Where Infrastructure Alone is Not Enough:

Developing Well-Functioning Non-Motorized Transport With a Focus on Cycling in the 'Northern-Inner' District of Cape Town

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Abstract

Post-apartheid Cape Town is characterized largely by a sprawling and inequitable city form. Well-located land within the city tends to be expensive, and as a result the majority of poor residents have to travel long and time-consuming distances to employment opportunities, often spending close to half their monthly income on commuting. Current development patterns largely perpetuate this situation. Whilst non-motorized transport (NMT) often presents as a potentially equitable and efficient form of mobility, the context of long distance commuting coupled with a lack of NMT-specific connected infrastructure within metropolitan Cape Town is not conducive to NMT.

The challenges and corresponding Interventions required to enable well-functioning NMT within cities broadly, and within the City of Cape Town in particular were explored through a variety of literature drawing on precedent from around the world, a review of NMT-related policy, and interviews with city officials and NGOs involved in promoting NMT. These challenges and interventions were then investigated in a particular context, namely the 'Northern inner' district of Cape Town, whereafter specific interventions were proposed.

Key findings regarding the implementation of well-functioning NMT (and cycling in particular) indicate that there are a number of interconnected factors that need to be considered beyond the provision of NMT-specific infrastructure. At the metropolitan level, by developing high-density affordable housing opportunities in well-located areas, more compact environments with increased proximity between origins and destinations can be created. Such environments are far better suited to NMT. This can in turn begin to address the inequitable and inefficient current city form. NMT-specific infrastructure is of course very important in all NMT-enabling development (and particularly for cycling), and as such the equitable provision of NMT-prioritized intersections, paths and lanes in relation to infrastructure for motorized transport are very important.

Finally, intermodal linkages between NMT and public transport, crime reduction through strategic placement and design of NMT infrastructure, and promotion of visibility and awareness of the value of NMT through public awareness campaigns

constitute broader required interventions to enable well-functioning NMT. Regarding implementation, given the multiple interconnected factors involved in creating well-functioning NMT, it is important that the proposed interventions take place simultaneously, through an integrated inter-departmental approach.

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List of acronyms

BEN	Bicycle Empowerment Network
BMP	Bicycle Master Plan
CoCT	City of Cape Town
CITP	Comprehensive Integrated Transport Plan
Du/ha	Dwelling units per hectare
EIA	Environmental Impact Assessment
GIS	Geographic Information Systems
IDP	Integrated Development Plan
NMT	Non-motorized transport
NGO	Non-governmental organization
PLTF	Provincial Land Transportation Framework
SDF	Spatial Development Framework
TCT	Transport for Cape Town
TDA	Transport and Urban Development Authority
UCT	University of Cape Town

Chapter 1: Introduction

1.1 Well-functioning non-motorized transport: the problem (and opportunities)

Like many other post-apartheid South African cities, the CoCT is characterized by a high level of spatial inequality. Apartheid spatial segregation along racial lines left an overall legacy of an inequitable and inefficient city form, which remains largely entrenched within the city. Well-located housing in the city in relation to socio-economic opportunities tends to be very expensive and thus inaccessible to the poor. The majority of poor residents in the CoCT live in neighborhoods that are far from employment and socio-ecoomic opportunities and as a result, have to commute long and time-consuming distances to work, often spending up to 40 percent of their salary on this commute (CoCT NMT Department, 2016).

Current middle and high-income development patterns within the CoCT are largely characterized by low-density greenfield developments on the outskirts of the increasingly sprawling city, with little regard for socio-economic integration (CoCT, 2012a). Subsidized housing for lower income groups has also largely been developed in peripheral areas within the city, mainly due to well-located land being very expensive, coupled with inadequate amounts of state subsidies (Tissington, 2011; McGaffin et, 2015). The creation of well-functioning mobility within a sprawling, low density and spatially inequitable CoCT is particularly challenging. Public transport within the CoCT has thus proven to be both costly and highly inefficient.

Whilst well-functioning non-motorized transport (NMT) has the potential to be an equitable, widely-accessible and efficient mode of transport within cities, the long-distance commutes that characterize many of the home-to-work trips within the CoCT are neither suitable for walking nor cycling. Instead, the current main functioning of NMT within the CoCT is as a necessity for many poor residents, in the form of the initial walking trip from home to public transport stops. In terms of

cycling, the relatively small numbers of commuter cycling tend to be divided between a small minority of middle class cyclists who generally have a choice of a wide variety of other viable transport modes, and a bigger majority of low-income commuter cyclists, cycling more out of necessity than choice, due to economic constraints (CoCT NMT Department, 2016).

There are a number of other significant barriers for NMT within metropolitan Cape Town. These include an overall lack of infrastructure for both cycling and walking; the lack of connectivity between the existing infrastructure; a lack of formal integration of NMT with public transport; and the lack of sufficient pedestrian and cyclist safety in relation to both motorized transport and crime.

There is an urgent need for the CoCT to begin developing well-located, high-density, affordable housing opportunities within the CoCT in order to begin to alleviate spatial inequality through improving access to socio-economic opportunities. This can in turn create a more economically sustainable and productive city form. It can also begin to solve many of the mobility challenges inherent in the CoCT, whilst creating more compact urban environments that are conducive to mobility in general, and well-functioning NMT in particular.

Moreover, such compact urban environments can be created with NMT (and cycling in particular) as a priority within the CoCT, in order to drastically reduce the high transportation costs faced by many residents, to create safer environments for pedestrians and cyclists, and to create greater intermodal connectivity with public transport, for more efficient overall mobility. This in turn can aid in creating an equitable means of connectivity between residents and socio-economic opportunities on a local scale. This requires a thorough understanding of the many issues involved in creating well-functioning NMT, beyond those relating purely to infrastructure at both the metropolitan and local scales.

1.2 Guiding values

This dissertation originates from a position that the principal goal of planning is to enable equitable and sustainable access to socio-economic opportunities, and to ensure the overall wellbeing for all. A key element of this approach is the provision

of housing that is both well-located and affordable (particularly for poorer residents), and the creation of compact, mixed-use environments which allow proximity between origins and destinations as far as possible. In turn, provision for equitable forms of both non-motorized and motorized modes of transport is regarded as key.

1.3 Dissertation format

The following chapter (Chapter 2) sets out the research question and method that guide the exploration of the above research problem in the dissertation going forward. Chapter 3 provides an overview of literature, exploring the diverse arguments for building NMT into cities, whilst Chapter 4 reviews policy and strategy documents relating to NMT on a national, provincial and municipal level. Chapter 5 constitutes a contextual analysis of municipal Cape Town, as well as a local area that constitutes the site for intervention. Chapter 6 then makes proposals for the local area, drawing on the previous three chapters. Chapter 7 draws final conclusions.

Chapter 2: Research method

2.1: Introduction

The purpose of this chapter is to provide an overview of the research undertaken for this dissertation. This chapter begins by outlining the research questions and purpose of the study. The research methods are then discussed, before finally moving to a discussion of the overall limitations of the research.

2.2 Research questions

The research questions addressed by this dissertation are:

1) What are the current development and mobility constraints and opportunities within the Cape Town metropolitan area in general and in 'Northern inner' district of Cape Town in particular?
2) What are the constraints on NMT, and cycling in particular, in the Cape Town metropolitan area and the 'Northern inner' district of Cape Town?
3) What interventions are required to build NMT into the 'Northern inner' district of Cape Town?

2.3 Research purpose

The current inequitable and sprawling spatial form of the CoCT is characterized by disconnection of (majority poor) residents from socio-economic opportunities. Current development patterns for both middle and high income residents, and low income residents (subsidized state housing) are largely reinforcing this disconnection. Mobility in general and NMT-specific mobility in particular are not functioning well as a result of long distances required to travel from home to employment opportunities within a sprawling city, a lack of NMT-specific infrastructure, a lack of integration between NMT and public transport, and largely unsafe conditions for NMT users. The primary aims of this dissertation are therefore to create a guide for planning interventions to enable both equitable access to socio-economic opportunities through well-located housing opportunities, and to create

well-functioning, efficient, safe, and equitable NMT within the CoCT.

2.4 Description of research method and techniques

The overall approach taken by this dissertation is the case study method. The research began with a review of largely international literature on the importance of NMT in cities, and on the arguments for building NMT into cities. The literature was initially sourced, searching online journal databases for key words such as 'cycling', 'walking', 'pedestrians', 'bicycles', and 'non-motorized'. Relevant journal articles were then identified, and subsequent literature was sourced through the respective bibliographies of these journals. Additional literature on NMT within the global south in particular was sourced from the University of Cape Town (UCT) Center for Transport Studies. The arguments put forward by various authors were compiled into sub-sections regarding the variety of factors involved in enabling well-functioning NMT. The purpose of the literature review was to extract the concepts that have shaped thinking about NMT, and to highlight precedent from other parts of the world that presented approaches to NMT which either worked well, or did not work well. Particular attention was given to examples from the global south, given the project site's location in the global south.

Thereafter, by reviewing policies referring to NMT on a national, provincial and municipal level, an overview of the institutional context for NMT within the CoCT was gained. The infrastructure proposals from CoCT NMT policy and strategy documents were also reviewed, and in turn formed the basis of the bicycle and pedestrian facility infrastructure guidelines in the proposal chapter.

In order to ground the literature review and the policy review in particular, a semi-structured interview was conducted with the City of Cape Town Non-Motorized Transport department on 12 August 2016. This interview helped to gain a deeper understanding of the CoCT NMT policy and strategy documents, as well as some of the bigger issues facing NMT within metropolitan Cape Town. Limited site visits also took place throughout the research period via car and on foot.

Additionally, a second interview was carried out with the chairperson of the Bicycle Empowerment Network (BEN) NGO, Louis de Waal at the BEN headquarters in

Marina de Gama in Cape Town on 5 August 2016. De Waal is a retired civil engineer and has been instrumental in promoting cycling within the city for many years, and is recognized as such by many transport engineers and activists within the city (Ride Your City, 2011). The interview was thus also very useful in order to gain a deeper understanding the issues facing NMT within the CoCT, as well as to gain insight into aspects of NMT policy implementation that are often inadequate within the CoCT. The two interviews were conducted in a conversational manner as far as possible. The interviews were recorded and later transcribed, from which key issues were identified in relation to the NMT-related policies reviewed.

The next step was to undertake a contextual analysis both at the metropolitan level, and at the level of the project site. The Northern inner district was chosen as a case study site for the project. The district is well-located and accessible (straddling both the N1 and N7 highways, and the Koeberg and Voortrekker Road corridors) in relation to both the Cape Town and Bellville CBDs. The district has seen increasing development in recent years, whilst parts of the district have been identified by the Cape Town Spatial Development Framework (SDF) as the 'economic hub' of metropolitan Cape Town (CoCT, 2012a). The site also consists of two large parcels of under-utilized and well-located state-owned land (Ysterplaat Air Force Base and Wingsfield Military Base) with potential for development. Thus, given its prominent location and development potential, the Northern inner district was chosen as the project site in order to function as a case study for future NMT-prioritized equitable development within the CoCT.

The project site was analysed in terms of economic opportunities, land-use, mobility, environmentally sensitive areas, and developable land. The data for this analysis was obtained largely from CoCT policy documents, Geographic Information Systems (GIS) data, Google Maps, and Google Street View.

The contextual analysis, combined with the sub-sections presented in the literature review, and the infrastructure proposals in the CoCT NMT policy and strategy documents, formed the basis for proposals for the project site. Well-located residential densification, and equitable, safe and efficient NMT functioning were prioritized. It is important to note that whilst the research and proposal processes as a whole followed a linear structure, and incrementally stepped down in scale,

many steps in the process were iterative. Researching precedent and interviews for example, frequently led to changed perceptions, further reading, and reworked proposals. In many ways, this constitutes 'triangulation' whereby the use of multiple data sources and methods leads to increased validity and reliability within research, making findings more robust (Yin, 2004; Lauria & Wagner, 2006).

The initial values outlined in the previous chapter largely informed the approach of this dissertation, and as such constituted a guiding force for the literature and policy reviews, contextual analysis, and ultimately for the proposals for the project site. The research process of this dissertation is illustrated in figure 2.1.

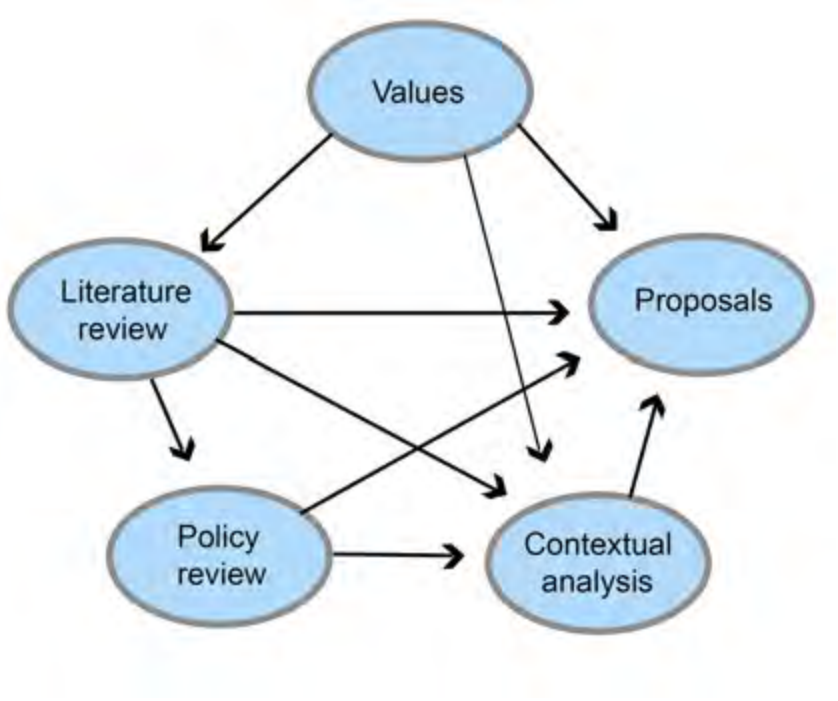

Figure 2.1: Research method flow diagram (Source: Author)

2.5 Strengths and limitations of case study research method

According to Yin (1994), the case study research method is most pertinent firstly to answer descriptive questions (such as 'what?' and 'how'), and secondly to collect data in 'natural settings' instead of having to rely on 'derived' data. The method is therefore best suited to the objectives of this dissertation. Flyvberg (2011) contends that cases should be studied in relation to their broader contexts, and in relation to a series of interrelated circumstances and events. This is especially relevant to planning in general, and planning in South Africa in particular, given the historical

complexity and persistent inequality within post-apartheid South African cities.

Regarding the strengths of the case study method, Flyvberg (2011) contends that detail, depth and richness can be gained through the in-depth study of a case, which would not otherwise be possible through a broader level study. Furthermore, Duminy et al (2014) contend that the case study method allows the necessary nuanced view of reality, particularly pertinent for the inherently socially complex task of planning, which can allow relevant understanding of the current urban challenges faced.

The impossibility of generalization of results from the in-depth case study method to all other case studies is often cited as the biggest limitation inherent in the method. Flyvberg (2011) states that formal generalization on the basis of a single case is overvalued and in many cases problematic. Instead, he proposes 'transferability' whereby cases aid in the accumulation of knowledge within a field, which in turn can be transferrable to different contexts, and 'falsified' through a scientific approach, if not applicable to the new context.

Additional criticism is also leveled at the case study method as being biased towards verification of preconceived notions of researchers. Whilst it is always important to be aware of bias and subjectivity within research, Flyvberg (2011) contends that subjectivity is characteristic of all methods of research, and that an in-depth case study method in particular tends towards falsification when the nuances inherent in the specific context under study are unpacked (Flyvberg, 2011). The Northern inner district was thus chosen as the project site in order to study the complexities inherent in developing well-functioning NMT-prioritized equitable development. The findings could in turn be tested in other areas within metropolitan Cape Town, through further in-depth case study analysis.

2.6 Research constraints

In addition to the limitations inherent in the case study method explored above, there were several limitations and constraints in the overall research process. The time constraint of the dissertation proved to be one of the major constraints. Full time research commenced on 30 May 2016, and the dissertation was handed in on

7 November 2016. The depth and breadth of research and analysis was therefore limited. Whilst only two interviews were conducted during the research period, further interviews with NGOs, social campaigns actively involved in the promotion of NMT within the CoCT, and in the development of the project site region, would have added greater depth and nuance to the research.

The time constraint placed an additional limitation on site visits. An ethnographic method with participant observation techniques would have proven very useful for the research as a whole. Bernard (1995) contends that participant observation allows a greater understanding of the direct lived experiences of research participants. Direct observations, conversations with residents who utilize NMT within the site, and substantial direct experiences of the site, both on a bicycle, and on foot would thus have added important insight into both policy and contextual analysis, and to NMT-specific proposals made for the project site.

2.7 Conclusion

This chapter outlined the research questions and purposes that have guided this research. It then explored the steps undertaken in the following chapters, before exploring the case study method in this dissertation. The limitations of the research undertaken were then outlined. The next chapter will begin an exploration of literature in order to extract concepts and precedents to guide the implementation of NMT within the project site.

Chapter 3: Non-motorized transport: a literature review

3.1 Introduction

The intervention proposed by this dissertation in the defined metro sub-region will place a particular emphasis on the implementation of (NMT). As such this chapter shall examine literature from various cities across the world on the diverse preconditions for successful implementation and functioning of NMT. NMT can be defined as that which uses human power or animal power rather than machine power. Whilst there are many forms of NMT, the dominant forms in cities throughout the world are walking and cycling. Therefore within this chapter, NMT shall be used in order to refer to walking and cycling.

This chapter begins by firstly exploring factors relating to the impact of the built environment, before turning to an understanding of the importance of intermodality in terms of the relationship of NMT to other modes of transport. This is followed by a consideration of factors relating to the equitable provision of NMT facilities in relation to the provision of facilities for other modes of transport. The influence of crime on NMT is then investigated, before turning to factors relating to the natural environment. Finally, beyond infrastructural aspects, cultural and social factors involved in the successful implementation of NMT are explored. This chapter thus provides the theoretical basis for the remainder of this dissertation.

