Operational Plan-Phase 1 of IPTN

2016-2020

Mangaung Metropolitan Municipality

Volume 1

November 2016

Revision 0

Content

Annexures

1 Introduction

The development of the Integrated Transport Networks (ITN) in metropolitan areas is a process driven at national level by the NDoT. The ITN is planned and implemented by Metropolitan authorities under the direction and guidelines set by the NDoT and funded by National Treasury (NT).

The endeavour is in line with the overarching national objective of improving the quality of public transport services for communities countrywide, to reduce the cost of service delivery, to minimize the subsidy burden on all spheres of government, and to provide affordable fares to public transport passengers. Another objective is to reduce private car traffic volumes that minimise congestion and travel time, accidents, harmful gas emissions, and improves traffic safety.

The Mangaung Metropolitan Municipality(MMM) Integrated Public Transport Network(IPTN), hereafter referred to as the Mangaung IPTN, is intended to transform the public transport system in the City through the provision of a high-quality, safe and affordable public transport system. The IPTN system is aimed at improving the provision and level of service of road-based public transport.

1.1 Overview of Mangaung Metropolitan Municipality (MMM)

The Mangaung Metropolitan Municipality (MMM), hereafter Mangaung, as illustrated on **Figure 1-1** covers approximately 6863 km² and comprises of three prominent urban centres surrounded by an extensive rural area. The urban areas include Bloemfontein, Botshabelo and Thaba Nchu. Bloemfontein is the judicial capital and one of the largest cities in South Africa. Furthermore, it is the administrative capital of the Free State Province and represents the economic hub of the provincial economy.

The Municipality is centrally located within the Free State Province and is accessible via several national and provincial routes. Due to the central location and function of Bloemfontein in the context of Free State Province, most of the provincial and national road networks converge at the City, resulting in the radial network evident on **Figure 1-2**. The most prominent routes include the N1 (which is the primary north-south corridor in South Africa), the N6 (which links Bloemfontein to the Eastern Cape via Aliwal North), and the N8 (which links Lesotho in the east with Kimberley in the west via Bloemfontein). Other prominent routes converging in the town include R702 to Dewetsdorp, R706 to Jagersfontein, R64 to Warrenton, R700 to Bultfontein and R30 to Virginia/Welkom.

The area is also serviced by an east/west and north/south railway line (serving the same movement desire lines of routes (N1 and N8) and the Bram Fischer National Airport. An airport was historically developed outside Thaba Nchu, but is currently no longer in operation.

Botshabelo is located approximately 60km to the east of Bloemfontein along route N8 and represents the largest single township development in the Free State. It was established as a decentralised residential township in the early 1980s and was intended to provide much-needed labour to Bloemfontein without the inconvenience of having the labour residential areas at employer's doorstep.

Another 12km further to the east of Botshabelo is the third urban node, Thaba Nchu. It used to be part of the Bophuthatswana homeland area and is surrounded by a large expanse of rural settlements on trust (communal) land as clearly visible in the far eastern parts of the Mangaung municipal area.

The surrounding rural areas of Mangaung accommodate extensive commercial farming in the west and communal commercial/subsistence farming in the east around Thaba Nchu.

The population in MMM was in the order of 775 180 people in 2011, of which 60% (464 588) lived in Bloemfontein area, followed by 34% (264 000) who lived in the Botshabelo/ Thaba Nchu area. The remaining 6% (46 591) of the population live in DeWetsdorp, Wepener and the rural areas surrounding Bloemfontein and Botshabelo/ Thaba Nchu.

MMM is the largest contributor to the GDP of the province and boasts a fairly diverse economy. There is, however, a disturbing downturn in the Gross Value Added by the region substantiated by the fact that the majority of economic sectors have declined during the period 1996 – 2011. The exceptions in this regard are mining and quarrying, and general government services where a modest increase of 0.0% to 0.1% and 2.7% to 2.8% was attained during this period.

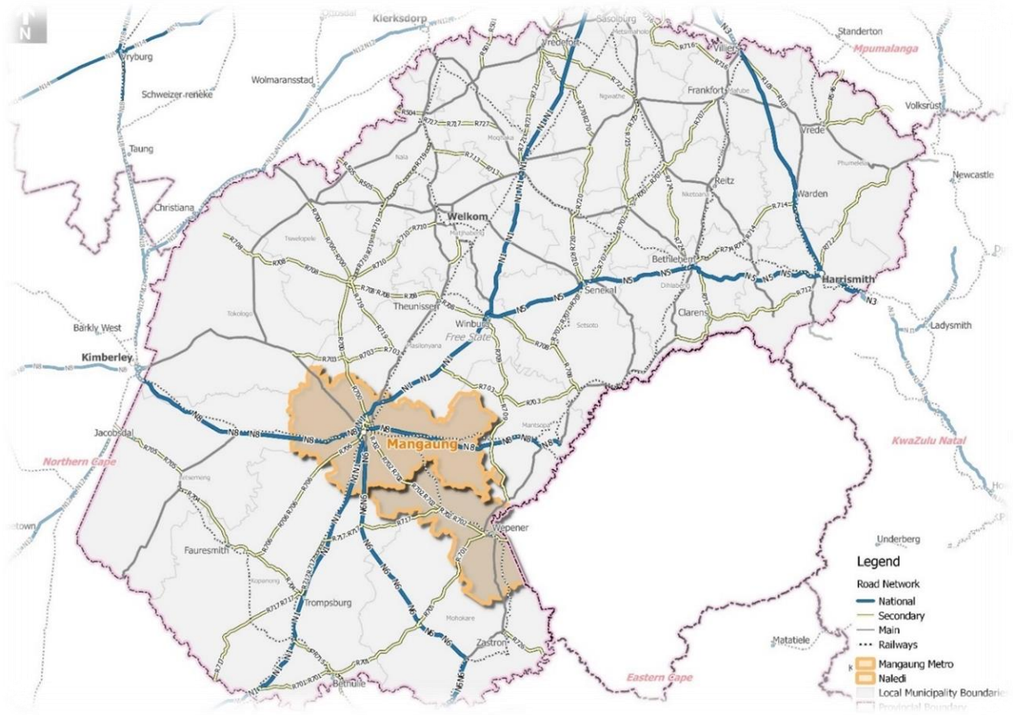


Figure 1-1: Regional Locality

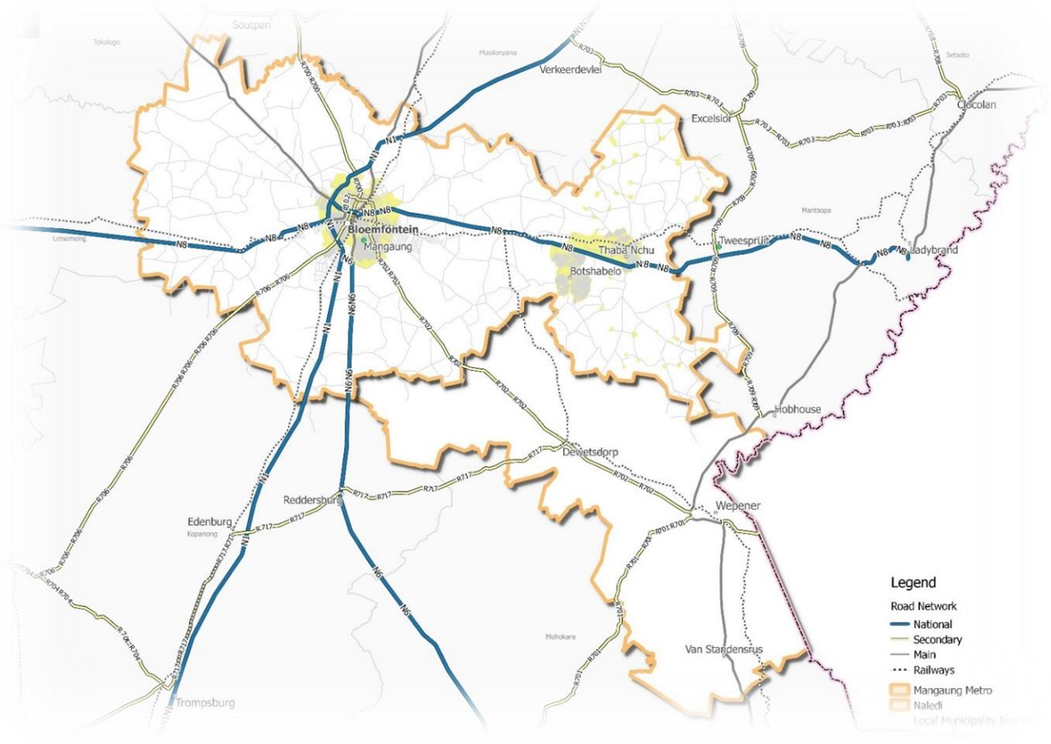


Figure 1-2: Mangaung Local Municipality

1.2 Transportation Overview

Mangaung is known as the “walking city” with more than 17% of all work-related trips made by walking all the way from origin to destination (National Household Travel Survey 2013- NHTS 2013). The NHTS 2013 furthermore estimate that approximately 190 000 work-related person trips are made during this period. **Figure 1-3** reflects the total number of trips generated during the morning peak period from each Traffic Analysis Zone (TAZ). The highest number of trips are generated from the Mangaung TAZ (91 000), followed by the Botshabelo/Thaba Nchu (42 235) cluster and Bloemfontein (45 454). The mode mostly used by travellers from Bloemfontein is the private vehicle, whereas most trips from Mangaung and Botshabelo/Thaba Nchu are undertaken by walking and public transport..

Table 1-1 presents the mode split per origin TAZ with a total mode split for the Mangaung Metropolitan area of 32.56%-taxi, 10.55%-bus, 8.44% with lift-clubs or as a passenger, and 29.3% with private vehicles. The mode split per origin-destination pair (TAZ pairs) are reflected in **Diagram 1-1.** More than 40% of passenger trips are made by public transport and at least 17% of passengers travelling during the morning peak period walk all the way to work. This demand pattern thus calls for a transportation system that provides safe and reliable services.

The Municipality is currently in the process of finalising the Integrated Public Transport Network (IPTN) Plan 2014, expected to be completed by April 2017. The IPTN aims to bring an affordable public transportation alternative to the citizens in Mangaung and will address trends in demand for transport services by mode and income group; average trip lengths (time, distance, cost, reliability, safety).

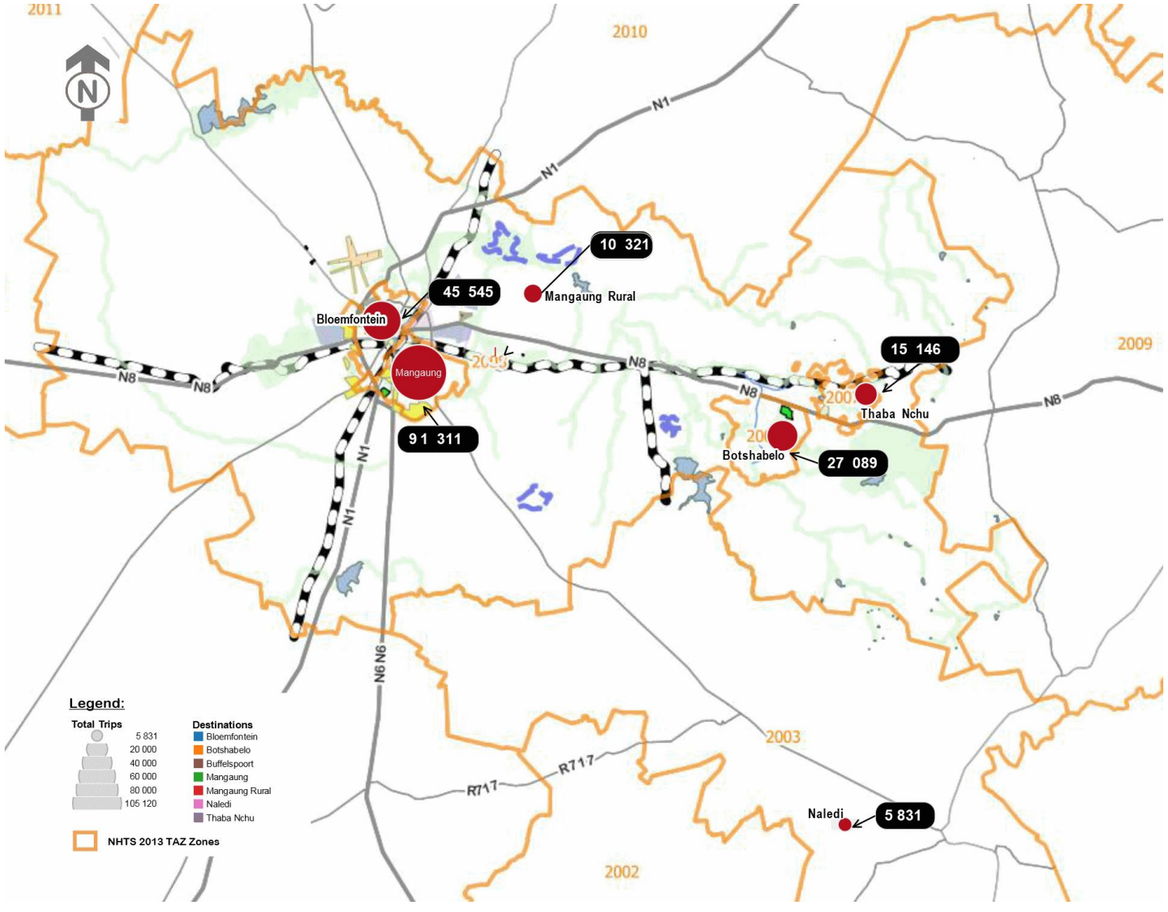


Figure 1-3: NHTS 2013 – Total Daily Trips Generated from Traffic Analysis Zones in Mangaung

Diagram 1-1: Main Mode to Work (NHTS 2013)

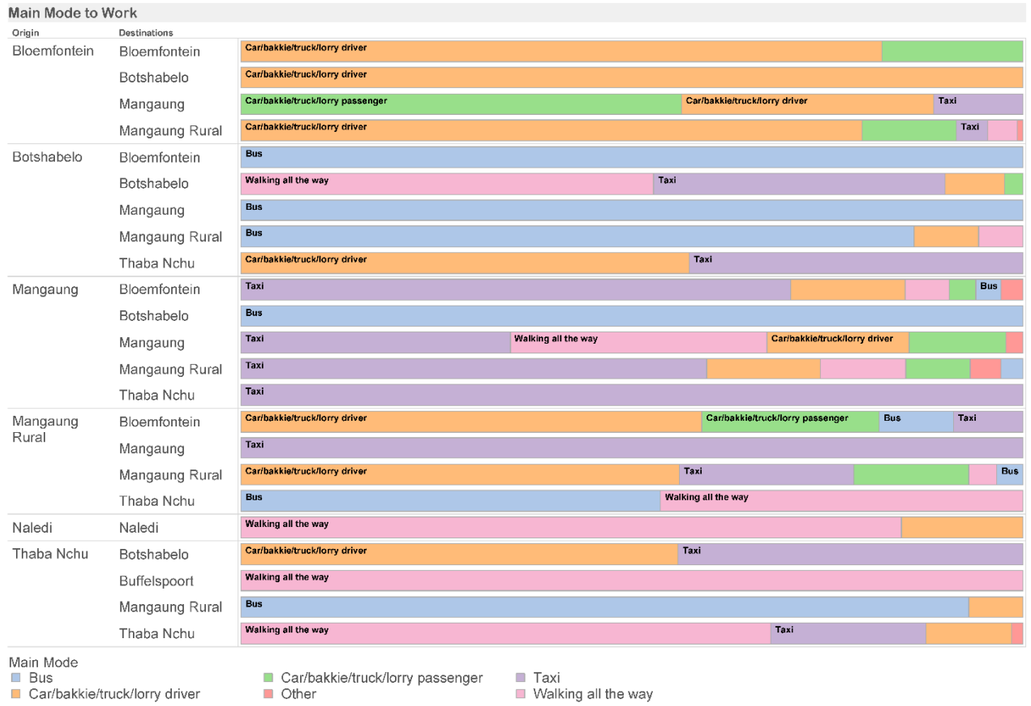


Table 1-1: Main Mode to Work per Origin Zone

Origin	Bus	Car/bakkie/truck/ lorry driver	Car/bakkie/truck/ lorry passenger	Taxi	Walking all the way	Other
Naledi		15.48%			84.52%	
Bloemfontein		77.24%	16.24%	3.47%	2.59%	0.46%
Mangaung	2.78%	15.10%	8.19%	56.31%	14.27%	3.34%
Botshabelo	43.98%	9.32%	1.09%	18.67%	26.94%	
Thaba Nchu	33.55%	10.35%		13.01%	42.25%	0.85%
Mangaung Rural	7.55%	49.91%	14.49%	22.60%	5.45%	
Total	**10.55%**	**29.53%**	**8.44%**	**32.56%**	**17.16%**	**1.77%**

1.3 Vision for Transport and System

The transportation vision defined for the city is:

“By 2015 Mangaung is recognised nationally and internationally as a safe and attractive place to live, work and invest, is served by an effective, efficient, reliable, safe, affordable and convenient transport system with a public transport focus, providing high levels of mobility and accessibility for the movement of people and goods, with a focus on integrated strategic planning between spatial development, transportation systems and economic development to enhance the quality of life in the area with minimum negative impact on the environment”.

This vision will be the basis of the design principles for the IPTN system.

1.4 Structure of Report

The development of a Public Transport System is an iterative process and is refined over time through the development of the IPTN Plan and Operational Plans to implement the phases identified in the IPTN. This report provides an overview of the Full Integrated Transport Network, methodology used for the design and phasing thereof. The identified phases are detailed to determine infrastructure and operational requirements (roadways, stations, services, support systems, etc). These are costed and evaluated to determine the financial viability and sustainability of each phase taking into consideration:

- Capital cost and Operational cost,
- Industry transition;
- Business and Financial aspects,
- Marketing and Communication;
- Funding available.

The report relies on the Guidelines and Requirements set for the qualification for a Public Transport Network Grant. The guidelines stipulate that Operational plans need to include a:

- **Project Management Plan** (project planning coordination, budget management, time management, management information systems, risk assessment, and quality assurance);
- **Operations Plan** (transport technologies and modes evaluated, demand modelling, financial modelling, full network route plan to a conceptual (sketch-plan) level, detailed operational system plan/s for prioritised corridor/s,universal design access policy and plan, operational characteristics, equipment and vehicle specifications, traffic modelling, integration of IPTN with existing transport modes, including rail and informal services, and a NMT integration plan);
- **Business and Institutional Plan** (business structure, institutional plan, industry transition plan, operator contracts, finance plan, economic evaluation including the calculation of benefit-to-cost ratios for development in the priority corridor);
- **Marketing and Communications Plan** (marketing and branding plan, communications plan); and
- **Infrastructure Design Plans** (road works, top structures, depot facilities, control centres, non-motorised integration facilities, etc.).
- Full Network Plan for the city providing detail on high level phasing and cost for the total system.

1.5 Report Structure

In response, the operational plan for the MMM integrated transport network was developed during 2014. This Draft First Order Operational Plan was adopted by Council in 2014, given that the areas identified for clarification and a business and financial plan are developed.

The area identified for clarification are:

- an update of the Spatial Development Framework incorporating the cities spatial re-structuring policy,
- the revision of the land use models for the base year and future years, and
- the re-evaluation of the proposed network and system design details stemming from the above updates;
- Development of a business and financial plan.

With the First Order Operational Plan as the departure point the document is structured to provide the criteria assumptions and results of the iterative process used in the development of the operational plan for the Mangaung IPTN.

An iterative process is required since a system is designed (capital and operational) stemming from a set of infield surveys (traffic counts, household travel survey, taxi facility surveys etc). This design however needs to be gauged against policies relating industry transition, funding availability, minimum business and institutional requirements for the effective operation of a system. The first design needs to be adjusted in terms of capital and operational and other aspects till it can fit into the funding available without compromising quality of the system.

The approach to developing this system and related operational plan are presented in **Figure 1-4.**

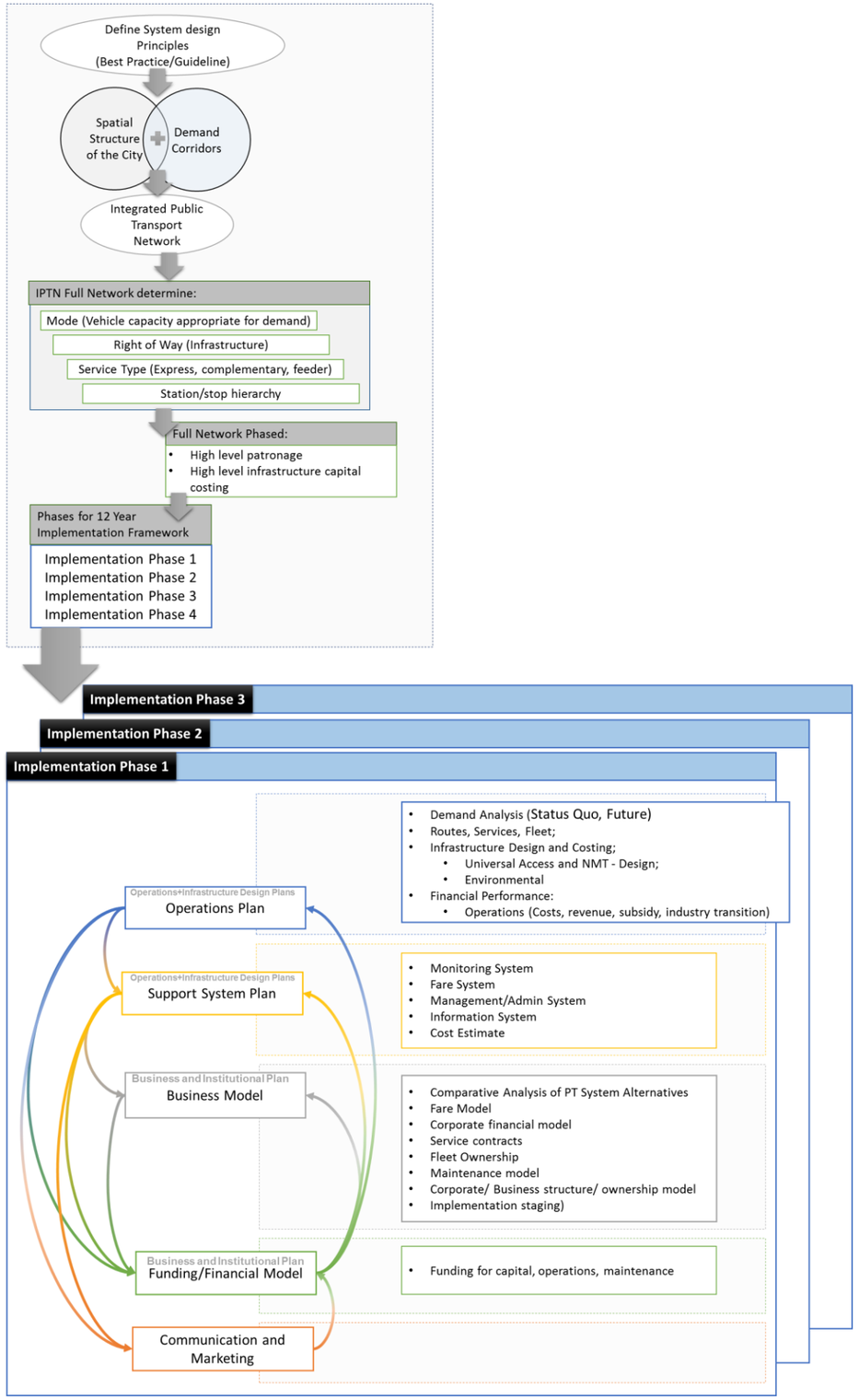


Figure 1-4: Operational Report Structure

2 Design Principles

The First Order Operational Plan 2014(Ops. Plan-2014) applied a full network design methodology developed from various international best practises. The outline of the methodology is presented in **Figure 2-1**. The methodology represents an integrated approach between land use, public transport movement, infrastructure provision and passenger convenience. The report concluded that areas of improvement to the Integrated Public Transport Network (IPTN) network design were to revisit the spatial structure and land use models for the base year and future years. This report relies on the update of land use model and the preparation of future land use scenarios that align with the overall spatial development framework for the city.

The chapter structure follows the design-methodology approach and provides detail pertaining to data used and changes made to the design approach per component of the IPTN network.

The methodology can be described as follows:

- Contextualise the spatial orientation of the city including the City's demographic profile (population density, income levels, car ownership etc.).
- Land Use Model (2015, 2025, 2036)
- Define primary and secondary demand corridors (movement networks);
- Develop a full IPT Network for MMM;
- Select appropriate road links to service the identified network
- Evaluate the full IPTN defined in terms of:
  - network coverage;
  - transfer between routes and services;
  - directness of routes and services; and
  - corridor and route spacing.
- Where necessary the network is adjusted to comply with minimum design standards.

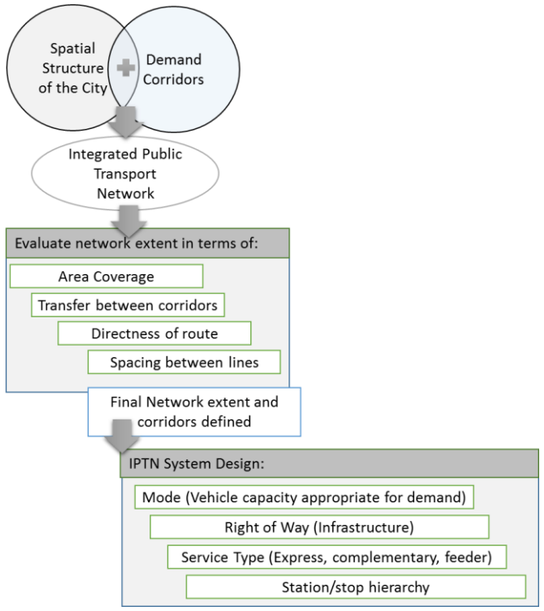


Figure 2-1: IPTN System Development Methodology

The full network is divided into phases based on primary and secondary demand corridors and spatial coverage. For each of these phases routes and services area are determined. For each phase the patronage is estimated. The patronage estimation and routes are then used to determine the:

- Appropriate mode for each phase and network;
- Right of way – infrastructure (dedicated bus way, mixed traffic etc.)
- The service type and routes are revisited based on the outcome of the demand modelling process;
- Stations and stop position and size is finalised.

Based on these routes, services and station positions are determined. The appropriate mode, infrastructure,

- Determine right of way appropriate per demand corridor, and stations and stops positions, and hierarchy.

2.1 City Spatial Structure and Demand Corridors

The approach and data incorporated in the development of the City Spatial Structure and to derive the Demand corridors are:

- Draft First Order Operational Plan 2014 (Ops. Plan-2014);
- Contextualise the spatial orientation of the city including the City's demographic profile (population density, income levels, car ownership etc.).
- Demographic- and Economic Forecasts (2025, 2036)
- Land Use Model (2015, 2025, 2036)

- Obtain regional and local travel patterns and mode use from Ops. Plan-2014 and enhance with National Household Travel Survey 2013. The results and outcome of NHTS 2013 were available after the finalisation of the Ops. Plan-2014. The final demand corridors will be determined once the Mangaung Metropolitan Municipality (MMM) Household Travel Survey is available during January 2017,
- Determine existing public transportation demand to identify main travel corridors (classified public transport link counts, public transport facility surveys and bus and taxi on-board surveys). Align these corridors with the origins and destinations as defined from spatial structure, NHTS 2013 and MMM HTS 2017(once available),
- Define primary and secondary demand corridors (movement networks);
- Develop full IPTN.
- The full network is evaluated based on the same methodology applied in the Ops. Plan-2014 pertaining to:
- Network extent -

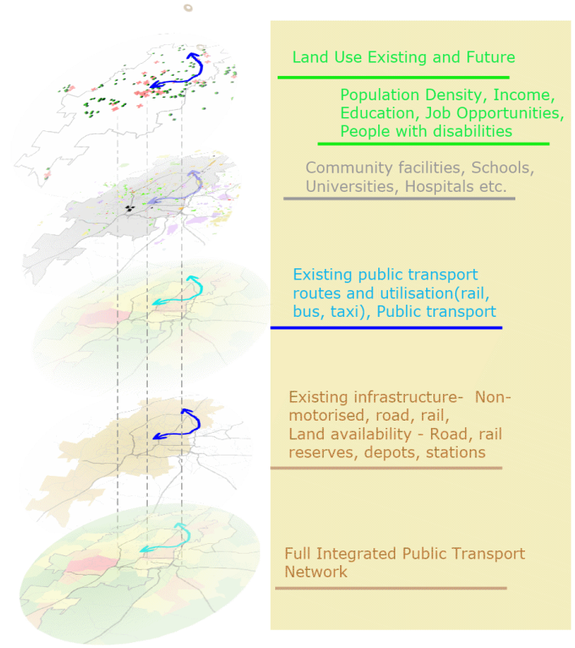


Figure 2-2: Contextualise Spatial Orientation of City – Input data/parameters

2.2 Network Evaluation Criteria

The principles that were selected to evaluate a representative network are:

- Area coverage of the network (Access to Public Transport);
- Transfer between routes and services (Mobility);
- Directness of routes and service (Mobility); and
- Spacing between routes and corridors (Economic Feasibility, Frequency of Service versus Accessibility).

2.2.1 Area Coverage

One of the first factors to consider in transit system design is the extent of the network and the area it covers/serves. A transit network should ideally cover to the greatest extent possible whilst balancing what is economically reasonable and socially desirable / equitable.

Areas within a 5-minute walking distance from transit stations are the primary service areas; the highest number of potential passengers living in this area can be expected to make use of the available service, provided it is of satisfactory quality.

Areas with a 5 to 10-minute walking distance from a public transport stop represent the secondary service area; in this area, the percentage of people willing to use the transit service reduces rapidly, the further they are from a public transport stop.

The unwillingness of people to walk long distances is illustrated in **Figure 2-3**. The figure illustrates that people living or working in an area that requires more than 10 minutes of walking to a public transport stop, will require some form of feeder system in conjunction with the primary transport service.

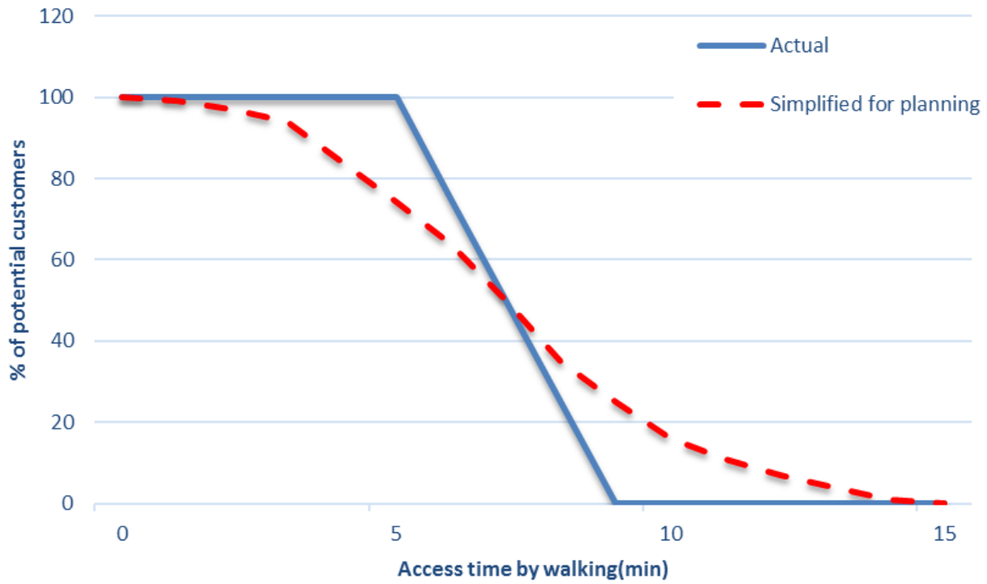


Figure 2-3: Potential Transit Passengers using Transit as a Function of Walking Access Time

2.2.1.1 Transfer between Routes and Services

Once the area coverage has been determined, various operational factors should be examined such as possible transfers between routes and different modes. Passengers always prefer a direct ride as opposed to one that requires a transfer. Passengers exhibit a reluctance to transfer primarily due to the conditions under which transfer takes place. Public transport users are not likely to transfer or switch mode if the total journey length is less than 10 km. A passenger will transfer mode within the first 5km of the journey given that the next and possible final leg of the journey is more than 10km. This rule will be used to determine if transfers can be allowed on primary demand corridors.

2.2.1.2 Directness of Routes

The directness of a route can be defined as the ratio between the actual travel distance between two points when using the transit system, and the straight line distance between the two points. This ratio should preferably be minimised, although this can prove to be quite difficult in some cases because transit routes are constrained by street patterns and topography. The best way to minimise the “Directness of route ratio” is to create routes that connect large traffic generators (land use) and place routes along the highest passenger desire lines, while serving populated areas in between as much as possible.

Optimising the directness of the route is often in direct conflict with an attempt to maximise coverage. The best coverage is often obtained by using circuitous routes, rather than direct routes. Direct routes are justified in areas where transit demand is high, but in areas with low demand service would be too infrequent if direct routes where used.

2.2.1.3 Spacing Between Corridors and Routes

The spacing between routes should consider the distance between parallel routes determined by the density of travel demand along parallel corridors. As mentioned before, a person is well served by a transit system if he/she resides within a 5-minute walking distance of the transit line (approximately 400m if a person walks at a speed of 1,3m/s).

For a given transit demand in one direction, there is an option of either supplying a few routes with frequent service or many routes with infrequent services. In general, it is preferable to have fewer lines with very frequent service rather than many lines with infrequent services.

If there is sufficient demand, line spacing of 800m is advised (which means maximum walking distance from transit service will be 400m). However, if demand is not substantial enough to support lines so close to each other, spacing can be increased to 1,6km, which will result in a maximum walking distance of 800m (10 minutes), which is also still acceptable. Spacing larger than this will typically result in poor coverage.

2.3 Mode Strategy

MMM is known as the walking city due to the distance that people walk and the topography of the area. To embrace this culture the mode strategy from the 2014 Operational Plan is retained. The mode strategy is refined by the adoption of a node strategy and the selection of a mode between nodes based on the volume of passengers that will travel using primary and secondary modes. The number of passengers travelling to local nodes or secondary nodes for more than 3 km will determine if a motorised feeder service is required to the node. The mode strategy and catchment area per mode is presented in **Figure 2-4**.

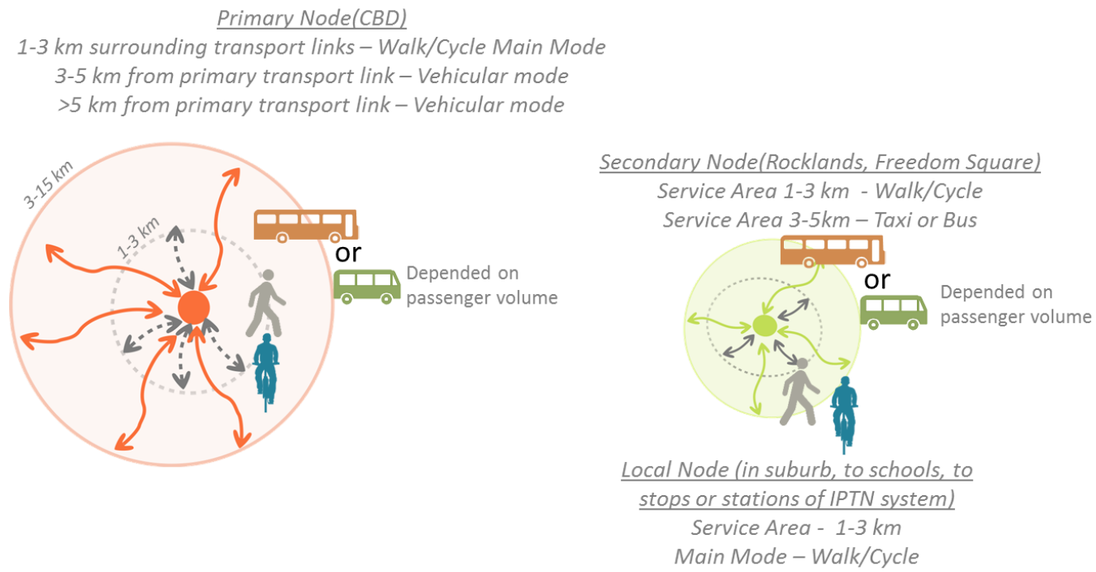


Figure 2-4: Node hierarchy and associated mode strategy

Vehicular modes can be road or rail based depending on the volume of passengers and the distance between nodes. The selection of the appropriate mode is based on the number of passengers per hour that needs to be transported along a specific corridor. Passenger volumes per mode per the Ops. Plan-2014 are provided in **Table 2-1**. These volumes will be use to evaluate when a motorised service can be implemented along a corridor to ensure long term sustainability and viability.

Table 2-1: Mode Capacities

Non-motorised	Peak Hour Passengers	Distance	BRT - Exclusive Right of Way kerb lane	Peak Hour Passengers	Distance
	<500	1 -3 km		3,000 to 6,000	< 35 km
Mini-bus Taxi - Mixed Traffic			BRT - Exclusive Right of Way Median/Separate Bus Way Express service (one lane)		
	<3 000	< 10 km		8,000 to 15,000	< 35 km
Bus –conventional - Mixed Traffic			BRT - Mixed traffic		
	2,500 to 4,000	< 50 km		2,000 to 6,000	< 35 km
Quality Bus Service - With signal priority measures			Heavy Rail - Exclusive Right of way		
	2,500 to 6,000	< 50 km		20,000 to 80,000	>15 km

2.4 Routes

The route types that will be considered during the development of the system are trunk routes, complementary routes and feeder routes prioritised to be non-motorised modes. Feeder routes serviced by vehicular modes will not form part of the system in the short term (Refer to **Figure 2-6)**. The purpose of feeder routes is to collect passengers from an area surrounding a specific node and bring passengers to the nearest stop or station where passengers then transfer to services operating along complementary or trunk routes. Considering that the CBD of Bloemfontein is not more than 12km from the most of the surrounding suburbs except Botshabelo or Thaba Nchu, the option of feeder routes in Bloemfontein and Mangaung Township will lead to increase in journey times and was thus not considered suitable for implementation.

2.5 Services

Several service types were proposed in the Ops. Plan-2014. For the update and evaluation of the system two types of services will be utilised during the design of the operational plan for Phase 1 of the MMM IPTN system, these include express and local services. **Figure 2-5** illustrate the service concepts.

