**83,967**	2.1701	709	**1,538**
0.0122	31,061	**379**	0.0092	709	**7**
2.6369	436,733	**1,151,622**	1.5153	505	**765**
4.8875	343,127	**1,677,032**	2.8086	45	**128**
0.0636	5,066,657	**322,239**	0.0475	13522	**642**
0.5341	5,066,657	**2,706,101**	0.3996	13522	**5,403**
0.2765	200,018	**55,305**	0.2069	15566	**3,221**
0.4698	4,917,262	**2,310,130**	0.3485	21754	**7,581**
0.1540	200,018	**30,803**	0.1152	15566	**1,793**
0.6329	200,018	**126,591**	0.4735	15566	**7,371**
0.1694	200,018	**33,883**	0.1256	15566	**1,955**
0.3169	4,917,262	**1,558,280**	0.2371	21754	**5,158**
0.3883	7,234,519	**2,809,164**	0.2901	57918	**16,802**
1.0393	7,234,519	**7,518,836**	0.7776	57918	**45,037**
1.3270	1,574,985	**2,090,005**	0.9927	100030	**99,300**
0.5156	1,574,985	**812,062**	0.3852	100030	**38,532**
0.0881	1,574,985	**138,756**	0.0659	106545	**7,021**
0.9666	5,066,657	**4,897,431**	0.7671	13522	**10,373**
0.1584	3,293,365	**521,669**	0.1281	43593	**5,584**
1.1655	3,293,365	**3,838,417**	0.9428	43593	**41,099**
1.9404	1,937,922	**3,760,344**	1.5366	2130	**3,273**
0.7039	4,652,331	**3,274,775**	0.5575	13702	**7,639**
0.0388	4,652,331	**180,510**	0.0308	13702	**422**
0.2819	4,725,742	**1,332,187**	0.2280	7155	**1,631**
1.2369	4,725,742	**5,845,270**	0.9929	7155	**7,104**
0.2990	4,653,116	**1,391,282**	0.2368	13702	**3,245**
0.0622	1,137,506	**70,753**	0.0465	10427	**485**
0.7545	3,686,250	**2,781,275**	0.6103	50285	**30,689**
0.0629	7,540,883	**474,322**	0.0500	163186	**8,159**
0.2394	2,363,378	**565,793**	0.1900	16222	**3,082**
0.0098	7,540,883	**73,901**	0.0077	163186	**1,257**
0.0346	7,540,883	**260,915**	0.0274	163186	**4,471**
0.0378	7,540,883	**285,045**	0.0300	163186	**4,896**
2.1999	1,861,014	**4,094,045**	1.6458	1953	**3,215**
0.7396	2,194,962	**1,623,394**	0.5983	16085	**9,624**
0.2190	2,194,962	**480,697**	0.1771	16085	**2,849**
0.5044	4,652,331	**2,346,636**	0.3995	13702	**5,474**
0.0191	4,652,331	**88,860**	0.0151	13702	**207**
0.7309	2,218,308	**1,621,361**	0.5912	15063	**8,905**
0.9540	2,218,308	**2,116,266**	0.7717	15063	**11,624**
0.2372	2,189,826	**519,427**	0.1883	25047	**4,716**
0.0031	1,506,424	**4,670**	0.0023	28183	**65**
0.5888	2,230,957	**1,313,587**	0.4673	16141	**7,543**
0.0566	2,230,957	**126,272**	0.0450	16141	**726**
0.7438	2,189,826	**1,628,792**	0.5903	25047	**14,785**
0.0275	2,189,826	**60,220**	0.0205	25047	**513**

TRANSPORT COSTS US $			PHASE	3	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC3	TOT_FLOW	TOT TRSP COST	VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST
1.1908	1,506,424	**1,793,850**	0.8909	28183	**25,109**
1.2118	577,617	**699,956**	0.9066	4868	**4,414**
0.0101	102,189	**1,032**	0.0075	56	**0**
0.5302	102,189	**54,180**	0.3956	56	**22**
0.0363	102,189	**3,709**	0.0269	56	**2**
1.6252	92,730	**150,705**	1.2127	656	**796**
0.8721	92,730	**80,870**	0.6582	656	**432**
4.0227	93,026	**374,214**	3.0052	656	**1,972**
1.8520	93,026	**172,284**	1.3768	656	**903**
0.0383	102,189	**3,914**	0.0284	56	**2**
0.0289	102,189	**2,953**	0.0214	56	**1**
0.0429	1,606,526	**68,920**	0.0321	8272	**266**
1.1033	1,616,816	**1,783,833**	0.8254	8283	**6,836**
1.6381	586,760	**961,172**	1.2223	2392	**2,924**
0.7279	102,189	**74,383**	0.5432	56	**30**
1.0734	102,189	**109,689**	0.8009	56	**45**
0.1703	102,525	**17,460**	0.1271	56	**7**
2.0097	336	**675**	1.4941	0	**0**
0.5721	102,189	**58,462**	0.4269	56	**24**
0.6380	102,189	**65,196**	0.4815	56	**27**
1.3846	102,189	**141,490**	1.0332	56	**58**
9.5000	2,763,715	**26,255,290**	2.0000	7974	**15,949**
0.0373	1,651,669	**61,607**	0.0302	4842	**146**
0.3918	1,784,989	**699,359**	0.3169	560	**177**
0.5036	1,169,354	**588,887**	0.3768	12372	**4,662**
0.8023	1,651,669	**1,325,134**	0.6490	4842	**3,142**
3.1412	2,987,598	**9,384,642**	2.3500	10066	**23,655**
1.8038	578,761	**1,043,969**	1.3460	9203	**12,388**
0.5759	2,693,128	**1,550,972**	0.4302	1675	**721**
0.0199	2,987,598	**59,453**	0.0149	6591	**98**
1.0080	3,009,704	**3,033,782**	0.8154	5415	**4,416**
0.3578	3,670,918	**1,313,455**	0.2840	1111	**316**
0.0086	4,117,418	**35,410**	0.0068	11427	**78**
0.0091	3,009,704	**27,388**	0.0068	5415	**37**
0.3675	3,009,704	**1,106,066**	0.2973	5415	**1,610**
1.1514	3,009,704	**3,465,373**	0.9313	5415	**5,043**
1.4331	528,275	**757,071**	1.0684	1536	**1,641**
2.7508	239,503	**658,826**	2.0527	870	**1,785**
1.1412	1,616,816	**1,845,110**	0.8554	8283	**7,085**
1.0601	138,480	**146,802**	0.7910	678	**536**
3.1209	20,396	**63,653**	2.3555	220	**518**
1.6475	138,480	**228,145**	1.2293	678	**833**
0.0238	4,148,227	**98,728**	0.0193	12136	**234**
0.5874	120,788	**70,951**	0.3380	1289	**436**
0.5656	56,278	**31,831**	0.3247	1121	**364**
3.2275	120,788	**389,844**	1.8525	1289	**2,388**
4.2849	56,278	**241,145**	2.4624	1121	**2,760**
0.0408	4,148,227	**169,248**	0.0330	12136	**400**
1.1670	4,148,227	**4,840,981**	0.9440	12136	**11,456**

TRANSPORT COSTS US $			PHASE	3	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC3	TOT_FLOW	TOT TRSP COST	VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST
0.5725	4,148,227	**2,374,860**	0.4631	12136	**5,620**
0.7014	436,733	**306,325**	0.4026	505	**203**
1.5287	2,786,700	**4,260,028**	1.1437	8606	**9,843**
0.7550	2,786,700	**2,103,958**	0.5648	8606	**4,861**
1.7926	558,299	**1,000,807**	1.3392	1628	**2,180**
0.2147	1,309,208	**281,087**	0.1606	9752	**1,566**
3.0000	1,455,103	**4,365,310**	1.0000	0	**0**
0.8633	1,429,826	**1,234,369**	0.6404	14070	**9,010**
0.0220	617,390	**13,583**	0.0164	2992	**49**
1.3066	2,194,962	**2,867,937**	1.0569	16085	**17,000**
0.3555	87,213	**31,004**	0.2821	1107	**312**
1.0996	172,736	**189,941**	0.8227	5936	**4,883**
1.5029	617,390	**927,876**	1.1227	2992	**3,359**
0.5789	331,874	**192,122**	0.4325	1751	**757**
2.9696	3,911	**11,615**	2.2158	88	**196**
0.0929	558,299	**51,866**	0.0701	1628	**114**
1.0636	558,299	**593,807**	0.8028	1628	**1,307**
0.2597	558,299	**144,990**	0.1940	1628	**316**
0.0950	2,194,962	**208,521**	0.0768	16085	**1,235**
0.0818	87,213	**7,134**	0.0649	1107	**72**
0.5436	87,213	**47,409**	0.4314	1107	**478**
0.4657	87,213	**40,615**	0.3475	1107	**385**
1.3013	87,213	**113,490**	0.9216	1107	**1,020**
0.3676	87,213	**32,059**	0.2974	1107	**329**
0.1349	87,213	**11,765**	0.1091	1107	**121**
0.7220	87,213	**62,968**	0.5840	1107	**647**
0.0321	87,213	**2,800**	0.0260	1107	**29**
0.0268	87,213	**2,337**	0.0213	1107	**24**
0.0772	1,309,208	**101,071**	0.0578	9752	**564**
0.9732	172,736	**168,107**	0.7281	5936	**4,322**
0.0150	2,256,482	**33,847**	0.0112	53766	**602**
3.0393	2,256,482	**6,858,127**	1.7381	53766	**93,451**
0.0258	2,256,482	**58,217**	0.0191	53766	**1,027**
0.5696	724,903	**412,905**	0.3278	7169	**2,350**
0.2537	724,903	**183,908**	0.1494	7169	**1,071**
4.7758	56,278	**268,772**	2.7412	1121	**3,072**
0.3672	724,903	**266,184**	0.2110	7169	**1,513**
0.6800	724,903	**492,934**	0.3907	7169	**2,801**
0.0897	2,804,404	**251,555**	0.0671	84207	**5,650**
0.4554	2,804,404	**1,277,126**	0.3614	84207	**30,432**
0.0779	2,804,404	**218,463**	0.0583	84207	**4,909**
0.3213	634,511	**203,868**	0.2404	43158	**10,375**
0.7858	243,976	**191,717**	0.5879	9106	**5,353**
1.0621	2,256,482	**2,396,610**	0.6074	53766	**32,658**
0.9040	724,903	**655,312**	0.5195	7169	**3,724**
1.5588	724,903	**1,129,978**	0.8958	7169	**6,422**
0.7546	724,903	**547,012**	0.4315	7169	**3,094**
0.6058	3,911	**2,369**	0.4526	88	**40**
0.1683	3,911	**658**	0.1257	88	**11**

TRANSPORT COSTS US $				PHASE 3	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC3	TOT_FLOW	TOT TRSP COST	VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST
1.3594	3,911	**5,317**	1.0144	53	**54**
1.2988	3,911	**5,080**	0.9691	53	**51**
0.2371	3,911	**927**	0.1769	53	**9**
1.1602	3,911	**4,538**	0.8606	53	**46**
2.4417	37,177	**90,775**	1.8219	69	**126**
0.7138	37,177	**26,537**	0.5326	69	**37**
0.9503	205,387	**195,180**	0.7542	620	**467**
0.1211	168,210	**20,370**	0.0961	627	**60**
0.8333	5,232,176	**4,359,972**	0.6613	49372	**32,650**
0.0568	2,033,507	**115,503**	0.0449	6315	**284**
0.8235	433,139	**356,690**	0.6661	9937	**6,619**
0.6195	431,796	**267,498**	0.4634	9586	**4,442**
0.2702	431,796	**116,671**	0.2145	9586	**2,056**
0.1523	431,796	**65,763**	0.1140	9586	**1,093**
0.7446	431,796	**321,515**	0.5570	9586	**5,340**
0.0040	5,617,012	**22,468**	0.0032	50984	**163**
0.0087	414,011	**3,602**	0.0069	1734	**12**
0.0708	8,533,897	**604,200**	0.0562	55465	**3,117**
0.0080	2,945,574	**23,565**	0.0064	4521	**29**
0.6289	431,796	**271,556**	0.4991	9586	**4,784**
0.0069	3,359,585	**23,181**	0.0051	6255	**32**
0.1020	3,359,585	**342,678**	0.0761	6255	**476**
0.5630	2,804,404	**1,578,879**	0.4458	84207	**37,539**
0.2705	1,574,985	**426,033**	0.2147	100030	**21,476**
0.5247	1,574,985	**826,395**	0.4164	100030	**41,653**
0.0645	4,241,061	**273,548**	0.0518	0	**0**
0.4838	6,198,959	**2,999,056**	0.4094	98853	**40,470**
0.3478	2,868,322	**997,602**	0.2814	85663	**24,106**
0.0171	3,648,661	**62,392**	0.0128	80097	**1,025**
0.0267	3,277,780	**87,517**	0.0199	90801	**1,807**
0.0412	2,872,777	**118,358**	0.0307	52818	**1,622**
0.1612	6,150,557	**991,470**	0.1279	180473	**23,083**
0.4069	1,233,568	**501,939**	0.3230	75298	**24,321**
0.3023	7,234,519	**2,186,995**	0.2262	64049	**14,488**
0.1810	1,233,568	**223,276**	0.1437	69941	**10,051**
0.1895	1,233,568	**233,761**	0.1406	69941	**9,834**
0.0593	7,234,519	**429,007**	0.0443	64049	**2,837**
0.5410	2,582,377	**1,397,066**	0.4376	26811	**11,732**
0.6597	2,582,377	**1,703,594**	0.5336	26811	**14,306**
0.0555	2,582,377	**143,322**	0.0449	26811	**1,204**
2.1463	468,232	**1,004,966**	1.6034	338	**541**
0.2722	468,232	**127,453**	0.2050	338	**69**
0.2198	2,053,552	**451,371**	0.1778	8138	**1,447**
0.0677	2,053,552	**139,025**	0.0547	8138	**445**
0.2511	2,156,643	**541,533**	0.1876	69320	**13,004**
0.1642	2,156,643	**354,121**	0.1226	69320	**8,499**
1.2057	2,156,643	**2,600,265**	0.9007	69320	**62,436**
0.5957	2,582,377	**1,538,322**	0.4819	26811	**12,920**
0.1157	1,233,568	**142,724**	0.0865	69941	**6,050**

TRANSPORT COSTS US $			PHASE	3	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC3	TOT_FLOW	TOT TRSP COST	VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST
0.5123	1,233,568	**631,957**	0.3833	69941	**26,809**
0.3888	3,293,365	**1,280,460**	0.2901	43593	**12,646**
0.4945	1,233,568	**610,000**	0.3699	69941	**25,871**
0.7146	1,233,568	**881,508**	0.5339	69941	**37,342**
0.0321	1,233,568	**39,598**	0.0240	69941	**1,679**
0.6723	2,156,643	**1,449,911**	0.5030	69320	**34,868**
0.0425	1,233,568	**52,427**	0.0318	69941	**2,224**
0.0977	468,232	**45,746**	0.0725	338	**24**
0.0300	469,249	**14,077**	0.0224	296	**7**
0.2646	438,773	**116,099**	0.1997	3016	**602**
2.1480	528,275	**1,134,734**	1.6028	1536	**2,461**
0.5166	92,730	**47,905**	0.3840	656	**252**
1.3588	2,256,482	**3,066,108**	0.7771	53766	**41,782**
0.1655	243,976	**40,378**	0.1531	9106	**1,394**
0.3450	2,256,482	**778,486**	0.1973	53766	**10,608**
0.9490	243,976	**231,534**	0.7554	9106	**6,878**
0.0583	4,725,742	**275,511**	0.0468	9102	**426**
0.8423	138,480	**116,641**	0.6285	678	**426**
0.2733	1,616,816	**441,876**	0.2045	8283	**1,694**
1.1663	1,616,816	**1,885,693**	0.8726	8283	**7,227**
0.9648	2,868,322	**2,767,357**	0.7804	85663	**66,851**
1.5759	558,299	**879,824**	1.1759	1628	**1,914**
0.0902	152,887	**13,790**	0.0673	678	**46**
1.1530	3,199,754	**3,689,317**	0.9326	719	**670**
0.1823	3,178,406	**579,423**	0.1353	488	**66**
0.0245	724,903	**17,760**	0.0183	7169	**131**
0.3630	486,204	**176,492**	0.2693	709	**191**
0.0626	3,359,585	**210,310**	0.0729	6255	**456**
0.1194	3,359,585	**401,134**	0.1378	6255	**862**
0.2105	3,359,585	**707,193**	0.2393	6255	**1,497**
0.0509	3,359,585	**171,003**	0.0579	6255	**362**
0.2332	1,490,183	**347,511**	0.2651	18764	**4,974**
0.4704	1,735,784	**816,513**	0.5347	23203	**12,406**
0.1649	2,902,301	**478,590**	0.1874	6255	**1,172**
0.5090	2,946,303	**1,499,668**	0.5786	18722	**10,833**
0.1598	786,996	**125,762**	0.1817	0	**0**
0.4971	1,455,103	**723,332**	0.5651	0	**0**
0.0558	0	**0**	0.0631	6388	**403**
0.1663	4,241,061	**705,288**	0.1891	63417	**11,992**
0.0666	4,241,061	**282,455**	0.0757	79660	**6,030**
0.2640	4,241,846	**1,119,847**	0.3001	93486	**28,055**
0.6450	4,241,061	**2,735,484**	0.7332	92341	**67,704**
0.1617	4,241,061	**685,780**	0.1838	0	**0**
0.0424	4,241,061	**179,821**	0.0491	0	**0**
0.3047	4,241,061	**1,292,251**	0.3464	93486	**32,383**
0.1282	316,318	**40,552**	0.2597	1921	**499**
0.1953	316,318	**61,777**	0.3958	1921	**760**
0.8055	6,061,667	**4,882,672**	0.9121	24722	**22,549**
3.9753	14	**54**	2.9698	0	**0**