It is important to note that there is significant contestation amongst authors writing on NMT around what are considered important factors involved in the successful functioning of NMT in cities. Many authors agree that there are a number of factors influencing successful NMT functioning across a variety of contexts. For the purposes of a coherent analysis however, the pertinent arguments regarding various factors for successful NMT functioning have been divided into the sections listed above. Additionally, cities that fall within the Global South tend to have significantly different contexts within which NMT can take place. As much of the literature around NMT originates from cities within the Global North, and given the significant differences in the challenges faced within the Global North as compared to the Global South, it is important to gain an understanding of the issues specific to

Global South cities. This is particularly as the focus of this dissertation is on Cape Town, namely a city within the Global South. As such, this chapter draws on literature and examples from cities within both the Global South and the Global North.

3.2 Built environment factors

Furness (2010) contends that whilst NMT is an extremely important form of mobility, it remains neglected in many cities around the world. Infrastructure, urban design and dominant cultural norms commonly and historically favor motorized transport in general and private car travel in particular.

When considering cities where NMT functions effectively, Dutch cities are often the first to come to mind. Within the three largest Dutch cities, NMT accounts for 40% of commuting trips and 67,4% of retail trips. Given the intensive regulation of spatial development in the Netherlands since the 1970s, and the corresponding high levels of cycling and walking in large- and medium-sized Dutch cities, the Netherlands is an important case from which to explore urban design and infrastructural factors on the travel behavior of individuals. Schwanen et al (2004) contend that among other factors, built environment factors play a strong role in this. They argue that over the past two decades, the Netherlands has paid significant attention to the impact of urban form on transport mode choice and travel distance.

In comparison with cities in the United States, Schwanen et al (2004) argue that European cities in general have placed greater emphasis on policies that encourage the development of compact urban forms and investment in built-up areas, rather than on policies that allow for privately financed and less-directed urban growth. Compact urban forms and mixed use, which allow residential proximity to retail facilities and work opportunities, tend to allow for reduced trip lengths, and in turn more convenient conditions in which to walk and cycle, provided walking and cycling infrastructure is in place (Schwanen et al, 2004).

Interestingly, despite having one of the highest NMT rates in general, and cycling rates in particular within Western Europe, the average Dutch commute was measured at an average of 46 minutes per day, substantially higher than many

other Western European countries. Dutch commutes however are different from other Western European countries as the total share of NMT modes of transport is in many cases up to three times higher within Dutch cities. The authors contend that some of the reasons behind this are pro-bicycle and public transport planning, as well as overall less positive and supportive attitudes towards cars in the Netherlands (Schwanen et al, 2004).

Cervero and Duncan (2003) contend that well-connected streets, smaller block sizes, mixed land use and residential proximity to retail activities are instrumental in increasing NMT. They argue that these built environment factors naturally allow for decreases in overall trip distances and reductions in the need for individuals to travel beyond their immediate neighborhood, and in turn contribute significantly to increasing NMT (Cervero and Duncan, 2003).

Cervero and Duncan (2003) argue that with regard to walking, diversity of land use and density in terms of employment opportunities within a small radius of roughly 1,5 kilometers from the trip origin are argued to be the strongest positive factors influencing walking. Urban design elements such as block size and gridiron streets were however not considered as influential on the decision to walk. Cycling on the other hand was argued to be most positively influenced by both diversity of land use and density of employment opportunities within a bigger radius of roughly 8 kilometers of a person's origin. Urban design elements are argued to have a significantly bigger influence on cycling than on walking, at the destination more so than at the origin of cycling trips. This is presumed to be as a result of dense employment settings such as urban centers having high numbers of roadway conflict points and potential safety hazards (Cervero and Duncan, 2003).

In an analysis of Beijing, Zhao (2013) explores the influence of built environment factors on bicycle commuting within a country previously known as 'the kingdom of bicycles'. Over the last two decades, the city has seen a rapid decline in bicycle usage. Zhao (2013) contends that in addition to built environment and urban design factors, other such socio-economic and demographics factors also have an effect on cycling and NMT prevalence in cities. Within Beijing, 82% of bicycle trips take place within 3,5 kilometers of their destination. As such, Zhao (2013) has taken

a radius of 3,5 kilometers from the trip destination as the space within which to analyse the impact of the built environment on cycling (Zhao, 2013).

With regard to built environment factors then, Zhao (2013) found that a low spatial correlation between jobs and housing, and single use environments has shown to decrease the probability of cycling. Furthermore, lower destination accessibility indicated usually by longer travel time also tends to lead to a smaller likelihood of cycling. Regarding residential density, Zhao (2013) argues that whilst many authors in Europe and North America see it as a strong influence on decisions to cycle, Zhao (2013) argues that it does not make any clear impact in Beijing. In order to promote cycling then, policies that can shape a mixed environment are of utmost importance in Beijing, as these can begin to quell the increasing single-use segregated land use found in the city, as well as the factors decreasing the likelihood of cycling listed above (Zhao, 2013).

Exclusive bicycle lanes are associated with increased probabilities of cycling. However, Zhao (2013) found that in relation to this, a diversity of land use is a more effective determinant of cycling. For Zhao (2013) then, the most effective means to encourage cycling for commuting is to combine improvements in cycling-specific infrastructure, like exclusive bicycle lanes separate from motorized traffic, with built environment-based improvements, namely the mixing of land use. China's increasingly market-driven housing reform has led to increased distance being between jobs and residences through increasingly single use environments. This trend is thus occurring in a similar way to the trend within many cities in the United States, as noted by Schwanen et al (2004) above. In terms of creating more radical change in favor of NMT then, Zhao advocates for policy to place NMT in general and cycling in particular on par with motorized transport. This equity should be reflected in overall government spending on transport (Zhao, 2013).

Levels of cycling in the United States and Canada are commonly assumed to be similar as a result of the countries' proximity to one another. Pucher and Buehler (2006) found however that Canadian cities have a much higher cycling rate in comparison to those in the US. In some cases the rate is up to three times higher. Pucher and Buehler (2006) argued that in 2000/2001, cycling within the US accounted for 0,4% of all commuting trips, whilst in Canada cycling accounted for

1,2% of commuting trips. In an analysis of this difference, the authors found that amongst other factors, built environment factors play a significant role in the higher cycling rate

In relation to cities in the US, Canadian cities tend to have more mixed use development, less suburban sprawl, and higher residential densities. Pucher and Buehler (2006) contend that the densities of the five largest Canadian metropolitan areas (2620 persons per square kilometer) have averaged higher than the ten largest United States metropolitan areas (1270 persons per square kilometer) by 76%. This has resulted in a greater proximity between origins and destinations, shorter trips, and thus greater bikability and walkability (Pucher and Buehler, 2006). The authors argue that if the United States is to increase its levels of cycling and of overall bikability, it is essential to put policy 'sticks' in place. Such 'sticks' are non-negotiable policies, namely strict land use leading to higher densities and more mixed use developments, like those found in European cities such as Amsterdam. Additionally, car-reducing policies such as those which raise fuel and parking taxes are essential (Pucher and Buehler, 2006).

In exploring a city well known for developing NMT in recent years, Cervero et al (2009) explored the influence of built environment factors in Bogota in Colombia. The authors contend that the case of Bogota is a very unique example. Bogota is city well known for its sustainable urban transport systems, in particular its cycle infrastructure and designated pedestrian spaces. From the years 1996 to 2003, the share of trips within the city increased 0,58% to 4,4%. Bogota is also a city that falls within the Global South, and has significant levels of poverty and inequality, with over half of the population living below the poverty line (Cervero et al, 2009).

In the city of Bogota, Cervero et al (2009) argue that compact neighborhoods with small blocks averaging 40 by 40 meters, mixes of retail facilities, housing, schools and economic opportunities are commonplace and have historically been so within the city. The authors contend that of greater significance in terms of the growth in NMT usage however has been the construction of NMT-specific infrastructure. Dedicated 'set aside' cycle ways and pedestrian facilities within close proximity to trip origins, namely residences, are commonplace. Cervero et al (2009) therefore argue that the built environment conditions in place prior to the

construction of NMT infrastructure were ultimately instrumental in the creation of well-functioning NMT systems. This is illustrated further by looking at newer, car-oriented neighbourhoods within Bogota. Within these neighbourhoods, land use activities are segregated over long distances, and despite NMT infrastructure being in place, NMT usage is significantly reduced in comparison with the more compact neighborhoods mentioned above (Cervero et al, 2009).

From the variety of arguments explored, it is thus clear that there is no clear-cut definition regarding which built environment factors are considered most important. However, the authors explored above agree that compact, mixed land uses, and correspondingly shorter travel distances and times are important factors in well-functioning NMT. It is also clear that there is variety between contexts in terms of which specific built environment factors are of greatest significance.

3.3 Intermodality

As with other modes of transport, is important that NMT is not understood in isolation. Instead NMT needs to be conceptualized in terms of its interrelationship with a variety of transport modes. According to Barnfield and Plyushteva (2015) through an analysis of cycling in Sofia, Bulgaria, increasing the role of cycling within cities should not come at the expense of other modes of transport. Instead, the authors argue that moving around cities is inherently about combining different travel modes (Barnfield & Plyushteva, 2015).

Whilst policy and discourse often tend to refer to cyclists in a single identity, Barnfield and Plyushteva (2015) emphasize that cyclists in Sofia cannot be defined in terms of a singular modal identity. Where possible cyclists take bicycles on trains within Sofia as connecting or intermediate phase of their trips. As in many cities in the world, in Sofia, there is no provision for bicycles on other modes of transport such as busses and trams, both physically and in within policy. Barnfield and Plyushteva (2015) thus contend that the ability of cyclists to travel with bicycles on public transport, combined with a greater public awareness of this would make a substantial difference in terms of overall cycling provision in Sofia (Barnfield & Plyushteva, 2015).

Similarly, Schwanen et al (2004) argue that competition between the bicycle and public transport, as with the bicycle and the motorcar, should be avoided as far as possible. Instead the allowance of bicycles to be transferred on public transport should be encouraged in a complimentary approach (Schwanen et al, 2004). Zhao (2013) explicitly states that within the city of Beijing, effective public transport systems actively reduce NMT use in general and cycling in particular unless integration between modes is actively facilitated (Zhao, 2013).

For Vuchic (1999), from a broader perspective, balanced transportation systems are key to sustainable city development. Such systems are intermodal, where each mode performs where it is most efficient operationally and physically in order to provide the most convenient and economically efficient means of transportation to passengers. NMT and public transport should be promoted as the most important modes to plan for (Vuchic, 1999). The UN Habitat report (2013) on urban mobility states that in the developed world, the bicycle often functions as a feeder mode in order to serve public transport facilities. Schwanen et al (2004) therefore argue that it is important to create travel times that are competitive with the unsustainable private car dominance, through this interconnection between NMT and public transport (Schwanen et al, 2004).

3.4 Crime

In a study of cycling within the Masiphumelele township in Cape Town, Irlam (2016) found that the reality of crime was a significant factor in deterring residents from cycling. Many residents shared a common fear of bicycles getting stolen, particularly when cycling to work in the dark in the early hours of the morning, or late at night. Irlam (2016) also found that women were less inclined to cycle than men largely as a result of fears around crime and the potential of getting attacked whilst having their bicycles stolen. Concerns around crime within the Masiphumelele community are argued to be exacerbated by a longstanding lack of police presence (Irlam, 2016).

Fears around bicycle theft in terms of storage are also widespread and are often also a barrier to cycling. Irlam (2016) contends that small homes in Masiphumelele are often too overcrowded to fit bicycles inside, whilst train stations, taxi

interchanges, schools and workplaces are often neither equipped with bicycle storage facilities, nor are the facilities secure. Irlam (2016) argues that given that many of the residents catch the train everyday, stations should urgently create secure facilities for storing bicycles, whilst cyclists within the community should look to cycle together through activism programs and in turn increase both individual and collective safety from crime and attacks (Irlam, 2016).

With regard to creating safer NMT infrastructure, McClintock (2002) argues that paths that combine both pedestrians and cyclists tend to reduce the risk of crime as higher volumes of concentrated NMT traffic allow for greater overall surveillance. Additionally, McClintock argues that higher densities surrounding NMT paths is of further significance in reducing crime. He argues that more segregated lower density layouts tend to face higher levels of theft and attacks (McClintock, 2002). Similarly, Behrens (2005) contends that within the context of South Africa, where high levels of violent crimes and corresponding fears are widespread, it is particularly important that pedestrian pathways enable continuous movement, connecting discontinuous cul-de-sacs and crescents, and creating paths that are as open to public surveillance as is possible (Behrens, 2005).

Crime and associated fears are by no means limited to countries within the Global South. Brands et al (2013) conducted a study on crime and its subsequent effects on NMT during the night time within the city of Utrecht in the Netherlands. They argue that that gender plays a strong role in fears around walking and cycling at night within the city, as women are likely to avoid walking and cycling as far as possible at night. Brands et al (2013) contend that solutions to crime and the fear regarding crime cannot be found in generic policies such as improving lighting and police presence. Instead, policy-makers should look into how lighting can be made 'smarter' such as through lighting 'buffer zones' surrounding walking and cycling paths, in addition to lighting the paths themselves where potential criminals could hide. Additionally, the authors recommend police patrols on foot or on bicycle rather than in cars, particularly in crime hotspots (Brands et al, 2013).

3.5 Equitable infrastructure and facility provision

Within many cities in the world, there exists an inequality in terms of both policy relating to NMT, as well as the physical provision of NMT infrastructure themselves. The UN Habitat report (2013) on urban mobility states that in 2005, roughly 37% of all urban trips worldwide were either made on foot or on a bicycle.

Hutabarat Lo (2010) contends that high levels of income, mobility and infrastructural inequality characterize the city of Jakarta in Indonesia. This inequality is closely reflected in policies and development relating to mobility and pedestrian infrastructure. The provision of infrastructure for pedestrians in the city has been inconsistent. Hutabarat Lo (2010) contends that the provision of pedestrian infrastructure has increasingly been in the form of exclusive pedestrian plazas and retail precincts. Such infrastructure reflects the overall inequality that characterizes Jakarta, as such facilities tend to only be accessible by wealthy residents of the city, whilst such facilities are not provided for the city's poor. There is thus a need to provide pedestrian-specific infrastructure for poor residents of the city, as the poor have consistently been neglected in this regard (Hutabarat Lo, 2010).

In moving to African cities, Pirie (2013) contends that in the worldwide list of having 'best practice' mobility that is economy promoting, socially inclusive and environmentally friendly, African cities are conspicuously absent. Pirie (2013) argues that most Anglophone Sub-Saharan African (ASSA) cities are facing generalized problems of traffic congestion, high accident rates and pollution. Additionally, mobility rates within ASSA cities tend to be very low in comparison with many cities within the Global North. Poverty tends to be a significant cause of low mobility rates (Pirie, 2013).

With regard to NMT within ASSA cities, populations tend to have a high dependence on walking within these cities, yet it tends to be a highly neglected aspect both within policy and in terms of physical infrastructure. Cycling is not very widespread within many ASSA cities. Pirie (2013) contends that in many ASSA cities, NMT is not considered to fall within the category of transport, and thus often is not included in transport policy. High rates of walking within ASSA cities are often the result of inefficient and geographically fragmented publicly-provided transport

services. Pirie (2013) contends that in many ASSA cities, people dependent on NMT are forced to share the same street space with motorized traffic, as the welfare of pedestrians is frequently sacrificed to ensure more efficient flows of motorized traffic. In areas where pavements are provided, there is often competition for space with traders (Pirie, 2013).

The benefits of building NMT into ASSA cities are manifold. Pirie (2013) argues that it can significantly increase labour productivity and efficiency by allowing more personalized and flexible mobility, and increase the overall safety of pedestrians and cyclists within ASSA cities. Additionally, job creation in the form of small enterprises such as bicycle repairs can begin to blossom. This in turn can have positive knock-on effects on the environment, economies, safety and overall efficiency of ASSA cities (Pirie, 2013).

In terms of solutions to the NMT problems, Pirie (2013) suggests increasing sidewalks and pedestrianized areas, and importantly maintaining them, particularly regarding the negotiation of space with traders. From a broader perspective, an overall spatial separation needs to take place between motor vehicles, cyclists and pedestrians. Additionally from a non-infrastructural perspective, Pirie states that the obstructive attitudes of many officials have proven problematic as NMT is often considered a 'primitive' mode of transport (Pirie, 2013).

In an analysis of transport planning in Nairobi, Khayesi et al (2010) contend that the city has not adequately taken care of NMT and the informal economy. The resulting state has been a competing use of roads and pavements, where the most vulnerable road users in relation to motorized traffic, namely cyclists, pedestrians and street vendors have been subject to insecurity, harassment, and overall neglect by planners and policy. In Nairobi, walking is argued to be the most important mode of transport. As mentioned by Pirie, NMT too tends to be associated with anti-modernity and inefficiency (Khayesi et al, 2010).

In terms of solutions, Khayesi et al (2010) argue that physical streets should be spaces that enhance both physical movement in general, and physical movement in its diversity. Within the context of Nairobi, informality on streets in terms of trading constitutes a big industry and as such needs to be catered for in policy and

practice. Additionally, as fuel resources are increasingly in decline, Khayesi et al (2010) argue that policy needs to reflect a radical reorientation away from the fixation on the motor vehicle. Increased pedestrian and cycling infrastructure should thus ensue within the city (Khayesi et al, 2010).

Salon and Aligula (2012) also studied urban mobility in Nairobi. They contend that the trend both within the city and in many cities in sub-saharan Africa is that as people become wealthier, they tend to change to modes of transport that are safer, more reliable and more comfortable. Thus those who can afford it tend to buy cars, whilst those who can't afford to buy cars tend to take public transport or taxis. Those who can't afford public transport or taxis tend to walk. The outcome of such trends is thus that as residents become wealthier, congestion will increase (Salon and Aligula, 2012).

Salon and Aligula (2012) contend that many of the poor residents live in informal settlements along main transport corridors within the city and close to employment corridors. Additionally, a large portion of Nairobi's population is unable to afford any form of public transport and as such is limited to NMT, with walking being overwhelmingly dominant in relation to bicycles. Short walking trips in proximity to their neighbourhoods remains the reality for a majority of Nairobi's population. Nairobi and many other sub-Saharan African cities therefore need to focus on making life safer for the vast numbers of pedestrians not catered for, whilst simultaneously making NMT more attractive by providing sufficient infrastructure and creating differentiated services to cater for a variety of income groups. Additionally, policies need to be implemented that can begin the process of reducing traffic congestion, such as parking taxation, particularly close to the CBD (Salon & Aligula, 2012).