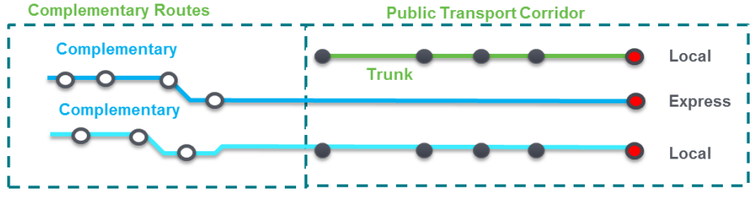


Figure 2-5: Service Design

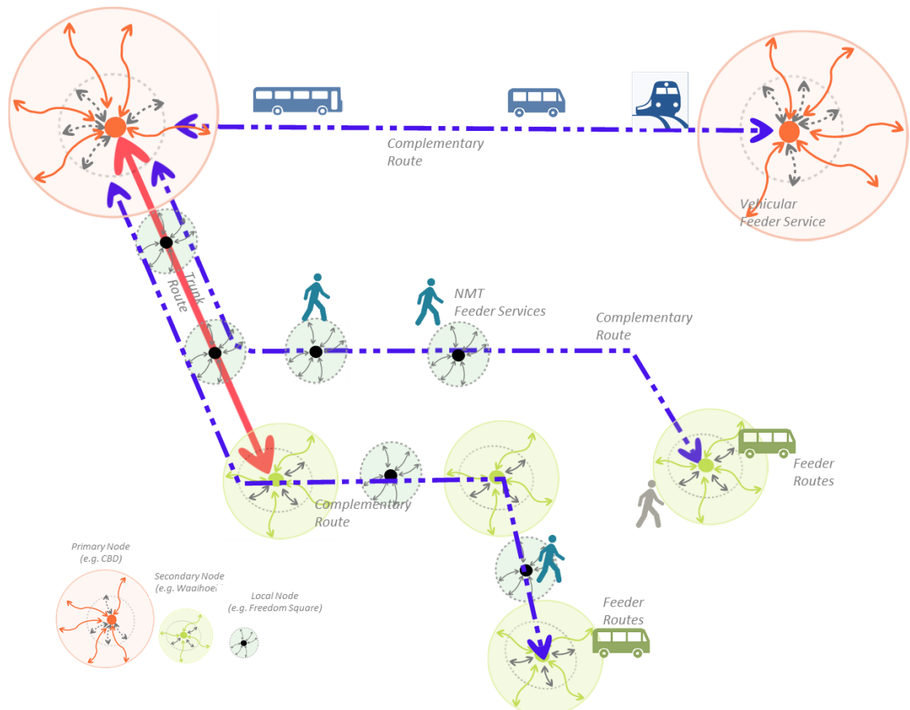


Figure 2-6: Service Concept

2.6 Operational Hours

The system will provide services for 12-hours of the day from 06:00 in the morning till 18:00 at night for the first phases of implementation. The system operational hours can be expanded especially taking into consideration future implementation phases from Bostshabelo and Thaba Nchu.

2.7 Infrastructure (right of way)

The first order operations plan proposed a full BRT option with segregated bus lanes and median stations. However, stemming from several detailed studies (macro-economic and traffic impact) done for the update of the project it was concluded that a mixed traffic operational model and infrastructure design need to be considered during the evaluation of the full network and the selected first phase of implementation. Refer to **Annexure B** for the comparison between full BRT versus BRT lite option for MMM.

Mixed traffic operations imply that no dedicated lane is provided or constructed for public transport operations. A typical public transport environment is presented in **Figure 2-7**. Mixed-traffic operating in general traffic lanes is suitable for operation with relatively low congestion, but may still result in buses being subjected to delays caused by traffic. Mixed-traffic operation complicates capacity calculations for both bus and other vehicle flow since it exposes buses to possible traffic congestion and slows general traffic as buses must stop to collect passengers.

The typical station and stop configurations that can be implemented as part of the mixed traffic operational model are presented for different intersection and road classes:

- Figure 2-8 - Far-Side Large Stations -Bus Stop In Lane;
- Figure 2-9 - Far-Side-Uncontrolled Station-Bus layby;
- Figure 2-10 - Near-Side Uncontrolled Station –Bus Stop In Lane; and
- Figure 2-11 - Near side – Uncontrolled Station (Queue Jump).

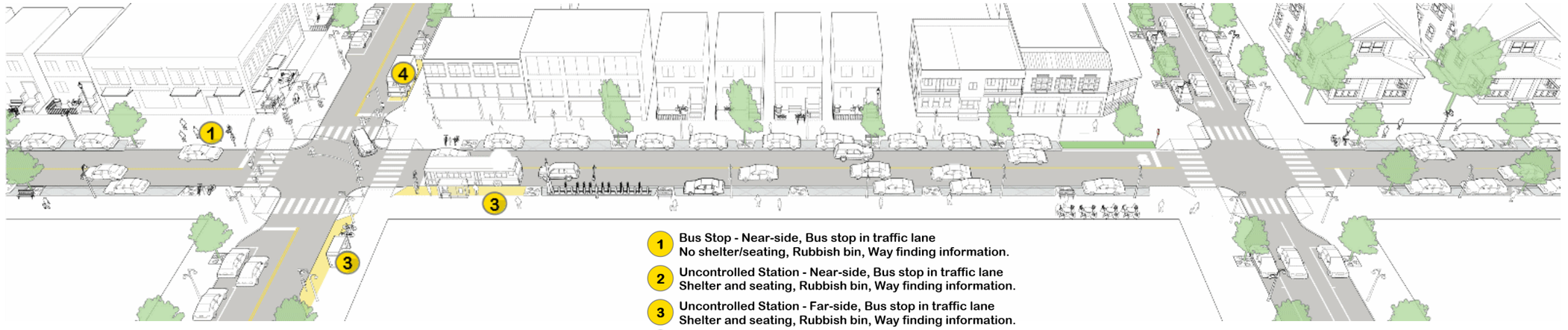


Figure 2-7: Typical Mixed Traffic Environment for Quality Public Transport Service

Figure 2-8: Far-Side Large Stations -Bus Stop In Lane

Figure 2-9: Near-Side Uncontrolled Station –Bus Stop In Lane

Figure 2-10: Far-Side-Uncontrolled Station-Bus Pull-Out

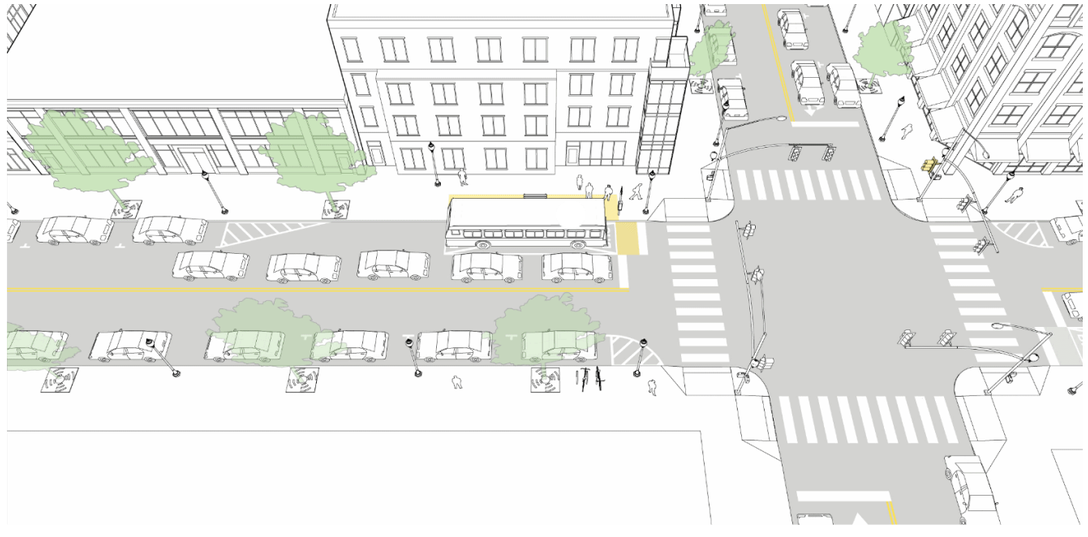


Figure 2-11: Near side – Uncontrolled Station (Queue Jump)

2.8 Infrastructure Stations

Public transport stops, stations, and terminals come in many sizes, with differing levels of activity and passenger amenities, but all serve as points where public transport passengers begin, end, or continue their trips. The quality of the passenger environment at stops, stations, and terminals are important elements of a public transport system and the perception of passengers of a public transport system.

Stops, stations, and terminals can include a number of elements, like, waiting areas, walkways, doors, stairs, escalators, elevators, fare gates, ticket machines, information displays, and bicycle storage facilities. Station element design involves a combination of estimating passenger flows and providing sufficient space for passengers, as determined by a selected design level of service.

Station design must accommodate persons with disabilities, but attention should be given to designs that are convenient to passengers with disabilities (e.g., elevators co-located with stairways), rather than merely Universal Accessible compliant (e.g., an elevator provided in a remote location).

The MMM IPTN facilities comprise of four types of facilities:

- Controlled access station;
- Uncontrolled access station; and
- Stops.

The selection of the type of facility design that needs to be used per stop point along routes was derived from:

- Estimated number of passengers that will board/alight at the point;
- Land-use in direct vicinity of the station;
- First or last station along trunk routes are controlled access station to function as a gateway to the system; and
- Only stops will be provided along complementary routes.

Design principles for controlled access stations are provided in Table 2-3, uncontrolled access stations and stops design principles are listed in Table 2-4 Table 2-5.

The design level of service for each element of the station or stop are provided per facility type and the LOS need to be determined per station through applying evaluation methodologies provided in “Transit Capacity and Quality of Service Manual—2nd Edition “ when patronage estimation per station is available.

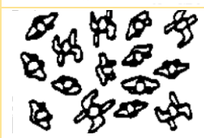
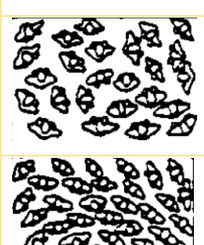
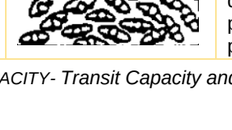
2.8.1 Levels of Service for Queuing and Waiting Areas

An illustration of the Level of Service (LOS) concept for passenger queuing and waiting is reflected in **Table 2-2**. The thresholds were developed based on average pedestrian space, personal comfort, and degrees of internal mobility. LOS is presented in terms of average area per person and average interpersonal space (distance between people).

The LOS required for waiting within a facility is a function of time spent waiting, the number of people waiting, and a desired level of comfort. Typically, the longer the wait, the greater the space per person required. A person’s tolerance of a level of crowding will vary with time. People will accept being tightly packed on an elevator for 30 seconds, but not in a waiting area for 15 minutes.

A person’s acceptance of limited personal spacing will also depend on the characteristics of the population, the weather conditions, and the type of facility. For example, commuters may be willing to accept higher levels or longer periods of crowding than intercity and recreational travellers.

Table 2-2: Levels of Service for Queuing Areas

LOS	Average Pedestrian Area	Average Inter-Person Spacing		LOS Description
	(m2/p)	(m)		
A	1.2	>=1.2		Standing and free circulation through the queuing area possible without disturbing others within the queue.
B	0.9-1.2	1.1-1.2		Standing and partially restricted circulation to avoid disturbing others within the queue is possible.
C	0.7-0.9	0.9-1.1		Standing and restricted circulation through the queuing area by disturbing others is possible; this density is within the range of personal comfort.
D	0.3-0.7	0.6-0.9		Standing without touching is impossible; circulation is severely restricted within the queue and forward movement is only possible as a group; long-term waiting at this density impacts on personal comfort.
E	0.2-0.3	<0.6		Standing in physical contact with others is unavoidable; circulation within the queue is not possible; queuing at this density can only be sustained for a short period without serious discomfort.
F	<0.2	Variable		Virtually all persons within the queue are standing in direct physical contact with others; this density is extremely discomforting; no movement is possible within the queue; the potential for pushing and panic exists.

Source: *Part 7/STOP, STATION, AND TERMINAL CAPACITY- Transit Capacity and Quality of Service Manual—2nd Edition*

Table 2-3: Design Principles for Controlled Access Stations

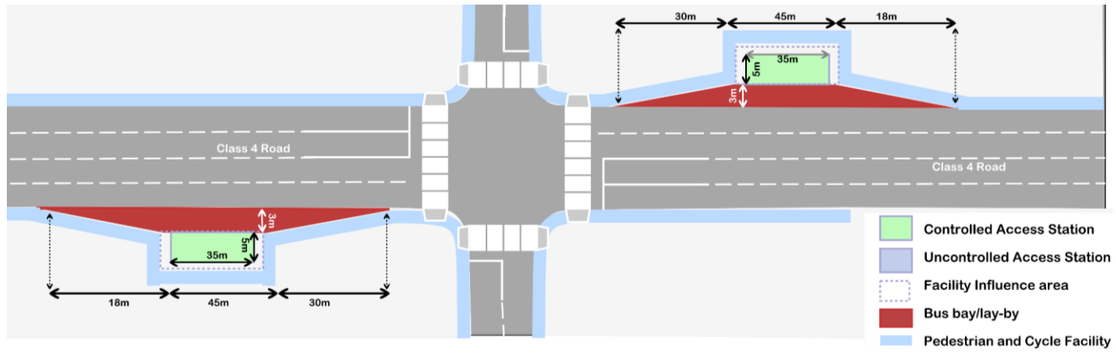
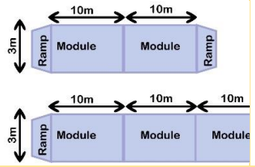
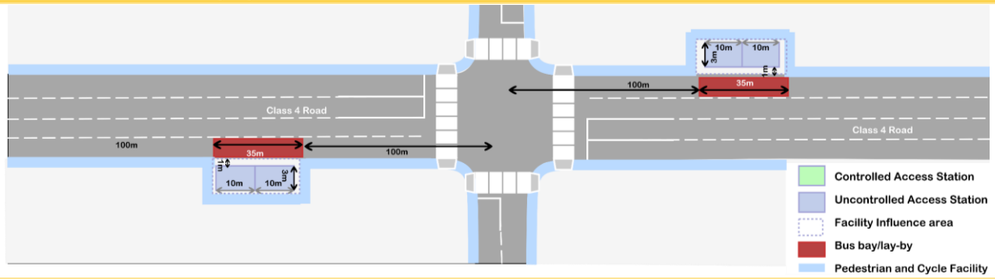
Function/ Equipment/Capacity	Controlled Access Station			
Passenger Volumes per peak 15 minutes: >400 per hour The station capacity/passenger waiting area can be increased modularly. The full module and the half module extension are shown below.				
Station Placement and Intersection Configuration: **Class 4 Roads – Bus lay-by – Controlled Access**				
Level of Services: • **Determine size of wating are/number of turnstiles and other station elements. The selecte LOS per design element is indicated.**	• Pedestrian waiting area: • Pedestrian Walkways: • Staircase: • Station Access Points/Gates:	• LOS D-F • LOS C-D • LOS C-D • LOS C-D		
Station Sizing:	• 35 Metre long station x 5 metres deep in • 45 x 3 metre kerbside layby • Situated right-up to layby roadway with Kassel Kerb docking • Station floor need to be raised to match low-entry bus. Low entry bus, entry level is 340mm; • Comply with Universal Access requirements • Station can be increase in modules of 10metre to allow for increase in passenger demand.			
Station Doors	• Two automated doors to align with left front door and middle door on left side of bus, • Usually 1100 mm wide with 30mm clearance for door handles each side when door is open. Height is 1900mm. • One lockable manual roller door at entrance • One emergency exit at other end of station			
Stainless steel cubicles inside station building	• 1 Metre for electricity • 1 Metre for ITS • 1 Toilet and wash basin • Closable recess in wall for comms, eg microphone & IP phone • 500 mm for cleaning equipment			
Signalling and signage	• Pedestrian phase required at signals nearest to controlled access station or pedestrian crossing at priority controlled intersections • Signalling to be upgraded at relevant intersections to include voice and visual signalling • Median to facilitate crossing on trunk			
Amenities				
Seating	**Shelter**	**Bicycle parking**	**Refuse removal**	**Fare Collection Equipment**
• Seating rails • Lockers under seating rails • 4 fold-down seats attached to a seating rail in paid area • Guardrails to facilitate correct passenger flow	• Enclosed no direct access.	• Yes	• Local collection; • Bins to be provided in station	• Fare gates - 3 gates per station - One of 3 for wheelchair
Municipal Services				
Electricity	**Sewerage & water**	**Lighting**	**Safety**	**Signage and Information**
• Connected to grid with backup as above • Electricity backup: Generator at each station to run light, doors and ITS, or cavity under floor at cubicle to house backup batteries	• Sewerage required for access controlled stations • Water required for access controlled stations	• LED	• Fire fighting equipment under seating rails • First Aid equipment	• Static passenger travel information only
APTMS equipment:	• Two CCTV cameras per station – at fare gates and from other end - preference for initial WiFi • Automated door openers on buses and in stations • Sleeves for optic cable provided for all stations, not for stops off trunk - cabling to follow when demand requires • Communication and fare collection equipment to be supplied to vendors around stations, • City pay points and customer care facility • PA System in box in cubicle with IP phone			
Universal access:	Take note of compliance on: • Tactile requirements at access through to boarding doors • Level entry to buses • Slope limit of 1:15 at access ramp			

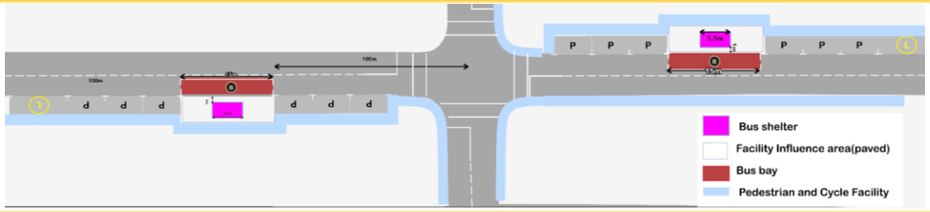
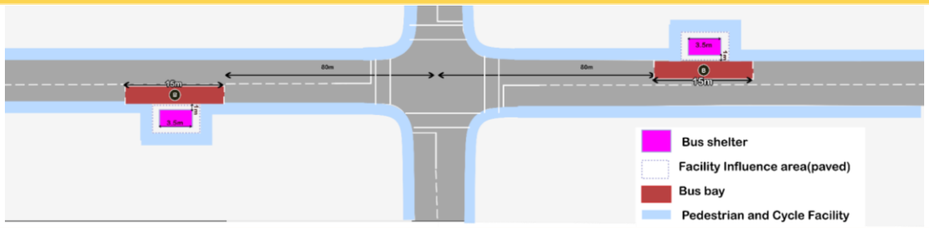
Table 2-4: Design Principles for Uncontrolled Access Stations

Function/ Equipment/Capacity	Uncontrolled Access Station
Passenger Volumes per peak 15 minutes: 100><400	
The station capacity/passenger waiting area can be increased modularly. The full module and the half module extension are shown below. 	
Station Placement and Intersection Configuration:	
Class 4 Roads – Bus lay-by – Uncontrolled Access 	
	
Level of Services:	• Pedestrian waiting area: • Pedestrian Walkways: • No controlled station access points/gates: — • LOS C-D • LOS C-D • LOS C-D
Station Sizing:	• 10 Metre long x 3 metres deep open station in 35 x 3 metre layby. Average configuration should require ± 2 modules • Stations to be manufactured in 10 metre modules to cater for varied demand at different locations • Station set back ± 1 metre from Kassel kerb to facilitate quick boarding only through left front door
Station Doors	• No doors - largely enclosed with open doorways through which to board • Open doorways to be at least 1 100 mm wide
Cubicles	• No cubicles
Signalling and signage	• Pedestrian phase required at signals nearest to controlled access station or pedestrian crossing at priority controlled intersections, • Signalling to be upgraded at relevant intersections to voice and lit signals • Median to facilitate crossing on trunk
Amenities and Support hardware	

Seating	Shelter	Bicycle parking	Refuse removal	Fare Collection Equipment
• Seatin rail at back • Guardrails to facilitate correct passenger flow	• Direct access • Only roof with limited side panelling	• Yes, at selected stations	• Local collection; • Bins to be provided in station	• No equipment - fare control when boarding bus only through left front door

Municipal Services				
Electricity	**Sewerage & Water**	**Lighting**	**Safety**	**Signage and Information**
LED preferred at stops, to illuminate static passenger info. Not required-nice to have item. Solar system prone to be stolen • Electricity backup: No	• No water or sewerage required	• LED if possible	• Fire fighting equipment under bum rails • First Aid equipment	Room for advertising • Room for static passenger information, eg service map and timetables
APTMS equipment:	• No APTMS equipment • Sleeves for optic cable required for all stations when roadways are constructed on trunk, even for open stations - later cable supply if demand warrants • Comms to be supplied to AFC vendors around stations, City pay points and customer care facility			
Universal access:	Take note of compliance on: • Tactile requirements at access through to boarding doors • Level entry to buses • Slope limit of 1:15 at access ramp			

Table 2-5: Stop Design Principles

Function/ Equipment/Capacity	Uncontrolled Access Station
Passenger Volumes per peak 15 minutes: <100	
Provided along complementary routes. Where no dedicated sidewalk is provided side-walks will be provided long the identified non-motorised network leading to the stop.	
Station Placement and Intersection Configuration:	
Class 5 Roads – Bulb Station 	
Class 5 Roads – Next to Road 	
Level of Services:	• Pedestrian waiting area: • Pedestrian Walkways: — • LOS C-D • LOS C-D
Station Sizing:	• 35 x 3 metreStation set back ± 1 metre from Kassel kerb to facilitate quick boarding only through left front door
Amenities	

Seating - Yes	**Shelter - Yes**	**Bicycle parking - No**	**Refuse removal - Yes**	**Fare Collection Equipment - No**

3 System and Network Planning

3.1 Regional Context

The Mangaung Metropolitan Municipality as illustrated on **Figure 3.1** covers approximately 6863 km² and comprises three prominent urban centres surrounded by an extensive rural area. The urban areas include Bloemfontein, Botshabelo and Thaba Nchu. Bloemfontein is the judicial capital and one of the largest cities in South Africa. Furthermore, it is the administrative capital of the Free State Province and also represents the economic hub of the provincial economy.

The Municipality is centrally located within the Free State Province and is accessible via several national and provincial routes serving the city. Due to the central location and function of Bloemfontein in the context of Free State Province, most of the provincial and national road networks converge at the City, resulting in the radial network evident in Figure 3.1. The most prominent routes include the N1 (which is the primary north-south corridor in South Africa), the N6 (which links Bloemfontein to the Eastern Cape via Aliwal North), and the N8 (which links Lesotho in the east with Kimberley in the west via Bloemfontein). Other prominent routes converging in the City include R702 to Dewetsdorp, R706 to Jagersfontein, R64 to Warrenton, R700 to Bultfontein and R30 to Virginia/Welkom.

The area is also serviced by an east/west and north/south railway line (serving the same movement desire lines of routes N1 and N8) and the Bram Fischer National Airport. An airport was historically developed outside Thaba Nchu, but is currently no longer in operation.

Botshabelo is located about 55km to the east of Bloemfontein along route N8 and represents the largest single township development in the Free State. It was established as a decentralised residential township in the early 1980s and was intended to provide the much-needed labour in Bloemfontein without the inconvenience of having labour reside on the employers' doorstep.

Another 12km further to the east of Botshabelo is the third urban node, Thaba Nchu. It used to be part of the Bophuthatswana homeland area and is surrounded by a large expanse of rural settlements on trust (communal) land as clearly visible in the far eastern parts of the Mangaung municipal area (refer to **Figure 3-1**).

The surrounding rural areas of Mangaung accommodate extensive commercial farming in the west and communal commercial/subsistence farming in the east around Thaba Nchu.

Mangaung MM is the largest contributor to the GDP of the province and boasts a fairly diverse economy. There is, however, a disturbing downturn in the Gross Value Added by the region substantiated by the fact that the majority of economic sectors have declined during the period 1996 – 2011. The exceptions in this regard are mining and quarrying, and general government services where a modest increase of 0.0% to 0.1% and 2.7% to 2.8% was attained during this period.

3.2 Existing Land Use and Spatial Structure

The following represent the main features and key considerations associated with the land use and spatial structure of the Mangaung Metropolitan Municipality:

- The municipality consists of three Urban Nodes of which Botshabelo and Thaba Nchu are located approximately 55km and 67km respectively to the east of Bloemfontein.
- Bloemfontein is the primary activity node in Mangaung (and Free State Province) and holds a range of retail, office, commercial and industrial activities clustered in a central core area around the CBD.
- The dominant movement pattern in Bloemfontein is radial with all the major routes converging in the central core area, which comprises the CBD, several industrial and commercial areas, as well as some of the highest order community facilities/institutions e.g. the university and regional sports and recreational facilities.
- However, the CBD is in decline with many economic activities locating and relocating towards the west. Although limited at present, there is also a trend for new economic activities to cluster around the four access interchanges along the N1 freeway where it runs through the western parts of the City.
- Similarly, middle and high-income residential development gradually expands towards the west, and more specifically the northwest, while low income residential development continues towards the southeast.
- This growth pattern in opposite directions perpetuates the Apartheid spatial structure of Bloemfontein and the relocation of economic activity towards the north-west and west marginalise the disadvantaged communities to the south-east even more.
- As a result, average travel distance and travel times of these communities increase continuously while the combination of regional traffic on the N1 and surrounding middle and high income residential development continue to favour investment in this part of the City.
- Job creation opportunities around Botshabelo and Thaba Nchu and between these areas and Bloemfontein have also had very limited success to date and would require significant interventions to reverse this trend.

3.3 Demographic Features (Census 2011)

The population in the Mangaung MM were in the order of 775 180 people in 2011, of which 44% (344 430) lived in the Phase 1 priority area, followed by 34% (264 000) who lived in the Botshabelo/ Thaba Nchu area. The remaining urban area of Bloemfontein hold 16% (120 158) of the population and the surrounding rural area 6% (46 591). Refer to Table 3-1: Mangaung MM: Population Composition by Population Group, Census 2011**Table 3-1** and **Diagram 3-1**.

The population composition of the Mangaung MM is shown in **Diagram 3-2**.

The age distribution of the population is reflected in **Table 3-2** and **Diagram 3-3**. Important to note is that 15% of the population could be regarded as young adults (119 336) and 44% is of working age (338 032), which means that a large number of people will be dependent on public transport to get to and from work and/or educational facilities each day.

Table 3-3 to **Table 3-5** reflect the people with disabilities which could have a bearing on the provision of public transport along the Phase 1 BRT line:

- Persons with degrees of walking and climbing difficulties are reported to be in the order of 11 746 people (3% of population).
- Persons with assistive devices and medication (e.g. walking stick/frame) equals 8324 people (2% of population).
- Persons with assistive devices and medication (e.g. wheelchair) equals 5904 people (2% of population).

REGIONAL CONTEXT

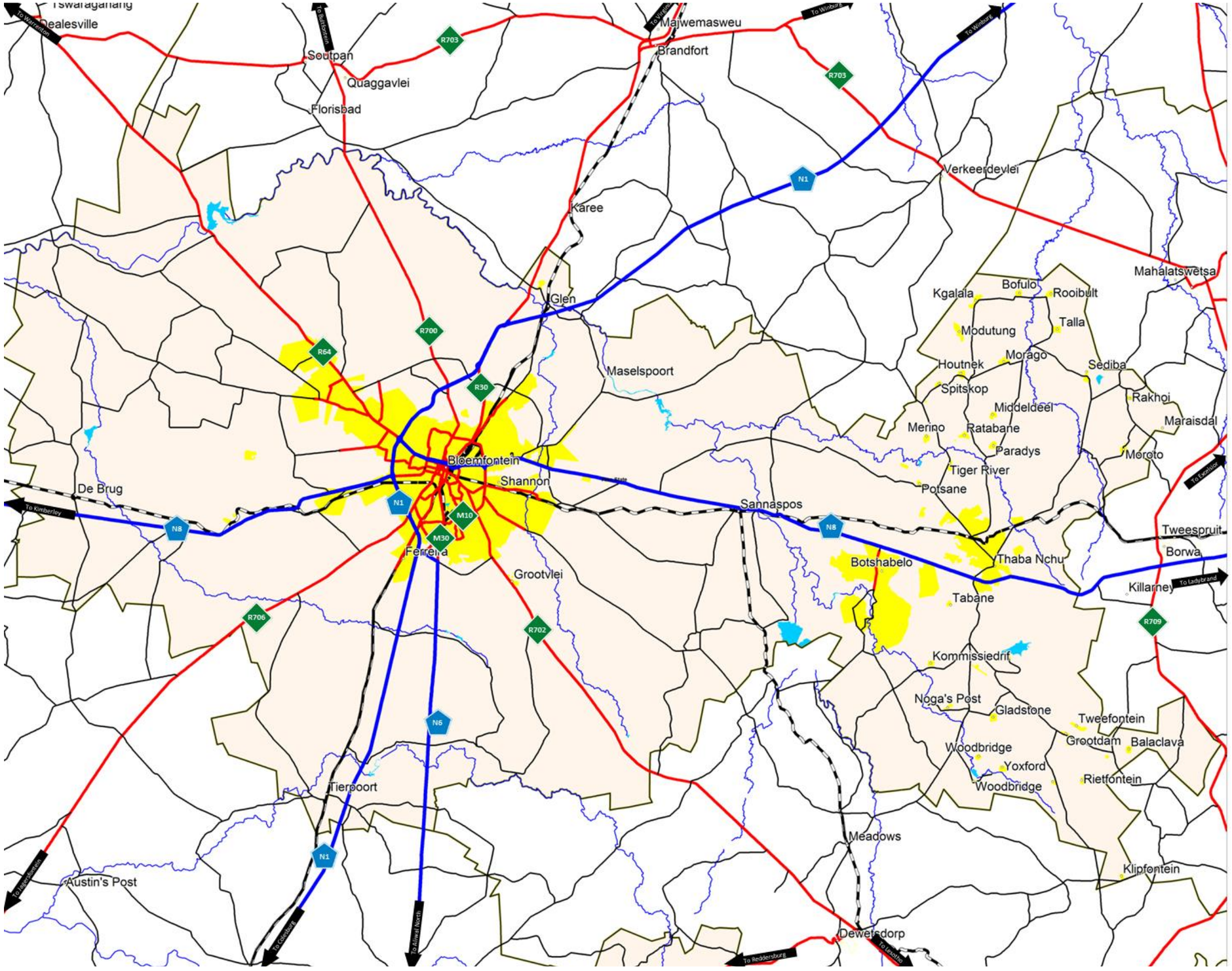


Figure 3-1: Regional Context

Table 3-1: Mangaung MM: Population Composition by Population Group, Census 2011

Reporting Zones	Black African	Coloured	Indian or Asian	White	Other	Total	%
Phase 1: Priority area	309,020	29,932	1,165	3,449	864	344,430	**44%**
Bloemfontein Remaining	39,393	5,520	1,403	73,055	787	120,158	16%
Botshabelo /Thaba Nchu	261,606	950	597	334	513	264,000	34%
Rural	38,267	1,402	162	6,640	120	46,591	6%
Mangaung MM	**648,286**	**37,804**	**3,327**	**83,478**	**2,284**	**775,179**	100%
%	**84%**	**5%**	**0%**	**11%**	**0%**	**100%**	

Diagram 3-1: Mangaung MM: Population Distribution, 2011

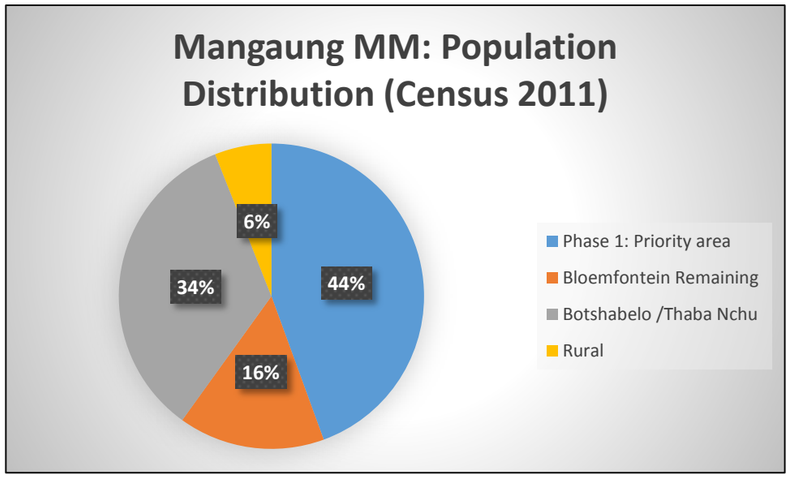


Diagram 3-2: Mangaung MM: Population Composition, 2011

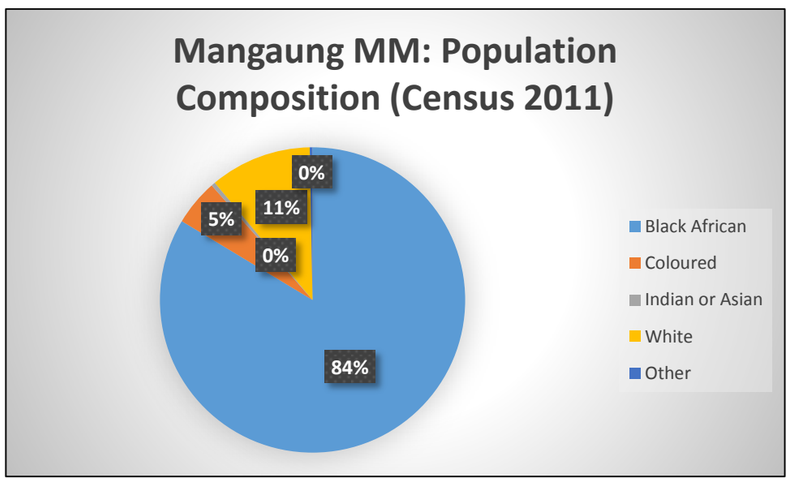


Table 3-2: Mangaung MM: Age Distribution, Census 2011

Reporting Zones years	Pre School (0-5)	School Going (6-18)	Young Adult (19-25)	Working age (26-62)	Pensioners (62+)	Total
Phase 1: Priority area	42,895	75,307	52,873	156,517	16,841	344,433
Bloemfontein Remaining	8,674	19,161	22,177	57,498	12,645	120,155
Botshabelo /Thaba Nchu	35,994	67,710	38,323	105,183	16,792	264,002
Rural	5,483	9,823	5,963	18,834	3,048	43,151
Mangaung MM	93,046	172,001	119,336	338,032	49,326	771,741
Reporting Zones	**Pre School %**	**School Going %**	**Young Adult %**	**Working age %**	**Pensioners %**	**Total %**
Phase 1: Priority area	12%	22%	15%	45%	5%	100%
Bloemfontein Remaining	7%	16%	18%	48%	11%	100%
Botshabelo /Thaba Nchu	14%	26%	15%	40%	6%	100%
Rural	13%	23%	14%	44%	7%	100%
%	**12%**	**22%**	**15%**	**44%**	**6%**	**100%**

Diagram 3-3: Mangaung MM: Age Distribution, 2011

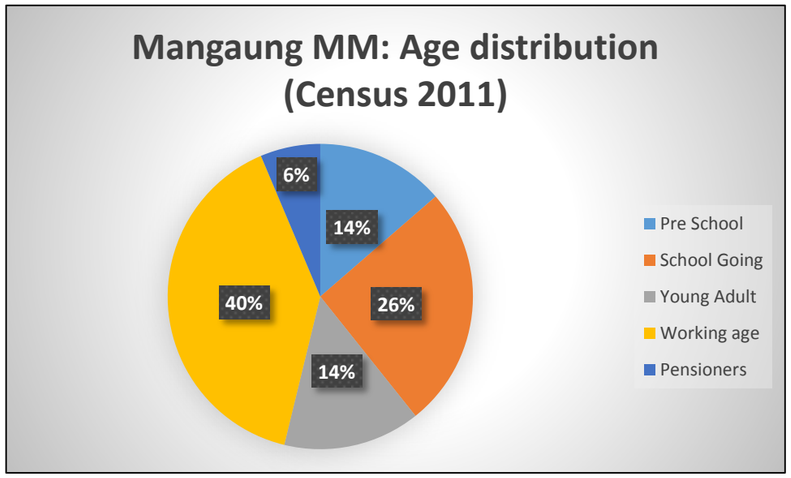


Table 3-3: Mangaung MM: Persons with Walking or Climbing Difficulties, Census 2011

Reporting Zones	No difficulty	Some difficulty	A lot of difficulty	Cannot do at all	Other	Total
Phase 1: Priority area	302,936	7,690	2,405	1,651	29,748	344,430
Bloemfontein Remaining	98,078	2,632	644	374	18,433	120,161
Botshabelo /Thaba Nchu	235,352	7,017	2,120	1,481	18,017	263,987
Rural	37,477	1,243	394	237	3,804	43,155
Mangaung MM	**673,843**	**18,582**	**5,563**	**3,743**	**70,002**	**771,733**
Reporting Zones	**No difficulty %**	**Some difficulty %**	**A lot of difficulty %**	**Cannot do at all %**	**Other %**	**Total %**
Phase 1: Priority area	88%	2%	1%	0%	9%	100%
Bloemfontein Remaining	82%	2%	1%	0%	15%	100%
Botshabelo /Thaba Nchu	89%	3%	1%	1%	7%	100%
Rural	87%	3%	1%	1%	9%	100%
Mangaung MM	**87%**	**2%**	**1%**	**0%**	**9%**	**100%**
Note: Other includes: Do not know, Undetermined, Unspecified, Not Applicable						

Note: Other includes: Do not know, Undetermined, Unspecified, Not Applicable

Table 3-4: Mangaung MM: Persons with Assistive Devices and Medication – Walking Stick or Frame, Census 2011

Reporting Zones	Yes	No	Other	Total
Phase 1: Priority area	8,324	317,637	18,468	344,429
Bloemfontein Remaining	4,317	98,183	17,664	120,164
Botshabelo /Thaba Nchu	7,786	248,977	7,228	263,991
Rural	1,683	38,992	2,474	43,149
Mangaung MM	**22,110**	**703,789**	**45,834**	**771,733**
Reporting Zones	**Yes %**	**No %**	**Other %**	**Total %**
Phase 1: Priority area	2%	92%	5%	100%
Bloemfontein Remaining	4%	82%	15%	100%
Botshabelo /Thaba Nchu	3%	94%	3%	100%
Rural	4%	90%	6%	100%
Mangaung MM	**3%**	**91%**	**6%**	**100%**

Note: Other includes: Do not know, Unspecified, Not Applicable

Table 3-5: Mangaung MM: Persons with Assistive Devices and Medication – Wheelchair, Census 2011

Reporting Zones	Yes	No	Other	Total
Phase 1: Priority area	5,904	319,073	19,450	344,427
Bloemfontein Remaining	3,177	99,274	17,708	120,159
Botshabelo /Thaba Nchu	4,313	252,218	7,463	263,994
Rural	1,002	39,643	2,509	43,154
Mangaung MM	**14,396**	**710,208**	**47,130**	**771,734**
Reporting Zones	**Yes %**	**No %**	**Other %**	**Total %**
Phase 1: Priority area	2%	93%	6%	100%
Bloemfontein Remaining	3%	83%	15%	100%
Botshabelo /Thaba Nchu	2%	96%	3%	100%
Rural	2%	92%	6%	100%
Mangaung MM	**2%**	**92%**	**6%**	**100%**

Note: Other includes: Do not know, Unspecified, Not Applicable

3.4 Mangaung Spatial Development Framework and Built Environment Performance Plan (BEPP)

The main statutory document guiding and directing development towards achieving the future spatial vision of Mangaung is the Mangaung Spatial Development Framework (2016) (see **Figure 3-2**and **Figure 3-3**).

The MSDF aims to address the spatial and socio-economic inefficiencies of the metropolitan area and to achieve a spatial structure that complies with the norms and principles of the Spatial Planning and Land Use Management Act (SPLUMA), including Spatial Justice, Spatial Efficiency, Spatial Sustainability, Spatial Resilience and Good Governance.

In order to achieve this, the MSDF suggests an integrated approach comprising a number of significant interventions summarised as follow:

- Improving the functional integration and relationship between Bloemfontein, Botshabelo and Thaba Nchu by enhancing development along the N8 corridor and/or the railway line running parallel to it;
- Stimulating economic growth and mixed use development in the eastern and south-eastern parts of Bloemfontein which would create a more balanced city structure for the town (refer to **Figure 3-2**), and benefit communities in Mangaung Township, Botshabelo and Thaba Nchu;
- Strengthening the city core through CBD regeneration and consolidating the urban structure by way of an Urban Edge;
- Enhancing local economic development in Bothsabelo and Thaba Nchu and between these two areas by way of corridor development (refer to **Figure 3-3**). This includes the establishment of a labour based manufacturing hub/IDZ at Botshabelo, and reinforcing Thaba Nchu as a rural market town; and
- Improving access from the surrounding rural communities to these areas.

The MSDF states that this approach will reduce the competing pressures between the different areas, reinforce the soundness and inherent strengths and efficiency of the compact basic city structure, and optimise use of limited public and private sector resources.