TRANSPORT COSTS US $			PHASE	3	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC3	TOT_FLOW	TOT TRSP COST	VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST
1.0399	5,986,434	**6,225,293**	1.1776	29780	**35,069**
0.4791	1,091,924	**523,141**	0.9682	6709	**6,496**
0.4180	3,690,709	**1,542,716**	0.4733	23386	**11,068**
0.3376	4,797,040	**1,619,481**	0.3823	29636	**11,330**
1.1265	2,763,715	**3,113,325**	1.2756	12356	**15,762**
0.2394	2,763,715	**661,633**	0.2711	7974	**2,162**
0.3717	480,494	**178,600**	0.7529	715	**538**
3.0000	3,359,585	**10,078,754**	1.0000	6255	**6,255**
8.3000	4,241,061	**35,200,807**	1.0000	0	**0**
0.0000	0	**0**	1.5000	57029	**85,544**
0.0000	0	**0**	1.5000	6388	**9,581**
0.7197	7,234,519	**5,206,683**	0.5384	80292	**43,229**
0.0000	0	**0**	1.5000	16243	**24,364**
0.0000	0	**0**	1.5000	6131	**9,197**
0.2609	4,241,061	**1,106,493**	0.2966	85791	**25,446**
0.0000	0	**0**	1.0000	3134	**3,134**
0.0000	0	**0**	1.5000	6552	**9,828**
6.0000	785	**4,712**	1.0000	0	**0**
0.0000	0	**0**	1.0000	101659	**101,659**
3.0000	559,889	**1,679,667**	1.0000	5561	**5,561**
3.0000	1,017	**3,052**	1.0000	85	**85**
2.0324	2,033,507	**4,132,899**	1.6095	6315	**10,164**
3.0000	44,001	**132,004**	1.0000	13629	**13,629**
4.0000	189,612	**758,448**	2.0000	6532	**13,065**
3.0000	1,091,924	**3,275,772**	1.0000	6709	**6,709**
0.0000	0	**0**	2.0000	4382	**8,764**
5.0000	480,494	**2,402,470**	2.0000	715	**1,430**
7.5000	446,500	**3,348,748**	2.0000	10316	**20,633**
1.3708	3,670,918	**5,032,095**	1.0880	1111	**1,209**
3.4384	1,989,012	**6,839,020**	2.5504	342	**873**
0.2719	438,773	**119,302**	0.2052	3016	**619**
1.0865	617,390	**670,795**	0.8117	2992	**2,429**
5.0000	1,189,749	**5,948,745**	2.0000	403	**806**
6.5000	14,408	**93,649**	1.0000	0	**0**
0.3170	4,241,061	**1,344,416**	0.3603	93486	**33,683**
0.7368	28,075	**20,686**	1.5178	465	**706**
2.9642	327,963	**972,148**	1.9239	1663	**3,199**
3.0000	316,318	**948,954**	1.0000	1921	**1,921**
3.0000	786,996	**2,360,987**	1.0000	0	**0**
5.2496	14	**71**	3.9217	0	**0**
3.0000	28,075	**84,225**	2.0000	465	**931**
3.3566	132,421	**444,485**	2.5333	81	**205**
1.5533	2,068	**3,212**	1.1604	351	**407**
2.3088	2,068	**4,774**	1.7247	351	**605**
1.1751	387	**455**	0.8779	3203	**2,812**
0.8183	387	**317**	0.6113	3203	**1,958**
0.8685	152,996	**132,877**	0.6555	639	**419**
TRANSPORT COSTS PHASE 3		**346.592.899**	TRANSPORT COSTS PHASE 3		**2.342.555**

TRANSPORT COSTS US $			PHASE	4	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC4	TOT_FLOW	TOT TRSP COST
0.2298	31,061	**7,138**	0.1719	658.1548	**113**
2.7033	31,061	**83,967**	2.1701	658.1548	**1,428**
0.0122	31,061	**379**	0.0092	658.1548	**6**
2.6369	436,699	**1,151,531**	1.5153	529.2435	**802**
4.8875	343,092	**1,676,863**	2.8086	21.0924	**59**
0.0636	4,970,885	**316,148**	0.0475	5722.6694	**272**
0.5341	4,970,885	**2,654,949**	0.3996	5722.6694	**2,287**
0.2765	200,018	**55,305**	0.2069	13463.7217	**2,786**
0.4698	4,821,490	**2,265,136**	0.3485	16057.5525	**5,596**
0.1540	200,018	**30,803**	0.1152	13463.7217	**1,551**
0.6329	200,018	**126,591**	0.4735	13463.7217	**6,375**
0.1694	200,018	**33,883**	0.1256	13463.7217	**1,691**
0.3169	4,821,490	**1,527,930**	0.2371	16057.5525	**3,807**
0.3883	7,138,747	**2,771,975**	0.2901	52221.9266	**15,150**
1.0393	7,138,747	**7,419,300**	0.7776	52221.9266	**40,608**
1.3270	1,574,985	**2,090,005**	0.9927	93668.9198	**92,985**
0.5156	1,574,985	**812,062**	0.3852	93668.9198	**36,081**
0.0881	1,574,985	**138,756**	0.0659	108647.6616	**7,160**
0.9666	4,970,885	**4,804,857**	0.7671	5722.6694	**4,390**
0.1584	3,223,329	**510,575**	0.1281	10249.9759	**1,313**
1.1655	3,223,329	**3,756,789**	0.9428	10249.9759	**9,664**
1.9404	1,973,878	**3,830,112**	1.5366	698.1878	**1,073**
0.7039	4,556,545	**3,207,352**	0.5575	11629.4926	**6,483**
0.0388	4,556,545	**176,794**	0.0308	11629.4926	**358**
0.2819	4,629,970	**1,305,188**	0.2280	5082.2954	**1,159**
1.2369	4,629,970	**5,726,809**	0.9929	5082.2954	**5,046**
0.2990	4,557,344	**1,362,646**	0.2368	11629.4926	**2,754**
0.0622	1,145,026	**71,221**	0.0465	11649.7111	**542**
0.7545	3,688,769	**2,783,177**	0.6103	44639.3823	**27,243**
0.0629	7,445,097	**468,297**	0.0500	165248.7229	**8,262**
0.2394	2,234,164	**534,859**	0.1900	15309.5751	**2,909**
0.0098	7,445,097	**72,962**	0.0077	165248.7229	**1,272**
0.0346	7,445,097	**257,600**	0.0274	165248.7229	**4,528**
0.0378	7,445,097	**281,425**	0.0300	165248.7229	**4,957**
2.1999	1,896,970	**4,173,144**	1.6458	523.1446	**861**
0.7396	2,065,753	**1,527,831**	0.5983	15176.9060	**9,080**
0.2190	2,065,753	**452,400**	0.1771	15176.9060	**2,688**
0.5044	4,556,545	**2,298,321**	0.3995	11629.4926	**4,646**
0.0191	4,556,545	**87,030**	0.0151	11629.4926	**176**
0.7309	2,213,308	**1,617,707**	0.5912	8229.0687	**4,865**
0.9540	2,213,308	**2,111,496**	0.7717	8229.0687	**6,350**
0.2372	2,184,826	**518,241**	0.1883	18212.2516	**3,429**
0.0031	1,513,944	**4,693**	0.0023	26960.6522	**62**
0.5888	2,101,747	**1,237,509**	0.4673	15228.5026	**7,116**
0.0566	2,101,747	**118,959**	0.0450	15228.5026	**685**
0.7438	2,184,826	**1,625,073**	0.5903	18212.2516	**10,751**
0.0275	2,184,826	**60,083**	0.0205	18212.2516	**373**

TRANSPORT COSTS US $			PHASE	4	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC4	TOT_FLOW	TOT TRSP COST
1.1908	1,513,944	**1,802,805**	0.8909	26960,6522	**24,019**
1.2118	577,664	**700,013**	0.9066	4959,3844	**4,496**
0.0101	102,189	**1,032**	0.0075	55,5068	**0**
0.5302	102,189	**54,180**	0.3956	55,5068	**22**
0.0363	102,189	**3,709**	0.0269	55,5068	**1**
1.6252	92,730	**150,705**	1.2127	579,7724	**703**
0.8721	92,730	**80,870**	0.6582	579,7724	**382**
4.0227	93,026	**374,214**	3.0052	580,0316	**1,743**
1.8520	93,026	**172,284**	1.3768	580,0316	**799**
0.0383	102,189	**3,914**	0.0284	55,5068	**2**
0.0289	102,189	**2,953**	0.0214	55,5068	**1**
0.0429	1,606,526	**68,920**	0.0321	8348,7653	**268**
1.1033	1,616,816	**1,783,833**	0.8254	8358,6604	**6,899**
1.6381	586,760	**961,172**	1.2223	2352,1510	**2,875**
0.7279	102,189	**74,383**	0.5432	55,5068	**30**
1.0734	102,189	**109,689**	0.8009	55,5068	**44**
0.1703	102,525	**17,460**	0.1271	55,8950	**7**
2.0097	336	**675**	1.4941	0,3882	**1**
0.5721	102,189	**58,462**	0.4269	55,5068	**24**
0.6380	102,189	**65,196**	0.4815	55,5068	**27**
1.3846	102,189	**141,490**	1.0332	55,5068	**57**
9.5000	2,754,214	**26,165,037**	1.0000	8070,5292	**8,071**
0.0373	1,642,169	**61,253**	0.0302	4785,8734	**145**
0.3918	1,784,989	**699,359**	0.3169	559,6147	**177**
0.5036	1,169,354	**588,887**	0.3768	12412,2538	**4,677**
0.8023	1,642,169	**1,317,512**	0.6490	4785,8734	**3,106**
3.1412	2,987,632	**9,384,751**	2.3500	10041,5941	**23,598**
1.8038	578,734	**1,043,921**	1.3460	9178,8163	**12,355**
0.5759	2,693,128	**1,550,972**	0.4302	1675,4270	**721**
0.0199	2,987,632	**59,454**	0.0149	6561,5889	**98**
1.0080	3,019,239	**3,043,393**	0.8154	5374,3538	**4,382**
0.3578	3,687,280	**1,319,309**	0.2840	1148,3641	**326**
0.0086	4,126,953	**35,492**	0.0068	11472,9930	**78**
0.0091	3,019,239	**27,475**	0.0068	5374,3538	**37**
0.3675	3,019,239	**1,109,570**	0.2973	5374,3538	**1,598**
1.1514	3,019,239	**3,476,352**	0.9313	5374,3538	**5,005**
1.4331	528,275	**757,071**	1.0684	71,1694	**76**
2.7508	239,503	**658,826**	2.0527	878,9121	**1,804**
1.1412	1,616,816	**1,845,110**	0.8554	8358,6604	**7,150**
1.0601	138,480	**146,802**	0.7910	668,1216	**528**
3.1209	20,396	**63,653**	2.3555	225,1864	**530**
1.6475	138,480	**228,145**	1.2293	668,1216	**821**
0.0238	4,157,762	**98,955**	0.0193	12130,8995	**234**
0.5874	120,788	**70,951**	0.3380	1280,6969	**433**
0.5656	56,278	**31,831**	0.3247	1112,1207	**361**
3.2275	120,788	**389,844**	1.8525	1280,6969	**2,372**
4.2849	56,278	**241,145**	2.4624	1112,1207	**2,738**
0.0408	4,157,762	**169,637**	0.0330	12130,8995	**400**
1.1670	4,157,762	**4,852,108**	0.9440	12130.8995	**11,452**

TRANSPORT COSTS US $				PHASE	4	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC4	TOT_FLOW	TOT TRSP COST
0.5725	4,157,762	**2,380,319**		0.4631	12130.8995	**5,618**
0.7014	436,699	**306,300**		0.4026	529.2435	**213**
1.5287	2,822,508	**4,314,769**		1.1437	8695.3552	**9,945**
0.7550	2,822,508	**2,130,994**		0.5648	8695.3552	**4,911**
1.7926	558,444	**1,001,066**		1.3392	214.0804	**287**
0.2147	1,309,352	**281,118**		0.1606	11022.8178	**1,770**
3.0000	1,455,106	**4,365,317**		1.0000	0.0000	**0**
0.8633	1,559,179	**1,346,040**		0.6404	16678.0392	**10,681**
0.0220	617,391	**13,583**		0.0164	3225.3863	**53**
1.3066	2,065,753	**2,699,113**		1.0569	15176.9060	**16,040**
0.3555	87,213	**31,004**		0.2821	1107.0823	**312**
1.0996	301,940	**332,013**		0.8227	6971.6975	**5,736**
1.5029	617,391	**927,876**		1.1227	3225.3863	**3,621**
0.5789	331,874	**192,122**		0.4325	1517.8616	**656**
2.9696	3,911	**11,615**		2.2158	44.6419	**99**
0.0929	558,444	**51,879**		0.0701	214.0804	**15**
1.0636	558,444	**593,961**		0.8028	214.0804	**172**
0.2597	558,444	**145,028**		0.1940	214.0804	**42**
0.0950	2,065,753	**196,247**		0.0768	15176.9060	**1,166**
0.0818	87,213	**7,134**		0.0649	1107.0823	**72**
0.5436	87,213	**47,409**		0.4314	1107.0823	**478**
0.4657	87,213	**40,615**		0.3475	1107.0823	**385**
1.3013	87,213	**113,490**		0.9216	1107.0823	**1,020**
0.3676	87,213	**32,059**		0.2974	1107.0823	**329**
0.1349	87,213	**11,765**		0.1091	1107.0823	**121**
0.7220	87,213	**62,968**		0.5840	1107.0823	**647**
0.0321	87,213	**2,800**		0.0260	1107.0823	**29**
0.0268	87,213	**2,337**		0.0213	1107.0823	**24**
0.0772	1,309,352	**101,082**		0.0578	11022.8178	**637**
0.9732	301,940	**293,848**		0.7281	6971.6975	**5,076**
0.0150	2,256,482	**33,847**		0.0112	53775.0723	**602**
3.0393	2,256,482	**6,858,127**		1.7381	53775.0723	**93,466**
0.0258	2,256,482	**58,217**		0.0191	53775.0723	**1,027**
0.5696	724,903	**412,905**		0.3278	7156.1186	**2,346**
0.2537	724,903	**183,908**		0.1494	7156.1186	**1,069**
4.7758	56,278	**268,772**		2.7412	1112.1207	**3,049**
0.3672	724,903	**266,184**		0.2110	7156.1186	**1,510**
0.6800	724,903	**492,934**		0.3907	7156.1186	**2,796**
0.0897	2,601,394	**233,345**		0.0671	74961.4597	**5,030**
0.4554	2,601,394	**1,184,675**		0.3614	74961.4597	**27,091**
0.0779	2,601,394	**202,649**		0.0583	74961.4597	**4,370**
0.3213	431,501	**138,641**		0.2404	33903.7165	**8,150**
0.7858	70,966	**55,765**		0.5879	1183.1177	**696**
1.0621	2,256,482	**2,396,610**		0.6074	53775.0723	**32,663**
0.9040	724,903	**655,312**		0.5195	7156.1186	**3,718**
1.5588	724,903	**1,129,978**		0.8958	7156.1186	**6,410**
0.7546	724,903	**547,012**		0.4315	7156.1186	**3,088**
0.6058	3,911	**2,369**		0.4526	44.6419	**20**
0.1683	3,911	**658**		0.1257	44.6419	**6**

TRANSPORT COSTS US $				PHASE	4	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC4	TOT_FLOW	TOT TRSP COST
1.3594	3,911	**5,317**		1.0144	6.9624	**7**
1.2988	3,911	**5,080**		0.9691	6.9624	**7**
0.2371	3,911	**927**		0.1769	6.9624	**1**
1.1602	3,911	**4,538**		0.8606	6.9624	**6**
2.4417	37,177	**90,776**		1.8219	23.3955	**43**
0.7138	37,177	**26,537**		0.5326	23.3955	**12**
0.9503	109,947	**104,483**		0.7542	4785.5968	**3,609**
0.1211	168,210	**20,370**		0.0961	627.0905	**60**
0.8333	5,162,140	**4,301,611**		0.6613	16251.5237	**10,747**
0.0568	2,033,507	**115,503**		0.0449	6022.5555	**270**
0.8235	307,076	**252,877**		0.6661	4621.5432	**3,078**
0.6195	307,438	**190,458**		0.4634	4599.9413	**2,132**
0.2702	307,438	**83,070**		0.2145	4599.9413	**987**
0.1523	307,438	**46,823**		0.1140	4599.9413	**524**
0.7446	307,438	**228,918**		0.5570	4599.9413	**2,562**
0.0040	5,525,281	**22,101**		0.0032	25800.9633	**83**
0.0087	368,879	**3,209**		0.0069	9549.9439	**66**
0.0708	8,409,556	**595,397**		0.0562	50487.9310	**2,837**
0.0080	2,889,917	**23,119**		0.0064	24686.9677	**158**
0.6289	307,438	**193,348**		0.4991	4599.9413	**2,296**
0.0069	3,258,795	**22,486**		0.0051	34236.9115	**175**
0.1020	3,258,795	**332,397**		0.0761	34236.9115	**2,605**
0.5630	2,601,394	**1,464,585**		0.4458	74961.4597	**33,418**
0.2705	1,574,985	**426,033**		0.2147	93668.9198	**20,111**
0.5247	1,574,985	**826,395**		0.4164	93668.9198	**39,004**
0.0645	4,198,859	**270,826**		0.0518	0.0000	**0**
0.4838	5,987,776	**2,896,886**		0.4094	89609.6046	**36,686**
0.3478	2,665,312	**926,995**		0.2814	76417.7979	**21,504**
0.0171	3,543,772	**60,598**		0.0128	74055.3944	**948**
0.0267	3,172,890	**84,716**		0.0199	82904.6590	**1,650**
0.0412	2,766,483	**113,979**		0.0307	48367.8813	**1,485**
0.1612	5,939,374	**957,427**		0.1279	202745.1880	**25,931**
0.4069	1,168,532	**475,476**		0.3230	52248.5043	**16,876**
0.3023	7,138,747	**2,158,043**		0.2262	58605.3142	**13,257**
0.1810	1,168,532	**211,504**		0.1437	31269.8422	**4,493**
0.1895	1,168,532	**221,437**		0.1406	31269.8422	**4,397**
0.0593	7,138,747	**423,328**		0.0443	58605.3142	**2,596**
0.5410	2,577,377	**1,394,361**		0.4376	20122.1506	**8,805**
0.6597	2,577,377	**1,700,296**		0.5336	20122.1506	**10,737**
0.0555	2,577,377	**143,044**		0.0449	20122.1506	**903**
2.1463	468,232	**1,004,966**		1.6034	443.6037	**711**
0.2722	468,232	**127,453**		0.2050	443.6037	**91**
0.2198	2,048,552	**450,272**		0.1778	1303.8563	**232**
0.0677	2,048,552	**138,687**		0.0547	1303.8563	**71**
0.2511	2,091,607	**525,203**		0.1876	31880.1061	**5,981**
0.1642	2,091,607	**343,442**		0.1226	31880.1061	**3,909**
1.2057	2,091,607	**2,521,851**		0.9007	31880.1061	**28,714**
0.5957	2,577,377	**1,535,344**		0.4819	20122.1506	**9,697**
0.1157	1,168,532	**135,199**		0.0865	31269.8422	**2,705**