In a comparison of travel behavior between Nairobi, Dar es Salaam and Cape Town, Masaoe et al (2011) found that NMT plays a significant role in all sub-Saharan African cities. The authors contend that Nairobi and Dar es Salaam have high demand for both NMT and public transport, particularly given the vast numbers of residents living below the poverty line. As such, Masaoe et al (2011) contend that the biggest mobility challenges for Nairobi and Dar es Salaam are to find ways to provide for the demand of NMT and public transport. In Cape Town however,

policies that aid in increasing NMT and public transport usage are encouraged, particularly across the greatly varied income groups, within the context of high numbers of poorer residents using NMT and public transport out of necessity, the majority of wealthier residents using private cars because they can afford it (Masaoe et al, 2011).

From the above authors, it is clear that NMT is very important for the efficient functioning of cities, and particularly those within the Global South. Policy-makers thus need to begin to understand the value that well-supported NMT can bring to cities largely reliant on it, whilst simultaneously planning for the complexity that can be found on the level of the street.

3.6 Natural environment factors

Whilst it is evident that built environment and infrastructural factors have an influence on NMT, factors relating to the natural environment also have a significant impact on NMT usage. Cervero and Duncan (2003) take a strong position on this influence. They argue that the factors of weather and topography need to be understood if we are to comprehend fully the built environment influences on NMT. In a study on the San Francisco Bay area in the United States, Cervero and Duncan (2003) contend that darkness, rainfall and topography had a stronger influence on whether people use NMT than that of the built environment. With regard to darkness, it was found that people were significantly less likely to walk or cycle in the dark in the San Francisco Bay area. With regard to rainfall however, the authors found that it did not decrease the overall likelihood of cycling; however it was found that people were much less likely to walk in the rain. In terms of topography, the authors found that steep terrain deterred walkers more than it deterred cyclists (Cervero and Duncan, 2003).

Rodriguez and Joo (2004) explored the effects of topography on NMT in more detail. They argue firstly that steep topography discourages both walking and cycling, as commuters tend to want to avoid vigorous physical activity before getting to work or to school. Secondly, the authors cite the significance of travel time as cycling or walking on steep slopes tends to significantly increase travel times. Cervero and Duncan (2003) therefore argue that it is important to plan NMT

routes and infrastructure with an understanding of both built environment and natural environmental factors, namely planning routes as far as possible to avoid hilly and steep terrain (Cervero and Duncan, 2003).

In looking to a city in the Global South where initiatives to promote walking and cycling have proven very successful, Cervero et al (2009) argue that factors relating to the natural environment played a significant role in Bogota's successful promotion of NMT. The authors contend that Bogota is situated on a plateau and faces a very mild climate. Thus the city falls within conditions that are argued to be conducive to NMT (Cervero et al, 2009).

It is important to note however that the cities in the Global North, such as Amsterdam and Copenhagen, where NMT and cycling in particular is widespread and successfully functioning, face significantly different climates to that of Bogota. In a countrywide study on cycling in the Netherlands, Rietveld and Daniel (2004) contend that whilst the Netherlands is largely characterized by predominantly flat topography and very widespread cycling overall, in cities in the Netherlands where there is hilly terrain, it was found that cycling tends to be less frequent in comparison to those with overall flatter terrain. With regard to the weather, unlike Bogota, the Netherlands faces far colder and wetter conditions overall. Rietveld and Daniel (2004) argue that whilst factors of wind and rain which are frequent in the country tend to diminish the overall comfort, pleasure and effort of cycling, people tend to adapt to the conditions by taking preventative measures such as wearing waterproof clothing, rather than switching to another mode of transport (Rietveld and Daniel, 2004).

In a comparative study of cycling between London and Amsterdam, Qi (2014) found that between the two cities, the weather is a minor consideration for people to take up cycling, but is rather a consideration for someone who is to cycle more. Qi (2014) found that the respondents were mostly used to the weather, and as such it was of small concern to them. It was however noted that protective clothing, and good facilities such as covered parking areas could help to mitigate these concerns. Additionally of interest in the study is that whilst it is often claimed that lower levels of cycling in London are due in part to worse climatic conditions, detailed examination of the average conditions of the two cities revealed London

has more favorable conditions for cycling in terms of temperatures, rainfall, and number of rainy days (Qi, 2014).

Whilst it is clear that natural environment factors do indeed have an influence on NMT usage in cities, the degree of this influence is ultimately contested. In terms of topography, both cycling and walking are less likely to take place on steep terrain. However, in terms of aspects relating to the weather, there are cities where NMT and cycling in particular are significantly widespread in mild climates such as Bogota, as well as in climates with less-favorable colder and wetter climates such as Amsterdam.

3.7 Social and cultural factors

The provision of infrastructure alone is not sufficient in order to create successful NMT within cities. In cities where NMT functions effectively, it is common to find a 'culture' whereby walking and cycling is understood and valued as an effective and valuable means of urban transport and mobility.

In the context of Brazil, Jones and Novo de Azevedo (2013) contend that Brazil has seen an increasing culture of consumption, largely in pursuit of acquiring cars. The authors argue that within the country, the motor industry has been effective in linking car ownership with Brazilian identity. High traffic congestion and high accident rates of pedestrians and cyclists have ensued as car ownership has increased. Jones and Novo de Azevedo (2013) contend that cycling tends to have significant stigma attached to it, particularly as mainly low-income residents cycle for commuting purposes. Given that the majority of people aspire to be higher income, the authors label low-income cyclist 'invisible' within the Brazilian context (Jones & Novo de Azevedo, 2013).

Recreational cyclists however are labeled as 'visible' as they tend to be middle class, and tend to cycle within designated boundaries, such as on purpose-built trails. Invisible cycling therefore tends to be very dangerous within contexts favoring the acquisition and possession of cars. It is thus essential that commuter cycling be made visible by embedding it in the urban fabric through dedicated bicycle infrastructure that is separate from motorized traffic, and in turn encouraging all

classes in society to cycle. Jones and Novo de Azevedo (2013) thus contend that it is essential to create a culture of cycling beyond just the provision of infrastructure, before lower paid workers purchase cars in the context of incomes rising and credit becoming more available.

Within cities where cycling is considered to be established, Aldred and Jungnickel (2014) argue that cycling has become normalized to the extent that it has become 'culturally invisible'. Cities such as Copenhagen and Amsterdam can be considered examples of where cycling has become 'culturally invisible' to a large extent. In contexts where it is still emerging however, harder work is required in order to attain meanings, infrastructures and institutional competences that can lead to cycling becoming 'visible' (Aldred & Jungnickel, 2014). Jones and Novo de Azevedo (2013) cite an example within Brazil that aimed to begin changing the 'culture' and overall perceptions of cycling. The government-funded 'Way to School' social program was an initiative aimed at guaranteeing students access to school. 27 000 bicycles were distributed across 70 municipalities. Jones and Novo de Azevedo (2013) contend that the initiative was an effective means to begin to create this 'culture', and improved regard for cycling by beginning with the youth (Jones & Novo de Azevedo, 2013).

As in Brazil and many countries around the world, Williams and Arkaraprasrtkul (2016), found that car ownership and aspirations towards car ownership dominate within the city of Shanghai. They argue that such aspirations are a cultural phenomenon, despite Shanghai having the most extensive metro train network in the world, and thus high corresponding availability of public transport. The authors contend that the combined impact of many individuals acting out of their self-interest in terms of owning and driving cars is destroying the system as a whole, whilst significantly reducing its benefits as the current system is both environmentally and socially unsustainable. The system as it stands is ultimately limiting the agency of the Shanghai residents as a whole through high rates of congestion (Williams & Arkaraprasrtkul, 2016).

Williams and Arkaraprasrtkul (2016) contend that in order for sustainable change to be made, in addition to creating cycling and public transport infrastructure, the symbolism of the car itself needs to be targeted and in turn displaced by

subsequently raising the symbolic appeal of cycling and mass transit. The authors suggest that the approach of the city of Bogota has been successful in this regard. They cite the building of extensive NMT infrastructure, reducing space and ease of movement for cars within the city and implementing the 'ciclovia' program whereby all streets are closed to cars and opened for NMT use only on Sundays and national holidays. Williams and Arkaraprastkul (2016) suggest that such a move in Shanghai would increase the agency of individuals increasingly constrained by the proliferation of car and corresponding congestion and pollution within the city. This is particularly urgent in the context of an increasingly strong economy such as that of Shanghai (Williams & Arkaraprasrtkul, 2016).

To bring the focus to a South African context, Mashiri et al (2013) contend that the country has seen a limited exposure to the range and potential benefits of NMT. The solution to the problem is manifold. Firstly, the authors see a need to begin at a grassroots level by developing a critical mass in terms of NMT ownership and usage. This should be achieved by targeting specific groups of society, namely school and tertiary communities, communities located within inaccessible areas, and amongst employees for their employers. Beneficiary communities need to be actively involved in such projects, whilst simultaneously building and maintaining value chains ensuring availability of spare parts, 'after-sales' service, and ultimately building beneficiary capacity within communities. NGOs such as the Bicycle Empowerment Network are currently undertaking projects moving in this regard (Mashiri et al, 2013).

Mashiri et al (2013) argue that exposure to successful and widespread functioning of NMT in South Africa has tended to be very limited. They argue that this limited exposure often wrongfully masquerades as cultural barriers within the country. To overcome this, the authors recommend widespread advertising and awareness campaigns (Mashiri et al, 2013). Within Cape Town, initiatives such as Open Streets that has taken place in a variety of neighborhoods whereby streets are closed to motorized transport and opened only for NMT (based on the Ciclovia initiative from Bogota), can prove effective in this regard.

In promoting NMT further, Mashiri et al suggest that both labour and faith-based organizations should play an active collective role. Additionally, training programs

around the engagement with and the potential economic opportunities surrounding NMT should be held. In totality, the authors argue that an entire social change initiative needs to take place, positioning NMT away from a mundane mode of transport (Mashiri et al, 2013). Similarly regarding public participation, Lubitow et al (2015) contend that public participation and relationships with community members is key. They argue that it is important to understand how walking and bicycles are understood locally before infrastructure is built. Community concerns must therefore be built into NMT plans in order for them to prove sustainable (Lubitow et al, 2015).

McCarthy (2010) contends that a failure to combine physical infrastructure with widespread education about the values, importance and safety of walking and cycling, is unlikely to be very successful. She states that in cities where cars dominate on roads and in mindsets, drivers tend to see themselves as insiders, and in turn see cyclists in particular as outsiders and 'deviants'. Within these contexts, she contends that there is moral reluctance to take care of the welfare of cyclists. McCarthy regards public education programs aimed at normalizing utilitarian cycling as essential in order to begin reversing this problem. She suggests advertising campaigns showing celebrities engaged in NMT, as well as creating an increase in cyclists on the road through collective events aimed at bringing NMT users and cyclists in particular into more widespread public awareness (McCarthy, 2010). The aims of the monthly #Moonlightmass campaign that takes place in Cape Town has similar goals, aiming at increasing the overall awareness of cyclists as road users (Moonlightmass, 2012).

In terms of bringing such awareness campaigns to the youngest in society, Pucher and Beuhler (2006) contend that in some European countries, NMT awareness and training programs are compulsory as part of children's primary school experiences. Such programs can prove instrumental in creating longer lasting inter-generational awareness and change in attitudes toward NMT (Pucher and Beuhler, 2006).

From the arguments of the above authors, it is clear that interventions to incorporate NMT into cities must take social and cultural aspects into consideration. Understandings of both the symbolic and practical value of walking and cycling in particular need to be raised, particularly within contexts dominated by motorcars.

3.8 Conclusion

This chapter has explored the importance of NMT in cities, as well as the various factors involved in the effective implementation of NMT. It is clear that beyond infrastructural and built environment factors, interaction between different transport modes, working with the natural environment, addressing the effects of crime, and understanding social and cultural aspects are all important for the effective implementation of NMT within cities across a variety of contexts from both the Global North and the Global South. The following chapter will undertake an exploration of policy relating to NMT at the national, provincial and municipal levels.

Chapter 4: The Policy Context of Non-Motorized Transport

4.1 Introduction

This chapter explores and assesses the policies and regulations relating to NMT in South Africa. It first outlines national, provincial and municipal policies and legislation most relevant to NMT in South African in general, and within the City of Cape Town (CoCT) in particular, drawing on policy documents and interviews with CoCT officials. In Cape Town, NGOs also play an important role in influencing policy and practice regarding NMT, and as such the chapter draws on these perspectives from interviews.

4.2 National and provincial policies

Within South Africa, there is a national policy on NMT (2008). At the provincial level, some provinces (Western Cape, North West, Gauteng) have an NMT strategy, whilst at the metropolitan level, most major cities (Ekurhuleni, Metro Municipality City of Johannesburg, City of Tshwane, City of eThekwini, City of Polokwane, City of Cape Town, Stellenbosch Municipality, Rustenburg Local Municipality) have an NMT strategy, or at least a guiding document (Jennings, 2015).

Key national policies and strategies relating to NMT include the *National Public Transport Strategy* (2007), the draft *National NMT Policy* (2008), the *National Land Transport Act* (2009), and the *National Land Transport Strategic Plan* (2015) (Jennings, 2015).

The *National Public Transport Strategy* (2007) notes the importance of NMT in creating an integrated approach to mobility in South African cities. According to the strategy, NMT should provide links with public transport at the municipal level, and aid in creating a wider range of sustainable transport options, particularly for shorter trips (National Department of Transport, 2007).

At the national level, there is an NMT policy; however it has remained in draft form since its inception in 2008. The *National NMT Policy* sees NMT as a widely available and heavily relied upon mode of transport in South Africa, stating that "...as a

mode of transport, non-motorized (transport) is available to almost anyone", and that "walking is the most important means of transport in developing countries" such as South Africa (National Department of Transport, 2008: 9). The document states that walking is the most easily available of all transport means, whilst cycling constitutes as an affordable, reliable and easily accessible means of mobility, with added health and environmental benefits and potential economic opportunities (National Department of Transport, 2008). That the *National NMT Policy* has remained in draft form to this date is perhaps suggestive of a lack of significance placed on NMT at the national level.

The *National Land Transport Act* (2009) requires that provinces create Provincial Land Transportation Frameworks (PLTFs). Whilst it is required that PLTFs present a framework guided by the *National Land Transport Strategic Framework*, prepared by the Minister of Transport, there is no direct legal mandate to create an NMT plan at the provincial level. The consideration of NMT at the provincial level is therefore largely dependent on the goals of the minister at the national level. At the municipal level, municipalities are required to create Integrated Transport Plans. Whilst these plans are required to include plans for motorized transport, there is again outright no legal mandate to include plans for NMT unless the MEC in the province requires NMT to be included (National Department of Transport 2009).

The current *National Land Transport Strategic Framework* (2015) however does recognize the importance of NMT for its potential linking and function with other forms of transport, and that it should be developed alongside public transport. In terms of investment in NMT, the document states that "it is important that cities not only mainstream NMT considerations in planning…. but also develop programs that will attract new cyclists and pedestrians". (National Department of Transport, 2015: 25).

At the provincial level in the Western Cape, the PLTF of 2011 requires that each municipality develop and implement NMT plans into their Integrated Transport Plans by 2014, along with the development of NMT master plans. Additionally, the amount of bicycle lanes was required to be doubled by 2014, whilst every provincial road project in the municipality is to have an NMT component as a means to provide examples of effective transport planning. Dedicated public works

projects were also required to expand by 2014 in the process of implementing NMT upgrades.

In terms of the City of Cape Town (CoCT) the PLTF mentions the need to establish land-use incentives and NMT improvements within 10 underdeveloped public transport nodes by 2014 that are of provincial significance, to be chosen by provincial authorities. The CoCT is listed as a priority where the majority of these nodes were to be identified (Western Cape Department of Transport and Public Works, 2011). These priority nodes are listed in *City of Cape Town Policy and Strategy* below.

4.3 City of Cape Town policy and strategy documents

Key policy, strategy, and guiding documents relating to NMT within the CoCT include the *NMT Policy and Strategy (2005)*, the regionally divided *City-Wide NMT plan for the City of Cape Town* (2010), the *Bicycle Master Plan (2011)*, and the *Comprehensive Integrated Transport Plan (2013*). The CoCT NMT department is located within the CoCT's transport authority known as Transport for Cape Town (TCT). It was founded in 2005 and is comprises a small group of 5 individuals. The main focus of the department is identifying and designing NMT projects within the CoCT, with the major focus being on the infrastructural aspects of NMT development.

City of Cape Town NMT Policy and Strategy (2005)

The CoCT's 2005 *NMT Policy and Strategy* is an overall assessment of the current status quo of NMT within the city, a policy enforcing the specifics of NMT development, and strategies for NMT projects within the city. It is divided into two documents, namely the status quo assessment and the policy framework documents. In terms of the 2005 status quo within CoCT, the overall NMT environment was identified to be of a low and inadequate nature. This is particularly evident in the lower income areas of the city.

Inadequate NMT infrastructure and an overall lack of integration of NMT with other modes of transport resulted in many barriers to NMT usage, and particularly in

concerns relating to safety. Additionally, lack of maintenance, high levels of crime, and corresponding underutilization are often argued to be characteristics of public open spaces and existing NMT infrastructure and facilities (CoCT, 2005a). In an interview with the CoCTs NMT department, it was stated that additional issues relating to NMT are those around affordability of bicycles for low-income residents of the city, the sprawling nature of the city and corresponding long travel distances, and the barriers that freeways, railways and canals pose to NMT desire lines and networks (CoCT NMT Department, 2016).

The city's goals for NMT as stated in both 2005 documents are to create environments where people feel safe to walk and cycle, whilst simultaneously integrating NMT into the overall transport system and allowing the sharing of public space and roadways between both motorized and non-motorized transport. Interventions that improve the quality and dignity of environments are noted as key to making NMT more attractive overall, whilst simultaneously increasing environmental sustainability. Additionally, it is noted that it is important to promote a changed culture whereby NMT is considered acceptable. Overall, if NMT is properly integrated with and connected with other modes of transport and public transport in particular, it can create socio-economic empowerment through wide access to low-cost mobility (CoCT, 2005a).

The policy and strategy document seeks to guide NMT development within the city in response to the status quo assessment. The document characterizes its strategies in terms of several goals. Firstly NMT is envisioned as a means to improve overall access and connectivity within the city. Secondly, promoting livability, and equality throughout the city in terms of mainly of safety and security of individuals. Thirdly, the implementation of NMT infrastructure and increasing the overall availability of low cost mobility is sought to create environmental and social transformation. Fourthly, regarding environmental sustainability by reducing overall pollution, and improving sustainable land use principles. Fifthly, the need to increase awareness of both the existence and the potential benefits of NMT is highlighted. Lastly, integration is regarded as key between government departments, and between the public and private sector (CoCT, 2005b).

