VCS Project Document

BRT REA VAYA PHASE 1A AND 1B, SOUTH AFRICA

Version 1.1

20/04/2011

Project Title	**Date of Issue**
BRT Rea Vaya Phase 1A and 1B, South Africa	20/04/2011
Version	**Report Prepared By**
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1. Project Details

1.1. Summary Description of Project

The objective of the BRT (Bus Rapid Transit) Rea Vaya in Johannesburg, South Africa is to establish an efficient, safe, rapid, convenient, comfortable and effective modern mass transit system based on a BRT system. The Metropolitan area of the city of Johannesburg has a population of around 3.2 million inhabitants distributed over 1,644 sqkm[1]. The situation before the project is around 1 million vehicles plying the streets of the City of Johannesburg comprising around 800,000 private cars, 40,000 motorcycles, 50,000 taxis and around 50,000 public transit mini-buses and buses[2]. The city has also a rail system operating into the city for suburban trips.

The PD includes Phase 1A and 1B of Rea Vaya with 2 exclusive BRT bus lanes plus their complementary and feeder lines. The first line entered operations August 30th 2009 while the 2nd line is under construction. The geographical boundary of the project is the metropolitan area of the city of Johannesburg. Gases included are CO_2, CH_4 and N_2O.

The pre-project situation as well as changes in detail with the project is described in chapter 1.7. The baseline situation is that passengers would use conventional modes of transport including buses, minibus-taxis, cars, suburban train, motorcycles and Non-Motorized Transport thus causing baseline trip emissions in absence of the project. Project emissions are based on the actual fuel consumption of buses forming part of the project. Leakage emissions are caused by changes of congestion and speed resulting potentially in a rebound and a speed effect plus potential change of load factors of remaining buses and minibus-taxis in the city. Emission reductions are the result of reduced GHG (Greenhouse Gases) emissions per passenger trip comparing the baseline with the project situation.

Average expected emission reductions of the project are 39,829 tCO_2 avoided per annum.

1.2. Sectoral Scope and Project Type

Sectoral scope 7: Transport

Grouped project: No

VCS 2007.1 is used for this PD.

1.3. Project Proponent

Organization:	City of Johannesburg: Transportation Department
Street/P.O.Box:	Johannesburg Roads Agency Building, 66 Sauer Street, Johannesburg
City:	Johannesburg
Postfix/ZIP:	2017

[1] File 10, see http://www.joburg-archive.co.za/2007/pdfs/joburg_overview2.pdf
[2] File 1

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The project proponent "Transportation Department" is responsible for:

- Project investment;
- Project implementation;
- Project operation; and
- VCS Project monitoring.
-

1.4. Other Project Participants

Organization:	City of Johannesburg: Environment and Infrastructure Department
Street/P.O.Box:	118 Jorissen Street, 6th Floor Traduna House
City:	Johannesburg
Postfix/ZIP:	2017
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E-Mail:	LindaP@joburg.org.za
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Represented by:	Linda Phalatse
Title:	Head of Climate Change & Resilience
Last Name:	Phalatse
Middle Name:	
First Name:	Linda
Mobile:	+27 83 544 0998
Direct Tel:	+27 11 587 4251
Personal E-Mail:	Linda.Phalatse410@gmail.com

This project participant is responsible for:

2. Promoting design, coordination and implementation of projects that reduce Greenhouse Gases
3. Overall Environmental Management Policy and Planning

4. Ensure data and information quality control in the crediting period

Organization:	Grütter Consulting AG
Street/P.O.Box:	Thiersteinerstr. 22/5
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Title:	CEO
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Grütter Consulting is responsible for all aspects concerning relation of the project to carbon finance including:

- Methodology formulation (author of the CDM methodology AM0031 used for this project);
- Project document formulation.

Grütter Consulting has no property rights on emission reduction credits.

1.5. Project Start Date and Project Crediting Period

Based on VCS Program Document 2010 the definition of the project start date is the "date on which the project began generating GHG emission reductions or removals".

Project start date: 30/08/2009[3]

First Project crediting period: 01/01/2012 to 31/12/2021

1.6. Estimated GHG Emission Reductions of Removals

Scale: Project according to VCS.

Table 1: Estimated GHG Emission Reductions

Year	Estimation of emission reductions in tCO_{2eq}
2012	42,463

[3] File 11, see: http://www.reavaya.org.za/photo-gallery/historic-day/category/2

2013	41,862
2014	41,267
2015	40,678
2016	40,095
2017	39,517
2018	38,946
2019	38,380
2020	37,819
2021	37,265
Total	**398,292**

1.7. Description of Project Activity

Project Chronology

Step	(expected date)
Project start date	30/08/2009
PD finalization	02/2011
Crediting period start	01/2012
Monitoring reports	Annual; 1st report early 2013
1st crediting period	1/2012 to 12/2021
Project termination	Not limited, minimum 35 years

Organizational Aspects

From an organizational viewpoint the System has regulators, managers and operators:

- The national Department of Transport (DoT) of South Africa[4] is a national public entity, which is in charge of national transportation policies, regulations and plans.
- The Council for Scientific and Industrial Research (CSIR[5]) is a statutory research council, established by Government. The CSIR is part of the Department of Science and Techonology[6] (national public entity). The CSIR performed the environmental baseline study for Department of Environmental Management.

[4] http://www.transport.gov.za
[5] http://www.csir.co.za/
[6] http://www.dst.gov.za

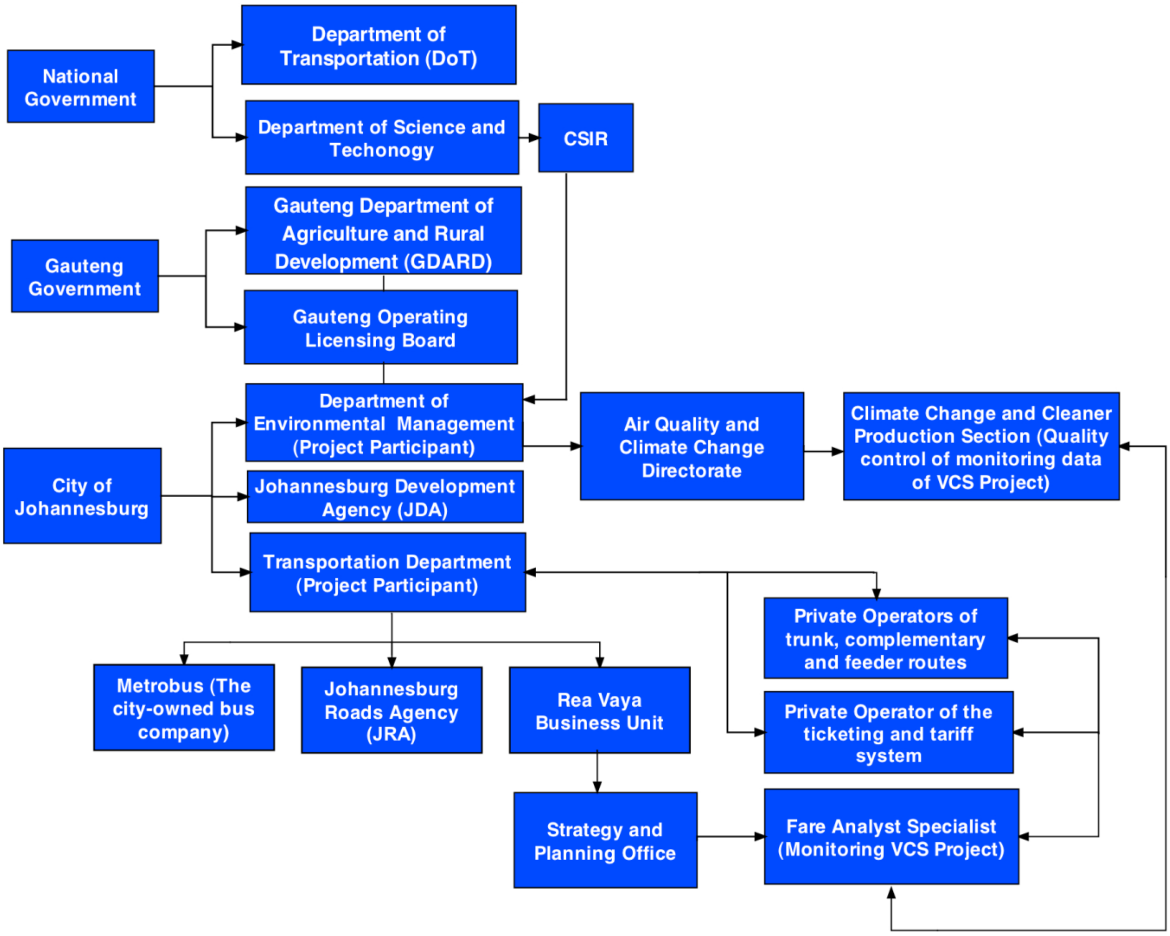
- The provincial Gauteng Operating Licensing Board is responsible for issuing operating licenses required for the operation of public transport services in Johannesburg.
- The Gauteng Department of Agriculture and Rural Development (GDARD)[7] is the environmental authority of the Government of Gauteng, which issues technical concepts and authorizations regarding the mitigation measures of environmental impacts.
- The City of Johannesburg's Department of Environmental Management[8] is a public entity, which is responsible for environmental policy and strategy in the City of Johannesburg. The Department of Environmental Management through its Air Quality and Climate Change directorate promotes the design, coordination and implementation of projects that reduce Greenhouse Gases in the City of Johannesburg.
- The Transportation Department[9] is the regulatory authority for the City of Johannesburg. It is responsible for the development of strategy and programmes and plans to direct and manage the private, business and public transport systems in Johannesburg[10]. The Transportation Department must approve any operating license before it is issued by the Gauteng Operating Licencing Board, and it is responsible for planning transportation services and road infrastructure in the City of Johannesburg.
  The Transportion Department oversees two other City entities: the Johannestburg Roads Agency (JRA) [11] and Metrobus[12]. The JRA is responsible for the design, maintenance, repair and development of Johannesburg's road network and maintains the trunk complementary and feeder route infrastructure, and Metrobus is the City's public transport provider (the city-owned bus company).
- The Johannesburg Development Agency (JDA)[13] is a public entity that promotes productive partnerships and cooperation between all relevant stakeholders of the BRT system. It has been responsible for the construction of the depots, trunk routes and stations of Rea Vaya Phase 1A and 1B.
- Rea Vaya[14] is the system manager and is a business unit within the Transportation Department. The system manager plans, manages and controls the BRT system.
- A private operator[15] (in the future potentially various private operators), which invests in buses and operates the trunk, feeder and complementary routes of Rea Vaya. Operators have a termed contract awarded in a procurement process, which was a negotiated process in Phase 1A, by the Transportation Department.
- A private operator, which acquires, installs and operates the ticketing and tariff system and is responsible for the fare collection and distribution. The operator has a termed contract awarded in an open and competitive bidding process by the Transport Department

[7] http://www.gdard.gpg.gov.za
[8] http://www.joburg.org.za/index.php?option=com_content&task=view&id=968&Itemid=114
[9] http://www.joburg.org.za/content/view/1226/78/
[1010] The Transportation Department designs polices and laws for minibus taxi and conventional buses (Metrobus and PUTCO).
[11] http://www.joburg.org.za/content/view/58/71/
[12] http://www.joburg.org.za/index.php?option=com_content&task=view&id=59&Itemid=71&limit=1
[13] http://www.jda.org.za/what-we-do
[14] http://www.reavaya.org.za/
[15] Note: Phase 1A operations are presently being (until February 2011) by a temporary company (special purpose vehicle) established by the City of Johannesburg. This company, called Clidet 957 (Pty) Ltd, will be taken over by the shareholders from the taxi industry.

The entities that take part in the development and monitoring of the VCS Project are:

1. The Transportation Department through the Strategy and Planning Office (Fare Analyst Specialist) in the Rea Vaya business unit is the focal point of the VCS Project. This directorate will be in charge of managing all data and the monitoring reports in relation to the VCS project.
2. The Department of Environmental Management through the Air Quality and Climate Change is a project paticipant. The Climate Change and Cleaner Production Section of Air Quality and Climate Change directorate is in charge of performing data and information quality control of the VCS project in the crediting period.

Figure 1: Organization Chart of the Project



Features of the System

Features of the BRT Rea Vaya include exclusive right-of-way lanes, rapid boarding and alighting, pre-board fare collection and fare verification for trunk routes, enclosed trunk route stations, clear route maps, real-time information displays, automatic vehicle location technology to manage vehicle movements, effective reform of the existing institutional structures for public transit, clean vehicle technologies and excellence in marketing and customer service. The technology deployed has 4 main components being infrastructure, buses, transit management and fare system.

Infrastructure

The project plans to establish in total 43 km of exclusive separated bus lanes including new bus-stations[16]. Phase 1A and 1B included in the PD has a total distance of trunk routes of 43 km. The system has trunk, complementary and feeder routes:

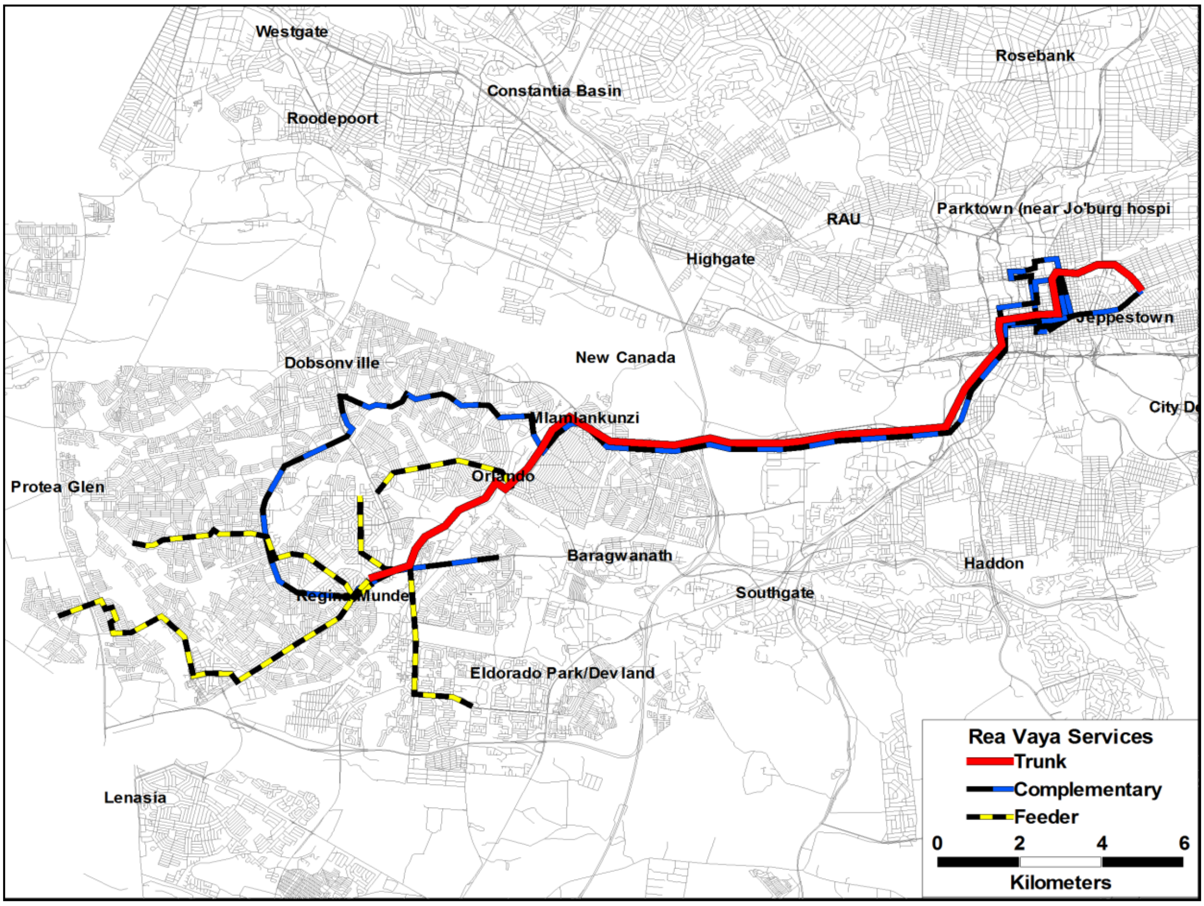
- Rea Vaya Trunk route: Busway located between mixed traffic lanes, purpose-built to carry the weight of high-frequency, fully laden, articulated buses, with stations allowing level boarding built in the bus way for the exclusive use of buses designed to interface with them, typically through right-handed bus doors and a bus floor 940mm from the ground. Routes connect major passenger origins and destinations.
- Rea Vaya Complementary routes: Routes using a combination of normal mixed traffic roads and Rea Vaya trunk route/s, and connecting major passenger origins and destinations, served by buses able to interface with both kerbside Rea Vaya bus stops and median Rea Vaya stations (with left-handed and right-handed doors).
- Rea Vaya Feeder routes: Routes terminating or commencing at a Rea Vaya station, using normal mixed traffic roads, and connecting areas of significant passenger origins to a Rea Vaya trunk or complementary route, either kerbside outside the station, or at the station itself (such buses requiring left-handed and right-handed doors).

The Phase 1A trunk route[17] has a length of 25km[18] and 27 stations. It is complemented by 5 feeder routes totalling 54km to increase the catchment area (See Annex 1). The 4 complementary routes totalling 90km improve the system coverage. Figure 1 shows the Routes of Phase 1A. A list of routes of Phase 1A is included in Annex 1A.

The Phase 1B trunk route[19] has a length of 18km. It is complemented by 12 feeder routes totalling 62km[20] to increase the catchment area and 6 complementary routes totalling 82km[21] to improve the system coverage[22]. Figure 2 shows the Routes of Phase 1A and 1B. A list of routes of Phase IB is included in Annex 1B.