TRANSPORT COSTS US $			PHASE	4	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC4	TOT_FLOW	TOT TRSP COST
0.5123	1,168,532	**598,639**	0.3833	31269.8422	**11,986**
0.3888	3,223,329	**1,253,230**	0.2901	10249.9759	**2,974**
0.4945	1,168,532	**577,839**	0.3699	31269.8422	**11,567**
0.7146	1,168,532	**835,033**	0.5339	31269.8422	**16,695**
0.0321	1,168,532	**37,510**	0.0240	31269.8422	**750**
0.6723	2,091,607	**1,406,188**	0.5030	31880.1061	**16,036**
0.0425	1,168,532	**49,663**	0.0318	31269.8422	**994**
0.0977	468,232	**45,746**	0.0725	443.6037	**32**
0.0300	469,295	**14,079**	0.0224	392.7064	**9**
0.2646	438,739	**116,090**	0.1997	2991.5861	**597**
2.1480	528,275	**1,134,735**	1.6028	71.1694	**114**
0.5166	92,730	**47,905**	0.3840	579.7724	**223**
1.3588	2,256,482	**3,066,108**	0.7771	53775.0723	**41,789**
0.1655	243,976	**40,378**	0.1531	9105.7349	**1,394**
0.3450	2,256,482	**778,486**	0.1973	53775.0723	**10,610**
0.9490	70,966	**67,347**	0.7554	1183.1177	**894**
0.0583	4,629,970	**269,927**	0.0468	10153.0382	**475**
0.8423	138,480	**116,641**	0.6285	668.1216	**420**
0.2733	1,616,816	**441,876**	0.2045	8358.6604	**1,709**
1.1663	1,616,816	**1,885,693**	0.8726	8358.6604	**7,294**
0.9648	2,665,312	**2,571,493**	0.7804	76417.7979	**59,636**
1.5759	558,444	**880,051**	1.1759	214.0804	**252**
0.0902	152,578	**13,763**	0.0673	668.1216	**45**
1.1530	3,216,425	**3,708,538**	0.9326	610.2908	**569**
0.1823	3,194,933	**582,436**	0.1353	159.2064	**22**
0.0245	724,903	**17,760**	0.0183	7156.1186	**131**
0.3630	486,204	**176,492**	0.2693	673.6776	**181**
0.0626	3,258,795	**204,001**	0.0729	34236.9115	**2,496**
0.1194	3,326,134	**397,140**	0.1378	21846.7854	**3,010**
0.2105	3,326,134	**700,151**	0.2393	21846.7854	**5,228**
0.0509	3,326,134	**169,300**	0.0579	21846.7854	**1,265**
0.2332	1,497,436	**349,202**	0.2651	23190.7577	**6,148**
0.4704	1,736,004	**816,616**	0.5347	23834.7549	**12,744**
0.1649	2,911,309	**480,075**	0.1874	19569.6697	**3,667**
0.5090	2,953,605	**1,503,385**	0.5786	23139.8502	**13,389**
0.1598	913,059	**145,907**	0.1817	5361.6591	**974**
0.4971	1,455,106	**723,333**	0.5651	0.0000	**0**
0.0558	67,338	**3,757**	0.0631	36434.4199	**2,299**
0.1663	4,334,531	**720,833**	0.1891	68583.6430	**12,969**
0.0666	4,334,531	**288,680**	0.0757	85497.3296	**6,472**
0.2640	4,335,330	**1,144,527**	0.3001	89405.2841	**26,831**
0.6450	4,334,531	**2,795,773**	0.7332	93987.9741	**68,912**
0.1617	4,401,869	**711,782**	0.1838	9253.9624	**1,701**
0.0424	4,401,869	**186,639**	0.0491	9253.9624	**454**
0.3047	4,334,531	**1,320,732**	0.3464	89405.2841	**30,970**
0.1282	316,319	**40,552**	0.2597	1783.5704	**463**
0.1953	316,319	**61,777**	0.3958	1783.5704	**706**
0.8055	6,154,920	**4,957,788**	0.9121	25474.1034	**23,235**
3.9753	14	**54**	2.9698	0.0000	**0**

TRANSPORT COSTS US $				PHASE	4	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC4	TOT_FLOW	TOT TRSP COST
1.0399	5,950,481	**6,187,905**		1.1776	31389.8076	**36,965**
0.4791	1,091,924	**523,141**		0.9682	8261.2082	**7,999**
0.4180	3,674,347	**1,535,877**		0.4733	23743.6175	**11,238**
0.3376	4,780,369	**1,613,852**		0.3823	31389.8076	**12,000**
1.1265	2,754,214	**3,102,623**		1.2756	12462.2479	**15,897**
0.2394	2,754,214	**659,359**		0.2711	8070.5292	**2,188**
0.3717	480,460	**178,587**		0.7529	781.5701	**588**
0.2312	67,338	**15,569**		0.4663	46266.7212	**21,574**
0.2904	126,063	**36,609**		0.5885	5361.6591	**3,155**
0.5817	203,010	**118,091**		1.1783	9253.9624	**10,904**
3.0000	3,258,795	**9,776,386**		1.0000	34236.9115	**34,237**
8.3300	4,198,859	**34,976,498**		1.5000	0.0000	**0**
1.0000	0	**0**		1.0000	96800.1975	**96,800**
1.5000	0	**0**		1.0000	21162.1581	**21,162**
0.7197	7,138,747	**5,137,756**		0.5384	75519.0008	**40,659**
1.0000	0	**0**		1.0000	16913.6866	**16,914**
1.0000	0	**0**		1.0000	6385.3346	**6,385**
0.2609	4,334,531	**1,130,879**		0.2966	91881.3963	**27,252**
1.0000	0	**0**		1.0000	8703.1194	**8,703**
1.0000	0	**0**		1.0000	14978.7418	**14,979**
6.0000	799	**4,796**		1.0000	0.0000	**0**
1.0000	0	**0**		1.0000	109698.2954	**109,698**
3.0000	567,362	**1,702,086**		1.0000	6696.3735	**6,696**
3.0000	1,064	**3,193**		1.0000	283.3254	**283**
2.0324	2,033,507	**4,132,899**		1.6095	6022.5555	**9,693**
3.0000	42,296	**126,887**		1.0000	13576.2419	**13,576**
4.5000	203,010	**913,546**		1.0000	9253.9624	**9,254**
2.0000	126,063	**252,127**		1.0000	5361.6591	**5,362**
4.0000	318,818	**1,275,273**		1.0000	10936.6374	**10,937**
3.0000	1,091,924	**3,275,771**		1.0000	8261.2082	**8,261**
3.0000	0	**0**		1.0000	4391.7187	**4,392**
5.0000	480,460	**2,402,298**		1.0000	781.5701	**782**
7.5000	439,673	**3,297,549**		1.0000	10659.3833	**10,659**
1.3708	3,687,280	**5,054,523**		1.0880	1148.3641	**1,249**
3.4384	2,024,821	**6,962,144**		2.5504	159.2064	**406**
0.2719	438,739	**119,293**		0.2052	2991.5861	**614**
0.4555	67,338	**30,673**		0.9236	43726.8179	**40,386**
3.0000	0	**0**		0.5000	20771.1309	**10,386**
1.0865	617,391	**670,795**		0.8117	3225.3863	**2,618**
5.0000	1,170,467	**5,852,335**		1.0000	0.0000	**0**
6.5000	14,098	**91,637**		1.0000	0.0000	**0**
0.3170	4,334,531	**1,374,046**		0.3603	89405.2841	**32,213**
0.7368	28,075	**20,686**		1.5178	465.3580	**706**
2.9642	327,963	**972,147**		1.9239	1473.2198	**2,834**
3.0000	316,319	**948,958**		1.0000	1783.5704	**1,784**
3.0000	786,995	**2,360,986**		1.0000	0.0000	**0**
5.2496	14	**71**		3.9217	0.0000	**0**
3.0000	28,075	**84,225**		1.0000	465.3580	**465**
3.3566	132,421	**444,483**		2.5333	81.0725	**205**

TRANSPORT COSTS US $				PHASE 4		2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC4	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC4	TOT_FLOW	TOT TRSP COST
1.5533	362	**563**		1.1604	21.6019	**25**
2.3088	362	**836**		1.7247	21.6019	**37**
1.1751	387	**455**		0.8779	3202.3203	**2,811**
0.8183	387	**317**		0.6113	3202.3203	**1,958**
0.8685	152,994	**132,875**		0.6555	635.5272	**417**
TRANSPORT COSTS PHASE 4		**345,533,371**		TRANSPORT COSTS PHASE 4		**2,171,546**

TRANSPORT COSTS US $			PHASE	5	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC5	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC5	TOT_FLOW	TOT TRSP COST
0.2298	30,988	**7,121**	0.1719	658	**113**
2.7033	30,988	**83,771**	2.1701	658	**1,428**
0.0122	30,988	**378**	0.0092	658	**6**
2.6369	609,033	**1,605,959**	1.5153	529	**802**
4.8875	515,426	**2,519,146**	2.8086	21	**59**
0.0636	4,287,926	**272,712**	0.0475	5,727	**272**
0.5341	4,287,926	**2,290,181**	0.3996	5,727	**2,288**
0.2765	200,018	**55,305**	0.2069	13,464	**2,786**
0.4698	4,138,532	**1,944,282**	0.3485	16,062	**5,598**
0.1540	200,018	**30,803**	0.1152	13,464	**1,551**
0.6329	200,018	**126,591**	0.4735	13,464	**6,375**
0.1694	200,018	**33,883**	0.1256	13,464	**1,691**
0.3169	4,138,532	**1,311,501**	0.2371	16,062	**3,808**
0.3883	6,455,789	**2,506,783**	0.2901	52,224	**15,150**
1.0393	6,455,789	**6,709,501**	0.7776	52,224	**40,609**
1.3270	1,574,985	**2,090,005**	0.9927	93,676	**92,992**
0.5156	1,574,985	**812,062**	0.3852	93,676	**36,084**
0.0881	1,574,985	**138,756**	0.0659	108,648	**7,160**
0.9666	4,287,926	**4,144,710**	0.7671	5,727	**4,393**
0.1584	3,132,049	**496,117**	0.1281	14,982	**1,919**
1.1655	3,132,049	**3,650,403**	0.9428	14,982	**14,125**
1.9404	1,569,783	**3,046,006**	1.5366	629	**967**
0.7039	3,873,707	**2,726,703**	0.5575	11,629	**6,483**
0.0388	3,873,707	**150,300**	0.0308	11,629	**358**
0.2819	3,947,011	**1,112,662**	0.2280	5,082	**1,159**
1.2369	3,947,011	**4,882,058**	0.9929	5,082	**5,046**
0.2990	3,874,385	**1,158,441**	0.2368	11,629	**2,754**
0.0622	811,287	**50,462**	0.0465	15,956	**742**
0.7545	3,223,453	**2,432,095**	0.6103	50,126	**30,592**
0.0629	6,762,260	**425,346**	0.0500	165,249	**8,262**
0.2394	2,137,411	**511,696**	0.1900	12,224	**2,323**
0.0098	6,762,260	**66,270**	0.0077	165,249	**1,272**
0.0346	6,762,260	**233,974**	0.0274	165,249	**4,528**
0.0378	6,762,260	**255,613**	0.0300	165,249	**4,957**
2.1999	1,492,875	**3,284,175**	1.6458	458	**754**
0.7396	1,977,937	**1,462,882**	0.5983	12,123	**7,253**
0.2190	1,977,937	**433,168**	0.1771	12,123	**2,147**
0.5044	3,873,707	**1,953,898**	0.3995	11,629	**4,646**
0.0191	3,873,707	**73,988**	0.0151	11,629	**176**
0.7309	2,081,734	**1,521,540**	0.5912	9,426	**5,573**
0.9540	2,081,734	**1,985,975**	0.7717	9,426	**7,274**
0.2372	2,053,252	**487,031**	0.1883	19,410	**3,655**
0.0031	1,180,200	**3,659**	0.0023	31,269	**72**
0.5888	2,013,823	**1,185,739**	0.4673	12,153	**5,679**
0.0566	2,013,823	**113,982**	0.0450	12,153	**547**
0.7438	2,053,252	**1,527,209**	0.5903	19,410	**11,458**
0.0275	2,053,252	**56,464**	0.0205	19,410	**398**

TRANSPORT COSTS US $				PHASE	5	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC5	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC5	TOT_FLOW	TOT TRSP COST
1.1908	1,180,200	**1,405,382**		0.8909	31,269	**27,858**
1.2118	570,228	**691,003**		0.9066	9,666	**8,763**
0.0101	45,939	**464**		0.0075	0	**0**
0.5302	45,939	**24,357**		0.3956	0	**0**
0.0363	45,939	**1,668**		0.0269	0	**0**
1.6252	92,479	**150,296**		1.2127	5	**6**
0.8721	92,479	**80,651**		0.6582	5	**3**
4.0227	149,512	**601,443**		3.0052	5	**14**
1.8520	149,512	**276,897**		1.3768	5	**6**
0.0383	45,939	**1,759**		0.0284	0	**0**
0.0289	45,939	**1,328**		0.0214	0	**0**
0.0429	1,606,771	**68,930**		0.0321	8,924	**286**
1.1033	73,502	**81,095**		0.8254	191	**158**
1.6381	586,508	**960,759**		1.2223	1,789	**2,187**
0.7279	45,939	**33,439**		0.5432	0	**0**
1.0734	45,939	**49,311**		0.8009	0	**0**
0.1703	102,525	**17,460**		0.1271	56	**7**
2.0097	57,068	**114,689**		1.4941	0	**0**
0.5721	45,939	**26,282**		0.4269	0	**0**
0.6380	45,939	**29,309**		0.4815	0	**0**
1.3846	45,939	**63,607**		1.0332	0	**0**
9.5000	2,960,384	**28,123,643**		1.0000	8,605	**8,605**
0.0373	1,574,504	**58,729**		0.0302	4,814	**145**
0.3918	1,784,989	**699,359**		0.3169	560	**177**
0.5036	1,111,739	**559,872**		0.3768	12,975	**4,889**
0.8023	1,574,504	**1,263,224**		0.6490	4,814	**3,124**
3.1412	2,815,298	**8,843,415**		2.3500	10,042	**23,598**
1.8038	407,038	**734,214**		1.3460	9,179	**12,355**
0.5759	2,693,128	**1,550,972**		0.4302	1,675	**721**
0.0199	2,815,298	**56,024**		0.0149	6,590	**98**
1.0080	2,583,121	**2,603,786**		0.8154	5,374	**4,382**
0.3578	3,166,286	**1,132,897**		0.2840	1,086	**308**
0.0086	3,691,259	**31,745**		0.0068	11,473	**78**
0.0091	2,583,121	**23,506**		0.0068	5,374	**37**
0.3675	2,583,121	**949,297**		0.2973	5,374	**1,598**
1.1514	2,583,121	**2,974,205**		0.9313	5,374	**5,005**
1.4331	24,209	**34,694**		1.0684	68	**73**
2.7508	190,868	**525,040**		2.0527	879	**1,805**
1.1412	73,502	**83,881**		0.8554	191	**164**
1.0601	83,960	**89,006**		0.7910	668	**528**
3.1209	20,389	**63,633**		2.3555	179	**423**
1.6475	83,960	**138,324**		1.2293	668	**821**
0.0238	3,722,141	**88,587**		0.0193	12,131	**234**
0.5874	120,788	**70,951**		0.3380	1,281	**433**
0.5656	56,278	**31,831**		0.3247	1,112	**361**
3.2275	120,788	**389,844**		1.8525	1,281	**2,372**
4.2849	56,278	**241,145**		2.4624	1,112	**2,738**
0.0408	3,722,141	**151,863**		0.0330	12,131	**400**
1.1670	3,722,141	**4,343,738**		0.9440	12,131	**11,452**

TRANSPORT COSTS US $				PHASE	5	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC5	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC5	TOT_FLOW	TOT TRSP COST
0.5725	3,722,141	**2,130,926**		0.4631	12,131	**5,618**
0.7014	609,033	**427,176**		0.4026	529	**213**
1.5287	2,130,887	**3,257,488**		1.1437	8,646	**9,889**
0.7550	2,130,887	**1,608,820**		0.5648	8,646	**4,883**
1.7926	44,832	**80,366**		1.3392	275	**368**
0.2147	1,805,968	**387,741**		0.1606	11,138	**1,789**
3.0000	1,443,215	**4,329,645**		1.0000	0	**0**
0.8633	1,344,295	**1,160,530**		0.6404	7,165	**4,588**
0.0220	1,015,603	**22,343**		0.0164	10,102	**166**
1.3066	1,977,937	**2,584,372**		1.0569	12,123	**12,813**
0.3555	87,213	**31,004**		0.2821	1,107	**312**
1.0996	434,049	**477,280**		0.8227	1,867	**1,536**
1.5029	922,787	**1,386,857**		1.1227	4,171	**4,683**
0.5789	18,655	**10,799**		0.4325	572	**247**
2.9696	0	**0**		2.2158	45	**99**
0.0929	44,832	**4,165**		0.0701	275	**19**
1.0636	44,832	**47,683**		0.8028	275	**221**
0.2597	44,832	**11,643**		0.1940	275	**53**
0.0950	1,977,937	**187,904**		0.0768	12,123	**931**
0.0818	87,213	**7,134**		0.0649	1,107	**72**
0.5436	87,213	**47,409**		0.4314	1,107	**478**
0.4657	87,213	**40,615**		0.3475	1,107	**385**
1.3013	87,213	**113,490**		0.9216	1,107	**1,020**
0.3676	87,213	**32,059**		0.2974	1,107	**329**
0.1349	87,213	**11,765**		0.1091	1,107	**121**
0.7220	87,213	**62,968**		0.5840	1,107	**647**
0.0321	87,213	**2,800**		0.0260	1,107	**29**
0.0268	87,213	**2,337**		0.0213	1,107	**24**
0.0772	1,805,968	**139,421**		0.0578	11,138	**644**
0.9732	434,049	**422,416**		0.7281	1,867	**1,359**
0.0150	2,256,482	**33,847**		0.0112	53,775	**602**
3.0393	2,256,482	**6,858,127**		1.7381	53,775	**93,466**
0.0258	2,256,482	**58,217**		0.0191	53,775	**1,027**
0.5696	724,903	**412,905**		0.3278	7,156	**2,346**
0.2537	724,903	**183,908**		0.1494	7,156	**1,069**
4.7758	56,278	**268,772**		2.7412	1,112	**3,049**
0.3672	724,903	**266,184**		0.2110	7,156	**1,510**
0.6800	724,903	**492,934**		0.3907	7,156	**2,796**
0.0897	2,593,590	**232,645**		0.0671	74,961	**5,030**
0.4554	2,593,590	**1,181,121**		0.3614	74,961	**27,091**
0.0779	2,593,590	**202,041**		0.0583	74,961	**4,370**
0.3213	423,698	**136,134**		0.2404	33,904	**8,150**
0.7858	78,770	**61,897**		0.5879	1,183	**696**
1.0621	2,256,482	**2,396,610**		0.6074	53,775	**32,663**
0.9040	724,903	**655,312**		0.5195	7,156	**3,718**
1.5588	724,903	**1,129,978**		0.8958	7,156	**6,410**
0.7546	724,903	**547,012**		0.4315	7,156	**3,088**
0.6058	0	**0**		0.4526	45	**20**
0.1683	0	**0**		0.1257	45	**6**