The Mangaung Development Concept and Approach as noted above is confirmed in the Mangaung Urban Network and Integration Zone Plan (**Figure 3-4**) which was submitted to National Treasury as part of the Mangaung Built Environment Performance Plan (BEPP) report. The following key findings and proposals as illustrated on **Figure 3-4** are important to note:

- The N8 corridor linking three secondary nodes (Airport Node, Botshabelo and Thaba Nchu) is identified as an activity corridor focused on integrating these secondary nodes through several development initiatives. This corridor consists of road (National Route N8) and rail infrastructure and is earmarked as a strategic corridor initiative in the National Development Plan (NDP) as part of the Strategic Integrated Projects (SIP) group 7.
- The Botshabelo-Thaba Nchu Integration Zone/Corridor linking the Botshabelo CBD with the Thaba Nchu CBD, consisting of the following links:
- Botshabelo main road linking the Botshabelo CBD to the N8 Corridor;
- N8 Corridor from Botshabelo up to Thaba Nchu;
- Brand Street in Thaba Nchu linking into the core of Thaba Nchu; and
- Possible integration of surrounding land uses with the Thaba Nchu railway station.
- As part of a major intervention to stimulate economic development in the eastern parts of Bloemfontein, the proposed Airport Development Node has been identified as a key secondary node to be developed. The proposal is to develop it in two distinct phases. Phase 1 comprises land (700 ha) to the south of route N8 and covers the areas of Shannon and Bloemspruit. The area to the north of route N8 (1100 ha) is intended to be developed as Phase 2 and will cover the area east of the Bram Fisher National Airport up to the alignment of the proposed eastern bypass route, as well as land to the north and north-west of the airport. A critical factor to the successful development of this node would be the construction of the eastern bypass route through Bloemfontein, which links to the N1 freeway to the north and south of the town. This route will provide regional access to the Airport Node for north-south moving national and local traffic, and will enhance the total viability of the proposal, as the local economy of Bloemfontein will not be able to sustain a development of this magnitude.
- The Mangaung Built Environment Performance Plan also identified a number of underserved townships earmarked for upgrading, consolidation and infill development. As illustrated on **Figure 3-4** these include the Grasslands area to the east; Bloemside Phase 1, 2 and 3 to the south thereof; a number of underserved townships representing the southern parts of Mangaung (including Batho, Bochabela, Phahameng, Namibia, Freedom Square, Rocklands, JF Mafora and Kopanong); and Lourierpark to the south-west. Development in these areas includes the upgrading of infrastructure and amenities, promotion of local economic development, and the upgrading/formalisation of informal settlements.
- Several mixed income and mixed housing typology project areas were also identified – the so-called “7 Land Parcels” initiative, including Brandkop 702 north of Lourierpark, Brandkop Race Track to the north thereof adjacent to the south of route N8 west, Cecilia directly to the north of N8 west, Pellissier infill development, Vista Park Phase 2 and Phase 3 which are located to the west of Church Street, and Hillside View located to the east of Church Street (see **Figure 3-5**).
- The Mangaung Built Environment Performance Plan also identified five “urban hub” areas earmarked to consolidate mixed economic activities. In the western parts of the City it includes the areas surrounding route N8 in Schoemanpark immediately west of the N1-N8 intersection, as well as the area around route R64 north of Langenhovenpark and west of the Nelson Mandela Road/R64-N1 interchange. The remaining two urban hubs reflected in the Built Environment Performance Plan are the Mangaung Township to the east of the Hamilton-Vista economic activity area and the Schoemanpark (Ooseinde-Transwerk Industrial cluster) located to the east of the CBD along N8 East.
- **Figure 3-5** also indicates five Integration Zones intended to enhance the functional integration and linkages between disadvantaged communities and the Bloemfontein CBD (the sixth Integration Zone is between Botshabelo and Thaba Nchu – see **Figure 3-6**).

MANGAUNG SPATIAL DEVELOPMENT FRAMEWORK

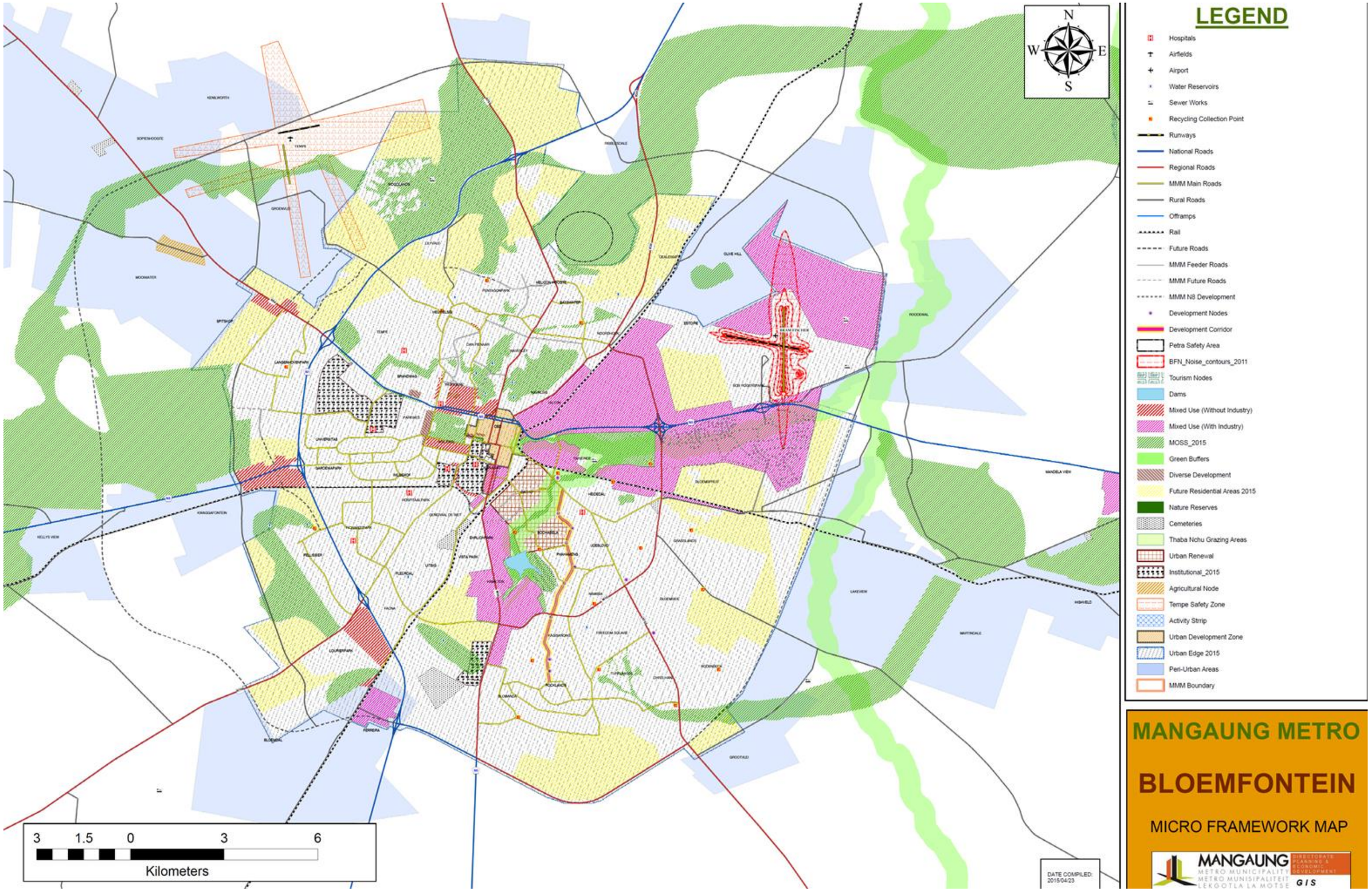


Figure 3-2: Mangaung Spatial Development Framework

BOTSHABELO AND THABA NCHU SPATIAL DEVELOPMENT FRAMEWORK

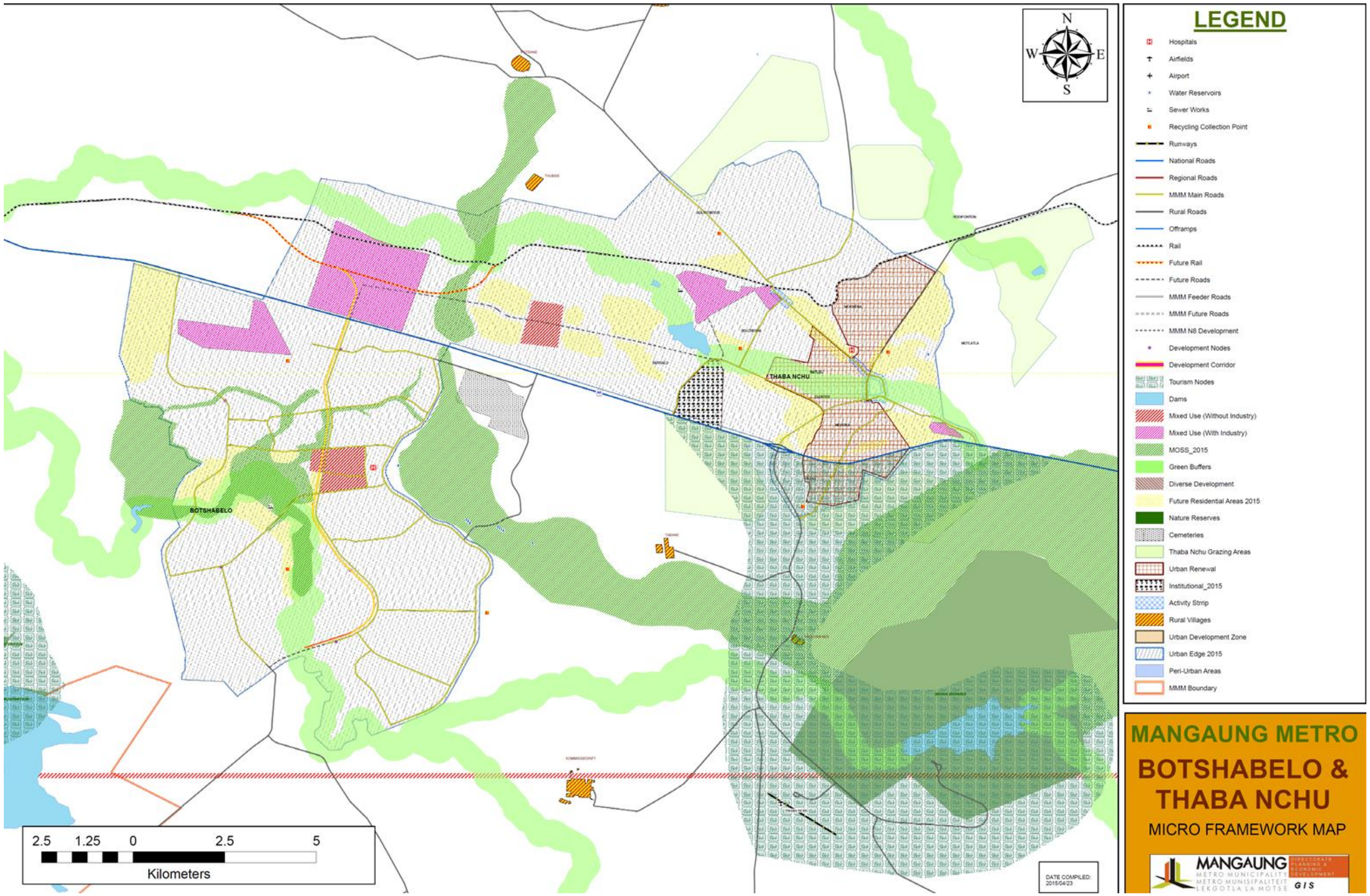


Figure 3-3: Botshabelo and Thaba Nchu Spatial Development Framework

MANGAUNG URBAN NETWORK AND INTEGRATION ZONE PLAN

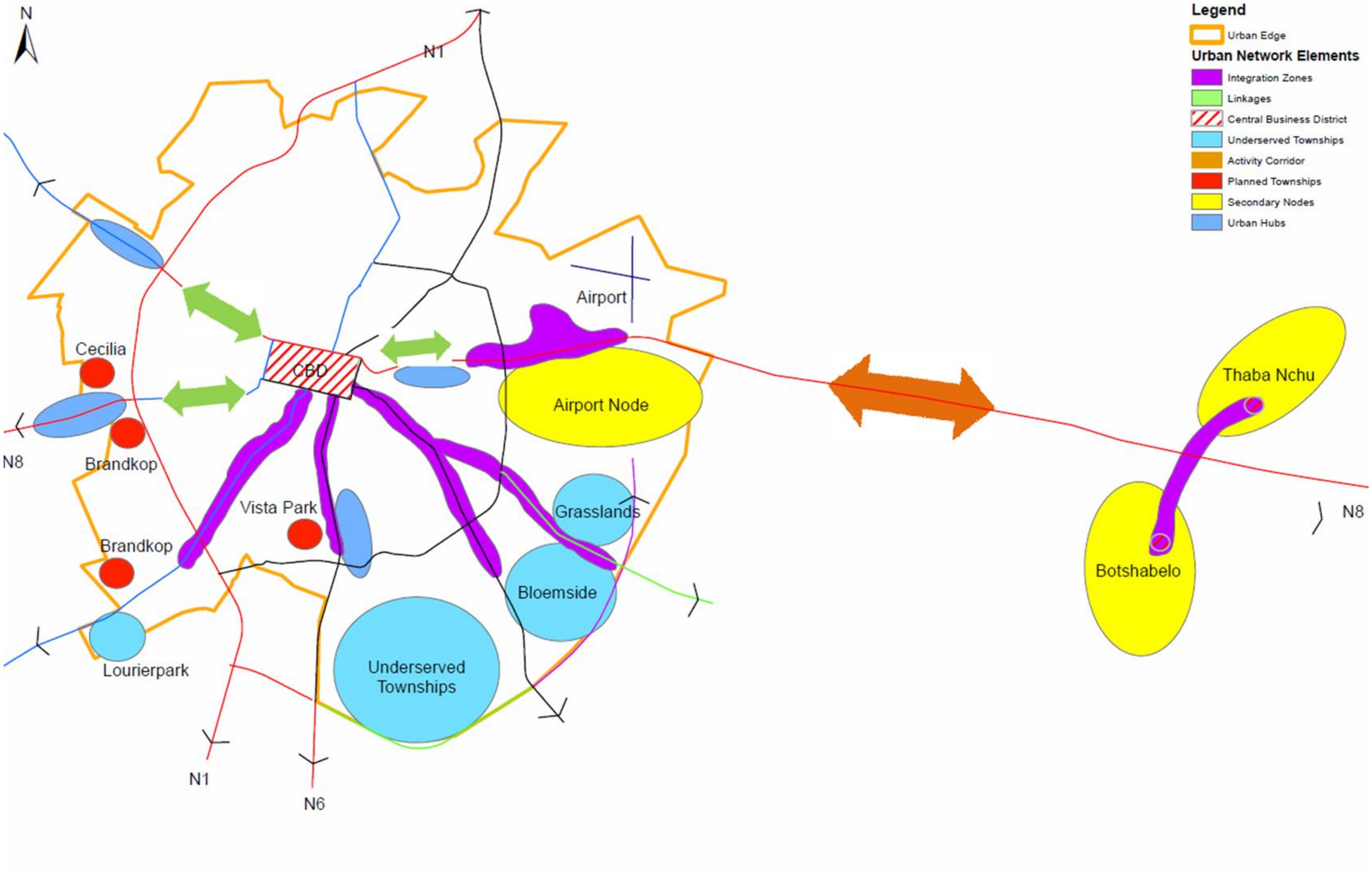


Figure 3-4: Mangaung Urban Network and Integration Zone Plan

MANGAUNG RESTRUCTURING INTERVENTIONS

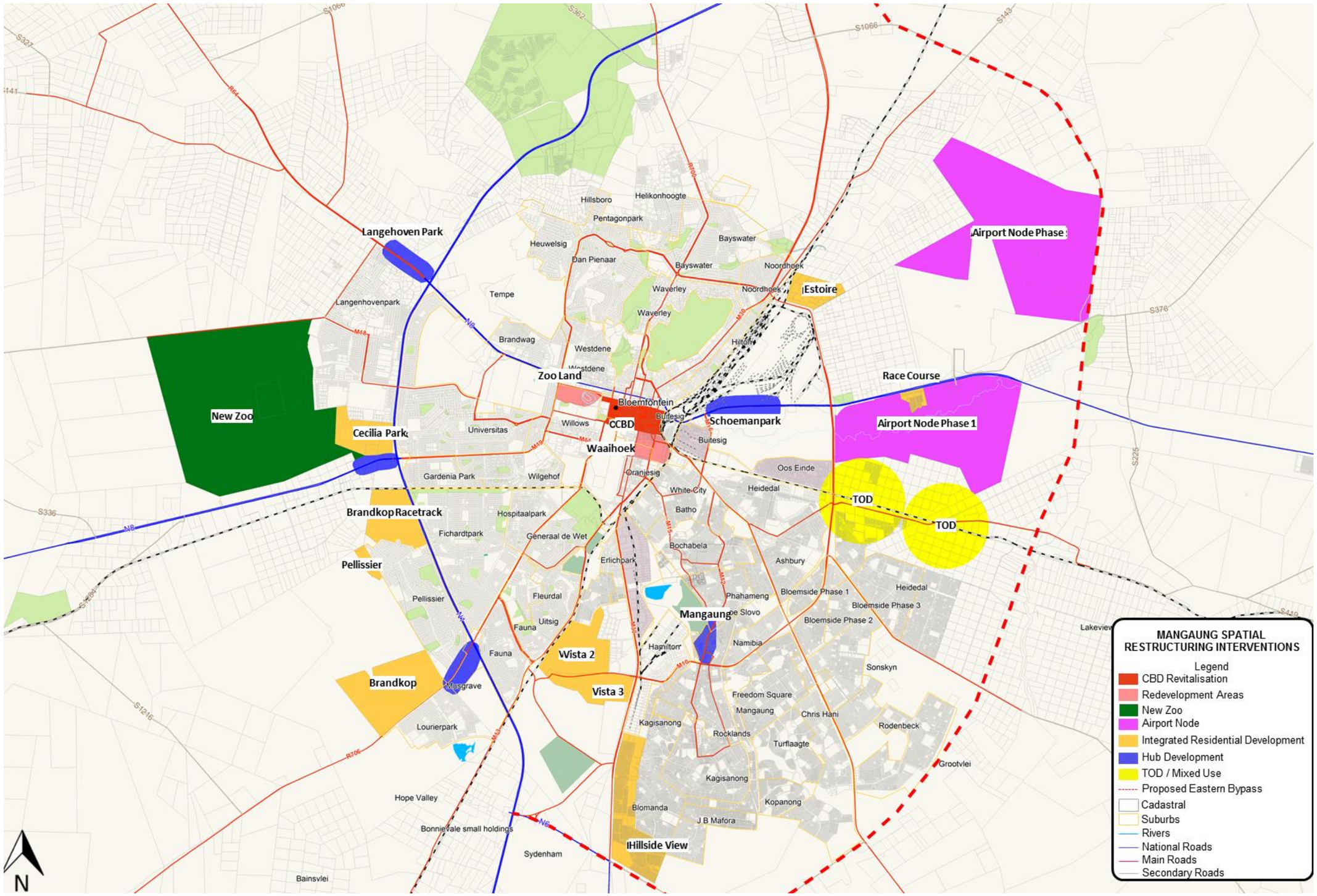


Figure 3-5: Mangaung Restructuring Interventions

BOTSHABELO-THABA NCHU RESTRUCTURING INTERVENTIONS

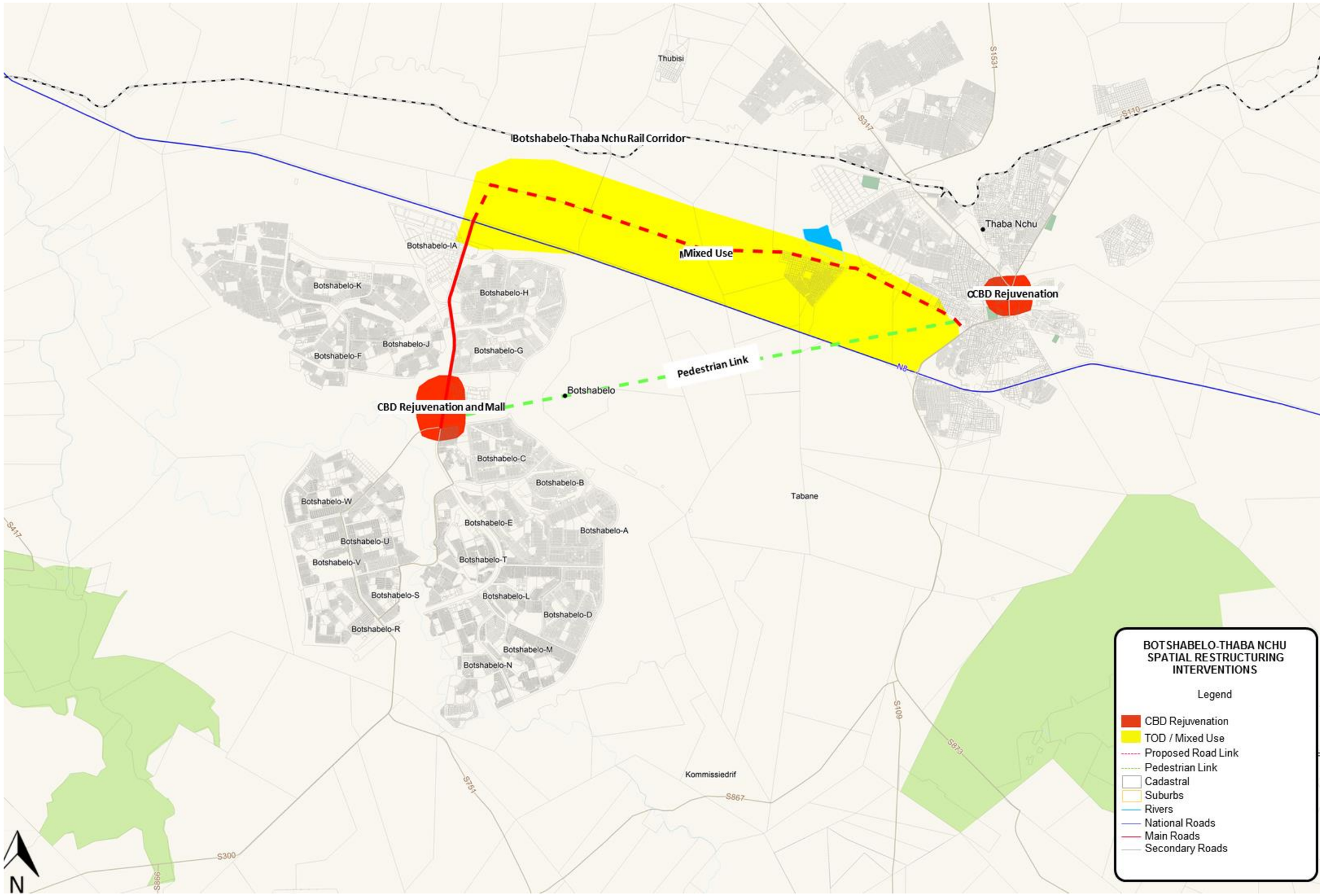


Figure 3-6: Botshabelo-Thaba Nchu Restructuring Interventions

3.5 Spatial Transformation/ Restructuring Strategy

Following from the Mangaung Spatial Development Framework and Built Environment Performance Plan (BEPP), the Mangaung Integrated Development Plan identified 5 key focus areas/ objectives towards achieving a balanced city structure as summarised in **Table 3-6** below and illustrated on **Figure 3-7**:

Table 3-6: Restructuring Objectives and Strategy

Restructuring Objectives and Strategy	
Promote Economic Development	3 Central Business District N8 Corridor (Airport Node) Industrial Development Nodes/ SDZ's Other Nodes (Waaihoek, New Botshabelo Node, Soutpan, disadvantaged communities)
De-racialising the built environment	7 Land Parcels (Cecilia/ New Zoo, Pellissier infill, Brandkop, Vista X2, 3, Hillside View X34, 35, Estoire)
Promote Intensification/ Densification	IRPTN Corridor (Phase 1 & CBD) Existing Urban Area
Prevent/ Curb Spatial Fragmentation	Limit expansion Promote spatial integration
Support Rural Development	Enhance rural development in identified nodes

3.6 Scenario Development (Demographic Projections and Economic Forecasts)

In order to plan for the future, one needs to have a vision of future impact on human and business aspects in terms of population projections and forecasted economic growth. IHS Information and Insight was requested to provide an external (non-transport) perspective to feed into the land use model and subsequently into the Mangaung Integrated Public Transport Network, which will form the backdrop to the rest of the Mangaung IPTN planning activities.

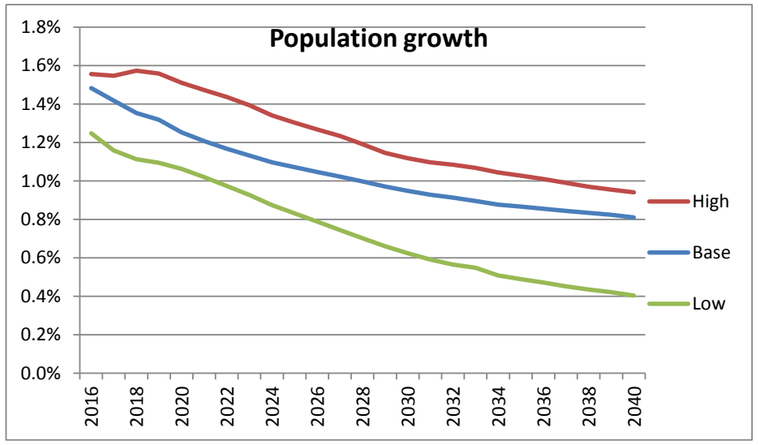
Sophisticated models were used to provide demographic and economic forecasts that included short-, medium-, and long term projections. Assumptions were formulated to provide Low-, Middle-, and High Scenarios for both population and economic growth. For a detailed description of the Scenario Development process the reader is referred to the Volume A IPTN Document: "Urban Growth and Land-use Scenarios".

In summary the resulting population numbers are shown in **Table 3-7** and **Diagram 3-4**.

Table 3-7: Resulting Population Numbers

	2011	Growth p.a.	2015	Growth p.a.	2025	Growth p.a.	2036
Low			833,138	1.0%	923,024	0.6%	986,688
Base	784,687	1.5%	833,138	1.2%	943,280	0.9%	1,045,301
High			833,138	1.5%	963,929	1.1%	1,089,138

Diagram 3-4: Population Growth per Scenario, 2016-2040



The recommended population projection is the base scenario, as this scenario carries the highest probable outcome.

Similar to the population, **Diagram 3-5** below shows the High-, Middle-, and Low Economic growth forecasts with the resultant formal workers (**Table 3-8**).

Diagram 3-5: Economic Growth Forecasts, 2012-2038

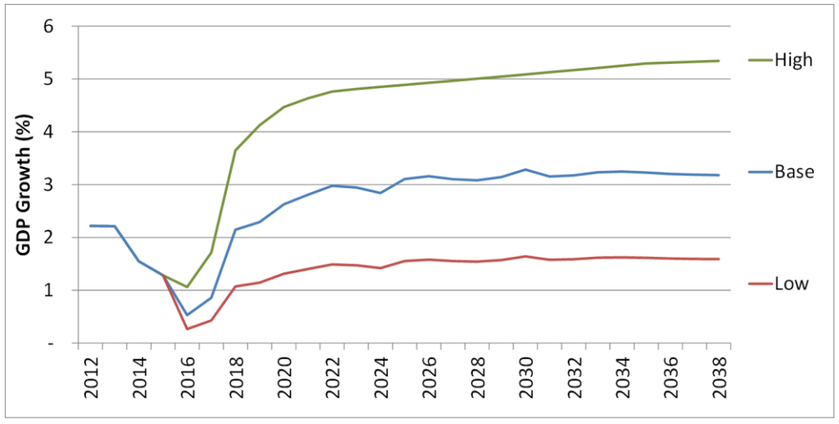


Table 3-8: Resulting Formal Workers

	2011	Growth p.a.	2015	Growth p.a.	2025	Growth p.a.	2036
Low			221,022	0.1%	222,459	0.8%	243,555
Base	206,906	1.7%	221,022	0.4%	229,080	1.3%	262,914
High			221,022	0.7%	237,653	1.8%	288,985

The recommended economic growth scenario is the base scenario, for it deem to be the most realistic at this stage.

MANGAUNG RESTRUCTURING INTERVENTIONS

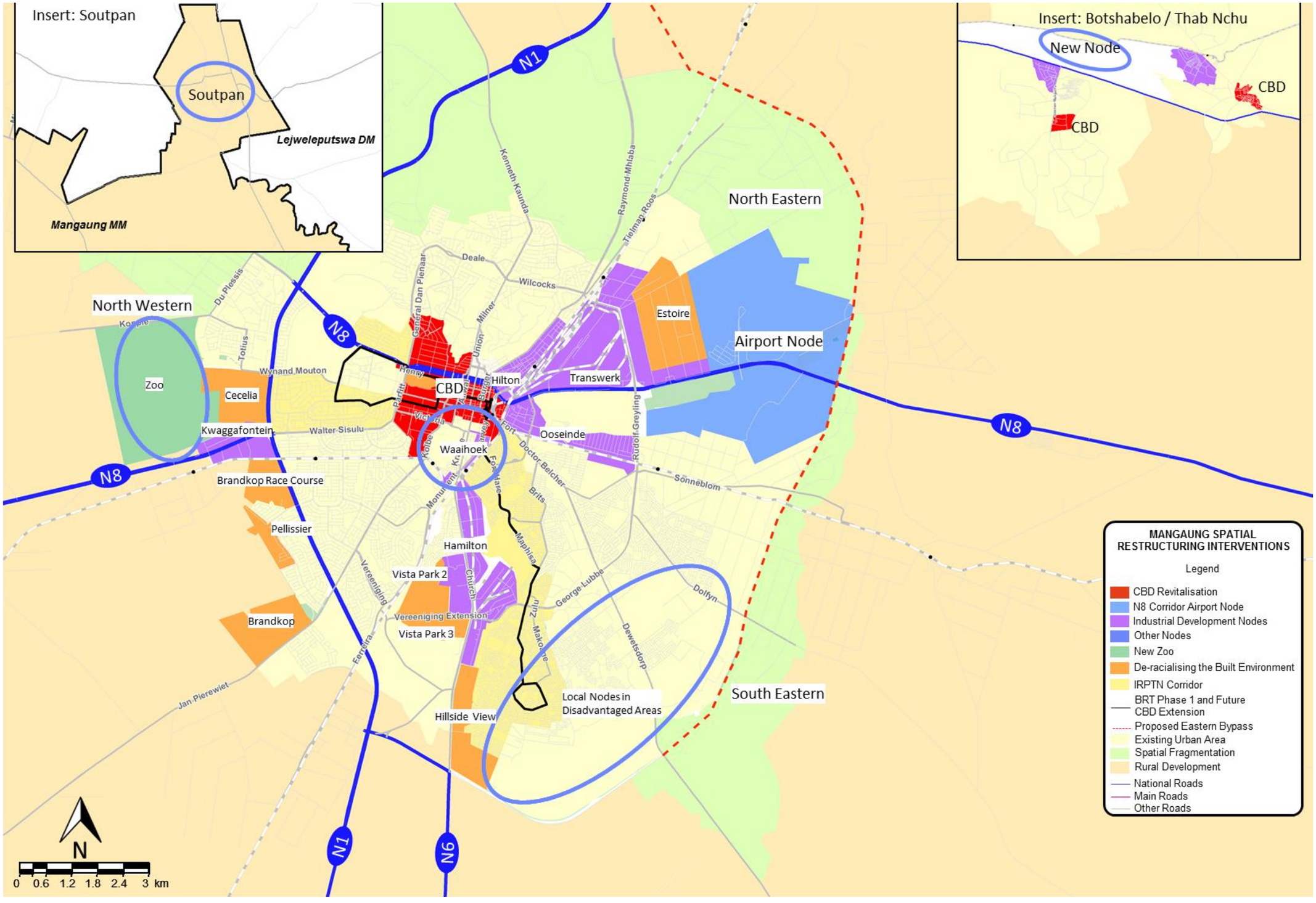


Figure 3-7: Mangaung Restructuring Interventions

3.7 Land Use Model Results

A land use model was developed and populated to simulate the Spatial Transformation/Restructuring Strategy described in par. 3.1.5. The base scenario population and economic growth control totals (Tables 3.7 and 3.8) served as input to the model.

The base year used in the model was 2015 with design years 2025 and 2036.

Table 3-9 reflects the existing and expected number of dwelling units, population and formal workers for the Mangaung MM. It is evident that the expected growth will be in the order of 113 200 dwelling units, 212 160 people and 41 900 formal job opportunities.

Table 3-9: Preferred Scenario: Dwelling Units, Population, Formal Workers, 2015-2036

Base Scenario: Dwelling Units, Population, Formal Workers						
Variable	**Current**	**Future**		**Increment**		**Total Increment**
	2015	**2025**	**2036**	**2015-2025**	**2025-2036**	
Dwelling Units	261,155	323,437	374,364	62,282	50,927	113 209
Population	833,138	943,280	1,045,301	110,142	102,020	212,162
Formal Workers	221,022	229,080	262,914	8,058	33,834	41,892

Source: IHS Information and Insight

The Mangaung Integrated Development Plan 2016/17 identified the following key focus areas/ 5 restructuring objectives towards achieving a balanced city structure. The following methodology was followed in populating the land use model:

- Promote Economic Development

  This objective was achieved by firstly focusing on redevelopment in the CBD's of Bloemfontein, Thaba Nchu and Botshabelo, as well as increasing the occupancy rate of vacant buildings. In other words, a proportion of the population and job opportunity growth were allocated to the abovementioned CBD's.

  Secondly the development potential of the N8 Corridor was calculated and incorporated in the model as part of a phased approach to develop the node.

  The next priorities were the industrial nodes of Transwerk, Hillton, Ooseinde, Hamilton, Thaba Nchu and Botshabelo. The point of departure was to assume that vacant buildings will be occupied again and that vacant serviced stands will be developed. The allocation of job opportunities was done accordingly.

  Similarly, economic development was strengthened in new business nodes such as Waaihoek, the New Zoo area, the new node between Botshabelo and Thaba Nchu, as well as local nodes in the Mangaung, Thaba Nchu and Botshabelo areas.

- Deracialising the Built Environment

  The main focus of this objective was to incorporate the seven land parcels (Cecilia, Pelissier Infill, Brandkop, Brandkop Race Course, Vista Park X2, 3, Hillside View and Estoire) in the modelling. The number of units, population and job opportunities that could be created by these developments were calculated and incorporated in the model.

- Promote Intensification and Densification

  Apart from general densification in the existing urban footprint by way of subdivision and/ or redevelopment of land, infill development were also allocated to all vacant erven and vacant buildings along Phase 1 IPTN routes.

- Prevent/ Curb Spatial Fragmentation

  The outward expansion of the urban fabric of Mangaung was limited to only a small percentage of the future growth.

- Support Rural Development

  Growth in agriculture, mining and tourism job opportunities, as well as limited residential growth, were allocated to the rural zones.

The methodology described above is further explained in the IPTN Volume A report: "Urban Growth and Land-use Scenarios".

The results can be displayed in several ways, depending on the level of detail required, for instance:

- Per Phase 1 and Phase 2;
- Per 5 Restructuring Objectives;
- Per Planning zone and;
- Per Traffic analysis zone(TAZ). The city was divided in to traffic analysis zones based on the Census zones, national household travel survey analysis zones and adapting these to align with land use patterns and other structuring elements.

3.7.1 Results per Phase 1 and 2

Figure 3.8 reflects the relative position of the Phase 1 Priority Development Area in comparison with the remainder of the study area (Phase 2). It is evident that the CBD and the south-eastern quadrant of the Mangaung Metropolitan Municipality constitute 45% of all households, 44% of all population and 40% of all formal workers.

The relative contribution of Phase 1 is expected to continue in future on almost the same levels with increments of 46 500 households, 85 200 people and 12 000 job opportunities in the next 21 years.

3.7.2 Results per Transformation Objectives

As discussed in par 3.1.5 the Mangaung Integrated Development Plan identified the 5 key focus areas/ Objectives towards achieving a balanced city structure:

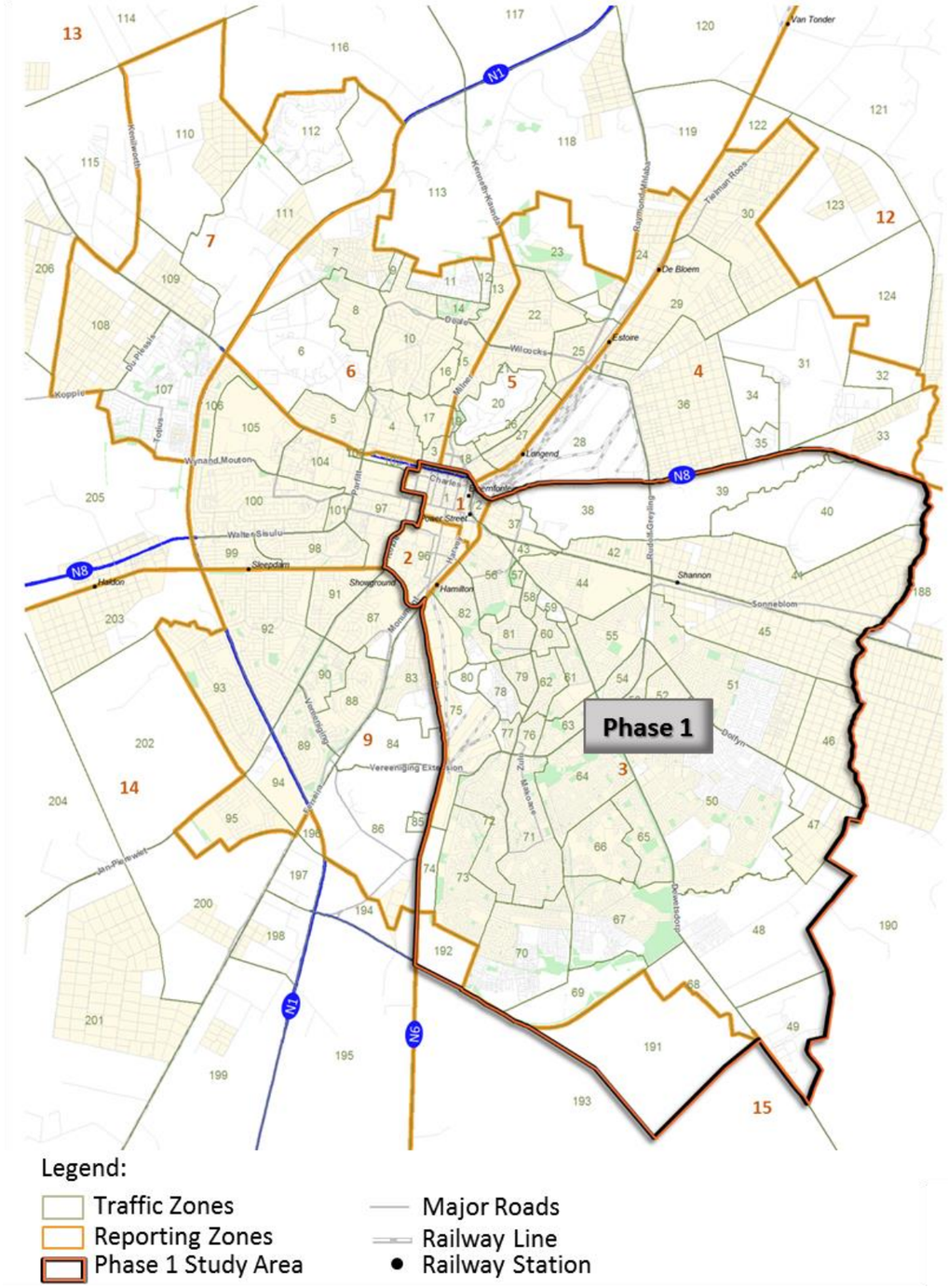
The allocation of jobs per transformation objective is explained in Table 3-9, and the increment allocated is shown in Figure 3-9.