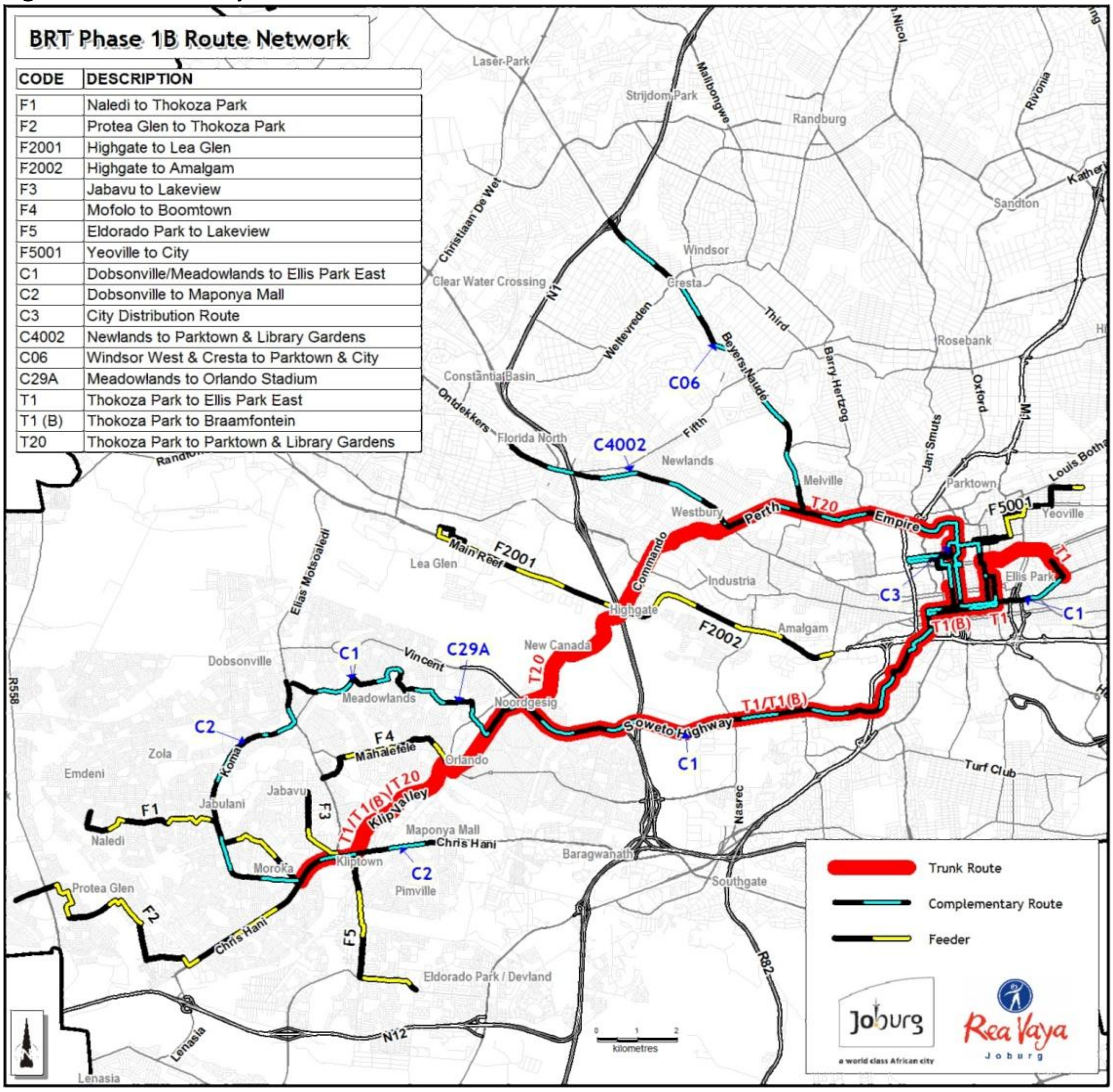
Figure 1: BRT Rea Vaya Phase 1A Routes

[16] File 9, p.3
[17] See File 13; Phase 1A was revised in 2008
[18] One-way, File 13, slide 2
[19] See File 14 p.5; Phase 1B was revised downwards 2010
[20] One-way, File 14, p. 14
[21] One-way, File 14, p. 14
[22] File 14, p. 8/9



Source: File 13, slide 4

Figure 2: BRT Rea Vaya Phase 1A and 1B Routes



Source: File 14, p. 9

Routes of feeder and complementary lines as well as distances might change over time due to city development, experience with operations of lines as well as changing transit demand.

Photo 1: Trunk Route BRT Rea Vaya

In the city centre the stations have a distance between each of 500m[23]. Each station has a modular design to ensure uniformity of the corridor's image with obstacle-free waiting areas and elevated level-access to articulated buses with a high platform. All trunk route stations have access ramps for mobility-impaired passengers.

Photo 2: BRT Rea Vaya Stations

Bus Technology

Technology used is Euro IV diesel units with particle filter for trunk, complementary and feeder buses[24]. According to national standards only Euro III would have been required i.e. the project buses

[23] File 15, slide 24

[24] File 16, see http://www.reavaya.org.za/component/content/article/84-january/81-success

over-achieve the national standards[25]. Trunk buses are new articulated 18m units with a design capacity of 112 persons with platform-level access including room for disabled persons. Feeder and complementary buses have a design capacity of 81 passengers[26]. As projected in total around 81 articulated buses and 197 complementary and feeder buses will be used in the project for Phase 1A and 1B[27]. The number of units can change due to actual passenger demand and experience gained during operations.

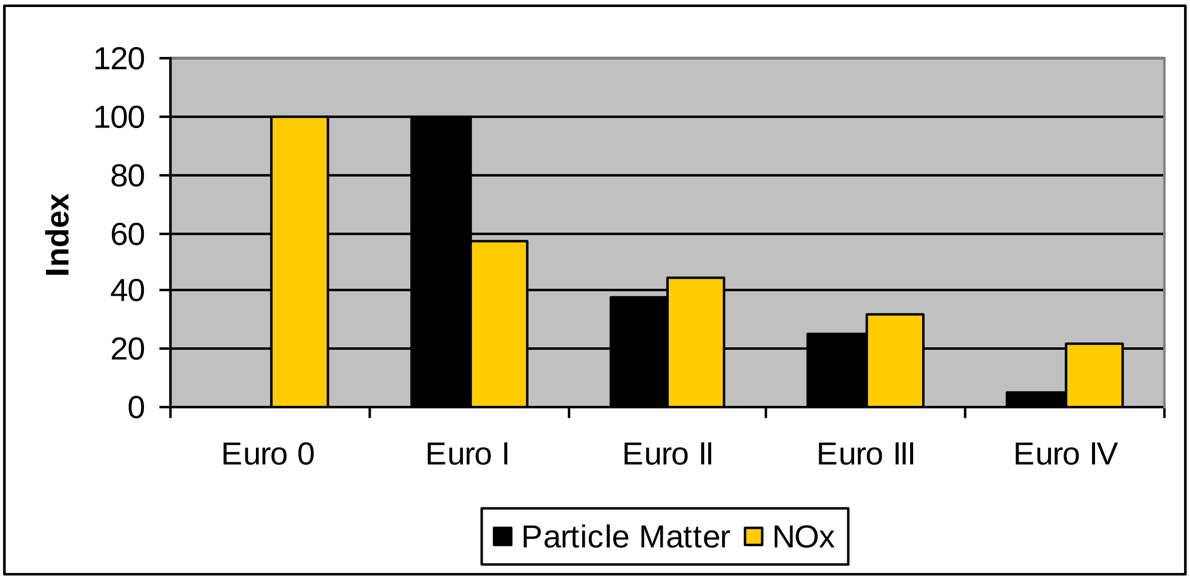
Photo 3: Rea Vaya Trunk and Complimentary/Feeder Bus

Diesel used by the project has 50ppm of sulphur[28]. The Particle Matter (PM) and NO_x emissions of project buses are significantly lower compared to conventional baseline buses operating currently in Johannesburg which have an average model year of 2001 for buses and of 1997 for minibuses meaning that a large number of conventional buses are Euro II, Euro I or elder.[29] Also Euro IV is better than the minimum standard for new diesel buses (Euro III) legally required.

Figure 4 compares the emission of different Euro categories of HDVs (Heavy Duty Vehicles). Project vehicles thereby comply with the standard Euro IV. Particle matter emissions of Euro IV engines are factor 20 lower than Euro I and for NO_x Euro IV emissions are 3 times lower than Euro I units thus demonstrating the highly significant local emission reductions of project versus baseline buses. Particle as well as NO_x (an important pre-cursor of ground-level ozone) emissions are thereby critical components of local air quality.

Figure 4: Emissions of Particle Matter and NO_x (Indexed)[30]

[25] File 16, p.3
[26] File 16, p.3
[27] See File 7 for bus data
[28] File 16, p.3
[29] File 1; Metrobus e.g. runs Euro 0, II and III buses, see File 17
[30] Euro 0 standard had no particulate limits



Source: Regulations 88/77/EWG for Euro 0; 91/542/EWG for Euro I and II; 1999/96/EG for Euro III and IV

The bus manufacturer has offered driver and technical (mechanic) training transformation of skills by providing SETA accredited business principles, management training and executive coaching to enhance the business skills of the Phase 1A Operators to ensure the smooth running of the unit responsible for the maintenance and repairs of the vehicles to achieve maximum up time[31].

Transit Management

The operational fleet centre manages trunk bus dispatch, informs passengers, produces reports and maintains records. Trunk buses are equipped with GPS (Global Positioning System) to identify their position and track distance driven[32]. This is linked to the operation centre.

[31] File 16, p.5
[32] File 24, see http://www.joburg.org.za/content/view/4399/266/

Photo 4: Rea Vaya Operation Centre

The novelty of the operational fleet centre is that an efficient management of bus fleets and bus dispatch can take place optimizing load factors through coordinated scheduling of service. Also passengers have real-time information about the next available bus and are informed of potential transit problems.

Fare System

The system is based on pre-board ticketing. Tickets can be bought at Rea Vaya stations or at selected and clearly marked shops near the stations[33]. This streamlines the boarding process, allows drivers to concentrate on bus operations and plays a key role in optimizing operations. Tickets are separated in inner-city circular routes, trunk routes and feeder + trunk routes[34]. Currently Rea Vaya operates with a paper ticketing system which will be replaced with automatic fare collection gates around April 2011.

[33] Vendor information can be found on the Rea Vaya website see http://www.reavaya.org.za/consumer-information/ticket-information-

[34] see http://www.reavaya.org.za/consumer-information/ticket-information-

Photo 5: Ticketing

Relation to Existing Transport Sector and Fleet Scrapping

The existing public transit routes will be re-organized and units are taken out of service in the metropolitan area of Johannesburg as the new system requires fewer buses and mini-buses for the same level of service through the usage of larger units and through improved occupation rates[35]. The shareholders of the Phase 1A Bus Operating Company were all operating minibus-taxis on the routes affected by Phase 1A. It was agreed in the negotiations between the City of Johannesburg and representatives of affected minibus-taxi operators that 585 minibus-taxis must be withdrawn from the affected BRT Phase 1A routes and that their operating licences allowing them to operate a public transport service must be cancelled. This is covered in the Participation Framework Agreement and confirmed in the Negotiation Closure Agreement[36]. The City agreed to pay compensation for loss of income to the owners removing their vehicles in the interim stages. Several compensation for loss of income agreements were signed between the City and taxi representatives. In South Africa there is a minibus-taxi recapitalisation programme. Taxi owners can submit old minibus-taxis to the government-appointed Taxi Scrapping Agency for scrapping, and they receive a payment of R 54,300. They have to have all the correct documentation and operating licence for the vehicle. By October 2010, a total of 313 minibus-taxi owners had submitted 579 vehicles and operating licences to the City in order to become the final shareholders. The six vehicles allocated to Faraday Taxi Association are excluded as their members did not participate in the negotiations. However, their shares are being reserved for a year, and they may come forward and remove these minibus-taxis from the road. In return for surrendering their vehicles and operating licences, the owners will receive one share per vehicle surrendered in the Phase 1A Bus Operating Company that will operate Phase 1A.

[35] See File 15 slide 18 for the original design of affected, diverted and reduced routes for entire Phase I (original Phase I planning, which was significantly longer than new Phase 1A and 1B)

[36] See File 18 for vehicle scrapping details; File 19 for signed Participation Framework Agreement; File 20 Negotiation Closure Agreement; File 21 Letter Scrapping Agency; File 22 Plenary Resolution Annexure; File 23 taxi scrapping database

The company will be 100%-owned by these former taxi operators. They must each invest R 54,000 equity per share into the company. Phase 1A operations are presently being operated by a temporary company (special purpose vehicle) established by the City of Johannesburg. This company, called Clidet, will be taken over by the shareholders from the taxi industry. Takeover is likely to happen in January 2011, when the 12-year operating contract will commence.

Technology Transfer

The project uses EST (Environmentally Sound Technologies) and best practices in BRT including Euro 4 buses, electronic tracking of buses and pre-board ticketing. The first BRT was established in Curitiba, Brazil in the 70ties. Bogota/Colombia then took a leading role early this Century in world-class BRT systems. The system approach of Bogota was then reproduced in the BRT Rea Vaya[37]. Various international organizations or companies have been involved in the BRT Rea Vaya and in technology transfer from other countries including ITDP (Institute for Transportation & Development Policy; see File 12), GTZ, the Clinton Foundation and Logit (Brazilian company responsible for design of Phases 1A and full Phase 1, see e.g. File 15). Buses for Phase 1A were imported from Brazil[38].

Emission Reduction Measures of Rea Vaya

The BRT Rea Vaya reduces GHG emissions by improving the resource efficiency of transporting passengers in the urban area of Johannesburg i.e. emissions per passenger trip are reduced compared to the situation without project. This is realized through the following changes:

- Improved efficiency: new and larger buses are used which have an improved fuel efficiency per passenger transported compared with those used in the absence of the project[39]. On trunk routes the project uses articulated buses with a design capacity of 112 passengers, which is factor 7 the minibus-taxi capacity of 16 passengers replaced basically[40].
- Mode switching: The BRT system is more attractive to clients due to reduced transport times, increased safety and reliability and more attractive buses. It can thus attract private car and minibus-taxi users with higher emission rates to switch to BRT buses.
- Load increase or change in occupancy: The BRT has a centrally managed organisation dispatching vehicles on trunk routes. The occupancy rate of vehicles can thus be increased due to organisational measures. The baseline public transit system is characterized through a large number of private companies competing for the same passengers resulting in an oversupply of mini-buses and low occupation rates.
- Reduction of the existing fleet of minibus-taxis and buses through public transit re-organization and minibus-taxi scrapping (see former paragraph). This is an integral part of the BRT project.

Sustainable Development Impact

The project contributes to sustainable development in a significant manner:

[37] See e.g. File 12 of the scoping study for the BRT Rea Vaya performed by ITDP.
[38] File 16, p.4
[39] Increased efficiency basically due to usage of larger units with less fuel consumption per passenger plus bus-only lanes which allow for higher average speeds and less stop and go traffic of buses.
[40] File 1 capacity of minibus-taxis; see scrapping and relation to existing transport system for bus type replaced

- Improved environment through less GHG and other air pollutant emissions, specifically particle matter, NO_x and sulphur dioxide. This is achieved through a more efficient transport system and through new buses.
- Improved social wellbeing as a result of less time lost in congestion, less respiratory diseases due to less particle matter pollution, less noise pollution and fewer accidents per passenger transported.
- Fewer accidents due to improved public transit organization and management.
- Socio-economic and environmental benefits due to reduced time for transport[41], less congestion, and improved air quality.

Policies

The national « Transport Legislation, Policies and Strategies" published 2009[42] includes the national strategies on transport.

No policy with a measurable impact on GHG emissions related to the project has been identified.

In terms of NMT Johannesburg has a NMT framework[43]. However this has no incidence on the project.

In terms of alternative fuels South Africa has a national biofuel strategy proposing a 2% biofuel blend[44]. If implemented the project monitors the biofuel blend based on AM0031.

1.8. Project Location

The project is located within the Metropolitan Area of Johannesburg which includes 7 regions[45]. The geographical boundary of the project is the routes from origin to destination used by the people. The project itself includes all feeder, complementary and trunk bus routes of the BRT Rea Vaya Phase 1A and 1B. In the baseline situation people make the same trips but would have used potentially different routes. The geographical location of the project is thus the Metropolitan Area of Johannesburg.

The city of Johannesburg has the geographical coordinates of 26° 12′ S, 28° 2′ E. [46]

1.9. Conditions Prior to Project Initiation

The pre-project scenario is the usage of buses, minibus-taxis, metered taxis, passenger cars, motorcycles, sub-urban train and NMT (Non-Motorized Transit) for transit purposes. All of these transit modes are partially substituted by the project. The baseline situation is that in absence of the project activity these modes of transit would continue to operate being renovated under BAU

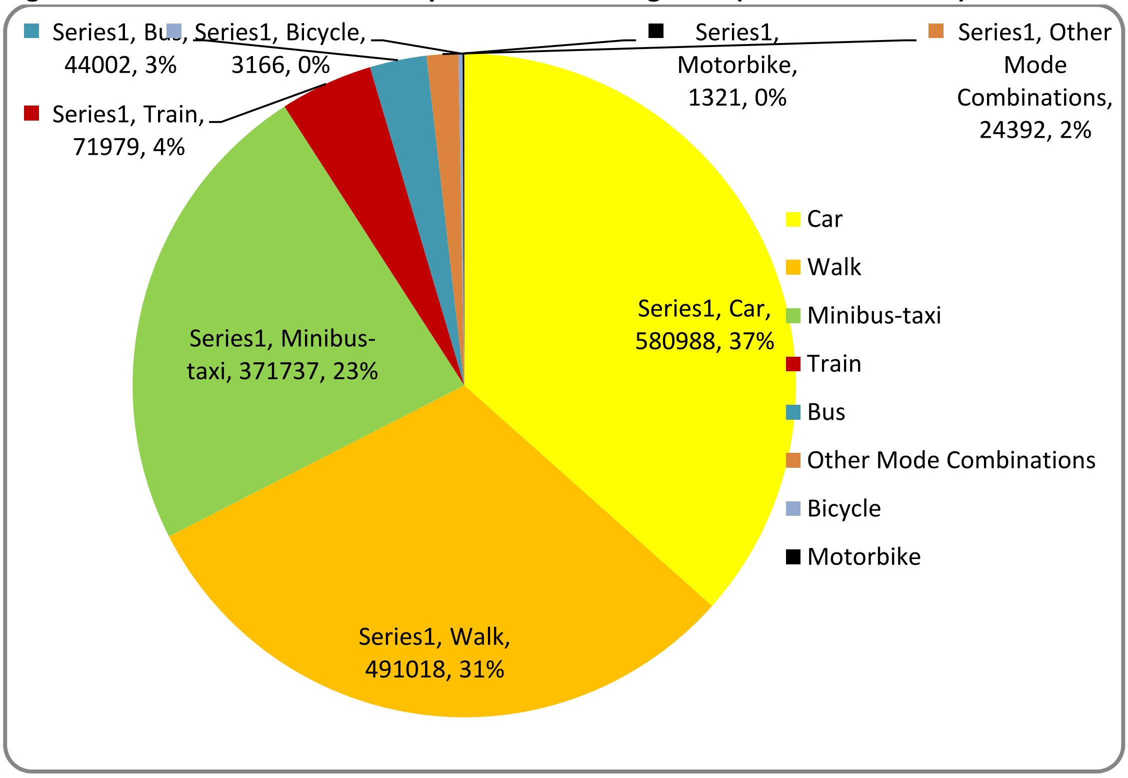
[41] File 25 p. 23
[42] File 39
[43] File 40
[44] File 41, p. 3
[45] File 10, section 4
[46] http://en.wikipedia.org/wiki/Johannesburg

(Business As Usual). This is reflected in the technology improvement factor applied to baseline emission factors per mode of transport.