TRANSPORT COSTS US $			PHASE	5	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC5	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC5	TOT_FLOW	TOT TRSP COST
1.3594	0	**0**	1.0144	1	**1**
1.2988	0	**0**	0.9691	1	**1**
1.1602	0	**0**	0.8606	1	**1**
2.4417	37,220	**90,879**	1.8219	3,176	**5,787**
0.7138	37,220	**26,567**	0.5326	3,176	**1,692**
0.9503	107,204	**101,876**	0.7542	4,666	**3,519**
0.1211	168,210	**20,370**	0.0961	627	**60**
0.8333	5,069,878	**4,224,729**	0.6613	22,632	**14,966**
0.0568	2,032,524	**115,447**	0.0449	10,551	**474**
0.8235	304,333	**250,618**	0.6661	4,761	**3,171**
0.6195	304,695	**188,759**	0.4634	4,730	**2,192**
0.2702	304,695	**82,329**	0.2145	4,730	**1,015**
0.1523	304,695	**46,405**	0.1140	4,730	**539**
0.7446	304,695	**226,876**	0.5570	4,730	**2,635**
0.0040	5,429,659	**21,719**	0.0032	28,492	**91**
0.0087	383,664	**3,338**	0.0069	9,578	**66**
0.0708	8,409,297	**595,378**	0.0562	50,597	**2,844**
0.0080	3,003,124	**24,025**	0.0064	23,526	**151**
0.6289	304,695	**191,623**	0.4991	4,730	**2,361**
0.0069	3,386,788	**23,369**	0.0051	33,103	**169**
0.1020	3,386,788	**345,452**	0.0761	33,103	**2,519**
0.5630	2,593,590	**1,460,191**	0.4458	74,961	**33,418**
0.2705	1,574,985	**426,033**	0.2147	93,676	**20,112**
0.5247	1,574,985	**826,395**	0.4164	93,676	**39,006**
0.0645	4,875,515	**314,471**	0.0518	0	**0**
0.4838	6,515,238	**3,152,072**	0.4094	89,610	**36,686**
0.3478	2,657,508	**924,281**	0.2814	76,418	**21,504**
0.0171	3,805,750	**65,078**	0.0128	74,057	**948**
0.0267	3,434,868	**91,711**	0.0199	82,910	**1,650**
0.0412	3,031,968	**124,917**	0.0307	48,369	**1,485**
0.1612	6,466,836	**1,042,454**	0.1279	202,944	**25,957**
0.4069	1,167,031	**474,865**	0.3230	52,547	**16,973**
0.3023	6,455,789	**1,951,585**	0.2262	58,630	**13,262**
0.1810	1,167,031	**211,233**	0.1437	34,427	**4,947**
0.1895	1,167,031	**221,152**	0.1406	34,427	**4,840**
0.0593	6,455,789	**382,828**	0.0443	58,630	**2,597**
0.5410	2,451,609	**1,326,321**	0.4376	21,302	**9,322**
0.6597	2,451,609	**1,617,327**	0.5336	21,302	**11,367**
0.0555	2,451,609	**136,064**	0.0449	21,302	**956**
2.1463	466,611	**1,001,487**	1.6034	6,373	**10,219**
0.2722	466,611	**127,011**	0.2050	6,373	**1,307**
0.2198	1,916,979	**421,352**	0.1778	2,505	**445**
0.0677	1,916,979	**129,779**	0.0547	2,505	**137**
0.2511	2,090,106	**524,826**	0.1876	28,723	**5,388**
0.1642	2,090,106	**343,195**	0.1226	28,723	**3,521**
1.2057	2,090,106	**2,520,041**	0.9007	28,723	**25,871**
0.5957	2,451,609	**1,460,424**	0.4819	21,302	**10,265**
0.1157	1,167,031	**135,025**	0.0865	34,427	**2,978**
0.5123	1,167,031	**597,870**	0.3833	34,427	**13,196**

TRANSPORT COSTS US $			PHASE	5	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC5	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC5	TOT_FLOW	TOT TRSP COST
0.3888	3,132,049	**1,217,741**	0.2901	14,982	**4,346**
0.4945	1,167,031	**577,097**	0.3699	34,427	**12,734**
0.7146	1,167,031	**833,960**	0.5339	34,427	**18,380**
0.0321	1,167,031	**37,462**	0.0240	34,427	**826**
0.6723	2,090,106	**1,405,178**	0.5030	28,723	**14,448**
0.0425	1,167,031	**49,599**	0.0318	34,427	**1,095**
0.0977	466,611	**45,588**	0.0725	6,373	**462**
0.0300	461,854	**13,856**	0.0224	5,092	**114**
0.2646	499,236	**132,098**	0.1997	2,992	**597**
2.1480	24,209	**52,000**	1.6028	68	**109**
0.5166	92,479	**47,775**	0.3840	5	**2**
1.3588	2,256,482	**3,066,108**	0.7771	53,775	**41,789**
0.1655	243,976	**40,378**	0.1531	9,106	**1,394**
0.3450	2,256,482	**778,486**	0.1973	53,775	**10,610**
0.9490	78,770	**74,752**	0.7554	1,183	**894**
0.0583	3,947,011	**230,111**	0.0468	10,157	**475**
0.8423	83,960	**70,720**	0.6285	668	**420**
0.2733	73,502	**20,088**	0.2045	191	**39**
1.1663	73,502	**85,726**	0.8726	191	**167**
0.9648	2,657,508	**2,563,964**	0.7804	76,418	**59,636**
1.5759	44,832	**70,651**	1.1759	275	**323**
0.0902	102,578	**9,253**	0.0673	668	**45**
1.1530	2,656,704	**3,063,180**	0.9326	547	**510**
0.1823	2,625,970	**478,714**	0.1353	110	**15**
0.0245	724,903	**17,760**	0.0183	7,156	**131**
0.3630	478,778	**173,796**	0.2693	6,621	**1,783**
0.0626	3,386,788	**212,013**	0.0731	33,103	**2,420**
0.1194	3,462,155	**413,381**	0.1377	12,887	**1,775**
0.2105	3,462,155	**728,784**	0.2393	12,887	**3,084**
0.0509	3,462,155	**176,224**	0.0579	12,887	**746**
0.2332	1,143,166	**266,586**	0.2651	13,621	**3,611**
0.4704	1,060,001	**498,624**	0.5347	14,683	**7,851**
0.1649	3,048,498	**502,697**	0.1874	12,897	**2,417**
0.5090	3,097,238	**1,576,494**	0.5786	12,897	**7,462**
0.1598	919,712	**146,970**	0.1817	8,386	**1,524**
0.4971	1,958,830	**973,734**	0.5651	598	**338**
0.0558	75,367	**4,205**	0.0631	39,263	**2,478**
0.1663	5,010,962	**833,323**	0.1891	71,606	**13,541**
0.0666	5,010,962	**333,730**	0.0757	88,584	**6,706**
0.2640	5,011,640	**1,323,073**	0.3001	92,528	**27,768**
0.6450	5,010,962	**3,232,070**	0.7332	97,106	**71,198**
0.1617	5,086,329	**822,459**	0.1838	9,254	**1,701**
0.0424	5,086,329	**215,660**	0.0491	9,254	**454**
0.3047	5,010,962	**1,526,840**	0.3464	92,528	**32,052**
0.1749	515,615	**90,181**	0.1981	598	**119**
0.1282	508,688	**65,214**	0.2597	1,264	**328**
0.5550	1,337,946	**742,560**	0.6285	3,050	**1,917**
0.1953	980,179	**191,429**	0.3958	3,245	**1,284**
0.8055	5,241,025	**4,221,645**	0.9121	25,094	**22,889**

TRANSPORT COSTS US $				PHASE	5	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC5	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC5	TOT_FLOW	TOT TRSP COST
0.3451	1,060,140	**365,854**		0.3908	6,413	**2,506**
1.0399	5,508,369	**5,728,153**		1.1776	23,414	**27,572**
0.3634	1,732,064	**629,432**		0.4115	7,965	**3,277**
0.1493	1,333,312	**199,063**		0.1691	8,313	**1,406**
0.5594	1,732,064	**968,917**		0.6335	7,965	**5,046**
0.4791	160,147	**76,726**		0.9682	970	**939**
0.4180	4,138,223	**1,729,777**		0.4733	24,256	**11,480**
0.3376	4,131,366	**1,394,749**		0.3823	23,414	**8,951**
0.3627	1,732,064	**628,220**		0.4107	7,965	**3,271**
0.5874	1,600,929	**940,386**		0.6651	8,743	**5,815**
1.1265	2,960,384	**3,334,872**		1.2756	13,036	**16,629**
0.7209	113,619	**81,908**		0.8163	56	**46**
0.2394	2,960,384	**708,716**		0.2711	8,605	**2,333**
0.3717	652,866	**242,670**		0.7529	782	**588**
0.2312	75,367	**17,425**		0.4676	37,167	**17,379**
0.2904	128,849	**37,418**		0.5885	8,386	**4,935**
0.5817	210,814	**122,630**		1.1783	9,254	**10,904**
3.0000	3,386,788	**10,160,363**		1.0000	33,103	**33,103**
7.3000	4,875,515	**35,591,262**		1.0000	0	**0**
0.0000	0	**0**		1.0000	96,992	**96,992**
0.0000	0	**0**		1.0000	24,032	**24,032**
0.7197	6,455,789	**4,646,231**		0.5384	75,607	**40,707**
0.0000	0	**0**		1.0000	16,977	**16,977**
0.0000	0	**0**		1.0000	6,411	**6,411**
0.2609	5,010,962	**1,307,360**		0.2966	94,992	**28,175**
0.0000	0	**0**		1.0000	8,707	**8,707**
0.0000	0	**0**		1.0000	14,972	**14,972**
6.0000	678	**4,068**		1.0000	0	**0**
0.0000	0	**0**		1.0000	103,223	**103,223**
3.0000	241,058	**723,174**		1.0000	6,363	**6,363**
3.0000	6,856	**20,567**		1.0000	1,473	**1,473**
2.0324	2,032,524	**4,130,902**		1.6095	10,551	**16,982**
3.0000	48,741	**146,223**		1.0000	0	**0**
7.0000	210,814	**1,475,695**		1.0000	9,254	**9,254**
1.0000	128,849	**128,849**		1.0000	8,386	**8,386**
4.0000	10	**41**		1.0000	1,843	**1,843**
1.0000	1,959,911	**1,959,911**		1.0000	4,589	**4,589**
1.0000	148,141	**148,141**		1.0000	753	**753**
3.0000	1,487,330	**4,461,990**		1.0000	8,733	**8,733**
3.0000	113,619	**340,858**		1.0000	56	**56**
5.0000	652,866	**3,264,331**		1.0000	782	**782**
7.5000	524,973	**3,937,296**		1.0000	10,597	**10,597**
1.3708	3,166,286	**4,340,345**		1.0880	1,086	**1,181**
3.4384	1,248,480	**4,292,775**		2.5504	110	**280**
0.2719	499,236	**135,742**		0.2052	2,992	**614**
0.4555	75,367	**34,330**		0.9226	43,700	**40,317**
3.0000	0	**0**		1.0000	14,232	**14,232**
1.0865	922,787	**1,002,608**		0.8117	4,171	**3,386**
3.0000	344,510	**1,033,530**		1.0000	9,061	**9,061**

TRANSPORT COSTS US $				PHASE	5	2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC5	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC5	TOT_FLOW	TOT TRSP COST
5.0000	1,377,489	**6,887,447**		1.0000	0	**0**
6.5000	18,618	**121,018**		1.0000	0	**0**
0.3170	5,010,962	**1,588,475**		0.3603	92,528	**33,338**
0.7368	28,089	**20,696**		1.5178	465	**706**
2.9642	18,655	**55,297**		1.9239	527	**1,015**
3.0000	27,918	**83,755**		1.0000	955	**955**
3.0000	790,863	**2,372,590**		1.0000	0	**0**
2.0000	28,089	**56,177**		1.0000	465	**465**
3.3566	123,587	**414,833**		2.5333	70	**178**
1.5533	362	**563**		1.1604	32	**37**
2.3088	362	**836**		1.7247	32	**55**
1.1751	388	**456**		0.8779	44	**39**
0.8183	388	**318**		0.6113	44	**27**
0.8685	123,446	**107,213**		0.6555	644	**422**
TRANSPORT COSTS PHASE 5		**331,702,531**		TRANSPORT COSTS PHASE 5		**2,159,685**

TRANSPORT COSTS US $			PHASE	6	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC6	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC6	TOT_FLOW	TOT TRSP COST
0.2298	176,141	**40,477**	0.1719	7.9722	**1**
2.7033	176,141	**476,162**	2.1701	7.9722	**17**
0.0122	176,141	**2,149**	0.0092	7.9722	**0**
2.6369	773,434	**2,039,467**	1.5153	993.0631	**1.505**
4.8875	679,827	**3,322,656**	2.8086	484.9120	**1.362**
0.0636	4,152,110	**264,074**	0.0475	5646.9991	**268**
0.5341	4,152,110	**2,217,642**	0.3996	5646.9991	**2.257**
0.2765	200,018	**55,305**	0.2069	13463.9077	**2.786**
0.4698	4,002,716	**1,880,476**	0.3485	15982.0681	**5.570**
0.1540	200,018	**30,803**	0.1152	13463.9077	**1.551**
0.6329	200,018	**126,591**	0.4735	13463.9077	**6.375**
0.1694	200,018	**33,883**	0.1256	13463.9077	**1.691**
0.3169	4,002,716	**1,268,461**	0.2371	15982.0681	**3.789**
0.3883	6,319,973	**2,454,045**	0.2901	52144.0192	**15.127**
1.0393	6,319,973	**6,568,348**	0.7776	52144.0192	**40.547**
1.3270	1,574,985	**2,090,005**	0.9927	92458.2544	**91.783**
0.5156	1,574,985	**812,062**	0.3852	92458.2544	**35.615**
0.0881	1,574,985	**138,756**	0.0659	108647.8473	**7.160**
0.9666	4,152,110	**4,013,430**	0.7671	5646.9991	**4.332**
0.1584	3,081,083	**488,044**	0.1281	13618.8416	**1.745**
1.1655	3,081,083	**3,591,002**	0.9428	13618.8416	**12.840**
1.9404	1,619,267	**3,142,025**	1.5366	627.8131	**965**
0.7039	3,737,957	**2,631,148**	0.5575	12454.3036	**6.943**
0.0388	3,737,957	**145,033**	0.0308	12454.3036	**384**
0.2819	3,811,195	**1,074,376**	0.2280	3432.8783	**783**
1.2369	3,811,195	**4,714,068**	0.9929	3432.8783	**3.409**
0.2990	3,738,699	**1,117,871**	0.2368	13371.4683	**3.166**
0.0622	822,288	**51,146**	0.0465	12413.8110	**577**
0.7545	3,234,513	**2,440,440**	0.6103	45034.4652	**27.485**
0.0629	6,728,442	**423,219**	0.0500	162209.4468	**8.110**
0.2394	2,056,111	**492,233**	0.1900	12134.8982	**2.306**
0.0098	6,728,442	**65,939**	0.0077	162209.4468	**1.249**
0.0346	6,728,442	**232,804**	0.0274	162209.4468	**4.445**
0.0378	6,728,442	**254,335**	0.0300	162209.4468	**4,866**
2.1999	1,542,359	**3,393,036**	1.6458	456.9763	**752**
0.7396	1,891,002	**1,398,585**	0.5983	12036.9118	**7,202**
0.2190	1,891,002	**414,129**	0.1771	12036.9118	**2,132**
0.5044	3,737,957	**1,885,426**	0.3995	12454.3036	**4,975**
0.0191	3,737,957	**71,395**	0.0151	12454.3036	**188**
0.7309	2,081,789	**1,521,579**	0.5912	9407.6324	**5,562**
0.9540	2,081,789	**1,986,027**	0.7717	9407.6324	**7,260**
0.2372	2,053,307	**487,044**	0.1883	18631.1529	**3,508**
0.0031	1,191,207	**3,693**	0.0023	26957.2123	**62**
0.5888	1,926,942	**1,134,583**	0.4673	12067.1857	**5,639**
0.0566	1,926,942	**109,065**	0.0450	12067.1857	**543**
0.7438	2,053,307	**1,527,250**	0.5903	18631.1529	**10,998**

TRANSPORT COSTS US $			PHASE 6		2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC6	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC6	TOT_FLOW	TOT TRSP COST
0.0275	2,053,307	**56,466**	0.0205	18631.1529	**382**
1.1908	1,191,207	**1,418,489**	0.8909	26957.2123	**24,016**
1.2118	576,883	**699,067**	0.9066	4794.3995	**4,347**
0.0101	45,939	**464**	0.0075	0.0000	**0**
0.5302	45,939	**24,357**	0.3956	0.0000	**0**
0.0363	45,939	**1,668**	0.0269	0.0000	**0**
1.6252	92,677	**150,619**	1.2127	4.7192	**6**
0.8721	92,677	**80,824**	0.6582	4.7192	**3**
4.0227	150,254	**604,428**	3.0052	4.7197	**14**
1.8520	150,254	**278,271**	1.3768	4.7197	**6**
0.0383	45,939	**1,759**	0.0284	0.0000	**0**
0.0289	45,939	**1,328**	0.0214	0.0000	**0**
0.0429	1,606,573	**68,922**	0.0321	8923.8185	**286**
1.1033	81,392	**89,800**	0.8254	175.2460	**145**
1.6381	586,707	**961,084**	1.2223	1789.3568	**2,187**
0.7279	45,939	**33,439**	0.5432	0.0000	**0**
1.0734	45,939	**49,311**	0.8009	0.0000	**0**
0.1703	102,525	**17,460**	0.1271	55.8950	**7**
2.0097	57,612	**115,782**	1.4941	0.0005	**0**
0.5721	45,939	**26,282**	0.4269	0.0000	**0**
0.6380	45,939	**29,309**	0.4815	0.0000	**0**
1.3846	45,939	**63,607**	1.0332	0.0000	**0**
9.5000	2,967,530	**28,191,536**	1.0000	8605.3924	**8,605**
0.0373	1,587,887	**59,228**	0.0302	4813.6164	**145**
0.3918	1,784,989	**699,359**	0.3169	559.6147	**177**
0.5036	1,111,394	**559,698**	0.3768	12974.8600	**4,889**
0.8023	1,587,887	**1,273,962**	0.6490	4813.6164	**3,124**
3.1412	2,650,897	**8,326,999**	2.3500	9577.7745	**22,508**
1.8038	679,855	**1,226,322**	1.3460	8714.9967	**11,730**
0.5759	2,693,128	**1,550,972**	0.4302	1675.4270	**721**
0.0199	2,650,897	**52,753**	0.0149	6589.7512	**98**
1.0080	2,411,228	**2,430,518**	0.8154	5373.9345	**4,382**
0.3578	2,831,215	**1,013,009**	0.2840	1051.6334	**299**
0.0086	3,373,817	**29,015**	0.0068	12123.3594	**82**
0.0091	2,411,228	**21,942**	0.0068	5373.9345	**37**
0.3675	2,411,228	**886,126**	0.2973	5373.9345	**1,598**
1.1514	2,411,228	**2,776,288**	0.9313	5373.9345	**5,005**
1.4318	23,835	**34,127**	1.0684	1.8064	**2**
2.7510	198,890	**547,146**	2.0527	841.3905	**1,727**
1.1434	81,392	**93,064**	0.8554	175.2460	**150**
1.0601	91,982	**97,511**	0.7910	705.6400	**558**
3.1209	20,391	**63,637**	2.3555	28.9417	**68**
1.6475	91,982	**151,541**	1.2293	705.6400	**867**
0.0238	3,549,851	**84,486**	0.0193	12131.3189	**234**
0.5874	87,493	**51,393**	0.3380	87.0766	**29**
0.5656	22,983	**12,999**	0.3247	821.4027	**267**
3.2275	87,493	**282,384**	1.8525	87.0766	**161**
4.2849	22,983	**98,482**	2.4624	0.0832	**0**
0.0408	3,549,851	**144,834**	0.0330	12131.3189	**400**

