

UNIVERSITY OF CAPE TOWN

# Transit-Oriented Development: A Case Study of Rosebank, City of Johannesburg

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A 60-credit minor dissertation presented to the University of Cape Town

By

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## **Abstract:**

The use of the Transit Oriented Development (TOD) concept is commonplace in many South African municipal spatial development frameworks aimed at guiding future urban development towards more compact and efficient forms.

The indication is that the achievement of planned TOD (i.e. where there is an approved spatial development framework), an area of high density, mixed land use served by car-competitive public transport services, is often hampered by the absence of aligned policies and other factors that would help achieve success.

This research looks into these policies and success factors, and more specifically considers whether parking provision and management in such areas is a critical component in achieving or discouraging modal change from private car usage to public and non-motorised movement and the achievement of a desirable high density live-and-work environment.

It uses the long-established Rosebank Regional Node in the City of Johannesburg and the approved Rosebank Urban Development Framework, 2008, (“RUDF”) as a case study, quantifying the spatial planning proposals and identifying possible shortcomings in the implementation of the TOD in this existing suburban area, now served by a Gautrain Station.

The quantification of the RUDF proposals serves to identify the proposed land uses within the node and facilitates the application of the relevant parking standards and trip generation factors applicable to each, thereby illustrating the traffic demand on the road network as well as the parking to be supplied if current parking policies are adhered to. These are then compared the road network’s capacity to identify mismatches.

The research shows that the current practice of promoting densification while applying the standard parking suburban regulations (drafted in 1979) will not achieve a less private-car-dependent lifestyle, and that without integrating parking policy and traffic demand management into the planning strategy, the likelihood is that the TOD vision will fail.

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## **1) Introduction**

The aim of the research presented in this minor dissertation is to identify the importance of an integrated parking policy and traffic demand management in all instances where Transit Oriented Development (TOD) is proposed as an urban restructuring tool. This will be the subject of the research dissertation that follows, using the Rosebank TOD and the Rosebank Urban Development Framework, 2008, (“RUDF”) in Johannesburg as a case study.

The TOD concept is becoming more commonplace in the spatial development frameworks being produced by municipalities in South Africa, and is integral to the RUDF. It denotes an area of high density, mixed land use served by adequate public transport.

This research is motivated by a concern that, while it is an important structuring instrument in the spatial transformation of urban areas, TOD is often promoted around existing or future transit facilities merely by densification policies and without the other vital elements of infrastructural upgrades, improvements to the public realm, parking policies and the like.

In recent land use approvals in Rosebank there has been no deviation from the standard suburban parking standards that applied prior to the TOD initiative, and this aspect is the primary focus of this paper.

### **1.1) Background**

The agglomeration of people in cities and their movements provide the dynamic mix that promotes economic development, but the spatial form of some cities must be addressed if a better economic, social, and environmental outcome is to be achieved, and the detrimental impacts of mismatched services, traffic congestion, pollution and health are to be countered.

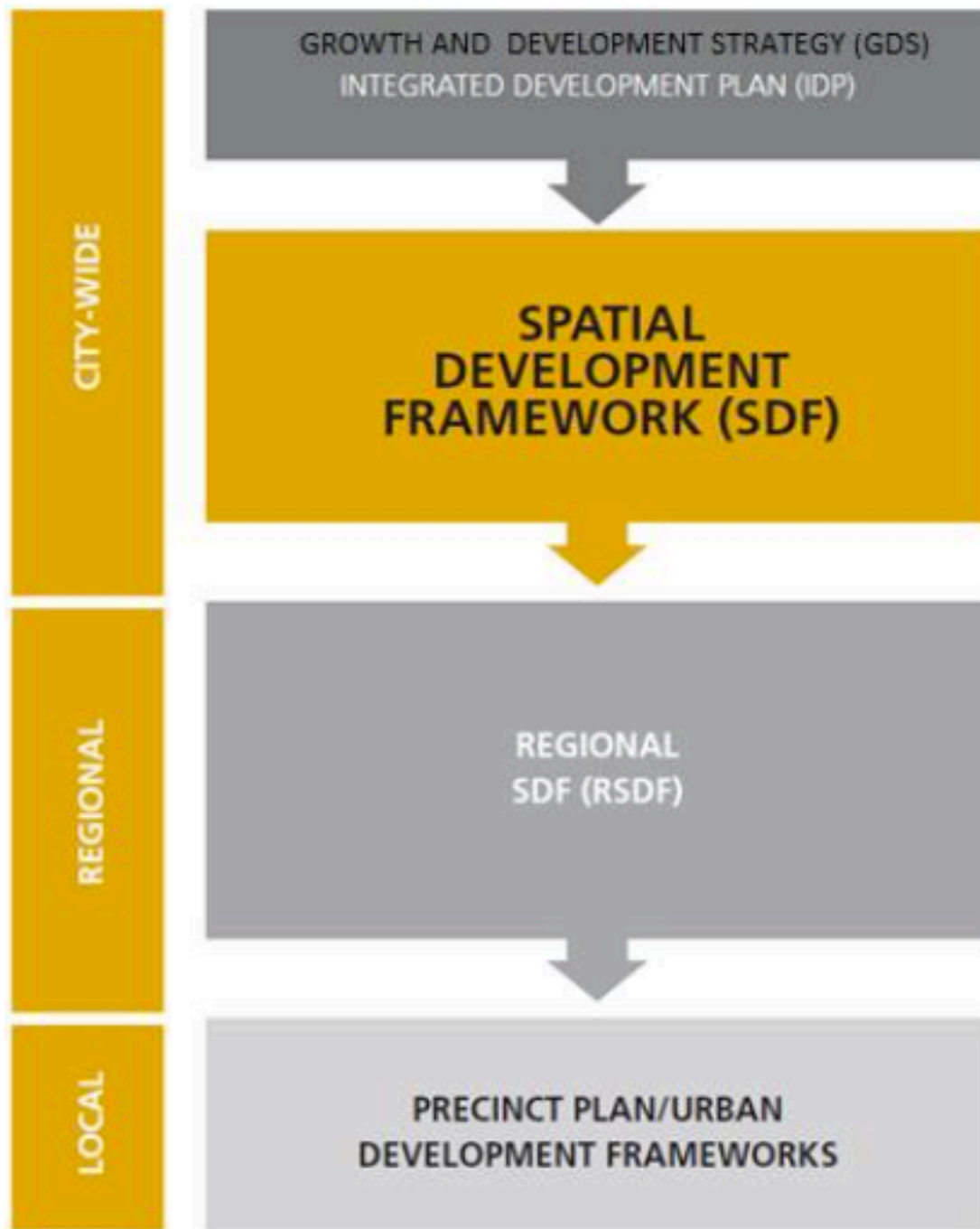
The importance of addressing urban planning and transport together is recognised (CoJ, 2011) as essential to the creation of compact, efficient cities, and this thinking has become a major feature in city planning under the term ‘Transit-Oriented Development’, or TOD. It is aimed at achieving economic, social and environmental benefits through compact forms of development supported by public transport facilities.

The movement of people within Johannesburg has been the focus of municipal attention for a number of years as the congestion levels on roads have become increasingly problematic and a hindrance to the economic activity and the continued beneficial growth of the city. The current inefficiency (CoJ, 2013) and dispersed land use pattern in Johannesburg is a product of many factors, including socio-economic and political ones. It is considered unsustainable by the planning authorities and the City, and has given rise to new legal planning tools to effect a different development strategy and urban form.

These changes to the legal and spatial policy environment have been most pronounced over the last two decades, the most recent legislation being the Spatial Land Use Management Act of 2013 (Department of Rural Development and Land Reform, 2015) that came into operation on 1 July 2015. This and its predecessor, the Development Facilitation Act of 1995, introduced a new normative backdrop to guide the land use decision-making of the three tiers of government towards a more compact and efficient form of city growth, and these principles now underpin most integrated “spatial development frameworks” (SDFs) produced under the new laws.

As alluded to above, as a city grows the need for alternatives to the private car system becomes more evident, and investment in an improved public transport system becomes an imperative. This is not unique to Johannesburg, and is common to many cities (Cervero, Ferrell, & Murphy, 2002) around the world trying to deal with similar problems resulting from spread out, low density development.

The Johannesburg City Council’s response has been to promote a poly-centric form of urban development (i.e. a multi-nodal structure linked by transportation corridors) as reflected in its Metropolitan Spatial Development Framework (2016). The metropolitan spatial vision is supported by a hierarchy (Figure 1) of more detailed spatial development policies/frameworks favouring densification within a more confined urban area, areas of existing concentrations of business and residential uses identified as “nodes”, and the areas adjacent to the main road networks identified as “corridors of freedom”.



**Figure 1: Hierarchy of Spatial Plans (City of Johannesburg Metropolitan Municipality, 2016)**

There have also been complementary initiatives to provide public transport to support nodes and corridors, particularly the Gautrain, a provincial initiative, and the Bus Rapid Transit (BRT) system, a municipal initiative. These are in their infancy, and their impacts on private vehicle travel need to be monitored and new approaches introduced to ensure their efficacy, reliability and appeal to commuters.

While these public transport initiatives are evolving, the City of Johannesburg (CoJ) is pursuing a parallel process of development “densification” in nodes and corridors by undertaking more detailed, local nodal development frameworks such as the Rosebank Urban Development Framework (RUDF) (2008) (Akanya, Karabo, Studiomas, 2008) and by granting enhanced land use rights in order to support the ridership of the trains and buses. These planned development frameworks are underpinned by TOD principles.

In some instances, such as the Corridors of Freedom, infrastructural upgrades and catalytic improvements have been planned and funding allocated by the City, but in many of the existing nodes identified for more intensive land use, such as Rosebank, the supporting actions and capital investments are lagging. The land use densification in these existing nodes is primarily driven by market responses to opportunities offered by the Council’s enhanced development rights incentives contained in the spatial development frameworks.

It is anticipated by the author that densification will mainly manifest in the more affluent areas where there is existing infrastructure and where land values permit demolition of existing low density housing and its replacement by more dwelling units or mixed use options. These areas are most likely to be marketable and appealing to an emerging “urban” community where work-and-live facilities are in close proximity and where public transport substitutes the need for more cars and parking facilities. Rosebank is a case in point.

## **1.2) Aim**

While it is recognised that there are a number of aspects that contribute to successful TOD outcomes, this research is primarily directed at understanding the consequences of pursuing an unmodified parking policy in a node designated for TOD outcomes.

The research questions that the research will endeavour to answer include:

- What are the success factors for TODs, with particular reference to parking supply and parking management?
- How has the TOD concept been used in the Rosebank Urban Development Framework for the future development of the Rosebank Regional Node in Johannesburg? And
- How has the TOD concept been applied in the Rosebank Urban Development

Framework to date, and what are the implications of the current development trajectory without parking and parking management interventions.

### **1.3) Outline**

This dissertation is divided into six chapters, including the introductory Chapter 1.

Chapter 2 provides a literature review to determine the contributory factors that help achieve successful Transit Oriented Developments (TODs).

Chapter 3 discusses the research process followed, why Rosebank was chosen as the case study, the method used to collect the data, and the method of analysis.

Chapter 4 presents an analysis of the current CoJ city spatial planning policy, the RUDF and related strategies for TOD in the Rosebank node (including the planning intentions and their implementation) which will form a backdrop to the case study. Focus is placed on the current and planned land use, public transport, accessibility, road network and travel demand management (TDM) measures (primarily parking supply).

Chapter 5 quantifies the proposed land use mix and floor area in the RUDF with the research completed in the literature review chapter (Chapter 2) and investigates the parking and traffic implications in the Rosebank node.

The final chapter (Chapter 6) reiterates the key points (good practices, barriers, etc.) identified in the dissertation as well as the mismatches/findings arising from the quantification process in the previous chapter.

Recommendations are then made on the proposed parking policies and regulations to better promote a reduced dependency on private vehicles in the Rosebank node.

## **2) Literature Review**

### **2.1) Introduction**

Considering that articulated densification (i.e. densification in specific locations, a concept described by Suzuki, Cervero, & Luchi, 2013), is needed to play a key role in Johannesburg's spatial future and that this has generally been coupled in contemporary policy discourse with TOD, it was necessary to do further research to better understand the concept, good accompanying practices, traveller behaviour, barriers and benefits.

This chapter reviews available literature on the definition of TODs, what they aim to achieve, and how they aim to achieve their goals, with an in-depth look at their parking policies and practices. Travel behaviour literature will be reviewed as the goal of TODs is to actively change modal choice or behaviour of travellers. It will serve to provide insight and comparative information to assess the performance of the Rosebank TOD, and inform the recommendations made to achieve a better TOD outcome in Rosebank.

In summary, the questions to be answered in this literature review are:

- What is the TOD concept and what are the relevant good practices?
- What are the barriers to TODs?
- What are the different travel behaviour change theories?
- What is the relevance of parking policies in TODs? And
- How can parking policies and regulation contribute to a better balance between private car usage, non-motorised travel, and public transportation?

### **2.2) The TOD Concept**

The concept of building public transit stations close to areas with greater densities has been around since the 1980s; however, transit-oriented developments only became accepted as a formal, modern planning concept in the book "The next American Metropolis" by Peter Calthorpe.

Calthorpe recognised that an alternative to urban sprawl and unsustainable urbanisation is “moderate and high-density housing, along with complementary public uses, jobs, retail and services, concentrated in mixed-use developments at strategic points along the regional transit systems.” (Calthorpe, 1993)

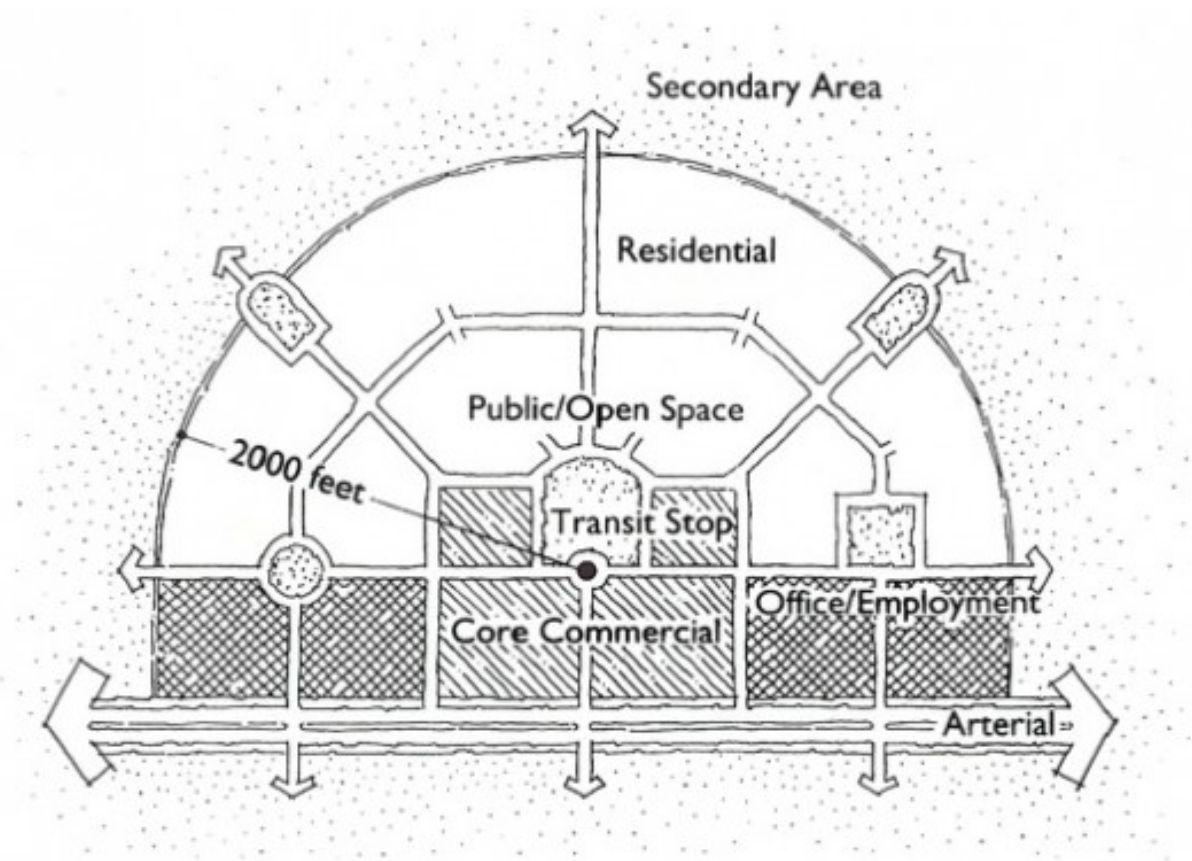


Figure 2: TOD Concept (Calthorpe, 1993)

Figure 2, taken from Calthorpe’s book, illustrates the concept of TODs: a transit stop provided in the centre of the development surrounded by highly dense commercial space followed by office, residential, and open space. Numerous papers have subsequently been written about TODs and with them came a number of definitions, for example:

- “A mixed-use community that encourages people to live near transit services and to decrease their dependence on driving” (Still, 2002)
- “A place of relatively higher density that includes a mixture of residential, employment, shopping and civic uses and types located within an easy walk of a bus or rail transit centre. The development design gives preference to the pedestrian and bicyclists, and may be accessed by automobiles” (Maryland DoT, 2000, p. 3)

- “They reflect a fundamental shift from the old, unsustainable paradigm of car-oriented urbanism toward a new paradigm where urban forms and land uses are closely integrated with efficient, low-impact, and people-oriented urban travel modes: walking, cycling, and transit.” (ITDP, 2014)

These definitions have similarities in their promotion of the concepts of high density, mixed-use developments close to a transit station with a transit-friendly design. The notions of high densities, prioritising pedestrian movement, minimizing private vehicle use and community-gathering areas are also evident in a large majority of definitions offered.

The thinking about TOD has developed a long way since 1993. The Institute for Transportation and Development Policy (ITDP) released a paper called “TOD Standard”. In this paper eight key principles are proposed to guide the development of TODs which follow:

Walk:	Develop neighbourhoods that promote walking
Cycle:	Prioritise non-motorised transport networks
Connect:	Create dense networks of streets and paths
Transit:	Locate development near high-quality public transport
Mix:	Plan for mixed land use
Densify:	Optimise density and transit capacity
Compact:	Create regions with short commutes
Shift:	Increase mobility by regulating parking and road use

The outcome of applying all eight of these principles will, it is said, achieve sustainable TOD development. (ITDP, 2014)

### **2.3) Good Practice in TODs**

The following practices have been identified by The Executive Office of Energy and Environmental Affairs, (2013) as key to achieving successful TODs:

### Supportive market conditions:

Attracting investment and development in an area will require a suitable market. There must be potential for development and land which allows for this development and/or redevelopment. The TOD area must offer more than non-TODs in terms of location, access and opportunities.