The share of public transit in trips has been steadily declining. In 1995 the ratio of private to public modes was 40% to 60%, in 1998 43% to 57% and in 2002 53% to 47% i.e. in less than a decade the share of public transit users dropped by 13 percentage points[47]. This trend is not solely the result of increasing car ownership, but also of the relative decline in that segment of trip makers who chose to use public transport (the so called 'selective' segment of the trip making population). Figure 5 shows the mode usage as of 2001 for all modes and figure 6 for motorized modes only. Car, followed by walking and minibus-taxi are the dominant trip modes accounting for over 90% of all trips made. Considering only motorized trip modes the predominant part is by cars with over 50% followed by minibus-taxis with 35%. Other modes play a minor role.

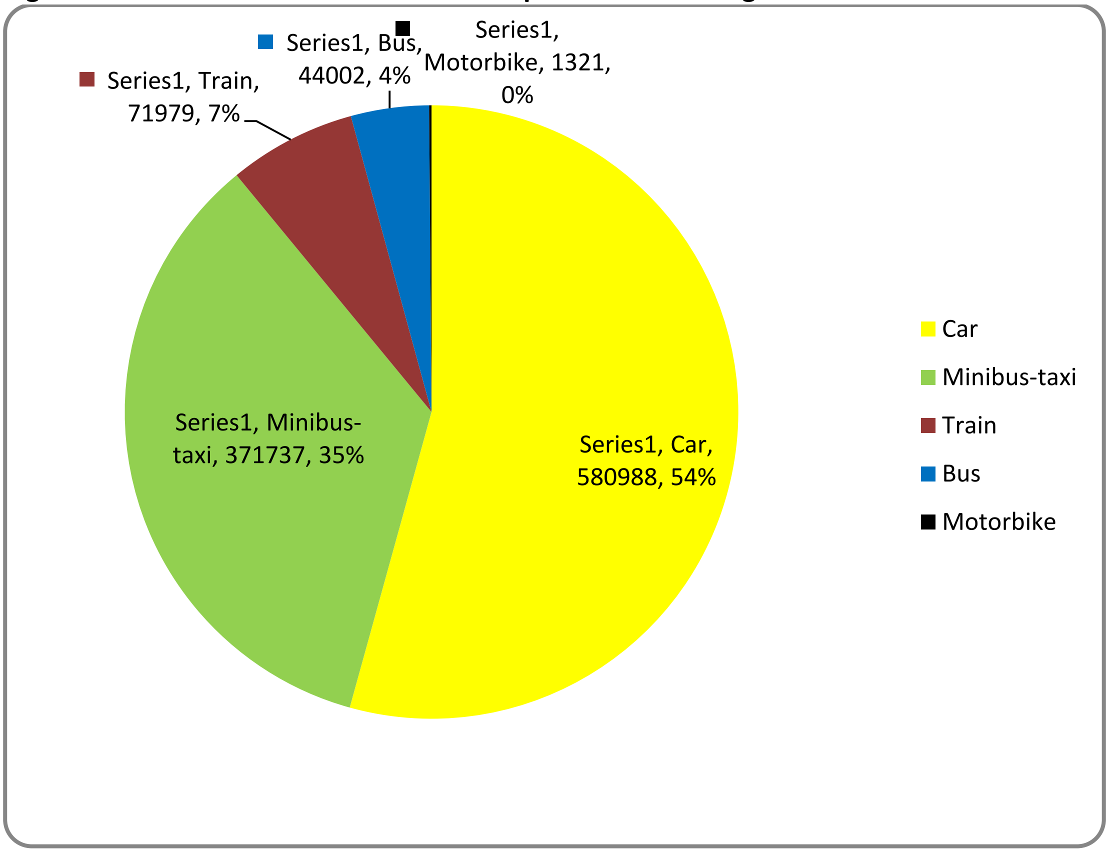
[47] File 6, p. 50

Figure 5: Share of Modes for All Trips in Johannesburg 2001 (Include all Modes)



Source: File 6 Table 3.29, p 53

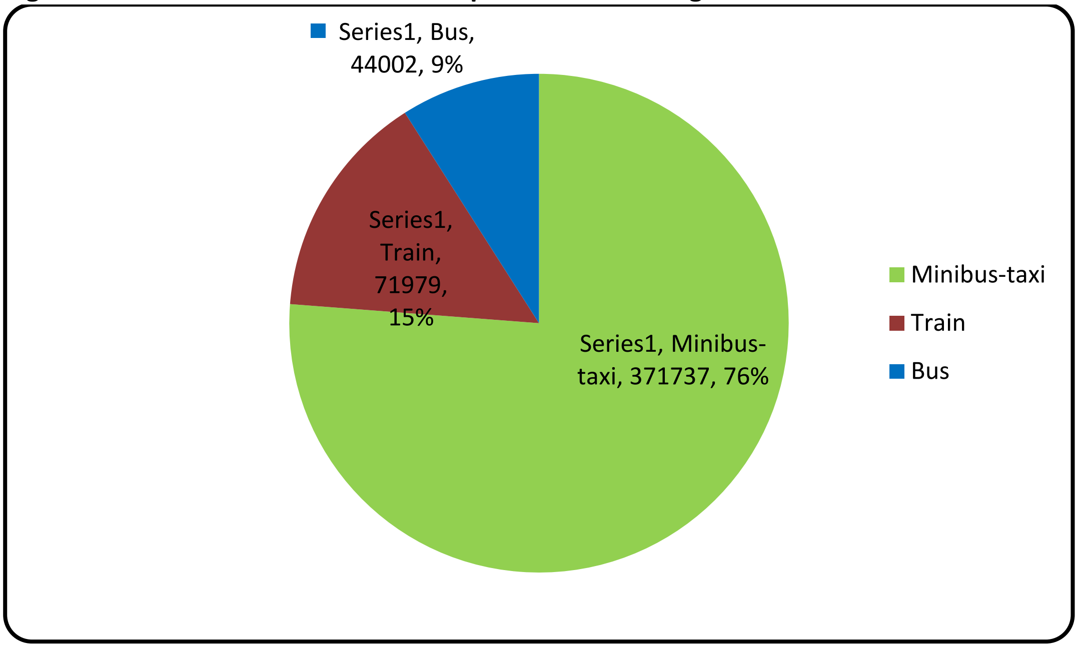
Figure 6: Share of Modes for Motorized Trips in Johannesburg 2001



Source: Based on File 6 Table 3.29, p 53 (author has excluded NMT)

Figure 7 shows the share of public transit modes in total public transit. Clearly minibus-taxis are the predominant mode of public transit in Johannesburg. Photo 6 gives an idea of this type of transport. A clear trend towards minibus-taxis and away from rail and bus can be observed[48].

Figure 7: Share of Public Modes for Trips in Johannesburg 2001



Source: Based on File 6 Table 3.29, p 53 (author has included only public transit means)

Photo 6: Minibus-Taxi

Prior project the baseline bus and minibus-taxi system is composed of:

- Around 5,000 large basically diesel powered buses with an average model year of 2001[49]. The main bus services are provided through services contracted and subsidized by the

[48] File 6, table 3-31, p. 53

province (mainly from Soweto, Eldorado Park, Lenasia and the Deep South), and by the city-owned bus company Metrobus. These services are provided by just over 960 buses. 300 to 500 small operators with 1,500 to 2,000 buses run mainly unscheduled, unsubsidized services for private hires, learner transport and inter-city services[50].

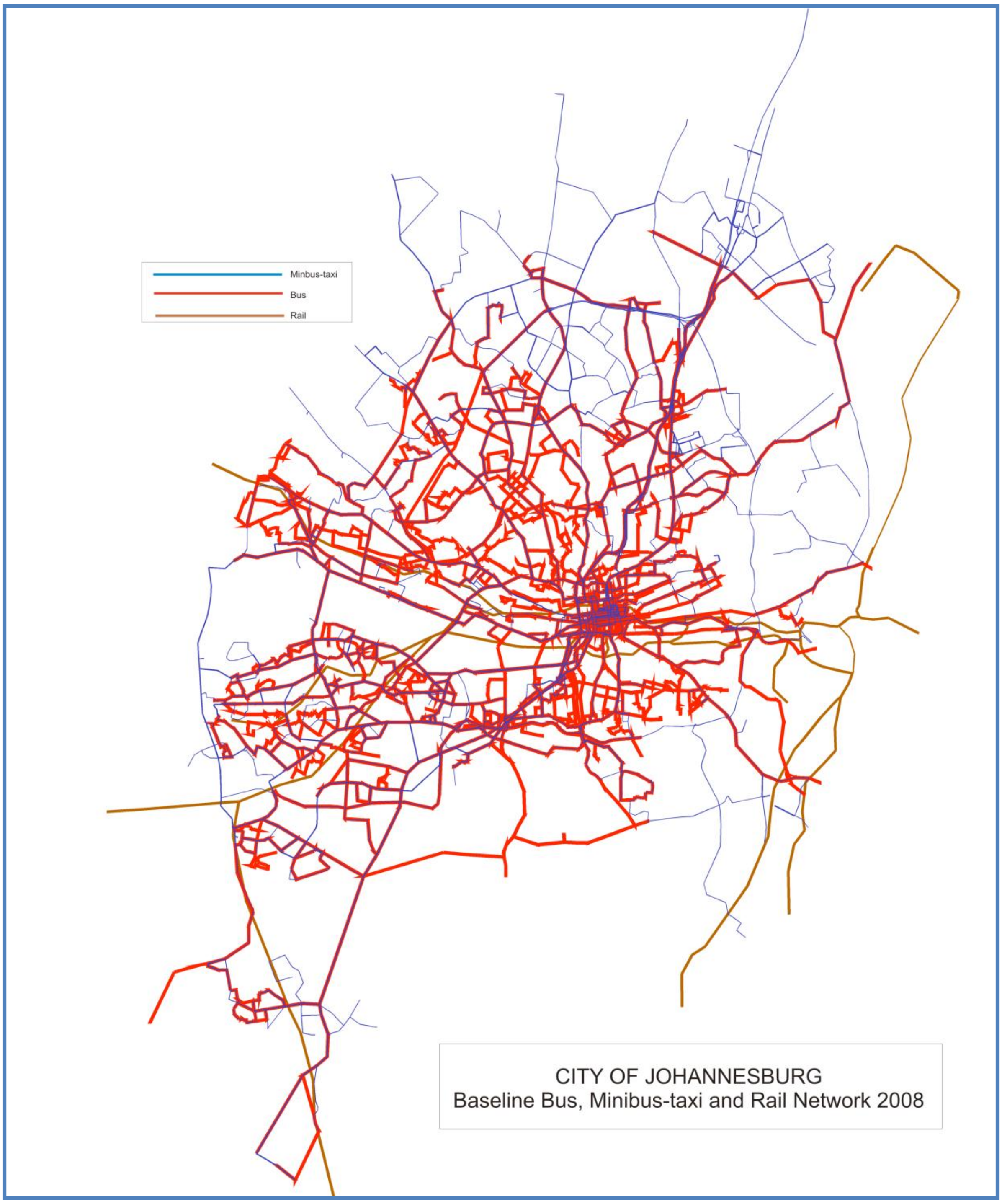
- Around 40,000 basically gasoline powered minibus-taxis (includes inter-city minibus-taxis) with a capacity of 16 persons and an average model year of 1997[51].

The average occupation rate of minibus-taxis is 42% while the occupation rate of buses is only 24%[52] which is an indicator of rather low current efficiency of the system.

Map 5 shows the baseline routes of minibus-taxis, buses and suburban rail.

Map 5: Baseline Public Transit Network of Johannesburg (2008)

[49] File 1; includes also inter-urban and non-public transit buses
[50] File 25, p. 5
[51] File 1, sheet "model year"
[52] File 2, City of Joburg, 2009



1.10. Compliance with Laws, Statues and Other Regulatory Framework

The most important pieces of legislation that governs the transport sector in South Africa are the following[53]:

- Urban Transport Act, 1977 (Act 78 of 1977)

[53] File 6, p 312

- National Road Traffic Act, 1989 (Act 29 of 1989)
- National Road Traffic Act, 1996 (Act 93 of 1996)
- National Land Transport Interim Arrangements Act, 1998 (Act 45 of 1998)
- National Land Transport Act, 2000 (Act 5 of 2009)
- National Land Transport Strategic Framework, 2002-2007
- National Environment Implementation Plan, First Edition (Notice 3410 of 2002; Government Gazette No 24140 of 13 December 2002)

Transport legislation in the Gauteng Province includes the following:

- Gauteng Public Passenger Road Transport Act, 2001 (Act 7 of 2001)
- Gauteng Transport Infrastructure Act, 2001 (Act 8 of 2001)
- Gauteng Transport Framework Revision Act, 2002 (Act 8 of 2002)
- Gauteng Transport Framework Amendment Bill, 2001
- Gauteng White Paper on Transport Policy

The key land use legislation from a national perspective is the following:

- Development Facilitation Act, 1995 (Act 67 of 1995)
- Local Government Municipal Systems Act, 2000 (Act 32 of 2000)
- White Paper on Spatial Planning and Land Use Management, July 2001

Also important are[54]:

- National legislation mandates the inclusion of accessibility issues in the provision and planning of transport.
- The Promotion of Equality and Prevention of Unfair Discrimination Act (2000) goes further by outlawing discrimination on the grounds of disability. This principle echoes the objective for transport articulated by the disability sector itself, as provided for in the White Paper on an Integrated National Disability Strategy (1997): *"To develop an accessible, affordable multi-modal public transport system that will meet the needs of the largest numbers of people at the lowest cost, while at the same time planning for those higher cost features which are essential to disabled people with greater mobility needs."*

The project is part of the Integrated Transport Plan of the City of Johannesburg which has listed and follows all these guidelines and regulations[55].

The BRT Rea Vaya Phase 1A and 1B has also all environmental permits as required[56].

1.11. Participation under Other GHG Programs

The project does not participate under any other GHG Program.

[54] File 6, p. 288
[55] File 25
[56] File 26 composed of 26a to 26i

1.12. Other Forms of Environmental Credit

The project does not receive any other form of environmental credit.

1.13. Additional Information Relevant to the Project

Eligibility Criteria

The project is not a grouped project and therefore this part is not relevant to the project.

Leakage Management

Leakage is considered in the methodology used.

Commercially Sensitive Information

No commercially sensitive information has been used.

Further Information

No further information is included.

2. Application of Methodology

2.6. Title and Reference of Methodology

CDM Methodology

AM0031, Version 03.1.0, Baseline Methodology for Bus Rapid Transit Projects

2.7. Applicability of Methodology

The methodology is applicable to project activities that reduce emissions through the construction and operation of a Bus Rapid Transit (BRT) system for urban road based transport. Table 2 relates the specific baseline as well as monitoring applicability conditions of the methodology with the proposed project.

Table 2: Applicability Conditions

Applicability condition	Project situation
The project has a clear plan how to reduce existing public transport capacities either through scrapping, permit restrictions, economic instruments or other means and replacing them by a BRT system.	The BRT Rea Vaya Phase 1A and 1B system includes trunk, complementary and feeder lines and replaces partially the current transport system with a modern and efficient new system. The project has eliminated baseline units through withdrawal of public transport operating licenses and scrapping or sale of the vehicles to which they

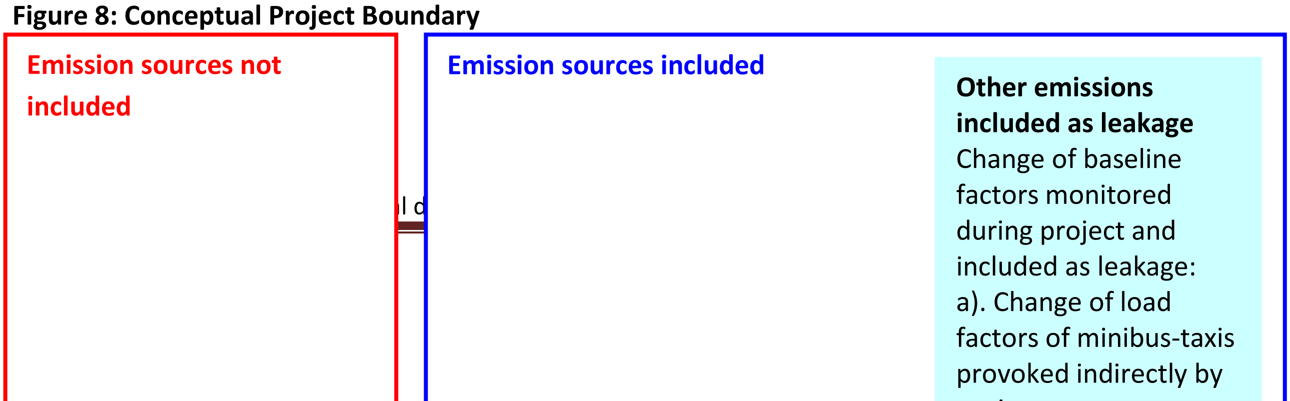
	certain[57].
Local regulations do not constrain the establishment or expansion of a BRT system.	No regulations constraining the establishment of BRTs exist. The BRT Rea Vaya Phase 1A and 1B forms part of the public transport policy[58].
Any fuels including (liquefied) gaseous fuels or bio-fuel blends, as well as electricity, can be used in the baseline or project case.	Baseline vehicles use gasoline and diesel and for the rail system electricity. Project units use diesel only.
The project activity BRT system is road-based. The baseline public transport system and other public transport options are road- or rail-based (the methodology excludes air and water based systems from analysis). However the methodology is not applicable if the project activity BRT system replaces an urban rail-based Mass Rapid Transit System (MRTS), i.e. if the MRTS stops operating after project implementation due to the project activity.	The BRT Rea Vaya Phase 1A and 1B system is road based. The baseline public transit system is road and rail based (suburban rail). The suburban rail is not affected by the BRT Rea Vaya Phase 1A and 1B and continues operations and is not replaced by the project.
The BRT system partially or fully replaces a traditional public transport system in a given city. The methodology cannot be used for BRT systems in areas where currently no public transport is available.	The BRT Rea Vaya Phase 1A and 1B replaces partially the existing public transport system. Public transport is available in Johannesburg in areas of operation/influence of the BRT Rea Vaya Phase 1A and 1B [59].
The methodology is applicable if the analysis of possible baseline scenario alternatives leads to the result that a continuation of the current public transport system is the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases (GHG) that would occur in the absence of the proposed project activity (i.e. the baseline scenario)	Section 2.4. of the PDD identifies the baseline as a continuation of the current public transport system.

2.8. GHG Sources, Sinks and Reservoirs

The spatial project boundary is the metropolitan area of Johannesburg. It is based on the origins and destinations of passengers using the project system and is based on the outreach of the project system including BRT trunk, complementary and feeder routes.