TRANSPORT COSTS US $			PHASE	6	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC6	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC6	TOT_FLOW	TOT TRSP COST
1.1670	3,549,851	**4,142,676**	0.9440	12131.3189	**11,452**
0.5725	3,549,851	**2,032,290**	0.4631	12131.3189	**5,618**
0.7014	773,434	**542,486**	0.4026	993.0631	**400**
1.5287	2,188,584	**3,345,688**	1.1437	8613.1861	**9,851**
0.7550	2,188,584	**1,652,381**	0.5648	8613.1861	**4,865**
1.7926	45,017	**80,698**	1.3392	65.4543	**88**
0.2147	1,806,153	**387,781**	0.1606	11007.4442	**1,768**
3.0000	1,437,853	**4,313,560**	1.0000	639.9565	**640**
0.8633	1,337,192	**1,154,398**	0.6404	7154.8898	**4,582**
0.0220	1,054,845	**23,207**	0.0164	9986.4157	**164**
1.3066	1,891,002	**2,470,783**	1.0569	12036.9118	**12,722**
0.3555	87,213	**31,004**	0.2821	1107.0823	**312**
1.0996	485,044	**533,354**	0.8227	1836.7438	**1,511**
1.5029	912,739	**1,371,756**	1.1227	4135.9629	**4,643**
0.5789	28,703	**16,616**	0.4325	606.5362	**262**
2.9696	0	**0**	2.2158	44.2259	**98**
0.0929	45,017	**4,182**	0.0701	65.4543	**5**
1.0636	45,017	**47,880**	0.8028	65.4543	**53**
0.2597	45,017	**11,691**	0.1940	65.4543	**13**
0.0950	1,891,002	**179,645**	0.0768	12036.9118	**924**
0.0818	87,213	**7,134**	0.0649	1107.0823	**72**
0.5436	87,213	**47,409**	0.4314	1107.0823	**478**
0.4657	87,213	**40,615**	0.3475	1107.0823	**385**
1.3013	87,213	**113,490**	0.9216	1107.0823	**1,020**
0.3676	87,213	**32,059**	0.2974	1107.0823	**329**
0.1349	87,213	**11,765**	0.1091	1107.0823	**121**
0.7220	87,213	**62,968**	0.5840	1107.0823	**647**
0.0321	87,213	**2,800**	0.0260	1107.0823	**29**
0.0268	87,213	**2,337**	0.0213	1107.0823	**24**
0.0772	1,806,153	**139,435**	0.0578	11007.4442	**636**
0.9732	485,044	**472,044**	0.7281	1836.7438	**1,337**
0.0150	1,701,199	**25,518**	0.0112	6527.1870	**73**
3.0393	1,701,199	**5,170,455**	1.7381	6527.1870	**11,345**
0.0258	1,701,199	**43,891**	0.0191	6527.1870	**125**
0.5696	182,840	**104,146**	0.3278	2886.6337	**946**
0.2595	743,857	**193,031**	0.1494	8207.9341	**1,226**
4.7758	22,983	**109,764**	2.7412	0.0832	**0**
0.3672	182,840	**67,139**	0.2110	2886.6337	**609**
0.6800	182,840	**124,331**	0.3907	2886.6337	**1,128**
0.0897	1,942,673	**174,258**	0.0671	27919.4486	**1,873**
0.4554	1,942,673	**884,693**	0.3614	27919.4486	**10,090**
0.0779	1,942,673	**151,334**	0.0583	27919.4486	**1,628**
0.3213	338,063	**108,620**	0.2404	34062.7371	**8,189**
0.7858	164,404	**129,188**	0.5879	787.1266	**463**
1.0621	1,701,199	**1,806,844**	0.6074	6527.1870	**3,965**
0.9040	182,840	**165,288**	0.5195	2886.6337	**1,500**
1.5588	182,840	**285,011**	0.8958	2886.6337	**2,586**
0.7546	182,840	**137,971**	0.4315	2886.6337	**1,246**
2.4417	37,779	**92,245**	1.8219	12.5826	**23**

TRANSPORT COSTS US $				PHASE 6	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC6	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC6	TOT_FLOW	TOT TRSP COST
0.7138	37,779	**26,967**	0.5326	12.5826	**7**
0.9503	109,043	**103,624**	0.7542	4665.7747	**3,519**
0.1211	168,210	**20,370**	0.0961	627.0905	**60**
0.8333	5,019,093	**4,182,410**	0.6613	19577.9054	**12,947**
0.0568	2,032,706	**115,458**	0.0449	6134.0233	**275**
0.8235	306,172	**252,132**	0.6661	4741.3585	**3,158**
0.6195	306,540	**189,901**	0.4634	4719.7571	**2,187**
0.2702	306,540	**82,827**	0.2145	4719.7571	**1,012**
0.1523	306,540	**46,686**	0.1140	4719.7571	**538**
0.7446	306,540	**228,249**	0.5570	4719.7571	**2,629**
0.0040	5,391,994	**21,568**	0.0032	27538.5877	**88**
0.0087	396,784	**3,452**	0.0069	7962.7459	**55**
0.0708	8,407,452	**595,248**	0.0562	50607.7536	**2,844**
0.0080	3,038,944	**24,312**	0.0064	23069.1659	**148**
0.6289	306,540	**192,783**	0.4991	4719.7571	**2,356**
0.0069	3,435,728	**23,707**	0.0051	31031.9118	**158**
0.1020	3,435,728	**350,444**	0.0761	31031.9118	**2,362**
0.5630	1,942,673	**1,093,725**	0.4458	27919.4486	**12,446**
0.2705	1,574,985	**426,033**	0.2147	92458.2544	**19,851**
0.5247	1,574,985	**826,395**	0.4164	92458.2544	**38,500**
0.0645	2,891,211	**186,483**	0.0518	8076.1741	**418**
0.4838	6,328,335	**3,061,648**	0.4094	86468.8542	**35,400**
0.3478	4,443,332	**1,545,391**	0.2814	81130.6590	**22,830**
0.0171	3,712,919	**63,491**	0.0128	71882.6140	**920**
0.0267	3,342,038	**89,232**	0.0199	81952.8214	**1,631**
0.0412	2,937,895	**121,041**	0.0307	47402.8183	**1,455**
0.1612	6,279,932	**1,012,325**	0.1279	203987.9285	**26,090**
0.4069	1,116,065	**454,127**	0.3230	52227.9248	**16,870**
0.3023	6,319,973	**1,910,528**	0.2262	58162.3147	**13,156**
0.1810	1,116,065	**202,008**	0.1437	34471.6062	**4,954**
0.1895	1,116,065	**211,494**	0.1406	34471.6062	**4,847**
0.0593	6,319,973	**374,774**	0.0443	58162.3147	**2,577**
0.5410	2,451,609	**1,326,321**	0.4376	21283.6845	**9,314**
0.6597	2,451,609	**1,617,327**	0.5336	21283.6845	**11,357**
0.0555	2,451,609	**136,064**	0.0449	21283.6845	**956**
2.1463	491,599	**1,055,118**	1.6034	459.8255	**737**
0.2722	491,599	**133,813**	0.2050	459.8255	**94**
0.2198	1,917,033	**421,364**	0.1778	2487.1420	**442**
0.0677	1,917,033	**129,783**	0.0547	2487.1420	**136**
0.2511	2,039,140	**512,028**	0.1876	28678.3421	**5,380**
0.1642	2,039,140	**334,827**	0.1226	28678.3421	**3,516**
1.2057	2,039,140	**2,458,591**	0.9007	28678.3421	**25,831**
0.5957	2,451,609	**1,460,424**	0.4819	21283.6845	**10,257**
0.1157	1,116,065	**129,129**	0.0865	34471.6062	**2,982**
0.5123	1,116,065	**571,760**	0.3833	34471.6062	**13,213**
0.3888	3,081,083	**1,197,925**	0.2901	13618.8416	**3,951**
0.4945	1,116,065	**551,894**	0.3699	34471.6062	**12,751**
0.7146	1,116,065	**797,540**	0.5339	34471.6062	**18,404**
0.0321	1,116,065	**35,826**	0.0240	34471.6062	**827**

TRANSPORT COSTS US $				PHASE 6	2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC6	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC6	TOT_FLOW	TOT TRSP COST
0.6723	2,039,140	**1,370,914**	0.5030	28678.3421	**14,425**
0.0425	1,116,065	**47,433**	0.0318	34471.6062	**1,096**
0.0977	491,599	**48,029**	0.0725	459.8255	**33**
0.0300	468,510	**14,055**	0.0224	365.7798	**8**
0.2646	663,637	**175,598**	0.1997	3455.4058	**690**
2.1480	23,835	**51,198**	1.6028	1.8064	**3**
0.5166	92,677	**47,877**	0.3840	4.7192	**2**
1.3588	1,728,761	**2,349,040**	0.7771	49720.8706	**38,638**
0.2064	243,976	**50,357**	0.1531	9105.7349	**1,394**
0.3450	1,701,199	**586,914**	0.1973	6527.1870	**1,288**
1.0184	164,404	**167,429**	0.7554	787.1266	**595**
0.0583	3,811,195	**222,193**	0.0468	10087.8880	**472**
0.8423	91,982	**77,477**	0.6285	705.6400	**443**
0.2733	81,392	**22,244**	0.2045	175.2460	**36**
1.1663	81,392	**94,928**	0.8726	175.2460	**153**
0.9648	2,006,591	**1,935,959**	0.7804	29575.4665	**23,081**
1.5759	45,017	**70,942**	1.1759	65.4543	**77**
0.0902	101,714	**9,175**	0.0673	790.6278	**53**
1.1530	2,322,497	**2,677,839**	0.9326	531.3014	**495**
0.1823	2,291,952	**417,823**	0.1353	408.8839	**55**
0.0245	743,857	**18,224**	0.0183	8207.9341	**150**
0.3630	503,820	**182,887**	0.2693	707.6127	**191**
0.0641	3,435,728	**220,230**	0.0731	31031.9118	**2,268**
0.1212	3,502,293	**424,478**	0.1377	17376.7044	**2,393**
0.2105	3,502,293	**737,233**	0.2393	17376.7044	**4,158**
0.0509	3,502,293	**178,267**	0.0579	17376.7044	**1,006**
0.2332	1,299,702	**303,090**	0.2651	18490.2841	**4,902**
0.4704	1,221,391	**574,543**	0.5347	19735.9628	**10,553**
0.1649	3,114,360	**513,558**	0.1874	17387.9806	**3,259**
0.5090	3,114,360	**1,585,209**	0.5786	18874.0717	**10,921**
0.1598	941,748	**150,491**	0.1817	8408.2819	**1,528**
0.4971	1,838,347	**913,842**	0.5651	866.4559	**490**
0.0555	66,565	**3,694**	0.0631	39072.9257	**2,466**
0.1663	3,121,094	**519,038**	0.1891	68880.7173	**13,025**
0.0666	3,121,094	**207,865**	0.0757	84831.9141	**6,422**
0.2640	3,121,836	**824,165**	0.3001	86266.8751	**25,889**
0.6450	3,121,094	**2,013,106**	0.7332	91749.3001	**67,271**
0.1617	3,187,659	**515,444**	0.1838	14520.2520	**2,669**
0.0432	3,187,659	**137,707**	0.0491	14520.2520	**713**
0.3047	3,121,094	**950,997**	0.3464	88741.0870	**30,740**
0.1749	406,166	**71,038**	0.1981	844.4498	**167**
0.2294	389,486	**89,348**	0.2597	1185.8338	**308**
0.5550	600,070	**333,039**	0.6285	3086.6350	**1,940**
0.3495	272,998	**95,413**	0.3958	3202.2989	**1,267**
0.8055	4,124,847	**3,322,564**	0.9121	20060.4742	**18,297**
0.3451	360,184	**124,299**	0.3908	6457.1204	**2,523**
1.0399	3,582,039	**3,724,963**	1.1776	19057.1224	**22,442**
0.3634	1,719,055	**624,704**	0.4115	7914.5322	**3,257**
0.1493	1,483,290	**221,455**	0.1691	8172.1160	**1,382**

TRANSPORT COSTS US $			PHASE 6		2015
WITH PROJECT SCENARIO					
FREIGHT			PASSENGERS		
VOC_FRE_TOT SC6	TOT_FLOW	TOT TRSP COST	VOC_PAS_TOT SC6	TOT_FLOW	TOT TRSP COST
0.5594	1,719,055	**961,639**	0.6335	7914.5322	**5,014**
0.8550	26,583	**22,728**	0.9682	998.1454	**966**
0.4180	2,591,095	**1,083,078**	0.4733	19536.9247	**9,247**
0.3376	2,596,368	**876,534**	0.3823	18840.3328	**7,203**
0.3627	1,719,055	**623,501**	0.4107	7914.5322	**3,250**
0.5874	1,593,385	**935,954**	0.6651	8758.7263	**5,825**
1.1265	2,967,530	**3,342,923**	1.2756	12572.6734	**16,038**
0.7209	114,163	**82,300**	0.8163	55.8956	**46**
0.2394	2,967,530	**710,427**	0.2711	8605.3924	**2,333**
0.6651	1,634,658	**1,087,211**	0.7529	4912.4329	**3,699**
0.4631	2,118,747	**981,192**	0.5244	5748.2107	**3,014**
0.5885	2,118,747	**1,246,882**	0.6574	6504.3390	**4,276**
0.6257	2,118,747	**1,325,700**	0.7085	6504.3390	**4,608**
0.3259	2,436,740	**794,134**	0.3691	51828.0081	**19,130**
0.4300	2,436,740	**1,047,798**	0.4870	51828.0081	**25,240**
0.4118	66,565	**27,411**	0.4676	38592.3234	**18,046**
0.5197	127,569	**66,298**	0.5885	5251.9961	**3,091**
1.0405	296,448	**308,454**	1.1783	9094.9418	**10,717**
3.0000	3,435,728	**10,307,183**	1.0000	31031.9118	**31,032**
7.3000	2,891,211	**21,105,842**	1.0000	8076.1741	**8,076**
0.0000	0	0	1.0000	86977.4240	86,977
0.0000	0	0	1.0000	23730.3521	23,730
0.7197	6,319,973	4,548,484	0.5384	74113.5116	39,903
0.0000	0	0	1.0000	15951.1969	15,951
0.0000	0	**0**	1.0000	6023.8102	**6,024**
0.2609	3,121,094	**814,293**	0.2966	90853.2016	**26,947**
0.0000	0	**0**	1.0000	7045.1805	**7,045**
0.0000	0	**0**	1.0000	16189.5929	**16,190**
6.0000	742	**4,454**	1.0000	4786.2322	**4,786**
0.0000	0	**0**	1.0000	105384.8029	**105,385**
3.0000	245,554	**736,661**	1.0000	7624.7955	**7,625**
3.0000	25,185	**75,555**	1.0000	321.2293	**321**
2.0324	2,032,706	**4,131,272**	1.6095	6134.0233	**9,873**
3.0000	0	**0**	1.0000	10340.7229	**10,341**
0.0000	0	**0**	1.0000	0.0000	**0**
3.0000	296,448	**889,343**	1.0000	9094.9418	**9,095**
1.0000	127,569	**127,569**	1.0000	5251.9961	**5,252**
4.0000	11	**42**	1.0000	1802.5008	**1,803**
1.0000	2,001,615	**2,001,615**	1.0000	4496.8982	**4,497**
1.0000	147,827	**147,827**	1.0000	664.5023	**665**
3.0000	1,479,242	**4,437,726**	1.0000	8748.5725	**8,749**
3.0000	114,163	**342,489**	1.0000	55.8956	**56**
3.0000	0	**0**	1.0000	3967.2810	**3,967**
5.0000	995,714	**4,978,568**	1.0000	898.0144	**898**
7.5000	542,603	**4,069,519**	1.0000	11072.1223	**11,072**
1.3708	2,831,215	**3,881,029**	1.0880	1051.6334	**1,144**
3.0000	0	**0**	1.0000	0.0000	**0**
3.4384	1,306,177	**4,491,160**	2.5504	110.9025	**283**
3.0000	0	**0**	1.0000	0.0000	**0**
0.0000	0	**0**	0.0000	0.0000	**0**