### Transit backing commitment:

Policy makers, transit agencies and other officials must commit to public transport systems that offer reliability, affordability and safety. Policies need to reflect the need for transit users and encourage public modes of transport. Station accessibility must be incorporated into the design. According to the ITDP's TOD standard (2014), access and proximity to high capacity public transit is a prerequisite for TOD recognition.

### Strong local leadership:

Public and private sectors should both be directed at supporting TOD goals via a well- planned strategy.

### Supportive public policies and tools:

TOD requires policies and strategies to guide and encourage development that supports the TOD design and encourages pedestrian activity. These policies and strategies include:

- High density, mixed use zoning:  
Support appropriate zonings that encourage high density levels, pedestrian activity, limit parking availability and much more. The zoning may have to be unique to the TOD area and may require location-specific research. Densification and mixed use zoning have also been highlighted in the ITDP (2014) as key to establishing sustainable TOD, there it is specified that residential and job densities must be able to support high quality transit.
- Public investment policies:  
Investing in public facilities to improve belief in the affected area and which could lead to private investment. These public investments show that the government acknowledges the importance and opportunity that the TOD brings which attracts the private sector.

- Design standards and guidelines:  
New developments need to have beneficial characteristics. Creating guidelines that promote pedestrian movement, pleasing aesthetics, connectivity, parking design and limitations, low impact design techniques, etc. The ability to walk and cycle the shortest possible distances in a compact development will minimize the time and effort required to reach different activities with short distances, compact cities require less extensive and costly infrastructure (ITDP, 2014).
- Incentives:  
Financial incentives such as tax rebates or exemptions are powerful tools which can be used to shape the area. Sharing infrastructure development costs and streamlining the development process are another two incentives which could be used.

## **2.4) Barriers to TOD**

Analysis of Bus Rapid Transit (“BRT”) projects and urban development trends allowed Suzuki et al. (2013) to identify eight barriers to TOD success that apply internationally, and therefore potentially in Johannesburg too. Comment on the RUDF is included under each item.

These include:

- a lack of a public transport investment assessment framework,
- sectoral (as opposed to integrated) responses to proposed developments,
- inadequate policies and regulations for promoting densities at strategic locations,
- restrictive regulations and administrative constraints,
- inconsistencies in planning instruments and deficiencies in their implementation,
- inadequate policies, regulations and supporting mechanisms for redeveloping built-up areas,
- neglected urban design at the neighbourhood and street level,
- financial constraints.

(Suzuki, Cervero, & Luchi, 2013)

As indicated earlier, the focus of this report relates to the parking policy and TOD outcomes that fall under Suzuki’s barrier category of “inadequate policies and regulations for promoting

densities at strategic locations”. The following quote from Bo Wang clearly indicates the relationship between TODs and parking supply, namely “One major challenge to implementing a TOD is parking: well-managed parking can improve the performance of a TOD in both transportation and financial perspectives; poorly-managed parking can undermine the expected benefits of a TOD and even cause the initiative to fail.” (Wang, 2012, p. 2).

Failure to address this component will result in the continued provision of parking in the ratios attributable to normal suburban areas and obstruct the objectives listed under the Good Practices section above. The importance of parking and travel demand management is discussed below.

## **2.5) Travel Behaviour Change Theories**

Travel Demand Management (TDM) measures can be used to change travel behaviours in order to reduce the number of trips being made in private vehicles as an alternative to increasing road capacities. “Travel demand management (TDM) is a diverse host of actions that are employed to improve the efficiency of the transportation system. These actions modify the demand placed on a transportation system by reducing single-occupancy vehicle (SOV) trips, encouraging off-peak travel, and/or reducing trip time or length.” (Obermann, 2012, p. 1). The use of TDM measures is especially evident in areas of high density and TODs, as alternative methods of transport are most available in these areas.

The measures used are a mix of incentives, education and marketing in combination with alternative transportation methods. Actively seeking to change the modal choice or behaviour of a traveller to one which is more sustainable will involve one of these TDM measures.

Adjei & Behrens (2012) identified a number of behaviour and behavioural change theories in their paper titled “Travel Behaviour Change Theories and Experiments: A Review and Synthesis”. Their paper identifies the various theories relevant to how behavioural choices are made, what factors effect choice-making, when behavioural change occurs, and how decision makers respond to behaviour change interventions. These are discussed further below:

Rational choice theory which suggests that users seek to maximise their utility by calculating the costs and benefits of each possible case. This theory assumes that users have access to all

relevant information and are able to compute the utility and disutility of each alternative (Glimcher, Dorris, & Bayer, 2005).

Prospect theory accommodates the degree of uncertainty in the behavioural decision, and Kahneman and Tversky (1979) do this by weighting alternatives with a greater certainty above those with uncertainty.

Habit formation theory proposes that the more an activity is done the stronger the formation of habit and less debate occurs. This theory is more recent than the others, but is very apparent in travel behaviour (Gärling & Axhausen, 2003).

Theories explaining when behavioural changes occur and how decision makers respond to behavioural change interventions are also of interest, particularly the following three:

The cognitive dissonance theory (Festinger, 1957), which relates behavioural change to behavioural (and environmental) cognition. Acquiring knowledge about a behaviour could lead to either a change in the behaviour itself or the knowledge acquisition will reinforce the behaviour.

The self-perception theory (Bem, 1967) is counter-intuitive as it indicates that an individual's attitude towards a particular behaviour may change after changing said behaviour. This theory suggests that once a person is forced to change a behaviour this may lead to a change in attitude towards the past behaviour (e.g. once someone is forced to use a train they might change their attitude towards the use of public transport).

Finally, the goal setting theory (Latham & Locke, 1991) that argues that the setting of goals for an individual will bring about changes in behaviour. If an individual sets out to use public transport the likelihood of their using public transport depends on the level of difficulty involved in using the public transport and the intensity of reaching this goal, in the case of public transport accessibility, is directly linked to difficulty levels.

While it is true that the modal choice of transportation has a direct impact on the parking supply, it is also true that the number of parking bays provided (i.e. availability) is likely have an effect on the type of transportation chosen. Parking supply is therefore a TDM measure that can be used effectively if used in combination with other TDM measures, provided that alternative transport methods are viable and reliable substitutes.

## 2.6) The Relevance of Parking Policy in TOD

A study of 4 000 households in 60 buildings near six Skytrain stations in Vancouver found that households located near these stations use public transit more often than distant households, and that they also owned 10% fewer vehicles than distant households. Based on these findings the City of Vancouver has reduced the parking requirements by 14% to 28% for new projects near to stations (Renne & Wells, 2002).

Bhat and Guo (2006) undertook a study isolating the influences on vehicle ownership in 233 transport analysis zones within the San Francisco Bay area and made the following conclusions:

There is a significant relationship that exists between household density and employment density on car ownership, namely the higher the household and employment densities the less likely a household is to own a private vehicle. They then consider the relationship between density measures and public transportation networks and find a high correlation. Once the local transportation network measures are removed the original relationship is significantly weaker, leading to the conclusion that the transportation network has a greater influence on vehicle ownership than housing and employment densities. Of all the relationships considered in their paper, household demographics have the greatest influence on vehicle ownership.

Boroski, Faulkner & Arrington (2002) identify the importance of supplying the right quantity of parking in TOD areas and its ability to:

- Reduce residential parking rates
- Reduce office/commercial rents
- Lessen urban water runoff
- Reinforce/encourage transit use
- Increase taxable square footage
- Improve local traffic circulation
- Improve urban design, and
- Generate congestion management credits for businesses

They indicate that general parking reduction standards (applicable in North America) should be used as a guideline, but each TOD should implement unique parking standards which would best benefit the development and transit participation in the area.

The University of Utah published research done to determine how much less parking is required at TODs, this research was conducted at five TODs: Englewood, CO’s TOD, Wilshire/Vermont TOD, CA’s Fruitvale Transit Village, Redmond, WA TOD, and Rhode Island Row in Washington DC. (Smart Growth America, 2017)

The key findings of this study are shown in Table 1.

**Table 1: Peak parking occupancy as percentage of supply and ITE guidelines (Smart Growth America, 2017)**

<b>TOD</b>	<b>Peak Parking Occupancy as Percentage of Supply</b>	<b>Peak Parking Occupancy as Percentage of ITE Guidelines</b>
<b>Englewood, CO2</b>	58%	46%
<b>Fruitvale Village</b>	84%	19%
<b>Redmond, WA</b>	74%	42%
<b>Rhode Island Row</b>	64%	33%
<b>Wilshire/Vermont</b>	67%	33%

Table 1 shows that the peak parking occupancy as a percentage of supply is never full with the highest occupancy percentage at 84%. It must be noted that the supply of parking in all of these TODs is lower than what the ITE guidelines suggest, If the Institute of Transportation Engineers (ITE) guidelines were followed then the peak occupancy percentage would be much lower, most notable only reaching 19% at the Fruitvale Village. This research indicates that applying the ITE guidelines will lead to oversupply of parking in TOD areas.

Parking regulations geared towards the provision of a predetermined number of parking bays per land use, rather than a TOD-specific evaluation of parking needs, can lead to an oversupply of parking.

It is also apparent that oversupply can be promoted by a property-by-property approach to parking provision and that shared parking may be a better option. Shared parking, according to Portland Metro (Stein & Resha, 2010, p. iii), “is when two or more land uses share the same parking spaces” and is more beneficial than allocated parking bays. Shared parking comes hand-in-hand with mixed land use as each land use has different peak parking demands and considering the differences in peak demands can lead to better utilization of parking bays.

Having allocated parking bays will lead to an oversupply of parking at any given time due to the above mentioned varied peak demand periods. The reduction of land used for parking with shared parking initiatives will preserve land which will be better allocated for densification purposes, but does shift the onus of overall parking management to the municipal authorities.

### **2.6.1) Types of parking**

Parking provision generally falls into three categories: On-street, off-street-open-air and off-street in-structure.

The physical manifestation of parking varies according to the category, with on-street occupying public street space, off-street-open-air requiring public street space to provide access to it, and in-structure parking space generally providing multiples of the site surface area in parking.

Off-street in-structure parking requires a large amount of space for each parking because of manoeuvring and parking space. Each parking bay roughly requires 25 m<sup>2</sup> of space, and, if the current CoJ parking ratios referred to later in this section are applied, this means that roughly an equal allocation of built floor area for parking as for offices is required. Notwithstanding the proportions of lettable commercial floor space to parking floor space, or the location of the site in a TOD such as Rosebank, the need to be competitive seems to drive the provision of on-site parking at high ratios. This is quite clearly at odds with the good practices for TOD listed earlier, where the commitment of the municipality to public transport must be tangible and offer reliability, affordability and safety if there is to be transformation.

The appeal of each of these categories of parking to car users is influenced by availability, accessibility, proximity to destination, cost, and safety, to name a few factors. These are discussed below.

### **2.6.2) Provision of parking**

The provision of parking is affected by the following factors, namely costs, regulations, land use policies, traffic network capacity, and the like. These are discussed below:

### 2.6.2.1) Direct Cost of Parking Provision

Parking provision costs are either direct costs or indirect costs.

Direct costs include the cost of land, construction and maintenance and operation. As indicated earlier a parking bay plus manoeuvring space takes up an area of roughly 25m<sup>2</sup>.

The Victoria Transport Policy Institute (“VTPI”) reports that the biggest proportion of the direct cost is incurred in the parking structure construction costs, which are determined by the size per space, shape of site, number of levels, topography, design, and geographic location (VTPI, 2016). The VTPI provides the following parking bay construction costs in Table 2 in North America.

**Table 2: Parking Structure Construction Costs (VTPI, 2016)**

City	Cost Per Space (\$)	City	Cost Per Space (\$)
Atlanta	16 866	Los Angeles	20 502
Baltimore	17 742	Miami	16 600
Boston	22 368	Minneapolis	20 769
Charlotte	15 915	Nashville	16 676
Chicago	22 425	New York	24 957
Cleveland	18 903	Philadelphia	21 892
Denver	17 571	St Louis	19 417
Dallas	16 257	San Francisco	23 320
Detroit	19 532	Seattle	19 608
Houston	16 581	<b><u>National Average</u></b>	<b><u>19 037</u></b>

The North American national average cost to construct a parking bay was calculated as \$19 037 in 2011. Considering each parking bay is roughly 25 m<sup>2</sup> in area, it costs \$761 per m<sup>2</sup>.

The South African cost of in-structure parking construction has been estimated by AECOM (2016) to cost R6 000 per m<sup>2</sup> which is slightly cheaper than construction in America. The construction cost of South African office space is estimated at R15 000 per m<sup>2</sup> (AECOM, 2016) which means that the parking construction cost is just less than half the price of the offices.

Another direct cost is the operations and maintenance component. This includes lighting, cleaning, fee collection, security, insurance, administration, etc., and can be substantial as

confirmed in a study completed in 1996 where the average annual cost per parking bay was found to be roughly \$500. (VTPI, 2015)

### **2.6.2.2) Indirect Costs of Parking Provision**

Indirect costs of parking are less obvious than direct costs and are not easily measured in monetary terms, but include opportunity costs, traffic impact study costs, and environmental impact costs.

Opportunity costs are defined as the value of the next best alternative that must be forgone to achieve the chosen alternative (Business Dictionary, 2016); in other words by supplying parking another land use opportunity, mobility, and land use accessibility must be sacrificed. One opportunity cost pertinent to TOD and particularly relating to on-street parking is reduced NMT mobility. Fewer parking bays will reduce the number of trips made by private vehicles and increase the number of NMT trips. In highly dense areas or areas planned for densification, such as TOD, NMT should take priority over parking bays therefore, making the justification of more on-street parking bays irrational.

Indirect costs include the perceived viability of TODs, the Return on Investment (ROI) and buy-in of TOD investors (Willson & Menotti, 2007). Other examples of indirect costs include the impact on the cost of developing the main land use (where, for example, a Todd Litman study showed that providing one parking bay per apartment will increase the price of the apartment by 12.5%, while providing two parking bays would increase the price by 25% (Litman, 2014), and the need to use traffic impact studies to identify ways to manage and provide capacity for additional traffic attracted by excessive provision of parking bays. He contends that abundant parking supply and low parking prices will lead to city sprawl and that this leads to increased per capita vehicle ownership and lower participation and investments in NMT and public transport. (Litman, 2014)

Environmental costs include the amount of energy consumed and green-house gas emitted during the construction and maintenance of parking facilities. (Shoup, 1995)

### **2.6.2.3) Regulation of Parking Space Ratios and Standards**

The parking ratios for particular land uses are generally regulated through the municipal Town Planning or Land Use Schemes, and the parking bay dimensions are based on accepted industry standards.

The Johannesburg Town Planning Scheme (1979) is applicable in Rosebank, and prescribes the parking ratios that should be applied throughout suburban Johannesburg. These generic parking ratios shown in Appendix 2 below have not been altered of late and are still being imposed - even though the importance of promoting public transit use has been identified in the City's recent land use policies such as the RUDF and the BRT-based Corridors of Freedom

These standards have perpetuated a number of problems, the main one of which being dispersed development and low development densities. Donald Shoup states that "minimum parking requirements increase development cost and they powerfully shape land use, transportation, and urban form" (Shoup, 1999, p. 556). Parking provision at these levels promotes conflict between mobility (physical movement) and land use accessibility (destinations located close together) (VTPI, 2015).

As the realisation that the current land use, transportation, and urban form are not ideal, the move towards mixed land-use, public and non-motorised transportation, and densification becomes more vital to city sustainability so the parking management needs to be used for this adaption.

The City of Johannesburg appears to be moving towards resolving a parking management response that accommodates the land use policy of mixed land-use, public and non-motorised transportation, and densification in its "Strategic Integrated Transport Plan Framework" and aims to do the following (CoJ, 2013):

- Encouraging employers to increase the cost of parking provided to employees.
- Developing comprehensive plans to address on-street parking in the CBD and all major nodes. While the City intends to restore a system of paid on-street parking in the CBD and all major commercial nodes, other nodes may require different solutions to ensure that they are accessible. Such a plan will be subject to public consultation.
- Amendments to land use and zoning policies in respect of what is required by developers in terms of parking. A number of amendments have been proposed to the

City's proposed new Consolidated Town Planning Scheme, anticipated in 2017, to facilitate improved parking management to support TDM. The key recommendations are that:

- Maximum parking provision limits should be introduced in public transport priority areas in terms of the City's Growth Management Strategy (GMS);
- Lower maximum parking requirements should be introduced around upgraded public transport corridors and in the marginalised areas in terms of the GMS;
- Lower off street parking requirements in the inner City and regional nodes as defined by the Consolidated Town Planning Scheme should be introduced;
- A shared parking concept - where the same parking spaces can be used for different land uses at different times - should be introduced for mixed land use developments; and
- The designers of shopping malls, other large retail facilities and office parks should be required to make provision for public transport vehicles, metered taxis and decent pedestrian access, as well as shared parking.

As identified earlier, the ratios, which are not adjusted to TOD, have the effect of curtailing the densities of development that can be achieved not only because of physical limitations of individual sites, but by virtue of the costs of building the required parking. These can directly contribute to an oversupply of parking in TOD that impacts on public transport promotion, non-motorised transportation (NMT), and area liveability as will be evident from the following sections.

#### **2.6.2.4) Traffic and Congestion**

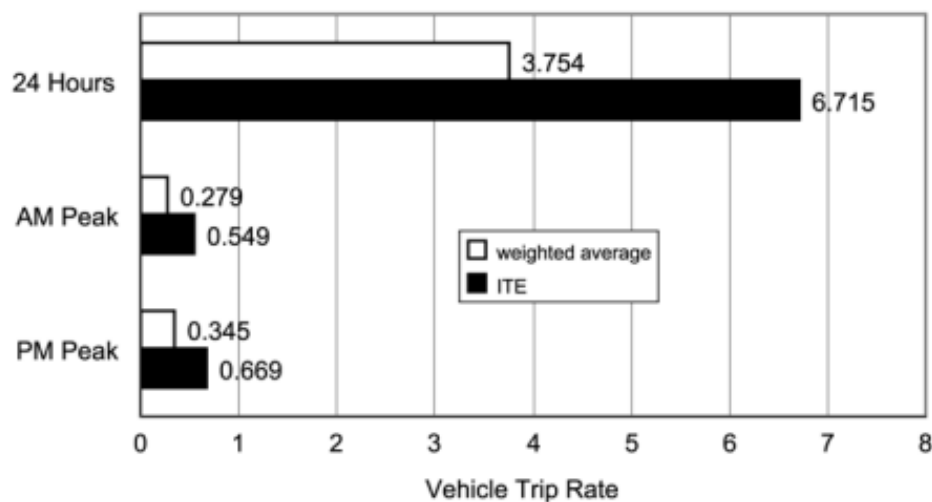
##### Trip Generation Rates

Zhang (2012) indicates that the trip generation rate is one of the most important indicators for measuring travel behaviour and transit ridership. These can potentially be used to measure the performance of TODs clarify the parking supply needs, and influence the parking policies and dynamics in TOD areas.