More than half (54%) of the indicated increase in job opportunities over the next 21 years can be expected to take place in the economic nodes which consist of the CBD (25%), followed by the N8 Corridor/ Airport Node (14%), other and newly developed nodes (11%), and the industrial areas (5%). A relatively large increase (27%) is expected to develop in the proposed "7 Land Parcels" areas, followed by a further 5% along the Phase 1 BRT corridor and 8% in the suburbs.

Regarding the increase in dwelling units, the largest growth is expected to take place in the existing urban footprint of the suburbs (31%), and a further 10% within the Phase 1 BRT corridor, which together means an increase of 40% which will contribute significantly to densifying the existing urban fabric. 28% Of the increment has been placed in nodes, which will contribute to the feasibility of the provision of public transport services in the future. (See Table 3-11 and Figure 3-10). The "7 Land Parcels" is expected to absorb 18% of all new residential growth in future.

DISTRIBUTION OF DWELLING UNITS, POPULATION AND FORMAL WORKERS PER PHASE 2015-2036

Phase 1 – Traffic



PHASES	HOUSEHOLDS			HOUSEHOLDS (%)		
	2015	2025	2036	2015	2025	2036
Phase 1	116,546	142,821	163,088	45%	44%	44%
Phase 2	144,695	180,702	211,362	55%	56%	56%
Mangaung	**261,242**	**323,524**	**374,451**	**100%**	**100%**	**100%**

PHASES	POPULATION			POPULATION (%)		
	2015	2025	2036	2015	2025	2036
Phase 1	369,784	415,308	455,006	44%	44%	44%
Phase 2	463,357	527,962	590,320	56%	56%	56%
Mangaung	**833,141**	**943,270**	**1,045,326**	**100%**	**100%**	**100%**

PHASES	FORMAl WORKERS			FORMAL WORKERS (%)		
	2015	2025	2036	2015	2025	2036
Phase 1	88,227	91,724	100,213	40%	40%	38%
Phase 2	132,901	137,763	162,787	60%	60%	62%
Mangaung	**221,129**	**229,487**	**263,000**	**100%**	**100%**	**100%**

Figure 3-8: Distribution of Dwelling Units, Population and Formal Workers per Phase 2015-2036

MANGAUNG RESTRUCTURING INTERVENTIONS – FORMAL WORKER INCREMENT (2015-2036) (%)

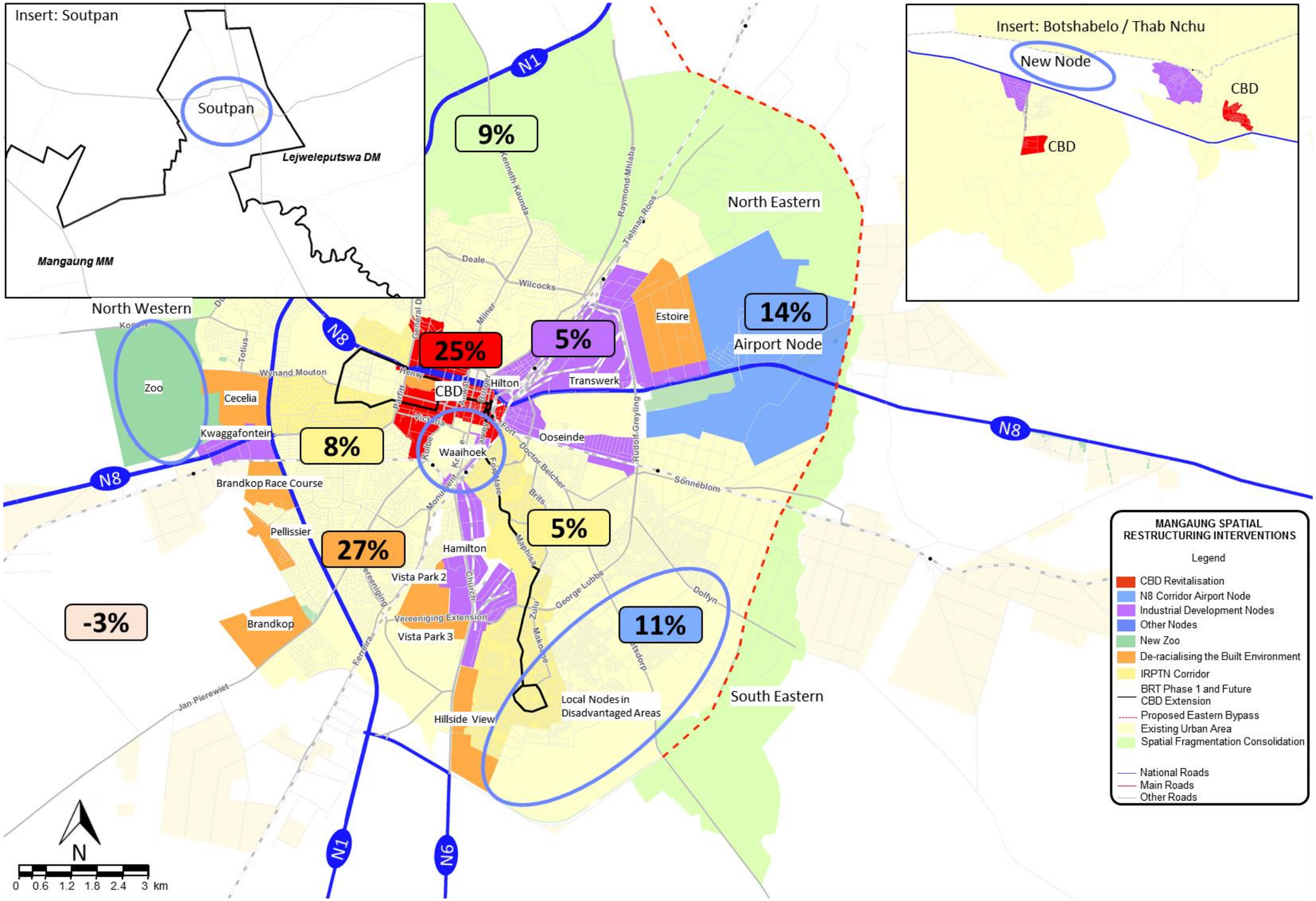


Figure 3-9: Mangaung Restructuring Interventions – Formal Worker Increment (2015-2036) (%)

MANGAUNG RESTRUCTURING INTERVENTIONS – DWELLING UNIT INCREMENT (2015-2036) (%)

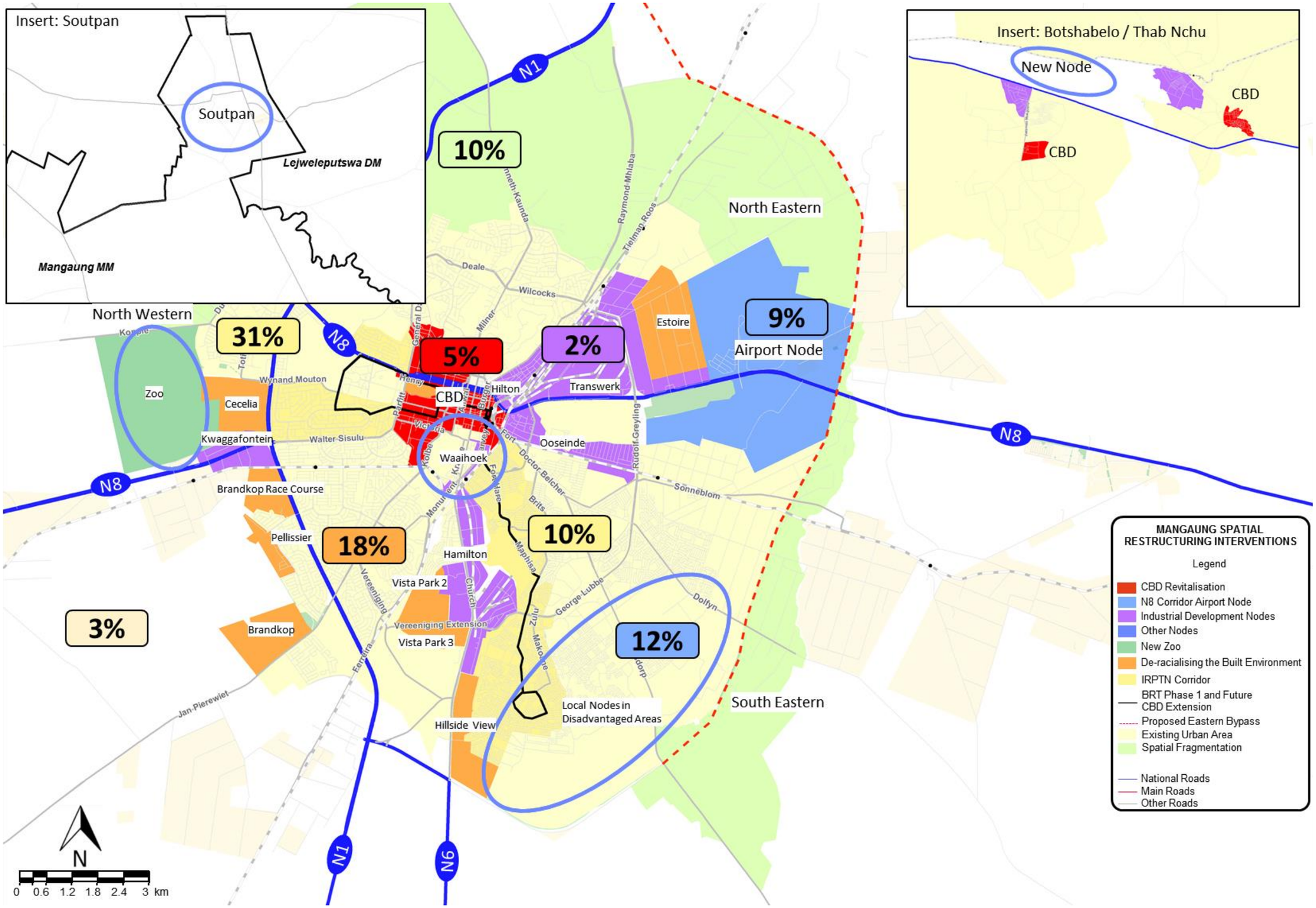


Figure 3-10: Mangaung Restructuring Interventions – Dwelling Unit Increment (2015-2036) (%)

Table 3-10: Spatial Transformation Objectives (Jobs) – Results 2015-2036

IDP Objective	Existing 2015	2036	Increment 2015 - 2036	Existing 2015 (%)	2036 (%)	Increment 2015 - 2036 (%)
	Jobs	Jobs	Jobs	Jobs	Jobs	Jobs
-ECONOMIC DEVELOPMENT	108,319	130,854	22,535	49%	50%	54%
• Central Business Districts	65,531	75,844	10,313	30%	29%	25%
• N8-Corridor	1,742	7,410	5,668	1%	3%	14%
• Industrial Development Nodes/SDZ's	27,148	29,271	2,123	12%	11%	5%
• Other Nodes	13,897	18,328	4,431	6%	7%	11%
-DE-RACIALISING THE BUILT ENVIRONMENT	6,757	18,216	11,459	3%	7%	27%
• 7 Land Parcels	6,757	18,216	11,459	3%	7%	27%
-INTENSIFICATION/DENSIFICATION/INFILL	85,271	90,900	5,629	39%	35%	13%
• IRPTN Corridor	18,379	20,560	2,181	8%	8%	5%
• Existing Urban area	66,892	70,340	3,448	30%	27%	8%
-SPATIAL FRAGMENTATION	5,778	9,407	3,629	3%	4%	9%
-RURAL DEVELOPMENT	15,003	13,622	(1,381)	7%	5%	-3%
TOTAL MANGAUNG MM	221,129	263,000	41,871	100%	100%	100%

Table 3-11: Spatial Transformation Objectives (Units) – Results 2015-2036

IDP Objective	Existing 2015	2036	Increment 2015 - 2036	Existing 2015 (%)	2036 (%)	Increment 2015 - 2036 (%)
	Units	Units	Units	Units	Units	Units
-ECONOMIC DEVELOPMENT	63,888	96,016	32,127	24%	26%	28%
• Central Business Districts	6,934	12,889	5,954	3%	3%	5%
• N8-Corridor	1,146	11,163	10,016	0%	3%	9%
• Industrial Development Nodes/SDZ's	6,253	8,478	2,225	2%	2%	2%
• Other Nodes	49,555	63,486	13,932	19%	17%	12%
-DE-RACIALISING THE BUILT ENVIRONMENT	2,512	22,995	20,484	1%	6%	18%
• 7 Land Parcels	2,512	22,995	20,484	1%	6%	18%
-INTENSIFICATION/DENSIFICATION/INFILL	176,545	222,267	45,722	68%	59%	40%
• IRPTN Corridor	41,652	52,750	11,097	16%	14%	10%
• Existing Urban area	134,892	169,517	34,625	52%	45%	31%
-SPATIAL FRAGMENTATION	6,686	18,019	11,333	3%	5%	10%
-RURAL DEVELOPMENT	11,612	15,154	3,542	4%	4%	3%
TOTAL MANGAUNG MM	261,242	374,451	113,209	100%	100%	100%

3.7.3 Results per Reporting Zone

Figure 3.11 illustrates the distribution of households per income group in 2015 and 2036. It is evident that within the Bloemfontein urban area, the majority of the low and middle income households live in the south-east (Mangaung area), whereas the majority of the high income households are located in the north-western suburbs. Although the majority of the low income households will still be living in the Mangaung area in the future, an increase in middle income households is expected in the western suburbs, mainly because of the “7 Land Parcels” initiative.

Figure 3.12 illustrates the distribution of job opportunities by Type in 2015 and 2016.

Note the dominance of office/ retail workers in and around the Bloemfontein CBD area, and it is expected to further increase in future when the redevelopment plans of the Zoo Lake precinct and other infill developments realise. Local Serving Workers (education-, health-, and other services) constitute the majority of the workers in the Universitas area.

Industrial Development is expected to increase in the N8 Corridor, while local service-; construction-; and transport workers are expected to increase in the Mangaung area, as more community facilities will be needed in future, and as the BRT gets constructed.

Figure 3-13 depicts the number of people per traffic zone (regional scale). It is evident that a large number of people are located in the south-eastern quadrant of Mangaung, as well as in the Botshabelo and Thaba Nchu areas, but also in the rural areas north and south of Thaba Nchu.

Figure 3-14 depicts the number of people per traffic zone (urban scale). The largest number of people are presently located in central Mangaung.

In future the increase is visible along the N8-Corridor, the CBD, and also in the “7 Land Parcel” projects of Estoire, Hillside View, Vista Park 2 and 3, Brandkop, Pellisier and Cecilia.

A further increase of population is also expected in the Langenhoven Park/ Woodlands Estate/ Rayton area to the north-west of the city.

From **Figure 3-15** it is evident that apart from the CBD, the highest residential densities are found in a north-south direction in Mangaung along Maphisa Road (Phahameng, Kagisanong). Future densities will increase along the proposed Phase 1 of the BRT, as well as in most of the suburbs in general, as infill and redevelopment take place.

Figure 3-16 illustrates the total number of formal workers per traffic zone in the Bloemfontein urban area. As expected the highest concentration of formal workers are found in the CBD and surrounding zones, as well as in the Hamilton Industrial area. It is expected that apart from the growth in the CBD, and the old Zoo redevelopment, the new Kwaggafontein/ Cecilia node will also be a prominent node in future.

Figure 3-17 illustrates the formal worker density per hectare per traffic zone, and it is clearly evident that the intensity of economic development is the highest in the CBD and surrounding zones (existing and in future).

DISTRIBUTION OF DWELLING UNITS PER INCOME 2015 AND 2036

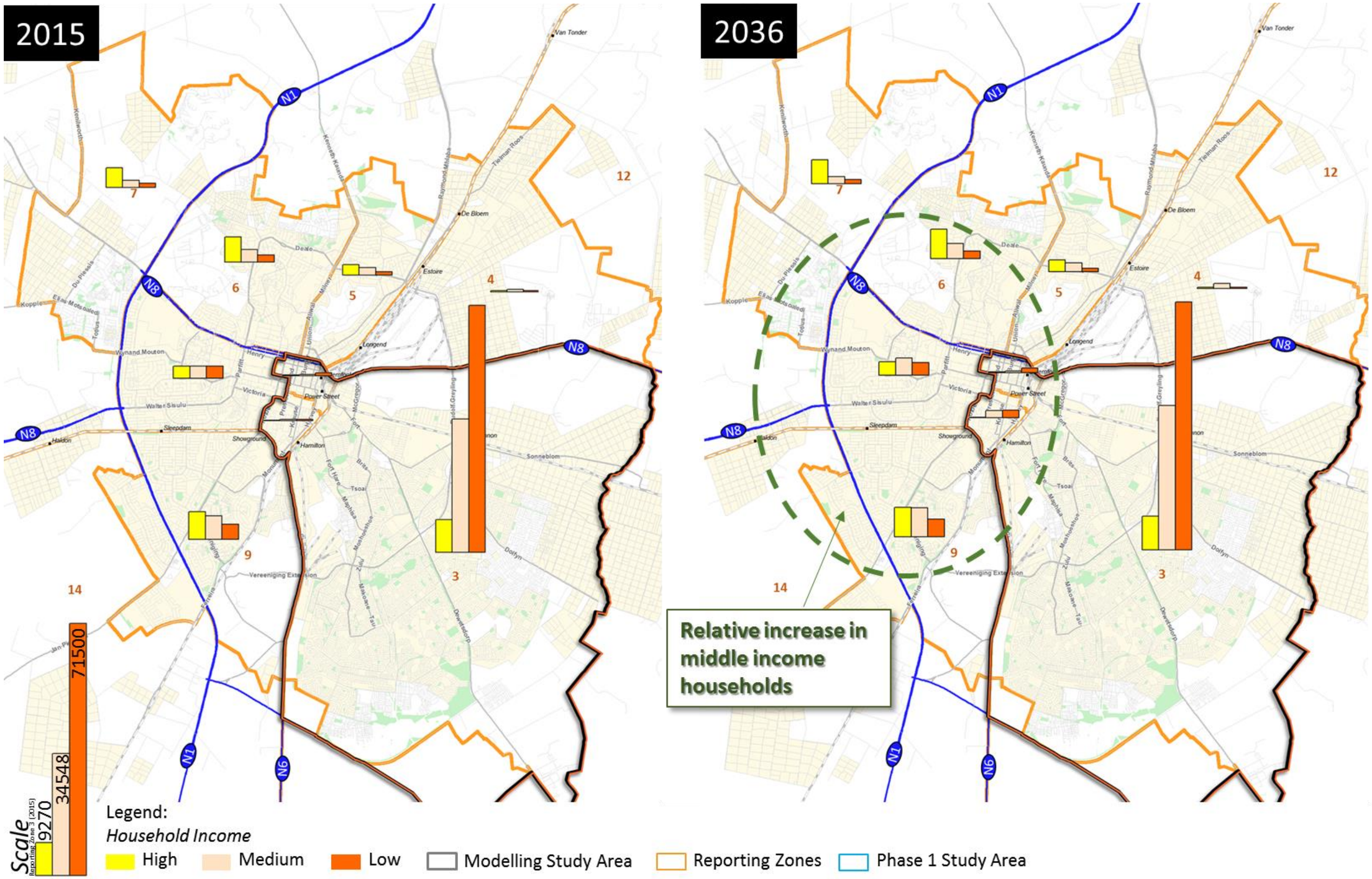


Figure 3-11: Distribution of Dwelling Units per Income 2015 and 2036

DISTRIBUTION OF FORMAL WORKERS PER TYPE 2015 AND 2036 - Phase 1

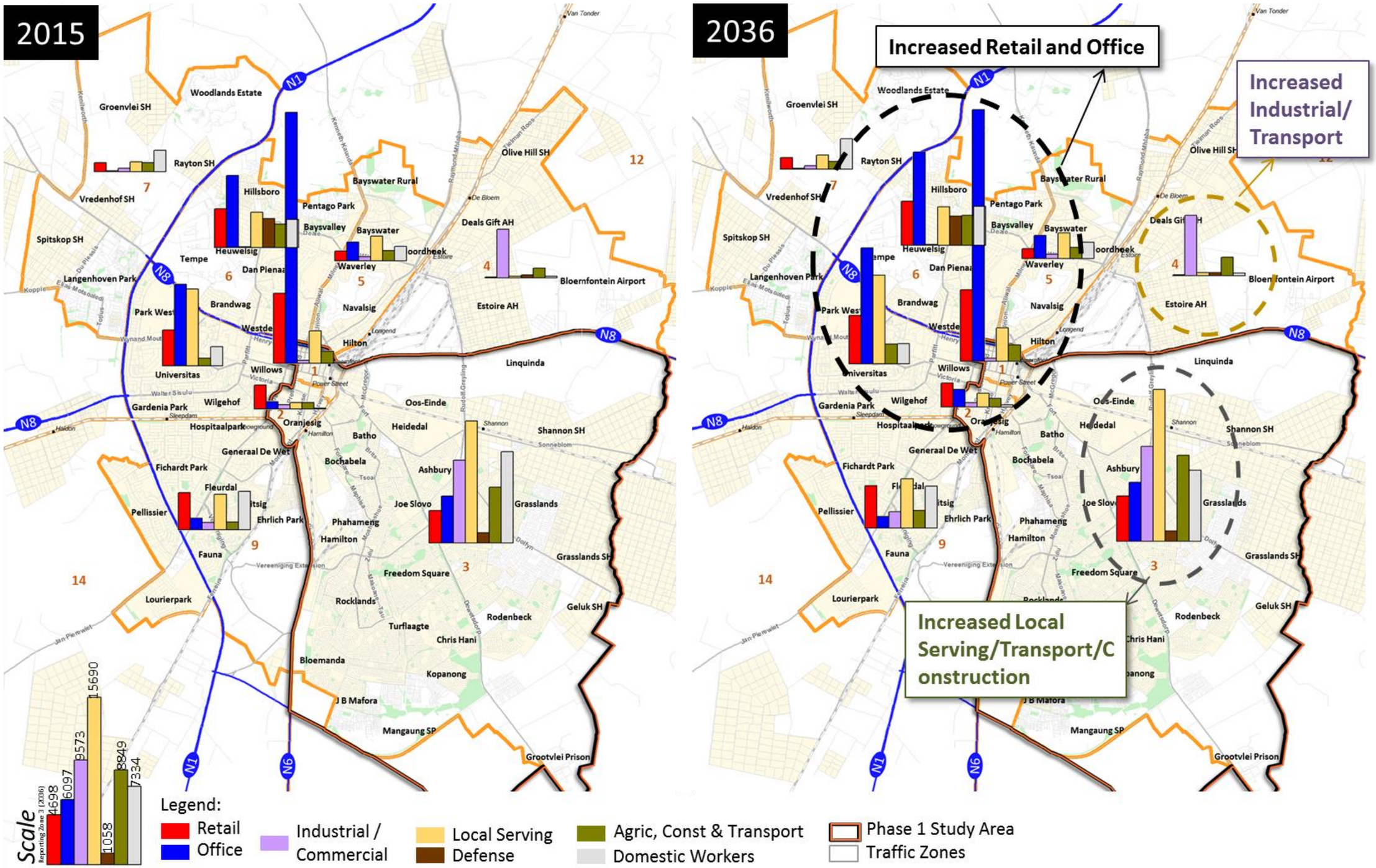


Figure 3-12: Distribution of Formal Workers per Type 2015 and 2036

POPULATION PER TRAFFIC ZONE, 2015 AND 2036

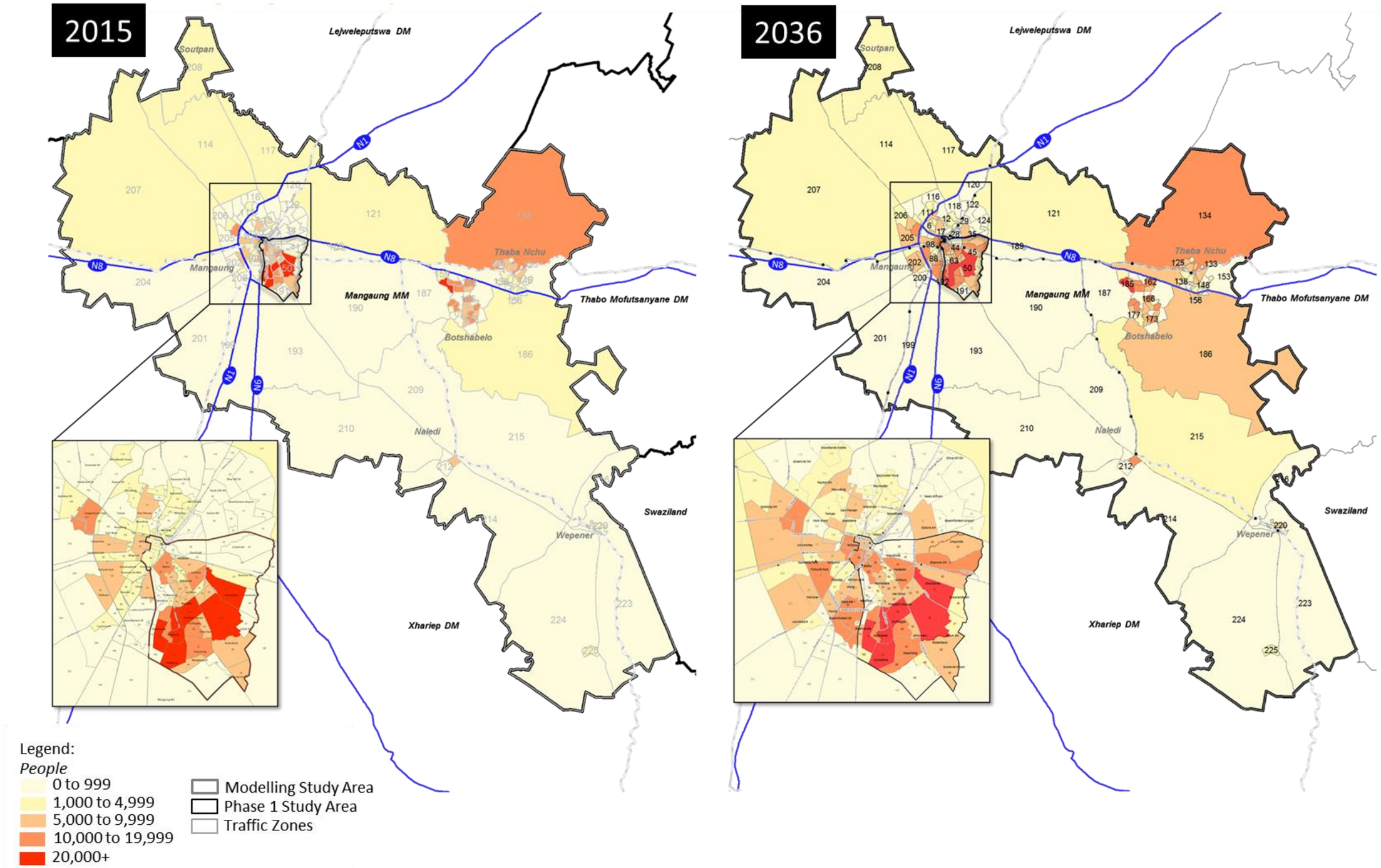


Figure 3-13:Mangaung MM Study Area – Population per Traffic Zone, 2015 and 2036

POPULATION PER TRAFFIC ZONE, 2015 AND 2036

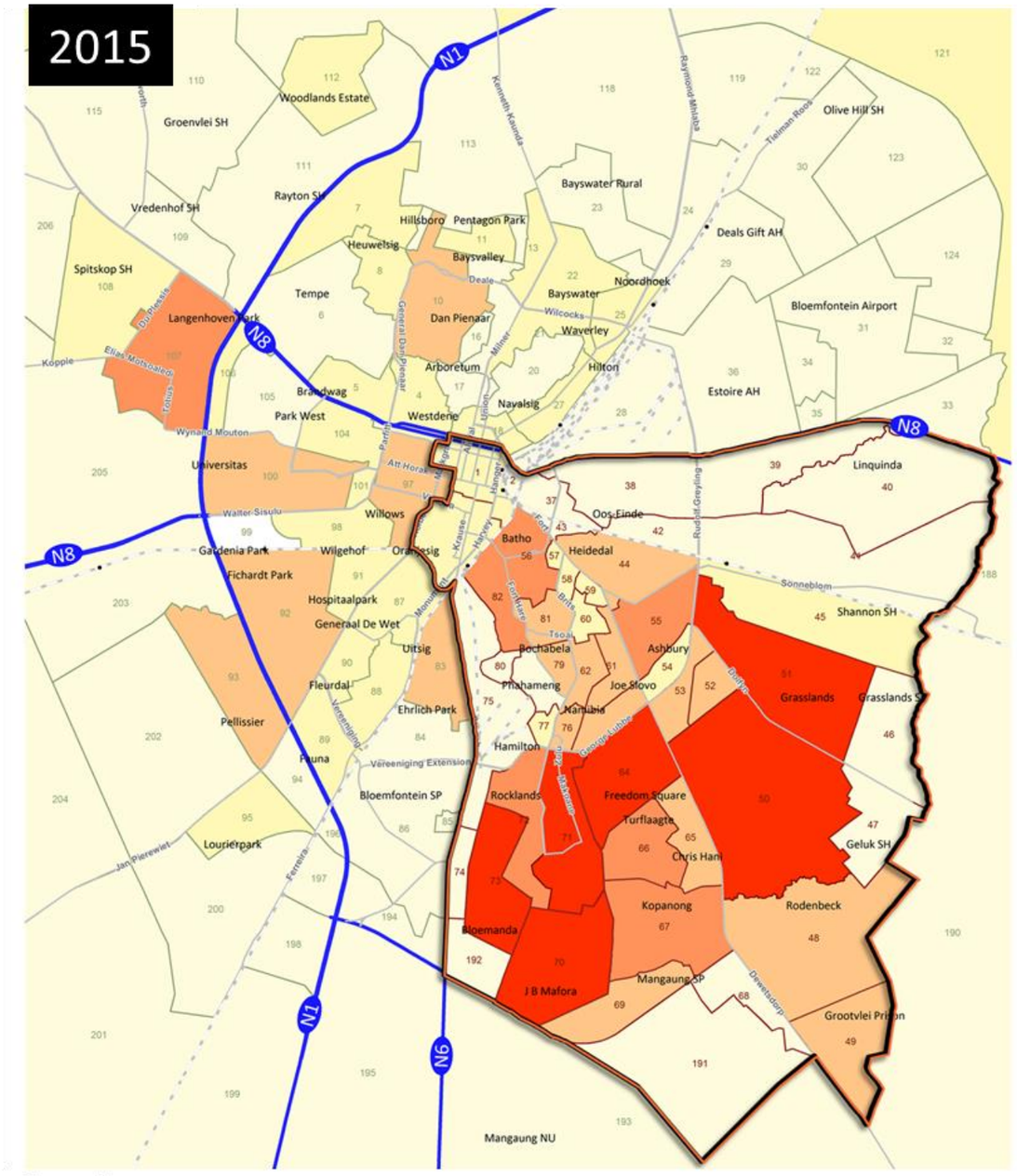
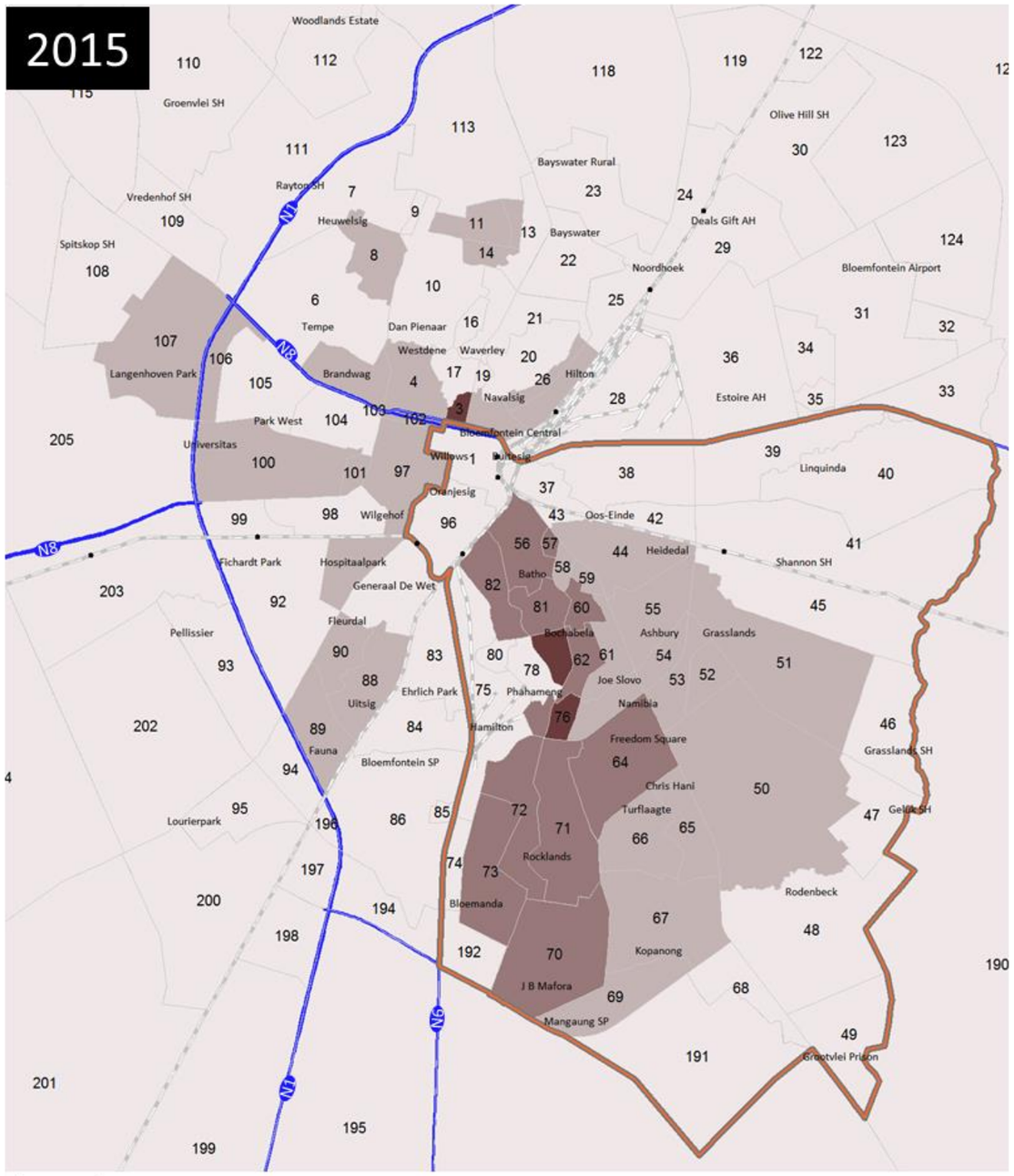
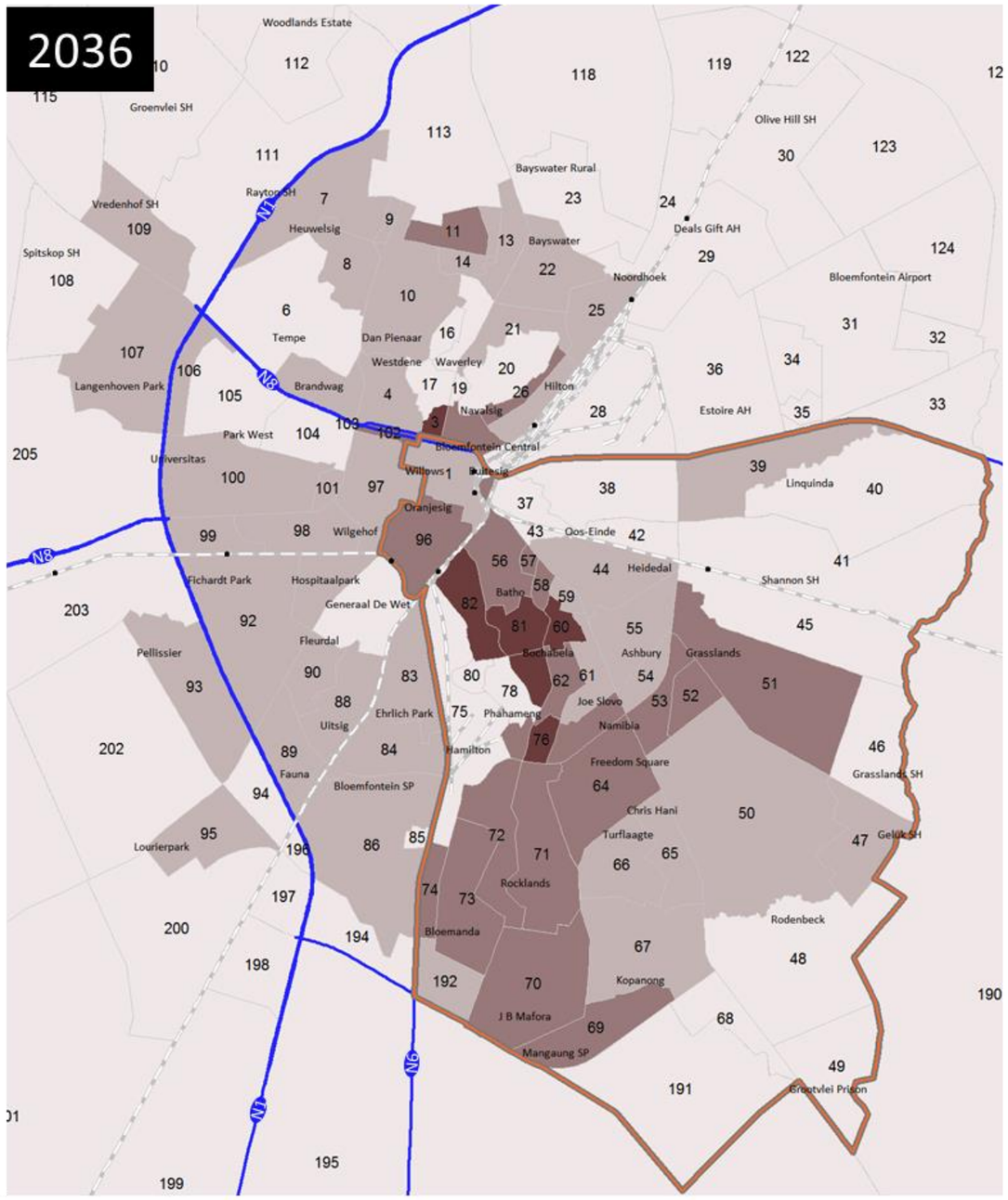


Figure 3-14: Phase 1 – Population per Traffic Zone, 2015 and 2036

RESIDENTIAL DENSITY (DWELLING UNITS/HA) 2015-2036





Legend:
du/ha
0 to 6
7 to 21
22 to 36
37 to 79
80+
Modelling Study Area
Phase 1 Study Area
Traffic Zones