In terms of where development of NMT should take place, priority NMT nodes and links were identified within the city, as was a stipulated requirement of the Western Cape PLTF. Such nodes include public transport interchanges, key access routes to schools and tertiary education facilities, areas of intense pedestrian activity, recreational sites, and tourism sites. 3 of these nodes are in Atlantic Seaboard, 5 are in the Southern Suburbs, 5 are in the Northern Suburbs, and 8 are in the Cape Flats. Additionally, priority NMT links were identified in conjunction with the bicycle master plan, in terms of important routes to schools and in terms of NMT access to public transport facilities, as illustrated in figure 4.1 (CoCT, 2005b).

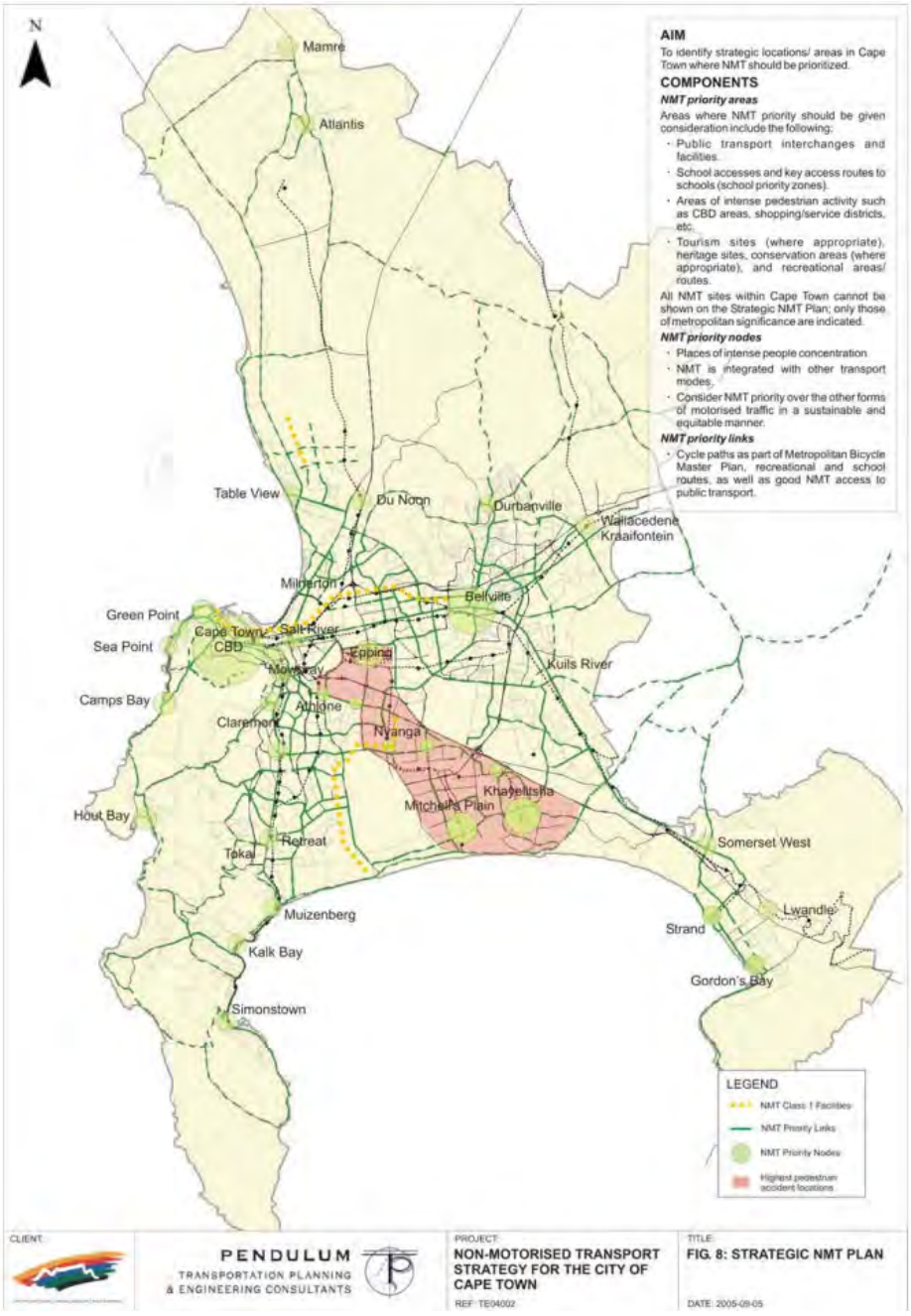

Figure 4.1: Priority nodes for NMT development (Source: CoCT, 2005b)

The document then gives specific guidelines regarding the design of safe and efficient infrastructure specific to cycling and walking in the CoCT. Regarding safe NMT routes, the document contends that lighting should be adequate in order to remove dark areas at night, whilst vegetation should be managed effectively in order to ensure good sight lines and surveillance of routes, and to reduce potential hiding places. More specifically regarding cycling, parking facilities should be visible and secure, routes should be clearly marked and sign-posted. From a crime reduction perspective, cyclists should be as close to high traffic areas (motorized or pedestrian) as possible, and should use as few underground crossings as possible (CoCT, 2005b).

In terms of the minimum design dimensions for pedestrian routes, the width should be at least 0,6 meters in each direction and the vertical clearance if necessary should be at least 2,1 meters, as illustrated in figure 4.2.

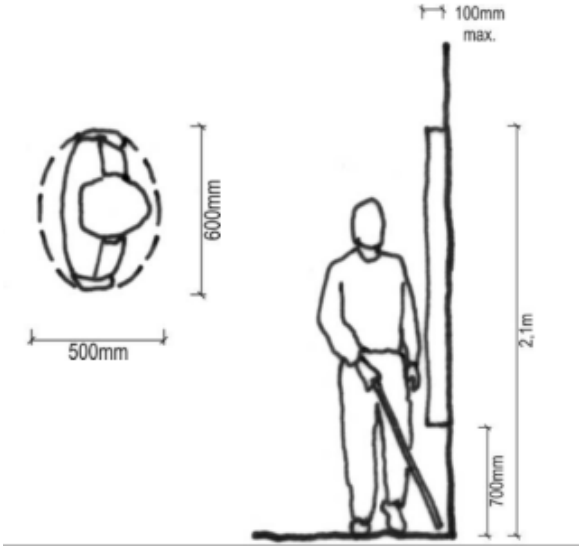

Figure 4.2: Minimum pedestrian design dimensions guidelines

(Source: CoCT, 2005b)

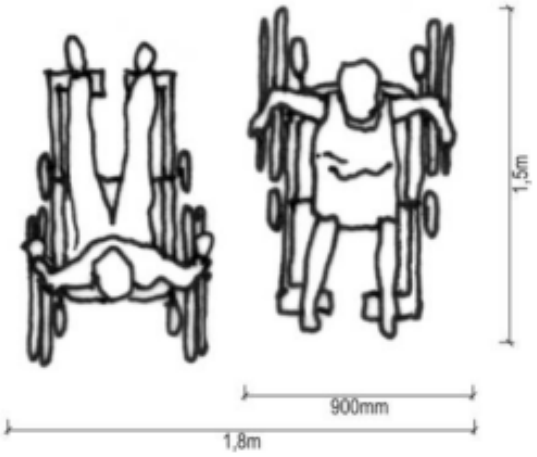

Figure 4.3: Minimum wheelchair design

(Source: CoCT, 2005b)

Paths that accommodate wheelchairs should be a minimum of 0,9 meters in each direction as illustrated in figure 4.3.

For cycling facilities, the stationary width should be at least 0,6 meters wide and 1,8 meters long, whilst on paths essential maneuvering is considered to be at 1 meter wide, whilst comfortable maneuvering is at 1,5 meters wide. When within the road

network next to a parking lane, cycle lanes should be at least 1,8 meters wide. This lane however should not be wider than two meters however in order to avoid motorists from using them. The minimum vertical clearance of bicycles is stated as 2,5 meters, as illustrated in figure 4.4.

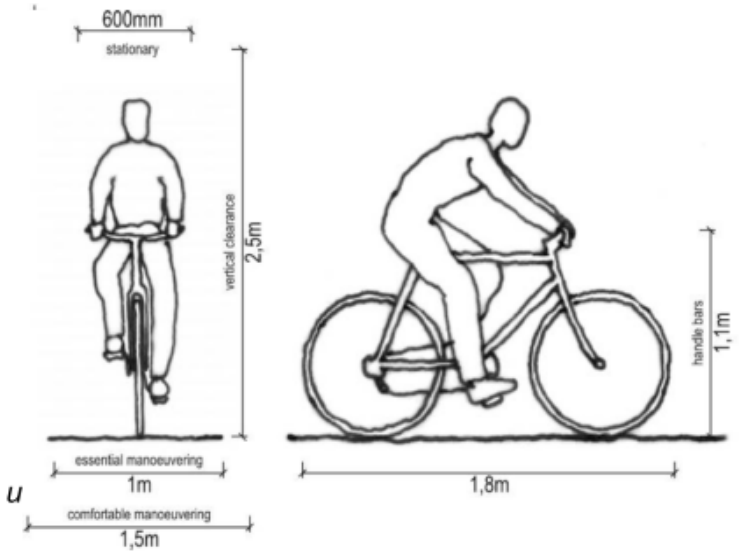

Figure 4.4: Minimum bicycle design guidelines (Source: CoCT, 2005b)

Between pedestrians and cyclists, design features should minimize conflicts and as such the two should be separated physically by bollards, street furniture or tree lines (CoCT, 2005b).

Whilst the above guidelines are minimum requirements, in reality when cyclists and pedestrians are moving they need extra room in order to maneuver around other objects and obstacles. As travel speeds increase, so too does this extra distance. This extra is known as the 'shy' distance. On a sidewalk, two pedestrians walking side by side need at least 1,8 meters, namely 0,6 meter each plus 0,6 meters of shy distance, as shown in figure 4.5.

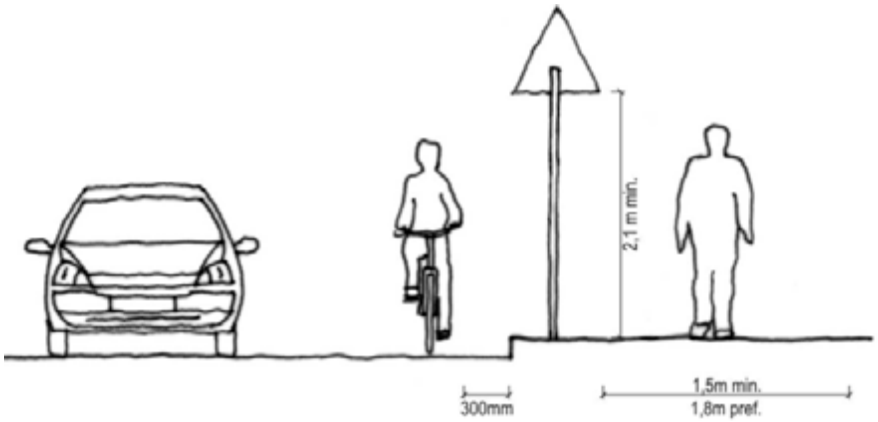

Figure 4.5: Pedestrian and bicycle shy distance (Source: CoCT, 2005b)

On local streets, pedestrian-specific sidewalks should be 1,5 meters wide, and on busier streets with a likelihood of people with disabilities, sidewalks should be at least 1,8 meters wide. Furthermore, instead of asphalt on sidewalks, bricks or blocks are preferable. With regard to cyclists, a 0,3 meter obstacle shy distance is needed, particularly away from a wall or curb as illustrated in figure 4.5 (CoCT, 2005b).

Bicycle facilities are classified in terms of 4 classes. Class 1 is "located along an independent alignment outside of the road reserve and reserved for either cyclists only or shared by pedestrians and cyclists". Class 2 is "located within the road reserve, but separated from the travel way and reserved for either cyclists only or shared by pedestrians and cyclists". Class 3 is a "bicycle path that forms part of the street or the carriageway and is marked accordingly". Class 4 is "Located on a low-volume street to serve as a link in a network of cycle facilities. The path is indicated by signs and markings." (CoCT, 2005b: 37). Examples of these classes are shown in figures 4.6 to 4.9.

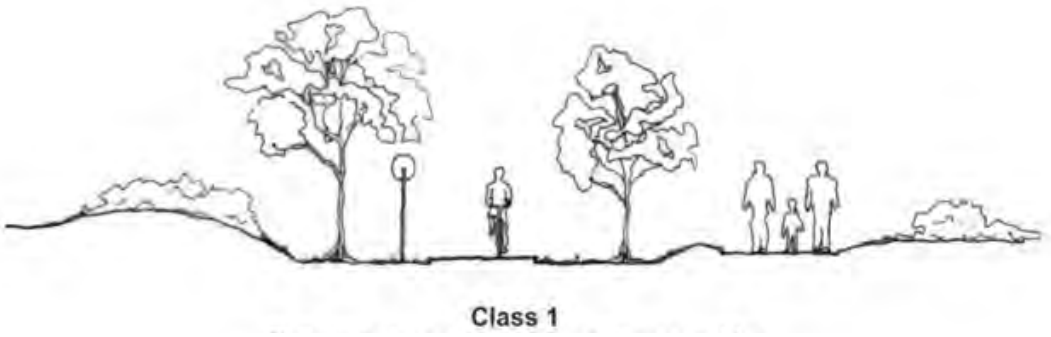

Figure 4.6: Class 1 bicycle infrastructure (Source: CoCT, 2005b)

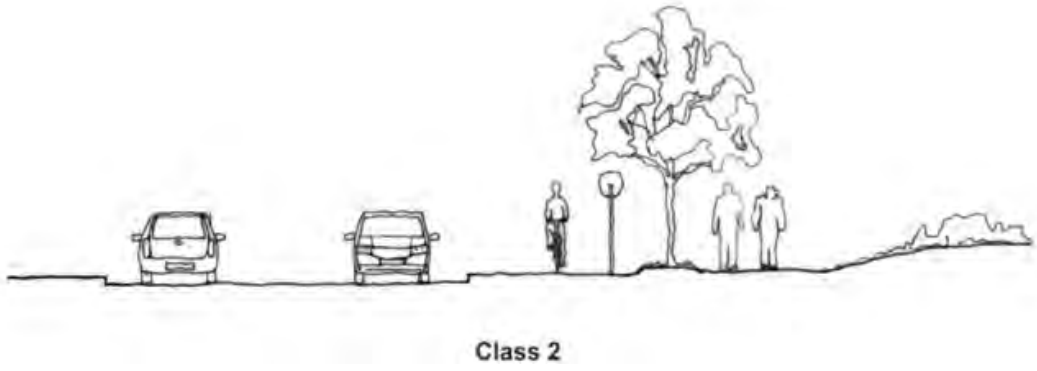

Figure 4.7: Class 2 bicycle infrastructure (Souce: CoCT, 2005b)

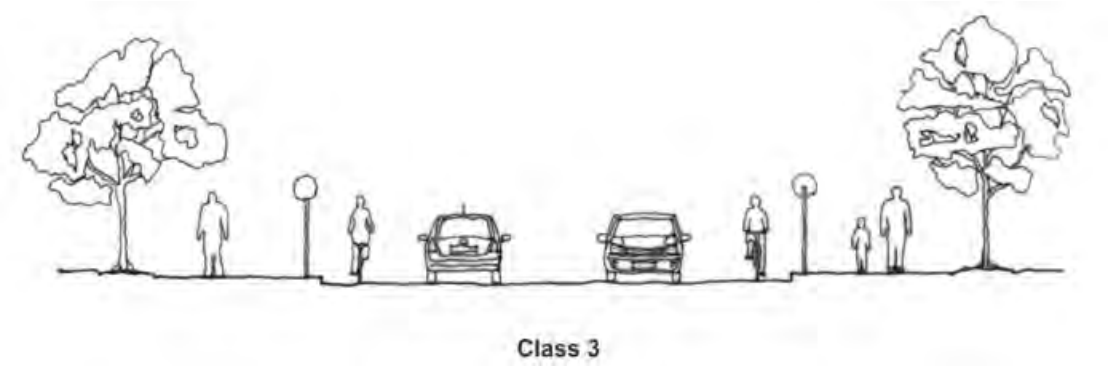

Figure 4.8: Class 3 bicycle infrastructure (Source CoCT, 2005b)

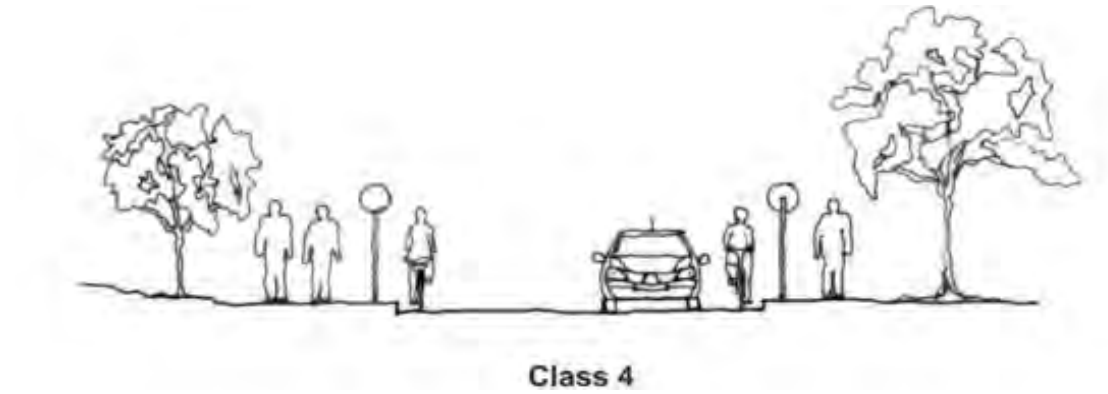

Figure 4.9: Class 4 bicycle infrastructure (Source CoCT, 2005b)

When cycle lanes are within the road network, they should always be one-way facilities, in the same direction as adjacent motorized traffic. Only on one-way streets can two-way lanes be acceptable. Cycle lanes should be surfaced with asphalt, cement or fine gravel screenings (CoCT, 2005b).