Cervero (2008) wrote about the problem of overestimation of trip generation rates and how they affect decision-making in terms of developing in TODs. Many TOD proposals in the USA

have been halted and redesigned due to the anticipated effect the increase in vehicle activity would have on the roads, based on non-TOD assumptions that exaggerate congestion on the surrounding roads.

Cervero’s report showed that household travel patterns in a sample of 17 multi-family housing projects in Philadelphia, Portland, San Francisco Bay, and Washington D.C. comprising a variety of project sizes near rail transit stations showed a reduction in trip generation rates per dwelling unit of about 50% for housing around transit stations. The rates did vary with the more dense dwelling units having lower trip generation rates than the less dense dwellings; however, the noticeably lower trip generation rates of all households close to a transit station is a clear indication for the need of policy adjustments. The implementation of a sliding scale traffic impact fee will drastically impact developers and investors, encouraging smart growth with the use of smart calculations to support its economics (Cervero, 2008).



**Figure 3: Comparison between Weighted Average Vehicle Trips and ITE Estimates (Vehicle Trip Reduction Impacts of Transit-Oriented Housing (2008))**

Figure 3 illustrates the difference between the weighted average vehicle trip rates (weighted by dividing the sum of all trips by the sum of all independent variable units, e.g. number of trips by the number per employee or occupied dwelling unit) in comparison to the ITE trip generation rates (Institute of Transportation Engineers, 2003) which are the standard rates applied in US cities for traffic impact assessments and are used to calculate impact fees. As illustrated, the actual trip generation rate is about half of the ITE rate used.

## South African Trip Generation Rates

The Committee of Traffic Officials (COTO, 2013) has recommended trip generation rates that should be applied throughout South Africa. These rates have been calculated using data from various local and international sources.

### Trip Generation Adjustment Factors in South Africa

According to the COTO report (COTO, 2013, p. Appendix A) there needs to be a trip generation adjustment factor when working with areas that make use of concepts which decrease the number of private vehicle trips in the area. The report suggests that if an area is situated in a transit node or corridor there should be a trip generation adjustment factor of 15%, meaning that there are likely to be 15% fewer trips made in private vehicles from developments in transit nodes or along transport corridors. This reduction factor is considered reasonable for low vehicle ownership areas and areas with a high level of public transit service, and was established by considering current trip generation rates in these different areas.

Table 3 contains the results of the AM trip generation rates after being subject to the 15% adjustment factor for the land uses relevant in this paper.

**Table 3: South African AM and PM Trip Generation Rates after adjustment of 15% (COTO, 2013)**

<b>Am and PM Trip Generation Rate</b>		
<b>Land Use</b>	<b>AM Rates (trips per 100m<sup>2</sup>)</b>	<b>PM Rates (trips per 100m<sup>2</sup>)</b>
<b>Residential</b>	0.55	0.55
<b>Offices</b>	1.79	1.79
<b>Retail</b>	0.51	2.89
<b>Hotels</b>	0.43	0.43

### Directional Split

The directional split represents the percentage of trips going to the development under investigation and out of the development/area. The directional split depends on a number of factors, one of which is the type of activity at the destination. If this activity is work-related then most of the trips into the area are likely to be into the area in the morning and out of the area during the afternoon traffic peak.

Retail and residential uses, however, have a different split with most trips made to these areas will be outside of office hours and therefore take place during the daily peaks. This logic is shown in Table 4 as the different land uses have different morning and afternoon directional splits: Office developments have more trips leaving the area in the afternoon, residential development has most of its trips coming into the area in the afternoon, and retail has a 50:50 balance during the afternoon peak.

**Table 4: AM and PM Peak Hour Directional Split (TMH 17: South African Trip Data Manual (2013))**

<b>Directional Split</b>				
<b>Land use</b>	<b>AM</b>		<b>PM</b>	
	<b>In</b>	<b>Out</b>	<b>In</b>	<b>Out</b>
<b>Residential</b>	25%	75%	70%	30%
<b>Office Space</b>	85%	15%	20%	80%
<b>Retail</b>	65%	35%	50%	50%
<b>Hotels</b>	60%	40%	55%	45%

### Modal Split

The modal split (i.e. the mode of transport) used in the Sandton Integrated Transport Masterplan (ARUP , 2015) for the Sandton Metropolitan Node in Johannesburg and data from the most recent National Household Travel Survey (NHTS) (DoT, 2013) are relevant to the Rosebank node.

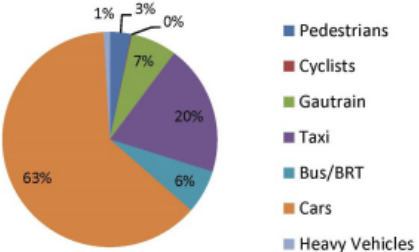
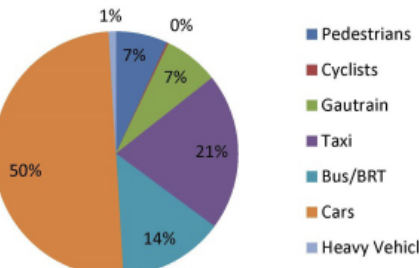
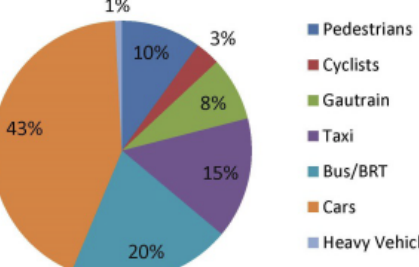
The NHTS was conducted in 2013 to better understand the travelling habits of households around the country. The survey shows the current modal split in Rosebank as follows: 64% of travellers make use of private vehicles, 5% make use of busses, 13% use taxis, 1% use the train, and 12% travel by NMT (appendix 4). Most of the private vehicle trips are single occupant trips.

Table 5 indicates three scenarios for influencing the modal split identified in the Sandton Integrated Transport Masterplan. These scenarios are:

- 1) Business as usual- current trajectory
- 2) Improved public transport
- 3) Desired urban form, liveable accessible node

The modal split applicable to each of these scenarios shows that the use of cars decreases as the transit and NMT provision increases.

Table 5: Target Modal Split for Sandton Node (ARUP , 2015)

Scenario	Target Modal Split	Interventions																
<p><b>1. Business as usual – current trajectory</b></p>	 <table border="1"> <caption>Modal Split Data for Scenario 1</caption> <thead> <tr> <th>Mode</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Cars</td> <td>63%</td> </tr> <tr> <td>Taxi</td> <td>20%</td> </tr> <tr> <td>Bus/BRT</td> <td>6%</td> </tr> <tr> <td>Heavy Vehicles</td> <td>1%</td> </tr> <tr> <td>Pedestrians</td> <td>7%</td> </tr> <tr> <td>Cyclists</td> <td>3%</td> </tr> <tr> <td>Gautrain</td> <td>0%</td> </tr> </tbody> </table>	Mode	Percentage	Cars	63%	Taxi	20%	Bus/BRT	6%	Heavy Vehicles	1%	Pedestrians	7%	Cyclists	3%	Gautrain	0%	<p>BRT services introduced, pressure for commercial development in core continues, reliance on private cars, provision and allocation of road space for private cars continues</p>
Mode	Percentage																	
Cars	63%																	
Taxi	20%																	
Bus/BRT	6%																	
Heavy Vehicles	1%																	
Pedestrians	7%																	
Cyclists	3%																	
Gautrain	0%																	
<p><b>2. Improved public transport</b></p>	 <table border="1"> <caption>Modal Split Data for Scenario 2</caption> <thead> <tr> <th>Mode</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Cars</td> <td>50%</td> </tr> <tr> <td>Taxi</td> <td>21%</td> </tr> <tr> <td>Bus/BRT</td> <td>14%</td> </tr> <tr> <td>Heavy Vehicles</td> <td>1%</td> </tr> <tr> <td>Pedestrians</td> <td>7%</td> </tr> <tr> <td>Cyclists</td> <td>7%</td> </tr> <tr> <td>Gautrain</td> <td>0%</td> </tr> </tbody> </table>	Mode	Percentage	Cars	50%	Taxi	21%	Bus/BRT	14%	Heavy Vehicles	1%	Pedestrians	7%	Cyclists	7%	Gautrain	0%	<p>Infill frequent bus services introduced, park and ride facilities, HOV lanes, public transport priority</p>
Mode	Percentage																	
Cars	50%																	
Taxi	21%																	
Bus/BRT	14%																	
Heavy Vehicles	1%																	
Pedestrians	7%																	
Cyclists	7%																	
Gautrain	0%																	
<p><b>3. Desired urban form, livable accessible node</b></p> <p>✓</p>	 <table border="1"> <caption>Modal Split Data for Scenario 3</caption> <thead> <tr> <th>Mode</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Cars</td> <td>43%</td> </tr> <tr> <td>Taxi</td> <td>15%</td> </tr> <tr> <td>Bus/BRT</td> <td>20%</td> </tr> <tr> <td>Heavy Vehicles</td> <td>1%</td> </tr> <tr> <td>Pedestrians</td> <td>10%</td> </tr> <tr> <td>Cyclists</td> <td>3%</td> </tr> <tr> <td>Gautrain</td> <td>8%</td> </tr> </tbody> </table>	Mode	Percentage	Cars	43%	Taxi	15%	Bus/BRT	20%	Heavy Vehicles	1%	Pedestrians	10%	Cyclists	3%	Gautrain	8%	<p>Liveable accessible node, integrated transport, residential densification along pt corridors promoted, permeable pedestrian network, clear public transport corridors, strategic cycle corridors connected to core, street space reallocated for nmt, connected green spaces, integrated PT services, ticketing and information</p>
Mode	Percentage																	
Cars	43%																	
Taxi	15%																	
Bus/BRT	20%																	
Heavy Vehicles	1%																	
Pedestrians	10%																	
Cyclists	3%																	
Gautrain	8%																	

### 2.6.3) Parking supply as a tool

Manipulating parking availability through policy, incentives, design and availability of public transport would appear to be strategies that could influence car ownership, car travel, the demographics of households likely to live in the affected area, and the attractiveness of the area for business activity.

This view is confirmed in the paper: “Effects of TOD on Housing, Parking and Travel” (2008), where Cervero showed that parking supply can be used as a tool to control the demand for private vehicle travel. This paper found, among other things, that trip generation begins to fall as density in the area increases and parking supply is reduced.

Litman (2006) indicates that supplying too much parking will be as harmful as supplying too little. As Litman illustrates in his Cycle of Automobile Dependency illustration (Figure 4), generous parking supply is a part of the cycle that leads to automobile dependency. The parking supply in combination with parking management is the only way to get parking “right”.

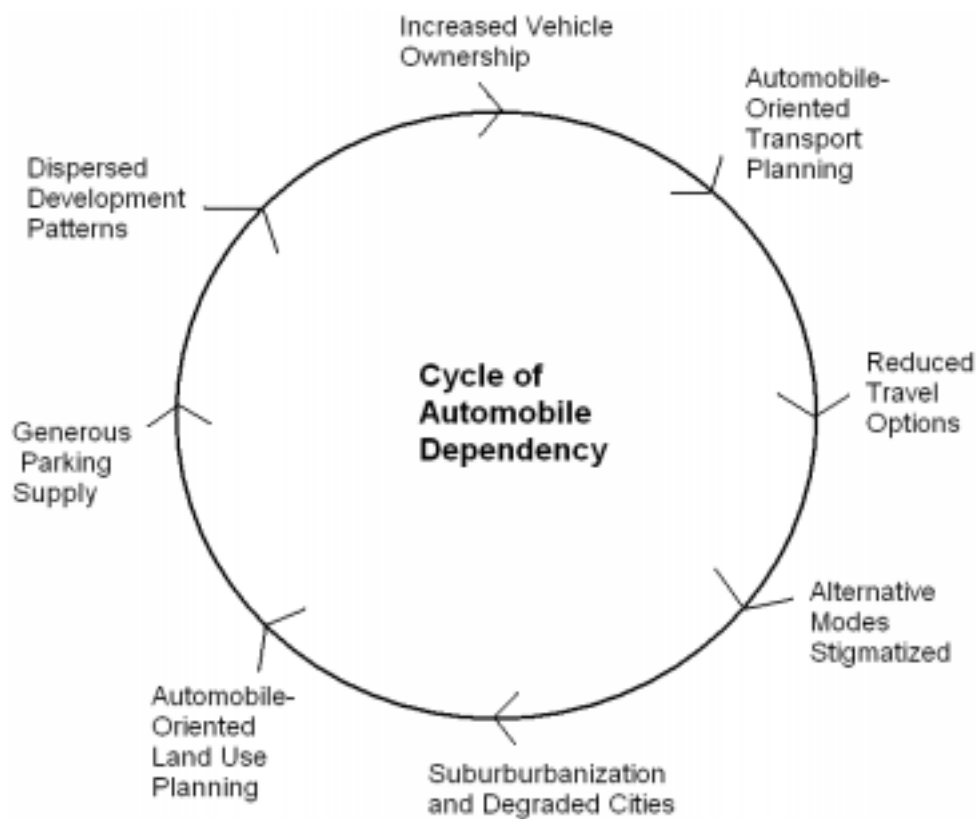


Figure 4: Cycle of Automobile Dependency (Litman (2006))

It is also held to influence public transport ridership, affordable housing and land conservation (Cervero, Adkins, & Sulliva, 2009).

The control of parking supply, if used in conjunction with other tools and policies, can have the following TOD benefits:

#### Lower construction costs and financially feasible TODs:

The construction cost of buildings and dwelling units generally includes the costs of the parking bay construction. This additional cost impacts the planning, rezoning and developing of TODs, and decreasing the number of parking bays will bring about lower construction costs, better return on investments and lower dwelling unit costs. Garland Stewart, C.P.E Manager, observed that a lower ratio of parking per dwelling unit would reduce the construction cost per additional unit (Cervero, 2008).

The economic viability of TOD is dependent on the construction costs associated with its development, and reducing the number of parking bays provided will boost the return on investments for public and private developers and improve the appeal to investors. In the study by Cervero (2008) he showed that the parking capital costs play a significant role in the affordability of housing and construction costs of TODs.

Other research indicating that costs of parking are bundled into the cost of development and therefore has the ability to increase the prices of all goods and services offered at these developments. (Shoup, 1999) That being said it is highly likely that the costs of parking are not necessarily being paid for by the people using the parking and the option to opt out of private vehicle use will have no parking costing incentive. Unbundling of parking is therefore necessary to help incentivise public and non-motorised transportation (NMT).

#### Increased densities

Lowering the parking ratio, as may be expected, will allow for a higher ratio of development-to-parking, making higher floor area ratios more attainable. Cervero (2008) found in his case studies that reducing the parking-to-dwelling unit ratio by 50% allowed for an additional 20-33% more dwelling units to be constructed.

### Urban form

The indirect impacts of lowering parking ratios include the way which private and public investors build and their response to the public realm, where greater pedestrian movement will need to be accommodated rather than the disproportionate use of public street space for private cars and on-street parking.

The planning and investment in the public realm should be far greater in areas accommodating pedestrians and aiming at TOD outcomes.

### Reduction of road traffic:

Reducing the parking supply for households, offices, retail and services in an area should result in less road traffic entering and exiting the given TOD.

This can be achieved by reducing the physical supply of parking bays, by increasing the cost of usage of parking bays, by managing the accessibility of the area to private vehicles, by attracting households seeking a less-car-dependent lifestyle to locate in the area, and by providing an adequate alternative to private vehicle travel (Litman, 2014).

### Transit ridership increases:

Assuming that the provided public transport has sufficient capacity, it is anticipated that the greater the dependency on public transport, the greater the chance that the public transport system will be financially sustainable.

Much of the thinking behind the Johannesburg nodes and corridors has to do with improving the ridership on the public transport facilities provided or being planned (CoJ, 2013). The theory is that the greater the number of households living in reasonable proximity to the facility, the higher the chance of better usage of the facility. The management of the factors that encourage car ownership and usage need to play a complementary role in achieving this outcome.

### Interactive and liveable community:

The shift to a higher density urban lifestyle should increase the number of people walking, cycling and using public transport. The shift in emphasis from a transitory gathering place to a higher density neighbourhood, together with the improvement and accessibility of the public

space within the node is thought likely to increase the amount of interaction of the community and improve the liveability of the area.

A further consideration is the demographics in the area of interest, where Cervero (2002) discovered that the demographics of people attracted to live in TODs were in general, beneficial to the area. The study found that increasing numbers of couples without children, single professionals, foreign immigrants and what they termed “empty nesters” (parents whose children have moved out of the house and they are seeking to downsize their living space) were moving into TODs. These demographic trends, coupled with increasing transit use, are conducive to low vehicle ownership and therefore decreased parking demand. This research highlighted the importance of the knowledge of the demographics of the area when considering altering the parking supply.

The relationship between parking, pedestrian circulation, and safety was studied by A. Sideris (1999) who concluded that the circulation of pedestrians is critical to the safety of the area. Areas allocated to uses that do not encourage the circulation of pedestrians, such as parking bays and lots, are liable to decrease the safety of the TOD.

#### Market appeal

It is commonly agreed in reports (Cervero, Adkins, & Sullivan, 2009) and (Shoup, 1999)) that the reduction of parking spaces will be of overall benefit to TOD projects; however, parking provision is also a marketing tool for private sector developments. Policy cannot be solely determined by the City, but must include private sector buy-in. Higgins (Higgins, 2007) established that collaboration between stakeholders is vital in the acceptance of parking strategies and pricing that deviated from conventional regulations, and he goes further in saying that if implementation of TOD parking policies that have not been accepted by all stakeholders takes place, sluggish and stymied execution will likely be the outcome. Successful implementation of parking policies will result from various trade-offs being negotiated by the different stakeholders.

#### **2.6.4) Potential problems with parking limitations**

As most TODs in the Johannesburg context, including Rosebank, are superimposed on existing developed areas, their planning requires an understanding of the local area and its dynamics, and appropriate supportive integrated public policies and interventions.