The conceptual project boundary is given in Figure 8.

Figure 8: Conceptual Project Boundary



Emissions caused by the remaining transport system which continues to circulate in the project area (taxis, cars, conventional public transport)

Emissions caused by freight, ship, rail and air transport

Direct project and baseline emissions
Emissions caused by passengers transported by the BRT project (trunk, complementary and feeder units)

Downstream emissions included as leakage
Congestion change provoked by project resulting in (inter alia):
- Increased vehicle speed
- Rebound effect

Table 3: Emissions Sources Included in the Project Boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	Mobile source emissions of different modes of transport passengers transported by the project would have used in absence of the project BRT	CO_2	Yes	Main source
		CH_4	Yes	
		N_2O	Yes	
Project activity	BRT bus emissions of trunk, complementary and feeder route services	CO_2	Yes	Main source
		CH_4	Yes	
		N_2O	Yes	
Leakage	Change of occupation rates of baseline buses and minibus-taxis as well as congestion related leakage	CO_2	Yes	Main source
		CH_4	Yes	
		N_2O	Yes	

Trunk as well as complementary and feeder route locations, distances and routings might still change as the current information is based on planning data and projections. Annex 1A and 1B includes the list of all routes.

2.9. Baseline

Steps followed to identify the baseline are:

Step 1: Identify all alternatives

Step 2: Analyze options using the latest version of the CDM "Tool for the demonstration and assessment of additionality"

Step 3: If step 2 results in more than one possible scenario, the baseline scenario is the one with the lowest emissions.

Step 1: Identification of Options

Basically the city has the option to choose between transport alternatives that favour more the usage of private cars and options that favour more public transport. The trend in mode share towards private and away from public transit in Johannesburg shows clearly that private transport means have been favoured in the past (see chapter 1.9). Concerning public transit following basic options for Johannesburg exist:

1. Implementation of a rail-based mass transit system such as metro or Light Rail Transit (LRT);
2. Continuation of the current road-based transit system;
3. Public transit sector re-organization;
4. Implementing the project without carbon finance.

The alternatives of rail-based MRTS (Mass Rapid Transit Systems) have also been considered in the scoping study for BRT realized by ITDP November 2006[60].

Step 2: Assessment of Options

ALTERNATIVE 1: RAIL- BASED MASS TRANSIT SYSTEM

Three types of rail-based mass rapid transit (MRT) systems are in general considered[61]:

- Light Rail Transit (LRT) which also includes trams operating as single rail car or as short train of cars typically on exclusive right-of-way lanes at surface levels. LRTs can also be elevated. LRTs have carrying capacities comparable to BRTs with less than 30,000 phd (passenger per hour per direction per line) and trams have capacities in the order of 15,000 phd.
- Metros which can function underground, elevated or on surface level. The core difference to LRTs is the larger capacity of passenger transport. Metros have capacities in the range of 50,000 to 80,000 phd per line[62].
- Sub-urban or inter-urban rail with some stations in the city. The main difference to LRTs is that carriages are heavier, distances travelled are longer and transport is between cities or between the city and its sub-urban areas.

The core difference between metro and BRT is the investment cost and the carrying capacity passengers per hour per line. For the area of operation of the BRT no passenger transit demand as required by metros is available. Table 4 shows differences between BRTs/Bus Lane systems, LRTs and metros and table 5 gives examples of the carrying capacity of various MRTS worldwide.

Table 4: Comparison BRTs, LRTs and Metros

Characteristic	BRT / Bus lane	LRT / Tram /Monorail	Metro
Passenger carrying capacity (phd)[63]	15-35,000	10-25,000	50-80,000
Average operating speed (km/h)	15-25	15-25	30-40
Space requirement	2-4 lanes taken away from existing road space	2-4 lanes taken away from existing road space	Separate from roadway corridors

[60] File 12
[61] Adapted from File 28: GTZ training course “Mass Transit”, 2004, box 2, page 13
[62] See Table 5
[63] See examples following table

Source: IEA, Bus Systems for the Future, 2002, Table 2.1.

Table 5: Passenger Carrying Capacity of Metros/LRTs vs. Planned BRT Lines Johannesburg (phd per line[64])

System/City	phd (passenger per hour per direction) capacity
Metro Mumbai 1[65]	81,000
Metro Sao Paulo	60,000
Metro Bangkok	50,000
LRT Kuala Lumpur	30,000
LRT Tunis	12,000
BRT Bogota	33,000
BRT Quito	15,000
BRT Curitiba	15,000
BRT Rea Vaya Phase 1A	8,000
BRT Rea Vaya Phase 1B	13,000

Source: GTZ/ITDP sustainable transport sourcebook 3A, Mass Transit Options, 2005, Table 10 (File 29); for LRT Tunis table 1, p.5; BRT Rea Vaya File 7 sheet "DATE_KM_ PHD"

The expected ridership of the BRT Rea Vaya lines is around 8,000-13,000 phd or far less than the phd of metros or LRTs. Based on the expected passenger demand metro or LRT is thus not a viable alternative for Johannesburg as the very high investment for rail systems will not be viable with the expected passenger numbers. The required investment of LRT, metro and BRT options have a significant difference[66]:

- LRT at level with costs between 13-38 million USD per kilometre;
- Elevated LRT or monorail with costs between 50-102 million USD per kilometre;
- Metro with costs between 41-350 million USD per kilometre;
- BRT Rea Vaya as originally estimated around 3 million USD per kilometre[67].

Metros and LRTs are clearly far more expensive than BRTs. As the passenger demand in Johannesburg is sufficient to be covered through a BRT (see former table) it makes no sense to invest significant additional resources in a metro or LRT. This was also confirmed by the scoping study for the BTR Rea Vaya realized by ITDP[68]. It is also reflected in the public transport action plan formulated by the Department of Transport which focuses on BRT[69].

Summarized a metro or LRT is due to the expected passenger demand and the high investment cost of LRTs/metros not a feasible option for Johannesburg.

ALTERNATIVE 2: CONTINUATION OF THE CURRENT SYSTEM

[64] The carrying capacity of each line is independent of other lines and thus carrying capacities of lines cannot be summed. The logic of a carrying capacity is to see which system along a certain stretch is required i.e. "x" passengers demand transit services between A and B. The question is thereafter which transport system i.e. metro, LRT, BRT, simple bus service etc matches best the passenger flow demand along that corridor.
[65] See PDD published on UNFCCC website
[66] See L. Wright, GTZ, Training Course: Mass Transit, 2004, page 16, table 6 (File 28) for LRT, and metros.
[67] File 12, p. 90 (21.6 million Rand at 11.2006 exchange rate of 0.133 USD /Rand)
[68] File 12, p.13
[69] File 27

A continuation of the current transport system complies with all applicable legal and regulatory requirements. A continuation of the current system has various advantages compared to all other options:

- No large-scale public investment requiring additional subsidies;
- Lowest risk of all options.

The continuation of the current situation is thus clearly a realistic and attractive alternative. The carrying capacity of the current public transport system is in line with the actual transport demand. The current occupation rate of only 24% of buses and 42% of minibus-taxis[70] is a clear reference that the current system can fulfil the passenger demand. Increasing passenger demand can be accommodated through improved occupation rates or by establishing new routes using also alternate roads. Also bus operators can add new routes and new units as the current system is profitable for them. This is what has occurred in the last few decades in the city i.e. growing passenger demand has been accommodated without major problems especially by increasing minibus-taxi service. The existing transport system relies not on single or fixed routes like a BRT but on a multitude of possible routes and modes of transport using the existing road infrastructure and modes of transit. It is thus highly flexible and can accommodate passenger flows in excess of any single-route based BRT.

ALTERNATIVE 3: PUBLIC TRANSIT RE-ORGANIZATION

This scenario implies a completely integrated, centrally managed and re-structured transport system which is a comprehensive and complete change of the current public transport system. No new infrastructure or hard-ware is required in this case. Currently the transport system has numerous companies especially in the minibus-taxi sector with many individual bus owners competing between each other for passengers. The proposed re-organization would include a centrally managed control of all units, dispatching them upon demand, a management and integration of tariffs, a re-definition of routes and significant structural changes from current operations relying on independent small bus-owners to transit operators embedded in a centrally controlled operation centre of fleet.

The barrier to implementing such a system is clearly of organizational and management nature with the considerable risk of non-functioning and the resistance to change of the existing transport sector. To manage such a change the entity in charge of transport management needs to be very strong and the involved parties i.e. the existing transport companies, need to agree upon the change. The political difficulties with the existing minibus-taxi sector which dominates public transit is also clearly outlined in the scoping study performed by ITDP[71]. Also simple organizational measures, while politically difficult to implement, will not resolve major problems of the public transit sector as identified in the Public Transport Action Plan page 5ff[72], and are thus not a more attractive alternative than to simply continue with the system as currently operating.

ALTERNATIVE 4: THE PROJECT WITHOUT CDM

[70] File 2
[71] File 12, p. 100
[72] File 27

Alternative 4 is detailed in Chapter 2.5 which makes an assessment of this option and shows why the project without CDM is not feasible.

Step 3: If Step 2 results in more than one possible alternative baseline scenario, the most likely baseline scenario is the scenario with the lowest baseline emissions

Step 2 only results in one possible baseline alternative i.e. a continuation of the current public transit system.

2.10. Demonstration and Assessment of Additionality

The additionality of the project is determined using the CDM “Tool for the demonstration and assessment of additionality (version 05.2, EB 39 Annex 10)”.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a. Define alternatives to the project activity

Chapter 2.4 step 1 identified the four available options. Step 2 of the same chapter assessed the feasibility of the 4 options and excluded option 1 and option 3. The remaining options are thus the project in absence of carbon finance or a continuation of the current transit system.

Sub-step 1b. Consistency with mandatory laws and regulations:

All alternatives identified are consistent with mandatory laws and regulations. No special law or requirements exist for BRTs. The most relevant laws have been listed in chapter 1.10.

Step 2. Investment analysis

The project proposal is public financed concerning infrastructure. The infrastructure is fully public financed. The user is currently paying only 40% of the bus operating costs. Financing of the capital costs as well as operational subsidies has been to date through[73]:

- National government has financed through the Public Transport Infrastructure and Systems Grant R 2,627 million towards capital investment and R 180 million towards operational expenditures (transitional and transformation costs).
- The City of Johannesburg has contributed R 277 million towards capital expenditure and R 59 million towards operational expenditure.
- External donors have funded R 37 million towards expenditures being basically marketing and communication, legal fees, taxi industry support and project management.

The system is thus not repaid by the system users through tariffs charged. In accordance with the methodology as the project is at least partially public financed concerning investment no investment analysis is made and the barrier analysis is applied. As no investment analysis is applied no cost-benefit analysis is applied.

Step 3. Barrier analysis

Sub-step 3a. Identify barriers that would prevent the implementation of the proposed CDM project activity

Three important barriers exist for the implementation of the BRT Rea Vaya:

- Resistance of minibus-taxi operators;
- Risk of operational deficits of the system;
- Prevailing practice barrier.

RESISTANCE OF MINIBUS-TAXI OPERATORS

The resistance of current operators was identified from the very start as a risk for the BRT system (see scoping study, 2006, p. 100)[74].

The policy approach in Rea Vaya is to offer the affected public transport operators 100% shareholding in the Bus Operating Company that runs the new services. In the case of Phase 1A the routes run by members of ten minibus-taxi associations were affected. All were invited to negotiate withdrawal of competing services and the formation of a bus operating company that would be given the bus operating contract. The leaders of the two umbrella taxi associations, Greater Johannesburg Regional Taxi Council and Top Six Taxi Management, participated in the process, along with several hundred taxi owners from nine of the ten associations. However, many owners and leaders and taxi association executive committees decided to oppose it. The latter formed an organisation in December 2008 to oppose Rea Vaya BRT called United Taxi Association Forum (UTAF). The door to their participation was kept open throughout negotiations, but they remained opposed. They

[73] File 30
[74] File 12

organised various major “strikes” by the majority of taxi owners and drivers in Johannesburg, and as taxis provide 72% of public transport, these strikes caused widespread disruption in the City. Strikes took place on:

- March 24th 2009 (during this stayaway, thousands of taxi owners marched on the Johannesburg City centre, and presented a petition opposing BRT to the secretary-general of the ruling party, the African National Congress).
- September 1st 2009 (the second day of Rea Vaya starter service operations).
- March 12th 2010 and March 15-17 2010 (when Rea Vaya feeder services were launched).

On April 20th 2009, two days before national elections were held, the national taxi umbrella body called SANTACO invited the then ANC president Jacob Zuma to a national meeting where he agreed that ‘we should hold our horses’ on BRT until such time as a new administration comes into place. They had threatened to strike against the BRT and disrupt the elections otherwise.

This caused a hold to be placed on various Rea Vaya preparations for the planned launch in May 2009. In May 2009 the national Minister of Transport advised the Executive Mayor of Johannesburg that Rea Vaya should not start operations during the FIFA Confederations Cup in June 2009 as planned, because it was too risky from a security point of view.

Repeated invitations to the opposing taxi associations to participate in Rea Vaya negotiations were rejected, and negotiations were eventually held in the year-long period between August 5th 2009 and September 28th 2010 and successfully concluded with the representatives of several hundred affected minibus-taxi owners who did want to participate.

UTAF also brought an urgent application on August 28th 2009 for a High Court interdict to stop Rea Vaya from launching on August 30th 2009. This was successfully opposed by the City of Johannesburg.

There have been several violent incidents against Rea Vaya BRT. These have been clustered around the launch, the first service expansion in March 2010, and the second service expansion in May 2010. The incidents are listed below. These have been potential barriers in the sense that they could have deterred further rollout of the services, which have been introduced in phases. They have also tried to deter affected taxi operators from continuing to take part in the negotiations around the formation of the bus operating company. They have also had the potential effect of damaging the image of Rea Vaya in the eyes of passengers.

The main incidents are listed below.

- On 2 September 2009, the third day of Phase 1A starter service operations, two Rea Vaya buses came under fire in Soweto and two people were shot and injured.
- Taxi industry participants in the negotiations have been regularly intimidated. Those from two of the most heavily impacted associations have been subjected to victimisation and harassment in the form of disciplinary action, and many have been unable to operate their taxis.
- One pro-BRT member of the heavily-affected association WATA was shot dead in December 2009. His fiancé and his brother were also shot and killed in November and December 2009 respectively, and it was possible that these hits were related to his support for the Rea Vaya BRT.

- Two leaders involved in the Phase 1A negotiating team were shot at but not injured in December 2009.
- On March 15th 2010, various feeders and a complementary route were introduced for the first time. There were several violent incidents in this period, during which there was a taxi strike. For example:
    - On March 12th 2010 a Rea Vaya bus carrying a few Rea Vaya drivers was shot at in a drive-by shooting in Soweto leaving 13 bullet holes in the bus.
    - On March 14th 2010 during the same stayaway, there was a case of attempted arson at the Rea Vaya Nancefield depot.
    - On March 15th, railway tracks were blockaded with rocks, trains were stoned en route, and rail passengers were prevented from walking to Rea Vaya stations; several bus stop poles on feeder routes were pushed down; two Rea Vaya buses were stoned injuring a passenger and one bus was petrol-bombed.
    - On March 16th another bus was stoned, and on March 17th the home of a Rea Vaya bus driver was petrol-bombed and burnt down.
    - On March 29th, two buses were shot at while approaching the depot at Eldorado Park.
    - On April 19th, sharp spikes were placed on BRT route. Tyres from three buses and a security response vehicle were damaged.

- Just prior to the May 3rd 2010 further roll-out of Phase 1A services, there were further attacks including on the night of Friday April 30th shots were fired at a Rea Vaya BRT trunk bus in Orlando, injuring four passengers, one of whom, Phulani Mayisela, died on admission to Chris Hani Baragwanath Hospital. Half an hour later shots fired at a Rea Vaya BRT Naledi feeder bus resulted in four others being injured, including the driver.

The displaced taxi drivers have been offered employment in Rea Vaya which has sought to be employment neutral. The informal culture of the taxi industry has posed some difficulties, and there have been several illegal work stoppages by the former taxi drivers who are employed as bus drivers, including one during a World Cup match to which they had transported spectators. They have also joined a public sector trade union, whereas their employer is a private sector company, which has created difficulties in terms of the bargaining council system and a demarcation dispute. The work stoppages are a barrier in that they damage the image of Rea Vaya as a reliable system.

All above shows that the system has faced a serious barrier of some of the minibus-taxi operators which prefer to continue operations as before. Their core fear is to lose independence, jobs and income. The resistance has been using legal as well as illegal methods. The identified barriers are real and substantiated by the elements listed above. No such barriers exist for a continuation of the current transport system as this requires no change in the organizational structure of the public transit system. With carbon finance the barrier can be alleviated as the additional finance source can be used to increase the financial attractiveness for the operator, formed out of former minibus-taxi owners. This path is being followed by the administration. The cost of the bus operating company (BOC) contract that has been negotiated and will be signed with the taxi-owned BOC is probably 25% or 30% or so higher than a commercially-tendered contract would have cost. This means that the service will definitely not be able to fund itself from fare revenue as was originally envisaged. Therefore good additional and sustainable funding streams need to be secured.

RISK OF OPERATIONAL DEFICITS OF THE SYSTEM

This barrier refers to a risk of the project. The risk is due to less than expected income and/or higher than expected operational costs. The risk of an operational deficit is presented and assessed. The monetary risk is in a certain range but cannot be pinpointed with reasonable certainty. It can thus not be incorporated in a transparent manner in a financial calculation (under Step 2 – Investment Analysis) - also the barrier is not based on investment returns as no returns are expected but on operational annual deficits leading to potential budget problems and a lack of system sustainability.

The concept of Rea Vaya was that the system users would pay for the operational costs and that operational expenses would be fully recovered through fare revenue[75]. However the risk of non-attainment of this objective was identified from the very start at the scoping study finalized November 2006 which indicates: "Another large challenge and risk is that of not achieving a commercial operation in terms of no operating subsidy. All of the existing bus services on the proposed Rea Vaya routes are currently subsidised – either by the City or by the Province, and the target is to implement a commercially viable system, without subsidy, and this is a large risk or challenge.[76]" The scoping study urged to find other income sources and listed explicitly as finance source for operations emissions trading[77].

The original design projects a positive cash flow for the entire Phase I starting from year 1 onwards[78]. However upfront it was considered as a risk that this goal might not be attained (see above). Carbon finance can play an important role in diversifying finance and in reducing the risk of a deficit by having an additional cash inflow. Ex-post it can be verified that the risk of a deficit was judged correctly. User fees currently pay only 40% of the bus operating costs i.e. the system is making a significant negative cash flow, instead of as projected having a positive cash flow[79]. The following table shows a comparison between planned and actual passenger numbers as well as revenues for Phase 1A.