In terms of class 1 cycle facilities located outside of the road network, the desirable minimum wide for two-way operation is 3 meters, whilst the absolute minimum is 2,5 meters. Cycling on sidewalks is a good option for less experienced cyclists, but is usually not supported by more experienced cyclists due to greater maneuverability required. Additionally, there is the added danger of collisions at intersections and in driveways. Regarding the relationship of cycle lanes with parked cars on-street, where cars are parallel parked, there should be enough distance between the cars and the cycle lane in order to avoid collisions with opening car doors. In areas where cars are parked diagonally or perpendicularly, cycling should be avoided as far as possible (CoCT, 2005b).

For both pedestrians and cyclist, intersections (including railway crossings) tend to be the most likely places for collisions. Curb ramps are an essential aspect of

intersections for prams, luggage, and in cases where bicycles paths are on sidewalks, as shown in figure 4.10. The minimum width of the ramps should be 1,5 meters.

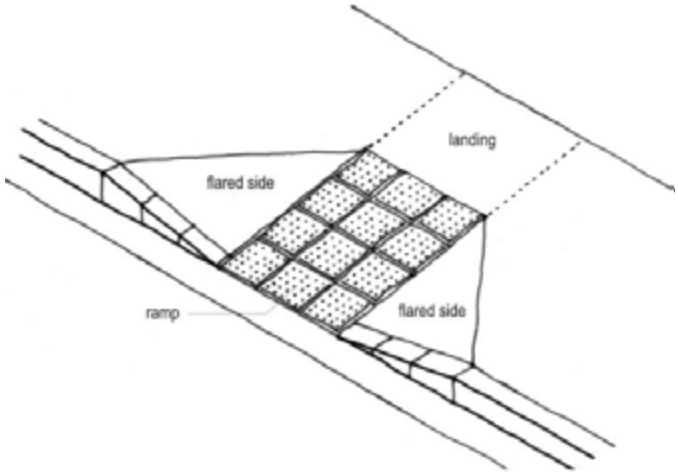

Figure 4.10: Curb ramp design guidelines (Source CoCT, 2005b)

Additionally, intersections need to be carefully designed in order to accommodate pedestrian and cyclist crossing that is separated from motorized traffic. Figure 4.11 shows an intersection where both pedestrian and bicycle route crossings, whilst figure 4.12 shows the intersection of a pedestrian zone and bicycle path with a road for motorized traffic and bicycles (CoCT, 2005b).

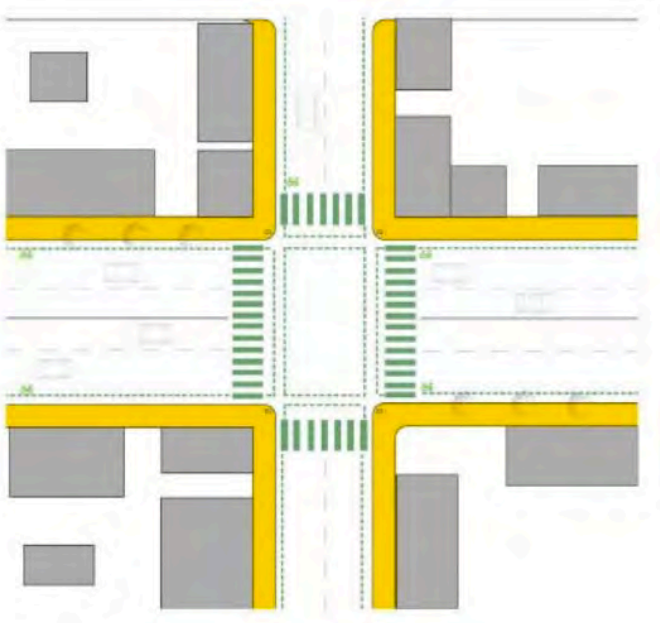

Figure 4.11 Intersection designed for NMT and motorized transport (Source: CoCT, 2005b)

Figure 4.12: Pedestrian and bicycle street crossing (Source CoCT,2005b)

The goals and priorities of the CoCT NMT policy and strategy documents are sound in terms of creating more equitable and interconnected transport systems. Additionally, the specifications in terms of infrastructure dimensions are thorough and very specific. However, there is little specificity given in terms of the actual implementation of NMT infrastructure and projects. In an interview with Louis De Waal, the chairperson of the Bicycle Empowerment Network (BEN) NGO, he argued that in reality consultants and stakeholders in the implementation process are not knowledgeable in terms of the actual everyday usage of NMT and as a result it is common to find discontinuous networks of bicycle lanes for example, even within the same road (De Waal, 2016).

City-Wide NMT Network plan for the City of Cape Town (2010)

In 2010, the city developed conceptual NMT plans for the different regions of the city. These included the Northern, Eastern, Central and Southern regions. Similarly to the 2005 *NMT Policy and Strategy* documents, the objectives of the plans were stated as seeking to create a safe and convenient environment for cyclists, commuters and pedestrians. Additionally it aims to create vibrant 'livable' environments to accommodate the diversity of needs inherent in the diverse population of Cape Town (CoCT, 2010). For the purpose of the focus area of the design aspect of this dissertation, the central region NMT network plans will be reviewed as the focus area falls within the central region, as illustrated in figure 4.13.

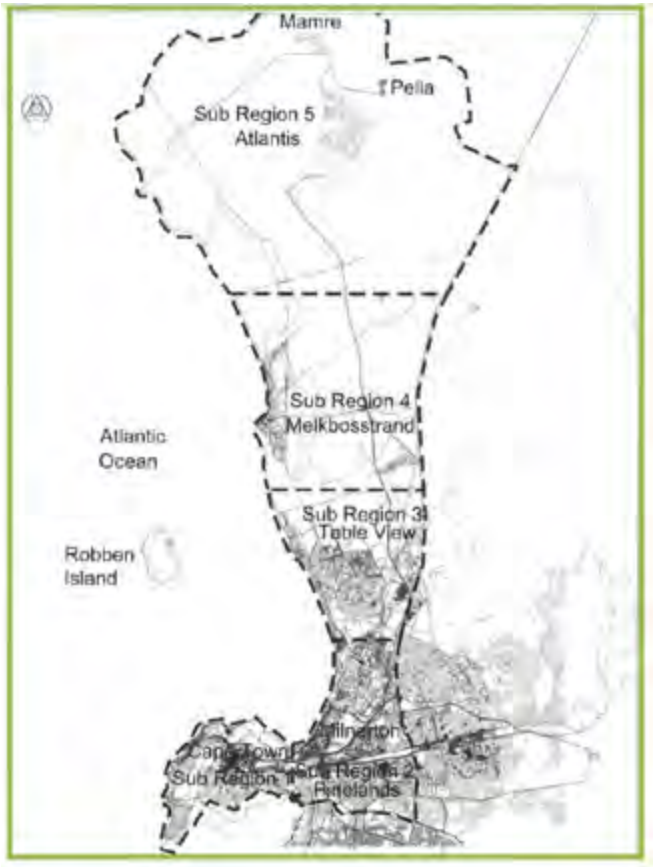

Figure 4.13: NMT sub-region network plans (Source: CoCT, 2010)

The regional plans are guided by the principles of integration and equity. Integration is referred to in terms of network planning facilities and spatial linkages across settlements and between settlements and social and institutional support networks. Equity is defined in terms of improving access both on foot and by other NMT modes in order to ensure all sectors of the population are able to access social, economic and public utility systems and services (CoCT, 2010). It is important to note that in terms of equity, the CoCT NMT department stated that the NMT and walking in particular is not a choice but a necessity for many residents within the city, as the "first mile is often a walking trip" of overall travel (CoCT NMT Department, 2016).

Regarding the movement network, the document contends that as far as possible pedestrian movement should be facilitated within settlements, and should be the main ordering element within public spaces. The document contends further that strict specific infrastructural requirements such as intersection spacing need to be malleable, context-specific, and open to spontaneity. Additionally, low order local streets are considered paramount in terms of pedestrian activities, and as such must be accommodating for such activities. More broadly, in terms of the

relationship between NMT and public transport, the document contends that public transport interchanges that accommodate NMT sufficiently are essential as many trips to such interchanges involve NMT within the city (CoCT, 2010). Figure 4.14 below illustrates both completed bicycle lane infrastructure projects, as well as proposed bicycle lanes within the sub-region. It is clear that a number of class 1, 2 and 3 bicycle path projects have been completed in the region, but there is still much room for improvement.

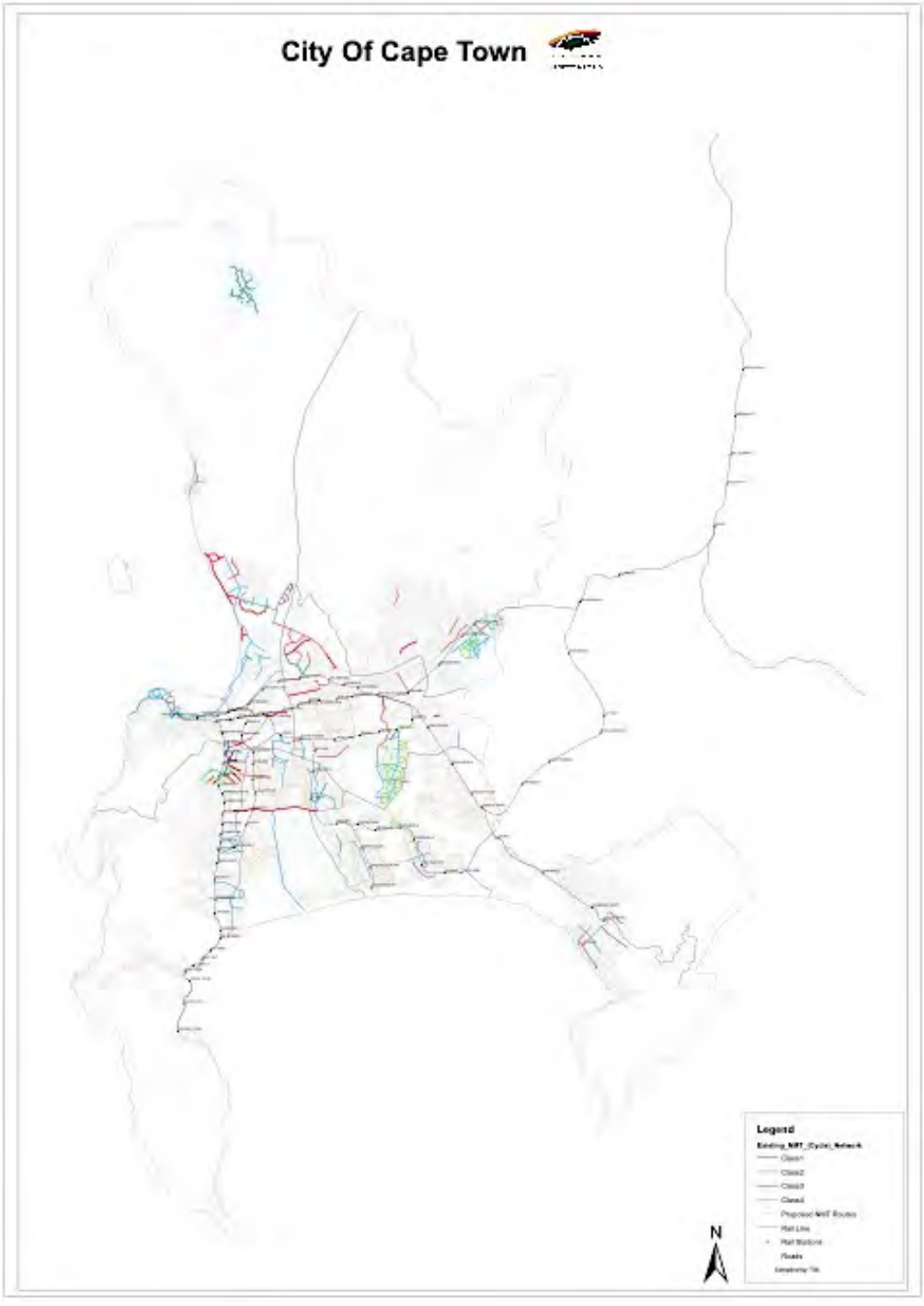

Figure 4.14: Completed and proposed bicycle routes– not to scale (Source: CoCT, 2010)

City of Cape Town Bicycle Masterplan (2011)

The 2011 *Bicycle Masterplan* (BMP) was first developed during the 1980s and 1990s as a means to create a network of cycle paths connecting suburbs to workplaces and strategic facilities within the city. The BMP was updated both in 2002 and in 2011. A Further update is currently in progress (CoCT NMT Department, 2016).

The 2011 BMP focused largely on sport and recreational cyclists rather than on commuter cyclists. As a result, much of the focus is on higher order routes for training, with an additional focus on local frequently cycled routes, and long distance commuting. Whilst a significant number of overall cyclists within the city are sport cyclists, particularly given the size of the Cape Argus Cycle Tour that takes place in the city, the large focus on these cyclists is out of sync with the equitable approach promoted by the *Policy and Strategy* document and the *City-Wide NMT Network plan.*

The aim of the BMP was to compliment the *City-Wide NMT Network Plan* through a specific focus on the cycling aspect of NMT. However, the municipality-wide scale at which it was done does not allow for it to function effectively as the cycling aspect of the *City-Wide NMT Network Plan.* The BMP frequently used training routes for the city are shown in figure 4.15, whilst higher order general cycling routes are shown in figure 4.16. The BMP recommended that numbers of cyclists be counted annually along major cycling routes and key intersections in addition to implementing information and warning signs for both cyclists and motorists along main cycling routes. (CoCT, 2011).

Figure 4.15: Frequently used cycle training routes- not to scale (Source: CoCT, 2011)

Figure 4.16: Higher order cycling routes- not to scale (Source CoCT, 2011)

Comprehensive Integrated Transport Plan 2013-2018 (2013)

The 2013 *Comprehensive Integrated Transport Plan 2013-2018* (CITP) was aimed to give TCT its mandate to bring about transformation in all aspects of the city's transportation network in order to benefit as many residents and visitors to the city as possible. Additionally, the aim is to create and deliver an 'integrated, intermodal and interoperable' transport system and related network (CoCT, 2013: xi). The CITP constitutes the required transport plan mandated by the Western Cape PLTF. Additionally, it forms the transport component of the city's Integrated Development Plan (IDP), and as such seeks to align with the IDP goals of creating an opportunity city, a safe city, a caring city, an inclusive city, and a well-run city (CoCT, 2013).

The overall objectives of the CITP are classed in terms of a 'sustainable transport strategy'. The CITP thus aims to address the transport problems from the three interrelated concerns regarding the environment, economy and social needs. It is argued that the current transport system in Cape Town meets neither the environmental, economic nor social requirements of sustainable transport. In order to reach sustainable transport then, the CITP contends that from an environmental perspective it is important to prioritize public transport and NMT, whilst encouraging more compact city development. From an economic perspective creating a transport system that is cost effective and resilient to changes in climate and non-renewable energy supplies is key. From a social perspective, enhancing the livability of the city's streets, improving safety, and reducing poverty and inequality are prioritized (CoCT, 2013).

In terms of the CITP strategy for NMT within the city, the aim is to create a continuous network of NMT and of cycle lanes in particular that are integrated with public transport and the overall transport network. Whilst these are similar to those listen in other NMT documents explored earlier, the CITP strategy fails to elaborate on what this means on a practical level.

It is argued that NMT constitutes the "most important and preferred mode in the public transport system, and needs to be considered as the primary means of travel" (CoCT, 2013: 124). In the interview with the city's NMT department it was

argued that there is “a lot of awareness in the city” regarding NMT. It was also argued that the proximity of many low-income settlements to rail networks has led to a reliance of NMT which the city has recognized. High rates of road pedestrian accidents have also led to awareness of the need for the prioritization of NMT infrastructure. However, despite the apparent documented importance of NMT in the city, the NMT department consists of only 5 members in relation to the TCT division which is ‘well over 100’. Furthermore, when asked whether the NMT department would grow, the department officials felt that it was unlikely to happen in the near future (CoCT NMT Department, 2016).

The document lists several completed NMT projects within the city and makes fairly specific proposals regarding future interventions. These include the painting of more cycle lanes green (illustrated in figure 4.17 (left) as has been the case in Bree Street in the CBD and on Albert road in Woodstock, as well as separating bicycle lanes from motorized traffic lanes with small plastic studs that are place on the road in order to indicate indicate a sharing of the road between cyclists and motorists, as also illustrated in figure 4.17 (right).

Figure 4.17 Green bicycle lanes and lane-separating studs (Source CoCT, 2013)

Additionally, overall respect for and visibility of NMT is considered key, as well as the widespread knowledge amongst officials and stakeholders “with respect to NMT planning, infrastructure design and maintenance” (CoCT, 2013: 195). Despite this however, the CoCT NMT department stated that there whilst there has been significant progress in terms of NMT infrastructure provision, the city has proven

ineffective regarding the maintenance of the infrastructure due to a lack of resources overall (CoCT NMT Department, 2016).

4.4 The role of NGOs: the Bicycle Empowerment Network perspective

The Bicycle Empowerment Network (BEN) is an NGO that aims to promote sustainable social and economic empowerment through the promotion of bicycle usage. BEN was established in 2002. The NGO imports donated bicycles from overseas countries and distributes them in low-income areas in Cape Town, and within smaller towns around the Western Cape. BEN seeks to create integrated sustainable systems through setting up Bicycle Empowerment Centers within target communities which function as entrepreneurial maintenance hubs as well as spaces of where cycling safety education takes place. BEN places a large focus on bicycles for school children, and as such seeks to obtain support from the school in the form of training members of the school maintenance staff to assist with bicycles as well. In addition to distributing bicycles, BEN engages decision-makers and stakeholders as a means to ensure NMT is well integrated into transport planning (Bicycle Empowerment Network, 2016). In order to better understand the issues relating to the implementation of NMT policy in general and cycling in particular within Cape Town, an interview was conducted with Louis De Waal, the chairperson of BEN on 5 August 2016.

4.4.1 (Dis) Continuous cycling networks

As mentioned earlier, according to De Waal, a continuous network of NMT infrastructure and bicycle lanes in particular is of utmost importance in the city. He provided an example from Military Road near the BEN headquarters:

> 'I am so cross with those consultants. They put in a lane of maybe 1.2 meters- it should actually be about 1,5 the lane for bikes in one direction. It's nice in parts, but then beginning to near the rail crossing, instead of widening the road a bit so that it's the same width all along- with the road reserve they can do something like that. They stopped the lane and they just hope for the best. You have to get to where it starts again. It could be 300 meters away. No child you could ever send to school on one of these.'