TRANSPORT COSTS US $				PHASE 6		2015
WITH PROJECT SCENARIO						
FREIGHT				PASSENGERS		
VOC_FRE_TOT SC6	TOT_FLOW	TOT TRSP COST		VOC_PAS_TOT SC6	TOT_FLOW	TOT TRSP COST
0.2719	663,637	**180,443**		0.2052	3455.4058	**709**
3.0000	0	**0**		1.0000	0.0000	**0**
3.0000	0	**0**		1.0000	821.3195	**821**
0.6383	2,613,513	**1,668,205**		0.7227	9589.3577	**6,930**
3.0000	561,016	**1,683,049**		1.0000	5321.3004	**5,321**
3.0000	176,772	**530,317**		1.0000	43265.3853	**43,265**
0.8157	66,565	**54,297**		0.9226	43789.5545	**40,400**
3.0000	0	**0**		3.0000	0.0000	**0**
8.1700	2,436,740	**19,908,169**		1.0000	51828.0081	**51,828**
1.1120	0	**0**		0.8267	0.0000	**0**
3.0000	0	**0**		1.0000	12960.7564	**12,961**
1.0865	912,739	**991,691**		0.8117	4135.9629	**3,357**
3.0000	364,742	**1,094,225**		1.0000	9142.4805	**9,142**
5.0000	985,774	**4,928,872**		1.0000	332.0660	**332**
6.5000	9,732	**63,257**		1.0000	162.8678	**163**
0.3170	3,121,094	**989,387**		0.3603	88741.0870	**31,973**
1.3404	28,089	**37,650**		1.5178	465.3580	**706**
2.9642	28,703	**85,080**		1.9239	562.3103	**1,082**
3.0000	37,649	**112,948**		1.0000	503.5401	**504**
3.0000	814,179	**2,442,536**		1.0000	3164.0934	**3,164**
	10,396	**0**			118.1159	**0**
	28,089	**0**			465.3580	**0**
5.2496	0	**0**		3.9217	0.0000	**0**
4.8092	0	**0**		3.5927	0.0000	**0**
2.0000	28,089	**56,177**		1.0000	465.3580	**465**
3.3566	129,169	**433,570**		2.5333	67.7125	**172**
1.5533	368	**572**		1.1604	21.6014	**25**
2.3088	368	**850**		1.7247	21.6014	**37**
	23,854	**0**			10405.1582	**0**
1.1751	24,222	**28,464**		0.8779	42.8339	**38**
0.8183	24,222	**19,821**		0.6113	42.8339	**26**
0.8685	129,414	**112,396**		0.6555	171.9407	**113**
TRANSPORT COSTS PHASE 6		**330,173,862**		**TRANSPORT COSTS PHASE 6**		**2.046.211**

8.2 ANNEX 2: ECONOMIC FEASIBILITY RESULTS

ECONOMIC ANALYSIS PHASE 1 W NG

PHASE	1W NG
IRR	31.40%
NPV (12%)	2.657.911.472

Years	COSTS US$					BENEFITS US$				CASH FLOWS US$
	With Project				TOTAL COSTS	SAVINGS IN TRANSPORT COSTS	SAVINGS IN ROAD MAINTENANCE	SAVINGS IN ROAD ACCIDENT	TOTAL BENEFITS	
	Investment			Maintenance						
	Infrastructure	Roll-Stock	Environment	Yearly						
2012										
2013										
2014										
2015	285,600,000		1,428,000		287,028,000					-287,028,000
2016	285,600,000	5,324,830	1,428,000		292,352,830					-292,352,830
2017	285,600,000	7,987,245	1,428,000		295,015,245					-295,015,245
2018	285,600,000	13,312,075	1,428,000		300,340,075					-300,340,075
2019				12,580,000	12,580,000	464,938,966	680,000	58,648,834	524,267,800	511,687,800
2020				12,580,000	12,580,000	483,504,327	680,000	58,648,834	542,833,161	530,253,161
2021				12,580,000	12,580,000	502,811,658	680,000	58,648,834	562,140,492	549,560,492
2022				12,580,000	12,580,000	522,890,626	680,000	58,648,834	582,219,460	569,639,460
2023				12,580,000	12,580,000	543,772,083	680,000	58,648,834	603,100,917	590,520,917
2024				12,580,000	12,580,000	565,488,114	680,000	58,648,834	624,816,948	612,236,948
2025				12,580,000	12,580,000	588,072,090	680,000	58,648,834	647,400,924	634,820,924
2026				12,580,000	12,580,000	611,558,713	680,000	58,648,834	670,887,547	658,307,547
2027				12,580,000	12,580,000	635,984,077	680,000	58,648,834	695,312,911	682,732,911
2028				12,580,000	12,580,000	661,385,715	680,000	58,648,834	720,714,549	708,134,549
2029				12,580,000	12,580,000	687,802,664	680,000	58,648,834	747,131,498	734,551,498
2030				12,580,000	12,580,000	715,275,522	680,000	58,648,834	774,604,356	762,024,356
2031				12,580,000	12,580,000	743,846,509	680,000	58,648,834	803,175,343	790,595,343
2032				12,580,000	12,580,000	773,559,534	680,000	58,648,834	832,888,368	820,308,368
2033				12,580,000	12,580,000	804,460,264	680,000	58,648,834	863,789,098	851,209,098
2034				12,580,000	12,580,000	836,596,191	680,000	58,648,834	895,925,025	883,345,025
2035				12,580,000	12,580,000	870,016,704	680,000	58,648,834	929,345,538	916,765,538
2036				12,580,000	12,580,000	904,773,172	680,000	58,648,834	964,102,006	951,522,006
2037				12,580,000	12,580,000	940,919,014	680,000	58,648,834	1,000,247,848	987,667,848
2038				12,580,000	12,580,000	978,509,788	680,000	58,648,834	1,037,838,622	1,025,258,622
2039				12,580,000	12,580,000	1,017,603,273	680,000	58,648,834	1,076,932,107	1,064,352,107
2040				12,580,000	12,580,000	1,058,259,560	680,000	58,648,834	1,117,588,394	1,105,008,394
2041				12,580,000	12,580,000	1,100,541,141	680,000	58,648,834	1,159,869,975	1,147,289,975
2042				12,580,000	12,580,000	1,144,513,010	680,000	58,648,834	1,203,841,844	1,191,261,844
2043				12,580,000	12,580,000	1,190,242,758	680,000	58,648,834	1,249,571,592	1,236,991,592
2044				12,580,000	12,580,000	1,237,800,680	680,000	58,648,834	1,297,129,514	1,284,549,514
2045				12,580,000	12,580,000	1,287,259,883	680,000	58,648,834	1,346,588,717	1,334,008,717
2046				12,580,000	12,580,000	1,338,696,398	680,000	58,648,834	1,398,025,232	1,385,445,232
2047				12,580,000	12,580,000	1,392,189,296	680,000	58,648,834	1,451,518,130	1,438,938,130
2048	-799,680,000			12,580,000	-787,100,000	1,447,820,811	680,000	58,648,834	1,507,149,645	2,294,249,645

ECONOMIC ANALYSIS PHASE 1 E NG

PHASE	1E NG
IRR	29.57%
NPV (12%)	2.424.168.272

REHABILITATION OF EXISTING LINES

YEARS	COSTS US$					BENEFITS US$				CASH FLOWS US$
	With Project				TOTAL COSTS	SAVINGS IN TRANSPORT COSTS	SAVINGS IN ROAD MAINTENANCE	SAVINGS IN ROAD ACCIDENT	TOTAL BENEFITS	
	Investment			Maintenance						
	Infrastructure	Roll-Stock	Environment	Yearly						
2012										
2013										
2014										
2015	220,147,200		1,100,736		221,247,936					-221,247,936
2016	220,147,200		1,100,736		221,247,936					-221,247,936
2017	220,147,200	5,324,830	1,100,736		226,572,766					-226,572,766
2018	220,147,200	7,987,245	1,100,736		229,235,181					-229,235,181
2019	220,147,200	13,312,075	1,100,736		234,560,011				0	-234,560,011
2020				12,121,200	12,121,200	477,390,064	655,200	56,509,877	534,555,141	522,433,941
2021				12,121,200	12,121,200	496,449,000	655,200	56,509,877	553,614,076	541,492,876
2022				12,121,200	12,121,200	516,269,559	655,200	56,509,877	573,434,636	561,313,436
2023				12,121,200	12,121,200	536,882,194	655,200	56,509,877	594,047,270	581,926,070
2024				12,121,200	12,121,200	558,318,570	655,200	56,509,877	615,483,647	603,362,447
2025				12,121,200	12,121,200	580,611,623	655,200	56,509,877	637,776,700	625,655,500
2026				12,121,200	12,121,200	603,795,605	655,200	56,509,877	660,960,682	648,839,482
2027				12,121,200	12,121,200	627,906,136	655,200	56,509,877	685,071,213	672,950,013
2028				12,121,200	12,121,200	652,980,263	655,200	56,509,877	710,145,340	698,024,140
2029				12,121,200	12,121,200	679,056,512	655,200	56,509,877	736,221,589	724,100,389
2030				12,121,200	12,121,200	706,174,953	655,200	56,509,877	763,340,029	751,218,829
2031				12,121,200	12,121,200	734,377,254	655,200	56,509,877	791,542,330	779,421,130
2032				12,121,200	12,121,200	763,706,753	655,200	56,509,877	820,871,830	808,750,630
2033				12,121,200	12,121,200	794,208,521	655,200	56,509,877	851,373,597	839,252,397
2034				12,121,200	12,121,200	825,929,429	655,200	56,509,877	883,094,506	870,973,306
2035				12,121,200	12,121,200	858,918,225	655,200	56,509,877	916,083,302	903,962,102
2036				12,121,200	12,121,200	893,225,605	655,200	56,509,877	950,390,682	938,269,482
2037				12,121,200	12,121,200	928,904,294	655,200	56,509,877	986,069,370	973,948,170
2038				12,121,200	12,121,200	966,009,123	655,200	56,509,877	1,023,174,199	1,011,052,999
2039				12,121,200	12,121,200	1,004,597,118	655,200	56,509,877	1,061,762,195	1,049,640,995
2040				12,121,200	12,121,200	1,044,727,586	655,200	56,509,877	1,101,892,663	1,089,771,463
2041				12,121,200	12,121,200	1,086,462,204	655,200	56,509,877	1,143,627,281	1,131,506,081
2042				12,121,200	12,121,200	1,129,865,118	655,200	56,509,877	1,187,030,194	1,174,908,994
2043				12,121,200	12,121,200	1,175,003,036	655,200	56,509,877	1,232,168,113	1,220,046,913
2044				12,121,200	12,121,200	1,221,945,338	655,200	56,509,877	1,279,110,414	1,266,989,214
2045				12,121,200	12,121,200	1,270,764,175	655,200	56,509,877	1,327,929,251	1,315,808,051
2046				12,121,200	12,121,200	1,321,534,586	655,200	56,509,877	1,378,699,662	1,366,578,462
2047				12,121,200	12,121,200	1,374,334,610	655,200	56,509,877	1,431,499,687	1,419,378,487
2048				12,121,200	12,121,200	1,429,245,408	655,200	56,509,877	1,486,410,485	1,474,289,285
2049	-770,515,200			12,121,200	-758,394,000	1,486,351,386	655,200	56,509,877	1,543,516,463	2,301,910,463

ECONOMIC ANALYSIS PHASE 2 W

PHASE	2W
I RR	34.01%
NPV (12%)	112.586.663

CONSTRUCTION OF NEW LINES

YEARS	COSTS US$					BENEFITS US$				CASH FLOWS US$
	With Project				TOTAL COSTS	SAVINGS IN TRANSPORT COSTS	SAVINGS IN ROAD MAINTENANCE	SAVINGS IN ROAD ACCIDENT	TOTAL BENEFITS	
	Investment			Maintenance						
	Infrastructure	Roll-Stock	Environment	Yearly						
2012										
2013										
2014										
2015										
2016										
2017										
2018										
2019	198,613,333		993,067		199,606,400					
2020	198,613,333		993,067		199,606,400					-199,606,400
2021	198,613,333		993,067		199,606,400				0	-199,606,400
2022	198,613,333	18,836,500	993,067		218,442,900				0	-218,442,900
2023	198,613,333	28,254,750	993,067		227,861,150				0	-227,861,150
2024	198,613,333	47,091,250	993,067		246,697,650				0	-246,697,650
2025				9,842,000	9,842,000	575,350,652	1,143,900	60,566,996	637,061,548	627,219,548
2026				9,842,000	9,842,000	598,329,432	1,143,900	60,566,996	660,040,328	650,198,328
2027				9,842,000	9,842,000	622,226,658	1,143,900	60,566,996	683,937,554	674,095,554
2028				9,842,000	9,842,000	647,079,055	1,143,900	60,566,996	708,789,951	698,947,951
2029				9,842,000	9,842,000	672,924,814	1,143,900	60,566,996	734,635,710	724,793,710
2030				9,842,000	9,842,000	699,803,655	1,143,900	60,566,996	761,514,551	751,672,551
2031				9,842,000	9,842,000	727,756,887	1,143,900	60,566,996	789,467,783	779,625,783
2032				9,842,000	9,842,000	756,827,470	1,143,900	60,566,996	818,538,366	808,696,366
2033				9,842,000	9,842,000	787,060,082	1,143,900	60,566,996	848,770,978	838,928,978
2034				9,842,000	9,842,000	818,501,189	1,143,900	60,566,996	880,212,085	870,370,085
2035				9,842,000	9,842,000	851,199,114	1,143,900	60,566,996	912,910,010	903,068,010
2036				9,842,000	9,842,000	885,204,114	1,143,900	60,566,996	946,915,010	937,073,010
2037				9,842,000	9,842,000	920,568,455	1,143,900	60,566,996	982,279,351	972,437,351
2038				9,842,000	9,842,000	957,346,493	1,143,900	60,566,996	1,019,057,389	1,009,215,389
2039				9,842,000	9,842,000	995,594,758	1,143,900	60,566,996	1,057,305,654	1,047,463,654
2040				9,842,000	9,842,000	1,035,372,042	1,143,900	60,566,996	1,097,082,938	1,087,240,938
2041				9,842,000	9,842,000	1,076,739,488	1,143,900	60,566,996	1,138,450,384	1,128,608,384
2042				9,842,000	9,842,000	1,119,760,682	1,143,900	60,566,996	1,181,471,578	1,171,629,578
2043				9,842,000	9,842,000	1,164,501,757	1,143,900	60,566,996	1,226,212,652	1,216,370,652
2044				9,842,000	9,842,000	1,211,031,487	1,143,900	60,566,996	1,272,742,383	1,262,900,383
2045				9,842,000	9,842,000	1,259,421,400	1,143,900	60,566,996	1,321,132,296	1,311,290,296
2046				9,842,000	9,842,000	1,309,745,882	1,143,900	60,566,996	1,371,456,778	1,361,614,778
2047				9,842,000	9,842,000	1,362,082,296	1,143,900	60,566,996	1,423,793,192	1,413,951,192
2048				9,842,000	9,842,000	1,416,511,099	1,143,900	60,566,996	1,478,221,995	1,468,379,995
2049				9,842,000	9,842,000	1,473,115,963	1,143,900	60,566,996	1,534,826,859	1,524,984,859
2050				9,842,000	9,842,000	1,531,983,911	1,143,900	60,566,996	1,593,694,807	1,583,852,807
2051				9,842,000	9,842,000	1,593,205,443	1,143,900	60,566,996	1,654,916,339	1,645,074,339
2052				9,842,000	9,842,000	1,656,874,679	1,143,900	60,566,996	1,718,585,575	1,708,743,575
2053				9,842,000	9,842,000	1,723,089,506	1,143,900	60,566,996	1,784,800,402	1,774,958,402
2054	-834,176,000			9,842,000	-824,334,000	1,791,951,722	1,143,900	60,566,996	1,853,662,618	2,677,996,618

ECONOMIC ANALYSIS PHASE 2 E

PHASE	2E
IRR	26.45%
NPV (12%)	2.628.906.525

CONSTRUCTION OF NEW LINES

YEARS	COSTS US$					BENEFITS US$				CASH FLOWS US$
	With Project				TOTAL COSTS	SAVINGS IN TRANSPORT COSTS	SAVINGS IN ROAD MAINTENANCE	SAVINGS IN ROAD ACCIDENT	TOTAL BENEFITS	
	Investment			Maintenance						
	Infrastructure	Roll-Stock	Environment	Yearly						
2012										
2013										
2014										
2015										
2016										
2017										
2018										
2019										
2020	192,000,000		960,000		192,960,000					-192,960,000
2021	192,000,000		960,000		192,960,000					-192,960,000
2022	192,000,000		960,000		192,960,000					-192,960,000
2023	192,000,000		960,000		192,960,000					-192,960,000
2024	192,000,000	18,836,500	960,000		211,796,500					-211,796,500
2025	192,000,000	28,254,750	960,000		221,214,750					-221,214,750
2026	192,000,000	47,091,250	960,000		240,051,250					-240,051,250
2027				11,100,000	11,100,000	660,505,497	1,172,400	68,308,642	729,986,539	718,886,539
2028				11,100,000	11,100,000	686,887,305	1,172,400	68,308,642	756,368,347	745,268,347
2029				11,100,000	11,100,000	714,323,618	1,172,400	68,308,642	783,804,660	772,704,660
2030				11,100,000	11,100,000	742,856,600	1,172,400	68,308,642	812,337,642	801,237,642
2031				11,100,000	11,100,000	772,530,101	1,172,400	68,308,642	842,011,143	830,911,143
2032				11,100,000	11,100,000	803,389,728	1,172,400	68,308,642	872,870,770	861,770,770
2033				11,100,000	11,100,000	835,482,908	1,172,400	68,308,642	904,963,950	893,863,950
2034				11,100,000	11,100,000	868,858,967	1,172,400	68,308,642	938,340,009	927,240,009
2035				11,100,000	11,100,000	903,569,203	1,172,400	68,308,642	973,050,245	961,950,245
2036				11,100,000	11,100,000	939,666,966	1,172,400	68,308,642	1,009,148,008	998,048,008
2037				11,100,000	11,100,000	977,207,740	1,172,400	68,308,642	1,046,688,782	1,035,588,782
2038				11,100,000	11,100,000	1,016,249,226	1,172,400	68,308,642	1,085,730,268	1,074,630,268
2039				11,100,000	11,100,000	1,056,851,436	1,172,400	68,308,642	1,126,332,478	1,115,232,478
2040				11,100,000	11,100,000	1,099,076,779	1,172,400	68,308,642	1,168,557,821	1,157,457,821
2041				11,100,000	11,100,000	1,142,990,161	1,172,400	68,308,642	1,212,471,203	1,201,371,203
2042				11,100,000	11,100,000	1,188,659,084	1,172,400	68,308,642	1,258,140,126	1,247,040,126
2043				11,100,000	11,100,000	1,236,153,751	1,172,400	68,308,642	1,305,634,793	1,294,534,793
2044				11,100,000	11,100,000	1,285,547,171	1,172,400	68,308,642	1,355,028,213	1,343,928,213
2045				11,100,000	11,100,000	1,336,915,273	1,172,400	68,308,642	1,406,396,315	1,395,296,315
2046				11,100,000	11,100,000	1,390,337,023	1,172,400	68,308,642	1,459,818,065	1,448,718,065
2047				11,100,000	11,100,000	1,445,894,546	1,172,400	68,308,642	1,515,375,588	1,504,275,588
2048				11,100,000	11,100,000	1,503,673,250	1,172,400	68,308,642	1,573,154,292	1,562,054,292
2049				11,100,000	11,100,000	1,563,761,962	1,172,400	68,308,642	1,633,243,004	1,622,143,004
2050				11,100,000	11,100,000	1,626,253,057	1,172,400	68,308,642	1,695,734,099	1,684,634,099
2051				11,100,000	11,100,000	1,691,242,609	1,172,400	68,308,642	1,760,723,651	1,749,623,651
2052				11,100,000	11,100,000	1,758,830,531	1,172,400	68,308,642	1,828,311,573	1,817,211,573
2053				11,100,000	11,100,000	1,829,120,735	1,172,400	68,308,642	1,898,601,777	1,887,501,777
2054				11,100,000	11,100,000	1,902,221,286	1,172,400	68,308,642	1,971,702,328	1,960,602,328
2055				11,100,000	11,100,000	1,978,244,574	1,172,400	68,308,642	2,047,725,616	2,036,625,616
2056	-940,800,000			11,100,000	-929,700,000	2,057,307,482	1,172,400	68,308,642	2,126,788,524	3,056,488,524