Table 6: Actual and Planned Performance of Phase 1A Rea Vaya

Item	Planned	Actual	Difference planned to actual
Daily passengers	136,000	30,000	22% of planned passengers
Revenues per day	R 500,000	R 170,000	34% of planned revenues

Source: File 31

Table 6 clearly shows that a large discrepancy between expected and actual passenger numbers, revenues and therefore of deficit exists.

Based on reports realized prior project start it can be concluded that the risk of operational deficits had been identified upfront without having made a concrete calculation of the magnitude of this risk. Also a diversification of income sources e.g. with emissions trading had been identified upfront. The risk of financial deficits is thus a real barrier for the project implementation. Carbon finance through its regular stream of income is especially helpful to overcome barriers related to negative cash-flows.

[75] File 12, p. 92
[76] File 12, p.100
[77] File 12, p. 93
[78] File 15, slide 46
[79] File 30, p.2

The magnitude of the risk can be seen ex-post where income from ticketing covers only 40% of operational expenses. Thus it can be concluded that this risk is real and a significant barrier.

PREVAILING PRACTICE BARRIER

As geographical region for prevailing practice the entire host country is taken. The BRT Rea Vaya is the 1st BRT to be operational in South Africa. The BRT Cape Town (called Cape Town's integrated rapid transit MyCiTi) started services May 29th 2010[80] and Port Elizabeths BRT on May31st 2010[81]. BRT Rea Vaya meanwhile started operations August 30th 2009 i.e. long prior any other BRT in South Africa. BRT Rea Vaya is the first BRT in entire Southern Africa. The BRT Rea Vaya is thus "first of its kind". The associated risks and uncertainties with being a first of its kind are compensated with the additional income source of carbon finance as well as with additional prestige and international recognition through being a VCS registered project difficult to measure in monetary terms.

Sub-step 3 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):

The alternative of continuation of the current situation does not face any of the above mentioned barriers. The minibus-taxi operators prefer a continuation of current practice, no subsidies need to be paid to these operators and no risk needs to be taken.

Step 4. Common practice analysis

The project is first of its kind in South Africa. Thus no common practice analysis is made as there is no other BRT operational as of time of project start of the BRT Rea Vaya.

2.11. Methodology Deviations

No methodology deviations have been made.

[80] http://www.capetown.gov.za/en/Pages/CitylaunchestwoMyCiTibusservices.aspx
[81] http://www.2010worldcupimpact.info/2010/06/24/fast-bus-lanes-for-port-elizabeth/

3. Monitoring

3.6. Data and Parameters Available at Validation

Data / Parameter:	**SEC_C**
Data unit:	l/100km
Description:	Specific energy consumption cars
Source of data:	Goyns, 2008, table 5.1. p.132 (File 35)
Value applied:	12.0
Justification of choice of data or description of measurement methods and procedures applied:	Local independent measurement. 94% of cars are gasoline and 6% diesel according to National Department of Transport, 2009 (File 1); based on AM0031 p. 8 fuels with less than 10% participation can be omitted thus for the baseline factor cars 100% gasoline is taken.
Any comment:	Data year 2008 (relevant for technology improvement factor)

Data / Parameter:	**SEC_{TB}**
Data unit:	l/100km
Description:	Specific energy consumption minibus-taxis
Source of data:	IPCC, 1996, Table 1.28 (p.1.71) and 1.40 (p.1.83) (corresponds to LDVs)
Value applied:	13.6
Justification of choice of data or description of measurement methods and procedures applied:	No local measurements available. Lowest of all published default values LDVs (Light Duty Vehicles) was taken. 91% of minibus-taxis are gasoline and 9% diesel according to National Department of Transport, 2009 (File1); based on AM0031 p.8 fuels with less than 10% participation can be omitted thus the baseline factor for minibus-taxis is based on 100% gasoline.
Any comment:	Data year 1996 (relevant for technology improvement factor)

Data / Parameter:	**$SEC_{Z,D}$**
Data unit:	l/100km
Description:	Specific energy consumption of large diesel buses
Source of data:	Metrobus, 2011 (File 42)
Value applied:	52.3
Justification of choice of data or description of measurement methods and procedures applied:	Based on full records of Metrobus. Data is the average of 7.2009 to 6.2010. All buses comparable size (minibus-taxis are separated) (File 1)
Any comment:	Data year 20010 (relevant for technology improvement factor)

Data / Parameter:	**$SEC_{Z,G}$**
Data unit:	l/100km
Description:	Specific energy consumption of large gasoline buses
Source of data:	IPCC, 1996, table 1-29 p.1.72
Value applied:	43.5

Justification of choice of data or description of measurement methods and procedures applied:	No local measurements available. Lowest of all published default values large gasoline buses was taken.
Any comment:	Data year 1996 (relevant for technology improvement factor)

Data / Parameter:	**$N_{Z,L,D}$ / $N_{Z,L}$ and $N_{Z,L,G}$/ $N_{Z,L}$**
Data unit:	%
Description:	Share of large diesel and gasoline buses
Source of data:	National Department of Transport, 2009 (File 1)
Value applied:	Large diesel buses: 89% Large gasoline buses: 11%
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	

Data / Parameter:	**DD_Z**
Data unit:	km
Description:	Distance driven all buses Metrobus per month
Source of data:	Metrobus, 2011 (File 42)
Value applied:	1,171,598
Justification of choice of data or description of measurement methods and procedures applied:	Average months distance of all buses between 7.2009 and 6.2010 (same period for SEC and for passengers)
Any comment:	

Data / Parameter:	**P_Z**
Data unit:	Passenger trips
Description:	Passengers trips with Metrobus buses in the baseline per month
Source of data:	Metrobus, 2011 (File 42)
Value applied:	1,405,207
Justification of choice of data or description of measurement methods and procedures applied:	Average months distance of all buses between 7.2009 and 6.2010 (same period for SEC and for passengers)The data used is conservative as it is the number of passengers and not the number of trips i.e. passengers using 2 buses are counted as 2 and not as 1. Trips are always less than passengers. This would lead to higher baseline emissions as AM0031 calculates emissions per passenger trip.
Any comment:	

Data / Parameter:	**DD_{TB}**
Data unit:	km
Description:	Distance driven per minibus-taxi per working day
Source of data:	City of Johannesburg, 2010 (File 5)
Value applied:	249
Justification of choice of data or description of measurement	Data is available of number of passengers per minibus-taxi per working day thus making the two datasets (distance and

methods and procedures applied:	passengers) compatible for calculation of emissions per passenger trip.
Any comment:	

Data / Parameter:	**P_{TB}**
Data unit:	Passenger trips
Description:	Passengers trips per minibus-taxis in the baseline per working day
Source of data:	City of Johannesburg, p. 139, 2007 (File 6)
Value applied:	120
Justification of choice of data or description of measurement methods and procedures applied:	Based on official origin-destination surveys (Gauteng Household Interview Survey)
Any comment:	

Data / Parameter:	**ROC_{TB}**
Data unit:	Percentage
Description:	Relative average occupation rate of minibus-taxis
Source of data:	City of Johannesburg, 2009 (File 2)
Value applied:	42%
Justification of choice of data or description of measurement methods and procedures applied:	The absolute number of passenger per minibus-taxi is 6.8 (File 2) passengers with a capacity of 16 (File 1). As capacities can change the relative figure is taken.
Any comment:	Used for leakage calculation change of occupation rate; The same study is performed again year 3, 6 and 10 for leakage monitoring.

Data / Parameter:	**OC_{C}**
Data unit:	Passengers
Description:	Average occupation rate of passenger cars
Source of data:	City of Johannesburg, 2009 (File 2)
Value applied:	1.61
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	

Data / Parameter:	**$ROC_{Z,0}$**
Data unit:	Percentage
Description:	Average occupation rate of buses
Source of data:	City of Johannesburg, 2009 (File 2)
Value applied:	24%
Justification of choice of data or description of measurement methods and procedures applied:	

Any comment:	Used for leakage calculation change of occupation rate; The same study is performed again year 3, 6and 10 for leakage monitoring.

Data / Parameter:	**$TD_{C,}$**
Data unit:	km
Description:	Average trip distance of users of passenger cars
Source of data:	City of Johannesburg, 2010 (File 3)
Value applied:	19.1
Justification of choice of data or description of measurement methods and procedures applied:	Survey monitors the trip distance and latter is adjusted in case the monitored trip distance is lower than the baseline trip distance. Based on survey of BRT users of Phase 1A. With an extended BRT trip distances tend to get larger, thus conservative.
Any comment:	

Data / Parameter:	**$N_{Z,TB,C}$**
Data unit:	Buses
Description:	Total number of baseline public transport buses, minibus-taxis and passenger cars in Johannesburg
Source of data:	National Department of Transport, 2009 (File 1)
Value applied:	Buses: 4,935 Minibus-taxis (includes inter-city usage): 43,570 Cars: 802,189
Justification of choice of data or description of measurement methods and procedures applied:	Includes all buses, not only Metrobus; Minibus-taxis include those used for intra-city trips (estimated at around 12,500 in the ITP of 2003). As the exact distribution is unknown the larger number is taken as this is conservative (potentially higher leakage emissions are calculated)
Any comment:	Used for calculation of SRS for congestion leakage

Data / Parameter:	**$VD_{Z,TB,C}$**
Data unit:	Km
Description:	Annual average distance driven of buses, minibus-taxis and cars in Johannesburg
Source of data:	Buses: Metrobus, 2009 (File 4) Minibus-taxis: City of Johannesburg 2010 (File 5) Cars: Goyns, 2008, p.100 last paragraph (File 35)
Value applied:	Buses: 35,983 Minibus-taxis: 74,802 Cars: 19,200
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	Used for calculation of congestion leakage

Data / Parameter:	**TR_C**
Data unit:	trips
Description:	Number of daily trips realized by passenger cars baseline
Source of data:	City of Johannesburg, 2007, Table 3.29 p. 53 (File 6)
Value applied:	580,988

Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	Used for calculation of congestion leakage

Data / Parameter:	SRS
Data unit:	%
Description:	Share of road space used by public transport in the baseline
Source of data:	Calculation
Value applied:	1%
Justification of choice of data or description of measurement methods and procedures applied:	Based on formula of AM0031 $SRS = \frac{DD_Z}{DD_Z + DD_{TB} + DD_C}$
Any comment:	DD is based on annual distance driven per unit multiplied with the number of units for the respective vehicle category

Data / Parameter:	RSB
Data unit:	km
Description:	Road space available baseline
Source of data:	City of Johannesburg, 2007, p.65 (File 6)
Value applied:	9,247
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	Used for calculation of leakage congestion

Data / Parameter:	RSP_p
Data unit:	km
Description:	Road space available project
Source of data:	City of Johannesburg, 2010 p. 5 for 1B (File 14) Logit, 2008 for 1A (File 13)
Value applied:	Road space quit cumulative: 2011 Phase 1A: 25 2012 onwards Phase 1A and 1B: 43
Justification of choice of data or description of measurement methods and procedures applied:	Road space project = road space baseline – road space quit by trunk lines Based on trunk routes planned
Any comment:	Used for calculation of leakage congestion

Data / Parameter:	BSCR
Data unit:	buses
Description:	Buses not required due to the project
Source of data:	City of Johannesburg, 2010 (File 18)
Value applied:	2011: 293 2012 onwards: 578

Justification of choice of data or description of measurement methods and procedures applied:	Based on scrapped units of Phase 1A: 585 minibuses in relation to 41 trunk buses; 2 minibuses are idem to 1 large baseline bus due to smaller size (length of vehicle, not carrying capacity as used to determine road space freed up)
Any comment:	Used for calculation of leakage congestion

Not used for this project are:

- V_B and V_P: No data available. Based on AM0031 p.20: "If the project has no data on speed changes or current speed, then it is assumed that the speed impact is equal to 0."
- No metered taxi or motorcycle data was collected as these modes are assumed to only have a minor share of BRT users. Users of metered taxis and/or motorcycles are taken as 0-emitters. This is in accordance with AM0031 p. 7. The minor relevance of these categories is also demonstrated in the 1st BRT passenger survey conducted (City of Johannesburg, 2010, File 3) which showed a share of 0.8% of passengers from metered taxis and 0.2% from motorcycles.

Default factors used from the methodology are not listed again in the PDD. Default factors used are:

- Technology improvement factor for buses, cars and taxis (AM0031, Table A.2).
- Emission factor per liter of fuel for various vehicle types (AM0031, Table A.1.).
- Elasticity factor trips (AM0031, appendix A, leakage parameter point 5)

3.7. Data and Parameters Monitored

Data / Parameter:	$\mathbf{P_{PJ}}$
Data unit:	Passengers
Description:	Passengers transported by project
Source of data:	Rea Vaya
Description of measurement methods and procedures to be applied:	Passenger numbers based on entry statistics based on data from agent responsible for ticketing and revenues. Revenues are not 100% identical to passenger numbers due to fare evasion estimated as 25-30% (see File 31)
Frequency of monitoring/recording:	Daily collection Aggregated monthly
Value applied:	For projections based on GTZ, 2010 (File 7) and Logit, 2007 (File 8) 2011: 40,845,600 2012 and following: 73,733,400
Monitoring equipment:	None
QA/QC procedures to be applied:	Checked with revenues based on ticket sales price
Calculation method:	Based on ticket sales figures, types of tickets sold and unit price of ticket type
Any comment:	Based on total passenger trips. If a passenger uses in his trip more than one project bus (e.g. feeder plus trunk bus) he is counted only once.

Data / Parameter:	$\mathbf{S_{PJ,i}}$
Data unit:	%

Description:	Share of passengers which in absence of the project would have used mode *i*
Source of data:	Survey realized by independent 3rd Party
Description of measurement methods and procedures to be applied:	Survey based on AM0031 with details in Annex 2
Frequency of monitoring/recording:	6x annually
Value applied:	Projections based on survey realized on Phase 1A of Rea Vaya by City of Johannesburg, 2010 (File 3) Buses: 8 % Passenger cars: 10% Minibus-taxi: 61% Rail-based transit system as well as others: 18% Non-Motorized Transport and Induced Traffic: 3%
Monitoring equipment:	None
QA/QC procedures to be applied:	See Annex 2
Calculation method:	Average values of the 6 surveys are used
Any comment:	

Data / Parameter:	$TC_{T/F/CF}$
Data unit:	Liter
Description:	Total diesel fuel consumed by the project trunk (T), feeder (F) and complementary/(CF) buses
Source of data:	Rea Vaya
Description of measurement methods and procedures to be applied:	Based on reports of operators with records of fuel consumption
Frequency of monitoring/recording:	Monthly aggregated annual
Value applied:	For projections based on reported average specific fuel consumption per bus type (average 1 to 11.2010; Rea Vaya, 2010 File 32): Articulated bus: 65.7 l/100km Complementary bus:49.1 l/100km Feeder bus: 49.1 l/100km Total diesel: 2011: 3.64 million litre 2012 and following: 6.58 million litre For Distance driven per buy type see following data unit/parameter
Monitoring equipment:	Fuel stations calibrated according to national regulations
QA/QC procedures to be applied:	Control of specific fuel consumption. Distance driven is therefore recorded. If deviations of specific fuel consumption are above normal fluctuations (due e.g. to changing load factors, ambient conditions and driver) then data is checked for consistency and potential errors. In case of deviations further controls are performed e.g. with fuel invoices.
Calculation method:	None
Any comment:	Complementary and feeder bus are the same bus types thus fuel consumption values are not segregated.

Data / Parameter:	**$DD_{T/F/CF}$**
Data unit:	Kilometres
Description:	Distance driven of BRT trunk (T), feeder (F) and complementary (CF) buses
Source of data:	Rea Vaya
Description of measurement methods and procedures to be applied:	Distance measurement based on GPS or comparable means or number of turn-arounds and distance per turn-around.
Frequency of monitoring/recording:	Monthly aggregated annual
Value applied:	Based on projections of average distance driven per bus type (GTZ, 2010, File 7) and number of units (GTZ, 2010, File 7). Articulated buses: 52,859 km/a with 41 units 2011 and 53,002 km/a with 81 units 2012 onwards Complementary buses: 44,206 km/a with 60 units 2011 and 38,819 km/a with 113 units 2012 onwards Feeder buses: 44,206 km/a with 42 units 2011 and 38,819 km/a with 84 units 2012 onwards
Monitoring equipment:	GPS in some cases; Calibration of GPS according to manufacturer
QA/QC procedures to be applied:	Payment of operators is made based on distance driven thus good control by Rea Vaya which effects payment and of operator who receives monies. Buses are separated in articulated buses operating on trunk routes, complementary buses operating on trunk/mixed routes and feeder buses operating on mixed routes. This separation is made due to different types of buses used and different driving conditions. The same separation is made in fuel consumption.
Calculation method:	Distance driven can be based on route length and number of turn-arounds per route
Any comment:	Used to control fuel consumption based on specific fuel consumption (see above)

Data / Parameter:	**N_{TB} / N_{Z}**
Data unit:	Minibus-Taxis / Buses
Description:	Number of minibus-taxis/buses in Johannesburg
Source of data:	National Department of Transport
Description of measurement methods and procedures to be applied:	Official statistic
Frequency of monitoring/recording:	year 3, 6 and 10
Value applied:	No projection available and no change of occupation rate is previewed. If no change of occupation rate occurs the parameter needs not be monitored.
Monitoring equipment:	None
QA/QC procedures to be applied:	None
Calculation method:	None
Any comment:	Used to calculate leakage load factor. Data is only required if the load factor of minibus-taxis and/or buses is more than 10% lower than the baseline value

Data / Parameter:	**ROC_{TB}**

Data unit:	%
Description:	Relative average occupation rate of minibus-taxis
Source of data:	Specific studies realized by Rea Vaya or 3rd Party
Description of measurement methods and procedures to be applied:	Same methodology is used as for baseline study or following guidelines of AM0031
Frequency of monitoring/recording:	year 3, 6 and 10
Value applied:	No change to baseline projected. This assumption is also based on no change after project implementation monitored in Bogota. See verification report TransMilenio 2009 (published on www.unfccc.int).
Monitoring equipment:	None
QA/QC procedures to be applied:	QA/QC of survey in accordance with AM0031
Calculation method:	None
Any comment:	Used for calculating leakage load factor of minibus-taxis. Leakage load factor change minibus-taxis has to be included if the occupation rate of minibus-taxis drops below 32% (42% baseline factor – 0.1 see methodology p. 17)

Data / Parameter:	**ROC_Z**
Data unit:	%
Description:	Average occupation rate of buses relative to capacity
Source of data:	Specific studies realized by Rea Vaya or 3rd Party
Description of measurement methods and procedures to be applied:	Same methodology is used as for baseline study or following guidelines of AM0031
Frequency of monitoring/recording:	year 3, 6 and 10
Value applied:	No change to baseline projected. This assumption is also based on no change after project implementation monitored in Bogota. See verification report TransMilenio 2009 (published on www.unfccc.int).
Monitoring equipment:	None
QA/QC procedures to be applied:	QA/QC of survey in accordance with AM0031
Calculation method:	None
Any comment:	Used for calculating leakage load factor of buses. Leakage load factor change buses has to be included if the occupation rate of buses drops below 14% (24% baseline factor – 0.1 see methodology p. 17)

Data / Parameter:	**$X_{i,C}$**
Data unit:	None
Description:	Fuel type used by passenger cars of users of the project BRT
Source of data:	Survey realized by independent 3rd Party
Description of measurement methods and procedures to be applied:	Survey based on AM0031 with details in Annex 2
Frequency of monitoring/recording:	6x annually
Value applied:	No change to original data projected
Monitoring equipment:	None

QA/QC procedures to be applied:	See Annex 2
Calculation method:	Average values of the 6 surveys are used
Any comment:	

Data / Parameter:	**TD_C**
Data unit:	Kilometres
Description:	Trip distance of project passengers which in absence of the BRT would have used passenger cars
Source of data:	Survey realized by independent 3rd Party
Description of measurement methods and procedures to be applied:	Survey based on AM0031 with details in Annex 2
Frequency of monitoring/recording:	6x annually
Value applied:	No change to original data projected
Monitoring equipment:	None
QA/QC procedures to be applied:	See Annex 2
Calculation method:	Average values of the 6 surveys are used
Any comment:	

Data / Parameter:	**X_Z**
Data unit:	None
Description:	Bio-fuel content of fuels used by project and baseline buses
Source of data:	Supplier of fuel
Description of measurement methods and procedures to be applied:	Confirmation by fuel supplier
Frequency of monitoring/recording:	Annually
Value applied:	Project buses are expected to use the same bio-fuel content as baseline buses in case bio-fuel usage is made complimentary in the future. Currently no bio-fuels are used.
Monitoring equipment:	None
QA/QC procedures to be applied:	None
Calculation method:	None
Any comment:	Used to assess the applicability condition

All the above monitored data will be stored for 2 years after the end of the crediting period.