In terms of the lane size, De Waal contends that the very minimum that can be worked with is 0.6 meters. He also argued that if roads are a double carriageway, they must have a cycle lane on either side of the road. He stated that as road users, bicycle should be treated like vehicles: "If you are a bicycle, you are a vehicle and you ride on the left hand side."

Of further importance in bicycle lane design, De Waal suggested that if cycle lanes are not separate to the road, the lanes should be painted a different a distinctive different colour as has been done on Albert Road in Woodstock and on Bree Street in the CBD as mentioned earlier. This should continue through intersections, as these tend to be the most dangerous in terms of overall safety, and should be accompanied by traffic signals for both pedestrians and bicycles, whereby all motorized traffic stops and pedestrians and bicycles have right of way.

4.4.2 Cycling and crime

De Waal made the point that there are often unforeseen consequences in the implementation of cycle infrastructure. In referring particularly to the so-called 'West Coast cycle lane' from the CBD to Table View, De Waal spoke of several reported incidences of crime. He suggested that despite being a "fantastic bike path... but you are a little bit lonely if you ride on your own"

4.4.3 Driver training

De Waal explained that he had proposed to the city in the past the idea of broadening the training of taxi and bus drivers in order to create a greater understanding of the dangers faced by cyclists and pedestrians. De Waal felt that taxi and bus drivers tend to be the most reckless in relation to NMT users and therefore as part of the licensing procedure should involve riding on a bicycle in order to "get the feeling of other busses passing them just so that they realize what its like if you are on a bike", as cyclists tend to have greater awareness and therefore make good drivers.

4.5 Conclusion

This chapter has explored policy and strategy documents relating to NMT at the national, provincial and local CoCT level. It is clear that NMT is given importance in

terms of overall transport systems at the national level. This has filtered down to the provincial level in the Western Cape with the subsequent requirement of all municipalities to produce NMT plans. Within the CoCT, NMT policy and strategy documents are extensive and thorough in terms of overall spatial plans and infrastructure guidelines. The human resources of the NMT department however has not proportionately reflected this emphasis however in comparison to the size of the CoCT's TCT division. Additionally, the implementation of NMT projects have often proven inefficient overall due to lack of interconnectedness of networks and required knowledge of NMT at the construction and implementation level, whilst the overall maintenance of the infrastructure by the CoCT has also been poor. The following chapter will undertake an analysis of both metropolitan Cape Town, and the project site.

Chapter 5: The project site area in context

5.1 Introduction

This chapter begins by analyzing the context of the City of Cape Town (CoCT) at the metropolitan scale focusing on the current development trends within the city, as well as the income-based segregation and the subsequent disconnection of many residents from economic opportunities. The purpose of this analysis is to inform a possible future role for the site and the contribution which development in this area can make to broader metropolitan planning issues. The project site area is then analyzed in terms of economic opportunities, land-use, mobility, environmentally sensitive areas, and developable land. The main existing goals of the Blaauwberg District Plan are then explored.

5.2 Guiding Values

This dissertation originates from a position that the central goal of planning is to enable equitable and sustainable access to socio-economic opportunities, and to ensure the enhanced overall wellbeing for all. Critical elements of this approach include the provision of housing that is both well located and affordable, particularly for poorer residents who tend to be disadvantaged in unregulated capitalist markets, as well as the provision of, and for, equitable forms of both motorized and non-motorized mobility.

5.3 Metropolitan residential and employment patterns

The CoCT, like many other post-apartheid South African cities, is characterized by spatial inequality. Within the City, formal employment opportunities are mainly concentrated in a broad band between the Cape Town and Bellville CBDs, running along the Voortrekker Road corridor. Other significant concentrations of formal opportunities are in the Southern Suburbs, and along the West Coast, as illustrated in figure 5.1 (CoCT, 2012a).

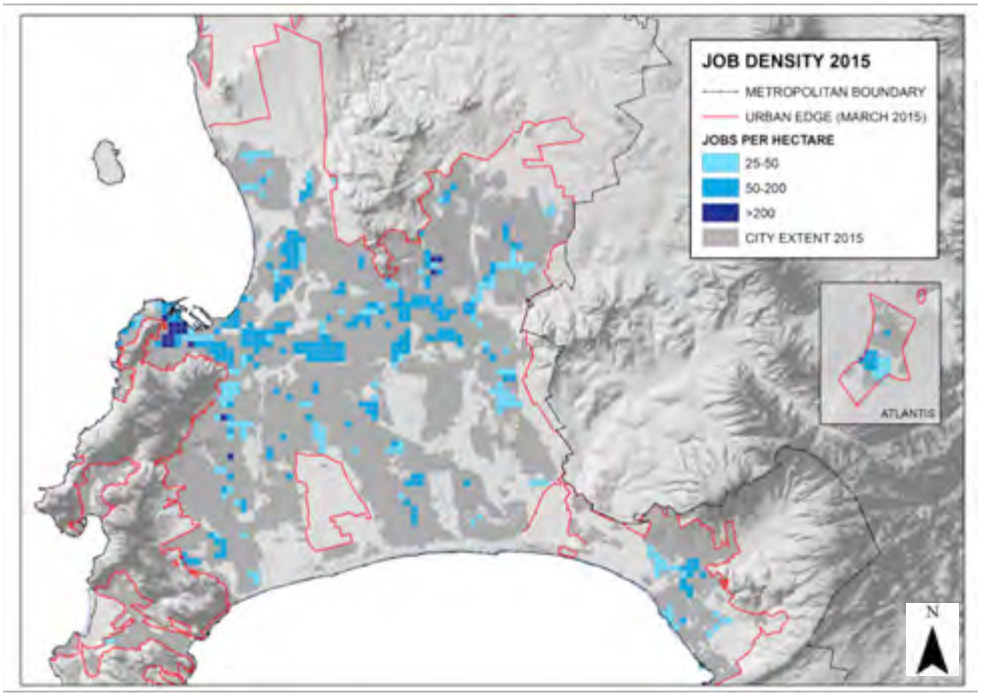

Figure 5.1 Job density within the CoCT (Source: Rabe 2016)

In terms of overall employment statistics, the 2011 census found the unemployment rate to be at 23,9%. Regarding employment opportunities within various sectors, the majority of employment is within the formal sector, accounting for 83% of employment. These jobs are found mainly in the trade and hospitality, finance and business services, community and personal services sectors, manufacturing, and to a lesser extent, in the construction sectors, as shown in figure 5.2. Employment in the informal sector accounts for 11% of jobs, whilst employment within private households accounts for 7%, (CoCT, 2012a). It is important to note that for the majority of poor residents within the CoCT, employment opportunities are found within low-skilled and informal sectors.

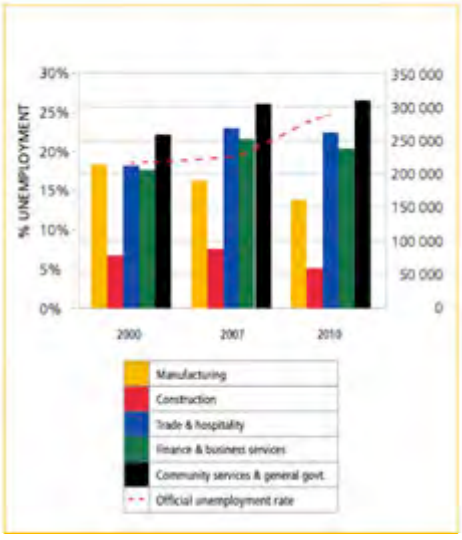

Figure 5.2 Employment by sector within the CoCT (Source: CoCT, 2012a)

In terms of the relationship between employment and housing within the CoCT, there is an overall spatial mismatch within the city. The highest densities in the city are situated in the metro southeast. It is argued within the CoCT SDF that more than a third of the city's population is concentrated in this region (CoCT, 2012a). The region is however the least economically developed and is home to most of the poor residents within the city. The city's densities are illustrated in figure 5.3. The resultant scenario is one where a large percentage of the city's workforce commutes great distances to work (CoCT, 2012a). In a study conducted by the CoCT's TCT, it was found that many residents in the city spend up to 40% of their monthly salaries on commuting costs over significant distances (CoCT NMT Department, 2016).

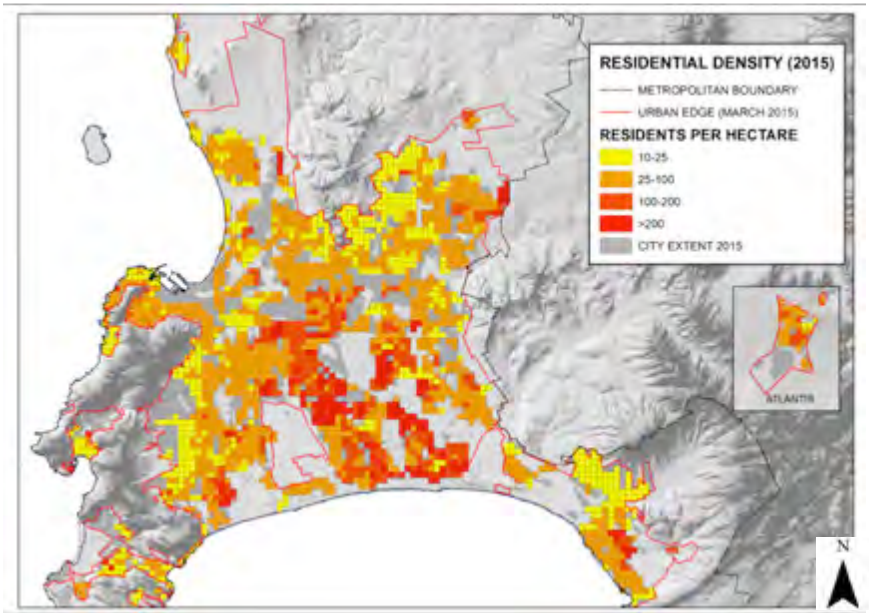

Figure 5.3: CoCT residential density (Source Rabe, 2016)

The former apartheid spatial segregation along racial lines left an overall legacy of an inequitable and inefficient city form, which is still largely entrenched within the city. Higher income groups have as a result remained largely in low-density suburbs in proximity to economic concentrations in the Southern Suburbs, in the Somerset West area, and within the Northern Suburbs of Cape Town. Broadly speaking, lower income groups tend to be situated in the metro southeast, as shown in figure 5.4. As the CoCT is experiencing increased urbanization, as a result of both in-migration and natural growth, the city's population is expected to grow from what was an estimated 3,7 million residents in 2010, to an expected 5 million in 2030 (CoCT, 2012a). It is also estimated that 335 000 low-income households currently live in

housing conditions that are informal and as such sub-optimal. It is estimated that by 2032, this number will grow to about 655 000 (Shisaka, 2014).

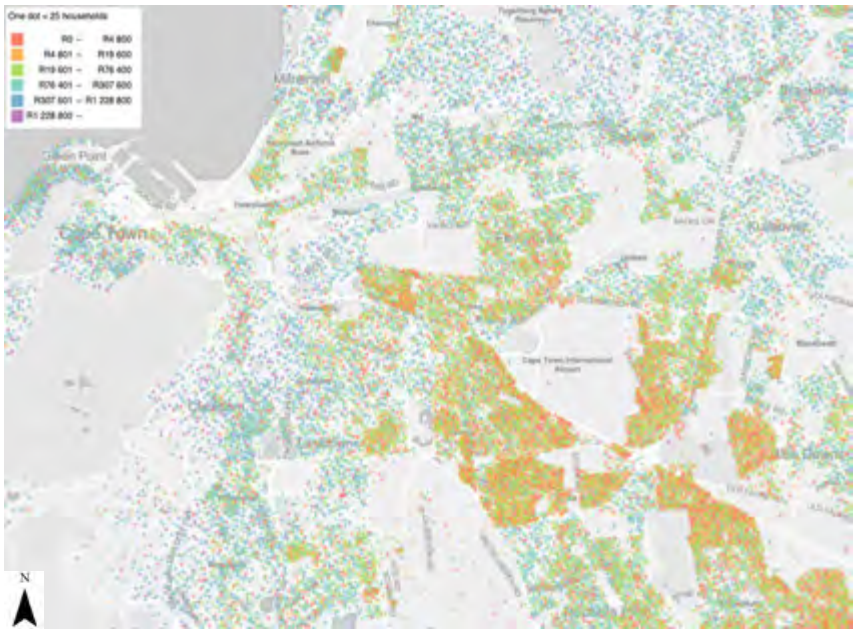

Figure 5.4: CoCT income distribution (Source Frith, 2013)

In terms of both past and current market housing development trends within the city, they have largely been characterized by medium to higher income greenfield developments that have for the most part been located on the periphery of the city, within areas such as Parklands, the Strand, Somerset West and Kraaifontein, as shown in Figure 5.5. Such developments tend to take place with little regard for socio-economic integration, and are generally of a lower density. As such, they tend not to contribute to efficient infrastructure, NMT or public transport provision (CoCT, 2012a).

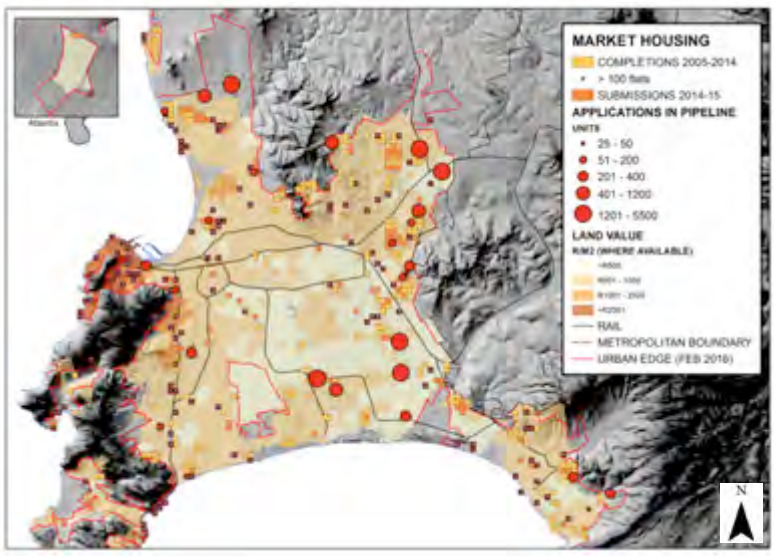

Figure 5.5: CoCT market housing development distribution (Source Rabe, 2016)

Subsidized housing for lower income groups has also largely been developed in peripheral areas within the city, mainly due to the expensive nature of well-located land, and the inadequate amounts of state subsidies (Tissington, 2011; McGaffin et, 2015). These include areas such as Delft, Somerset West, Blue Downs, Du Noon, Macassar, Bloekombos, Wallacedene and Mitchells Plain. Within the metro southeast, namely Khayalitsha and surrounding areas, the focus of development has largely been on the de-intensification and upgrading of informal settlements as shown in figure 5.6. Similar to higher income developments, lower income developments have tended to be monofunctional, and lacking in terms of the creation of integrated settlements (CoCT, 2012a).

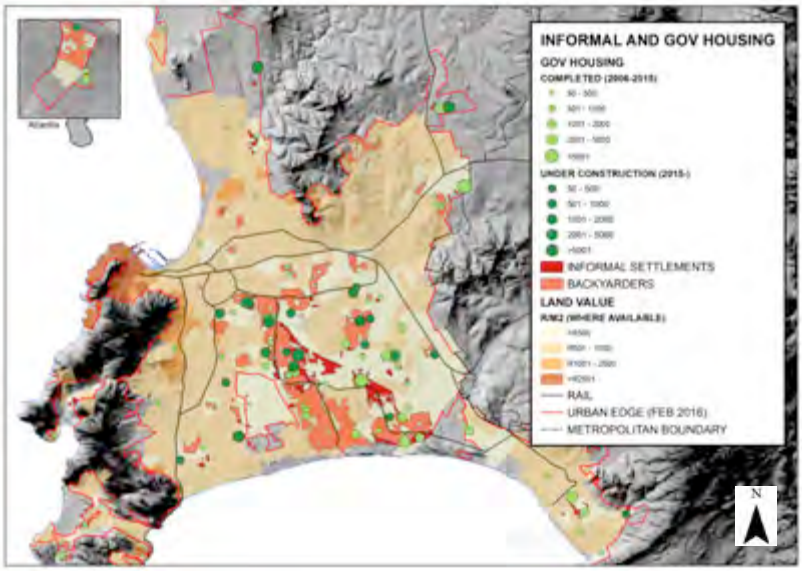

Figure 5.6: Informal and government-subsidised housing (Source: Rabe 2016)

It is important to note that well-located, high-density, affordable housing in cities reduces transport costs and times for individuals, whilst reducing overall transport and infrastructure provision costs for the city as a whole. This in turn creates better overall access to socio-economic opportunities. For a city, this can create a more financially and economically sustainable, and productive situation. (Turock, 2009; Harrison and Todes, 2014). In the case of the CoCT, well-located land in proximity to employment opportunities within the CBD, Century City and Claremont nodes tends to be very expensive and thus inaccessible to poorer residents. Developments within these areas have proven to be lucrative for developers and investors, and as such, the housing needs of poorer residents within well-located areas have often been overlooked (Massyn et al, 2015). For the CoCT, in order to begin to address the persistent inequality inherent in the metro, it is essential that

the capitalist market does not go unregulated, but rather that social and gap housing developments take place on well-located land within the metro.

5.4 Metropolitan mobility context

Regarding mobility within the city, given that the highest densities in the CoCT fall within the metro southeast, and with the resultant distance from employment opportunities, figure 5.7 illustrates peak origin-to-destination routes on an average weekday morning within the city. It is clear that the majority of trips are over 10 kilometers, and as such are likely to be time-consuming and costly to commuters, particularly in congested traffic conditions.