Figure 3-15: Residential Density (Dwelling Units/ha) 2015-2036

NUMBER OF FORMAL WORKERS PER TRAFFIC ZONE 2015-2036

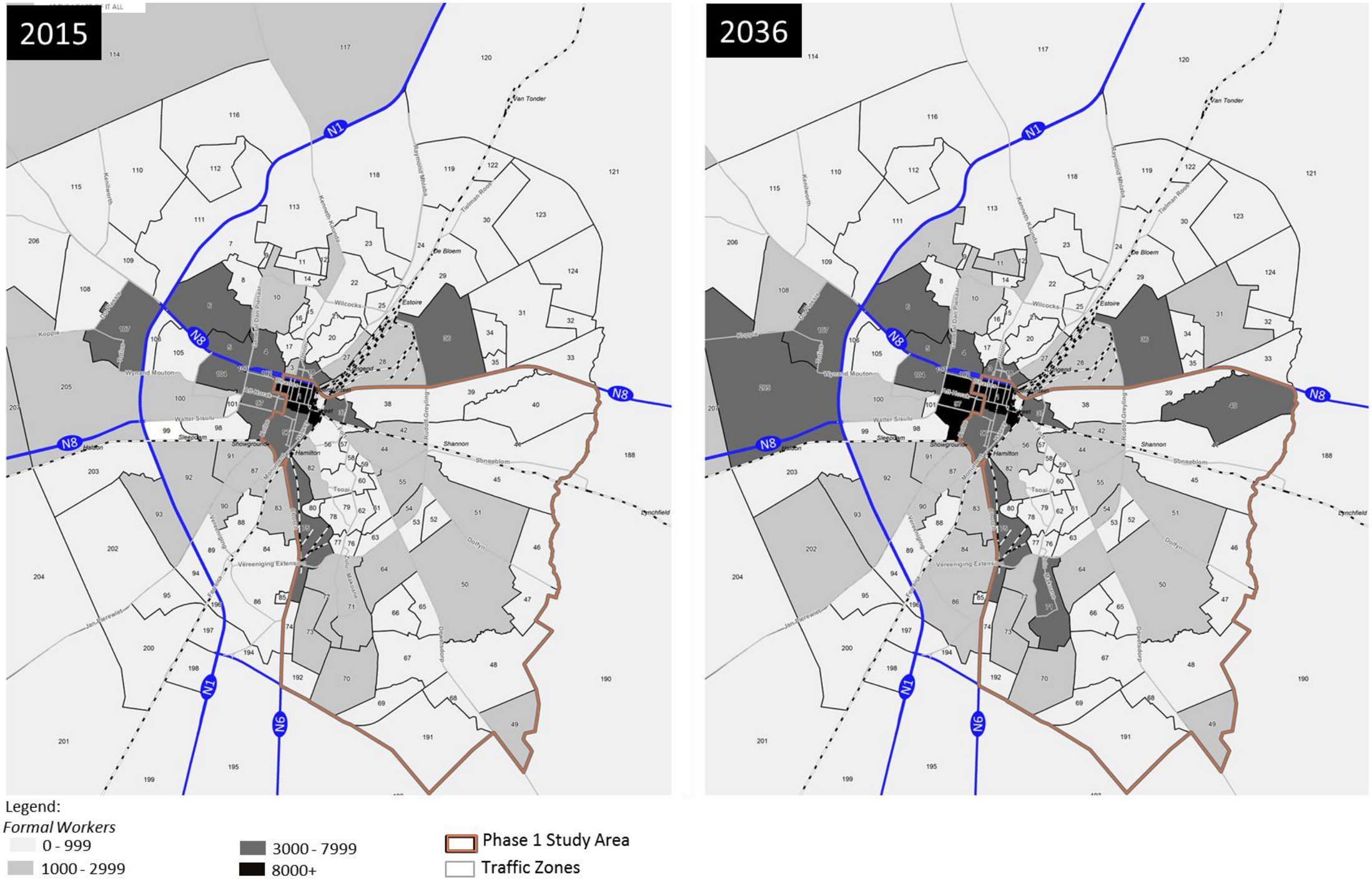


Figure 3-16: Number of Formal Workers per Traffic Zone 2015-2036

FORMAL WORKERS DENSITY PER TRAFFIC ZONE

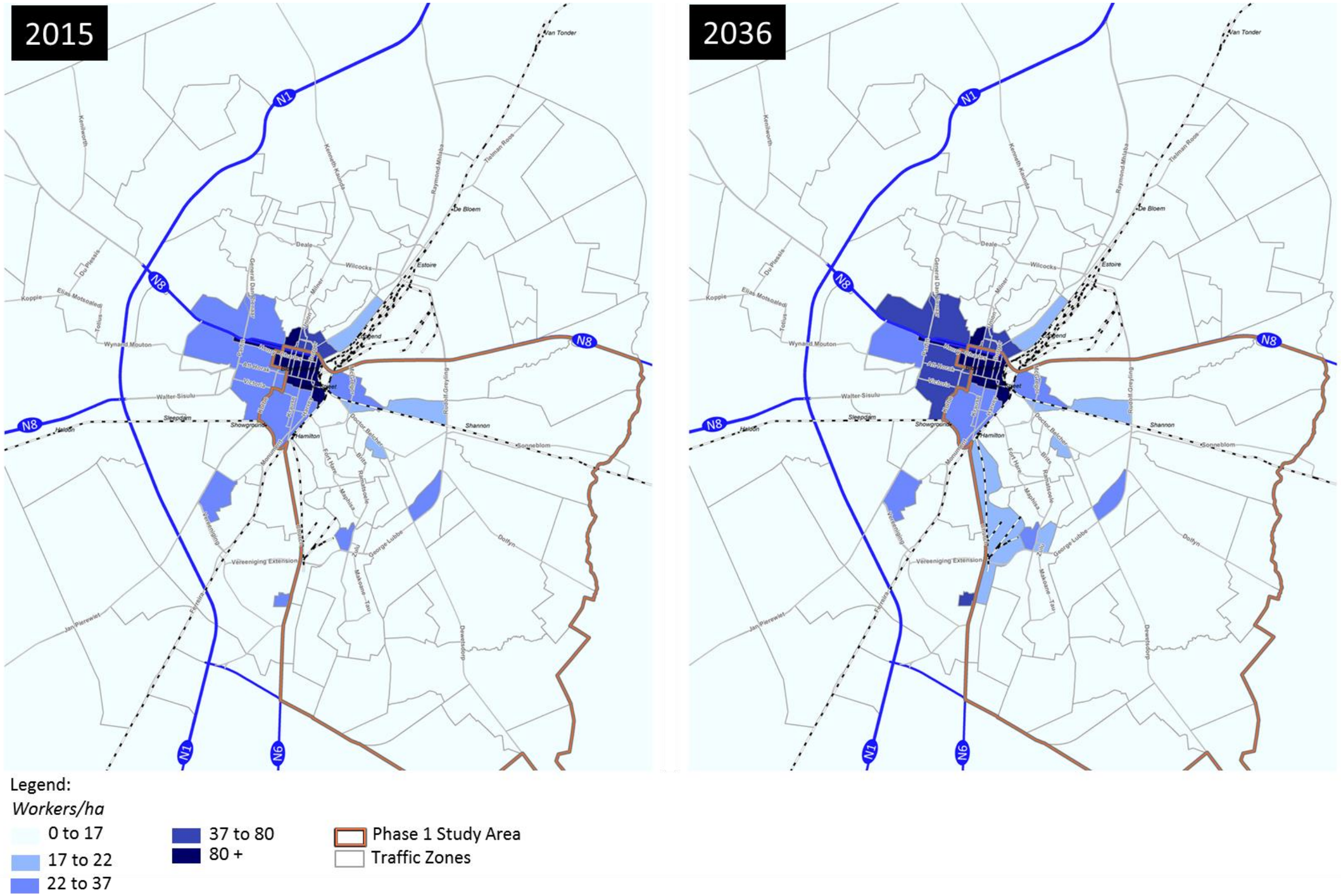


Figure 3-17: Formal Workers Density per Traffic Zone

3.8 Transport Network

3.8.1 Roads

The existing road network in the Bloemfontein urban node is characterised by a radial form. The road network is characterised by a number of road classes, of which Class 1 (National Roads / Freeways) and Class 2 (Arterials) form structuring elements within the urban nodes. The Bloemfontein urban node is characterised by the following key road network elements (Refer to Figure 3-18):

- Class 1: National Roads / Freeways
  - National Route N1 (connecting Gauteng to Cape Town)
  - National Route N8 (connecting Botshabelo / Thaba Nchu, Bloemfontein and Kimberly)
  - National Route N6 (connecting East London and Bloemfontein)
- Class 2: Arterials
  - Raymond Mhlaba Street (R30)
  - Kenneth Kaunda Road (R700)
  - General Dan Pienaar Road
  - Nelson Mandela Drive (R64)
  - Walter Sisulu (N8 western extension)
  - Jagersfontein / Curie / Kolbe Avenue (R706)
  - Ferreira Road
  - Church Street (M30 / N6 southern extension)
  - Dewetsdorp Road (R702)
  - Meadows Street
  - Thaba Nchu Road

The radial road network is also characterized by an outer and an inner ring road system. The outer-ring road is formed by the N1, approaching from the north, hugging the western boundary of Bloemfontein, and exiting to the south. The N6 extension along the southern boundary between the N1 and the R701 completes a portion of the outer ring road loop. The eastern portion of the ring road loop has not been constructed, but plans are afoot to complete this portion of the ring road, thereby linking the N6 extension (from R706) up with the N1 (towards the north). This extension of the ring-road's eastern section will provide very important regional access to the eastern parts of Bloemfontein urban node, and particularly to the planned Airport Node Development.

The inner ring-road is formed by the M10 alignment which runs along the southern and eastern boundaries of the Boemfontein urban node, which becomes Rudolf Greyling Avenue as the M10 crosses the National Route N8, thereafter becoming Wilkocks Road and Deale Road forming the northern edge of the inner ring-road, thereafter turning south againg along General Dan Pienaar and Parfitt Avenue, which forms the western boundary of the inner ring-road.

A number of future road links are proposed within Mangaung Municipality, most notably:

- N6 extension along the eastern edge of Bloemtontein from Dewetsdorp Road towards the north linking at Renoster Avenue (Refer to "A" on Figure 3-18).
- Renoster Avenue extension (north-west from the Airport) along the western boundary of Bloemfontein reconnecting at N6/N1 interchange (south of Bloemfontein) (Refer to "B" on **Figure 3-18**).
- Du Plessis Road extension along the western edge of Bloemfontein urban node (following a similar alignment to the National Route N1) (Refer to "C" onFigure 3-18).
- Thaba Nchu / Botshabelo east-west link from Brand Street (Thaba Nchu) north of the N8 alignment linking into the main road intersection of Botshabelo (Refer to "D" on **Figure 3-18**).

3.8.2 Rail Network and Stations

Mangaung is served by two railway lines, namely:

- Bloemfontein-Maseru railway line which connects Thaba Nchu to Bloemfontein along the National Route N8 corridor alignment in an east-west direction
- Johannesburg-Bloemfontein-East London / Port Elizabeth railway line, which traverses the Bloemfontein urban node in a north-south direction

Currently these railway lines carry no commuter services within the Mangaung area and they are exclusively used by Transnet Freight Rail (TFR) for freight transport and by Shosholoza Meyl for long distance passenger transport along the Johannesburg – Bloemfontein – Port Elizabeth service, the Johannesburg – Bloemfontein – East London service and the Cape Town – Kimberley – Bloemfontein – Pietermaritzburg – Durban service.

The following railway infrastructure initiatives are planned within the Mangaung area:

- According to the Spatial Development Framework (SDF) a railway connection proposal has been made to connect Botshabelo to the Thaba Nchu-Bloemfontein Railway line section.
- A feasibility study is planned to determine the feasibility of developing an additional railway link / siding to serve the Airport Development Node (Phase 2)
- The PRASA railway upgrade program has issued a tender for a Rail Feasibility Study of the N8 rail corridor (which forms part of Strategic Integrated Project (SIP) 7).

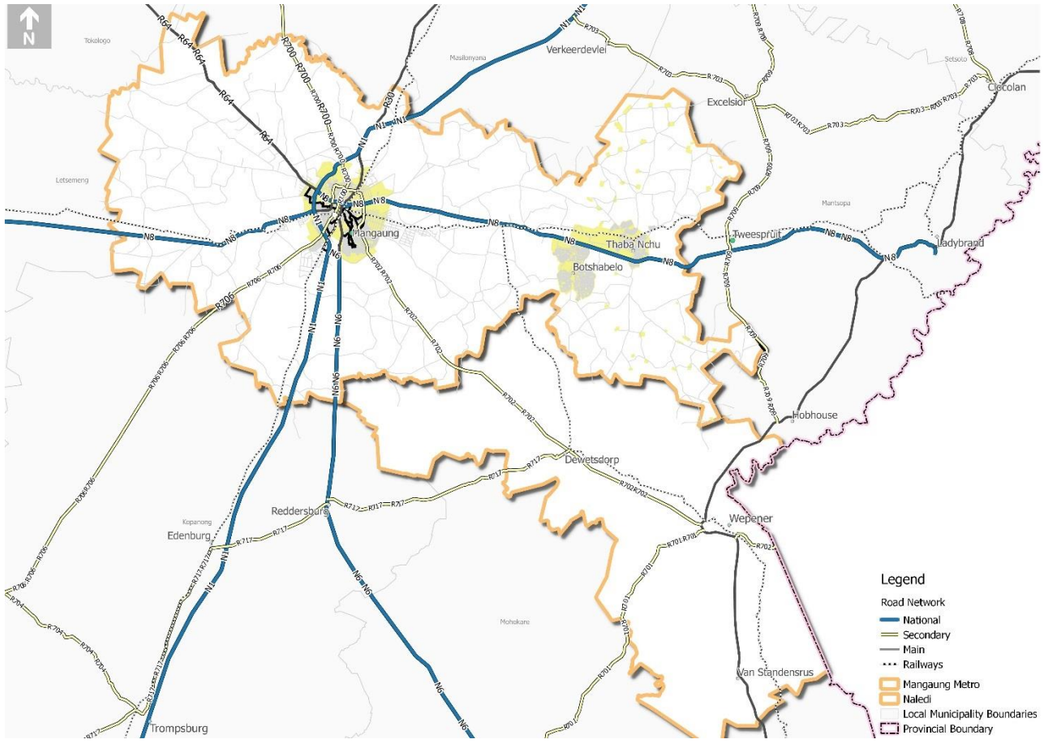


Figure 3-18: MMM Transport Network (Ops. Plan 2014)

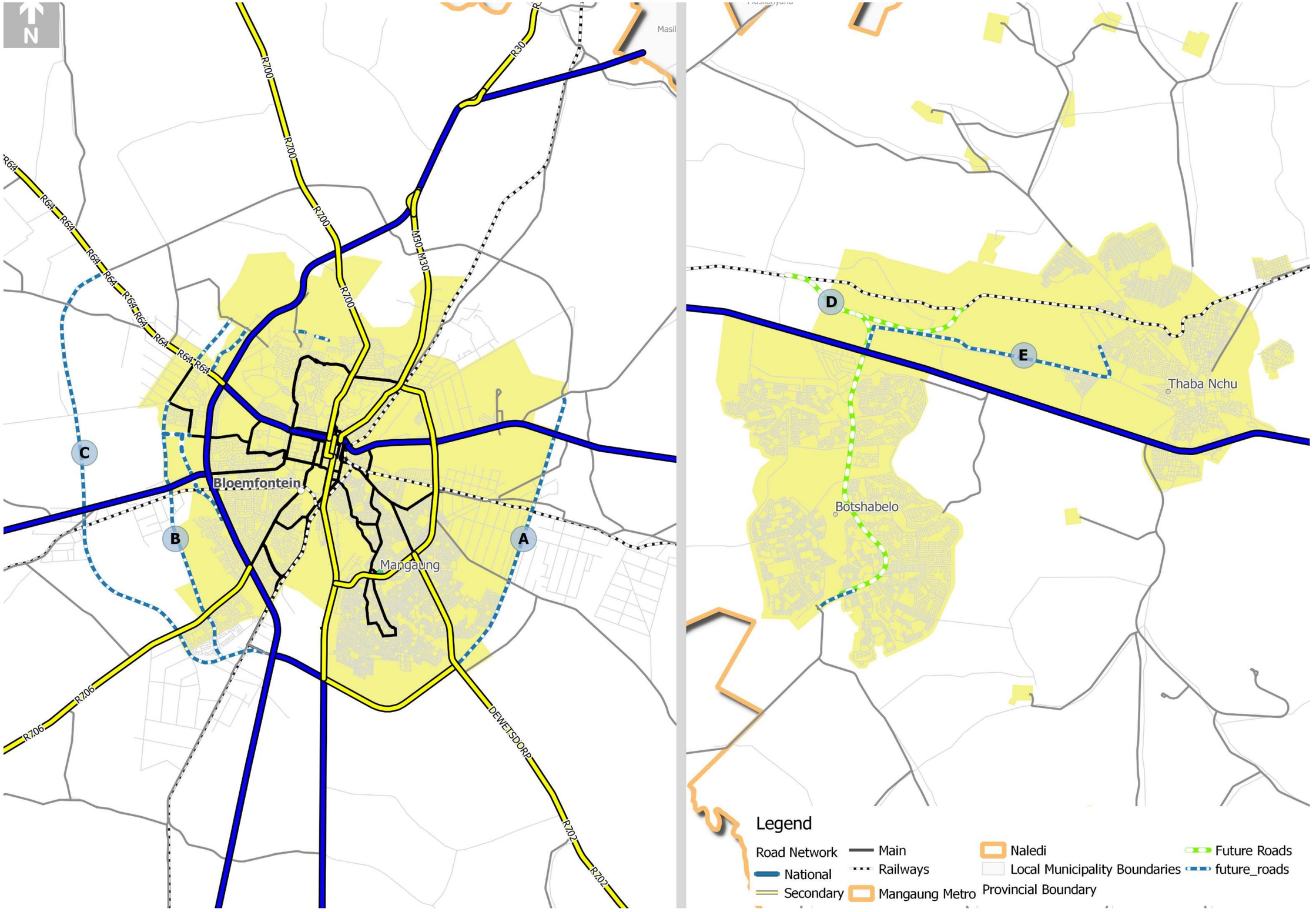


Table 3-12: Bloemfontein, Botshabelo and Thaba Nchu Road Network

3.8.3 Public Transport Network

The Mangaung road-based bus and minibus-taxi public transport facilities include the following:

- 23 Minibus -taxi ranks
- 4 Bus facilities

Table 3-13: Number of Formal and Informal Public Transport Facilities per Mode

Urban Node	Mode	Formal	Informal	Total
Bloemtontein	Bus	2	0	2
	Minibus-Taxi	4	12	16
Thaba Nchu	Bus	1	0	1
	Minibus-Taxi	1	2	3
Botshabelo	Bus	1	0	1
	Minibus-Taxi	2	2	4

The Mangaung road-based bus and minibus-taxi public transport routes are also reflected in Figure 3-19 in and Figure 3-20 respectively.

The contracts operated by Itumeleng Bus Service (IBL) provides for subsidised public passenger transport services between Bloemfontein and Thaba Nchu, Botshabelo, Mangaung and Soutpan as well as distribution services to be operated from Central Park Terminus to Bloemfontein's residential areas. The provincial contracts payment certificates indicate that the services are operated by 214 buses (203 peak and 11 spare buses). IBL operates these services in terms of 5 tendered contracts that are funded through the Public Transport Operational Grant (PTOG) by means of allocations made by the National Treasury in terms of the Division of Revenue Act (DORA). The Free State Department of Police, Roads and Transport acts as contracting authority for the contracts. The contracts with IBL for services operated between Bloemfontein and Botshabelo, Thaba Nchu and Mangaung were entered into in 1998. The contract for services operated between Bloemfontein and Soutpan was entered into in January 2015 after the previous operator, GS Thebeagae Bus Services who operated the contract since 1998, abandoned the contract.

A detailed report on the contracts and services are provided in Annexure E. The report provides the following detail:

- Section 4 - Information on the services operated by IBL within the Mangaung Municipal,
- Section 5 - Information on the types, number and capacity of the buses used;
- Section 6 - Operational statistics collected on the subsidised services operated by IBL;
- Section 7 -Operational statistics collected on the unsubsidised services.

The institutional structure and ownership within the minibus-taxi industry in Bloemfontein, Botshabelo and Thaba Nchu is also formalized, with three taxi associations established that provide paratransit commuter services in Mangaung, namely (Refer to Table 3-14):

- Greater Bloemfontein Taxi Association (GBTA)
- Thaba Nchu Long and Short Distance Taxi Association (THALSDTA)
- Botshabelo Amalgamated Taxi Association (BATA)

Table 3-14: Mangaung Metropolitan Municipality Mini-bus Taxi Association Information

Operator	Members	Routes	Vehicles
Greater Bloemfontein Taxi Association	2 331	95	2 609
Thaba Nchu Long and Short Distance Taxi Association	318	26	374
Botshabelo Amalgamated Taxi Association	*	80	*

*Note: * denotes that no member or vehicle information was provided for Botshabelo Amalgamated Taxi Association*

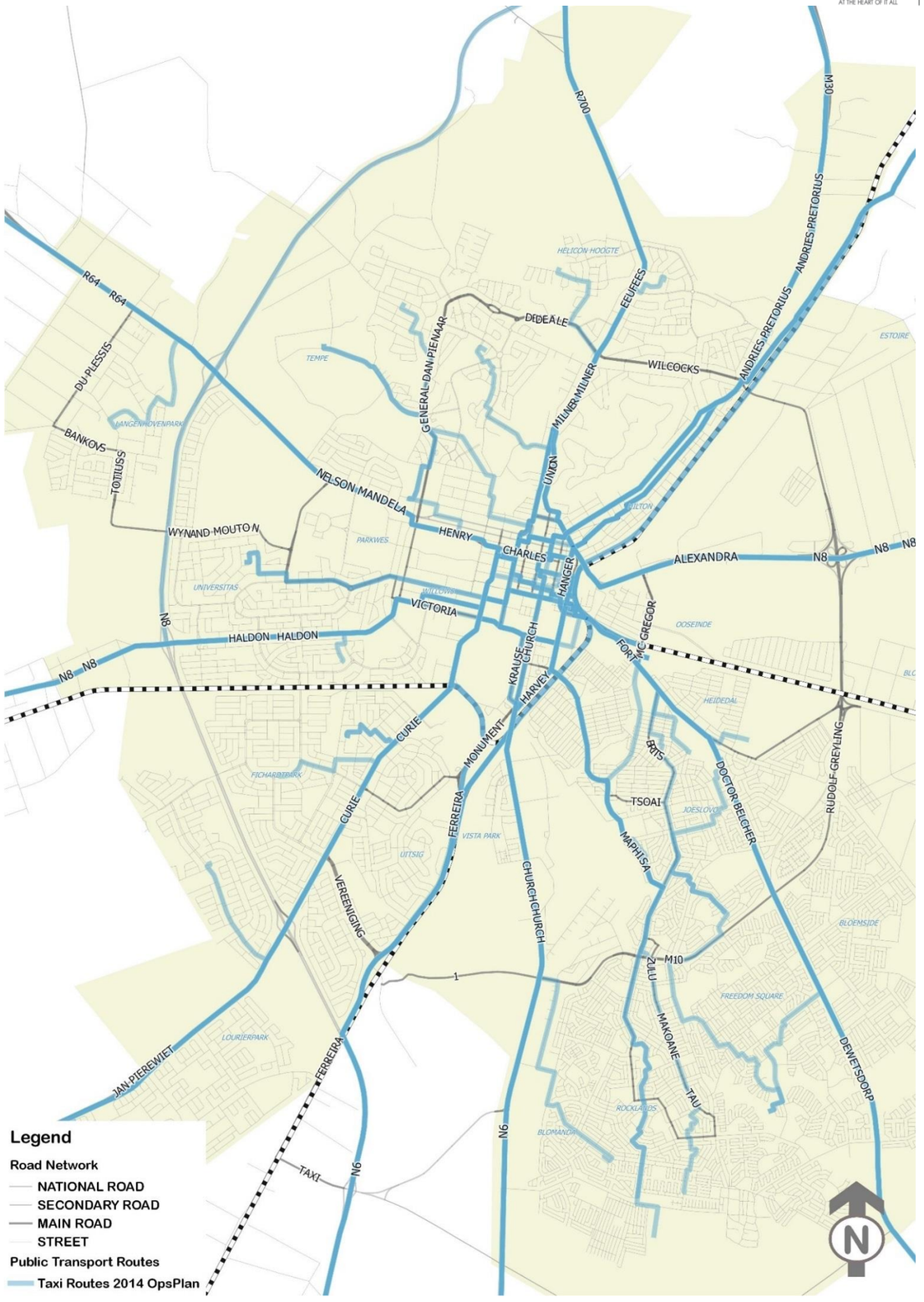


Figure 3-19: MMM Taxi Network (Ops. Plan 2014)

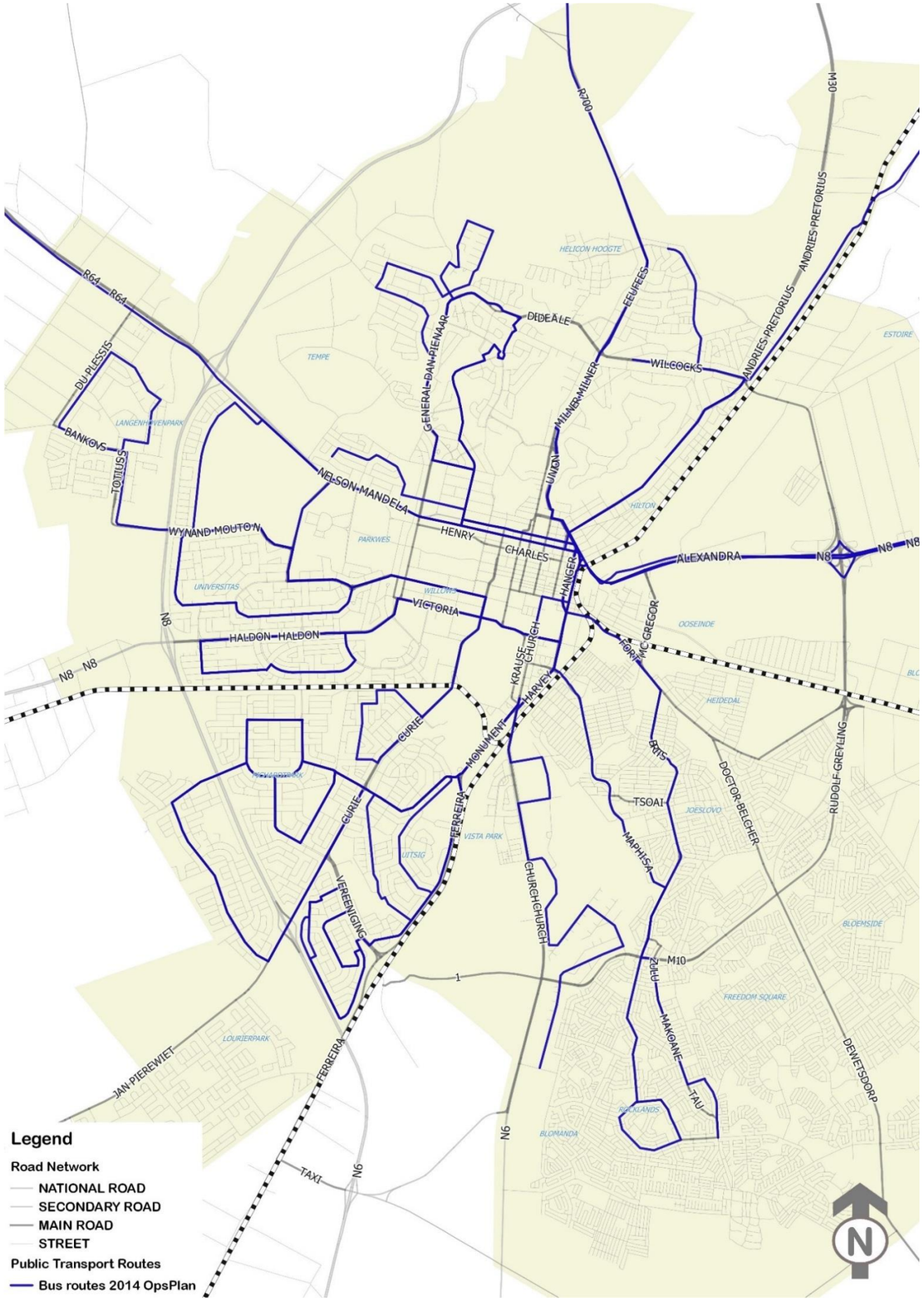


Figure 3-20: MMM Bus Route Network (Ops. Plan 2014)

3.9 Demand Corridors

The demand corridors were derived from observed demand and from the land use model developed for the base year 2015 and future year 2036. The land use model is based on the spatial restructuring elements of the city and the macro-economic analysis done for the purpose of the development of the IPTN.

The observed demand is based on several surveys commissioned from March 2016 to November 2016 with final analysis and results to be included in the final IPTN document during April 2017.Summary of the surveys and the date when results and preliminary analysis will be available and included in the Operational Plan is presented in **Table 3-15**.

Table 3-15: Observed Demand Surveys 2016

Survey Type	Count Duration	Commissioned	Data Captured	Data Validated	Data Analysed	Survey Analysis and Report Incorporation Date
Manual Vehicle Occupancy Link Counts	12 hour	April/May 2016	Yes	Yes	Yes	No
Manual Classified Intersection Counts	12 hour	April/May 2016	Yes	Yes	Yes	No
Taxi Facility Survey	12 hour for 3 consecutive days	April/May 2016	Yes	Partially	Partially	No
Bus On-board Surveys	7 days	Yes	Yes	Yes	Partially	No
Taxi On-board Surveys	31 days	Yes	No	No	No	No
Household Travel Surveys		Yes	No	No	No	No

For the November 2016 Operational Plan submission the Manual Vehicle Occupancy Counts and the Facility Surveys were used to represent the observed demand for the Mangaung township area and the land use model origin destinations for 2015 and 2036.

3.9.1 Observed Demand 2016

3.9.1.1 12-Hour Manual Vehicle Occupancy Counts (VOC)

The VOC was commissioned for the week of 3 to 5 May 2016 at the positions shown in **Figure 3-21** and the detail description of the count positions are described in **Table 3-16**.

The analysis of the vehicle occupancy counts (VOC) provided the variables listed for the patronage estimation:

- Peak period distribution;
- Peak hour passenger and vehicle distribution;
- North-south direction split;
- Mode split.

The results of the analysis for all survey points are attached in Annexure C. Figure 3-22 and Figure 3-23 show the AM peak hour and PM peak hour person trips for the Mangaung Township area. During the AM peak hour, the majority (80%) of person trips observed are towards the CBD, while during the PM peak hour the directional split vary between count positions with the majority (>60%) of person trips from the CBD.

The peak hour existing public transport total trips to and from the area range between 1 000 and 7 000 per direction per hour depending on the count station. The total number of public transport users across modes from the area towards the CBD during the morning peak hour total to 16 000 passengers **per hour**, and from the CBD +-2400 **per hour**.

The VOC analysis further indicated that the peak hour factor or the percentage of the total number of trips made within a specific hour during the peak period (3-hours) are evenly spread across the 3 hours within the peak period. In other cities, the peak period is characterised by one peak hour where more than 50% of passengers are made in the specific hour. The implication of this is that a large number of public transport vehicles are only utilised within the specific peak hour and not during the rest of the day.

Table 3-16: List of VOC Counts

StNr	Name
MLC01	Moshoeshoe St (south of M10)
MLC02	Singonzo St (south of M10)
MLC03	Dewetsdorp Rd (south of M10)
MLC04	Meadows St (South of M10 at Heidedal)
MLC05	Fort Hare Rd and Mkuhlane St
MLC06	Belcher Rd & Mkuhlane St
MLC07	Moshoeshoe St (North of Chief Moroka Crescent)
MLC08	Singonza St (at Rocklands)
MLC09	Dewetsdorp Rd (at Chris Hani)
MLC10	Meadows St (between Grasslands and Sonskyn)
MLC11	Moshoeshoe St north of M10 George Lubbe St (4 lanes)
MLC17	Dr Belcher north of M10 George Lubbe St (2 lanes)
MLC13	Monapi St (North of M10)
MLC14	Sonneblom St (West of Iris St)
MLC15	Mkuhlane St and Kokozela St
MLC16	Hilton Rd and Fort Hare Rd
MLC21	M30 Kerk St north of the M10 George Lubbe St (4 lanes)
MLC26	Monument Rd south of Rhodes Ave (4 lanes)
MLC27	Fort Hare Rd east of Monument St (4 lanes)
MLC31	N8 east of Charles St (4 lanes)
MLC35	Hanger St south of Charles St (3 lanes)

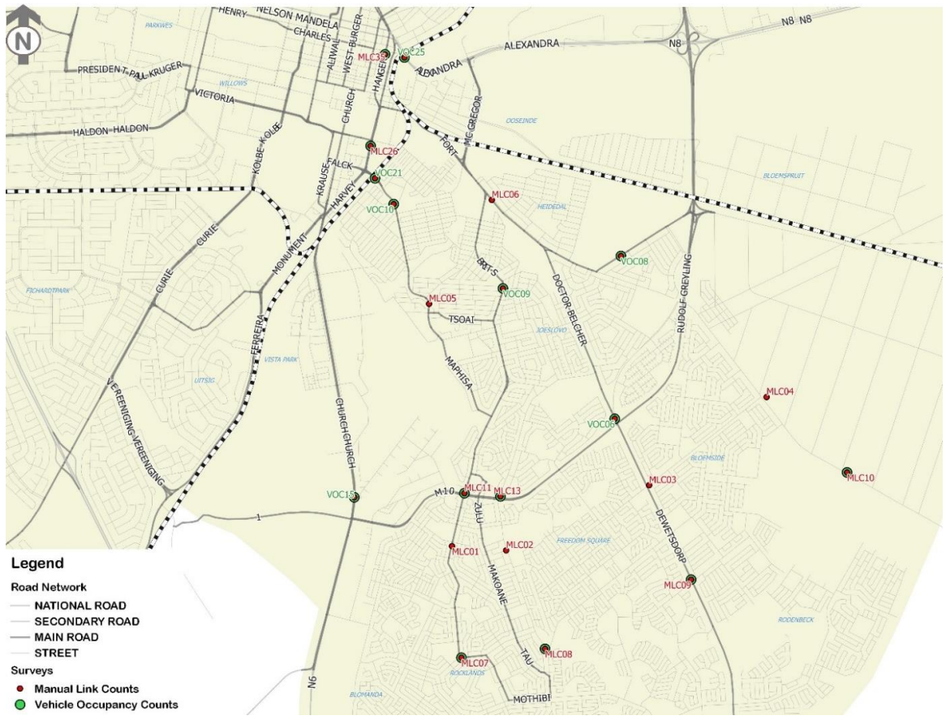


Figure 3-21: 12-Hour Manual Vehicle Occupancy Counts

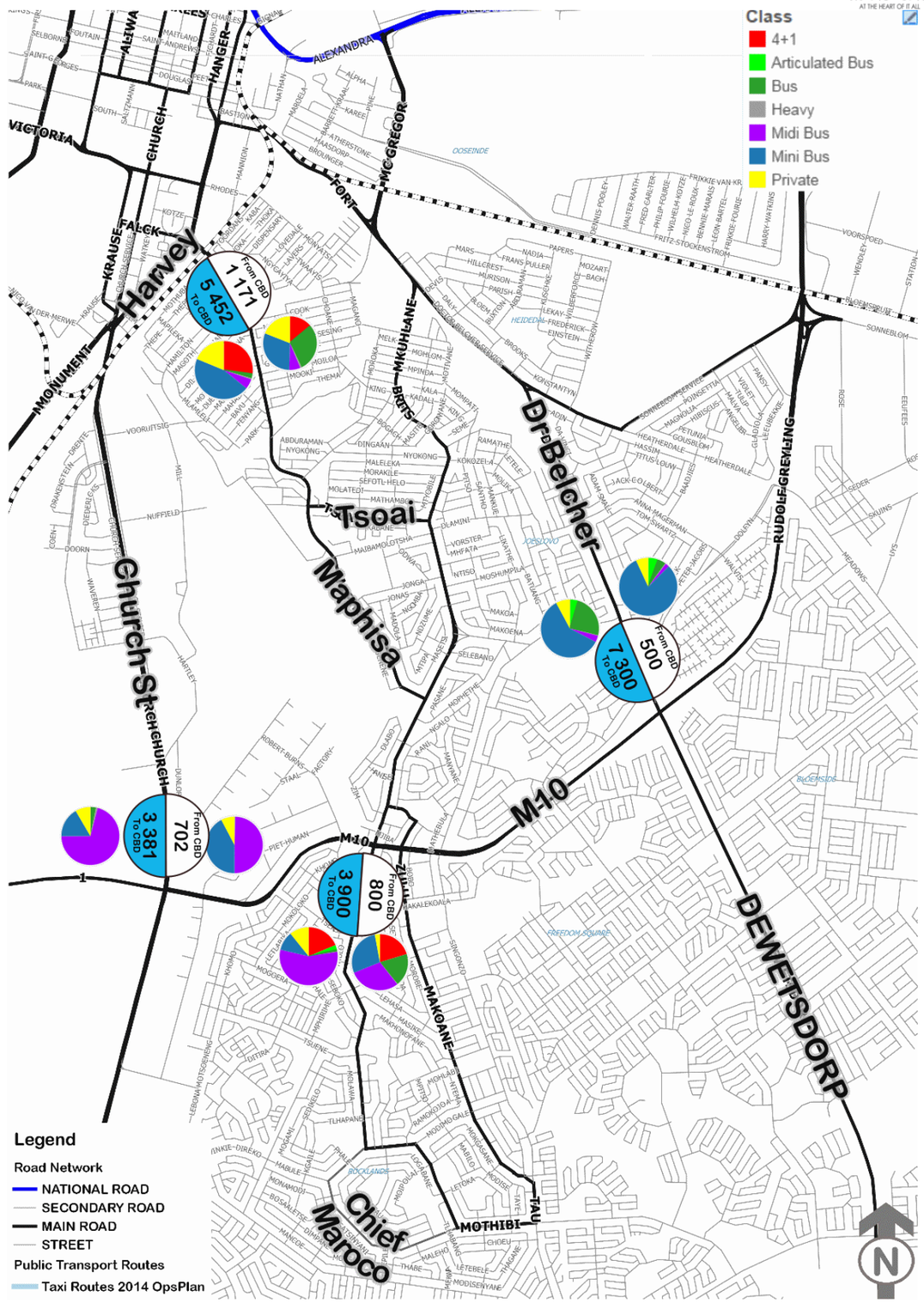


Figure 3-22: 06:00-07:00 - Total Passenger Volumes Surveyed 2016

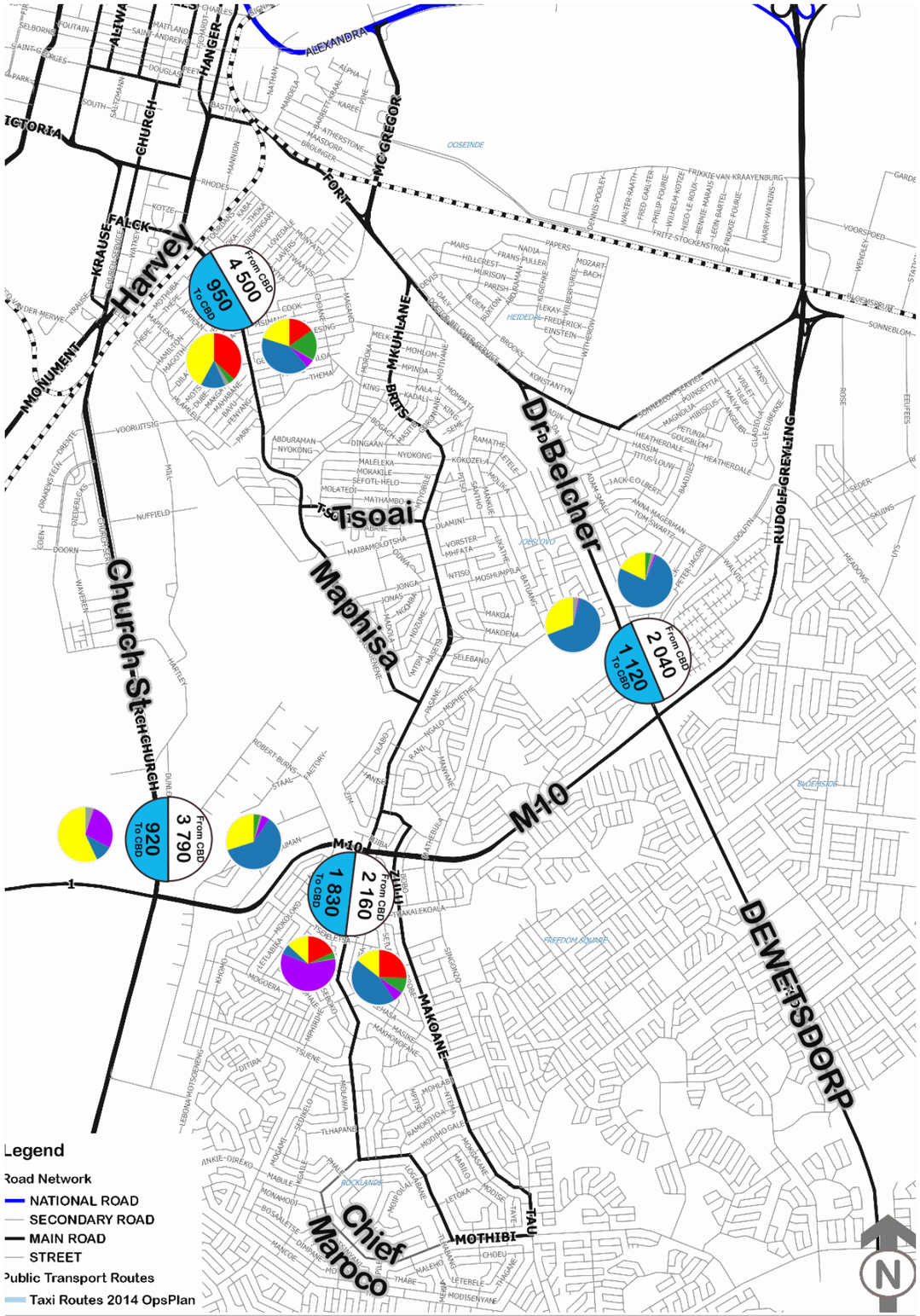


Figure 3-23: 17:00-18:00 - Total Passenger Volumes Surveyed 2016

3.9.1.2 Taxi Facility Surveys

The focus of the taxi facility survey was to obtain the number of vehicles and utilisation of the vehicles between specific origin destination pairs or along routes. The ranks and pick-up points were surveyed for a 12-hour period for three consecutive days. During the preparation for the surveys it was determined that taxi operators in Bloemfontein operate three distinct networks. The networks and associated facilities are presented in **Figure 3-24**. A list of the facility classification and map reference number is provided in **Table 3-17**. The detailed survey report and data analysis report is attached in **Annexure D**.