ECONOMIC ANALYSIS PHASE 2C

PHASE	2C
IRR	15.37%
NPV (12%)	1.138.049.702

CONSTRUCTION OF NEW LINES

YEARS	COSTS US$					BENEFITS US$				CASH FLOWS US$
	With Project				TOTAL COSTS	SAVINGS IN TRANSPORT COSTS	SAVINGS IN ROAD MAINTENANCE	SAVINGS IN ROAD ACCIDENT	TOTAL BENEFITS	
	Investment			Maintenance						
	Infrastructure	Roll-Stock	Environment	Yearly						
2012										
2013										
2014										
2015										
2016										
2017										
2018										
2019	198,613,333		993,067		199,606,400					-199,606,400
2020	390,613,333		1,953,067		392,566,400					-392,566,400
2021	581,262,222		2,906,311		584,168,533					-584,168,533
2022	581,262,222	18,836,500	2,906,311		603,005,033					-603,005,033
2023	581,262,222	28,254,750	2,906,311		612,423,283					-612,423,283
2024	581,262,222	65,927,750	2,906,311		650,096,283					-650,096,283
2025	572,600,889	28,254,750	2,863,004	9,842,000	613,560,643	593,890,293			593,890,293	-19,670,351
2026	572,600,889	47,091,250	2,863,004	9,842,000	632,397,143	617,605,440			617,605,440	-14,791,703
2027	380,600,889	37,673,000	1,903,004	20,942,000	441,118,893	642,268,384	1,172,400	68,308,642	711,749,426	270,630,533
2028	380,600,889	56,509,500	1,903,004	20,942,000	459,955,393	667,917,021	1,172,400	68,308,642	737,398,062	277,442,669
2029	380,600,889	94,182,500	1,903,004	20,942,000	497,628,393	694,590,760	1,172,400	68,308,642	764,071,802	266,443,409
2030				22,015,000	22,015,000	722,330,591	4,547,550	264,354,444	991,232,585	969,217,585
2031				22,015,000	22,015,000	751,179,139	4,547,550	264,354,444	1,020,081,133	998,066,133
2032				22,015,000	22,015,000	781,180,735	4,547,550	264,354,444	1,050,082,729	1,028,067,729
2033				22,015,000	22,015,000	812,381,483	4,547,550	264,354,444	1,081,283,478	1,059,268,478
2034				22,015,000	22,015,000	844,829,332	4,547,550	264,354,444	1,113,731,327	1,091,716,327
2035				22,015,000	22,015,000	878,574,147	4,547,550	264,354,444	1,147,476,141	1,125,461,141
2036				22,015,000	22,015,000	913,667,787	4,547,550	264,354,444	1,182,569,782	1,160,554,782
2037				22,015,000	22,015,000	950,164,186	4,547,550	264,354,444	1,219,066,181	1,197,051,181
2038				22,015,000	22,015,000	988,119,435	4,547,550	264,354,444	1,257,021,430	1,235,006,430
2039				22,015,000	22,015,000	1,027,591,868	4,547,550	264,354,444	1,296,493,862	1,274,478,862
2040				22,015,000	22,015,000	1,068,642,151	4,547,550	264,354,444	1,337,544,145	1,315,529,145
2041				22,015,000	22,015,000	1,111,333,377	4,547,550	264,354,444	1,380,235,372	1,358,220,372
2042				22,015,000	22,015,000	1,155,731,163	4,547,550	264,354,444	1,424,633,158	1,402,618,158
2043				22,015,000	22,015,000	1,201,903,750	4,547,550	264,354,444	1,470,805,745	1,448,790,745
2044				22,015,000	22,015,000	1,249,922,107	4,547,550	264,354,444	1,518,824,102	1,496,809,102
2045				22,015,000	22,015,000	1,299,860,043	4,547,550	264,354,444	1,568,762,037	1,546,747,037
2046				22,015,000	22,015,000	1,351,794,316	4,547,550	264,354,444	1,620,696,311	1,598,681,311
2047				22,015,000	22,015,000	1,405,804,759	4,547,550	264,354,444	1,674,706,753	1,652,691,753
2048				22,015,000	22,015,000	1,461,974,392	4,547,550	264,354,444	1,730,876,387	1,708,861,387
2049				22,015,000	22,015,000	1,520,389,560	4,547,550	264,354,444	1,789,291,554	1,767,276,554
2050				22,015,000	22,015,000	1,581,140,058	4,547,550	264,354,444	1,850,042,052	1,828,027,052
2051				22,015,000	22,015,000	1,644,319,274	4,547,550	264,354,444	1,913,221,268	1,891,206,268
2052				22,015,000	22,015,000	1,710,024,331	4,547,550	264,354,444	1,978,926,326	1,956,911,326
2053				22,015,000	22,015,000	1,778,356,237	4,547,550	264,354,444	2,047,258,231	2,025,243,231
2054				22,015,000	22,015,000	1,849,420,037	4,547,550	264,354,444	2,118,322,031	2,096,307,031
2055				22,015,000	22,015,000	1,923,324,980	4,547,550	264,354,444	2,192,226,974	2,170,211,974
2056	-3,640,896,000			22,015,000	-3,618,881,000	2,000,184,684	4,547,550	264,354,444	2,269,086,678	5,887,967,678

ECONOMIC ANALYSIS PHASE 3

PHASE	3
IRR	14.48%
NPV (12%)	790.846.686

CONSTRUCTION OF NEW LINES

YEARS	COSTS US$					BENEFITS US$				CASH FLOWS US$
	With Project				TOTAL COSTS	SAVINGS IN TRANSPORT COSTS	SAVINGS IN ROAD MAINTENANCE	SAVINGS IN ROAD ACCIDENT	TOTAL BENEFITS	
	Investment			Maintenance						
	Infrastructure	Roll-Stock	Environment	Yearly						
2012										
2013										
2014										
2015										
2016										
2017										
2018										
2019	198,613,333		993,067		199,606,400					-199,606,400
2020	390,613,333		1,953,067		392,566,400					-392,566,400
2021	581,262,222		2,906,311		584,168,533					-584,168,533
2022	581,262,222	18,836,500	2,906,311		603,005,033					-603,005,033
2023	581,262,222	28,254,750	2,906,311		612,423,283					-612,423,283
2024	581,262,222	65,927,750	2,906,311		650,096,283					-650,096,283
2025	572,600,889	28,254,750	2,863,004	9,842,000	613,560,643	595,724,991			595,724,991	-17,835,653
2026	572,600,889	47,091,250	2,863,004	9,842,000	632,397,143	619,511,470			619,511,470	-12,885,673
2027	380,600,889	37,673,000	1,903,004	20,942,000	441,118,893	644,248,559	1,172,400	68,308,642	713,729,601	272,610,707
2028	380,600,889	56,509,500	1,903,004	20,942,000	459,955,393	669,974,263	1,172,400	68,308,642	739,455,305	279,499,912
2029	380,600,889	94,182,500	1,903,004	20,942,000	497,628,393	696,728,111	1,172,400	68,308,642	766,209,153	268,580,760
2030	365,568,000	0	1,827,840	22,015,000	389,410,840	724,551,211	4,547,550	264,354,444	993,453,205	604,042,365
2031	365,568,000	0	1,827,840	22,015,000	389,410,840	753,486,313	4,547,550	264,354,444	1,022,388,308	632,977,468
2032	365,568,000	0	1,827,840	22,015,000	389,410,840	783,577,882	4,547,550	264,354,444	1,052,479,876	663,069,036
2033	459,648,000	42,794,000	2,298,240	22,015,000	526,755,240	814,872,155	4,547,550	264,354,444	1,083,774,149	557,018,909
2034	459,648,000	64,191,000	2,298,240	22,015,000	548,152,240	847,417,222	4,547,550	264,354,444	1,116,319,216	568,166,976
2035	152,320,000	106,985,000	761,600	22,015,000	282,081,600	881,263,095	4,547,550	264,354,444	1,150,165,090	868,083,490
2036				60,865,000	60,865,000	916,461,788	6,362,550	374,559,053	1,297,383,391	1,236,518,391
2037				60,865,000	60,865,000	953,067,391	6,362,550	374,559,053	1,333,988,994	1,273,123,994
2038				60,865,000	60,865,000	991,136,161	6,362,550	374,559,053	1,372,057,764	1,311,192,764
2039				60,865,000	60,865,000	1,030,726,603	6,362,550	374,559,053	1,411,648,207	1,350,783,207
2040				60,865,000	60,865,000	1,071,899,563	6,362,550	374,559,053	1,452,821,166	1,391,956,166
2041				60,865,000	60,865,000	1,114,718,319	6,362,550	374,559,053	1,495,639,923	1,434,774,923
2042				60,865,000	60,865,000	1,159,248,681	6,362,550	374,559,053	1,540,170,285	1,479,305,285
2043				60,865,000	60,865,000	1,205,559,090	6,362,550	374,559,053	1,586,480,694	1,525,615,694
2044				60,865,000	60,865,000	1,253,720,725	6,362,550	374,559,053	1,634,642,328	1,573,777,328
2045				60,865,000	60,865,000	1,303,807,610	6,362,550	374,559,053	1,684,729,213	1,623,864,213
2046				60,865,000	60,865,000	1,355,896,732	6,362,550	374,559,053	1,736,818,335	1,675,953,335
2047				60,865,000	60,865,000	1,410,068,155	6,362,550	374,559,053	1,790,989,758	1,730,124,758
2048				60,865,000	60,865,000	1,466,405,146	6,362,550	374,559,053	1,847,326,750	1,786,461,750
2049				60,865,000	60,865,000	1,524,994,302	6,362,550	374,559,053	1,905,915,906	1,845,050,906
2050				60,865,000	60,865,000	1,585,925,683	6,362,550	374,559,053	1,966,847,287	1,905,982,287
2051				60,865,000	60,865,000	1,649,292,952	6,362,550	374,559,053	2,030,214,556	1,969,349,556
2052				60,865,000	60,865,000	1,715,193,517	6,362,550	374,559,053	2,096,115,120	2,035,250,120
2053				60,865,000	60,865,000	1,783,728,680	6,362,550	374,559,053	2,164,650,284	2,103,785,284
2054				60,865,000	60,865,000	1,855,003,799	6,362,550	374,559,053	2,235,925,403	2,175,060,403
2055				60,865,000	60,865,000	1,929,128,442	6,362,550	374,559,053	2,310,050,046	2,249,185,046
2056				60,865,000	60,865,000	2,006,216,561	6,362,550	374,559,053	2,387,138,164	2,326,273,164
2057				60,865,000	60,865,000	2,086,386,664	6,362,550	374,559,053	2,467,308,267	2,406,443,267
2058				60,865,000	60,865,000	2,169,762,000	6,362,550	374,559,053	2,550,683,603	2,489,818,603
2059				60,865,000	60,865,000	2,256,470,746	6,362,550	374,559,053	2,637,392,350	2,576,527,350
2060				60,865,000	60,865,000	2,346,646,208	6,362,550	374,559,053	2,727,567,812	2,666,702,812
2061				60,865,000	60,865,000	2,440,427,021	6,362,550	374,559,053	2,821,348,625	2,760,483,625
2062				60,865,000	60,865,000	2,537,957,366	6,362,550	374,559,053	2,918,878,970	2,858,013,970
2063				60,865,000	60,865,000	2,639,387,190	6,362,550	374,559,053	3,020,308,794	2,959,443,794
2064				60,865,000	60,865,000	2,744,872,438	6,362,550	374,559,053	3,125,794,041	3,064,929,041
2065				60,865,000	60,865,000	2,854,575,290	6,362,550	374,559,053	3,235,496,894	3,174,631,894
2066	-5,158,720,000			60,865,000	-5,097,855,000	2,968,664,416	6,362,550	374,559,053	3,349,586,019	8,447,441,019

ECONOMIC ANALYSIS PHASE 4

PHASE	4
IRR	14.01%
NPV (12%)	784.393.547

CONSTRUCTION OF NEW LINES

YEARS	COSTS US$					BENEFITS US$				CASH FLOWS US$
	With Project				TOTAL COSTS	SAVINGS IN TRANSPORT COSTS	SAVINGS IN ROAD MAINTENANCE	SAVINGS IN ROAD ACCIDENT	TOTAL BENEFITS	
	Investment			Maintenance						
	Infrastructure	Roll-Stock	Environment	Yearly						
2012										
2013										
2014										
2015										
2016										
2017										
2018										
2019	198,613,333		993,067		199,606,400					-199,606,400
2020	390,613,333		1,953,067		392,566,400					-392,566,400
2021	581,262,222		2,906,311		584,168,533					-584,168,533
2022	581,262,222	18,836,500	2,906,311		603,005,033					-603,005,033
2023	581,262,222	28,254,750	2,906,311		612,423,283					-612,423,283
2024	581,262,222	65,927,750	2,906,311		650,096,283					-650,096,283
2025	572,600,889	28,254,750	2,863,004	9,842,000	613,560,643	597,501,810			597,501,810	-16,058,834
2026	572,600,889	47,091,250	2,863,004	9,842,000	632,397,143	621,355,193			621,355,193	-11,041,950
2027	380,600,889	37,673,000	1,903,004	20,942,000	441,118,893	646,161,778	1,172,400	68,308,642	715,642,820	274,523,926
2028	380,600,889	56,509,500	1,903,004	20,942,000	459,955,393	671,959,673	1,172,400	68,308,642	741,440,715	281,485,322
2029	380,600,889	94,182,500	1,903,004	20,942,000	497,628,393	698,788,513	1,172,400	68,308,642	768,269,555	270,641,162
2030	365,568,000	0	1,827,840	22,015,000	389,410,840	726,689,516	4,547,550	264,354,444	995,591,510	606,180,670
2031	365,568,000	0	1,827,840	22,015,000	389,410,840	755,705,548	4,547,550	264,354,444	1,024,607,542	635,196,702
2032	365,568,000	0	1,827,840	22,015,000	389,410,840	785,881,190	4,547,550	264,354,444	1,054,783,185	665,372,345
2033	459,648,000	42,794,000	2,298,240	22,015,000	526,755,240	817,262,807	4,547,550	264,354,444	1,086,164,801	559,409,561
2034	649,600,000	64,191,000	3,248,000	22,015,000	739,054,000	849,898,615	4,547,550	264,354,444	1,118,800,610	379,746,610
2035	342,272,000	106,985,000	1,711,360	22,015,000	472,983,360	883,838,762	4,547,550	264,354,444	1,152,740,756	679,757,396
2036	397,152,000	0	1,985,760	60,865,000	460,002,760	919,135,399	6,362,550	374,559,053	1,300,057,002	840,054,242
2037	547,978,667	35,840,000	2,739,893	60,865,000	647,423,560	955,842,762	6,362,550	374,559,053	1,336,764,366	689,340,806
2038	547,978,667	53,760,000	2,739,893	60,865,000	665,343,560	994,017,260	6,362,550	374,559,053	1,374,938,863	709,595,303
2039	358,026,667	89,600,000	1,790,133	60,865,000	510,281,800	1,033,717,553	6,362,550	374,559,053	1,414,639,156	904,357,356
2040				79,291,000	79,291,000	1,075,004,649	8,230,050	487,951,399	1,571,186,098	1,491,895,098
2041				79,291,000	79,291,000	1,117,941,998	8,230,050	487,951,399	1,614,123,447	1,534,832,447
2042				79,291,000	79,291,000	1,162,595,583	8,230,050	487,951,399	1,658,777,033	1,579,486,033
2043				79,291,000	79,291,000	1,209,034,031	8,230,050	487,951,399	1,705,215,480	1,625,924,480
2044				79,291,000	79,291,000	1,257,328,708	8,230,050	487,951,399	1,753,510,157	1,674,219,157
2045				79,291,000	79,291,000	1,307,553,839	8,230,050	487,951,399	1,803,735,288	1,724,444,288
2046				79,291,000	79,291,000	1,359,786,615	8,230,050	487,951,399	1,855,968,064	1,776,677,064
2047				79,291,000	79,291,000	1,414,107,314	8,230,050	487,951,399	1,910,288,764	1,830,997,764
2048				79,291,000	79,291,000	1,470,599,426	8,230,050	487,951,399	1,966,780,876	1,887,489,876
2049				79,291,000	79,291,000	1,529,349,779	8,230,050	487,951,399	2,025,531,228	1,946,240,228
2050				79,291,000	79,291,000	1,590,448,674	8,230,050	487,951,399	2,086,630,123	2,007,339,123
2051				79,291,000	79,291,000	1,653,990,022	8,230,050	487,951,399	2,150,171,471	2,070,880,471
2052				79,291,000	79,291,000	1,720,071,493	8,230,050	487,951,399	2,216,252,942	2,136,961,942
2053				79,291,000	79,291,000	1,788,794,659	8,230,050	487,951,399	2,284,976,108	2,205,685,108
2054				79,291,000	79,291,000	1,860,265,159	8,230,050	487,951,399	2,356,446,608	2,277,155,608
2055				79,291,000	79,291,000	1,934,592,852	8,230,050	487,951,399	2,430,774,301	2,351,483,301
2056				79,291,000	79,291,000	2,011,891,995	8,230,050	487,951,399	2,508,073,444	2,428,782,444
2057				79,291,000	79,291,000	2,092,281,413	8,230,050	487,951,399	2,588,462,862	2,509,171,862
2058				79,291,000	79,291,000	2,175,884,681	8,230,050	487,951,399	2,672,066,131	2,592,775,131
2059				79,291,000	79,291,000	2,262,830,321	8,230,050	487,951,399	2,759,011,770	2,679,720,770
2060				79,291,000	79,291,000	2,353,251,992	8,230,050	487,951,399	2,849,433,441	2,770,142,441
2061				79,291,000	79,291,000	2,447,288,698	8,230,050	487,951,399	2,943,470,147	2,864,179,147
2062				79,291,000	79,291,000	2,545,085,005	8,230,050	487,951,399	3,041,266,455	2,961,975,455
2063				79,291,000	79,291,000	2,646,791,260	8,230,050	487,951,399	3,142,972,709	3,063,681,709
2064				79,291,000	79,291,000	2,752,563,822	8,230,050	487,951,399	3,248,745,271	3,169,454,271
2065				79,291,000	79,291,000	2,862,565,305	8,230,050	487,951,399	3,358,746,754	3,279,455,754
2066				79,291,000	79,291,000	2,976,964,825	8,230,050	487,951,399	3,473,146,275	3,393,855,275
2067				79,291,000	79,291,000	3,095,938,265	8,230,050	487,951,399	3,592,119,714	3,512,828,714
2068				79,291,000	79,291,000	3,219,668,539	8,230,050	487,951,399	3,715,849,988	3,636,558,988
2069				79,291,000	79,291,000	3,348,345,879	8,230,050	487,951,399	3,844,527,328	3,765,236,328
2070	-6,720,448,000			79,291,000	-6,641,157,000	3,482,168,124	8,230,050	487,951,399	3,978,349,574	10,619,506,574