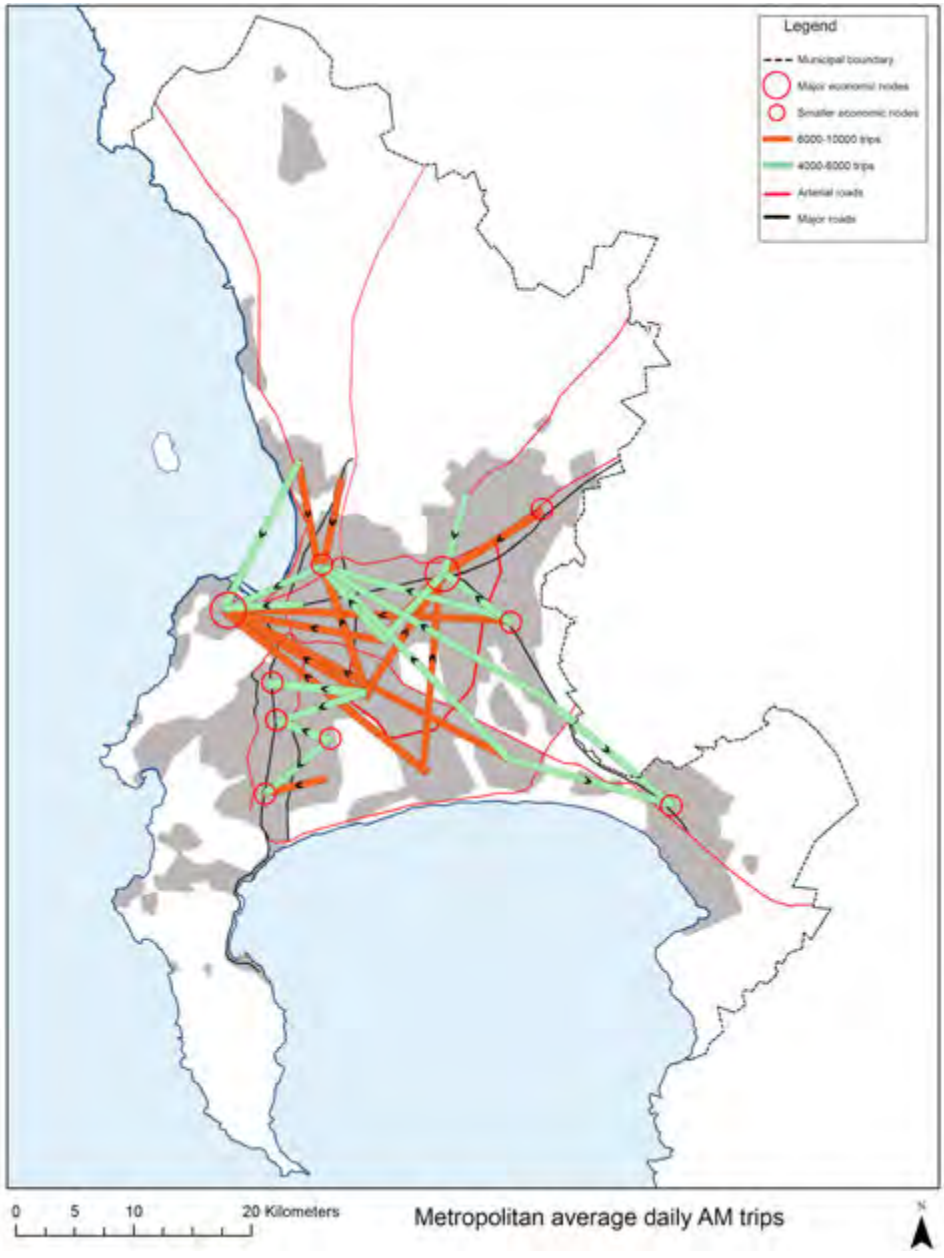

Figure 5.7: CoCT average daily AM trips (Source: Author, Data: GIS, UCT Library)

Within the CoCT, an estimated 55% of residents rely on public transport to get to employment opportunities (CoCT, 2013). In terms of access facilities and infrastructure however, many transport networks are aging and are of an inferior standard. There is also often overcrowding on public transport. The cost to address all the issues facing public transport in the city is considered to amount to billions of rand. In addition to the long distances between residence and work for the majority of residents, the city is characterized by very low densities of 15-19 dwelling units/ha nett, which makes for difficulties and inefficiencies in providing public transport to a sprawling city. Regarding the management of public transport, there is additional fragmentation in that both commuter and goods rail are managed at a national level by PRASA and Transnet respectively. This poses difficulties and added complexity in creating a more integrated system of public transport (CoCT, 2013).

Whilst a range of challenges regarding the implementation of NMT in cities in general were explored earlier in this dissertation in the literature review chapter, there are many challenges regarding NMT within the CoCT in particular. The CoCT NMT department stated that for the majority of poorer residents within the metro, the first kilometer is usually a walking trip. In terms of the relatively small numbers of cyclists cycling for commuter purposes, there is a division between a small minority of middleclass commuter cyclists, who generally have a choice between a wide variety of viable transport modes, and a bigger majority of low-income commuter cyclists, cycling more for necessity due to economic constraints (Petzer, 2016). One of the greatest barriers identified is the overall lack of infrastructure for both cycling and walking (CoCT NMT Department, 2016). The chairman of the BEN stated in an interview that Cape Town is characterized particularly by discontinuous and fragmented networks of NMT infrastructure and bicycle lanes in particular (Bicycle Empowerment Network, 2016).

The lack of integration of NMT with public transport modes, and the lack of sufficient pedestrian and cyclist safety from motorized transport as well as crime have resulted in many barriers to NMT usage and efficient functioning. As is the case for public transport, the sprawling nature of the city, with corresponding low densities, has led to travel distances that are in many cases too far for both walking and cycling trips. Finally, from an infrastructural perspective, the municipality has

inadequate resources to maintain infrastructure once it has been implemented (CoCT NMT department, 2016).

The development of well-located social and gap housing can be a means to begin addressing the mobility challenges within the metro. Creating higher densities and a more integrated system of both public transport and NMT can benefit the metro population immensely. Additionally, implementing safe NMT infrastructure is essential, given the current and future reliance on it by many residents, and poorer residents in particular.

5.5 Site in context

This section will explore the project site in detail in terms of what role it can play in metropolitan Cape Town and what currently exists in terms of urban development. The brief for this dissertation was to explore the potential for NMT functioning within a well-located and central area of the CoCT. This part of the City will be used as an example or case study of what pre-conditions and what infrastructure plans need to be in place to improve NMT. This dissertation recognizes that movement networks need to be considered in an integrated way across the entire city, but this local area has been chosen to demonstrate how such networks can be considered at a local scale.

The project site is thus situated in the 'Northern-inner' district of Cape Town, which has seen rapid development over the last decades. The project site is shown in figure 5.8. Much of the development within the site has been in the form of up-market private sector development, with the Century City development being the most apparent example of this. Regarding the existing residential footprint prior to increased private development, the area was and still is characterized largely by lower and middle-income areas. Additionally, two large pieces of state-owned land, namely the Ysterplaat Air Force Base and part of the Wingfield Military Base, are within the project site area. The CoCT SDF has identified both of these sites as land for future development (CoCT, 2012a).

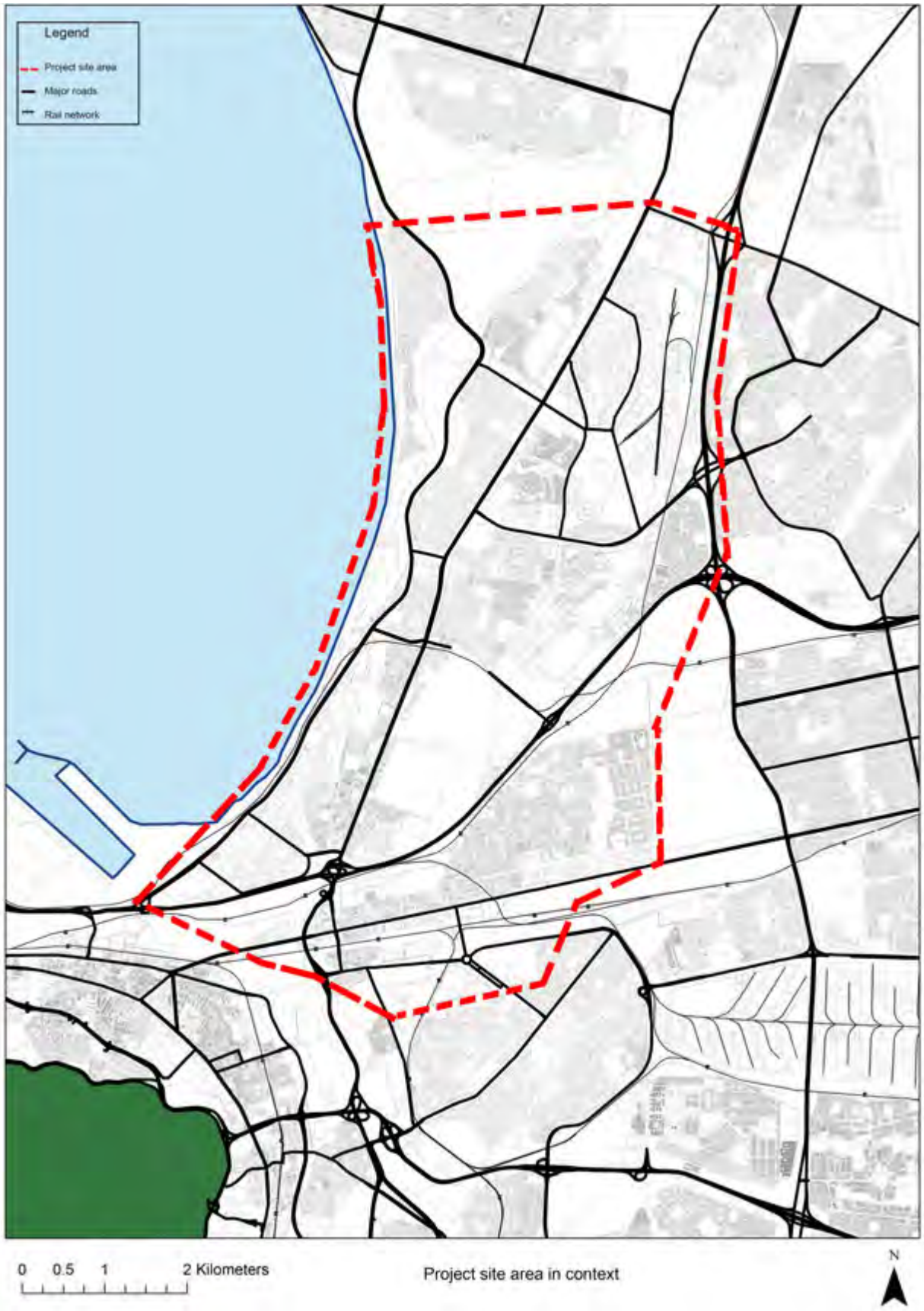

Figure 5.8: Project site in context (Source: Author, Data: GIS, UCT Library)

The site is of further importance to the metro as it forms an economic hub of the city. Significant industrial activities take place within the site, as well as large numbers of office and retail activities, particularly within the Century City development and along the Voortrekker and Koeberg Road corridors. In terms of connectivity, the site is also within close proximity to the CBD, and is highly accessible from a regional perspective, as both the N1 and N7 highways intersect the site. Regarding district planning, the project site is situated largely within the Blaauwberg district, with a small portion in the south of the site falling within the Table Bay district.

5.5.1 The role of the site in the metro

The project site has great potential to begin to address inherent spatial inequality in the CoCT. Instead of market-driven private developments being created, mixed use social and gap housing should be developed on the large tracts of well-located developable land that characterize the site area. The significant, particularly low-skilled and medium-skilled employment opportunities (within the surrounding industrial areas, along the northern Koeberg corridor, and within the CBD), both within and in proximity to future housing within the site, allow for a considerably increased integration of employment and living proximity, and reduction of the metro employment-housing imbalance.

The proximity of the developable areas within the site to employment opportunities will also be positive in terms of public transport. Increased densities will be in proximity to, and support public transport corridors, namely Koeberg and Voortrekker Road, as well as in proximity to rail links. Shorter distances travelled will mean a decreased expenditure of both time and money. Additionally, there is great potential for the site to function effectively in terms of NMT, given the shorter distances needed to travel, and higher densities and mixed use to be created within the developable areas.

5.5.2 Industrial and retail activities

This section considers the existing industrial and retail activities, particularly from the

perspective of employment opportunities within the project site and its immediate surrounding areas, illustrated in figure 5.9.

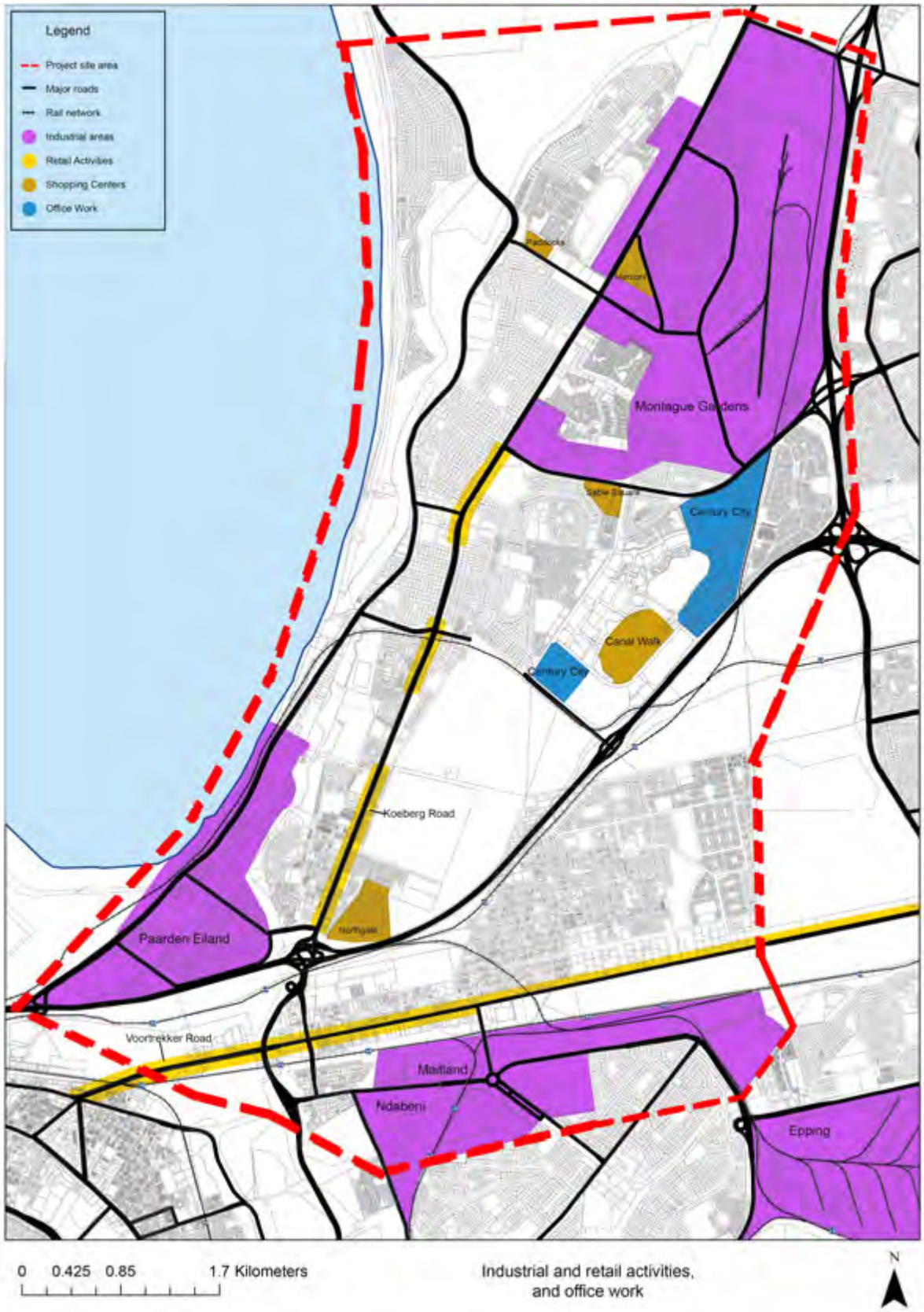

Figure 5.9: Project site industrial and retail activities, and office work
(Source: Author, Data: GIS, UCT Library)

Some of the most important industrial areas within the metro are found within and surrounding the project site area. According to the CoCT, these industrial areas provide for a significant portion of the largely low-skilled employment opportunities within the city (CoCT, 2012a).

The Paarden Eiland industrial area is within the site. Within the area of significance is the well-known 'Milnerton Flea Market' that takes place every weekend in the space between Marine Drive and the sea, where wide varieties of new and second-hand goods are sold. The market thus provides further employment opportunities. The Maitland and Ndabeni industrial areas are also within the site and are very close by. Additionally, the Epping industrial area is in close proximity to the site. Significant amounts of manufacturing, such as plastics, and freight warehouses, are situated in Epping. The Montague Gardens industrial area is one of the biggest industrial areas within the metro in terms of employment and industrial output (CoCT, 2012a). That the industrial areas are reasonably clustered within the project site provides a significant opportunity, in terms of employment possibility for increased densification of low-income and low-skilled residents within the area. Additionally, in terms of accessibility, the industrial areas are in reasonable proximity to one another and accessible generally, given their position in proximity to the Koeberg and Voortrekker Road corridors.

In addition to industrial activities, there are significant retail activities both within the project site area, and in the immediate surrounds. These provide additional employment opportunities within the area. Much of these retail activates are situated along the corridors that traverse the project site. The south of the site is traversed by the east-west Voortrekker Road corridor. Voortrekker Road currently has significant retail activities along it, and has been identified by the CoCT as a site for revitalization and intensification of both economic and residential activities (CoCT, 2012a). The Koeberg Road corridor runs from the eastern edge of central Cape Town and towards the north of the site. It too has significant retail activities along portions of it, particularly along the first kilometer from its start in the south, largely servicing lower income residents within the surrounding areas of Brooklyn and Rugby. As Koeberg Road progresses, retail activities become more sparsely dispersed yet targeted more towards higher income residents of the surrounding Milnerton and Milnerton Ridge. Given that both corridors have been identified by

the city as sites for mixed-use intensification (CoCT, 2012a; CoCT, 2012b), these activities could be intensified in the future, and provide employment in proximity to increased residential footprints.

Within the project site area, there are a number of shopping center developments. In the Century City development, is the Canal Walk shopping center. Canal Walk is a regional shopping center in that it services areas beyond the immediate surroundings. The retail within Canal Walk, however, is largely for middle to high income. An additional higher income shopping center is situated west of the Montague Gardens industrial area, known as The Paddocks, whilst within the Montague Gardens is the Marconi shopping center. North of the Century City development is the Sable Square shopping mall that services a lower income population than Canal Walk and The Paddocks center. Additionally, the Northgate Estate is situated just east of Paarden Eiland. It is largely a Business Park with the majority of shops specializing in home improvements, lifestyle and renovations for middle to higher income residents.