3.8. Description of the Monitoring Plan

The monitoring plan has two aims: to ensure the environmental integrity of the project activity and to ensure that the data monitoring requirements are closely aligned with the current practice of the project operator. Rea Vaya as system manager and business unit within the Transportation Department will be in charge of managing all data in relation to the VCS project including responsibility for data collection, quality assurance, reports and data storage.

QA and QC is assured by a special monitoring manual containing inter alia how to proceed with key measurements and survey, how to screen data for quality and how to handle potential errors. Staff in charge will be trained on the manual by Grütter Consulting AG.

The **responsibilities** of Rea Vaya are:

1. Collect in the required frequency all data for the monitoring of the VCS project.
2. Perform data and information quality control according to this manual.
3. File all documents in the manner and timing that this manual demands.
4. Check data quality and collect, if required, additional data.
5. Store all data: All data must be filed electronically. Hard copy reports and mails are to be scanned so there is an electronic copy. Every year an electronic file is created and named "BRT Rea Vaya VCS Monitoring year …". At least two (2) copies are kept in the form of CDs or DVDs or other data recording devices in separate places. All documents are to be saved for up to two (2) years after the last VCUs were issued.

A monitoring manual has been prepared for Rea Vaya and staff will be familiarized with this manual in a special training course. The Manual defines responsibilities and procedures, has a section on all data variables to be monitored, includes monitoring report formats as well as the format of the modal split survey. The data section has for each data variable information on how to collect the required information, the frequency of collection, data units, quality control measures to be realized, steps to be taken in case of data problems, and some additional hints and comments. The monitoring manual can be reviewed by the validator. The manual has been implemented successfully by various BRTs worldwide which have also passed successfully CER and/or VCU verifications including the BRT TransMilenio, Colombia or the BRT Chongqing, China and is thus based on working experience.

4. Ex-Ante Calculation of GHG Emission Reductions and Removals

4.6. Baseline Emissions

The numbers in the PD are rounded sometimes and the exact numbers can be found in the calculation excel file and in chapter 3.1 and 3.2.

Path A based on emissions per kilometre and emissions per passenger-trip from AM0031 is chosen. This is the preferred option according to the methodology.

For the purposes of calculating baseline emissions, first the relevant vehicles categories corresponding to the baseline are identified. After having identified these categories, the emission factor per passenger trip per vehicle category is determined. This is calculated ex-ante and includes a fixed technology-change factor per vehicle category. Total baseline emissions are determined ex-post based on the mode of transport BRT passengers would have chosen in absence of the project and their respective emission factor.

1. Determine Vehicle Categories

Relevant vehicle categories in Johannesburg include:

- Urban public transport buses (all large units);
- Minibus-taxis (capacity of 16 passengers);
- Passenger cars;
- Suburban rail;
- NMT (Non-Motorized Transport)

Motorcycles and metered taxis are not included as the expected mode shift from these modes of transit are considered as marginal. This has been confirmed by the pilot survey on the BRT where the usage of metered taxis in absence of the project was 0.8% and of motorcycles 0.2%[82]. AM0031 p.7 indicates that only vehicle categories relevant for the BRT project need to be included. The categories not included are subsumed in the future surveys as “other vehicle categories” and are assigned 0 baseline emissions. This is conservative as motorcycles and taxis of course have emissions.

Emissions from passengers which in absence of the project would have used suburban rail are counted as 0 based on AM0031 p. 13. Thus no emission factor for this mode of transit needs to be determined.

Relevant fuel types, for each vehicle category, are established. The project monitors annually the share of fuel types used for passenger cars. If changes larger than 10 percentage points of fuel types used occurs (for diesel, gasoline or gaseous fuels) or changes larger than 1 percentage points for all other fuels then the emission factors are adjusted accordingly.

Vehicle categories are differentiated according to fuel type. Based on AM0031 p. 7 diesel, gasoline and gas (CNG or LPG) are listed separately if a minimum of 10% of vehicles of the respective category

[82] File 3

use such a fuel, while the threshold for zero-emission[83] fuels is minimum 1%. Table 7 lists the vehicle categories and fuel types included in the project.

Table 7: Vehicle Categories and Fuel Types Used in Project

Vehicle Category	Fuel Type(s) Official Statistics	Fuel Type(s) as Used for Calculations	Method used to Determine Specific Fuel Consumption[84]
Passenger cars	6% diesel 94% gasoline	Gasoline 100% The percentage of diesel cars is below the threshold of 10% and therefore project calculations are based on 100% gasoline fuel	Alternative 2 based on national literature data
Minibus-Taxis	9% diesel 91% gasoline	Gasoline 100% The percentage of diesel minibus-taxis is below the threshold of 10% and therefore project calculations are based on 100% gasoline fuel	Alternative 2 based on IPCC
Buses	89% diesel 11% gasoline	89% diesel 11% gasoline	For diesel units Alternative 1 however not based on a sample but on full records of all buses; For gasoline units based on Alternative 2 based on IPCC

Source: National Department of Transport, 2009 (File 1)

2A. Calculate Emissions per Passenger Based on Relative Data

2A1. Determine Emissions per Kilometre for Vehicle Categories

GHG emissions per kilometre are calculated and fixed ex-ante for the project crediting period. It is a value based on specific fuel consumption data of the respective category multiplied by an annual technology improvement factor and the relevant correction factor.

Emissions per Kilometre for Different Vehicle Categories

$$EF_{KM,i} = \sum_x \left[SEC_{x,i} \times \left(EF_{CO2,x} + EF_{CH4,x} + EF_{N2O,x} \right) \times \left(\frac{N_{x,i}}{N_i} \right) \right] \quad \textbf{(1)}$$

where:

$EF_{KM,i}$	Transport emissions factor per distance of vehicle category *i* (gCO_{2e}/km)
$SEC_{x,i}$	Specific energy consumption of fuel type x in vehicle category *i* (litre/km)
$EF_{CO2,x}$	CO_2 emission factor for fuel type *x* (gCO_2/litre)
$EF_{CH4,x}$	CH_4 emission factor for fuel type *x* (gCO_{2e}/litre)
$EF_{N2O,x}$	N_2O emission factor for fuel type *x* (gCO_{2e}/litre)
N_i	Total number of vehicles in category *i*
$N_{x,i}$	Number of vehicles in vehicle category *i* using fuel type *x*

[83] Zero-emission in the context of operating emissions and not well-to-wheel or life-cycle emissions; this includes hydrogen.

[84] Alternative 1 or 2 according to AM0031

Table 8 shows the specific fuel consumption per vehicle category and the method of determination of the fuel consumption.

Table 9 shows the Emission Factors used by the project. This parameter is based on values given by AM0031. No bio-fuels, gaseous fuels or electricity are used by these vehicle categories.

Table 8: SFC per Vehicle Category

Vehicle category	SEC (l/100km)	Data year	Method used	Data source
Cars (gasoline)	12.0	2008	Local measurements	File 35, Goyns, 2008, table 5.1. p.132
Minibus taxis (gasoline)	13.6	1996	Default value	IPCC, 1996, Table 1.28 and 1.40 lowest value (corresponds to LDVs)
Buses (gasoline)	43.5	1996	Default value	IPCC, 1996, table 1-29 lowest value
Buses (diesel)	52.3	2009	Records Metrobus 12 months fuel consumption and distance driven (7.2009 to 6.2010)	File 42, Metrobus, 2011

Table 9: Default Emission Factors for Vehicle Categories and Fuel Types (gCO_{2e}/litre)

Vehicle category	CO_2 emission factors		CH_4 emission factors		N_2O emission factors	
	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel
Bus large	2,313	2,661	11	2	9	21
Minibus-taxi[85]	2,313		13		14	
Passenger cars	2,313		11		14	

Note: CH_4 and N_2O has been transformed in CO_2e using GWP factors
Source: AM0031, Appendix A, table A.1

2A2. Calculate Emissions per Passenger per Vehicle Category

Emissions per passenger trip are defined per vehicle category. All data is determined prior project start. A change in the occupancy rate of minibus-taxis and buses influencing this indicator is monitored as leakage.

Emissions per Passenger Trip Cars

$$EF_{P,C} = \frac{EF_{KM,C} \times TD_C}{OC_C} \quad \textbf{(2)}$$

where:

[85] Bus small in AM0031

$EF_{P,C}$ Emission factor per passenger transported before project start for cars (gCO_{2eq})
$EF_{KM,C}$ Emission per kilometer of cars (gCO_{2eq}/km)
TD_C Average trip distance for cars (km)
OC_C Average vehicle occupancy rate of cars (no unit)

Table 10 lists the occupation rate and the average trip distance used to calculate the EF per passenger for cars.

Table 10: Occupation Rate and Trip Distance Passenger Cars

Parameter	Unit	Value	Source
Occupation rate cars	Passengers	1.6	City of Johannesburg, 2009 (File 2)
Trip distance cars	km	19.1	City of Johannesburg, 2009 (File 3)[86]

Emissions per Passenger Trip for Minibus-Taxis and for Buses

$$EF_{P,Z/TB} = \frac{EF_{Z/TB} \times DD_{Z/TB}}{P_{Z/TB}} \qquad (3)$$

where:

$EF_{P,z/TB}$ Emission factor per passenger transported baseline buses (Z) and minibus-taxis (TB) (gCO_{2eq})

$EF_{KM,Z/TB}$ Emissions per kilometer baseline buses (Z) and minibus-taxis (TB) (gCO_{2eq}/km)

$DD_{Z/TB}$ Total distance driven by baseline buses (Z) and minibus-taxis (TB) (km)

$P_{Z/TB}$ Passengers transported by baseline buses (Z) and minibus-taxis (TB) (no unit)

Formula (3) of the methodology is simplified in the project case as only 1 bus size[87] operates in the Metropolitan Zone of Johannesburg. Small buses, called minibus-taxis are a distinct form of transport in Johannesburg and are thus included as a separate mode of transit.

Table 11 lists the distance driven and passengers transported used to calculate the EF per passenger for buses and minibus-taxis. Relevant in both cases is that the distance driven and the passengers transported refer to the same concept e.g. distance driven per unit and passengers transported per unit or distance driven all units per month and passengers transported all units per month. Passengers refer to passenger trips[88]. If a passengers uses 2 or more buses or 2 or more minibus-taxis he is only counted once as all calculations are based on emissions per passenger trip.

Table 11: Distance Driven and Passengers Transported Buses and Minibus-Taxis

Parameter	Unit	Value	Source
Average distance driven per working day minibus taxis	Km	249	City of Johannesburg 2010 (File 5)
Number of passenger trips per minibus-taxi per working day	Passenger trips	120	Calculated based on City of Johannesburg, p. 139, 2007 (File 6); calculation in VER spreadsheet
Distance driven of all buses of Metrobus per month	Km	1,171,598	Metrobus 2011 (average 7.2009 to 6.2010) (File 42)
Average number of passengers Metrobus per month[89]	Passengers	1,405,207	Metrobus, 2011 based o average 7.2009 to 6.2010 (File 42)

[86] Based on survey realized of BRT users. The value is monitored and if in the future lower than the baseline value the EF for passenger cars is re-calculated. This is based on AM0031.

[87] All are large units with a capacity between 65 and 90 passengers with less than 10% of units with 110 passenger capacity (File 17). Small units are separated as transit mode in minibus-taxis as they are considered a different mode of transit in South Africa.

[88] See AM0031 p.9 first paragraph

[89] No data available for multiple bus users; value is therefore conservative as passengers which use 2 or more buses are counted 2 or more times; this results in lower (more conservative) baseline emissions for buses

Formula (4) of the methodology is not used as this formula corresponds to the path B based on sectoral data.

3. Technological Change

The emission factor is not constant but annually updated according to the technology improvement factor per vehicle category. The technology improvement factor IR_y is a fixed default factor per vehicle category. The same technology improvement factor is applied over the entire project crediting period. The technology improvement factor is taken from AM0031.

Table 12: Default Technology Improvement Factors (per annum)

Vehicle category	Technology Improvement Factor IR
Buses	0.99
Passenger cars	0.99

Source: AM0031, Appendix A, Table A.2

Tables 13 and 14 show the resulting emission factors per km and for emissions per passenger for the years of the crediting period.

Table 13: Emission Factor per Kilometre per Vehicle Category (gCO_{2eq}/km)

Vehicle category	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Bus	1,320	1,306	1,293	1,280	1,268	1,255	1,242	1,230	1,218	1,205
Car	267	265	262	259	257	254	252	249	247	244
Minibus-taxi	271	268	266	263	260	258	255	253	250	248

Source: VER spreadsheet

Table 14: Emission Factor per Passenger per Vehicle Category (gCO_{2eq}/passenger)

Vehicle category	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Bus	1,100	1,089	1,078	1,067	1,057	1,046	1,036	1,025	1,015	1,005
Car	3,171	3,139	3,107	3,076	3,046	3,015	2,985	2,955	2,926	2,896
Minibus-taxi	676	669	663	656	650	643	637	630	624	618

Source: VER spreadsheet

4. Change of Baseline Parameters During Project Crediting Period

A change in the trip distance realized by passenger cars is monitored through the passenger survey. The corresponding baseline factor is adjusted downwards if the monitored trip distance is shorter than the value used prior project start. This is conservative as only a reduced trip length is accounted for. Only cars are included as motorcycles and taxis are not included in the project as vehicle categories.

Adjustment for Changing Trip Distance

$$CD_{C,y} = \frac{TD_{C,y}}{TD_C} \quad \textbf{(4)}$$

where:

$CD_{C,y}$	Correction factor for changing trip distance cars for the year y (no unit)
TD_C	Average trip distance in kilometers cars before project start (km)
$TD_{C,y}$	Average trip distance in kilometers cars in the year y (km)

Note:
The adjustment is only made if $TD_{C,y} < TD_C$ to ensure a conservative approach

Change of Fuel Used by Passenger Cars

For passenger cars $EF_{KM,C,y}$ is annually adapted according to changes in fuel composition of passenger cars. This is only made if the emission factor calculated is lower than the original emission factor used.

Determination of Baseline Emissions

Baseline Emissions

$$BE_y = \sum_i \left(EF_{P,i,y} \times P_{i.y} \right) \qquad \textbf{(5)}$$

where:

BE_y	Baseline emissions in year *y* (tCO_{2e})
$EF_{P,i,y}$	Transport emissions factor per passenger in vehicle category *i* in year *y* (tCO_{2e} / passenger)
$P_{i,y}$	Passengers transported by the project (BRT) in year *y* that without the project activity would have used category *i*, where *i* = Z (buses, public transport), TB (minibus-taxis), C (passenger cars), or R (suburban rail)[90] (passenger).

The mode passengers would have used in absence of the project is determined through the mode survey realized 6x annually and detailed in Annex 2. Emissions from passengers which in absence of the project would have used rail-based mass transit systems (*R*) are counted as $EF_{P,R,y}$ = 0 grams per passenger.

Baseline Emissions per Trip per Mode

$$EF_{P,C,y} = EF_{P,C} \times IR_{C,t} \times CD_{C,y} \qquad \textbf{(6)}$$

where:

$EF_{P,C,y}$	Transport emissions factor per passenger in cars in year y (tCO_{2e} / passenger)
$EF_{P,C}$	Transport emissions factor per passenger before project start (tCO_{2e} / passenger)
$CD_{C,y}$	Correction factor for changing trip distance cars for the year y (no unit)
$IR_{C,t}$	Technology improvement factor at year t for cars
t	Age in years of fuel consumption data used for calculating the emission factor in year y

[90] NMT and IT are not included as emissions are 0 for this category in the baseline; motorcycles (M) and taxis (T) are not included as mode categories by the project and are subsumed as “others” with 0 emissions;

The formula is only used for cars. Taxis and motorcycles are not included as vehicle categories by the project.

Passengers Transported per Baseline Mode

$$P_{i,y} = P_y \times S_{i,y} \quad \textbf{(7)}$$

where:

$P_{i,,y}$ Passengers transported by the project which in absence of latter would have used transport type *i*, where *i*= Z (buses, public transport), TB (minibus-taxis), C (passenger cars), R (rail-based urban mass transit) NMT (non-motorized transport) and IT (induced transport, i.e. would not have travelled in absence of project) (passengers).

P_y Total passengers transported by the project monitored in year *y* (passengers)

$S_{i,,y}$ Share of passengers transported by the project which in absence of latter would have used transport type *i*, where *i*= Z (buses, public transport), TB (minibus-taxis), C (passenger cars), R (rail-based urban mass transit), NMT (non-motorized transport) and IT (induced transport, i.e. would not have travelled in absence of project) (%).

The pilot survey on the existing BRT Line 1A showed the following mode distribution (S):

- Buses: 8%
- Minibus-taxis: 61%
- Cars: 10%
- Rail and others: 18%
- NMT and induced: 3%

Table 15 shows the projected baseline emissions and figure 9 shows the distribution of baseline emissions according to mode which would have been used by the project passenger in absence of the BRT.