The traffic, transportation and parking components of the planning should be integral to the land use proposals, and measures instituted to ensure the desired outcomes for a successful TOD. Inadequacies in the information used to interpret the functioning of the proposed TOD, the need to deal with and integrate numerous individual property developments, and the absence of a clear forward plan to manage, monitor and regulate developments to achieve the desired goals can lead to a disjuncture between planning and implementation. Some of these are suggested below:

#### Worsening traffic flows

As discussed earlier in the “travel behaviour change” section, the problems associated with calculating the utility of different modes of transport as well as habitual travel behaviour leads to reluctance in the changing of transport modes from private vehicles to public transport. Therefore, the reduction of parking supply without the increased availability and use of public transport or behavioural change can lead to the worsening of traffic conditions, overloading of parking areas, and increased circulation of vehicles seeking parking. (Shoup, 1995)

#### Promoting competing locations

TODs are part of a wider urban area and must compete with alternative locations for investment and development. Differing land use and parking regulations between competing areas will impact development decisions. This situation arose in Johannesburg, where parking zones were introduced in the mid-to-late 1970's, with minimal parking allowed in the CBD and "full" parking allowed outside the CBD. The effect, notwithstanding the competitive edge the CBD enjoyed over suburban locations in respect of public transportation, was to discourage further investment in the CBD and contribute to its general downgrading which remains evident today. (Ehrlich, Steele, & Zimble, 2015)

Absence of adequate financing mechanisms for development within TODs will leave other suburban locations with the competitive advantage (Ehrlich, Steele, & Zimble, 2015). This would result in already-apparent suburban office and retail development spread, further worsening low-density sprawl and associated unsustainable traffic patterns.

### Adequate transportation alternatives

If parking supply is to be decreased in an area it is important for there to be existing reliable, safe, and sufficient alternative public transport modes in place. The transition from car dependency to public transport dependency needs to be managed, and the inclination in the Johannesburg nodes has been to both require (the City Council) and provide (the developers) a full quantum of parking, notwithstanding the TOD intentions in many nodes and corridors. This raises the question about the impact of such excess parking provision on the TOD, and whether the parking facilities, particularly in structures, could possibly be refitted to serve an alternative function if no longer needed.

These matters have not been resolved as yet, as the parking and traffic planning has not been integral to the densification in some of the major Johannesburg TOD nodes served by the Gautrain, such as Sandton and Rosebank. This was found to be a fairly common experience in American TODs where the report “Getting the Parking Right: Transit Oriented Developments”, (Zhang, Mulholland, Zhang, & Gomez-Sanchez, 2012), found that most developers depend on established parking (suburban) regulations when calculating parking requirements for TODs. Adhering to unadapt parking regulations can result in the oversupply of parking in TODs, a failure to address the role of parking in TODs (MTC , 2007), and a reduction in the potential for attaining the multiple benefits of TODs (Willson, 2005).

### **2.6.5) Good practices for parking regulation**

Zhang, et al. created a matrix which they believe reflects the best possible TOD parking practices (Zhang, Mulholland, Zhang, & Gomez-Sanchez, 2012).

In summary, they suggest the following:

#### Parking Reductions:

The authors’ travel study (a study of travel in 17 TODs in New Jersey, Portland Oregon, Washington D.C, San Francisco) indicated that the ITE vehicle trip generation rates may overestimate parking requirements by up to 50%, which leads to advising for a reduction in parking provision rates by 20-50% in areas with adequate-to-good public transportation (Arrington & Cervero, 2008).

Parking deregulation may lead to developers assessing parking demand and providing market-priced parking to meet this local demand. Shared (“bundled”) parking should be utilised to accommodate peaks.

#### Design:

The design of parking should be based on the prioritisation of pedestrians as this is an important component of the design (i.e. separating parking from roads, and roads from pedestrians). Shared parking should be incorporated in the design as this could potentially reduce the demand and stagger the peak times requiring fewer bays (ITDP, 2014).

#### Location:

Parking facilities should be situated away from transit stations; it is suggested that they should be a 5-7 minute walk (Zhang, Mulholland, Zhang, & Gomez-Sanchez, 2012) so they are also out of sight; alternatively, a park-and-ride is required if the station is out of walking range. Offices are important in attracting work trips to transit modes and therefore these should be within a 200m walking distance from the station. It is suggested that retail and residential uses would also benefit from proximity to the station.

#### Management:

Parking should be managed using adequate parking databases to understand and influence the parking policies and their impacts.

#### Pricing:

Manipulation of the parking price can be used to increase monitoring and enforcement as well as increase transit use, whereas free parking encourages behaviour contrary to the goals of TODs (Shoup, 1995).

## **2.7) Chapter Conclusion**

This chapter set out to review the available literature in order to establish a base of information against which the Rosebank TOD could be compared later in this dissertation. The main questions that have been answered are the nature of the TOD concept and its relevant good

practices, the barriers to TODs, the relevant travel behaviour change theories, the relevance of parking policies in TODs, and how parking policies and regulation can contribute to a better balance between private car usage, NMT and public transportation.

The definitions given of TODs all have similarities concerning the concepts of promoting high density and mixed-use developments in close proximity to a transit station with a transit-friendly design. They require supportive market conditions, public transport commitment, strong local leadership, and supportive public policies to be effective in combatting sprawl and encouraging sustainable developmental growth.

The eight barriers to TOD success identified by Suzuki (2013) suggest that there are significant aspects requiring attention in the Rosebank node. Importantly for the purposes of this report the indication is that parking policy and TOD outcomes must be viewed together. Failure to address parking issues will result in the supply of parking in quantities not supportive of TOD goals.

TDM measures are dependent on the nature of travel behaviour. Understanding travel behaviour is vital when pursuing incentives, education and marketing to alter it. Using parking management and supply as a TDM measure will have an effect on modal choice, but if other TDM measures have an effect on travel behaviour this will affect parking demand.

It is apparent that the case study should consider the current political commitment by the City of Johannesburg to public transit as this has been found to be essential to the accessibility of TODs, where the high density of developments depend on high public transport ridership and this needs to be reflected in policies and practices. Parking policy is a tool that can be used for the encouragement of public transit ridership and if used effectively can have a big influence on the overall accessibility of the TOD area.

The need for TOD alternatives to standard parking regulations is clear throughout the literature review, most noticeably in a study conducted by the California Department of Transport which found an average parking supply reduction of 35% for retail, 15% for commercial, and 32% for office space applicable in TODs around North America.

The influence of parking supply in these proposed TOD areas is apparent in the cost of development, liveability, accessibility, road congestion, and safety. There is a balance between parking supply and demand that needs to be considered as the undersupply of parking leads to issues such as worsening of traffic flow and involuntary promotion of competing areas.

Parking reductions, design, location, management, and pricing are all aspects which need to be carefully considered and tailored to the TOD area for best use of parking supply as an influential behavioural tool promoting the use of public transport and high densities as needed in the Rosebank TOD.

The success of TODs is reliant on a number of different aspects, and using all the information gathered in this chapter it is possible to analyse the Rosebank node to address the mismatches and assess the potential success of the TOD. The densities, mixed land-uses and public transport infrastructure are all necessary. TDM measures, specifically parking management, also need to be utilised.

The next chapter will look at the case study research method. It will first explain why Rosebank will be used as a case study, explain how the information and data to be used was collected, and then explain the statistical procedure of analysing the data.

### **3) Case Study Research Method**

#### **3.1) Introduction**

The purpose of this chapter is to analyse the Rosebank Urban Development Framework (RUDF) and consider the proposed City of Johannesburg plans to convert the Rosebank node into a TOD. By quantifying the literal interpretation of the land use and densification proposals in the approved spatial development framework for this node, the impracticality of pursuing the current practice of applying the standard parking regulations in order to attain the vision of a less private-car-dependent lifestyle within the live-and-work environment of a TOD is highlighted, and suggests that without integrating parking policy into the planning strategy, the likelihood is that the vision will fail.

The chapter describes the research methodology of the study, explains why Rosebank is being used as the case study, describes where the data and information was collected and provides an explanation of the statistical procedure of analysing the data.

#### **3.2) Research Process**

The methodology adopted to research the TOD in Rosebank was to summarise the RUDF for Management District 2, the core of the Rosebank regional node. This serves as the basis of the analysis and provides some of the data that is required for the quantification process later on.

The next step proposes indicators of success/progress towards TOD in general, and in relation to the public transport aspects and traffic management aspects in particular.

The quantification and analysis of the densification proposals in the RUDF follow the changes that have occurred since the RUDF inception in 2008. This quantification considers the traffic and related studies underpinning the spatial development framework, including the assumptions on the political commitment, institutional capacity, and the like before assessing the findings against the indicators highlighting the shortcomings, and making proposals on the necessary changes to the implementation practices.

### 3.3) Case Study Selection

TODs are aimed at achieving economic, social and environmental benefits through compact forms of development supported by public transport facilities. As the current city spatial form is considered unsustainable, this has given rise to new legal planning tools to effect a different development strategy and urban form.

The most recent legislation on spatial planning and management (the Spatial Land Use Management Act of 2013) has introduced a normative backdrop to guide the land use decision-making towards a more compact and efficient city through, in Johannesburg's case, a polycentric model involving "nodes" and "corridors of freedom".

Rosebank, and more specifically the Rosebank regional node (RUDF Management District 2), has been identified as a node in the Spatial Development Framework (2010/11), as it possesses characteristics such as a mixed land use, public transport-backed access, relatively high density, etc. Figure 5 shows the Gautrain Rail line running through Gauteng with the Rosebank station having a central location relative to Johannesburg, and being the second station from the CBD (Park station being the closest). The two nodal areas in Johannesburg currently showing the closest signs of TOD characteristics are the Rosebank regional node and the Sandton metropolitan node. The RUDF (2008) is based on TOD principles, and there has been a history of implementation and clear parking policy direction, which led to its selection as the case study through which suggestions for policy changes could be explored.

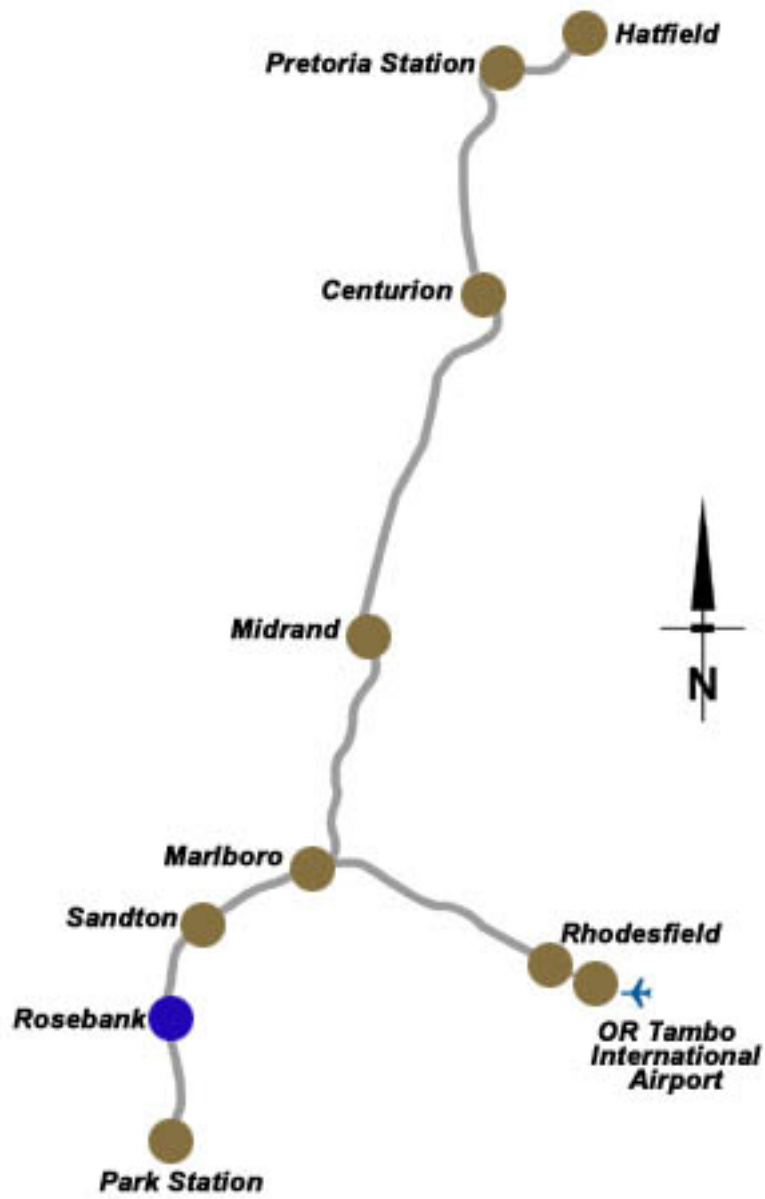


Figure 5: Gautrain Rail Link ([www.gautrain.co.za](http://www.gautrain.co.za). (2016))

### **3.4) Collection of Data**

The main quantitative data sources used in this dissertation are:

- Rosebank Traffic and Transport Study (GIBB, 2011), that provides information on the road network;
- Rosebank Urban Development Framework (Akanya, Karabo, Studiomas, 2008), that provides the land use data for the trip generation factors applied as well as the parking supply; and
- National Household Travel Survey (DoT, 2013) specific to the Rosebank Area (TAZCODE: 3027), that provides the data was used in the calculation of the modal split in the area.

### **3.5) Method of Analysis**

The method of analysis consists of an analysis of the RUDF (Rosebank Urban Development Framework, 2008) against the good practices (supportive market conditions, transit backing commitment, strong local leadership and supportive policies and tools) put forward in the literature review as well as a quantification of the proposed land use plans.

The quantification of the development proposed in the RUDF needs to be compared to realistic capacities and standards. The road network capacity within the Rosebank TOD was established by checking the road classifications leading into and out of the TOD, the number of lanes on each road, and the road classification capacities according to the South African Trip Data Manual (COTO, 2013).

Thereafter, the future trip generation was compared to the capacity. The future trip generation is dependent on the type of land uses, floor area, coverage, number of permitted storeys per zone, dwelling unit density, parking supply, modal split, and directional split. The modal split was calculated with data from the National Household Travel Survey (DoT, 2013) in combination with the Sandton Integrated Transport Masterplan (ARUP , 2015), and was applied to the trip generation to calculate future road network demand.

The number of parking bays to be supplied was calculated according to the minimum on-site parking requirements of the Johannesburg Town Planning Scheme, (1979), for each land use type and area. The space allocation for these parking bays is according to the Johannesburg Road Agency (JRA, 2015) standards.

### **3.6) Chapter Conclusion**

The purpose of this chapter was to describe the research method of this study, explain why Rosebank node was chosen as the case study, describe where the secondary data used in the study was collected from, and the method of analysis using the literature review as the base of good practices.

The Rosebank node was identified as a case study suitable for comparing successful TODs to the current densification plans in the RUDF due to characteristics such as mixed land use, high densities, central location and public transport backing. Data collected from the Rosebank Traffic and Transport Study, the RUDF and the National Household Travel Survey will be used to quantify the proposed plans for capacity comparisons.

The next chapter will analyse the Rosebank node to see whether the plans proposed in the RUDF are achievable considering the current policies and practices.

## **4) Case Study of the Rosebank Regional Node**

### **4.1) Introduction**

As alluded to in the previous chapters, the movement of people within Johannesburg has been the focus of municipal attention for a number of years as the congestion levels continue to rise, hindering the development of the City. As a result of the new legal planning tools put in place to counter the congestion and sparse urban form, the densification of the Rosebank Regional Node has been identified as a priority area.

The aim of this chapter is to analyse the Rosebank area and more specifically the Rosebank node which has been identified as a regional node in the polycentric model proposed in the current update of the City of Johannesburg Spatial Development Framework, 2016, to see whether the plans proposed in the RUDF are achievable considering the current policies and practices. The analysis will focus on the current and planned land use, public transport, accessibility, road network and transport demand management (TDM) measures (primarily parking supply) as identified in the RUDF (Rosebank Urban Development Framework, 2008).

The plans proposed in the RUDF (Rosebank Urban Development Framework, 2008) will then be quantified with the use of the research completed in the literature review chapter and compared to realistic expectations of the area and road network to see whether the plans are achievable.

### **4.2) Status Quo**

#### **4.2.1) Study area**

Rosebank is identified as a Regional Node in the Johannesburg City Council's Spatial Development Framework, (CoJ, 2011), and will be retained in the new polycentric model proposed in the current update of the Spatial Development Framework, 2016. It has had this status for the better part of a decade, more specifically since the approval of the RUDF in 2008

as part of the Spatial Development Framework component of the Integrated Development Plan for Johannesburg prepared in terms of the Municipal Systems Act, 2000.

Although the Regional Node's boundaries are roughly defined by an 800m walking zone from the Rosebank Gautrain Station, situated on Oxford Road at its intersection with Baker Street, the focus of this study is primarily on the so-called Rosebank Box that falls within the area defined by Oxford Road, Jellicoe Avenue, Jan Smuts Avenue and Bolton Road (M20). (Figure 6)

The City's recognition of Rosebank as a Regional Node derives from its historical regional accessibility from major roads, its existing mixed-use character, its potential for densification, and its proximity to the Rosebank Gautrain Station.

#### **4.2.2) Rosebank Urban Development Framework, 2008**

The City Council's expectations of the Rosebank Gautrain Station (and the intended complementary municipal bus rapid transit service along Oxford Road) to transform transportation patterns, coupled with its desire to promote a more compact and efficient urban form resulted in the preparation of the Rosebank Urban Development Framework (RUDF).

The objectives of the RUDF are as follows:

- “Define and delineate the nodal area
- Support an efficient movement system
- Develop appropriate urban form, land use and urban design guidelines
- Manage and monitor infrastructure and services provision, and
- Develop a monitoring and evaluation system.” (RUDF, p89).

Importantly, the RUDF (RUDF, p91) seeks to create “a cohesive entity”. The general intentions indicate that the objectives are those of a Transit Oriented Development or TOD.

#### **4.2.2.1) RUDF Proposals**

The key overall RUDF plan for the proposed future land uses and densities is called “Proposed Predominant Land Use” (Akanya, Karabo, Studiomas, 2008). This demarcates four Management Districts in the node that covers roughly 400 hectares.

The focus of this case study is Management District 2 (Figure 6) which coincides with the Rosebank Box described earlier. The main roads are clearly depicted with Oxford Road on the eastern edge, Jellicoe Avenue on the northern edge, Jan Smuts Avenue on the western edge, and Bolton Road (M20) on the southern edge. The Gautrain Station is incorrectly mapped, but lies at the corner of Bath Street and Oxford Road.