Table 3-17: Taxi Facility Surveys

Facility Label	Description	Type	Facility Label	Description	Type
N01-1	Mafora West	Rank	N02-1	Twin City Mall	Rank
N01-2	Mafora Central	Rank	N02-2	St Andrews -	Rank
N01-3	Ipopeng	Rank	N02-3	Bergman/Grasslands	Rank
N01-4	Phelindaba	Rank	N02-4	Heidedal/Bloemside	Rank
N01-5	Academy	Pick-up Point	N02-5	Phase 3	Rank
N01-6	Dept Of Home Affairs	Pick-up Point	N02-6	Namibia	Rank
N01-7	Batho Police Station	Pick-up Point	N02-7	Phase 6	Rank
N01-8	Shoprite	Pick-up Point	N02-8	Phase 4 & 5	Rank
N01-9	KFC	Pick-up Point	N02-9	Freedom	Rank
N01-10	Vista Park	Pick-up Point	N02-10	Twin City	Pick-up Point
N01-11	Hostel 1	Pick-up Point	N02-11	Engen Sam's Bottle Store	Pick-up Point
N01-12	SA Truck	Pick-up Point	N02-12	Freedom Crossing	Pick-up Point
N01-13	Mamane Str	Pick-up Point	N02-13	De Vis Str	Pick-up Point
N01-14	Sasol	Pick-up Point	N02-14	Maggerman	Pick-up Point
N01-15	Phahameng	Pick-up Point	N02-15	Masakhane 2	Pick-up Point
N01-16	4+1	Rank	N02-16	M 10	Pick-up Point
			N02-17	Bridge	Pick-up Point
			N02-18	Masakhane	Pick-up Point
			N02-19	Pelenomi	Pick-up Point
			N02-20	Engen	Pick-up Point
Facility Label	Description	Type	Facility Label	Description	Type
N03-1	Brandwag	Train Station	N03-10	Makro	Pick-up Point
N03-2	Route 16	Rank	N03-11	National Hospital	Rank
N03-3	Tempi	Rank	N03-12	Fona	Rank
N03-4	UFS	Rank	N03-13	Hyperrama	Rank
N03-5	Mimosa	Rank	N03-14	Rosepark Hospital	Pick-up Point
N03-6	North Ridge	Pick-up Point	N03-15	Hypermarket	Pick-up Point
N03-7	Sowesto	Rank	N03-16	Pellissier	Pick-up Point
N03-8	Louriepark	Rank	N03-17	Pasteur	Pick-up Point
N03-9	Casino	Rank	N03-18	Langenhoven Park	Pick-up Point
			N03-19	Andries Pretorius	Pick-up Point

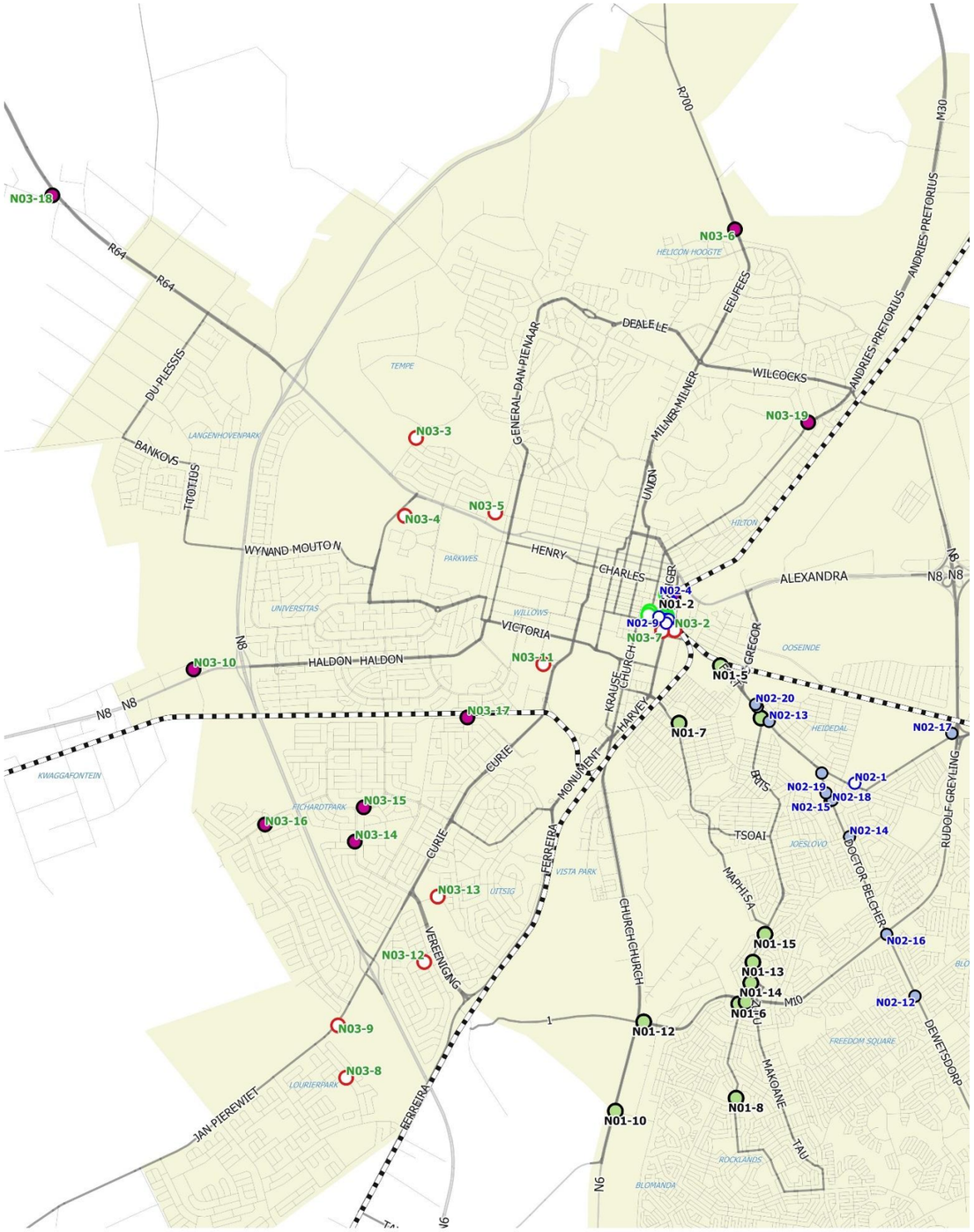


Figure 3-24: Taxi Facility Surveys 2016

The database comprises of +-37 000 recodes for the Greater Bloemfontein Taxi Association (GBTA) networks. The Thaba Nchu and Botshabelo database comprise of:

- Aisle counts recording queue length per aisle per rank - 17 000 records,
- Rank ingress and egress counts – 28 000 and 30 000 records.

The database verification with taxi operators is not yet finalised, however preliminary data analysis of GBTA indicate that during the four-day survey period 6 178 unique vehicles were observed comprising of:

- 2 530 - 4+1, 1
- 44 - Midi- and
- 3 504 - minibus taxi's.

Most of the taxis operate between one origin-destination pair (+-65%), 20% of taxis operate between 2 and 3 OD pairs and 15% operate between more than four OD pairs. The number of unique vehicles per origin-destination pairs are presented in **Table 3-18**.

Table 3-18: Number of Route/Origin-Destination Pairs per Public Transport Vehicle Type

Survey Date	Vehicle Type	Number of Origin-Destination Pairs per Vehicle				
		1	2	3	4	5 and more
28-Apr		1658	421	229	116	95
	4+1	596	143	59	16	14
	MIDI	35	10	3	3	2
	MINI	1027	268	167	97	79
29-Apr		1573	404	241	122	108
	4+1	714	167	87	22	15
	MIDI	32	10	5	5	4
	MINI	827	227	149	95	89
30-Apr		1665	410	135	75	150
	4+1	461	124	36	28	14
	MIDI	48	9	8	1	5
	MINI	1156	277	91	46	131
01-May		1608	354	210	104	80
	4+1	815	164	121	71	49
	MIDI	37	3		2	1
	MINI	756	187	89	31	30
03-May		2480	582	245	177	247
	4+1	970	207	99	85	136
	MIDI	56	10	1	3	2
	MINI	1454	365	145	89	109

3.9.2 Itumele Bus Service (IBL) Information

IBL is the main subsidised bus service provider in the Mangaung Metropolitan Municipality. The incorporation of these services in to the IPTN is envisaged in the long term implementation of the IPTN system. However, within the Bloemfontein area IBL provides distribution services from Central Park through the city and several local services from the Mangaung area and other suburbs. The detail analysis of the services number of passengers per day, revenue and cost of tickets are provided in Annexure E.

The main origin-destination pairs serviced by IBL is from Thaba Nchu and Botshabelo to the CBD, and several distribution services in the Bloemfontein area. During 2016 approximately 21 000 passengers were transported per day between Thaba Nchu/Botshabelo and Bloemfontain area.

The services with more than 600 daily passengers per direction in the Bloemfontein distribution area of IBL is shown in **Figure 3-25** and the detail for 10 February 2016 per service is detailed in Table 3-19. Several other distribution services are provided but with less than 600 daily passengers. A service with 600 or more daily passengers on average have between 100 and 750 passengers towards the CBD during the morning or afternoon peak hour.

Comparing the hourly volumes and route distance with Table 2-1(mode capacity) it can be concluded that the optimum mode along these routes are regular bus services taken into account that the route distances are near or more than 10km.

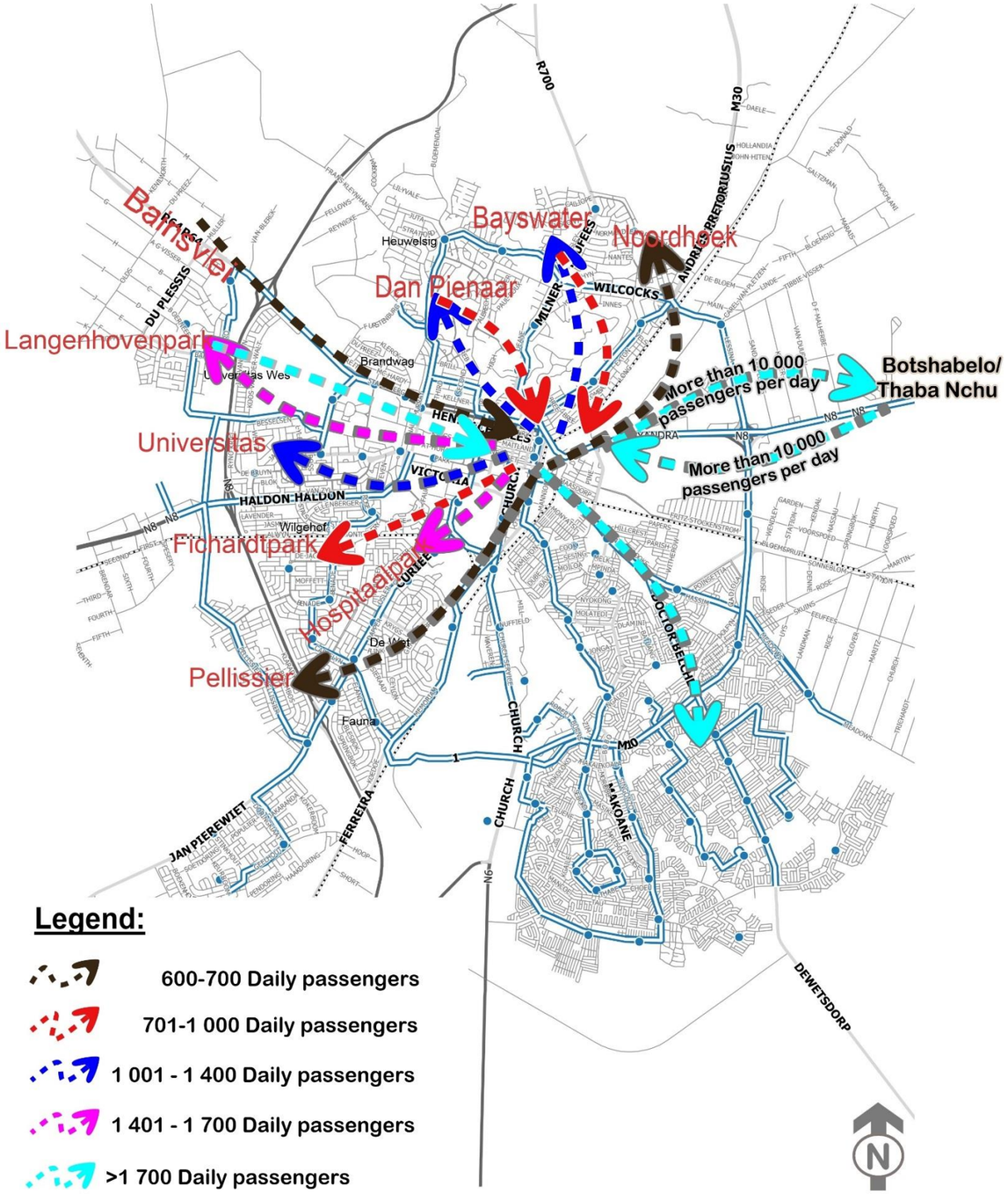


Figure 3-25: IBL 2015 Daily Passenger Summary

Table 3-19: IBL Passengers per route – 10 February 2016

Direction	From	To	Length(km)	Total Pass	06:00:00 AM	07:00:00 AM	08:00:01 AM	09:00:00 AM	10:00:00 AM	02:00:00 PM	03:00:00 PM	04:00:00 PM	05:00:00 PM	06:00:00 PM
R	Central Park	Bainsvlei	14	698	373	325	0	0	0	0	0	0	0	0
F	Central Park	Bayswater	8	1198	610	482	106	0	0	0	0	0	0	0
R	Bayswater	Central Park	8	845	0	0	0	0	0	85	111	331	253	0
F	Central Park	Dan Pienaar	8	1106	566	497	43	0	0	0	0	0	0	0
R	Dan Pienaar	Central Park	8	753	0	0	0	0	0	211	290	218	34	0
F	Central Park	Fichardt Park	10	728	416	266	3	0	0	0	0	0	3	0
R	Langenhovenpark	Central Park	13	1785	0	0	0	0	0	290	422	453	498	36
F	Central Park	Langenhovenpark	13	1437	763	520	66	0	0	0	0	0	0	0
F	Central Park	Noordhoek	8	659	349	283	27	0	0	0	0	0	0	0
R	Noordhoek	Central Park	8	559	0	0	0	0	0	178	136	158	87	0
R	Pellissier	Central Park	10	616	0	0	0	0	0	142	205	246	23	0
R	Central Park	Phelindaba	9	588	102	0	0	0	0	0	176	147	110	53
R	Central Park	Phase 4	11	905	0	0	0	0	0	0	140	256	320	51
R	Central Park	Turflaagte	11	615	1	0	0	0	0	134	0	145	261	73
F	Central Park	Universitas	8	690	326	245	87	0	0	0	0	0	0	0
R	Universitas	Central Park	8	686	0	0	0	0	0	123	202	129	162	0
F	Phase 6	Central Park	15	1058	527	0	0	0	0	0	0	9	0	0
R	Central Park	Phase 6	15	762	15	0	0	0	0	0	189	199	296	60
F	Central Park	Hamilton	4	753	421	332	0	0	0	0	0	0	0	0

3.9.3 NHTS 2013 – Primary and Secondary Demand Corridors

The NHTS 2013 quantified the main corridors for the city, in the absence of a Mangaung specific Household Travel Survey. The main corridors per hour are presented in **Figure 3-26**.

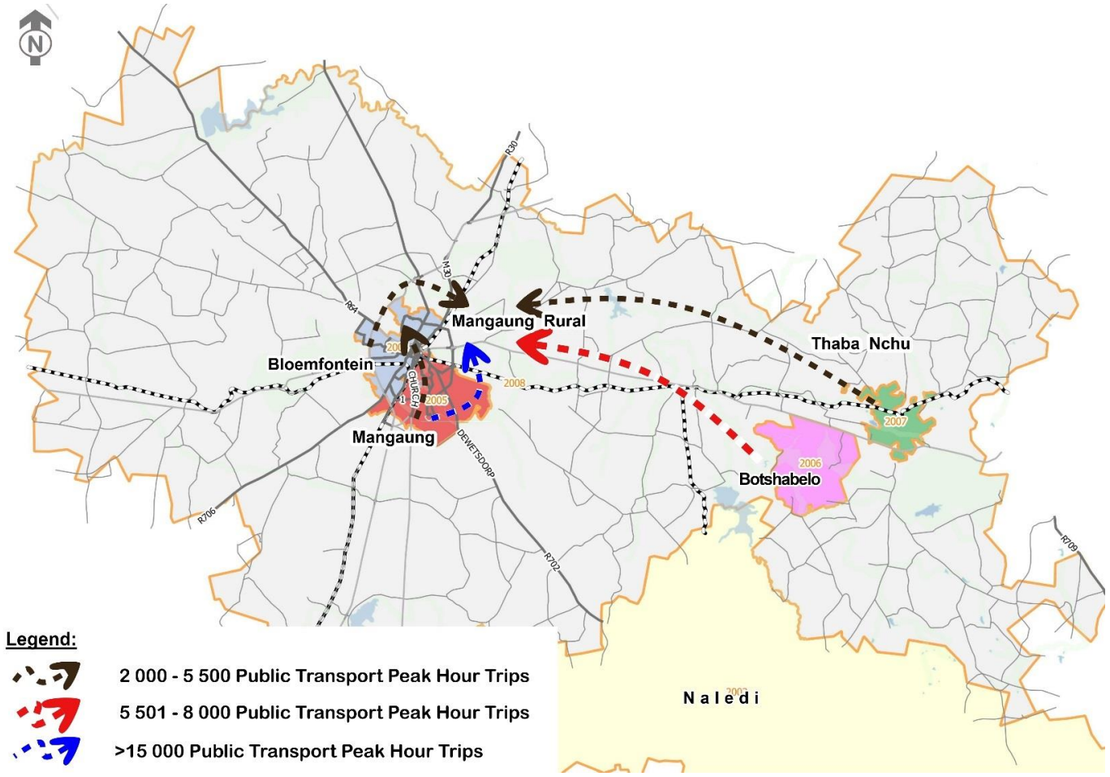


Figure 3-26: NHTS 2013 – Primary and Secondary Corridors

3.9.4 Main Origins and Destinations – Land Use Model

The observed demand provides the existing public transport and private vehicle movement within the transport system. This demand is influenced by the supply of public transport; supply is the routes and the services that public transport operators provide to passengers. These routes and services provided is based on where operators can earn the highest revenue and not necessarily serving the origins and destinations between which passengers prefer to travel.

To verify and enhance the observed demand two methodologies are used:

- Development of origin-destination matrix from the land use model; and
- Determining the origin-destination pairs from the household travel survey for Mangaung specific. The household travel survey will only be available during early 2017 and the primary and secondary origins ad destinations will at that point be revisited.

The primary. Secondary and minor origins and destinations were determined from the land use model for 2015 and 2036. The land use model provides a zoning system for the city and the number of people living in each zone and the number of job opportunities provided in each zone. For the identification of primary, secondary and minor origins and destinations the population density per zone is used to rank origin zones and the total number of formal and informal jobs per zone is used to rank destination zones. Zones were classified into primary, secondary and minor origins based on the following criteria:

- Primary origin – population density of more than 5 500 people per square kilometre;
- Secondary origin – population density of 3 000-5 499 people per square kilometre;
- Minor origin – population density of less than 2 999 people per square kilometre;

The criteria used for destination zone classification are:

- Primary destination – more than 10% of total jobs are provided in a specific zone;
- Secondary destination – between 5% and 10% of total jobs are provided in the zone;
- Minor destination – less than 5% of total jobs are provided in the zone.

The result of the ranking of the zones from an origin and destination point is presented in **Figure 3-27** present the primary origins and destinations, **Figure 3-28** present the secondary origins and destinations and minor origins destinations are presented in **Figure 3-29.**

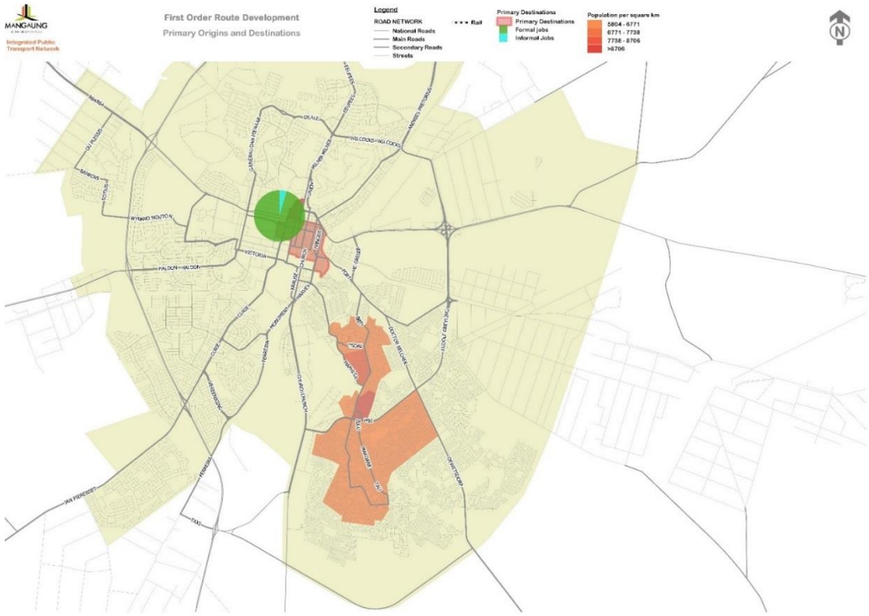


Figure 3-27: Primary Origins-Destinations

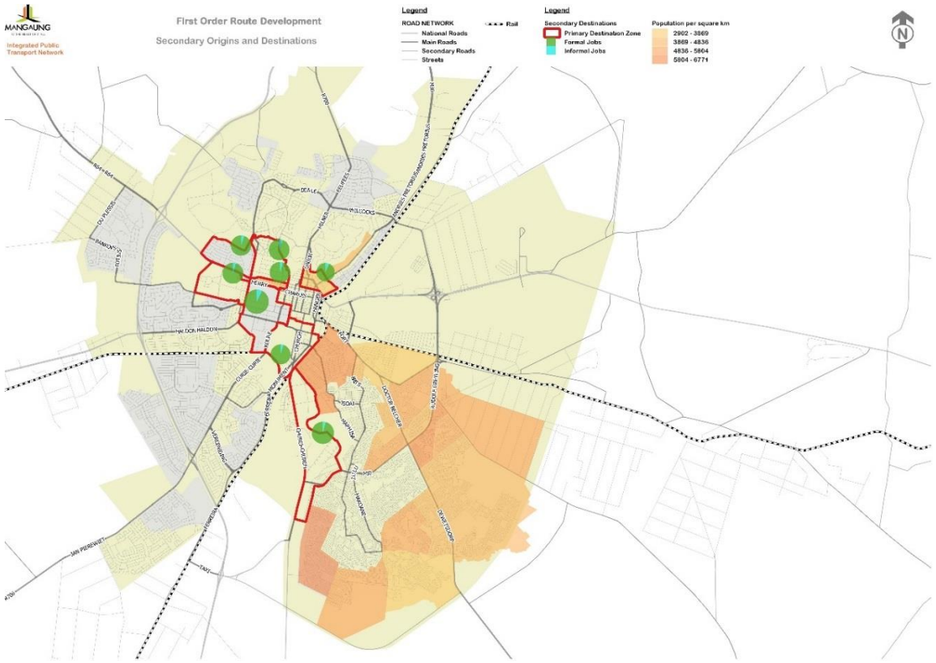


Figure 3-28: Secondary Origins-Destinations

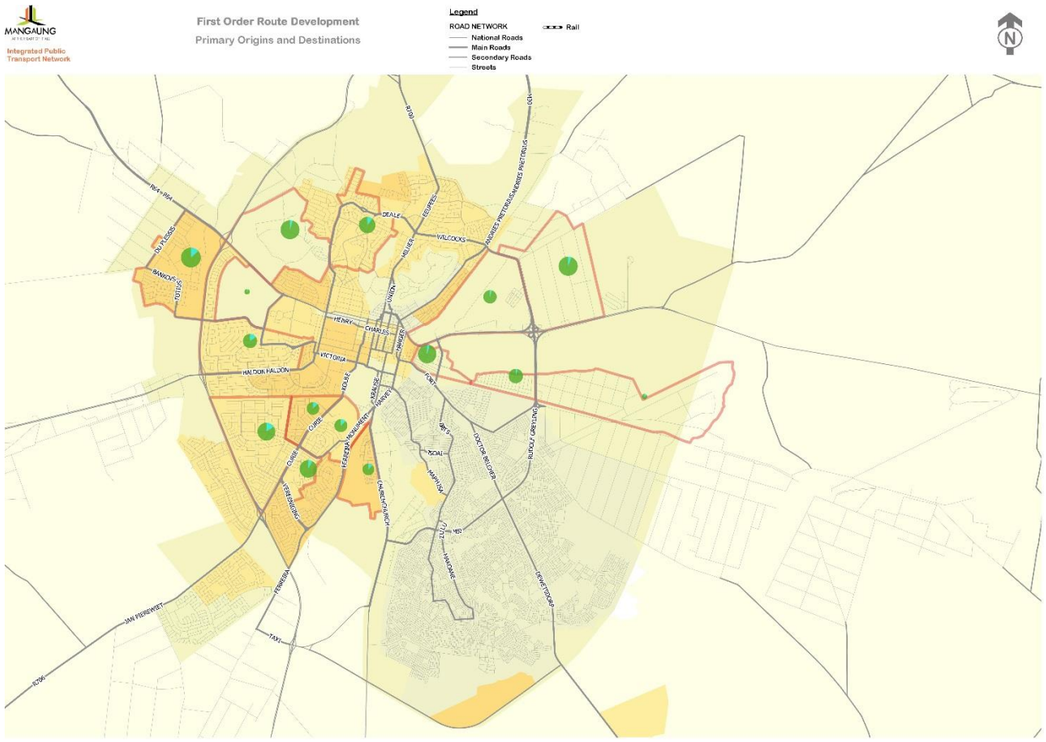


Figure 3-29: Minor Origin-Destinations

The development of the full network seeks to link the primary and secondary origins and with the development of links from the origins to the destinations. The primary and secondary destinations are situated in and around the Bloemfontein CBD. The development of the network focussed on providing links from the primary and secondary origins mainly situated in the south-eastern quadrant of the city to the CBD. These CBD focussed networks need to be expanded with the development of a radial network that links main residential areas with minor destinations. This approach resulted in a network that brings public transport service within 800m walking distance from residential and main employment destinations. The proposed full network for the Bloemfontein area is shown **Figure 3-30,** superimposed on to the Spatial Development Framework 2036.

The evaluation criteria defined to determine if the network provides in mobility, accessibility and sustainable transport principles are:

- Area coverage of the network (Access to Public Transport)
  - The proposed network area coverage is presented in **Figure 3-31.** The figure indicates 800m walking distance buffers from the proposed full network. Some of the Bloemfontein area is not within 800m of a network link. These areas are primarily low density areas and network links can be developed through providing feeder routes in these areas.
- Transfer between routes and services (Mobility):
  - The full network development addresses coverage and directness of routes. It is however, also necessary to determine the ideal location for transfer stations and stops. For this purpose, it is advisable that transfer does not occur within 5km from the end or start of a journey or route.
  - The full network and distances from the main origins towards the CBD is presented in **Figure 3-32**. The M10 is approximately 6.5km from the intermodal facility in the CBD in almost all travel directions. For a passenger to transfer at the M10 would be the optimum point for transfers in the wider network. It need to be considered that the travel time from Rocklands to the CBD is 19 minutes (Refer to Travel Time Survey Annexure F) during the morning peak hour a transfer will lead to increased travel time. Thus, in the design of services it is recommended that services are provided where passengers can transfer to gain access to minor destinations through link services that do not end in the CBD and direct services from residential areas to the CBD without transfers.
- Directness of routes and service (Mobility);
  - The network was designed from a primary, secondary and minor origin destination perspective and provides direct links between primary and secondary origins and destinations. During the design of implementation phases and services per phase, the directness of routes and services need to be re-evaluated based on primary and secondary origins and destinations identified.
  - The network was designed from a primary, secondary and minor origin destination perspective and provides direct links between primary and secondary origins and destinations. During the design of implementation phases and services per phase, the directness of routes and services need to re-evaluated from a primary and secondary origins and destinations identified.
- Spacing between routes and corridors (Economic Feasibility, Frequency of Service versus Accessibility):
  - The corridors are spaced 1,6km apart and where road networks are not available, some of the network links encroached into service/catchment areas. The implementation of routes and services along the network need to be evaluated from financial sustainability perspective. Although network coverage and route spacing comply with standards, the implementation of routes and services need to be considered from a financial and institutional perspective. Budget and capital funding, and operational and industry transition need to be secured before a new route or service is rolled-out.

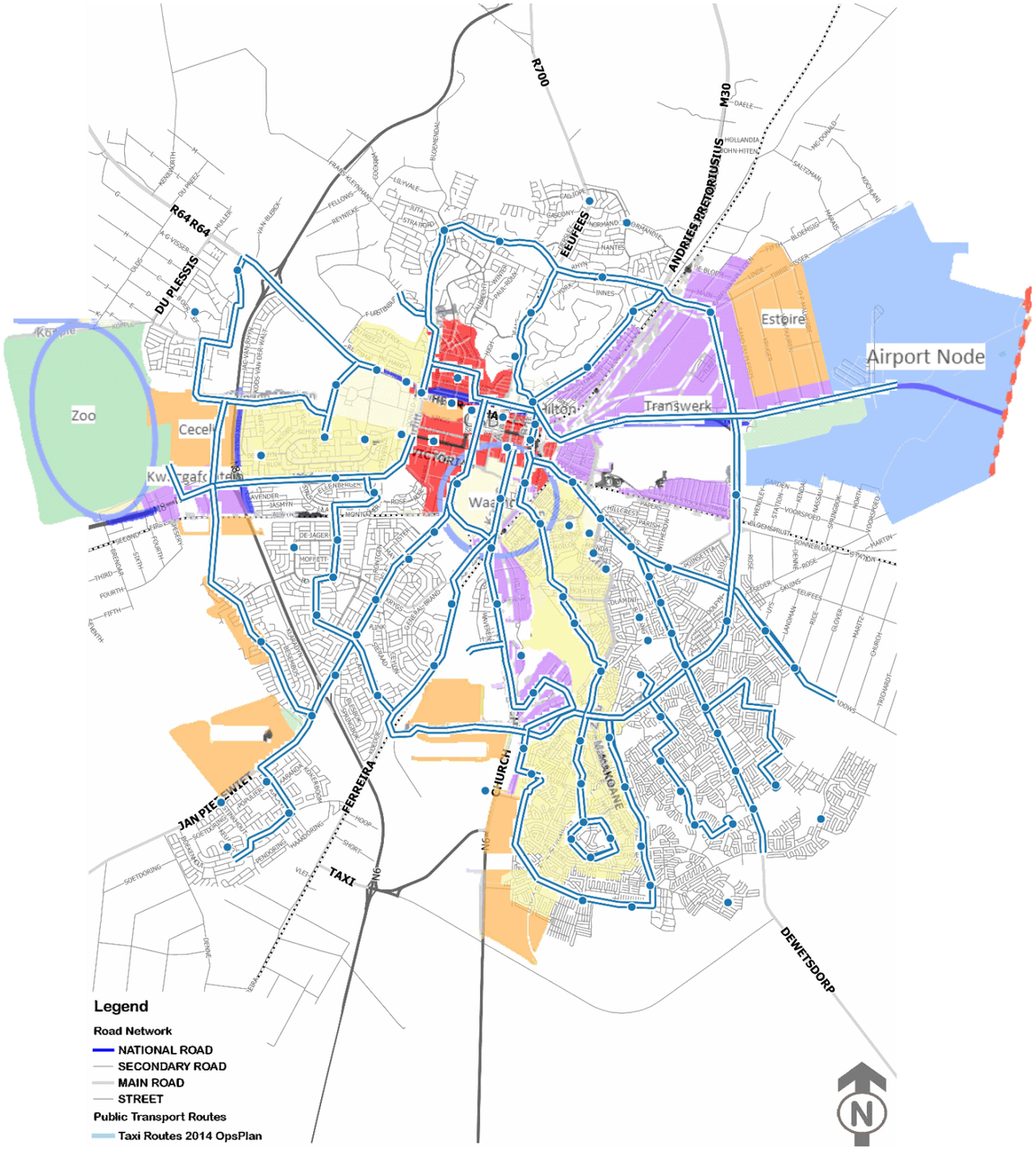


Figure 3-30: Full Network Design

Figure 3-31: Walking Distance (800 m) – Evaluation

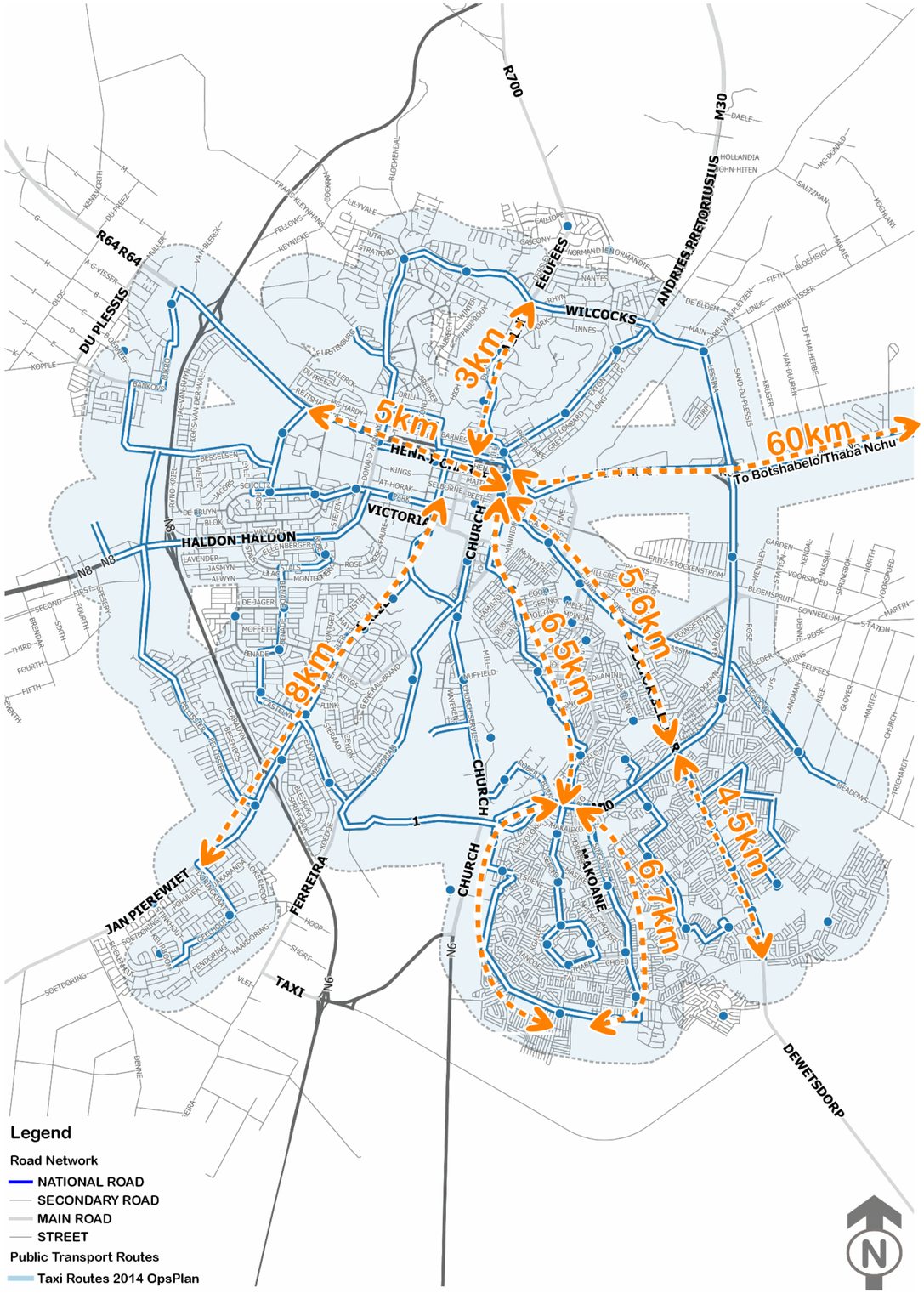


Figure 3-32: Transfer Distance Evaluated

3.10 Full Network

The implementation of the full network requires the incorporation of existing public transport operators, the provision of infrastructure (road and systems) and several related institutional structures that need to be in place. To implement the network and to ensure a sustainable system, a balanced approach to effectively address operator incorporation, infrastructure provision and the revenue that can be earned, needs to be followed. The revenue that will be generated depends on the number of passengers that will be attracted by the system. On a full network level, it will be sustainable and economically viable to implement the network within the most densely populated areas and areas where employed people reside.

In acknowledgement of the above approach the full network was divided into planning phases to streamline the development of detailed operational plans per phase. The planning phasing set-out to focus detail investigation rather than to develop detailed financial and operational plans for the full network. The planning phasing is based on a multi criteria analysis with three main criteria:

- Daily estimated patronage;
- Estimated Revenue;
- Capital cost;
- Industry Transition cost.