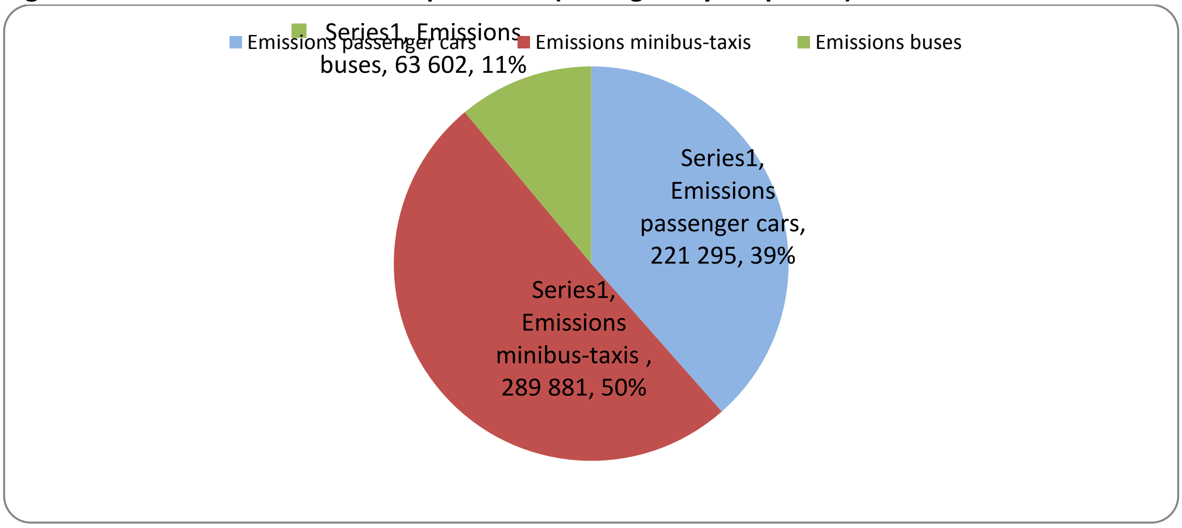
Table 15: Baseline Emissions (tCO_{2eq})

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Passengers (million)[91]	73.73	73.73	73.73	73.73	73.73	73.73	73.73	73.73	73.73	73.73
Baseline emissions	60,112	59,511	58,916	58,327	57,743	57,166	56,594	56,028	55,468	54,913

Source: VER spreadsheet

[91] Based on total passenger trips. If a passenger uses in his trip more than one project bus (e.g. feeder plus trunk bus) he is counted only once.

Figure 9: Baseline Emissions Share per Mode (average 10 year-period)



Source: VER spreadsheet

4.7. Project Emissions

Project emissions are based on the fuel consumed by the buses of the project (trunk, feeder and complementary buses). Alternative A based on total fuel consumption will be used primarily, however also alternative B might be used[92].

Alternative A: Use of Fuel Consumption Data

$$PE_y = \sum_x \left[TC_{PJ,x,y} \times (EF_{CO2,x} + EF_{CH4,x} + EF_{N2O,x})\right] \quad \textbf{(8)}$$

where:

PE_y	Project emissions in year *y* (tCO_{2e})
$TC_{PJ,x,y}$	Total consumption of fuel type *x* in year *y* by the project (liter)
$EF_{CO2,x}$	CO_2 emission factor for fuel type *x* (gCO_2 per liter)
$EF_{CH4,x}$	CH_4 emission factor for fuel type *x* (gCO_{2e} per liter)
$EF_{N2O,x}$	N_2O emission factor for fuel type *x* (gCO_{2e} per liter)

Alternative B: Use of Specific Fuel Consumption and Distance Data

This alternative uses as a basis fuel efficiency data (i.e. consumption per kilometre driven).

$$EF_{KM,j,y} = \sum_x \left[SEC_{j,x,y} \times \left(EF_{CO2,x} + EF_{CH4,x} + EF_{N2O,x}\right)\right] \quad \textbf{(9)}$$

where:

$EF_{KM,j,y}$	Transport emissions factor per distance for project bus category *j* in year *y* (gCO_2/km)
$SEC_{j,x,y}$	Specific energy consumption of fuel type x in project bus category *j* in year *y* (l/km)
$EF_{CO2,x}$	CO_2 emission factor for fuel type *x* (gCO_2 per liter)

[92] Phase 1B and contract assignment to private operators has not been done. This will determine the alternative to be used.

$EF_{CH4,x}$ CH_4 emission factor for fuel type *x* (gCO_{2e} per liter)
$EF_{N2O,x}$ N_2O emission factor for fuel type *x* (gCO_{2e} per liter)

Fuel-efficiency data is derived from annual data reported by the bus companies operating the units either of all units or of a representative sample of comparable units (comparable technology, vintage and size). To ensure a conservative approach, all data with specific fuel consumption values which are more than 20% lower than the average specific fuel consumption of comparable units are omitted from calculations. This ensures a conservative approach, as project emissions are potentially overstated.

As of today only diesel is used by project buses.

Table 16 shows the parameters and values required to calculate the project emissions and table 17 then shows the expected project emissions over the 10-year period.

Table 16: Project Emission Parameters

Parameter	Unit	Value	Source
Number of articulated buses	Buses	81	GTZ, 2010 (File 7)
SFC articulated buses	l/100km	65.7	Rea Vaya, 2010 (File 32)
Annual distance driven articulated buses	Km	53,002	GTZ, 2010 (File 7)
Number of complementary buses	Buses	113	GTZ, 2010 (File 7)
SFC complementary buses	l/100km	49.1	Rea Vaya, 2010 (File 32)
Annual distance driven complementary buses	Km	38,819	GTZ, 2010 (File 7)
Number of feeder buses	Buses	84	GTZ, 2010 (File 7)
SFC feeder buses	l/100km	49.1	Rea Vaya, 2010 (File 32)
Annual distance driven feeder buses	Km	38,819	GTZ, 2010 (File 7)

Table 17: Project Emissions (tCO_{2eq})

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Passengers (million)	73.73	73.73	73.73	73.73	73.73	73.73	73.73	73.73	73.73	73.73
Project emissions	17,649	17,649	17,649	17,649	17,649	17,649	17,649	17,649	17,649	17,649

Source: VER spreadsheet

4.8. Leakage

The following leakage sources are addressed:

1. Change of load factor of the baseline transport system due to the project involving minibus-taxis and buses.
2. Reduced congestion on remaining roads, provoking higher average vehicle speed, plus a rebound effect.

The project units use diesel and no gaseous fuels. Thus upstream emissions from gaseous fuels are not included in this project.

1. Change of Load Factor

The project could have a negative impact on the load factor of the remaining conventional bus fleet and the minibus-fleet. This is monitored. The monitoring is realized in the years 3 and 6 and 10 of the project. Formula (11) is only applied and leakage is only calculated if the occupation rate of baseline buses or the minibus-taxis drops by more than 10 percentage points relative to the situation prior project.

Occupation Rate

$$ROC_{i,y} = \frac{OC_{i,y}}{CV_{i,y}} \quad \textbf{(10)}$$

where:

$ROC_{i,y}$	Average occupancy rate relative to capacity in category *i* in year y, where *i* = Z (buses) or TB (minibus-taxis)
$OC_{i,y}$	Average occupancy of vehicle in category *i* in year *y* (passengers)
$CV_{i,y}$	Average capacity of vehicle *i* in year *y* (passengers)

Table 18: Occupation Rates Baseline

Vehicle category	Average number of passengers	Average Capacity	Average occupation rate	Benchmark occupation rate[93]
Buses	19.0	80	24%	14%
Minibus-taxis	6.8	16	42%	32%

Source: City of Johannesburg, 2009 (File 2) for average number of passengers and National Department of Transport, 2009, 2009 (File 1) for average capacity per vehicle category

Leakage Change Load Factor Buses / Minibus-Taxis

$$LE_{LF,Z,y} = EF_{KM,Z} \times VD_Z \times N_{Z,y} \times \left(1 - \frac{ROC_{Z,y}}{ROC_{Z,0}}\right) \quad \textbf{(11)}$$

where:

$LE_{LF,Z/TB,y}$	Leakage emissions from change of load factor in buses/minibus-taxis in year y (tCO_{2e})
$EF_{KM,z/TB}$	Baseline transport emissions factor per distance for buses/minibus-taxis (gCO_{2e} / km)
$VD_{Z/TB}$	Annual distance driven per vehicle for buses/minibus-taxis before the project start (km)
$N_{Z/TB,y}$	Number of buses/minibus-taxis in the conventional transport system operating in year y (units)
$ROC_{Z/TB,y}$	Average occupancy rate relative to capacity of conventional buses/minibus-taxis in year y
$ROC_{Z/TB,0}$	Average occupancy rate relative to capacity of buses/minibus taxis before start of project

[93] If the monitored occupation rate drops below these figures the leakage “Change of occupation rate” for this vehicle category is calculated.

Note:
If $ROC_{Z,0}$ - $ROC_{Z,y} \leq 0.1$ then $LE_{LF,Z,y} = 0$, i.e., if the occupancy rate of buses is not reduced by more than 0.1 then the project has had no negative effect (leakage).

The annual average distance driven of units is:

- Buses 35,983 km based on Metrobus, 2009 (File 4) based on total distance driven and number of units
- Minibus-taxis 74,802 km based on City of Johannesburg, 2010 (File 5) based on average minibus taxi length route (17.8km), average number of one-way trips per minibus taxi per day (7 units), working days per month (25 days) and months per year (12 months).

Metered taxis are not included as vehicle category and therefore also no occupation rate change is monitored (see AM0031 p.16 "The methodology also considers load factor changes in taxis **if they are included as vehicle category** by the project…").

2. Impact of Reduced Congestion on Remaining Roads

The project reduces the number of remaining buses and potentially other vehicles on the road used formerly for mixed traffic and thus also congestion. Congestion change occurs basically in the road where the new trunk lane operates and which was formerly used by mixed traffic. Reduced congestion has the following impacts relevant for GHG emissions:

- "Rebound effect" leading to additional trips and thus higher emissions
- Higher average speeds and less stop-and-go traffic leading to lower emissions

The impact of induced traffic (additional trips) provoked through the new transport system is addressed directly in the project emissions and is not part of the leakage[94].

The congestion and the speed impact are only calculated ex-ante and not monitored.

Step 1: Calculate additional road-space available

Additional Road Space Available

$$ARS_y = \sum_{w=1...y} \frac{BSCR_w}{N_Z} \times SRS - \frac{RSB - RSP}{RSB} \tag{12}$$

where:

ARS_y	Additional road space available in year y (percentage)
$BSCR_w$	Bus units scrapped by project in year w, where w = 1 to y (buses)
N_Z	Number of buses in use in the baseline (buses)
SRS	Share of road space used by public transport in the baseline (percentage)
RSB	Total road space available in the baseline (kilometers)
RSP	Total available road space in the project (= RSB minus kilometre of lanes that where reduced due to dedicated bus lanes) (kilometers)

[94] The survey of passengers includes as categories passengers which in absence of the project would not have realized the trip.

If $ARS_y < 0$, then we have a reduced road space in that year, and thus increased emissions due to reduced vehicle speed, but reduced emissions due to a negative "rebound effect".

Share Road Space Public Transit

This formula is required to determine SRS if no recent and good quality study is available which has calculated this parameter.

$$SRS = \frac{DD_Z}{DD_Z + DD_{TB} + DD_C} \quad \mathbf{(13)}$$

where:

SRS	Share of road space used by public transport in the baseline (percentage)
DD_Z	Total distance driven by public transport buses baseline (kilometers)
DD_T	Total distance driven in kilometers by minibus-taxis baseline (kilometers)
DD_C	Total distance driven in kilometers in by passenger cars baseline (kilometers)

SRS is in the project case 1%. The values of the parameters required to calculate SRS are listed in the table below.

Table 19: Parameters for SRS

Parameter	Value	Source
Annual distance driven per bus (km)	35,983	Metrobus, 2009 (File 4)
Number of buses	4,935	National Department of Transport, 2009 (File 1)[95]
Annual distance driven per minibus-taxis (km)	74,802	City of Johannesburg 2010 (File 5)
Number of minibus-taxis	43,570	National Department of Transport, 2009 (File 1)
Annual distance driven per car (km)	19,200	Goyns, 2008, p.100 last paragraph (File 35)
Number of cars	802,189	National Department of Transport, 2009 (File 1)

Table 20 shows the parameters required to calculate ARS.

Table 20: ARS

Parameter	Unit	2011	2012 and following	Data source
Road space quit cumulative	Km	25	43	File 14 p. 5 for 1B and File 13 for 1A (2011 Phase 1A, 2012 onwards Phase 1A and 1B)
Units retired cumulative	Buses	293	578	Based on scrapped units of Phase 1A: 585 minibuses in relation to 41 trunk buses; see File 18; 2 minibuses idem 1 large bus due to smaller size (based on vehicle length, not carrying capacity as this is relevant for road space used)
ARS	%	-0.1%	-0.2%	Calculated with formulae (12)

[95] includes all buses, not only Metrobus

Step 2: Assess the rebound impact of the additional road space

Rebound Effect

$$LE_{TRIPS,y} = ITR \times ARS_y \times TR_C \times TD_C \times EF_{KM,C} \times D_y \quad \textbf{(14)}$$

where:

$LE_{TRIPS,y}$	Leakage emissions from additional and/or longer trips in year *y* (tCO_{2e})
ITR	Elasticity factor for additional and/or longer trips: the factor is fixed at 0.1
ARS_y	Additional road space available (percentage)
TR_C	Number of daily trips realized by passenger cars baseline (trips)
TD_C	Average trip distance for passenger cars (kilometers)
$EF_{KM,C}$	Transport emissions factor per distance of passenger cars before the project start (gCO_{2e} / km)
D_y	Number of days buses operate in year *y* (buses)

The values of parameters not yet listed are:

- ITR is fixed at 0.1 (default value AM0031 Appendix A point 1 Leakage parameters)
- TRC is 580,988 based on File 6, City of Johannesburg, 2007, Table 3.29 p. 53
- D_y is 365 days

All other values have already been included in former tables. The following table shows the resulting rebound leakage impact of the project.

Table 21: Rebound Leakage (CO_{2eq})

2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
-384	-380	-377	-373	-369	-365	-362	-358	-354	-351

Source: VER sheet

Negative leakage means that emissions are reduced beyond baseline-project emissions.

Step 3: Assess the impact of changing vehicle speed from passenger cars

The speed effect is not calculated as no data and projections are available. The speed effect is thus estimated as being 0 in line with AM0031 p. 20. Anyway based on the limited outreach of the project a speed effect would be highly improbable.

Total leakage is thus equivalent to rebound leakage. Negative leakage is not accounted for. Thus leakage is taken as 0. This is conservative and in accordance with AM0031 p. 22 formulae 25.

4.9. Net GHG Emission Reductions and Removals

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(15)}$$

where:

ER_y	Emission reductions in the year y (tCO_{2e})
BE_y	Baseline emissions in year y (tCO_{2e})

PE_y Project emissions in year y (tCO_{2e})
LE_y Leakage emissions in year y (tCO_{2e})

Table 22: Emission Reductions

Year	Estimation of project activity emissions (tCO_{2e})	Estimation of baseline emissions (tCO_{2e})	Estimation of leakage (tCO_{2e})	Estimation of overall emission reductions (tCO_{2e})
2012	17,649	60,112	0	42,463
2013	17,649	59,511	0	41,862
2014	17,649	58,916	0	41,267
2015	17,649	58,327	0	40,678
2016	17,649	57,743	0	40,095
2017	17,649	57,166	0	39,517
2018	17,649	56,594	0	38,946
2019	17,649	56,028	0	38,380
2020	17,649	55,468	0	37,819
2021	17,649	54,913	0	37,265
Total	**176,485**	574,777	**0**	398,292

5. Environmental Impact

The environmental impact of the project is considered positive. Following environmental impacts are expected:

- Reduction of air pollution basically particle matter, NO_x and HCs due to the use of Euro 4 buses with particle filters plus having a more efficient public transport system which spurs people to shift from passenger cars to the less polluting public transport.
- Positive impact on potential transboundary air pollution due to reduced emissions of air pollutants (PM, NO_x, SO_2 basically). Transboundary air pollution is a particular problem from pollutants that are not easily destroyed or react in the atmosphere to form secondary pollutants. Typical transboundary air pollutants are carbon monoxide, PM10, non-methane VOCs[96] and NO_x (resulting potentially in ground-level ozone which again is a major component of smog) or sulphur dioxide (SO_2 together with NO_x are primary precursors of acid rain).
- Reduced noise pollution due to a reduced amount of vehicles, improved traffic fluidity with less stop-and-go traffic and more modern units.

The positive and negative socio-economic and environmental impacts of the project are basically in the area of air quality, noise, waste and quality of life. The major socio-economic and environmental impacts identified during the different phases (site preparation, construction, operational) are[97]:

- During construction, negative impacts of dust and noise on affected persons who are living near to construction sites. Removal of green areas where bus-stations are built. However these impacts are temporary and mitigation measures are provided for;
- Reduced transit time and thus a positive impact on the quality of life;
- Safe and efficient transport medium thus improving quality of life;
- Improved air quality and less pollution thus also reducing pollution related health problems;
- Recovery of green spaces along the corridors;
- Potential negative impact on people working in the conventional transport sector (see stakeholder part);
- Creation of additional jobs e.g. temporary construction jobs and permanent formal jobs for the BRT system operation;
- Improved signalling creates positive benefits for the community e.g. in terms of less accidents;
- Improved wellbeing of the community due to the BRT operations.
- Roads constructed increases the value of land and thus generates a positive economic impact;

[96] Volatile Organic Components
[97] File 26c p. 3-4, File 26e p.3-4, File 26f p.2, File 26g p. 5-6, File 26i p.2

For negative environmental impacts, mitigation measures are identified[98]. These impacts are temporary and are considered not to be significant. The overall conclusion is that the project has positive environmental impacts and potential negative environmental impacts during construction are minimized, therefore the global impact is positive, i.e., the negative impacts are low in comparison to the project benefits[99].

An Environmental Management Assessment and Environmental Management Plan (EMP) were elaborated for each construction segment of the project. The studies have been performed corresponding to Phase I-A (in operation) and Phase I-B[100].

The project complies with all legal requirements of the environmental legislation of Gauteng Provincial Government, enforced by the Environmental Authority (Department of Agriculture, Conservation and Environment).

[98] See Files 36 and 37
[99] File 26b p.2, File 26h p.2
[100] File 26

6. Stakeholder Comments

Main stakeholders identified include the general public, people living near construction sites of trunk routes and owners as well as drivers of conventional public transport units (basically minibus-taxis).

General Public

They are the users of the public transport system and the prime beneficiaries due to a reduced travel time, less congestion (also relevant for users of private vehicles), less accidents and an improved air quality. Also various meetings with involved institutions took place to achieve a general consensus on the project.