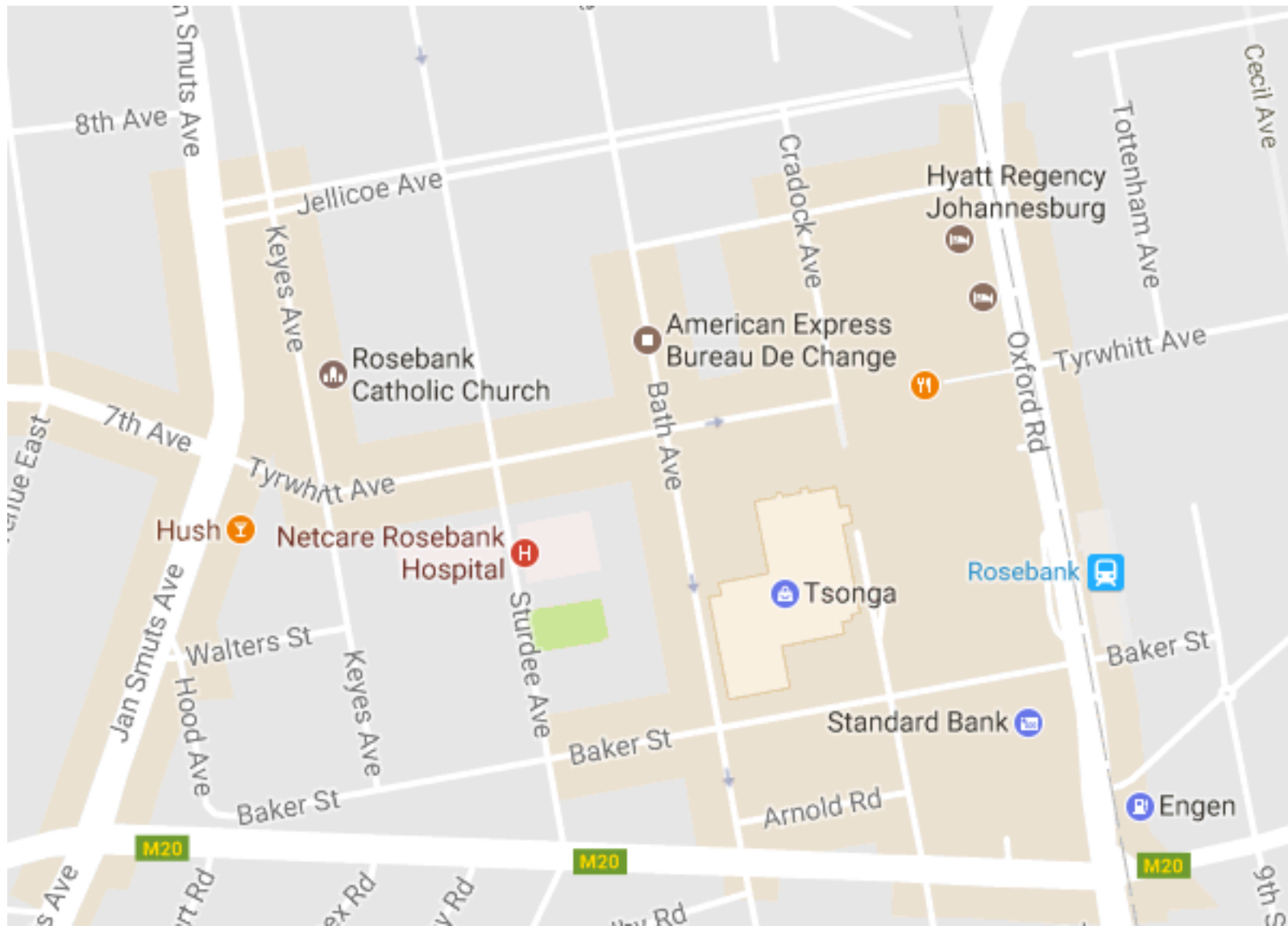


Figure 6: Rosebank Node Proposed Predominant Land Use Proposal (Google Maps, 2016)

In brief, the RUDF contains proposals for land use regulation and City development initiatives to support the intensified land use rights.

Land use regulation:

The RUDF land use regulatory considerations (i.e. what must inform land use zoning decisions) are addressed in the following categories:

#### Design Guidelines and Principles

The following are stipulated as considerations relevant to densification:

- The importance of sidewalks and pedestrian movement, as well as the need for proper design, street furniture and maintenance.
- The identification and protection of historical buildings.
- The management of overlooking and protection of privacy between higher and lower intensity uses
- The importance of landscaping as a device for mitigating impacts, and various visual and functional applications.
- The promotion of safety and security through design, and
- The design of the road interface with the public street and the importance of accommodating the pedestrian as a “critical consideration in any given development.”

#### Development Controls

The following development/zoning controls are proposed:

##### Height:

- Area 2B defined by Jan Smuts Avenue, Bolton Road, Fourth Avenue, Cradock Avenue and Jellicoe Avenue: 8-10 storeys.
- Area 2C between Tyrwhitt, Oxford, Bolton, and Fourth Avenue: 10-15 storeys.

### Land Use and Density:

The district has a variety of land uses:

- High-density residential is proposed in the area defined by Rosebank Road, Keyes Avenue, Jellicoe Avenue, and Cradock Avenue, as well as the area to the west of Bath Street until Tyrwhitt Avenue (outside study area).
- Furthermore, the area along Tyrwhitt Avenue between Keyes Avenue and Fourth Avenue is also for high-density residential use.
- Offices are proposed in the area defined by Rosebank Road, Keyes Avenue, Jan Smuts Avenue, and Chester Road west of Jan Smuts Avenue.
- The rest of the district, defined by Rosebank Road, Oxford Road, Bolton Road, Jan Smuts Avenue, Jellicoe Avenue, and Cradock Avenue is proposed for high intensity mixed use with a mix of 70% non-residential and 30% residential as a guideline.

With regard to density:

- The area between Rosebank Road, Cradock Avenue, Jellicoe Avenue east of Jan Smuts Avenue, and the part west of Jan Smuts Avenue between Eighth Avenue and Chester Street: 70-90 du/ha (outside study area).
- The area defined by Jellicoe Avenue, Cradock Avenue, Fourth Avenue, Bolton Street, Jan Smuts Avenue as well as the area defined by Baker Street, Oxford Road, the southern side of Glenhove Avenue and Tottenham Avenue: 95-110 du/ha.
- The area between Tyrwhitt Avenue, Fourth Avenue, Bolton Road, and Oxford Road: 100-120 du/ha.
- The area defined by Rosebank Road, Jellicoe Avenue, Tottenham Avenue, Tyrwhitt Avenue, and Cradock Road: 120-250 du/ha.

### Coverage (i.e. building footprint):

50% for Residential and 70% for Commercial/Offices

### Building Lines:

The standard building lines in the Johannesburg Town Planning Scheme (1979) apply (i.e. 6m on street frontages).

### Parking Provision:

The proposal is to provide the normal on-site parking ratios (e.g. 1.3 bays per small dwelling unit, 2,3 bays per larger dwelling unit, 4 bays per 100m<sup>2</sup> office floor area, 6 bays per 100m<sup>2</sup> retail floor area, etc.) as contained in the Johannesburg Town Planning Scheme (1979).

### Landscaping:

On-site landscaping is required.

### City development initiatives

The roll-out and phasing of new development proposed in the RUDF is linked to:

- The adequacy of water, sewer, electricity, roads and walkways;
- Adequate urban management; and
- A detailed design and development plan for Oxford Road and the areas abutting directly onto that road (RUDF, p136).

RUDF details the timeframes and development responsibilities for the main City Council interventions in the node. These include: (Akanya, Karabo, Studiomas, 2008, p. 166)

- Transportation interventions
  - The preparation of a Roads Master Plan;
  - The preparation of an Oxford Road upgrade plan;
- Infrastructure and services interventions
  - The preparation of a detailed infrastructure assessment and upgrading plan for water, electricity and sanitation.
- Urban management interventions
  - The coordination of service provision and maintenance issues, based on audits of existing municipal assets and facilities.
- Environmental interventions
  - The retention of existing trees and the design of appropriate landscaping to improve the streetscape.

- Community facility interventions
  - The upgrading of parks, the police station, the fire station and the library.
- Institutional interventions
  - The establishment of an Assessment and Evaluation Committee to assess proposals;
  - The involvement of all stakeholders; and
  - The development of a monitoring system to assess the health of the node.

### **4.2.3) Analysis of RUDF for Management District 2**

#### **4.2.3.1) Current Land use in Rosebank Box**

The study area consists of a variety of mixed land uses as depicted in Appendix 3.

Most retail takes place on the eastern half of the Rosebank Box, alongside Oxford Road that originally allowed for vehicle access from Oxford Road (**Error! Reference source not found.**). The retail malls within the Box consist of The Zone, the Mall, Rosebank Mews, and The Firs. Most public parking is in close proximity to the retail land uses as dictated by the demand and the town planning scheme requirement for on-site parking provision in suburban areas.

Figure 7 shows land that has been used for public open space, while Figure 8 shows land that has been used for healthcare facilities. The newly built standard bank building illustrated in Figure 9 shows the type of high densities commercial development being encouraged in the area.

Offices are mainly along the more accessible and visible edges of the Box, namely along Oxford and Bolton Roads, and Jan Smuts and Jellicoe Avenues Hotels and residential buildings are largely in the middle of the Box, alongside the institutional buildings (Appendix 3). Most of the residential buildings are 3-4 storey apartment blocks. The approximate floor area and land use mix at the time of the preparation of the RUDF is given as:

**Table 6: Current Land Use**

<b>Land Use</b>	
<b>Office Floor Area</b>	240 504m <sup>2</sup>
<b>Retail Floor Area</b>	73 762m <sup>2</sup>
<b>Dwelling Units</b>	980



Figure 6: Rosebank Shopping Mall



Figure 7: Rosebank Park



**Figure 8: Netcare Rosebank Hospital**



**Figure 9: Standard Bank Office**

#### 4.2.4) Traffic Movement in Rosebank

This sub-section and the next focus on the factors that directly affect the traffic movement in the Rosebank box. These factors include the road network, the condition of the road network and pedestrian facilities, the public transport facilities, the volumes and composition of traffic on the road network, the provision made for alternative forms of non-motorised traffic, and the parking availability.

The most recent traffic counts in the area will be compared against the road networks capacity to check if the traffic moves freely in the peak periods, the public transport and non-motorised transport in the area will be analysed, and the parking supplied in the area will be considered.

##### 4.2.4.1) The Road Network

The road network provides the lifeblood to the Node, and its condition and capacity is critical to the future success of the Node, even with alternative options for public transport and NMT in the area.

##### Road Hierarchy

The road hierarchy is classified by the CoJ into six different categories/class each with a different primary function and with related restrictions and limitations as depicted in Table 7. Oxford Road, Bolton Road and Jan Smuts Avenue are class 2 regional distributors, while Jellicoe Avenue and Baker Street are class 3 district distributors. The internal roads are generally class 4 local distributors, and there are some pedestrian malls including parts of Tyrwhitt and Cradock Avenues.

<b>Legend</b>	
	Not required, or poor performance is acceptable (low quality or no facilities, high travel delay)
	Accommodated with variable standards (average quality facilities, average travel delay)
	Accommodated with high standards (high quality facilities, low travel delay)

**Table 7: Road Classifications (CoJ, 2010)**

RIFSA Classification	Complete Streets Considerations	New Typology	Pedestrians	Bicycles	Public Transport	Motor Vehicles	Goods Vehicles	Emergency Vehicles
Class 1	The primary function is high mobility, hence complete streets principles are applicable primarily in ensuring adequate provision of grade separated crossings for pedestrians and cyclists	Motorway / Primary Distributor	Red	Red	Yellow	Green	Green	Green
Class 2	<p>This class of road represents major arterials and have historically catered for need of motorised travel. In the context of Complete Streets, the following needs to be taken into account:</p> <ul style="list-style-type: none"> <li>• These routes are the most direct linkages between home and work centres, hence cyclist are prone to use these routes. Consider providing Class 2 cycling facilities;</li> <li>• Some of these roads have low income residential settlements adjacent to them, hence special attention needs to be provided to pedestrian facilities and access to public transport stops;</li> </ul> <p>Where these roads form part of the Strategic Public Transport network, public transport modes need to be given priority.</p>	Arterial / Regional Distributor	Yellow	Yellow	Green	Green	Green	Green
		BRT Trunk Route	Yellow	Yellow	Green	Yellow	Yellow	Green
Class 3	Special care needs to be taken in separating motorised vehicles and pedestrians. Class 3 cycling facilities are appropriate.	District Distributor	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Class 4	<p>Due to high number of pedestrians along these roads, Class 3 cycling facilities are more appropriate.</p> <p>In CBD areas:</p> <ul style="list-style-type: none"> <li>• On-street parking is important, hence special care needs to be taken when providing cycling facilities adjacent to on-street parking.</li> <li>• Minimum sidewalk width in not appropriate due to high numbers of pedestrians and presence of other activities on the verge.</li> </ul> <p>In industrial areas</p> <p>Curb radii need to accommodate heavy vehicle turning movements, hence the presence of long crossing paths at intersections may not be avoidable.</p>	CBD Road / Activity Street / Local Distributor	Green	Green	Green	Yellow	Yellow	Green
		Industrial Road	Green	Yellow	Yellow	Yellow	Green	Green
Class 5	Speed reduction measures should be used to keep speeds within acceptable levels for the safe movement of pedestrians and cyclists.	Residential Collector	Green	Green	Yellow	Yellow	Yellow	Green
		Residential Street	Green	Green	Yellow	Yellow	Red	Green
Class 6	Motorised vehicles are not permitted except for emergency vehicles in an emergency situation. Class 1 bicycle facilities to be provided.	NMT Route / Greenway	Green	Green	Red	Red	Red	Green

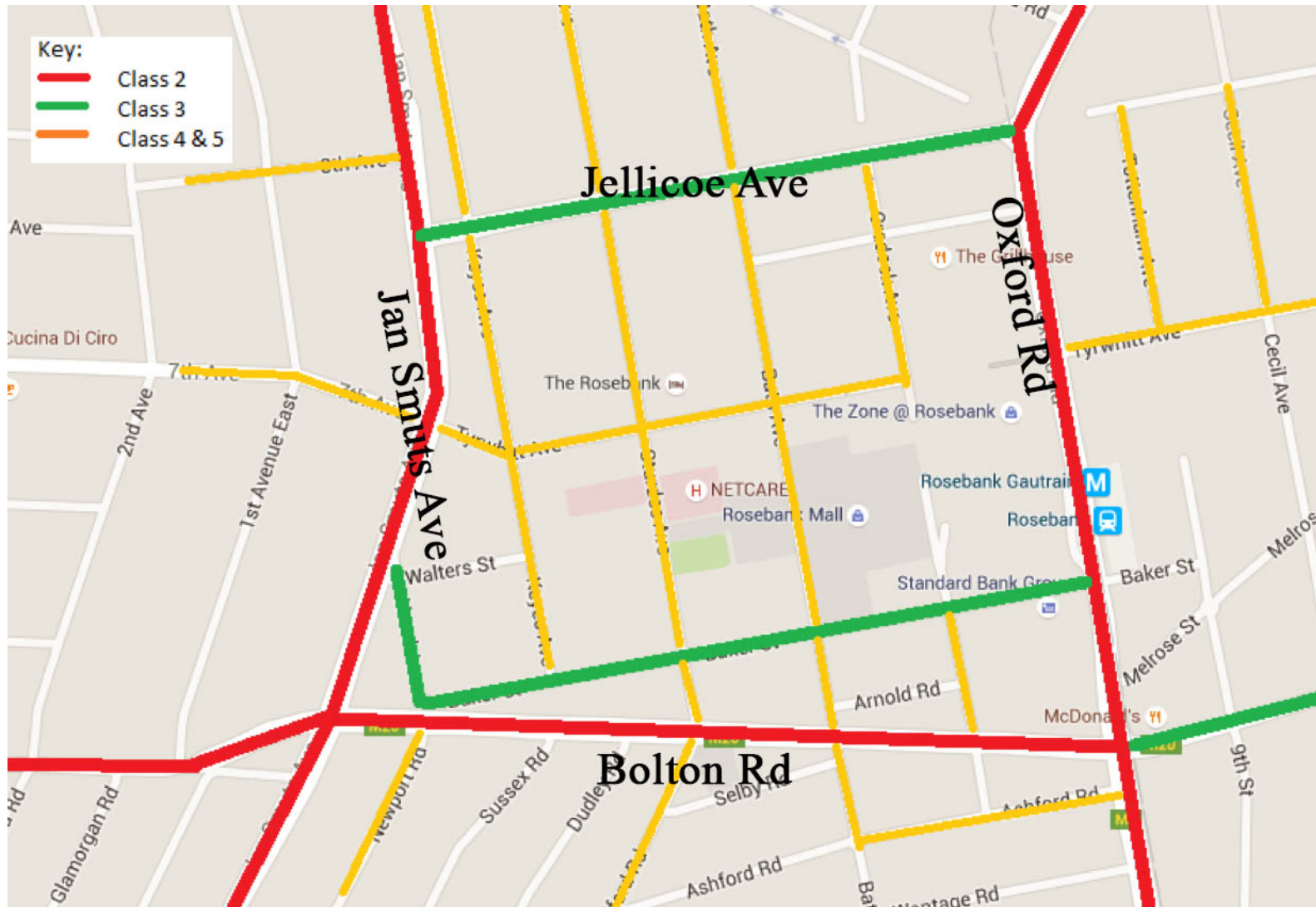


Figure 10: Road Classifications

## Road Capacity

The flow of traffic is defined by the University of Idaho in the following words: “Flow is the rate at which vehicles pass a given point on the roadway, and is normally given in terms of vehicles per hour.” (UIDHAO, 2013)

The traffic flow rates and road capacities are expressed in terms of vehicles per hour per lane. Capacities of roads are determined by the number of lanes, the speed limits, whether there is on-street parking, and a number of other factors. These factors have been included in the road classifications and therefore the capacities of lanes are linked to the road classification.

The Department of Public Transport and Roads summarises the capacities of the different road classes/types as shown in Table 8.