ECONOMIC ANALYSIS PHASE 5

PHASE	5
IRR	13.87%
NPV (12%)	740.315.124

CONSTRUCTION OF NEW LINES

YEARS	COSTS US$					BENEFITS US$				CASH FLOWS US$
	With Project				TOTAL COSTS	SAVINGS IN TRANSPORT COSTS	SAVINGS IN ROAD MAINTENANCE	SAVINGS IN ROAD ACCIDENT	TOTAL BENEFITS	
	Investment			Maintenance						
	Infrastructure	Roll-Stock	Environment	Yearly						
2012										
2013										
2014										
2015										
2016										
2017										
2018										
2019	198,613,333		993,067		199,606,400					-199,606,400
2020	390,613,333		1,953,067		392,566,400					-392,566,400
2021	581,262,222		2,906,311		584,168,533					-584,168,533
2022	581,262,222	18,836,500	2,906,311		603,005,033					-603,005,033
2023	581,262,222	28,254,750	2,906,311		612,423,283					-612,423,283
2024	581,262,222	65,927,750	2,906,311		650,096,283					-650,096,283
2025	572,600,889	28,254,750	2,863,004	9,842,000	613,560,643	617,989,288			617,989,288	4,428,645
2026	572,600,889	47,091,250	2,863,004	9,842,000	632,397,143	642,661,882			642,661,882	10,264,738
2027	380,600,889	37,673,000	1,903,004	20,942,000	441,118,893	668,320,439	1,172,400	68,308,642	737,801,481	296,682,588
2028	380,600,889	56,509,500	1,903,004	20,942,000	459,955,393	695,004,380	1,172,400	68,308,642	764,485,422	304,530,029
2029	380,600,889	94,182,500	1,903,004	20,942,000	497,628,393	722,754,702	1,172,400	68,308,642	792,235,744	294,607,350
2030	365,568,000	0	1,827,840	22,015,000	389,410,840	751,614,039	4,547,550	264,354,444	1,020,516,033	631,105,193
2031	365,568,000	0	1,827,840	22,015,000	389,410,840	781,626,733	4,547,550	264,354,444	1,050,528,727	661,117,887
2032	365,568,000	0	1,827,840	22,015,000	389,410,840	812,838,897	4,547,550	264,354,444	1,081,740,891	692,330,051
2033	459,648,000	42,794,000	2,298,240	22,015,000	526,755,240	845,298,489	4,547,550	264,354,444	1,114,200,484	587,445,244
2034	649,600,000	64,191,000	3,248,000	22,015,000	739,054,000	879,055,386	4,547,550	264,354,444	1,147,957,381	408,903,381
2035	342,272,000	106,985,000	1,711,360	22,015,000	472,983,360	914,161,458	4,547,550	264,354,444	1,183,063,452	710,080,092
2036	397,152,000	0	1,985,760	60,865,000	460,002,760	950,670,650	6,362,550	374,559,053	1,331,592,254	871,589,494
2037	747,786,667	35,840,000	3,738,933	60,865,000	848,230,600	988,639,064	6,362,550	374,559,053	1,369,560,668	521,330,068
2038	747,786,667	53,760,000	3,738,933	60,865,000	866,150,600	1,028,125,047	6,362,550	374,559,053	1,409,046,650	542,896,050
2039	721,354,667	89,600,000	3,606,773	60,865,000	875,426,440	1,069,189,277	6,362,550	374,559,053	1,450,110,881	574,684,441
2040	751,296,000	0	3,756,480	79,291,000	834,343,480	1,111,894,862	8,230,050	487,951,399	1,608,076,311	773,732,831
2041	587,776,000	0	2,938,880	79,291,000	670,005,880	1,156,307,429	8,230,050	487,951,399	1,652,488,879	982,482,999
2042	387,968,000	57,398,000	1,939,840	79,291,000	526,596,840	1,202,495,235	8,230,050	487,951,399	1,698,676,684	1,172,079,844
2043	387,968,000	86,097,000	1,939,840	79,291,000	555,295,840	1,250,529,264	8,230,050	487,951,399	1,746,710,713	1,191,414,873
2044	387,968,000	143,495,000	1,939,840	79,291,000	612,693,840	1,300,483,338	8,230,050	487,951,399	1,796,664,787	1,183,970,947
2045				106,264,000	106,264,000	1,352,434,232	10,963,800	653,941,399	2,017,339,432	1,911,075,432
2046				106,264,000	106,264,000	1,406,461,794	10,963,800	653,941,399	2,071,366,994	1,965,102,994
2047				106,264,000	106,264,000	1,462,649,063	10,963,800	653,941,399	2,127,554,262	2,021,290,262
2048				106,264,000	106,264,000	1,521,082,398	10,963,800	653,941,399	2,185,987,597	2,079,723,597
2049				106,264,000	106,264,000	1,581,851,613	10,963,800	653,941,399	2,246,756,813	2,140,492,813
2050				106,264,000	106,264,000	1,645,050,116	10,963,800	653,941,399	2,309,955,315	2,203,691,315
2051				106,264,000	106,264,000	1,710,775,048	10,963,800	653,941,399	2,375,680,247	2,269,416,247
2052				106,264,000	106,264,000	1,779,127,435	10,963,800	653,941,399	2,444,032,635	2,337,768,635
2053				106,264,000	106,264,000	1,850,212,346	10,963,800	653,941,399	2,515,117,545	2,408,853,545
2054				106,264,000	106,264,000	1,924,139,050	10,963,800	653,941,399	2,589,044,249	2,482,780,249
2055				106,264,000	106,264,000	2,001,021,185	10,963,800	653,941,399	2,665,926,384	2,559,662,384
2056				106,264,000	106,264,000	2,080,976,938	10,963,800	653,941,399	2,745,882,137	2,639,618,137
2057				106,264,000	106,264,000	2,164,129,219	10,963,800	653,941,399	2,829,034,418	2,722,770,418
2058				106,264,000	106,264,000	2,250,605,855	10,963,800	653,941,399	2,915,511,054	2,809,247,054
2059				106,264,000	106,264,000	2,340,539,786	10,963,800	653,941,399	3,005,444,985	2,899,180,985
2060				106,264,000	106,264,000	2,434,069,268	10,963,800	653,941,399	3,098,974,467	2,992,710,467
2061				106,264,000	106,264,000	2,531,338,087	10,963,800	653,941,399	3,196,243,286	3,089,979,286
2062				106,264,000	106,264,000	2,632,495,780	10,963,800	653,941,399	3,297,400,979	3,191,136,979
2063				106,264,000	106,264,000	2,737,697,864	10,963,800	653,941,399	3,402,603,063	3,296,339,063
2064				106,264,000	106,264,000	2,847,106,077	10,963,800	653,941,399	3,512,011,276	3,405,747,276
2065				106,264,000	106,264,000	2,960,888,624	10,963,800	653,941,399	3,625,793,823	3,519,529,823
2066				106,264,000	106,264,000	3,079,220,438	10,963,800	653,941,399	3,744,125,638	3,637,861,638
2067				106,264,000	106,264,000	3,202,283,451	10,963,800	653,941,399	3,867,188,651	3,760,924,651
2068				106,264,000	106,264,000	3,330,266,869	10,963,800	653,941,399	3,995,172,068	3,888,908,068
2069				106,264,000	106,264,000	3,463,367,464	10,963,800	653,941,399	4,128,272,663	4,022,008,663
2070				106,264,000	106,264,000	3,601,789,882	10,963,800	653,941,399	4,266,695,081	4,160,431,081
2071				106,264,000	106,264,000	3,745,746,951	10,963,800	653,941,399	4,410,652,150	4,304,388,150

ECONOMIC ANALYSIS PHASE 5

PHASE	5
IRR	13.87%
NPV (12%)	740.315.124

CONSTRUCTION OF NEW LINES

YEARS	COSTS US$					BENEFITS US$				CASH FLOWS US$
	With Project				TOTAL COSTS	SAVINGS IN TRANSPORT COSTS	SAVINGS IN ROAD MAINTENANCE	SAVINGS IN ROAD ACCIDENT	TOTAL BENEFITS	
	Investment			Maintenance						
	Infrastructure	Roll-Stock	Environment	Yearly						
2072				106,264,000	106,264,000	3,895,460,012	10,963,800	653,941,399	4,560,365,211	4,454,101,211
2073				106,264,000	106,264,000	4,051,159,259	10,963,800	653,941,399	4,716,064,459	4,609,800,459
2074				106,264,000	106,264,000	4,213,084,093	10,963,800	653,941,399	4,877,989,293	4,771,725,293
2075	-9,006,592,000			106,264,000	-8900328000	4,381,483,490	10,963,800	653,941,399	5,046,388,689	13,946,716,689

ECONOMIC ANALYSIS PHASE 6

PHASE	6
IRR	13.71%
NPV (12%)	676.492.456

CONSTRUCTION OF NEW LINES

YEARS	COSTS US$					BENEFITS US$				CASH FLOWS US$
	With Project				TOTAL COSTS	SAVINGS IN TRANSPORT COSTS	SAVINGS IN ROAD MAINTENANCE	SAVINGS IN ROAD ACCIDENT	TOTAL BENEFITS	
	Investment			Maintenance						
	Infrastructure	Roll-Stock	Environment	Yearly						
2012										
2013										
2014										
2015										
2016										
2017										
2018										
2019	198,613,333		993,067		199,606,400					-199,606,400
2020	390,613,333		1,953,067		392,566,400					-392,566,400
2021	581,262,222		2,906,311		584,168,533					-584,168,533
2022	581,262,222	18,836,500	2,906,311		603,005,033					-603,005,033
2023	581,262,222	28,254,750	2,906,311		612,423,283					-612,423,283
2024	581,262,222	65,927,750	2,906,311		650,096,283					-650,096,283
2025	572,600,889	28,254,750	2,863,004	9,842,000	613,560,643	620,390,416			620,390,416	6,829,773
2026	572,600,889	47,091,250	2,863,004	9,842,000	632,397,143	645,156,288			645,156,288	12,759,145
2027	380,600,889	37,673,000	1,903,004	20,942,000	441,118,893	670,911,800	1,172,400	68,308,642	740,392,842	299,273,949
2028	380,600,889	56,509,500	1,903,004	20,942,000	459,955,393	697,696,517	1,172,400	68,308,642	767,177,559	307,222,166
2029	380,600,889	94,182,500	1,903,004	20,942,000	497,628,393	725,551,588	1,172,400	68,308,642	795,032,630	297,404,237
2030	365,568,000	0	1,827,840	22,015,000	389,410,840	754,519,807	4,547,550	264,354,444	1,023,421,801	634,010,961
2031	365,568,000	0	1,827,840	22,015,000	389,410,840	784,645,677	4,547,550	264,354,444	1,053,547,671	664,136,831
2032	365,568,000	0	1,827,840	22,015,000	389,410,840	815,975,483	4,547,550	264,354,444	1,084,877,477	695,466,637
2033	459,648,000	42,794,000	2,298,240	22,015,000	526,755,240	848,557,361	4,547,550	264,354,444	1,117,459,355	590,704,115
2034	649,600,000	64,191,000	3,248,000	22,015,000	739,054,000	882,441,371	4,547,550	264,354,444	1,151,343,366	412,289,366
2035	342,272,000	106,985,000	1,711,360	22,015,000	472,983,360	917,679,577	4,547,550	264,354,444	1,186,581,571	713,598,211
2036	397,152,000	0	1,985,760	60,865,000	460,002,760	954,326,121	6,362,550	374,559,053	1,335,247,725	875,244,965
2037	747,786,667	35,840,000	3,738,933	60,865,000	848,230,600	992,437,314	6,362,550	374,559,053	1,373,358,918	525,128,318
2038	747,786,667	53,760,000	3,738,933	60,865,000	866,150,600	1,032,071,719	6,362,550	374,559,053	1,412,993,322	546,842,722
2039	721,354,667	89,600,000	3,606,773	60,865,000	875,426,440	1,073,290,237	6,362,550	374,559,053	1,454,211,841	578,785,401
2040	751,296,000	0	3,756,480	79,291,000	834,343,480	1,116,156,209	8,230,050	487,951,399	1,612,337,658	777,994,178
2041	804,096,000	0	4,020,480	79,291,000	887,407,480	1,160,735,508	8,230,050	487,951,399	1,656,916,957	769,509,477
2042	604,288,000	57,398,000	3,021,440	79,291,000	743,998,440	1,207,096,639	8,230,050	487,951,399	1,703,278,088	959,279,648
2043	798,421,333	86,097,000	3,992,107	79,291,000	967,801,440	1,255,310,850	8,230,050	487,951,399	1,751,492,299	783,690,859
2044	798,421,333	143,495,000	3,992,107	79,291,000	1,025,199,440	1,305,452,236	8,230,050	487,951,399	1,801,633,685	776,434,245
2045	410,453,333	28,708,000	2,052,267	106,264,000	547,477,600	1,357,597,857	10,963,800	653,941,399	2,022,503,056	1,475,025,456
2046	216,320,000	43,062,000	1,081,600	106,264,000	366,727,600	1,411,827,853	10,963,800	653,941,399	2,076,733,052	1,710,005,452
2047	216,320,000	71,770,000	1,081,600	106,264,000	395,435,600	1,468,225,570	10,963,800	653,941,399	2,133,130,769	1,737,695,169
2048				123,580,000	123,580,000	1,526,877,688	12,718,800	760,502,881	2,300,099,369	2,176,519,369
2049				123,580,000	123,580,000	1,587,874,353	12,718,800	760,502,881	2,361,096,034	2,237,516,034
2050				123,580,000	123,580,000	1,651,309,316	12,718,800	760,502,881	2,424,530,997	2,300,950,997
2051				123,580,000	123,580,000	1,717,280,077	12,718,800	760,502,881	2,490,501,758	2,366,921,758
2052				123,580,000	123,580,000	1,785,888,036	12,718,800	760,502,881	2,559,109,717	2,435,529,717
2053				123,580,000	123,580,000	1,857,238,649	12,718,800	760,502,881	2,630,460,330	2,506,880,330
2054				123,580,000	123,580,000	1,931,441,588	12,718,800	760,502,881	2,704,663,269	2,581,083,269
2055				123,580,000	123,580,000	2,008,610,912	12,718,800	760,502,881	2,781,832,593	2,658,252,593
2056				123,580,000	123,580,000	2,088,865,243	12,718,800	760,502,881	2,862,086,924	2,738,506,924
2057				123,580,000	123,580,000	2,172,327,945	12,718,800	760,502,881	2,945,549,626	2,821,969,626
2058				123,580,000	123,580,000	2,259,127,317	12,718,800	760,502,881	3,032,348,997	2,908,768,997
2059				123,580,000	123,580,000	2,349,396,788	12,718,800	760,502,881	3,122,618,469	2,999,038,469
2060				123,580,000	123,580,000	2,443,275,126	12,718,800	760,502,881	3,216,496,807	3,092,916,807
2061				123,580,000	123,580,000	2,540,906,647	12,718,800	760,502,881	3,314,128,328	3,190,548,328
2062				123,580,000	123,580,000	2,642,441,439	12,718,800	760,502,881	3,415,663,120	3,292,083,120
2063				123,580,000	123,580,000	2,748,035,593	12,718,800	760,502,881	3,521,257,274	3,397,677,274
2064				123,580,000	123,580,000	2,857,851,444	12,718,800	760,502,881	3,631,073,124	3,507,493,124
2065				123,580,000	123,580,000	2,972,057,817	12,718,800	760,502,881	3,745,279,497	3,621,699,497
2066				123,580,000	123,580,000	3,090,830,291	12,718,800	760,502,881	3,864,051,971	3,740,471,971
2067				123,580,000	123,580,000	3,214,351,467	12,718,800	760,502,881	3,987,573,148	3,863,993,148
2068				123,580,000	123,580,000	3,342,811,250	12,718,800	760,502,881	4,116,032,930	3,992,452,930
2069				123,580,000	123,580,000	3,476,407,138	12,718,800	760,502,881	4,249,628,819	4,126,048,819
2070				123,580,000	123,580,000	3,615,344,531	12,718,800	760,502,881	4,388,566,212	4,264,986,212
2071				123,580,000	123,580,000	3,759,837,041	12,718,800	760,502,881	4,533,058,722	4,409,478,722

ECONOMIC ANALYSIS PHASE 6

PHASE	6
IRR	13.71%
NPV (12%)	676.492.456

CONSTRUCTION OF NEW LINES

YEARS	COSTS US$					BENEFITS US$				CASH FLOWS US$
	With Project				TOTAL COSTS	SAVINGS IN TRANSPORT COSTS	SAVINGS IN ROAD MAINTENANCE	SAVINGS IN ROAD ACCIDENT	TOTAL BENEFITS	
	Investment			Maintenance						
	Infrastructure	Roll-Stock	Environment	Yearly						
2072				123,580,000	123,580,000	3,910,106,827	12,718,800	760,502,881	4,683,328,508	4,559,748,508
2073				123,580,000	123,580,000	4,066,384,930	12,718,800	760,502,881	4,839,606,611	4,716,026,611
2074				123,580,000	123,580,000	4,228,911,634	12,718,800	760,502,881	5,002,133,315	4,878,553,315
2075				123,580,000	123,580,000	4,397,936,832	12,718,800	760,502,881	5,171,158,513	5,047,578,513
2076				123,580,000	123,580,000	4,573,720,413	12,718,800	760,502,881	5,346,942,094	5,223,362,094
2077	-10,474,240,000			123,580,000	-10,350,660,000	4,756,532,659	12,718,800	760,502,881	5,529,754,340	15,880,414,340