Stakeholders and system users as well as the public in general may address complaints or remarks through the Rea Vaya[101] website or phone customer service (for general Rea Vaya queries phone the Johannesburg Call Centre on 011 375 5555 and for emergencies phone 011 375 5911). People placing complaints receive a personal addressed answer through the same mechanism used for addressing the complaint. Records of all complaints as well as follow-up measures are maintained by the Customer Service Department of Rea Vaya. Complaints concern, e.g, speed excess, full buses, bus delays, lack of buses, damages at bus-station. All complaints are categorized according to the type of complaint and means through which complaints were made (e.g. written, phone, Internet). Based on these reports, corrective action measures are taken by Rea Vaya. Rea Vaya has a service improvement plan which is based on evaluation reports. Included aspects concern both infrastructure as well as operational issues. Possible outcomes are e.g. an increase of bus frequencies, improved maintenance, driving practices for bus drivers, among others.

People Living Near Construction Sites

Persons living near to construction sites or sites where major bus-stations are built are potentially affected by these activities. Various meetings were organized with the affected people and their comments were received.

At construction sites, concerns are basically about disruptions of services, congestion and other inconveniences of daily life related to the direct (e.g. noise, dust) or indirect (e.g. congestion) construction impacts. The community through civil organizations such as residents associations have been participating in the project.

The main questions raised concerned the system itself, its purpose and constitution, benefits, the impact of the project on housing and workplaces, procedures for real-estate sales among affected residents, compensations for the value of real-estate sales and procedures for obtaining it, construction time periods, traffic management, among others.

In general the community was at all times informed and actively participated in the development of the project. It is important to mention that all the community inquiries made to the government have been addressed in time and form since the very beginning. The community through civil

[101] http://www.reavaya.org.za

organizations such as residents associations have been participating in the project at all levels of government. The remarks received from people living near to construction sites were followed-up and integrated by Rea Vaya. Also officials gave many seminars and presentations of Rea Vaya

Owners and Drivers of Minibus-Taxis

Owners and drivers of the existing (baseline) public transport system fear that they will suffer economic losses and want to be included in the system. Rea Vaya has been coordinating the project development closely with the transport organizations and has held numerous meetings with their representatives to discuss all parts of the project with the objective of democratizing the system, incorporating requirements of the existing transport sector into Rea Vaya and reducing resistance to the project.

The existing transport sector is directly involved in the system as the operator of trunk routes, complementary and feeder lines. After ten months of intensive negotiations, the City of Johannesburg and representatives of affected minibus taxi operators for Phase 1A reached an agreement on the contents of a future bus operating contract that was signed between them and the City[102]. An agreement was negotiated by the City of Johannesburg and representatives of 585 owners of minibus taxi vehicles that were serving the routes affected by Phase 1A of the Rea Vaya BRT System[103].

In order to participate in the project “Rea Vaya”, 313 minibus-taxi owners (of 585 vehicles[104]), decided themselves to constitute nine legal entities based on their taxi association of origin, each of the nine called a “Taxi Operator Investment Company - TOIC”. The objective of each company is to participate as a shareholder of the operating company of the Rea Vaya BRT. As a result of the negotiations the contract for the operation of “Phase 1A” was granted to the enterprise owned by nine Taxi Operator Investment Companies - TOICs, constituted by minibus-taxi owners who operated the route long before the initiation of Rea Vaya BRT.

[102] Files 19,20, 22, 33 and 34
[103] File 20, p.5
[104] File 20, p.4

7. Ownership

7.6. Proof of Title

Rea Vaya is a business unit within the Transportation Department. The Transportation Department[105] is responsible for planning transportation services and road infrastructure in the City of Johannesburg. It has planned, partially financed, and implemented the project.

7.7. Emissions Trading Programs

The project does not participate in any other emissions trading programs. South Africa is a Non-Annex I country and has no binding emission reductions. Also no national, regional or local emissions trading program exists.

[105] http://www.joburg.org.za/content/view/1226/78/

Annex 1A: Routes Rea Vaya Phase 1A

Planning Code (Passenger Code in brackets)	Route Description	Service Type	Length (km)[106]
C16 (C2)	Dobsonville to Maponya Mall (ext to UJ Soweto in 1B)	Complementary	24
C29 (C1)	Dobsonville / Meadowlands to Ellis Park East	Complementary	49
C3 (C3)	City Distribution Route	Complementary	17
F3003 (F5)	Eldorado Park to Lakeview	Feeder	9
F3008 (F1)	Naledi to Thokoza Park	Feeder	14
F3010 (F2)	Protea Glen to Thokoza Park	Feeder	21
F3014 (F3)	Jabavu to Lakeview	Feeder	5
F3018 (F4)	Mofolo to Boomtown	Feeder	9
T17 (T1)	Thokoza Park to Ellis Park East	Trunk	50

Source: Rea Vaya, 2010

Affected minibus-taxi routes of Phase 1A which have been withdrawn are included in File 38.

Annex 1B: Routes Rea Vaya Phase 1B

Planning Code (Passenger Code for 1A routes in brackets)	Route Description	Service Type	Length (km)[107]
C06	Windsor West & Cresta to Parktown & City	Complementary	30
C16 (C2)	Dobsonville to Maponya Mall (ext to UJ Soweto in 1B)	Complementary	24

[106] Turn-around length
[107] Turn-around lenght

C29A	Meadowlands to Orlando Stadium (ext to Highgate)	Complementary	16
C29 (C1)	Dobsonville / Meadowlands to Ellis Park East	Complementary	49
C3 (C3)	City Distribution Route	Complementary	17
C4002	Flora Centre to Parktown & Library Gardens	Complementary	28
F2001	Highgate to Lea Glen	Feeder	10
F2002	Highgate to Paarlshoop	Feeder	13
F3003 (F5)	Eldorado Park to Lakeview	Feeder	9
F3008 (F1)	Naledi to Thokoza Park	Feeder	14
F3009	Mapetla to Thokoza park	Feeder	9
F3010 (F2)	Protea Glen to Thokoza Park	Feeder	21
F3014 (F3)	Jabavu to Lakeview	Feeder	5
F3018 (F4)	Mofolo to Boomtown	Feeder	9
F5004	Parktown Distribution Route	Feeder	8
F3099	Pimville to Klipspruit	Feeder	8
F2004	Helen Joseph to Greymont	Feeder	7
F5001	Yeoville Feeder	Feeder	11
T17A (T1)	Thokoza Park to Ellis Park East	Trunk	50
T17B	Thokoza Park to Braamfontein	Trunk	45
T20	Thokoza Park to Parktown & Library Gardens	Trunk	46

Annex 2: Passenger Survey

The survey is realized bimonthly (6 times per year) with a minimal number of 500 passengers each to secure a confidence interval of 95% with a 5% error. Basically the survey asks the passengers which mode of transport they would have used in absence of the BRT. The categories of transport modes to choose from include buses, minibus-taxis, passenger cars, rail, Non-Motorized Transport (bicycle and pedestrian), others (metered taxis, motorcycles) and induced traffic (passenger would not have realized the trip in absence of the project). Passengers not willing to give an answer or who cannot identify a mode of transport are retired from the survey. The relative distribution is measured and the absolute numbers are calculated based on total passengers transported. The survey is in accordance with the approved methodology AM0031.

SURVEY MEASUREMENT OBJECTIVES AND DATA TO BE COLLECTED

The survey measurement objectives are:

1. Determine the mode of transport passengers of the BRT would have used in absence of the project activity.
2. Determine for passengers which would have used passenger cars in absence of the project the type of fuel used by the passenger car they would have taken in absence of the project.
3. Determine for passengers which in absence of the project activity would have used passenger cars the trip distance on the project system.

Data to be collected is:

1. Mode passengers would have used in the baseline.
2. Trip distance on the project system of passengers which respond with passenger cars.
3. Type of fuel used by cars for respondents of passenger cars.

TARGET POPULATION

Target population are the users of the BRT system aged over 12.

SURVEY SAMPLING PRINCIPLES INCLUDING SAMPLE SIZE AND DESIRED PRECISION

1. The sampling size is determined by the 95% confidence interval and the 5% maximum error margin. The sampling size used is minimum 500 valid surveys.
2. Sampling must be statistically robust and relevant i.e. the survey has a random distribution and is representative of the persons using the project transport system.
3. The methodology to select persons for interviews is based on a systematic random sampling based on the flow of passengers per station per day. The number of surveys conducted per station shall be proportional to the average number of entry passengers at that station (e.g. if 10% of passengers used station 1 as entry point then 10% of the surveys shall be conducted at that station). Records of minimum 1 week of passengers (entry station and passengers per day) shall be used to realize the survey design. Brackets per day can be used e.g. 6-9, 9-12,

12-15, 15-18. Also various stations can be clustered together. Surveys are conducted on stations of the BRT trunk routes. A new distribution of the surveys per station and per time bracket needs to be made if new trunk routes enter into operation.

4. Only persons over age 12 are interviewed
5. The survey is realized on all week days including weekends with the sample size per day being proportional to the number of passengers transported by the project per corresponding week day (e.g. if 15% of weekly passengers use the bus lane on Mondays then 15% of the surveys are conducted on Mondays). Surveys shall be conducted during the entire period of operation of the system e.g. 6AM to 11PM.

DATA COLLECTION PRINCIPLES

1. Non-responses should be recorded
2. Follow the defined sampling process
3. Note comments and other contextual events
4. Record and store all original surveys
5. Surveys are conducted at bus stations when people wait for bus-boarding. It should be avoided to realize the survey with people de-boarding the bus as latter will not want to invest time in a survey thus potentially giving wrong answers.
6. A random selection of respondents needs to take place. This can be ensured by asking every "x"th person entering the station (e.g. every 10th), starting counting upon termination of a questionnaire.
7. The specified number of surveys is realized for each station/time bracket.

SURVEY IMPLEMENTATION PRINCIPLES AND QUALITY ASSURANCE

1. The survey is realized by an independent third party with experience in surveys and/or transport.
2. Training of survey staff should take place to ensure an appropriate application of the survey.
3. The survey requires in general less than 5 minutes for its performance.
4. During data collection random checks on surveyors are realized either through an independent party or through the project owner to ensure that data is collected according to established procedures.

SURVEY FREQUENCY

The survey is realized 6x annually preferably every 2nd month. The selected weeks for surveys shall not correspond to a public holiday.

DATA REPORTING, PROCESSING AND ANALYSIS

1. Persons who respond negative to the control question 2a are counted as non respondent. This is conservative as the control question is only realized for respondents which indicate to having used high emission modes such as cars in the baseline. The control question is not a separate question but a question directly related to the foregoing one to control or ensure the response given and to eliminate potential answers given on purpose wrongly. Therefore bi-variable or bi-dimensional contingency tables are not applied.
2. A report is issued for each survey indicating all collected data

3. Data between years is compared. Variances might occur over time in terms of modes used and distances.

SURVEY

Interviewer:……………………………

Date: .-………………………………….

Time:…………………………………….

BRT station where the interview was performed:…………….

Name of person interviewed:……………………..

Phone number of person interviewed (if available):……………………..

Age over 12? ☐ Yes→ continue ☐ No: → stop

Question 1:

Assuming that Rea Vaya would not exist: What mode of transport would you have used for this specific trip you are doing currently?

For the interviewer:

- *The question is related to this specific trip and not to the trips realized by the person during the year in general.*
- *To clarify mention that you are comparing Rea Vaya with the transport system existing formerly respectively with the transport system which still exists in other parts of the city.*

Multiple choice **answers to question 1:**

(only tick one; if the passenger would have used more than one transport mode for the trip he is realizing currently then tick the mode which involves the longest distance):

1. conventional bus e.g. Metrobus (not Rea Vaya) → survey finished
2. Minibus-taxis→ survey finished
3. private car → please go to 2
4. per foot or bike → survey finished
5. Rail → survey finished
6. Other e.g. motorcycle or metered taxi → survey finished
7. would not have made the trip (induced traffic) → please go to 3

Question 2: *If the passenger responds with private car then ask:*

2A. Do you or your family own a car or do you have access to a car (e.g. company or friends car) or have you used a passenger car in the last 6 months?

☐ NO ☐ YES

2B. What fuel does the car use to which you have access?

☐ gasoline ☐ diesel ☐ gas (CNG, LNG or LPG) ☐ electric ☐ I don't know ☐ other:…….

2C. In which station did you start your trip (feeder, complementary or trunk line) and where will you finish your trip (feeder, complementary or trunk line)?

For the interviewer: Please advise the passenger that the original departing and final point is required. This may include bus trans-boarding such as first using a feeder line and then a main line. It is thus the origin and final destination of the passenger trip and not of the ride on this specific bus-line.

Entry station: …………………………………………… Departure station: …………………………………………………

3. If the passenger responds with induced traffic (he would not have made the trip in absence of Rea Vaya) realize the following control questions to ascertain that he has understood the question:

- Without Rea Vaya you would have stayed at home? *If the answer is NO it is NOT induced traffic*
- You do this trip only due to Rea Vaya? *If the answer is NO it is NOT induced traffic*
- Will you immediately return back after this trip with Rea Vaya or will you do something at the destination like go to work, school? *If the answer is NO i.e. the person goes to work or another activity it is NOT induced traffic*

If any of the above questions is responded with NO then it is NOT induced traffic. It is only induced traffic if the respondent answers all above questions with YES.

Annex 3: Referenced Files

File 1, National Department of Transport, Vehicle Registration Statistics, 2009

File 2, City of Johannesburg, Occupation rates vehicles, 2009

File 3, City of Johannesburg, Survey passengers Rea Vaya, 2010

File 4, Metrobus, Fuel consumption and distance driven, 2009

File 5, City of Johannesburg, distance driven minibus-taxis, 2010

File 6, City of Johannesburg, Integrated Transport Plan 2003/2008, Vol. 1, 2007

File 7, GTZ, Passenger and number of buses projections Rea Vaya, 2010

File 8, Logit, Rea Vaya Demand Modeling and Forecasting, 2007

File 9, City of Johannesburg, Rea Vaya BRT Project, 2008

File 10, City of Johannesburg, website: http://www.joburg-archive.co.za/2007/pdfs/joburg_overview2.pdf

File 11, City of Johannesburg, Project start date

File 12, ITDP, Rea Vaya Scoping Study, 2006

File 13, Logit, Rea Vaya – Operational design – Full Phase I, 2008

File 14, City of Johannesburg, Rea Vaya Phase 1B Revised and Final December 2010, 2010

File 15, Logit, Rea Vaya – Operational design, 2008

File 16, City of Johannesburg, Bus tender announcement, 2009

File 17, Metrobus, Bus statistics, 2010

File 18, City of Johannesburg, scrapping overview, 2010

File 19, City of Johannesburg, Participation Framework Agreement, 2010

File 20, City of Johannesburg, Negotiation Closure Agreement, 2010

File 21, Taxi Scrapping Administrator, Scrapping of Taxis for the City of Johannesburg, 2010

File 22, City of Johannesburg, Plenary Resolution Annexure A, 2010

File 23, Scrapping registration, 2010

File 24, E. Visser, City of Johannesburg,– so far, so good for Rea Vaya, 2009

File 25, City of Johannesburg, Integrated Transport Plan 2003/2008, Executive Summary, 2007

File 26, Environmental Permits Rea Vaya, includes Files 26a to 26i

File 27, Department of Transport, Public Transport Action Plan Phase I (2007-2010), 2007

File 28, GTZ, Training Course: Mass Transit, 2004

File 29, GTZ, Mass Transit Options, 2005

File 30, City of Johannesburg, Financial Information for BRT Rea Vaya Carbon Project, 2010

File 31, City of Johannesburg, Planned versus actual performance Rea Vaya, 2010

File 32, City of Johannesburg, Fuel consumption buses Rea Vaya, 2010

File 33, City of Johannesburg, Communication Taxi operators, 2010

File 34, City of Johannesburg, Stakeholders, 2010

File 35, Philip H. Goyns, Modelling real-world driving, fuel consumption and emissions of passenger vehicles: a case study in Johannesburg, 2008

File 36: Guateng Provincial Government, Basic Assessment Report and JDA, Environmental Management Plan for Bertram Rd, Main Rd to Main Reef Rd, Potchefstromm Rd to Immink Rd, Van Onselen Rd to Soweto Highway, Jabulani to Orlando, Klipspruit Valley Rd to Sofasonke, Lenasia to Koma Rd, Intersections on Nasrec Rd, Santoga v. to Nugget Str.

File 37 inludes:

a). JDA Collection of data in the City of Johannesburg for a CDM emissions baseline study along BRT routes and collection of local air pollutant data, 2009

b). CSIR, AIR QUALITY STATUS QUO ASSESSMENT FOR THE CITY OF JOHANNESBURG, 2010File 38, City of Johannesburg, affected minibus-taxi routes of Phase 1A, 2011

File 39, Gov. of South Africa, Register of all Legislations, Policies and Strategies, 2009

File 40, City of Johannesburg, Framework for NMT, 2009

File 41, Department of Minerals and Energy, Biofuels Industrial Strategy of the Republic of South Africa, 2007

File 42, Metrobus, statistics, 2011

Annex 4: Sensitivity Analysis

A sensitivity analysis is carried out for data and parameters, which are used to calculate baseline, project and leakage emissions. The sensitivity analysis is performed on all parameters except default and IPCC values listed as monitored values/parameters or values to be monitored. The sensitivity analysis is based on calculating the change of the data parameter that would be required to reduce emission reductions by 5%. This value gives an indication of the magnitude of change of the data parameter required to significantly change calculated emission reductions. Based on the methodology sensitive parameters are those where a change of less than 10% leads to a reduction of ERs of more than 5%.

Sensitivity Analysis

Parameter	% Change required for 5% less ERs	Sensitive or Not	Comment
Project passengers	4% less	Sensitive	The amount of project passengers is recorded daily by the system and also compared with fare revenues, thus this data is well controlled.
Project fuel consumption	>10% more	Not Sensitive	
Specific fuel consumption cars	> 10% reduction	Not sensitive	
Specific fuel consumption minibus-taxis	> 10% reduction	Not sensitive	
Specific fuel diesel buses	> 10% reduction	Not sensitive	
Specific fuel consumption gasoline buses	> 10% reduction	Not sensitive	

Number of passengers baseline bus per day	>10% more	Not sensitive
Distance driven baseline buses per day	>10% more	Not sensitive
Occupation rate passenger cars	> 10% increase	Not sensitive
Occupation rate minibus taxis	> 10% increase	Not sensitive
Average trip distance cars	> 10% reduction	Not sensitive
Average trip distance taxis	>10% reduction	Not sensitive
Daily distance driven per cars	> 10% change	Not sensitive
Daily distance driven per taxi	> 50% change	Not sensitive
SRS	> 10% change	Not sensitive
Bus units retired	> 10% change	Not sensitive