Table 8: Road Type Capacities Summary (DoT, 1996)

ROAD TYPE	AREA TYPE	PREVIOUS VALUES		NEW VALUES	
		FREE FLOW SPEED (km/h)	CAPACITY (vphpl)	FREE FLOW SPEED (km/h)	CAPACITY (vphpl)
1 (freeway)	rural	120	1 540	120	1 820
	suburban	120	1 390	120	1 900
	urban/cbd	120	1 390	110	1 900
2 (dual carriageway)	rural	100	1 440	100	1 240
	suburban	100	1 190	75	1 010
	urban/cbd	100	1 000	65	880
3 (multi-lane undivided)	rural	100	1 370	95	1 180
	suburban	100	1 060	70	920
	urban/cbd	100	950	65	800
4 (one carriageway of freeway)	rural	100	710	110	1 110
	suburban	100	710	110	1 110
	urban/cbd	100	710	100	1 110
5 (provincial road with surfaced shoulders)	rural	80	750	100	920
	suburban	80	750	70	770
	urban/cbd	80	750	60	680
6 (provincial road gravel shoulders)	rural	100	660	95	860
	suburban	100	660	70	640
7 (major roads and streets)	suburban	70	920	65	770
	urban/cbd	70	920	55	680
8 (streets)	suburban	60	560	55	600
	urban/cbd	60	560	45	520
9 (centroid connectors)	rural	100	-	80	-
	suburban	60	-	55	-
	urban/cbd	60	-	40	-

The class 2 roads in the Rosebank Box have free flow speeds of 75km/h and a capacity of 1010 vehicles per hour per lane, while the class 3 roads in the area have free flow speeds of 65km/h and therefore capacities of 800 vehicles per hour per lane. The class 4 roads in the area have free flow speeds of 60km/h and capacities of 680 vehicles per hour per lane.

## Traffic Volumes

The volume of traffic experienced on the different roads in the Rosebank Box gives an idea of the road network and its functional role. The purpose of showing this data is to give a very general idea of the vehicle traffic flow and the road capacity which are key to the movement into, though, and out of the area.

The following traffic counts were sourced from:

- Johannesburg Road Agency Tube Counts database (2007 – 2009);
- classified counts from the Strategic Public Transport Network Study (2006);
- various individual TIAs which were completed in Rosebank;
- Bus Rapid Transit Section 6: Traffic Evaluation, December 2008;

and presented in a Traffic and Transport Study undertaken by GIBB for the base year of 2006 (GIBB, 2011).

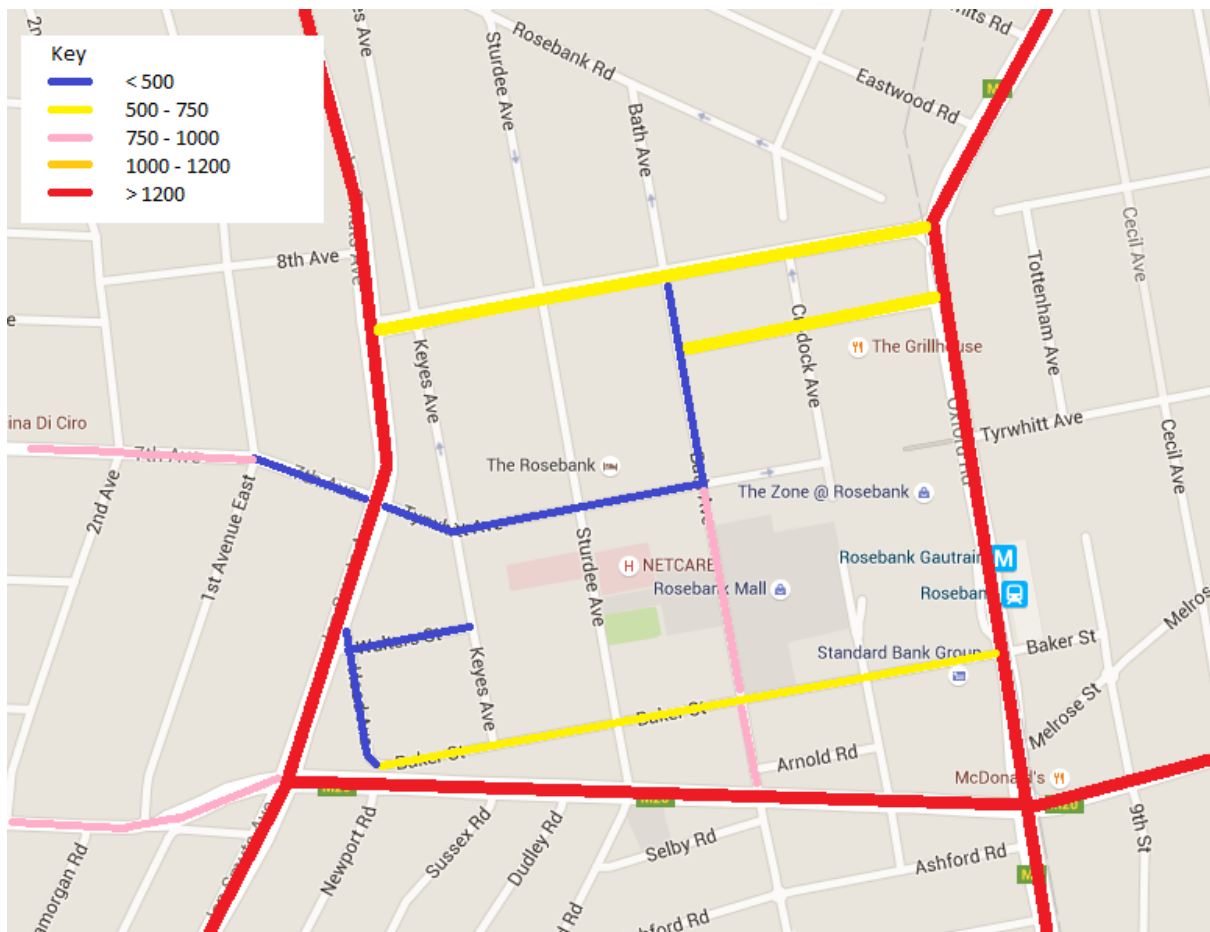


Figure 11: PM Peak Background Traffic Counts

The peak AM inbound traffic counts found that approximately 1 700 vehicles/hour were travelling on Jan Smuts Avenue, approximately 2 000 vehicles/hour were travelling on Oxford Road, approximately 1 600 vehicles/hour were travelling on Bolton Road, and approximately 1 000 vehicles/hour were travelling on Jellicoe Avenue.

Figure 11 shows that the majority of the traffic during the peak periods is on Oxford Rd, Jan Smuts Avenue, and Bolton Rd. These are the roads designed for the majority of the traffic in the area and can therefore handle the higher volumes. When this study took place in 2006 the road network is not operating at capacity. There have not been any major capacity increases to these road networks since 2006.

#### **4.2.4.2) Rosebank Box Road Network Capacity**

To be able to compare the number of road trips that the Rosebank Box will produce and attract in the future with the available road capacity, the current capacity of the road network needs to be calculated.

The methods used to calculate the current road network capacity in Rosebank were used in the Sandton Integrated Transport Masterplan (ARUP , 2015). Currently there are five Class 2 roads (Jan Smuts Avenue and Oxford Road) feeding into the Rosebank Box consisting of 16 lanes collectively. There is one Class 3 road with 3 lanes and one class 5 road with two lanes feeding into the area.

Combining the information from the above Figure 10 and Table 8 allows for the calculation of the road network capacity. Multiplying the applicable vehicle capacity per hour per lane that by the number of in-bound lanes will reveal the road network capacity.

The 16 class 2 inbound lanes have a capacity of 1 010 vehicles per lane per hour, the 3 class 3 inbound lanes have a capacity of 800 vehicles per lane per hour and the 2 class 5 inbound lanes have a capacity of 680 vehicles per lane per hour. Multiplying these out indicates that the maximum inbound capacity for the Rosebank road network is 19 920 vehicles per hour.

**Table 9: Rosebank Road Network Capacity**

<b>Road Class</b>	<b># Inbound and Outbound Lanes</b>	<b>Capacity per Lane per Hour</b>	<b>Inbound and Outbound Road Capacity</b>
<b>2</b>	16	1 010	16 160
<b>3</b>	3	800	2 400
<b>5</b>	2	680	1 360
<b>Grand Total</b>	<b>21</b>	-	<b>19 920</b>

#### **4.2.4.3) Public transport**

The past success of the Rosebank Node has been due in large part to its general accessibility by road and bus services, and its location in a stable and well-off part of Johannesburg. This has greatly been enhanced by the Rosebank Gautrain Station that came into operation in 2010.

The RUDF municipal planning envisaged the use of Oxford Road as a BRT route with stations near the Rosebank Gautrain Station. However, this has not eventuated to-date, with the BRT having been relocated to Louis Botha Avenue. Considering that the Rosebank densification is based on the assumption of sufficient supportive public transport, and that the BRT was one of the backbones of the RUDF, the augmentation of the public transport options is urgently required.

The RUDF supports the provision of sustainable modes of transport as reflected in:

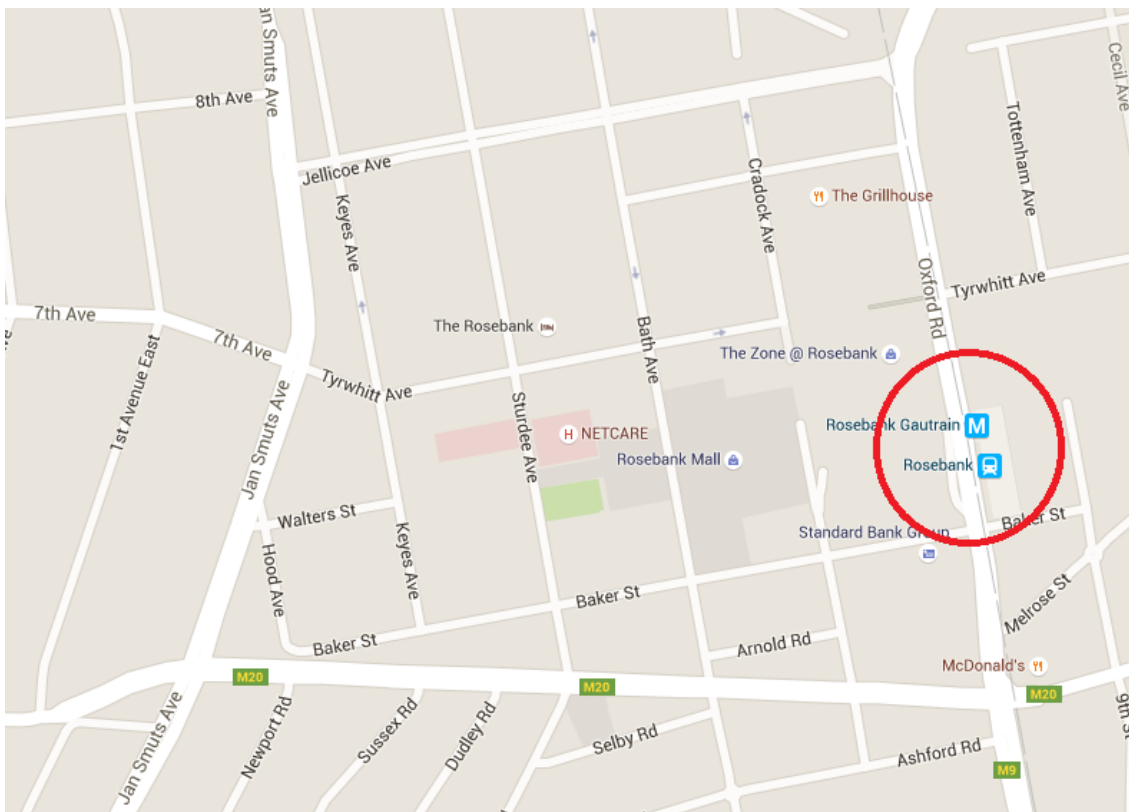
- The National Land Transport Act (No 5 of 2009)
- Moving South Africa: The Action Agenda (DoT, 1998)
- Joburg 2040: Growth and Development Strategy (CoJ, 2011)

The different modes of public transport are discussed in more detail below, following the hierarchical order:

## Gautrain

The Gautrain is a state-of-the-art rapid rail network in Gauteng. It comprises two main corridors, one running north to south with the southern-most station in the Johannesburg CBD and the northern-most station serving Hatfield in Pretoria. The east-west line serves the OR Tambo International Airport. There are seven intermediate stations as illustrated in Figure 5.

The Gautrain Rosebank station is the second-most southerly station served by the North-South line, and is situated approximately 5 km north of Park Station in the CBD of Johannesburg. It lies on the east side of Oxford Road between Tyrwhitt Avenue and Bath Road and adjoins the Rosebank Box as can be seen in Figure 12. (Gautrain, 2014)



**Figure 12: Position of Gautrain Station**

The design of the station is intended to promote integration with the surrounding activities as well as other transport systems, although the reasons for its peripheral location to the Rosebank Box, rather than within the Box, are unclear. Access to the station for walking passengers is provided by lifts located near the pedestrianised section of Tyrwhitt Avenue on the west of

Oxford Road, and there are walkway connections through existing developments to the core of the Box.

A parking garage for approximately 1 200 parking bays for park-and-ride commuters at the Station, and demarcated short-term parking and drop off zones are provided at the station on the east side of Oxford Road. Motorcycle parking bays, as well as bicycle storage facilities, are also provided.

The importance of reliable feeder systems to the station has been recognised by the Gautrain Management Agency, which lists accessibility as one of the key factors of success. A dedicated Gautrain bus service is provided to complement existing public transport services, and to allow for access to the wider area. Figure 13 shows the Gautrain bus routes that serve Illovo, Wanderers, Dunkeld West, Parkwood, Melrose, Oaklands, Highlands North, Orchards and Winston Ridge. The bus stops for Gautrain buses have been placed on either side of Oxford Road outside the Rosebank Gautrain Station making the pick-up and drop-off for the buses as quick as possible where congestion is highest. The Johannesburg Metro and Putco bus services, as well as the Minibus-taxi services, have been incorporated in the Gautrain system.

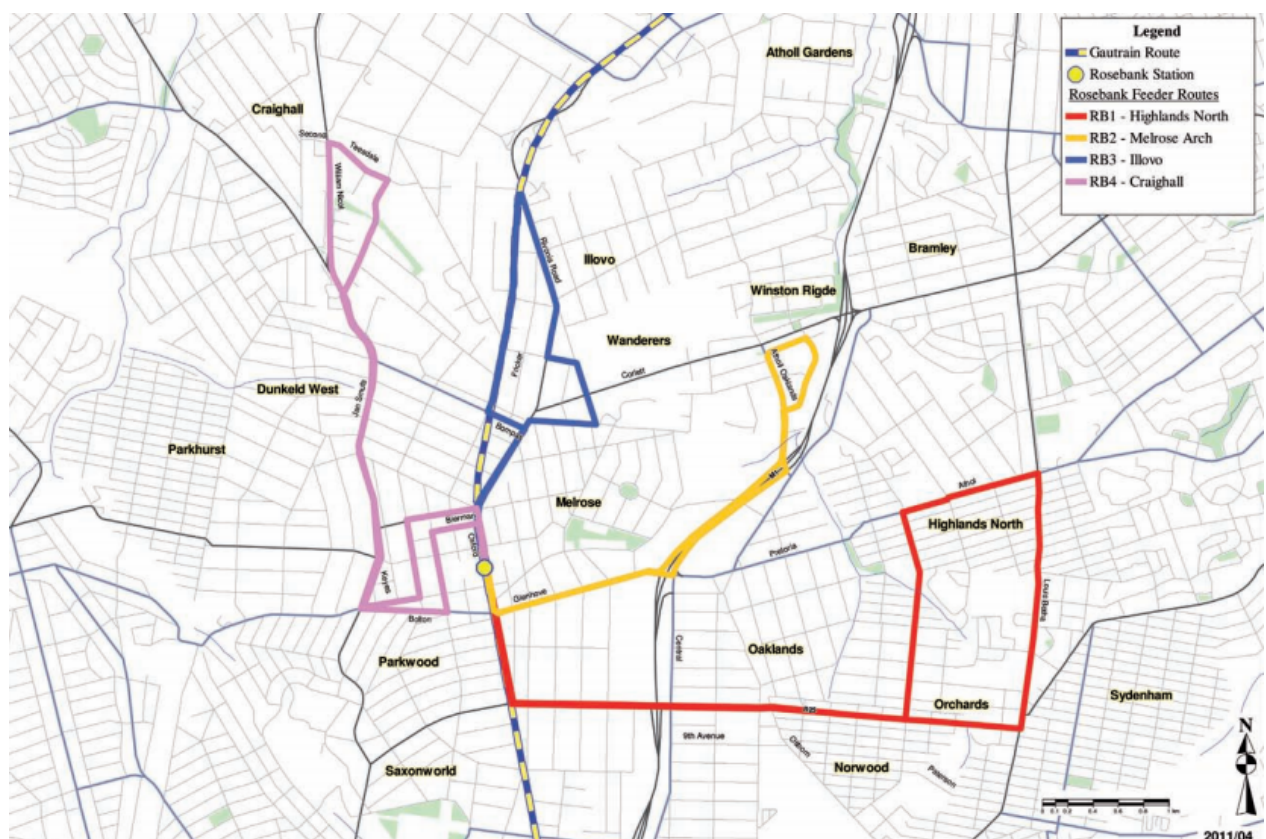


Figure 13: Gautrain Bus Routes (Gautrain, 2015)

In its latest annual report (Gautrain, 2014) the Gautrain Management Agency reports an increase in the ridership of the Gautrain and the Gautrain buses. These ridership numbers have been increasing ever since the establishment of the train and bus systems. Currently the train ridership sits at an average of 42 456 passengers per week day, with around 16 000 passengers per day on the weekends. The ridership of the bus feeder system is on average 18 284 passengers per weekday i.e. about 30% of the passengers who use the train also use the bus system. K Machako, spokesperson for the Gautrain operating company, Bombela, confirmed this in an interview with Irma Venter (2014). He also indicated that 90% of the Gautrain bus passengers use the train. (Machaka, 2013)

The increase of Gautrain ridership indicates that this is a public transport system which has the ability to continue its growth, allowing more people to access the Rosebank Box without the use of private vehicles. As this trend continues the dependency on private vehicle access to the Box is likely to be reduced.

## **Metro Bus**

The Metro bus system is a citywide bus service that operates within the City of Johannesburg according to a set schedule. This schedule is updated in accordance to the demand on an annual basis. The CoJ region has been divided into six operational zones and fares are determined by the number of zones travelled by the commuter.