The information used to determine the planning phasing per criteria are:

- Daily Passengers:
  - Primary and secondary OD pairs identified on regional level from NHTS 2013,
  - Primary and Secondary OD pairs based on land use model,
  - First order routes and services stemming from the full network,
  - Daily bus passengers per information obtained from IBL;
- Revenue – Ticket price of R8.00 was assumed multiplied by total daily passengers extrapolated to annual value;
- Capital cost determines utilising the following cost per infrastructure type:
  - Cost per route km - R 7 mil per running km;
  - Cost per stop – R 100 000 per stop
  - Cost per Station – R 300 000 per stop
- Industry Transition (per taxi) – R 400 000 per taxi. Number of taxis calculated based on number of passengers that will shift to IPTN services divided by 13 passengers per vehicles. No detail assumption on utilisation, since this is a first order ball park figure.

The routes used for the ranking to determine the first order planning phases are presented in Figure 3-33.

The first order estimated daily passengers, capital cost per kilometre, estimated transition cost and revenue are presented in **Table 3-20** per route. Each of the variables was ranked as follows:

Score	Infrastructure Cost	Daily Passengers	Revenue per Annum
1	0-49	>7 500	>30
2	50-79	3 500-7 500	15-30
3	80-99	1 501-3 500	5-15
4	100-300	<1 500	0-5

The combined score for these variables were determine and total per geographic area. The area or areas with the lowest score was selected to be investigated for implementation. The outcome of the scoring is presented **Table 3-21**. The full network is presented in **Figure 3-34** with the ranked planning phases. These planning phases needs to be detailed with service design, infrastructure requirement, industry transition and other operational costs to ensure that it can be rolled out within the PTN Grant budget allocated to the city. Thus, a financial and business viability evaluation is required to determine the implementation phases per planning phase.

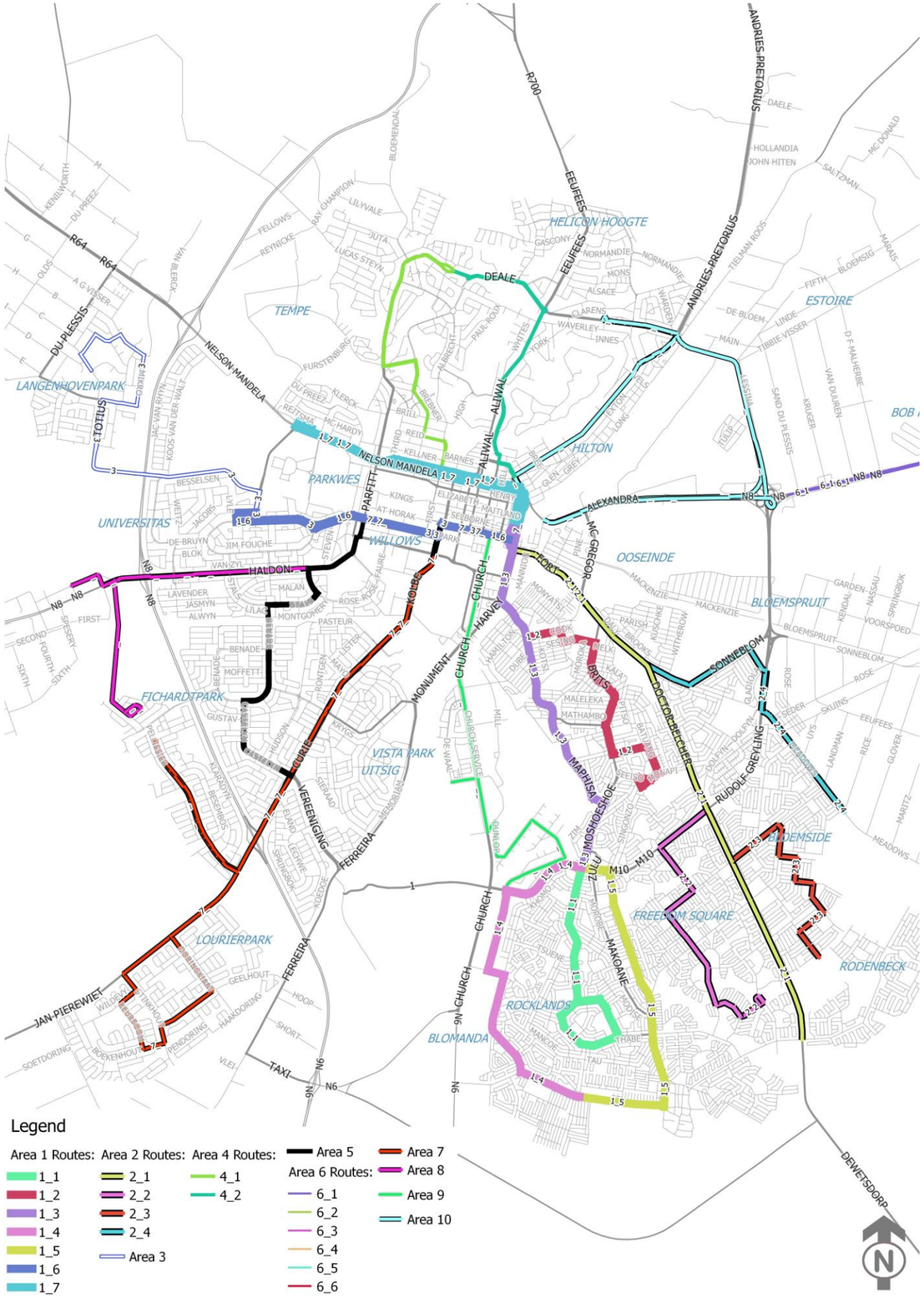


Figure 3-33: First Order Route Design

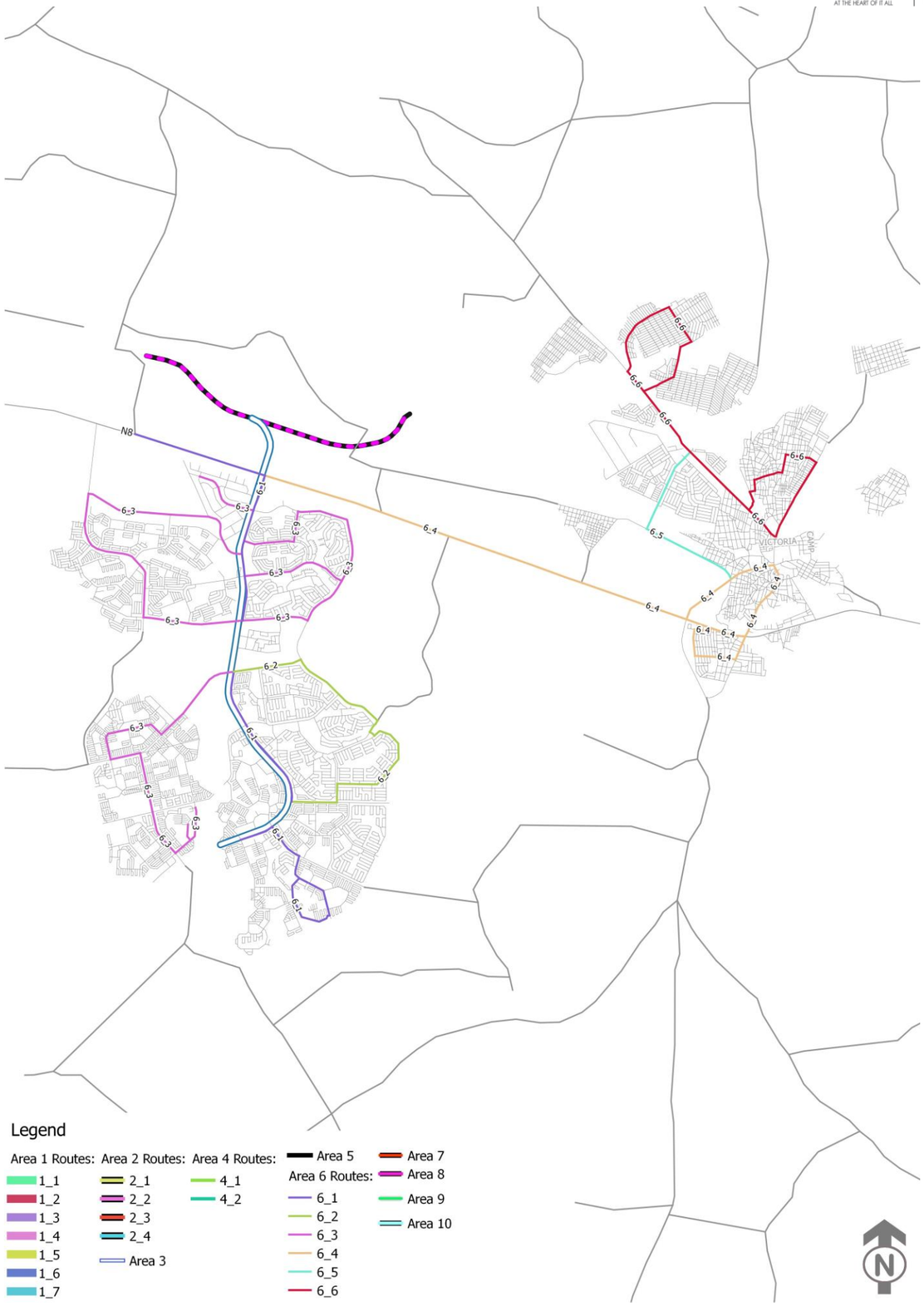


Table 3-20: High Level Capital Cost

Area	Route	New Trunk	Length	Stops	Stations	Cost per km	Cost per stop	Cost per Station	Total	Industry Transition	Total
1	1	4.3	10.8	3	5	30.10	0.30	1.50	31.90	20	51.90
1	2	5	7	7		35.00	0.70	-	35.70	20	55.70
1	3	6.5	6.5		6	45.50	-	1.80	47.30	20	67.30
1	4	7.2	13.7	5		50.40	0.50	-	50.90	20	70.90
1	5	6.7	13.2	5		46.90	0.50	-	47.40	20	67.40
1	6	4.2	4.2		4	29.40	-	1.20	30.60	20	50.60
1	7	4.2	4.2		4	29.40	-	1.20	30.60	20	50.60
2	1	9.9	9.9	4	5	69.30	0.40	1.50	71.20	20	91.20
2	2	5.9	11.3		5	41.30	-	1.50	42.80	20	62.80
2	3	7.5	13.1		4	52.50	-	1.20	53.70	20	73.70
2	4	3.4	7.8		3	23.80	-	0.90	24.70	40	64.70
3	1	7	11	7	1	49.00	0.70	0.30	50.00	32	82.00
4	1	6	6	5	1	42.00	0.50	0.30	42.80	40	82.80
4	2	6	6	5	1	42.00	0.50	0.30	42.80	32	74.80
5	1	10	14	10		70.00	1.00	-	71.00	32	103.00
6	1		11	10	2	-	1.00	0.60	1.60	0	1.60
6	2		9	8		-	0.80	-	0.80	0	0.80
6	3		10	10		-	1.00	-	1.00	0	1.00
6	4		7	7	2	-	0.70	0.60	1.30	0	1.30
6	5		5	5		-	0.50	-	0.50	0	0.50
6	6		8	8		-	0.80	-	0.80	0	0.80
7	1	6	12	6		42.00	0.60	-	42.60	32	74.60
8	1	6	11	6		42.00	0.60	-	42.60	4	46.60
8	2	3	10	3		21.00	0.30	-	21.30	4	25.30
9	1	5	5	5		35.00	0.50	-	35.50	2	37.50
9	2	4	9	4		28.00	0.40	-	28.40	2	30.40
10	1	10	10	10		70.00	1.00	-	71.00	16	87.00
10	2	6	12	6		42.00	0.60	-	42.60	16	58.60
11	1	4	8	4		28.00	0.40	-	28.40	32	60.40

Table 3-21: Implementation phases of IPTN Ranked

Area	Infrastructure Cost	Industry Transition Cost	Cost	Estimated Daily Pax	Revenue per Annum	Score
1	274.4	100	374.4	22 000	38.81	6
2	192.4	100	292.4	22 000	38.81	6
3	50	32	82	7500	13.23	7
8	63.9	8	71.9	3500	6.17	8
5	71	32	103	5500	9.70	9
9	63.9	4	67.9	2500	4.41	9
7	42.6	32	74.6	2500	4.41	9
4	85.6	72	157.6	3500	6.17	10
11	28.4	32	60.4	1500	2.65	10
10	113.6	32	145.6	1500	2.65	12
6	Existing subsidised services			21000	38.81	

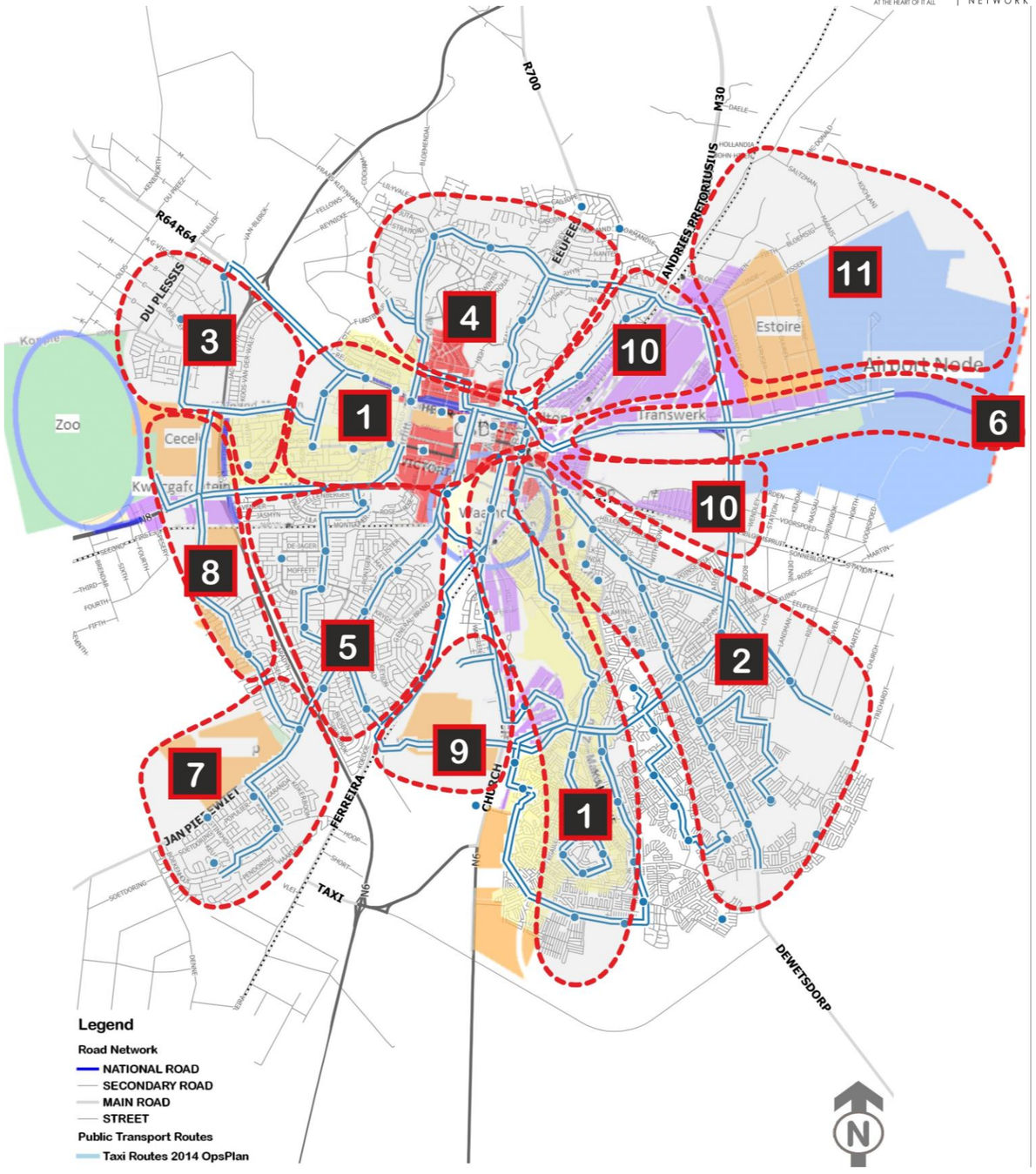


Figure 3-34: Full Network Phased

3.11 Patronage Estimation

The selection of a mode and the design of routes and services for the full network require the estimation of passenger numbers for the base- and future years. The transport demand model is not et available and for the purpose a patronage estimation model was developed following the typical demand model development four-step approach. However, the mode choice and trip assignment was done on a sketch model level and needs to be re- evaluated once the demand model is available. The demand model will be finalised once the taxi on-board surveys and the household travel surveys are analysed and available. The methodology applied for the patronage estimation is a four-step demand modelling approach. The four-stop model comprise of

- Step 1: Trip Generation – How many trips are generated/attracted?

  The purpose of trip generation (production) is to estimate the number of trips that are produced or originate in each Traffic Analysis Zone (TAZ). The city was divided into TAZ's as part of the land use model presented in previous sections. A set of equations is used to estimate the number of trips produced by and attracted to each zone based on its residential and employment characteristics. For example; the more employment a zone has, the more work trips it attracts and the more residential units in an area the more trips are generated from the area.

- Step 2: Trip Distribution – Where do trips go?
- This is the second component, where matches between origins and destinations are developed. Trip ends are linked to create complete trips. This can occur within the same zone, or between adjacent zones with varying distance. For example; trips between residential areas to employment areas. The trip distribution is influenced by the land ue model and the household travel survey. The land use model provides total number of trips generated or attracted but the household travel survey provides information on the percentage distribution from a specific zone to other zones. The finalisation of the patronage estimation can only occur once the data is available.
- Step 3: Mode Choice – What travel mode is used for each trip?

  Mode Choice predicts the choices that individuals or groups make in selecting their transportation modes. An important objective is to predict the share of trips attracted to public transportation. Other factors considered for mode choice include: travel time, travel cost and access to mass transit options. Data to develop a mode choice model is not available and the assumptions made to estimate mode choice are provided below for the in-term patronage estimation model.

- Step 4: Trip Assignment – What is the route of each trip?

  The final step is to determine the routes travelers choose to reach their destinations. For example, a congested corridor might change the route of a user to take a different route with a longer distance but same travel time. This assists with the analysis of new or future transportation projects or improvements. No dynamic trip assignment model is available and was done on a hand assignment model. The diversion of traffic and effect on mode shift can thus not be evaluated till the transport demand model is available.

The patronage estimation model was thus developed is alignment with the above process but acknowledging the short comings due to the lack of a full demand model. The transport demand model is part of the total IPTN system development and will only be available early 2017.

The data required for the patronage and demand model and the development timeframe are reflected in Error! Reference source not found.. The patronage estimation will be substituted with the transport demand model output early in 2017.

The development of the patronage estimation model and data sets utilised to date is presented in Error! Reference source not found.. The outcome of the patronage estimation model is an origin-destination matrix that provided the person trips per mode. The patronage estimation process and high level development assumptions are:

- Land-use model developed for 2016, 2025 and 2036;
  - A 12-year implementation plan is required, patronage estimation model developed for, 2016 and 2025;
- Patronage estimation was validated with vehicle occupancy counts 2016 for planning Phase 1 and 2;
- Vehicle occupancy counts 2016 was used to update the following assumptions previously based on NHTS 2013:
  - *Directional split (in- and outbound in peak hours of the day);*
  - *Percentage trips per peak period versus total trips per day;*
  - *Peak hour factor;*
  - *Mode split per zone.*

- Mode shift from existing public transport modes to the proposed new system is presented in Error! Reference source not found.. It is assumed, until the household travel survey is available, that mode shift from existing public transport modes to the IPTN system will only be in the Mangaung township area. This assumption stems from the identified Phase 1 and Phase 2 implementation strategies **(Refer to Figure 3-34**).

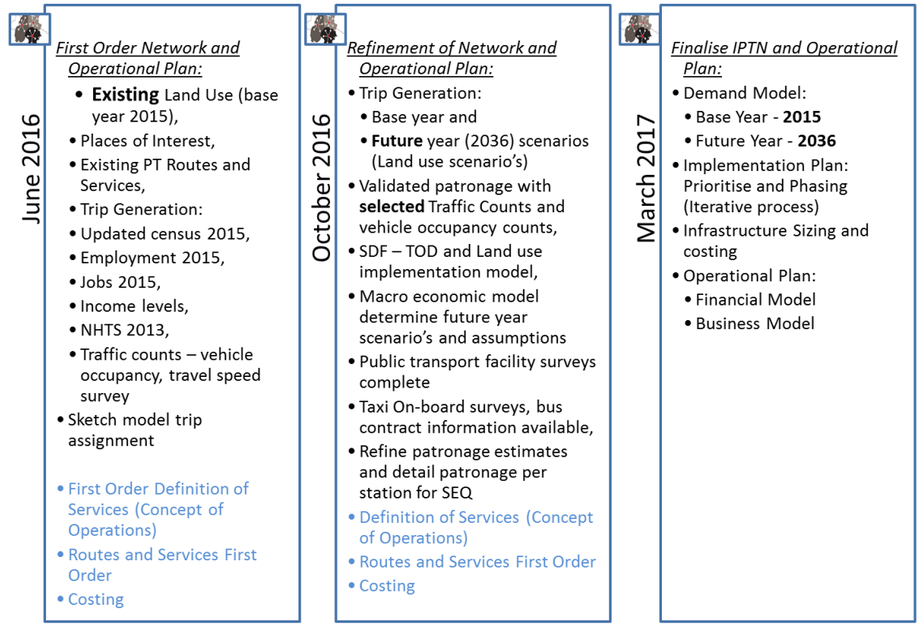


Figure 3-35: Patronage Estimation Input Data

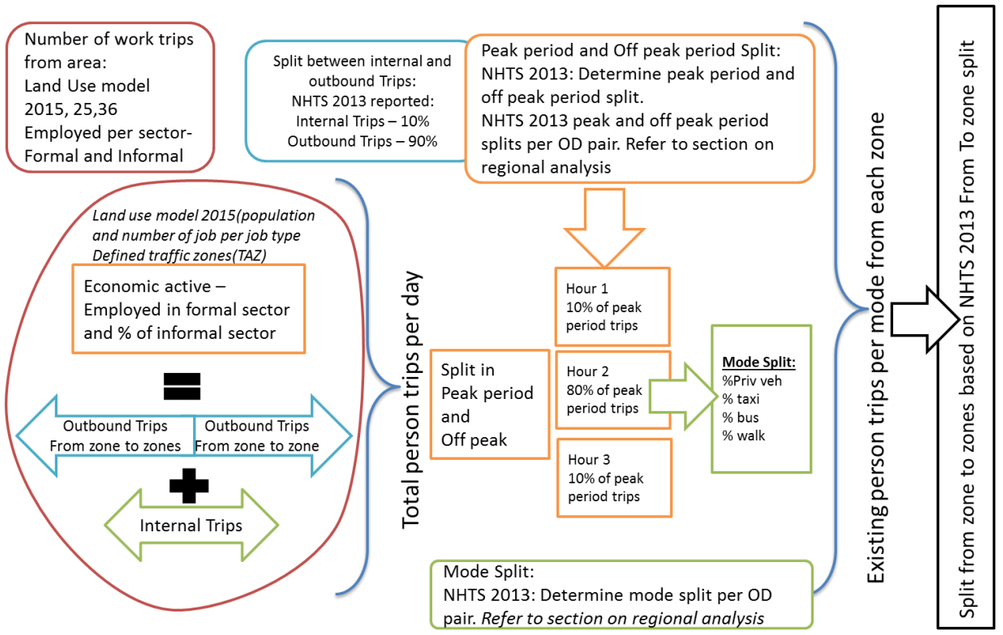


Figure 3-36: Patronage Estimation Process and Data Sets

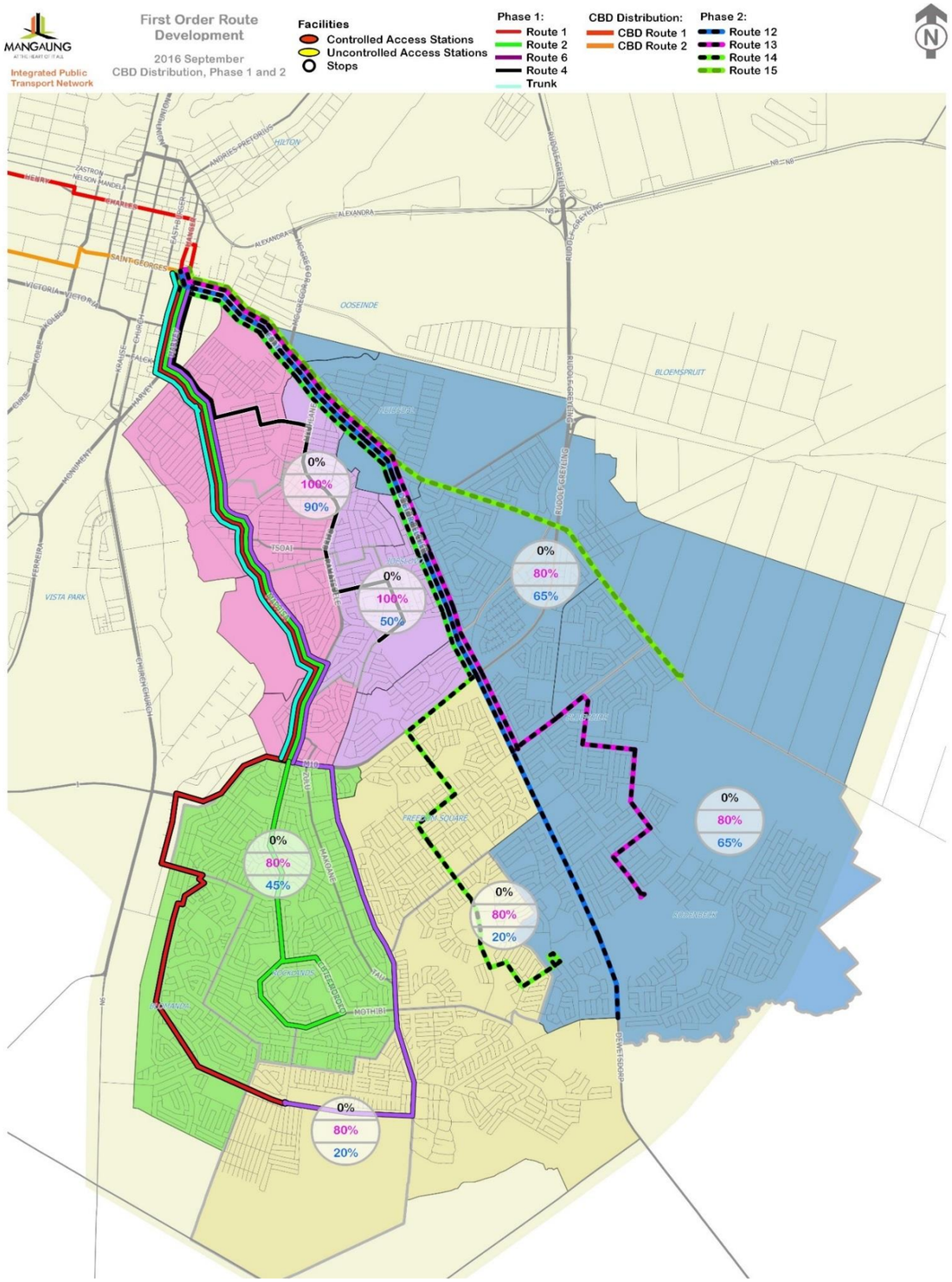


Figure 3-37: Mode Shift to New System – Assumed Percentage per Mode

3.12 Patronage Per Implementation Phase of the Full Network

The OD matrix developed in the patronage estimation model was used to determine the main origins and destinations for planning Phase 1 and 2.

The TAZ's within each planning phase was grouped together to determine main origin-destination pairs. The TAZ's that were grouped together and the naming of these is presented in **Figure 3-38**.

The percentage split of total trips per from grouped origin in Phase 1 to grouped destinations are presented in Error! Reference source not found.. The percentage trips generated from origins within Phase 1 to all grouped destinations are presented in Error! Reference source not found.. The detail for Phase 2 is presented in Error! Reference source not found. and Error! Reference source not found. respectively.

3.12.1 Phase 1 Route and Service Design

Approximately 40% of person trips that originate in Phase 1 ends within the CBD – within 1km radius of the Intermodal facility. However, 22% ends near the University of Free State (UFS) and 17% in the area surrounding the Bloemfontein Central University of Technology(CUT). Thus, to terminate routes and services at the intermodal facility will serve less than half of potential patrons. Therefore, it is imperative to extent services and routes to distribute patrons through the CBD for Phase 1, to ensure maximum attraction. Several of existing public transport users transfer at the intermodal facility, an enhancement to existing service quality, would be to provide services where no transfer is required at the intermodal facility and the distribution service fare is included in total fare. Thus, free of charge in the CBD distribution services for patrons travelling from origins within Phase 1.

The trips that originate in the Rocklands area contribute 56% of the total possible patrons and Bloemanda-18%, Phelindaba-12% and Batho approximately 18%.

These percentage was used to identify the route alignment. The route alignments stem from the existing taxi and bus route networks and the areas identified for social housing and other densification initiatives. The streets were evaluated from an aerial photo to determine where surfaced roads with ample road reserve are available for the implementation of stops and stations. Stops were spaced at 1km intervals along the routes taking into consideration land uses such as shopping centre, existing taxi loading points and bus stops. When the taxi on-board surveys and bus on=board surveys are available some of these positions might change to align with existing passenger preferences. The route alignments used to determine the

type of service, stop positions, vehicle fleet and total passenger numbers for Phase 1 is presented in

Figure 3-39: Planning Phase 1 Route Alignment

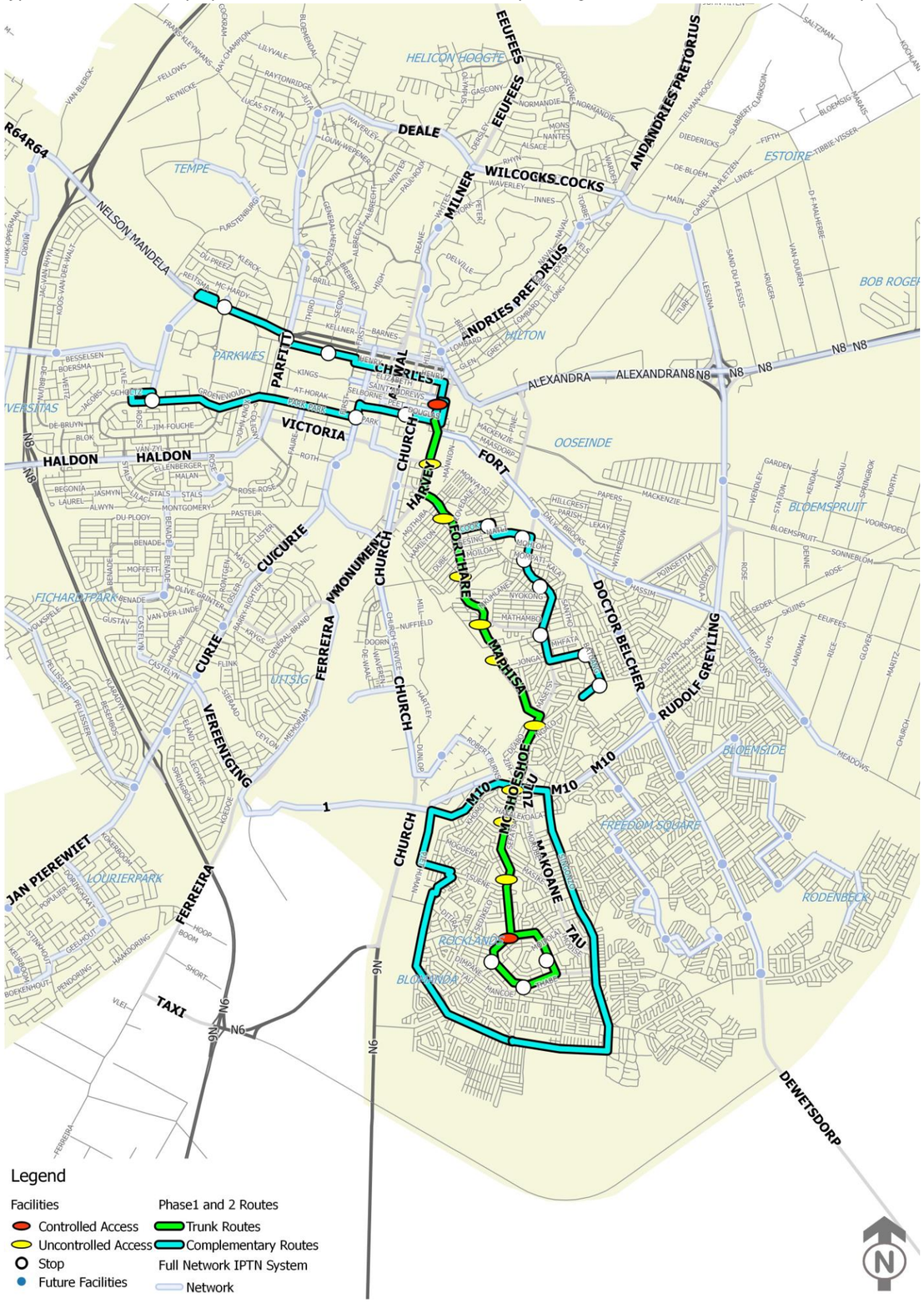


Figure 3-40.

Table 3-22: Percentage split to specific destinations from all origins in Phase 1

Area	% Trip Attraction
CBD	40%
Estiore(Industrial Area north of CBD)	2%
Heuwelsig (Suburb North of CBD along)	1%
Pentagon Park (Suburb North of CBD towards Tempe)	7%
Tempe	10%
UFS	22%
CUT	17%
Grand Total	

Table 3-23: Percentage split of trips generated from origins in Phase 1 to all destinations

Area	% trip generation
Bloemanda	18%
Batho	14%
Phelindaba	12%
Rocklands	56%

3.12.2 Phase 2 Route and Service Design

The person trip split for Phase 2 is approximately 62% of trips that originate in Phase 2 end in the vicinity of UFS and 26% in the vicinity of CUT. The routes and services part of Phase 2 will enhance CBD distribution passenger numbers. The majority of trips in Phase 2 originate in the Chris Hani area followed by Heidedal and Freedom Square. To a lesser extent trips originate from the Grassland area.

The route alignments used to determine the service design, stop positions, vehicle fleet and total passenger numbers are presented in Error! Reference source not found..

Table 3-24: Percentage split to specific destinations from all origins in Phase 12

Area	% Trip Attraction
Estiore	3%
Heuwelsig	6%
Tempe	2%
CUT	26%
UFS	62%

Table 3-25: Percentage split of trips generated from origins in Phase 2 to all destinations

Area	% Trip generation
Freedom Square	26%
Heidedal	28%
Grassland	14%
Chris Hani	33%

Figure 3-38: Main Origin and Destinations – Service Design First Phases of Implementation

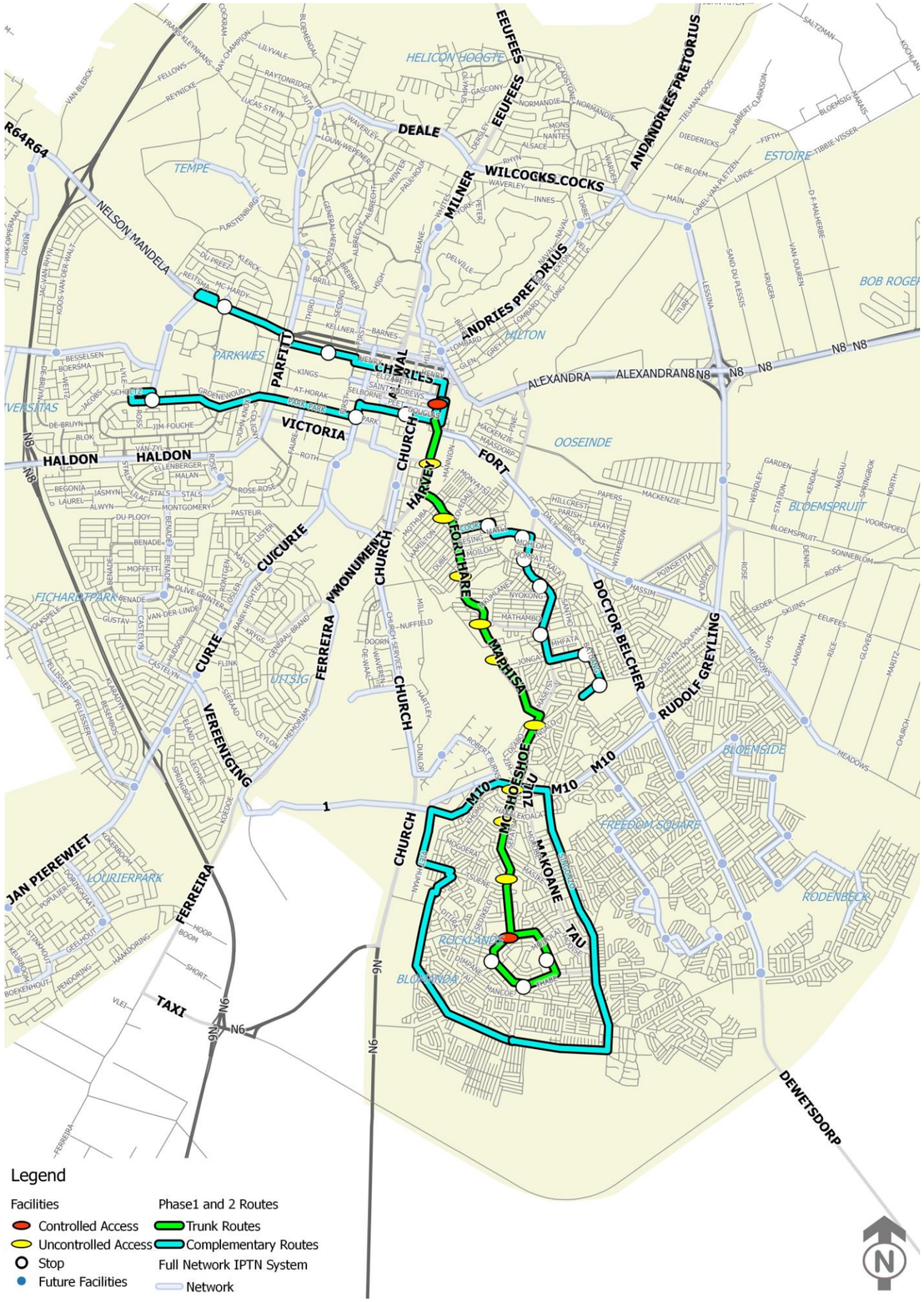


Figure 3-39: Planning Phase 1 Route Alignment

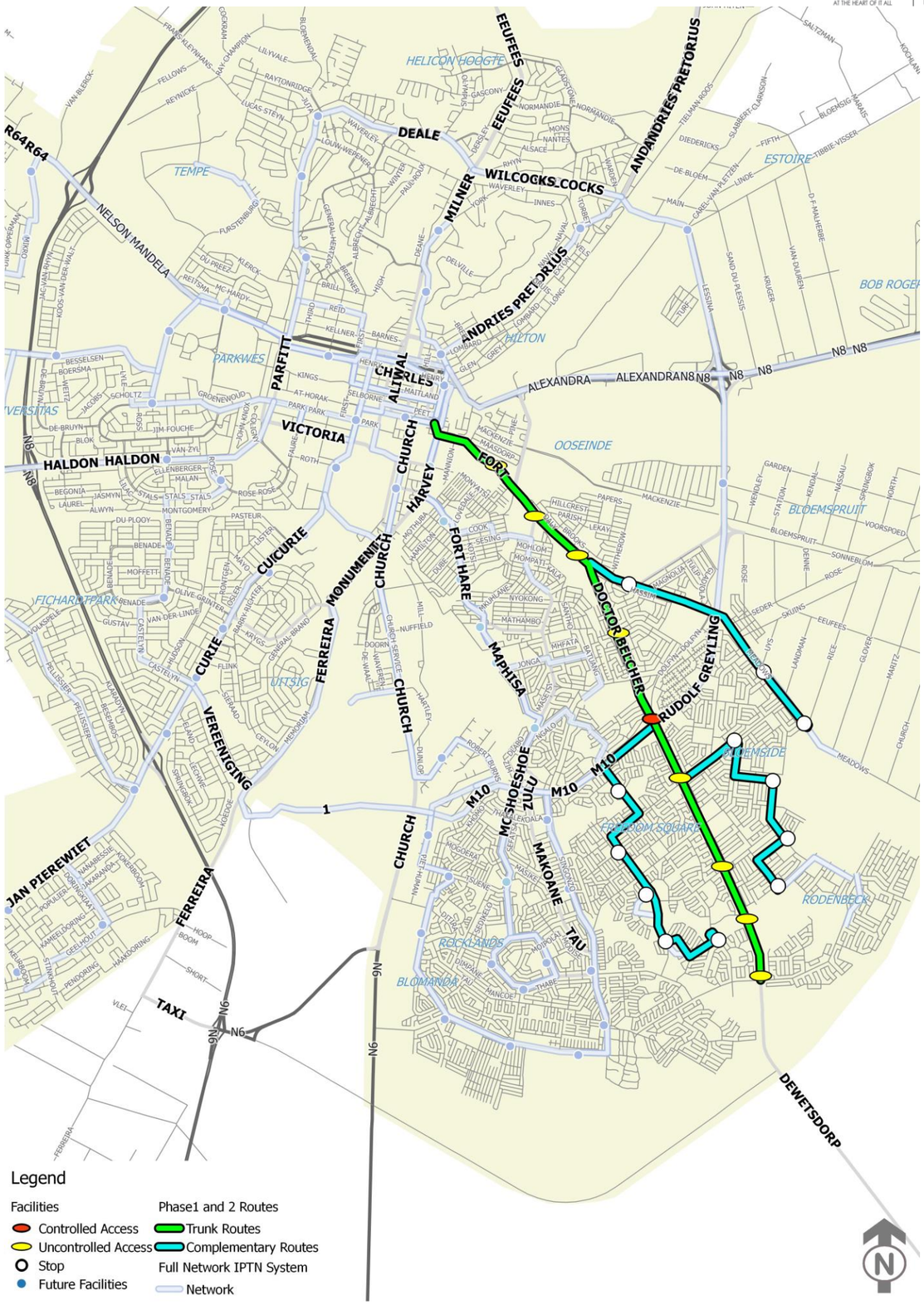


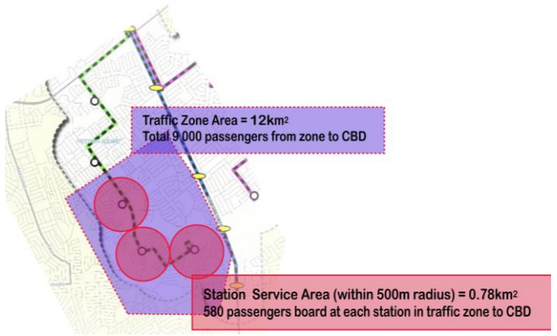
Figure 3-40: Planning Phase 2 Route Alignment

4 Service Strategy

4.1 Methodology

The service design per route is an iterative process to determine the optimum service design along a route based on the number of passengers boarding and aligning at each stop along the route. The total number of passengers per route is determined from the OD matrix developed as part of the patronage estimation model and applying the mode shift presented in Figure 3-37. The OD matrix used for the service design and route planning thus represent only the portion of total trips that will shift to the new system.