There are two zones that apply to the Rosebank Node and which serve as feeder and distribution services:

- Zone 2: From the corner of Jan Smuts Avenue and Empire Road in Braamfontein to the corner of Jan Smuts and Tyrwhitt Avenues in Rosebank, and
- Zone 3: From the corner of Jan Smuts and Tyrwhitt Avenues in Rosebank to Craighall Park.

This bus service also acts as a feeder system to the Rosebank Gautrain Station, although this is not its primary purpose. If the service starts playing a bigger role in terms of a feeder system to the Station then the schedules may be altered accordingly; for the time being there is no need as the demand for this role is not at an adequate level.

The Metro Bus ridership in 2013 was estimated at 80 670 which is roughly double the ridership of the Gautrain in 2014. The role of the bus service is an important one in the Rosebank area, particularly with the relocation of the BRT.

It is important to note that the dedicated Gautrain bus service and the Metro Bus service do not have similar routes and are therefore not in direct competition with one another.

### **Metered Taxis**

As Rosebank becomes less car dependent, the use of metered taxis will increase as will all other modes of transport. They act as feeders and distributors of the Gautrain commuters while also offering trips to and from surrounding areas, due to their door-to-door services. The fares of metered taxis (including Uber services although not technically a metered taxi service) are much higher than other modes of transport and therefore long trips are seldom made in this mode.

There are no designated waiting zones for metered taxis in the Rosebank area as they are largely summoned telephonically and only require pick-up and drop-off zones. A number of these non-designated zones are scattered around the study area including at the Gautrain Station, hotels, medical facilities, educational facilities and shopping malls.

### **Minibus Taxis**

Minibus taxis have been the predominant form of public transport in South Africa for many years. They are the most affordable mode of public transport in the Rosebank area (Akanya, Karabo, Studiomas, 2008). This attribute has attracted more commuters than other modes of public transport.

The 12-15 passenger minibuses tend to operate over their passenger capacity and without much regulation regarding driving style, licensing and maintenance. Nevertheless, they are a vital part of the overall transport system, and more attention to their integration into the overall system is required.

The Rosebank minibus taxi rank is situated on a closed section of Cradock Avenue between Biermann and Jellicoe Avenues. This rather inadequate taxi rank needs to be integrated with the NMT facilities as well as the other public transport modes in the study area.

In addition to the formal rank there numerous informal taxi waiting and drop-off points throughout the study area, some of which are in traffic lanes where they slow down traffic and cause unnecessary delays to other vehicles, including buses. These informal stopping points should either be formalised into the road design or be managed with more effective enforcement of traffic rules.

#### **4.2.5) Non-motorised travel**

##### **4.2.5.1) Walkability**

The accessibility/walkability research done by Space Syntax (2008) for the RUDF sought to understand the ease of access and mobility for pedestrians in the area. Accessibility refers to the ease of reaching goods, services, activities and destinations, which together are called “opportunities”. (Litman, 2015)

Figure 14 shows the walkability to the Rosebank Gautrain Station from all parts of the nodal area. The red zone shows the shortest walking time of 2.5 minutes or fewer minutes, followed by the yellow zone with a walking time of between 2.5 and 5 minutes, the green zone with a walking time of 5 to 10 minutes, and the blue zone with a waking time of 15 minutes. The distortion of the circles is due the core of the Rosebank node being west of Oxford Road, with low density residential and educational areas of Melrose to the east side of the Gautrain station.

Walkability in a TOD is not solely about distance, but includes safety, topography, urban design and the flow of the walk among other factors. It is however vital to the successful development of the nodal area and influences the vehicle trips, the parking provision, the design of the public spaces and the liveability of the area.

The walkability is most pronounced in the 5 minute zone (Akanya, Karabo, Studiomas, 2008), and the densification of the node should predominantly occur within this zone, before being extended wider afield.

As stated earlier, there is a limited degree of historical pedestrianisation along part of Tyrwhitt Avenue and Cradock Avenue that contribute to NMT movement in the Box.

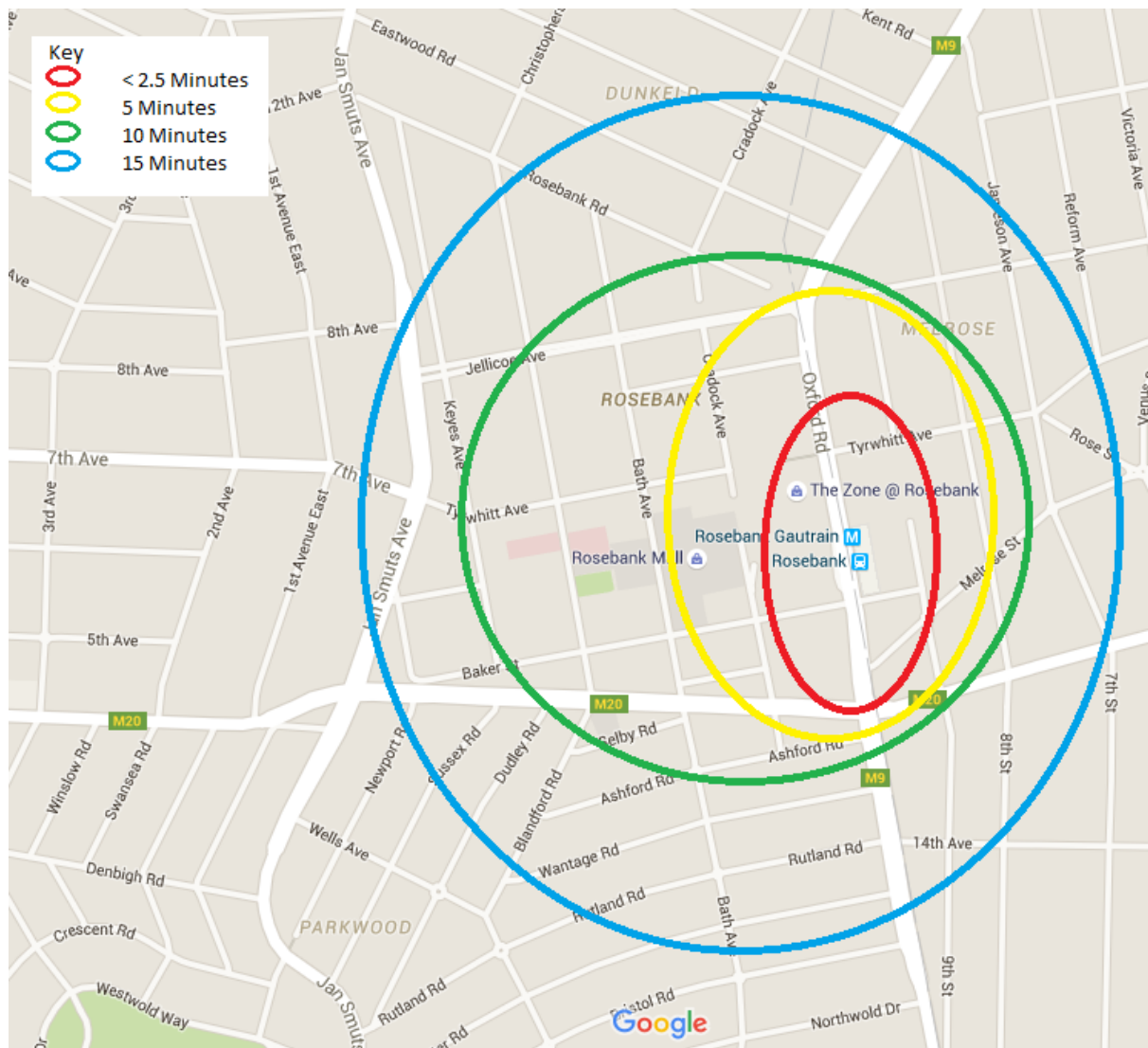


Figure 14: Walkability

#### 4.2.5.2) Parking provision

Parking provision in its various forms of on-street, off-street-open-air and off-street in-structure is a vital element in the Rosebank Box.

Currently there are six off-street, open-air and public parking facilities in the Rosebank Box:

Rosebank Gautrain Station: 1200 parking bays

The Zone:	1393 parking bays
The Mall:	1900 parking bays
Open parking at the Zone:	160 parking bays
Open public library parking;	60 parking bays
The Hyatt:	608 parking bays
The Zone phase 2:	1305 parking bays

The on-street parking available in the area is as follows:

Bath Street:	60 parking bays
Baker Street:	98 parking bays
Cradock Avenue:	5 parking bays
Biermann Avenue:	15 parking bays

The successful development of the TOD requires free-flowing movement into, around, and out of the Box, i.e. mobility and accessibility. (Mobility is the ease of movement without interruptions, while accessibility is the ability to get to different activities and land uses).

The current approach to new parking provision taken by the CoJ is a site-by-site one, meaning that the City does not view the parking issue as a whole and the cumulative effects are not readily evident. Neither is there any apparent monitoring of parking or assessment against the goals of TOD. This approach, unless modified, is likely to result in an oversupply, to the detriment of the TOD as described by Wang (2012).

The choice of parking provision rather than substantial reliance on public transit facilities is understandable if there is a perception that the public transit facilities are inadequate to support the needs of the Node. However, if the quantum of land use rights is to remain at the RUDF levels, and if the supporting levels of public are not improved, the Node will be compromised.

It is therefore imperative that an overall traffic impact study of the Node and matching programme or model be developed. This would help inform a better evaluation of individual traffic impact studies, as well as assist in monitoring the parking needs of the Node. As advised

earlier, the most recent traffic study was done a number of years ago in 2006/7 (GIBB, 2011) before the Rosebank Gautrain Station and many other, newer developments existed.

In summary, in spite of the densification intentions of the RUDF, there has been no study to address the traffic and parking management, or the consequences of densification proposed in the Rosebank Box.

#### **4.2.6) Modal Split**

The modal split used in the GIBB report (GIBB, 2011) on Rosebank states that the assumption is that that private vehicles will have a 53% modal split, the BRT/Bus will have 10%, and taxis will accommodate 37% of the trips. This modal split is clearly out-dated as the BRT system is not in place yet and the plans to provide this service have been altered. It needs to be adjusted to include the commuter passengers of the Gautrain and exclude the BRT system; Therefore, it is worthwhile considering the modal split used in the Sandton Integrated Transport Masterplan (ARUP , 2015) along with Rosebank specific data from the most recent National Household Travel Survey (NHTS) (DoT, 2013). Although the NHTS data is not particularly fit-for-purpose it is the best available data, and as mentioned above only the data relevant to the Rosebank area will be used as seen in Appendix 4.

Using the modal split scenarios proposed in the Sandton Integrated Transport Masterplan (2015) Table 5 and the current modal split in Rosebank, the Rosebank specific scenarios have been identified. The assumed similarities of the areas in terms of location, current modal split, local characteristics of the travelling population, TOD intentions, and planned interventions, as well as the authorship of the Sandton Urban Development Framework, 2008, by the same consortium as for Rosebank, suggests an alignment and comparability of the scenarios projected in the Sandton Integrated Transport Masterplan (ARUP , 2015) with those of Rosebank.

If the “business as usual” approach continues, the modal split will consist of 67% private vehicle use. If there is an improvement in the investment and operation of public transport then it is predicted that there will be a 15% increase in the number of people using the systems. If the node is transformed as intended (in terms of the RUDF) and the desired urban form is reached and a liveable, accessible node is achieved then the private vehicle use will drop to 45% and the use of other forms of transport will provide the remaining 55%.

Improvements to public transport and NMT systems are necessary to change the travel behaviour of people to and within the Rosebank Box and to create a less vehicle-dependent area. A radical change in Rosebank, as in the case of Sandton, is required to alter the travel patterns.

### **4.3) Chapter Conclusion**

This chapter set out to investigate the Rosebank Regional Node and the proposed land use, public transport, TDM measures, and road network plans specified in the RUDF. (Rosebank Urban Development Framework, 2008).

Curbing urban sprawl is a priority for cities as the majority of transport provision and city planning problems arise from increased travelling distance and spread-out housing locations. Lower costs of construction per dwelling unit due to compactness and minimization of parking bays per dwelling unit should lead to more affordable housing (Litman, 2014). A similar benefit would apply to business uses in Nodes.

As indicated in the Status Quo, the proposals in the RUDF require a multi-layered and complex engagement with developers, affected communities, changes to the institutional structures, funding allocations and the like to achieve the TOD intentions. These are summarised in Part 6 of the RUDF and set out in page 156 of the report.

The following chapter sets out to address the quantification of the densification proposal and the effects the densification will have on the local road network and parking supply.

## **5) Quantification of Proposed RUDF Land Use Rights**

### **5.1) Introduction**

The quantification of the RUDF plans in this chapter will allow for an understanding of the impacts of these development plans. Over-densification without supporting policies and regulations in place is likely to lead to undesirable effects on TODs. This chapter seeks to identify the likelihood/magnitude of problematic planning and policies with respect to the road network and parking supply in the Rosebank node.

The initial step is to determine the land uses that apply to the RUDF Management District 2 that covers the Rosebank Box. The planned height and coverage for each building and land use type available in the RUDF will be used in the calculation. The number of dwelling units is also determined using the average number of dwelling units planned per ha in the framework.

The quantification of the land use will allow for trip generation (of private vehicles) to be predicted for 2016, 2026 (ten years from now), and 2040 (in line with the CoJ's Growth and Management Strategy) to answer the question of possible network saturation. The existing and future road network has a finite capacity close to being realised, this capacity compared to the predicted trip generation will shed light on the possible over-densification without the supply of significant reliable public transport or NMT.

The parking supplied in the node is determined by the minimum parking standards which apply to the area, as well as the developer's preference. Predicting the parking supply based on the minimum regulations will allow impacts on the road network, space and cost to be calculated. This dissertation focuses on the road network impacts to justify the minimum standards or changes needed in parking policies.

## 5.2) Quantifying the data on land use mix and floor area proposed in the RUDF

In order to calculate the future land use within the Rosebank Box the planned land use and potential floor area from the RUDF was utilised.

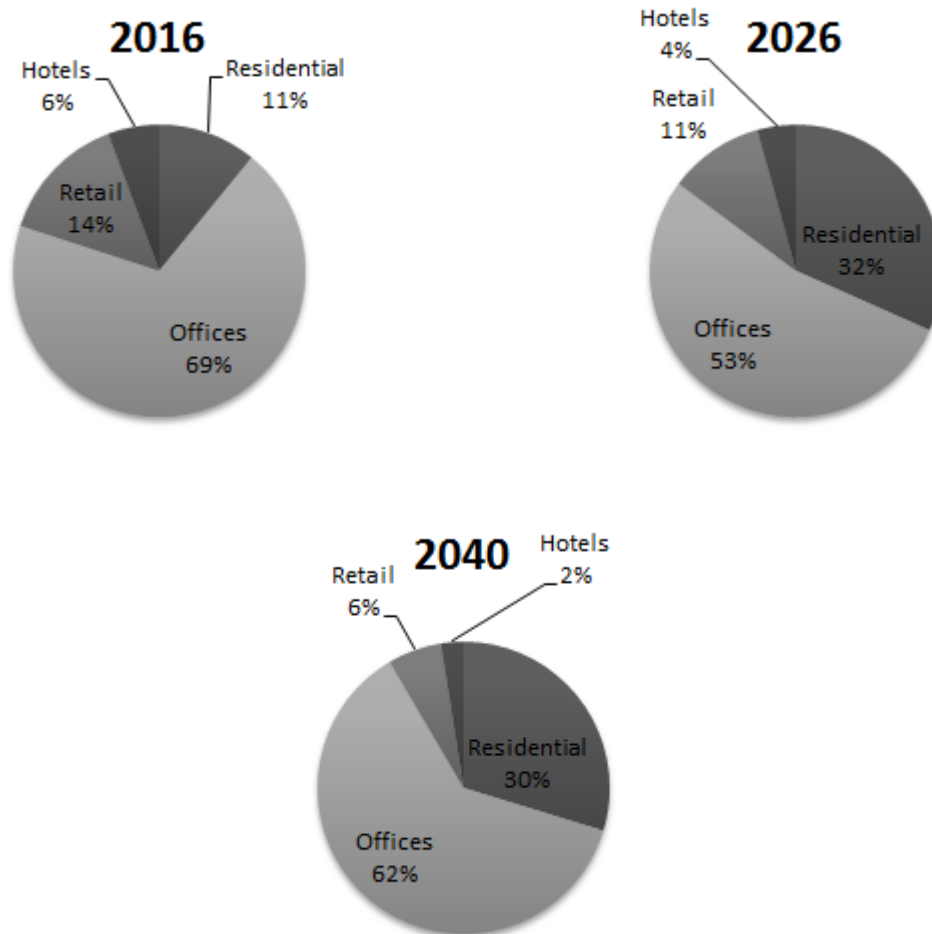
The total land use floor area was calculated using the indicative land use, and the coverage multiplied by the number of storeys permitted. The 2016 and 2026 figures are taken from the Gibb report (Arcus Gibb, 2011) and the 2040 figures are based on the RUDF proposals. The results of these calculations can be seen in Table 10 for year 2040.

**Table 10: Estimated Future Land Use**

<b>Land Use Inside Rosebank Box</b>			
	<b>Year</b>		
<b>Land use</b>	<b>2016</b>	<b>2026</b>	<b>2040</b>
<b>Residential (<math>m^2</math>)</b>	81 066	371 909	689 523
<b>Offices (<math>m^2</math>)</b>	514 305	628 881	1 434 208
<b>Retail (<math>m^2</math>)</b>	106 477	123 799	137 905
<b>Hotels (<math>m^2</math>)</b>	42 384	50 384	58 384
<b>Grand Total (<math>m^2</math>)</b>	<b>744 232</b>	<b>1 174 973</b>	<b>2 320 019</b>

The most noticeable changes in the longer term are those of residential land use (increasing by 608 457m<sup>2</sup> by 2040) and office space (increasing by 919 903m<sup>2</sup> by 2040). These land uses are expected to have the biggest changes owing to the number of storeys (height) allocated to them. Hotel and Retail land uses are also expected to grow, but not to the same extent as the previous two land use types.

The overall floor area used for all land uses is expected to more than double over the 24 year period in terms of the RUDF densification plans. This densification has clear implications for an already-struggling road network that will be further compromised if supporting policies and strategies are not initiated promptly.



**Figure 15: Land Use Predictions (Akanya, Karabo, Studiomas, 2008)**

The land use percentage predictions indicate that, initially, the percentage of land used for office space decreases as the residential land use increases, but that over the longer run the percentage of land used for offices increases.

The retail area constantly drops relative to the other land uses. This is due to the Rosebank Mall’s recent upgrading; this improvement to the Mall is seen to be sufficient for a number of years, therefore no further upgrades have been planned as yet. As demand for retail increases due to other increases of residential and commercial density in the area it is likely that there will be more retail planned before 2040 (which is not included in this forecast).

The dwelling unit density proposed in the RUDF stipulates that most of the allocated residential area will have an average density of 95-110 du/ha. For quantification purposes this paper uses 110 du/ha and applies it to the space planned for residential use. The results are as follows:

**Table 11: Predicted Number of Dwelling Units**

<b>Dwelling Units in Rosebank Box</b>			
	<b>Year</b>		
	<b>2016</b>	<b>2026</b>	<b>2040</b>
<b>Dwelling Units</b>	892	4 091	7 585

Table 11 indicates that by 2040 the number of dwelling units will increase by more than eight times from current levels. The drastic increase in the number of dwelling units is expected to have a significant influence on movement within the node, as there will be more foot traffic, NMT facility use and public transport use, as was proposed by Renne and Wells (2002).

### **5.3) Quantifying the parking and traffic implications**

#### **5.3.1) Trip Generation**

The trip generation rates used in the calculations are from COTO (2013). Table 3 shows the trip generation rates that were used in combination with the predicted land use as shown in Table 10, the predicted dwelling units shown in Table 11, and the directional split shown in Table 4. The resulting predicted AM peak hour trip generated for the years 2016, 2026, and 2040 are shown in Table 12, while the PM peak hour predicted trips generated are shown in Table 13. A comparison of these two tables shows whether the AM or PM peak hours will have a bigger impact on the road network.

**Table 12: Rosebank Box AM Peak Hour Trip Generation Predictions**

<b>AM Peak Hour Trip Demand</b>			
	<b>Year</b>		
<b>Land use</b>	<b>2016</b>	<b>2026</b>	<b>2040</b>
<b>Residential</b>	123	565	1 048
<b>Offices</b>	7 803	9 542	21 761
<b>Retail</b>	353	410	457
<b>Hotels</b>	108	128	149
<b>Grand Total</b>	<b>8 388</b>	<b>10 646</b>	<b>23 414</b>

**Table 13: Rosebank Box PM Peak Hour Trip Generation Prediction**

<b>PM Peak Hour Trip Demand</b>			
	<b>Year</b>		
<b>Land use</b>	<b>2016</b>	<b>2026</b>	<b>2040</b>
<b>Residential</b>	148	678	1 257
<b>Offices</b>	7 344	8 980	20 480
<b>Retail</b>	1 539	1 789	1 993
<b>Hotels</b>	81	96	112
<b>Grand Total</b>	<b>9 112</b>	<b>11 544</b>	<b>23 842</b>

Comparing the predicted AM and PM peak hour trip demand (Table 12 and Table 13) it is clear that the PM peak will have a bigger influence on the road network. Table 13 indicates that in 2016 the road network will be operating at 9 112 vehicles per hour, increasing to 23 842 vehicles in the PM peak by 2040. Comparing the Rosebank Box road network outbound capacity, estimated at 19 920 vehicles per hour, to the projected private vehicle generation rates, there is a clear mismatch. Physical limitations on the construction of new roads and widenings, which could increase the network capacity, lead to the conclusion that improvements need to be made to the nodal planning, development regulations and implementation approach in order to accommodate the additional trips through alternative transportation modes.

### **5.3.2) Parking Supply/Provision**

The provision of future parking in the Rosebank Box has been calculated according to the planned RUDF land use in Table 10 combined with the current minimum parking regulations shown in Appendix 2. The results follow:

**Table 14: Rosebank Box Planned Parking Supply**

<b>Planned Parking Supply</b>			
	<b>Year</b>		
<b>Land use</b>	<b>2040</b>	<b>Parking Supplied</b>	<b>Total Parking Bays</b>
Residential	7 585 Dwelling Units	1,5 per dwelling unit	11 378
Offices	1 434 208 $m^2$	4 per 100 $m^2$	57 369
Retail	137 905 $m^2$	6 per 100 $m^2$	8 275
Hotels	488 Rooms	1 per room	488
<b>Grand Total</b>			<b>77 510</b>

Table 14 shows the number of parking bays that will be supplied within the Rosebank Box by 2040 if the minimum parking regulations are followed. The majority of parking will be supplied for office space (57 369 bays), followed by residential parking bays (11 378 bays). Overall, the grand total of parking bays which will be supplied under current regulations is 77 510 parking bays.

Using this number of parking bays and the minimum parking standards applicable in Johannesburg, roughly 193ha of off-street parking floor area would need to be constructed.

In terms of this “business as usual” scenario, and the literal interpretation by the CoJ of the RUDF proposals in approving new land use applications, private car usage will remain the dominant form of transport serving the node. However, there are obvious problems with capacity and a clash with the underpinning TOD principles of the RUDF and the densification levels proposed therein.

Realistically, it can be expected that with “full” parking provision the node will not reach the levels of development proposed in the RUDF, but that it will reach a point when the consequences of applying suburban parking ratios in an area of concentrated development will be self-evident to the CoJ and developers, and its appeal as an investment area will diminish. However, it would be preferable to have anticipated this outcome and to have put suitable regulatory measures and alternative modes of movement in place at an earlier stage.

## 5.4) Chapter Conclusion

Quantifying the future land use, trip generation and parking provision as proposed in the RUDF allows for the comparisons between the existing road capacity and the future capacity.

The results suggest that the current and future road network capacity (because of the physical limitations on new road construction) is 19 920 vehicles per hour. The theoretical number of private vehicle peak hour trips that will be generated by 2040 is 23 842. There is a clear mismatch between these two figures, which leads to the conclusion that the only way to allow for the necessary trips into the area will be to convert a large proportion of these trips to alternative modes of transport. This requires policy and regulatory changes (NLTS, MSA, and Joburg 2040) to take effect in practice.

The only way to support the movement needs of the planned high densities within the Rosebank Box is by reducing the modal percentage for private cars and increasing the proportion of trips on public transport modes or via NMT. In this scenario, the need for parking supply declines substantially, and the change to current parking regulations and management becomes a means to a more sustainable TOD outcome.

Alternatively, the RUDF and its implications need to be reviewed to align with the realistic capacities of the CoJ to deliver public transport and finance the supporting interventions needed to support TOD.

It also is a literal interpretation of outcome of the “blue print” way that the implementation of the RUDF is being pursued by the City, but is unlikely to eventuate, as rationality will intervene, and new proposals will be influenced by the functioning and market appeal of the Node.

It is clear from the preceding sections that in addition to the numerous other steps identified in the RUDF to achieve a viable TOD, the City must develop a parking policy that is aligned to a practical and implementable quantum of land use rights. This requires a suitable database to help understand the supply and demand for parking, and the development of models to track the impacts and make adjustments to the policy, as required.

This research looks into these policies and success factors, and more specifically considers whether parking provision and management in such areas is a critical component in achieving

or discouraging modal change from private car usage to public and non-motorised movement and the achievement of a desirable high density live-and-work environment.

One major challenge to implementing a TOD is parking: well-managed parking can improve the performance of a TOD in both transportation and financial perspectives; poorly-managed parking can undermine the expected benefits of a TOD and even cause the initiative to fail.

## 6) Research Conclusions

This research set out to investigate whether parking provision and parking management, together with adequate alternatives to private transport, is a critical factor in the planning and implementation of a TOD plan. This involved:

- Identifying the success factors for TODs, with particular reference to parking supply and parking management.
- Identifying how the TOD concept has been used in the Rosebank Urban Development Framework for the future development of the Rosebank Regional Node in Johannesburg. And
- Establishing how the TOD concept has been applied in the Rosebank Urban Development Framework to date, and what the implications of the current development trajectory are without parking and parking management interventions.

The promoting of high density and mixed-use developments in close proximity to a transit station requires supportive market conditions, public transport commitment, strong local leadership, and supportive public policies. TDM measures play a vital role in the modal choice of travellers. Parking management and supply is a central TDM measure that can be used to alter travel behaviour by the encouragement of transit ridership and can have a big influence on the overall accessibility of a TOD. Parking reductions, design, location, management, and pricing are all aspects that need to be tailored to the specific TOD for best use of parking supply as an influential behavioural tool.

The Implementation Strategy proposed in the RUDF requires the densification to be matched by public transportation, infrastructure upgrades, facility provision, pedestrian-friendly public space, and the like, if the longer term outcomes are to be positive for the TOD. The findings of the research indicate that there are significant issues arising from the way the RUDF is being implemented, and these include most of the factors highlighted by Suzuki et al as barriers to TOD success, namely:

- a lack of a public transport investment assessment framework  
In Rosebank the primary investment has been in the Gautrain Station and its related facilities. The BRT proposal originally intended to complement the Gautrain Station

has been relocated from Oxford Road to Louis Botha Avenue, a Corridor of Freedom, and with it the primary investment in new public transport infrastructure.

- sectoral (as opposed to integrated) responses to proposed developments

The CoJ includes a number of Municipal Owned Entities, such as the Johannesburg Roads Agency (JRA), Johannesburg Water (JW) and City Power (CP). This “independence” encourages sectoral responses to on new development proposals, as is evidenced in the JRA support for parking requirements which have no TOD alignment.

- inconsistencies in planning instruments and deficiencies in their implementation

The Implementation Strategy proposed in the RUDF has not been followed; instead, a strategy of supporting private land use applications aligned with the land use proposals in the RUDF has been pursued.

- inadequate policies, regulations and supporting mechanisms for redeveloping built-up areas

The cumulative implications of the RUDF’s proposed land use rights for the existing urban area have not been adequately considered, and neither have there been adjustments to the parking and traffic aspects that are at the core of this report.

- neglected urban design at the neighbourhood and street level

The RUDF proposes various processes for the evaluation of new land use rights applications and urban designs for critical areas in the node. These have largely been overlooked by CoJ to-date.

- financial constraints

The CoJ faces many demands on its budget and it would appear that Rosebank node is not a current priority. The engineering services contributions paid to the CoJ by successful land use applicants do however provide an opportunity to invest in public improvements that will be required to match the substantially higher and more diverse land uses that the RUDF proposes.

Given the aim of this research, namely whether parking is an important component of a development strategy for TOD, the following can be concluded from the analysis presented in the preceding sections:

- Parking Regulation

With regard to parking regulation, the current CoJ practice of requiring full suburban parking ratios for new developments in the TOD is problematic, particularly if the land use proposals and densities in the RUDF are to be pursued. The calculations put forward in the research show the practicalities and spatial implications of this approach.

It is clear from the research findings that how parking is provided and managed is a crucial component to implementing a TOD. If the current “business as usual” approach continues it can be expected to undermine the expected benefits of the Rosebank TOD, which include favouring public transport, walking and the like, and may even cause the initiative to fail as it is strangled by the higher densities, limited road capacity, inadequate accessible parking, high development costs, and an unimproved public realm.

While parking is a critical factor in the evolution of the Rosebank node towards a TOD, it must be part of an integrated implementation strategy as proposed in the RUDF. The realisation of the densification in Rosebank is inextricably tied to the provision of supporting public transport to facilitate the lessening of private car dependencies, and parking is a key to effecting the transition.

- Current practice will lead to overprovision of parking

This paper indicates that in the year 2040 the expected outbound PM peak traffic on the existing local roads will be 23 842 vehicles trips per hour; however, the estimated road network outbound capacity is only 19 920 vehicles per hour. This mismatch highlights the problems to be expected if the current practices continue.

If the public transport to Rosebank is unlikely to be improved to the extent required to support the projected 2040 figure of 2 320 019 m<sup>2</sup> floor space for retail, office space, residential, and hotels, leading to 77 510 parking bays, the RUDF must be reviewed. Importantly, the relocation of the BRT from Oxford Road to Louis Botha Avenue since the approval of the RUDF signifies a diminished public transport capacity rather than an improvement, and the implications of this for the TOD need to be assessed. The worrisome factor is that additional enhanced rights continue to be granted by the City on the basis of the standard parking ratios.

- Monitoring of change

At present the threats of continuing along the current path of RUDF implementation are masked by the way that applications occur in a one-by-one basis, and the general lack of data collection, monitoring, and evaluation. This means that there is no way of accurately assessing the progress and projections of the area's success, or the triggering of responses to address cumulative consequences.

## **Study Recommendations**

The recommendations given below are based on the conclusions.

The behavioural theories discussed earlier suggest that discouraging private car usage and promoting TOD requires public belief of adequate investment in and proof of steps taken to provide a functioning and reliable public transport system.

In the short term:

It is essential that the implications of current land use and parking practice for the continued success of the Rosebank node are evaluated as suggested in this study.

In this regard it is important to note that the RUDF proposals are not "real" rights, but rights that can be obtained only by application to the City by showing merit and compliance with the policy objectives. They can be changed to deal with transportation, parking, phasing and other issues arising from current practices.

The review will require adequate baseline information, which the RUDF lists as a key area of intervention, but which has not been addressed to-date.

The Johannesburg Roads Agency should develop an overall traffic model for the Rosebank node and guidelines for inputs from new development proposals that move away from a site-by-site appraisal and standard parking ratios to a nodal and TOD appraisal. This is a further intervention identified in the RUDF as a necessary precursor to the implementation of the plan.

The individual traffic impact assessments used to justify new land use rights and developments prior to the completion of the traffic model must be adjudicated by Johannesburg Roads Agency on the TOD criteria, rather than standard parking and trip generation rates.

The Johannesburg Roads Agency must develop a plan for the incremental upgrading of road space to fulfil a complete street role in improving pedestrian movement, street furniture, landscaping and vehicle usage that can be developed using engineering services contributions generated by new development rights.

The monitoring and evaluation of change in the development circumstances of the Rosebank node requires adequate base-line data that must be researched and maintained to inform evaluation of proposals.

The findings and adjustments to policy and phasing of implementation must be prepared in consultation with affected property owners and communicated to the relevant organisations and civic groupings in the area.

The revised land use management scheme under preparation since the introduction of the Johannesburg Municipal Planning By-law, 2016, should define Rosebank (and other nodes), and stipulate matching maximum parking requirements.

In the longer term:

The improvement of public transport and NMT facilities should be effected before new development rights outside the initial development phase are considered.

The findings of the traffic modelling (and infrastructure improvements) must be used to revise the scale of potential development rights, and the introduction of new phases for densification.

The findings should be used to inform the further planning and development of other TOD nodes in the City's polycentric urban form model.

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# Appendix 1

Application for Approval of Ethics in Research (EIR) Projects  
Faculty of Engineering and the Built Environment, University of Cape Town

## APPLICATION FORM


**Please Note:**



Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form before collecting or analysing data. The objective of submitting this application prior to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the **EBE Ethics in Research Handbook** (available from the UCT EBE, Research Ethics website) prior to completing this application form: <http://www.ebe.uct.ac.za/usr/ebe/research/ethics.pdf>

APPLICANT'S DETAILS	
Name of principal researcher, student or external applicant	Michael Baylis
Department	Civil Engineering
Preferred email address of applicant:	MichaelLBaylis@gmail.com
If a Student	Your Degree: e.g., MSc, PhD, etc.,
	Name of Supervisor (if supervised):
If this is a research contract, indicate the source of funding/sponsorship	
Project Title	Transit Oriented Development – A Case Study of Rosebank, City of Johannesburg

**I hereby undertake to carry out my research in such a way that:**

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

SIGNED BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	Michael Baylis		01 Jul 2016

APPLICATION APPROVED BY	Full name	Signature	Date
Supervisor (where applicable)	R BEHRENS		18 JUL 16
HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section 1; and for all Undergraduate research (Including Honours).	M VANDERSCHUER		24/8/16
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.			

## Appendix 2

<u>1</u> Residential Uses	<u>2</u> Office Uses	<u>3</u> Business Uses	<u>4</u> Medical Uses	<u>5</u> Industrial and Commercial Uses	<u>6</u> Public Garages	<u>7</u> Places of Public Worship	<u>8</u> Other Public Uses
<p>Dwelling Units: 1,0 space per dwelling unit of 3 or less habitable rooms.</p> <p>2,0 spaces per dwelling unit of 4 or more habitable rooms.</p> <p>In addition to the above ratios: 0,3 spaces per dwelling unit for visitors.</p> <p>Residential buildings in respect Of which an on-consumption licence has been granted in terms of the Liquor Act, (87 of 1997): 1,0 spaces per bedroom; other residential buildings such as Boarding Houses: 0,6 spaces per bed; Old Age Homes: 0,3 spaces per bed</p>	<p>3,0 spaces per 100m<sup>2</sup> of floor area but for Banks, Building Societies and Medical consulting rooms: 6,0 spaces per 100m<sup>2</sup> of floor area.</p> <p>Note: 4,0 spaces per 100m<sup>2</sup> is now used for new office applications.</p>	<p>Totalisator Agencies, Restaurants: 6,0 spaces per 100m<sup>2</sup> floor area</p> <p>Shops: 6,0 spaces per 100m<sup>2</sup> of gross leasable floor area or unusable site area.</p> <p>Car sale lots: 2,0 spaces per 100m<sup>2</sup> of floor area or unusable site area</p>	<p>Veterinary Surgeons consulting rooms: 6,0 spaces per 100m<sup>2</sup> of floor area.</p> <p>Hospitals: 2,0 spaces per bed.</p> <p>Medical consulting Rooms: 6,0 spaces per 100m<sup>2</sup> of floor area.</p>	<p>1,0 spaces per 100m<sup>2</sup> of floor area.</p>	<p>Workshop floor area: 6,0 spaces per 100m<sup>2</sup>.</p> <p>Lubrication bay, wash-bay or tune-up bay: 4,0 spaces per bay.</p> <p>Floor area for the storage and sale of spare, car showrooms: 2,0 spaces per 100m<sup>2</sup> of floor area.</p>	<p>Churches and Synagogues: 0,15 spaces per seat.</p> <p>Mosques: 10,0 spaces per 100m<sup>2</sup> of floor area.</p>	<p>All other uses not specified to be to the satisfaction of the City Council in terms of Clause 53 (2)(b) and (3).</p>



Rosebank	Number of People per Mode
Q25TRAIN	2
Q25SHOSLZA	0
Q25BUS	10
Q25BRT	0
Q25METTAXI	1
Q25MINITAXI	26
Q25LONGTAXI	0
Q25SEDATAXI	0
Q25BAKITAXI	0
Q25CARPAS	38
Q25CARDRIV	96
Q25TRUCKPAS	4
Q25TRUCKDRIV	0
Q25COMVEH	3
Q25MBIKE	1
Q25BICYCLE	0
Q25ANITRANSP	0
Q25BOAT	0
Q25AIRCFT	0
Q25GAUT	3
Q25WALK	23
Q25OTHR	1

Rosebank Modal Split