Each OD pair needs to be apportioned to a specific route and stations along the route. For this purpose, the methodology was used. Estimated passengers from a specific TAZ was assumed to be evenly distributed throughout the TAZ. To apportion passengers from the TAZ to a specific station a 500m radius station catchment area per station was developed, resulting in 0.79 km^2 catchment area per station. The total number of passengers generated in the TAZ per OD pair, was divided by the total TAZ area(km2) and then multiplied by the station catchment area, thus representing the number of passengers that will board at the specific station. The figure to the right graphically illustrated the apportionment process.



The outcome of the apportionment is number of passengers that board and alight per station per OD pair. This was used as input in the calculation of service frequency, bus fleet and station passenger waiting area capacity to be provided.

Service frequency, fleet required per route, total travel time and total daily passengers is determined through applying the methodology presented in **Figure 4-1** and the following design parameters assumptions:

- Route distance – GIS measured;
- Operating Speed. Operating areas were defined per route applying the following operating speeds, obtained from the travel time survey completed during May 2016:
  - CBD - 23km/h
  - Mix traffic - 22 km/h
  - Within Suburb - 28 km/h
  - Along Arterial road - 50 km/h.
- Dwell time per station/stop:
  - Dwell time is calculated taking into account fare collection method, number of passenger boarding and alighting, number of doors of bus, Clearance time (Time for bus to move from loading point in order for next bus to start loading), Re-entry Delay (Join mixed traffic or dedicated bus lane (time vary based on two options).
  - Dwell time parameters used per stop/station classification:
    - *Intermodal Facility - 50s;*
    - *Controlled Access Station- 30s;*
    - *High capacity stop - 30s;*
    - *Uncontrolled Access Station - 15s;*
    - *Local Stop – 15s.*
- Passengers – see detail per station passenger calculation;
- Highest percentage in 30 minutes: 50% of passengers assume to travel in peak 30 minutes. Based on VOC analysis.
- Bus Capacity:
  - 72 passengers;
  - Peak hour utilisation – 100%;
  - Off-peak utilisation – 50%.

Annexure G show the typical output per route when applying the above parameters and assumptions.

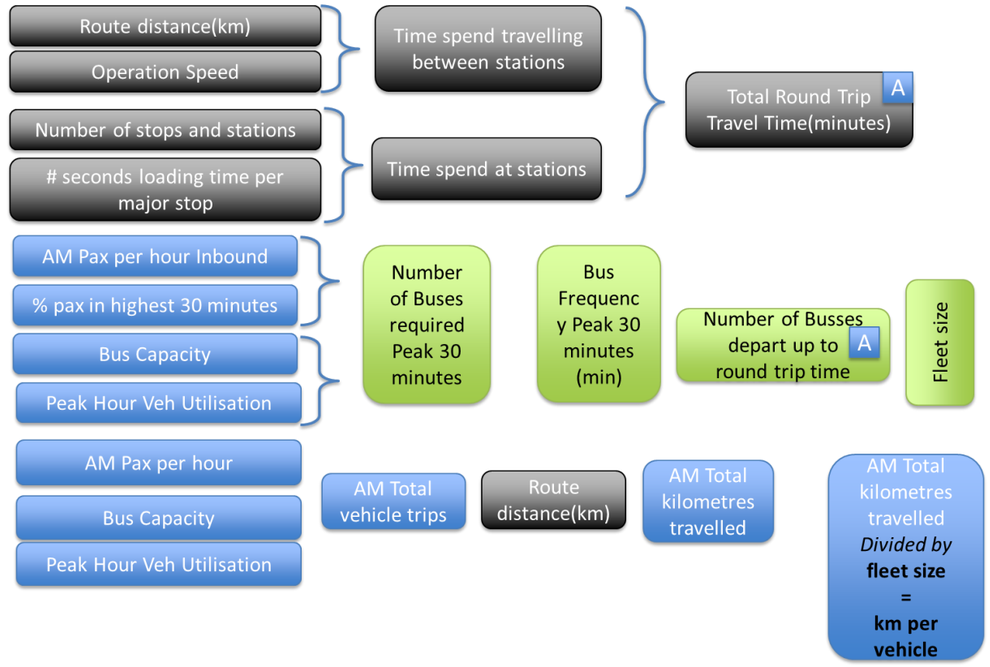


Figure 4-1: Service Frequency and Bus Fleet Calculation Methodology

4.2 Service per Planning Phase

For each of the Planning Phases services were designed per identified route. The detail of kilometre travel and other variables are attached in **Annexure G**. The services are presented in Figure 4-2 for Planning Phase 1 and for Planning Phase 2 in Figure 4-3.

The stations and stops were classified into low. Medium and high capacity stations/stops based on total number of passengers per service for Phase 1 and Phase 2. This station hierarchy needs to be adjusted once the on-board surveys and household travel surveys are available. The station/stop hierarchy is presented in Figure 4-4.

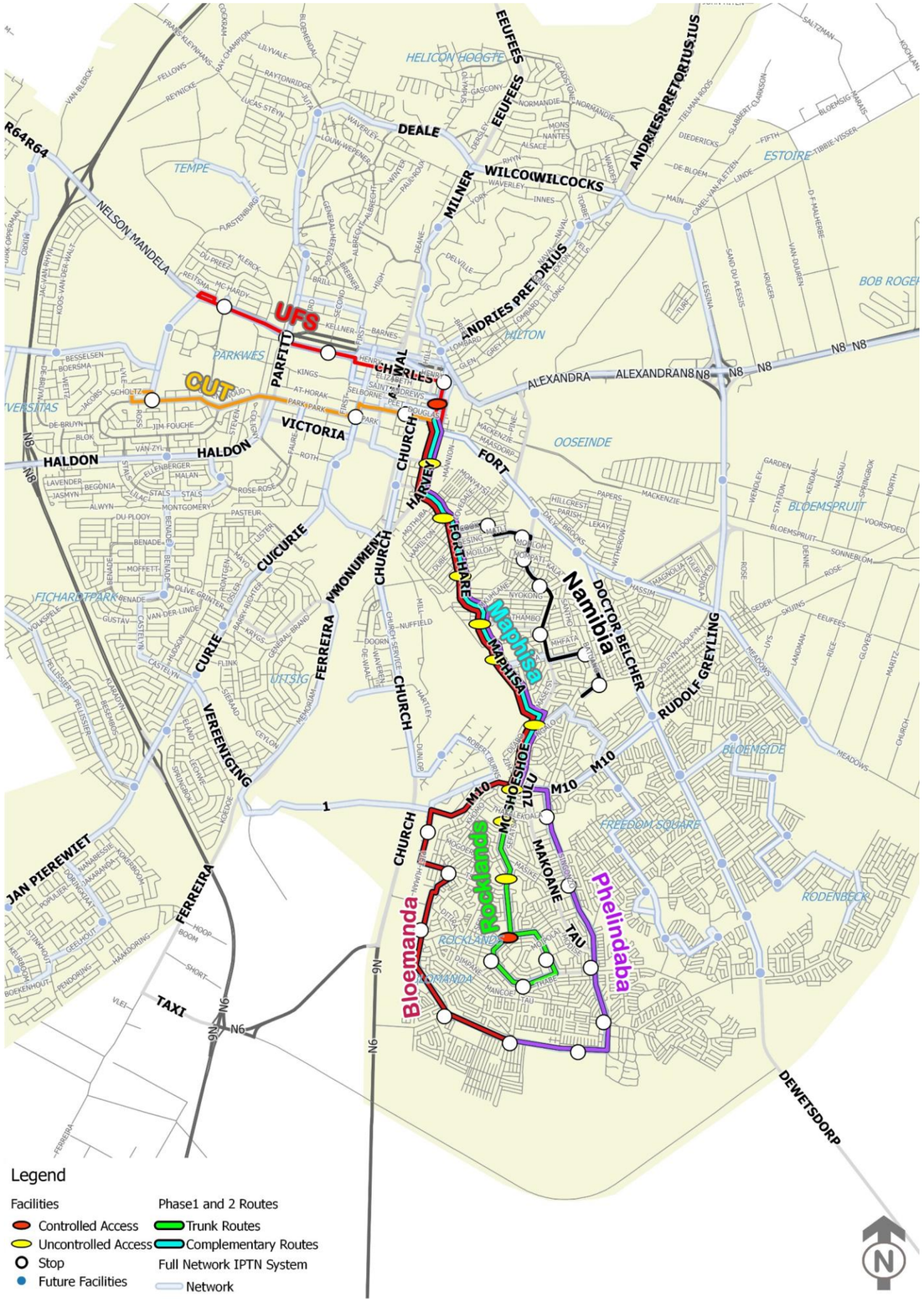


Figure 4-2: Phase 1 Services

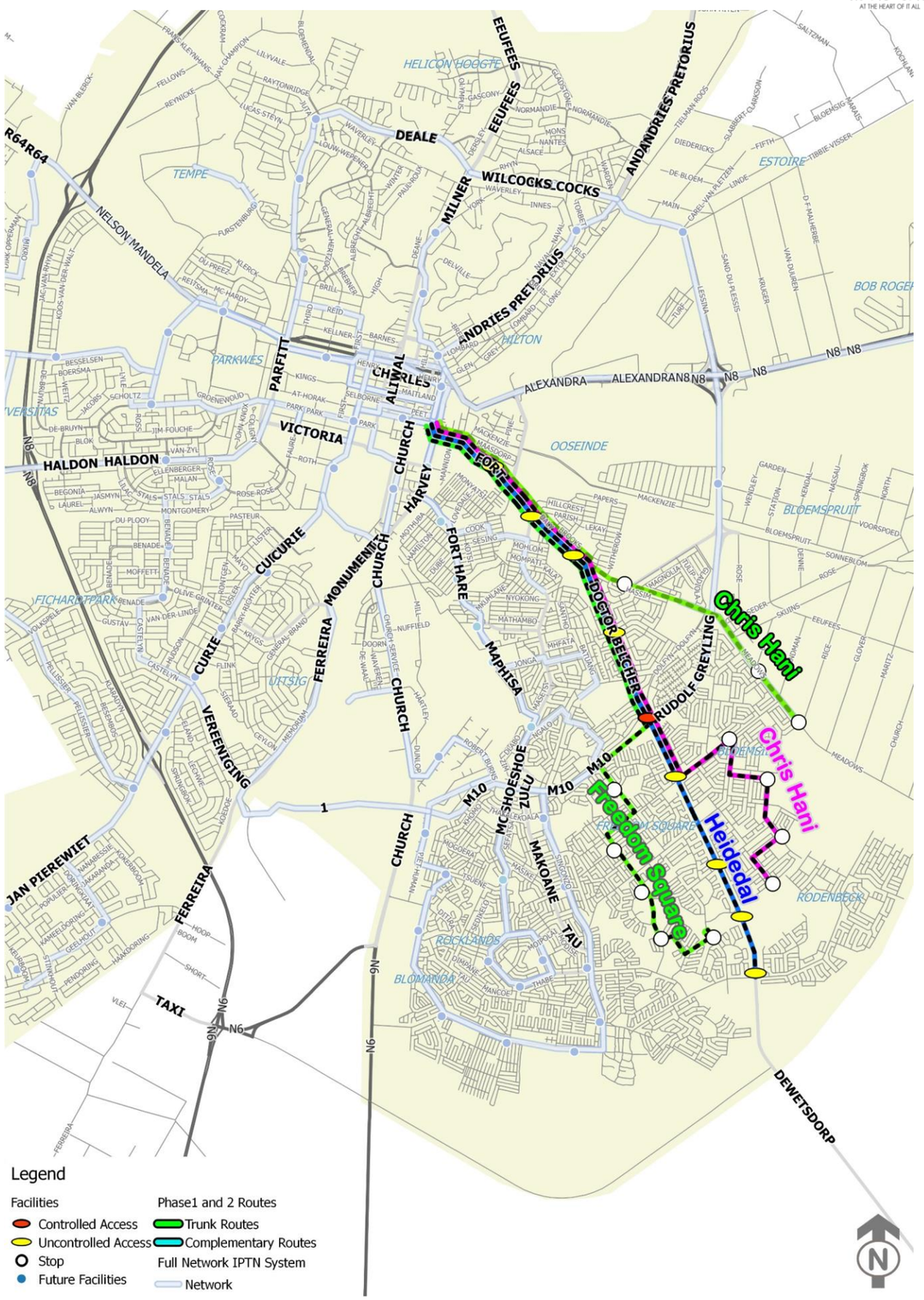


Figure 4-3: Phase 2 Services

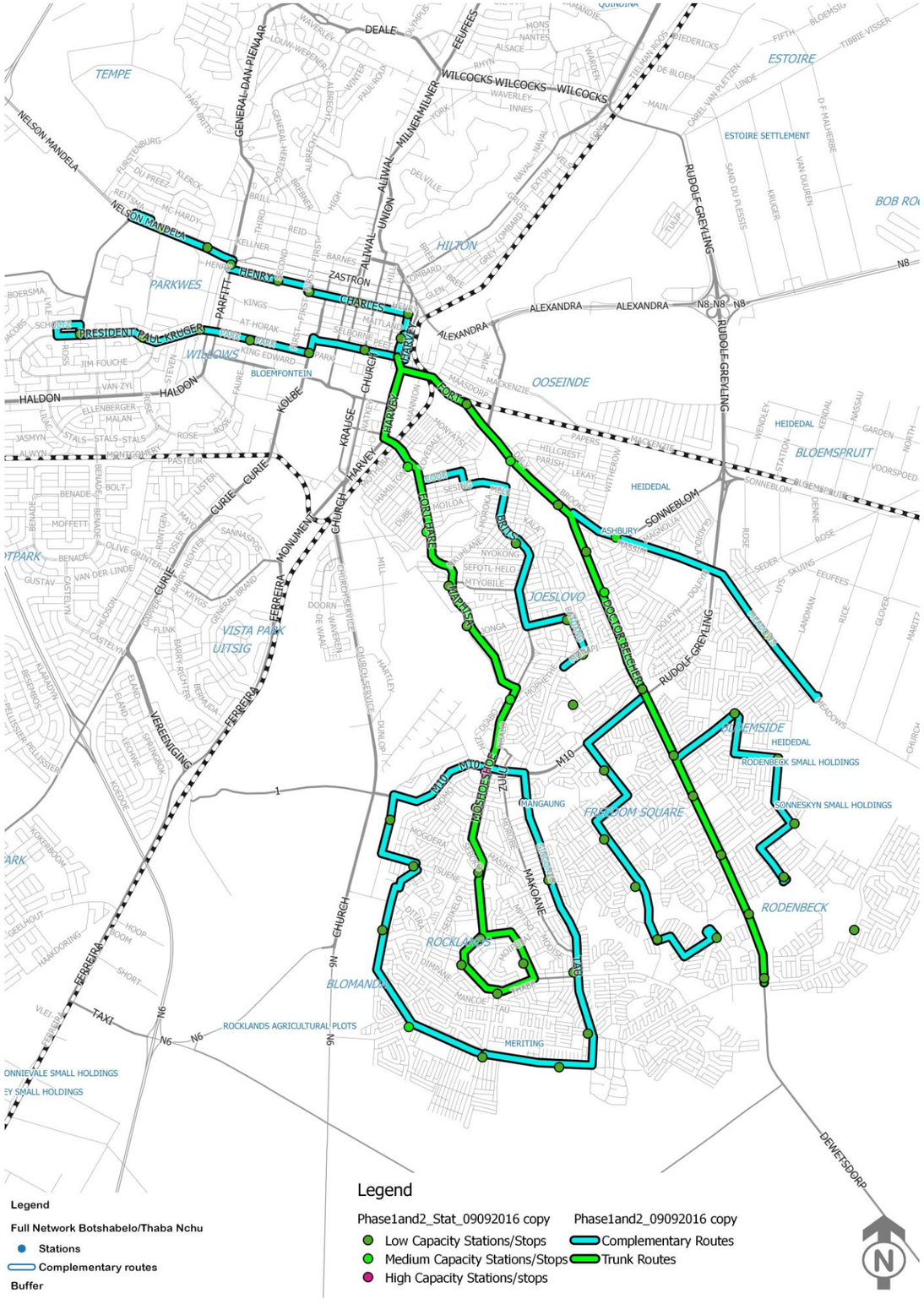


Figure 4-4: Phase 1 and 2 Station and Stop Hierarchy

Name	Phase	Bus Route #	Service type	Route Length One Direction(km)			Travel Time (Hr)	Stations			AM Pax per hour		Daily Passengers		Peak hour trips	Bus Fleet
				Total	Trunk	Complementary	Round Trip	Controlled Access	Uncontrolled Access	Stops	Inbound	Outbound	Inbound	Outbound		
Rocklands	1		Trunk Route	10.8	6.5	4.2	64	2	9	3	1072	214	3215	3215	15	15
Maphisa	1		Trunk Route	6.5	6.5	0.0	38	2	6	0	1028	206	3084	3084	14	9
Namibia	1		Complementary	7.0	2.1	4.9	31	1	2	7	534	107	1602	1602	7	5
UFS	1		Distribution	4.2		4.2	25	1		4	1740	348	3654	3654	24	10
CUT	1		Distribution	4.2		4.2	25	1		4	862	172	1810	1810	12	5
Bloemanda	1		Complementary	14	7	7	67	2	6	5	665	133	1996	1996	9	9
Phelindaba	1		Complementary	13	7	6	61	2	6	5	471	94	1412	1412	7	7
Heidedal	2		Trunk Route	10		10	37	2	4	4	1249	250	3748	3748	17	11
UFS	2		Distribution	4.2		4.2	25	1		5	771	154	2313	2313	11	4
CUT	2		Distribution	4.2		4.2	25	1		5	136	41	614	614	2	1
Freedom Square	2		Complementary	11		11	44	2	4	5	1241	248	3723	3723	17	13
Grassland	2		Complementary	8		8	28	2	3	3	612	122	1835	1835	9	4
Chris Han	2		Complementary	13		13	53	2	4	4	1447	290	4343	4343	20	18

5 Macro-Economic Analysis

This section discusses the Job Creation potential that the project may bring to South Africa and the Free State in general and Mangaung specifically. The potential job creation is derived from a macro-economic evaluation[1] as discussed below.

Improved infrastructure and especially improved transport infrastructure contributes to a more efficient economy, which in turn leads to improved competitiveness. This will lead to an increase in sustainable jobs in the long term. However, there is also a contribution to economic growth and development in the construction and development of the transport infrastructure in the short-term. Jobs will be created through the operationalisation of the transport systems.

The Integrated Public Transport Network will also contribute to GDP growth, employment, equality and poverty alleviation. The estimates of these are presented and discussed below.

5.1.1 Methodology

An initial macroeconomic impact assessment has been done in part of the first stage of the IPTN. This only covers 6,5 kilometres of road and busways. The impact of construction was derived using a Social Accounting Matrix (SAM) and a shock approach, which measures the value of additional commodities and services required to establish and operate the ITPN. (Full details of the approach are discussed in Annexure 3.2 this includes the cost estimates that were used for the analysis.)

The macroeconomic impact assessment looks at both the infrastructure costs for the construction of roads and busways, stations, a depot, and the operating costs as well.

5.1.2 Socio-economic profile of Mangaung

The Mangaung Metro Municipality covers more than 10 000 km^2 after the 2011 demarcation and is largely rural. Bloemfontein forms the economic hub of the municipality and indeed for the Free State province. Therefore, many people had been attracted to the area and migrated to the city in search of better living conditions and employment opportunities. The 2011 Census found that Mangaung had a population of over 747 000 people. With the inclusion of the new areas the population is closer to 800 000 people.

The Free State is best known for its agricultural and mining sector. It is estimated that 2014, the Free State contributed some R189 billion in current prices or some 5,3% to the GDP of South Africa. The Free States contribution in constant 2010 prices was R160 billion[2]. Over the past ten years (i.e.2005 to 2014), the Free State economy grew by 2.6 per cent on average compared to the national average of 3.3 per cent. Mangaung Metropolitan Municipality's economy is strongly driven by community services, trade, finance and transport. Mangaung is the largest contributor to the GDP of the province and is regarded as its most diverse economy. It contributes 29,8% to the provinces economy but only one half percent to South Africa's economy. In recent years, there has been a downward trend to municipality's contribution to both the South African and the Free State economies. (Full sectoral analysis of South Africa's, the Free State and Mangaung's economy are discussed fully in Annexure 3.2)

BRTs and the IPTN

Apartheid planning distorted settlement patterns and has resulted in a spatial landscape that is extremely inefficient and deeply divided. During apartheid, transport systems were designed to facilitate segregation. The predominant investment in infrastructure oriented to private vehicles, mainly in previously white areas, has exacerbated the poor levels of access and mobility in South African Cities as most individuals in marginalised communities cannot afford private cars. This legacy has stubbornly persisted in the post-apartheid era despite major transformative intent.

South African cities are characterised by sprawling, relatively low-density, mono-functional development (driven by both private and public-sector investment), and largely facilitated by privately owned motorised transport, be it automobile or mini-bus taxi. This has resulted in a context where many poor people live extraordinarily far from places of economic opportunity and are forced to travel long distances for long periods every day (Behrens and Wilkinson, 2003)

5.1.3 Multipliers

In general, a multiplier measures how much an endogenous variable changes in response to a change in some exogenous variable and often refers to the increase in final income arising from any new injection of spending gives the socio-economic impact of a spending of R862 million on Infrastructure and R54 million on operational costs. The respective multipliers that were calculated for each additional R1 Million spending into the respective economies (National and Provincial) are reflected in Table 3.1 below.

Table 5-1.1: Multipliers of the National and Free State Economic Contributions

		Free State Multipliers	Rest of South Africa
Output/ sales at basic value per R1 million final demand	Initial Impact	1,0000	0,0000
	First Round	0,6855	0,0409
	Direct Impact	1,6855	0,0409
	Indirect Effect	0,6569	0,1634
	Direct and Indirect Impact	2,3424	0,2043
	Induced Impact	0,4285	0,2202
	Economy-wide Impact	2,7709	0,4244
Imports per R1 million final demand	Initial Impact	0,0700	0,0000
	First Round	0,0667	0,0049
	Direct Impact	0,1366	0,0049
	Indirect Effect	0,0568	0,0170
	Direct and Indirect Impact	0,1934	0,0218
	Induced Impact	0,0338	0,0181
	Economy-wide Impact	0,2272	0,0400
Intermediate R1 million final demand	Initial Impact	0,0744	0,0000
	First Round	0,1017	0,0053
	Direct Impact	0,1761	0,0053
	Indirect Effect	0,1153	0,0281
	Direct and Indirect Impact	0,2914	0,0333
	Induced Impact	0,0829	0,0400
Labour Remuneration per	Economy-wide Impact	0,3743	0,0733

[1] It is important to note that this is a preliminary analysis that should be updated once the project planning is completed. The job creation potential is based on the initial phase 1 planning of the project. The IPTN is potentially a very large project with several stages and many phases within each stage. The full economic impact assessment on the entire ITPM is not possible until all the routes and type of infrastructure has been determined.

[2] The table below is in constant 2005 prices and obtained from Quantec. It is necessary to use this data because data for the metro is only available from Quantec. It therefore provides a better comparison. However, the nominal (2014) data will be much higher.

		Free State Multipliers	Rest of South Africa
Gross Operating Surplus per R1 million final demand	Initial Impact	0,1275	0,0000
	First Round	0,1234	0,0073
	Direct Impact	0,2509	0,0073
	Indirect Effect	0,1515	0,0388
	Direct and Indirect Impact	0,4024	0,0461
	Induced Impact	0,1033	0,0555
	Economy-wide Impact	0,5056	0,1016
GDP at basic values per R1 million final demand	Initial Impact	0,2036	0,0000
	First Round	0,2289	0,0127
	Direct Impact	0,4325	0,0127
	Indirect Effect	0,2711	0,0675
	Direct and Indirect Impact	0,7036	0,0801
	Induced Impact	0,1890	0,0960
	Economy-wide Impact	0,8925	0,1762
Capital Stock per R1 million final demand	Initial Impact	0,0747	0,0000
	First Round	0,3910	0,0084
	Direct Impact	0,4657	0,0084
	Indirect Effect	0,5951	0,1372
	Direct and Indirect Impact	1,0608	0,1456
	Induced Impact	0,3652	0,2006
	Economy-wide Impact	1,4260	0,3461
Employment Total Number per R1 million final demand	Initial Impact	2,1327	0,0000
	First Round	1,2961	0,0646
	Direct Impact	3,4288	0,0646
	Indirect Effect	1,2743	0,2895
	Direct and Indirect Impact	4,7031	0,3542
	Induced Impact	1,0165	0,4623
	Economy-wide Impact	5,7196	0,8165
Employment Highly Skilled per R1 million final demand	Initial Impact	0,0765	0,0000
	First Round	0,1166	0,0026
	Direct Impact	0,1931	0,0026
	Indirect Effect	0,1254	0,0298
	Direct and Indirect Impact	0,3186	0,0324
	Induced Impact	0,0919	0,0505
	Economy-wide Impact	0,4104	0,0829
Employment Skilled per R1 million final demand	Initial Impact	0,2374	0,0000
	First Round	0,3974	0,0091
	Direct Impact	0,6347	0,0091
	Indirect Effect	0,4488	0,1022
	Direct and Indirect Impact	1,0836	0,1113
	Induced Impact	0,3132	0,1726
	Economy-wide Impact	1,3967	0,2839
Employment Unskilled per R1 million final demand	Initial Impact	0,9011	0,0000
	First Round	0,4131	0,0293
	Direct Impact	1,3142	0,0293
	Indirect Effect	0,3626	0,0961
	Direct and Indirect Impact	1,6768	0,1254
	Induced Impact	0,3547	0,1339
	Economy-wide Impact	2,0315	0,2593
Employment Informal per R1 million final demand	Initial Impact	0,9178	0,0000
	First Round	0,3690	0,0236
	Direct Impact	1,2868	0,0236
	Indirect Effect	0,3374	0,0614
	Direct and Indirect Impact	1,6242	0,0850
	Induced Impact	0,2567	0,1054
	Economy-wide Impact	1,8809	0,1904

5.1.4 Macroeconomic impact of the construction Phase 1

As discussed above and presented in the infrastructure costs table above, the infrastructure costs will be in the order of R516 million. It is therefore relatively easy to adjust the macro economic impact once the costs and the phases have been finalised. There might be extrapolated impacts that will also be estimated once the costs and the phases have been finalised.

Table 5-2.2: Macroeconomic Impact of Construction on the National Economy (R million)

	Direct Impact	Indirect Effect	Induced Impact	Economy-wide Impact
Output/ sales at basic value	891	423	335	1649
Intermediate Imports	73	38	27	138

Labour Remuneration	94	74	63	231
Gross Operating Surplus	133	98	82	313
GDP at basic values	230	175	147	551
Capital Stock	245	378	292	914

Table3.3: Macroeconomic Impact of Construction on the Free State

	Direct Impact	Indirect Effect	Induced Impact	Economy-wide Impact
Output/ sales at basic value	870	339	221	1430
Intermediate Imports	71	29	17	117
Labour Remuneration	91	59	43	193
Gross Operating Surplus	129	78	53	260
GDP at basic values	223	140	98	461
Capital Stock	240	307	188	735

As can be seen form the construction phase, most of the macro-economic impacts accrue to the Free State and Mangaung.

5.1.5 Macroeconomic impact of Planning Phase 1

Planning is a vital component in any capital project and the costs for this are often capitalised. However, to estimate the impact of the planning component, these costs have been kept separate. The impact on the South African economy of R296 million by for profession services in the planning of the ITPN is given below. It has been assumed that most of the external planners are not from the Free State and therefore the impact is given for the whole of South Africa.

Table 3.4: Macroeconomic Impact of the planning of the ITPN on the National Economy

	Direct Impact	Indirect Effect	Induced Impact	Economy-wide Impact
Output/ sales at basic value	511	243	192	946
Intermediate Imports	42	22	15	79
Labour Remuneration	54	42	36	133
Gross Operating Surplus	76	56	47	180
GDP at basic values	132	100	84	316
Capital Stock	140	217	167	525

5.1.6 National job creation multipliers of the construction Phase 1

Table 3.5: The Impact on employment on the National Economy of Construction

	Direct Impact	Indirect Effect	Induced Impact	Economy-wide Impact
Employment Total	1803	807	763	3373
Employment Highly Skilled	101	80	73	255
Employment Skilled	332	284	251	867
Employment Unskilled	693	237	252	1182
Employment Informal	676	206	187	1069

An approximate total of 3 373 jobs should be created through the construction of phase 1. These jobs will only endure while the project lasts but skills will be developed that will contribute to further sustainable jobs in the future.

5.1.7 Job creation multipliers of the construction Phase 1 for the Free State

Table 5-3.6: The Impact on employment of the planning of the ITPN on the National Economy

	Direct Impact	Indirect Effect	Induced Impact	Economy-wide Impact
Employment Total	1034	463	438	1935
Employment Highly Skilled	58	46	42	146
Employment Skilled	191	163	144	497
Employment Unskilled	398	136	145	678
Employment Informal	388	118	107	613

An approximate total of 1 935 jobs should be created in the Free State and mainly in Mangaung through the construction of phase 1, These jobs will only last as long as the project lasts but skills will be developed that will contribute to further sustainable jobs in the future.

5.1.8 Construction Phase – Mangaung Metropolitan Municipality Impact

The construction costs of R516 million for the ITPN in Mangaung will result in an additional R1 147 million in turnover for the local economy. This will translate into an additional 2840 direct and indirect jobs. An additional 700 jobs will be created through an induced effect.

Most of the planning is being undertaken by firms and consultants outside Mangaung and therefore the impact on the municipality's economy will mirror the impact that has been experienced by the Free State Province.

5.1.9 The Total Operational Phase (all phases) – Mangaung Metropolitan Municipality Impact

To implement the ITPN, the MMM will establish a dedicated business unit. The current proposal is that the MMM will have to employ 52 employees (plus 5 inspectors) to fulfil the functions of the Business Unit. It might be necessary to source some of the individuals to be employed by the Business Unit from within the MMM which will reduce the job creation somewhat. Note needs to be taken that a significant number of positions is of a specialised nature requiring specialised training and experience. In addition, the Bus Operating Company will employ an additional 115 people of which 72 will be bus drivers. Fifty staff will be contracted in the station management function.

It is estimated that the cost of this operation will result in an additional 150 indirect and induced jobs.

5.1.10 Business opportunities

Depending on the way that the Integrated Public Transport Network is planned and especially how it is designed, can lead to the provision of economic infrastructure that can serve the local community while generating opportunities for Small, Micro and Medium Enterprises (SMME). This will contribute to stopping leakages in the local communities.

Annexure A: List of Figures and Tables

Figures

Tables

Annexure B: BRT versus BRT Lite Comparison

Annexure C: Manual Vehicle Occupancy – Data Analysis Report

Annexure D: Taxi Facility Survey Report and Analysis

Annexure E: Itumeleng Bus Service (IBL) Operational Analysis Report

Annexure F: Travel Time Survey

Add Station map with number

Add tables showing total number of passengers per station.

Annexure G: Detail Service Design Results

Name	Phase	Service type	Travel Distance One Direction	Trunk (km)	Mix traffic	Total Travel time Inbound (minutes)	Total TravelTime Round Trip(Hr)	Controlled Access Station	Uncontrolled Access Stations	Stops	AM Pax per hour Inbound	AM Pax per hour Outbound	PM Pax per hour Inbound	PM Pax per hour Outbound	Off Peak Inbound	Off Pek Outbound	Daily Passengers Inbound	Daily Passengers Outbound	% pax in highest 30 minutes	% pax in highest 15 minutes	Highest 30 min pax Inbound	Bus Capacity	Number of Busses Peak 30 minutes	Trips required for peak hour passengers	Number of Busses depart upto # round trip time	Bus Fequency Peak 30 minutes(min)
Rocklands(Trunk)	1	Trunk	10.8	6.5	4.2	37	64	2	9	3	1072	214	214	1072	965	965	3215	3215	0.5	0.25	712	72	10	15	15	4
Maphisa(Trunk)	1	Trunk	6.5	6.5	0.0	22	38	2	6	0	1028	206	206	1028	925	925	3084	3084	0.5	0.25	689	72	10	14	9	4
Namibia(Comp)	1	Complementary	7.0	2.1	4.9	18	31	1	2	7	534	107	107	534	481	481	1602	1602	0.5	0.25	327	72	5	7	5	8
UFS(Comp)	1	Dist	4.2		4.2	14	25	1		4	1740	348	348	1740	1566	1566	3654	3654	0.5	0.25	967	72	13	24	10	2
CUT(Comp)	1	Dist	4.2		4.2	14	25	1		4	862	172	172	862	776	776	1810	1810	0.5	0.25	479	72	7	12	5	5
Bloemanda	2	Complementary	14	7	7	38	67	2	6	5	665	133	133	665.4213926	599	599	1996	1996	0.5	0.25	712	72	10	9	9	6
Phelindaba	2	Complementary	13	7	6	38	61	2	6	5	471	94	94	470.6899319	424	424	1412	1412	0.5	0.25	712	72	10	7	7	9
Heidedal (Trunk&Comp)	2	Trunk	10		10	21	37	2	4	4	1249	250	250	1249	1125	1125	3748	3748	0.5	0.25	712	72	10	17	11	3
UFS(Comp)	2	Distribution	4.2		4.2	14	25	1		5	771	154	154	771	694	694	2313	2313	0.5	0.25	712	72	10	11	4	6
CUT(Comp)	2	Dist	4.2		4.2	14	25	1		5	136	41	41	204	185	185	614	614	0.5	0.25	712	72	10	2	1	32
Freedom Square(Comp)	3	Complementary	11		11	25	44	2	4	5	1241	248	248	1241	1117	1117	3723	3723	0.5	0.25	712	72	10	17	13	3
Grassland(Comp)	3	Complementary	8		8	16	28	2	3	3	612	122	122	612	551	551	1835	1835	0.5	0.25	712	72	10	9	4	7
Chris Hani(Comp)	3	Complementary	13		13	30	53	2	4	4	1447	290	290	1447	1303	1303	4343	4343	0.5	0.25	712	72	10	20	18	3

Name	Phase	Service type	Travel Distance One Direction	Bus Fequency Off Peak hour(min)	Peak Hour Veh Utilisation	Off Peak Veh Utilisation	Highest 30 min pax Outbound	AM Peak Trips To CBD	AM Peak Trips From CBD	PM Peak Trips To CBD	PM Peak Trips From	Off Peak Trips To CBD	Off Peak Trips From	Dailly One direction Trips	AM Peak Trips To CBD(km)	AM Peak Trips From CBD(km)	PM Peak Trips To CBD(km)	PM Peak Trips From CBD(km)	Off Peak Trips To	Off Peak Trips From CBD(km)	Daily Km	Pax per day per bus
Rocklands(Trunk)	1	Trunk	10.8	22	100 %	50%	536	15	3	3	15	27	27	57	321			321	577		1219	432.0
Maphisa(Trunk)	1	Trunk	6.5	23	100 %	50%	514	14	3	3	14	26	26	54	186			186	336		709	674.1
Namibia(Comp)	1	C Complementary	7.0	45	100 %	50%	267	7	1	1	7	13	13	28	104			104	188		397	655.2
UFS(Comp)	1	Dist	4.2	14	100 %	50%	870	24	5	5	24	44	44	92	203			203	366		772	740.1
CUT(Comp)	1	Dist	4.2	28	100 %	50%	431	12	2	2	12	22	22	45	101			101	181		382	740.6
Bloemanda	2	Complementary	14	36	100 %	50%	333	9	2	2	9	17	17	35	252			252	455		960	431.9
Phelindaba	2	Complementary	13	51	100 %	50%	235	7	1	1	7	12	12	25	173			173	311		656	432.0
Heidedal (Trunk&Comp)	2	Trunk	10	19	100 %	50%	625	17	3	3	17	31	31	66	343			343	618		1303	698.3
UFS(Comp)	2	Dist	4.2	31	100 %	50%	386	11	2	2	11	19	19	41	90			90	162		342	1057.3
CUT(Comp)	2	Dist	4.2	117	100 %	50%	68	2	1	1	3	5	5	10	16			24	43		83	1595.2
Freedom Square(Comp)	3	Complementary	11	19	100 %	50%	621	17	3	3	17	31	31	66	388			388	699		1476	588.4
Grassland(Comp)	3	Complementary	8	39	100 %	50%	306	9	2	2	9	15	15	32	132			132	238		501	925.9
Chris Hani(Comp)	3	Complementary	13	17	100 %	50%	724	20	4	4	20	36	36	76	523			523	941		1986	493.9