In terms of office activity within the project site area, the most significant numbers of office work employment are within the Century City development. These jobs however, remain of a very high skilled nature, and thus are mainly available to the more exclusive higher income population. It is important to note in terms of the Century City development that, whilst the Century City development is a well-functioning development in terms a mixed use 'live, work, play' environment, it is an example of a development on well-located land that does little to reduce the inequalities inherent in the CoCT, and to address the needs of poorer residents (Marks & Bezzoli, 2000).

5.5.3 Neighborhoods within and surrounding the project site

This section considers the characteristics of the neighborhoods both within and surrounding the project site. Figure 5.10 illustrates the variety of neighborhoods in terms of income and housing typologies, whilst figure 5.11 illustrates the rough densities both within and surrounding the project site area[1].

[1] Density data not available for neighborhoods mentioned

Figure 5.10: Project site housing typologies and residential densities

(Source: Author, Data: GIS, UCT Library)

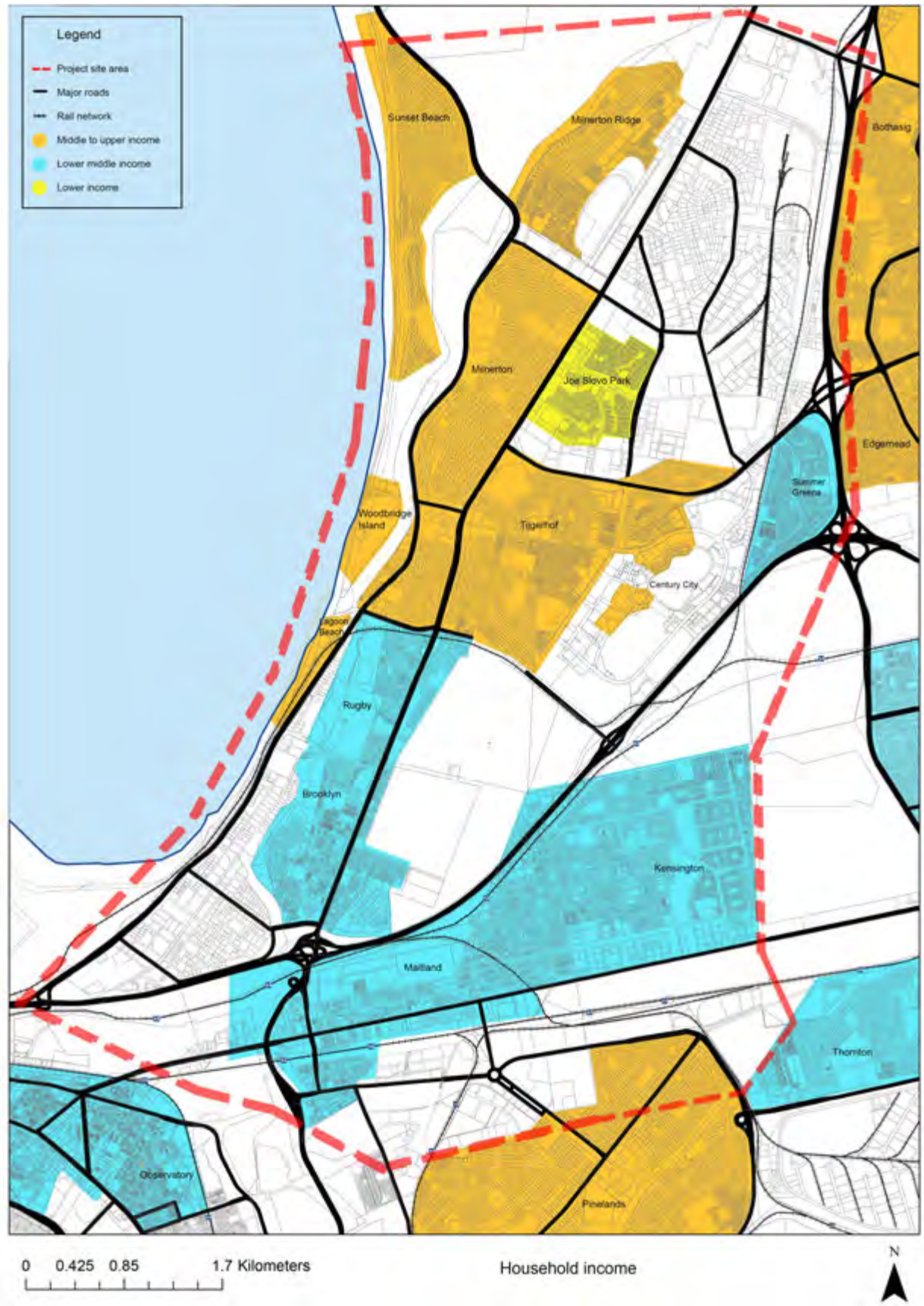

Figure 5.11: Project site household income (Source: Author, Data: GIS, UCT Library)

The project site area is comprised of and surrounded by a variety of residential neighborhoods in terms of income and housing typologies. The overall densities however, are low, as is the case with much of the CoCT, they have an average density of 15-19 du/ha gross (CoCT, 2012c).

The middle to high-income neighborhoods within the project site area are shown in figure 5.11. The majority of these neighborhoods are of a low density, and are largely mono-functional, serving only a residential purpose. The Century City development however, is a mixed-use development and is characterized by middle to high-income housing, both within private single-dwelling estates of lower densities, and within luxury apartments of higher densities. As mentioned earlier, whilst the well-located Century City does function well as a mixed-use development, it fails to address the pressing needs of poorer residents within the metro, given that it caters largely for middle to upper income residents.

The lower-middle income neighborhoods within the project site shown in figure 5.11, also consist of single dwelling units, and corresponding low densities. The available data for Kensington show that its density is very low at 10,5 du/ha gross (CoCT, 2012c). As with the middle to higher income neighborhoods mentioned above, these too are largely monofunctional. The lower-middle income neighborhoods outside of the project site, as shown in figure 5.11, largely consist of single dwelling units, with some higher-density apartments along main corridors. As such, densities within these areas are higher in these areas. Thus besides Century City, there is little in the way of infill and densification within the majority of neighborhoods within the project site.

There is one informal settlement within the project site. It is of a higher density than the surrounding neighborhoods. The CoCT states that the average density of an informal settlement within the city is 100 du/he gross (CoCT, 2012c). Whilst this settlement may constitute well-located land in terms of the location, in relation to employment opportunities, it is a particularly inequitable means of housing provision for poorer residents.

5.3.4 Existing movement and transport context

This section considers significant movement routes and corridors within and surrounding the project site in terms of a hierarchy of routes. Within the project site are the N1 highway that runs from west to the east, and the N7 highway that runs from south to north. Whilst in relation to the Koeberg and Voortrekker Road corridors within the site, the nature of highways is very different; they are very significant within the CoCT in terms of the road network and overall larger scale movement surrounding the project site area. The Marine Drive/R27 arterial road that runs along the coast is also within the project site. Like the N7, Marine Drive/R27 also functions as a significant link in a northerly direction, but runs into the CBD.

Regarding significant corridors, the Koeberg Road corridor currently functions as a significant north-south corridor within the 'Northern inner' district of the city in general, and within the project site in particular. The Voortrekker Road corridor currently functions as an east-west corridor within the city as a whole, particularly given that many of the employment opportunities are situated in a broad band along it, between the CBD and Bellville (CoCT, 2012a). Additionally, as mentioned earlier, both corridors currently have significant retail activities along them, and have been identified as sites for retail, commercial and residential intensification by the CoCT (CoCT, 2012a; CoCT, 2012b).

In terms of the movement structure of roads within the neighborhoods both in and surrounding the project site, as shown in figure 5.12, some of the neighborhoods are characterized by grid structures, which are relatively easy to navigate on foot and on a bicycle. However, some neighborhoods are characterized by 'cookie cutter' and introverted layouts as shown in figure 5.12, which can be difficult to navigate with NMT.

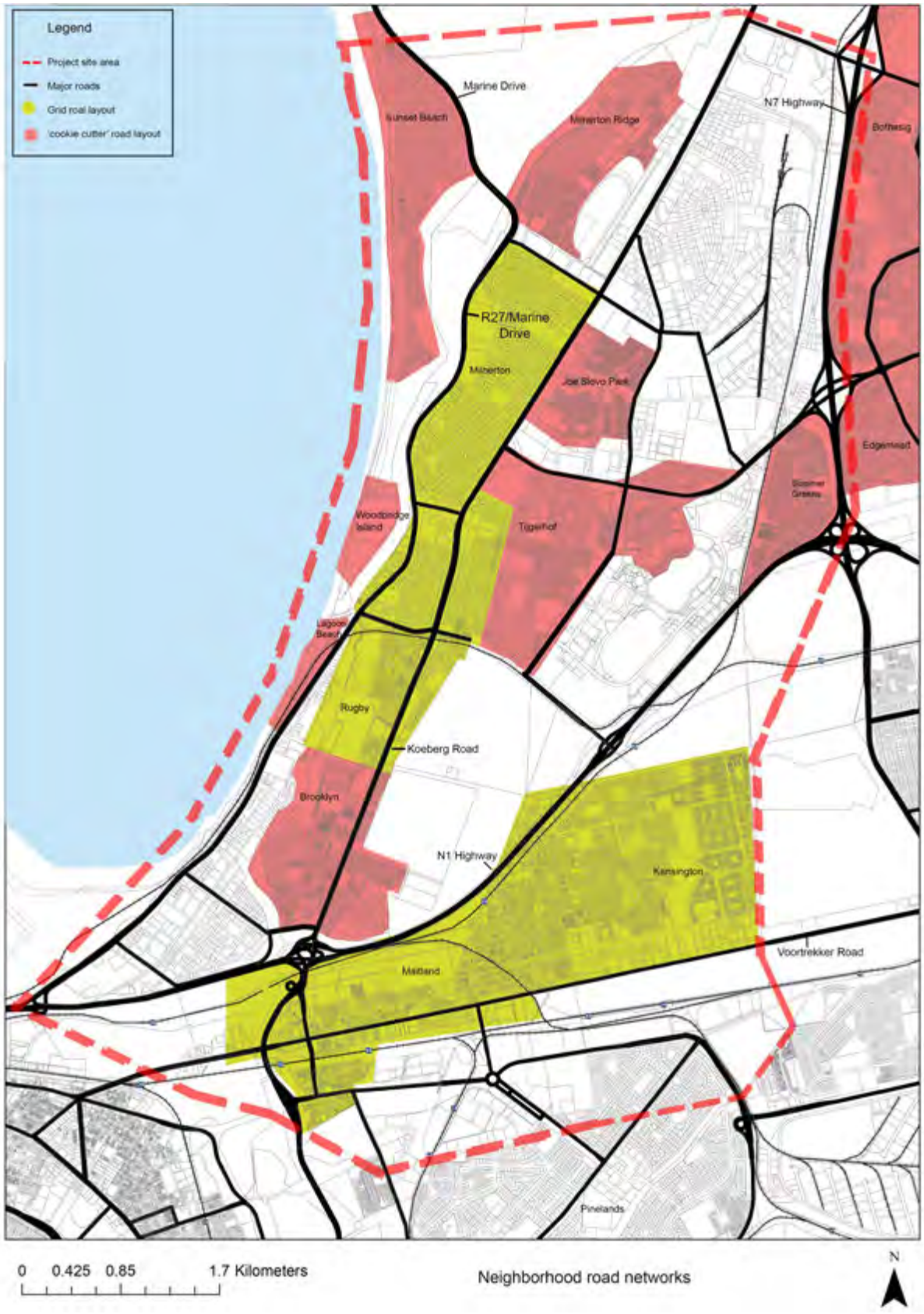

Figure 5.12: Project site neighborhood road network character (Source: Author, Data: GIS, UCT Library)

Regarding the public transport networks within the project site the IRT bus routes currently existing are illustrated in figure 5.13.

Figure 5.13: Project site IRT Routes (Source: Author, Data: GIS, UCT Library)

The IRT routes are largely connecting the north and south of the project site. Along Marine Drive/R27, the route extends from the CBD, through the project site and up to Atlantis. Whilst it is an efficient mode of transport with a separate lane along most of the road, the Blaauwberg District Plan contends that the densities along the route are by no means high enough to support a well functioning IRT system (CoCT, 2012b). Additionally the stops along the route are, in parts, up to a kilometer apart and are thus not very accessible.

Along the Koeberg Road corridor the IRT route extends, but along the southern part of the corridor, IRT lanes are currently under construction. In order for this lane to function effectively, the densities along the route will also have to be increased. The two other routes in the site are along Omuramba Road to Ratanga Road, and along Montague Drive. These link between Century City with Marine Drive/R27 and Koeberg Road. The densities along Omuramba Road are high, given the proximity of Joe Slovo Park informal settlement. However the stops are very sparsely laid out along the route, resulting in long walks and cycles. The Montague Drive route is very low density as it runs through the Montague Gardens industrial area, yet it does provide important access into the industrial area with more frequent stops.

Golden Arrow (non-IRT) busses currently run along the Koeberg and Voortrekker Road corridors. In terms of minibus taxis, figure 5.14 illustrates the existing routes within the site. The routes largely follow the IRT routes with greater connectivity within neighbourhoods. In addition, the taxis operate along the highways surrounding the site. Taxis are thus currently allowing greater area-specific access to public transport than IRT busses within the site. There are several minibus taxi ranks within the site, concentrated broadly along the Koeberg and Voortrekker Road corridors, also shown in figure 5.14.

Figure 5.14: Project site minibus taxi routes (Source: Author, Data: GIS, UCT Library)

Rail infrastructure within the site is illustrated in figure 5.15.

Figure 5.15: Project site rail and NMT infrastructure (Source: Author, Data: GIS, UCT Library)

In an interview with the CoCT's NMT department, it was stated that rail carries the most commuters of all the public transport modes within the city (CoCT NMT Department, 2016). It is therefore a very key component of the city's transport network. The city's Northern line runs just below the N1 highway, as shown in figure 5.15, and it is a passenger line. The line has some stations, but the distance between stations is too great, if development within the developable land in the site is to increase. The line that runs in a northerly direction is the Atlantis goods line, as shown in figure 5.15. The Blaauwberg District Plan outlines the importance and potential of opening up the Atlantis goods line to commuters in the future (CoCT, 2012b). The city's central line runs below the northern line and through the Cape Flats.

The project site is significantly lacking in terms of NMT infrastructure and bicycle infrastructure in particular. There is a distinct lack of connected bicycle infrastructure along main routes and corridors within the site, where NMT provision is ultimately most important in terms of the hierarchy of routes. The bicycle infrastructure is also largely only provided in a north-south direction. In addition, whilst most of the roads have some sidewalk pedestrian provision, some of the sidewalks along main routes and corridors are too small, in relation to the recommended length by the CoCT. NMT infrastructure within the site is also illustrated in figure 5.15. The major movement routes within the project site will now be analyzed in terms of existing NMT infrastructure.

Along Marine Drive/R27, class 1 paths (separate from the road reserve) and class 2 paths (in the road reserve but separate from the travel way) run from the neighborhood of Bloubergstrand to the north of the project site, all the way through to the CBD. These paths are illustrated in figure 5.16. Whilst these paths are substantial, and provide an important link to the CBD, there is little infrastructural connectivity with other bicycle paths within the project site.

Figure 5.16 Marine Drive/R27 NMT infrastructure

(Sources: Bicycling Magazine, 2010; Pedal Power, 2011)

The pedestrian provision along Marine Drive/R27 constitutes half the bicycle lanes, as illustrated in figure 5.16. Both the bicycle lane and the pedestrian lane are 1,8 meters each and thus wider than the minimum 1,5 meter recommended, and at the minimum required length for two pedestrians to pass side by side, as recommended by the CoCT NMT policy and strategy (CoCT, 2005b). The paths along the road however, are only on one side, and are thus not sufficiently wide enough to accommodate two bicycles travelling in different directions, for example within the bicycle lane. However, the paths largely see uni-directional traffic, generally either to or from the CBD depending on the time of day. Of additional importance is that there have been significant reports of muggings and bicycle theft along this route, largely where it becomes separated from car traffic and runs through Paarden Eiland to the CBD (Mervis, 2015). It is significant to note however, that along the opposite side of the road are inconsistent pedestrian sidewalks of roughly 2 meters in length.

The Koeberg Road corridor has class 2 bicycle paths in the north of the project site, next to the Montague Gardens industrial area, as shown in figure 5.17. This path continues along Racecourse Road to join the Marine Drive/R27 path, but does not continue down Koeberg Road. The path is also designed to accommodate pedestrians in one direction, given that each lane is only 1,5 meters wide (not the required 1,8 meters for two pedestrians to pass side-by-side) (CoCT, 2005b). On the other side of the road is a pedestrian sidewalk of 2 meters in width, which is

sufficiently wide. The remainder of Koeberg Road, south of Racecourse Road, lacks any formal bicycle paths. There are however, significant sidewalks (generally over 3,5 meters in width) for pedestrians along it, as shown in figure 5.17, which have potential for bicycle path continuation in many parts.

Figure 5.17: Koeberg Road NMT infrastructure (Source: Google Street View)

Along the Voortrekker Road corridor, the NMT infrastructure accommodates pedestrians, but makes no formal provision for bicycles, as shown typically in figure 5.18. The sidewalks are generously sized, around 3 meters wide, and wider in some parts. This space could allow for the possibility of adding bicycle paths onto the pavement in the future.

Figure 5.18: Voortrekker Road NMT infrastructure (Source: Google Street View)

Regarding the east-west secondary roads within the project site, there are a number of important links between Koeberg Road and Marine Drive/R27. Racecourse Road provides an important link, particularly between Koeberg Road and Marine Drive/R27. The road does not provide any formal bicycle paths and thus an important link between Koeberg Road and Marine Drive is absent. The

pedestrian sidewalk is 2 meters wide on either side of the road, and is thus sufficient for pedestrians, as illustrated in figure 5.19.

Figure 5.19: Racecourse Road NMT infrastructure (Source: Google Street View)

Loxton Road also does not provide formal bicycle paths. The pavements for pedestrians are the minimum 1,8 meters in width on either side of the road, as shown in figure 5.20.

Figure 5.20: Loxton Road NMT infrastructure (Source: Google Street View)

Boundary Road is also lacking in terms of formal bicycle paths. The sidewalks are 2 meters wide and thus are sufficient for the minimum requirements for pedestrians, as shown in figure 5.21.

Figure 5.21: Boundary Road NMT infrastructure (Source: Google Street View)

Section Street does not provide formal infrastructure for bicycles. The sidewalks are also 1,8 meters wide on average and thus provide sufficient minimum requirements for pedestrians, as illustrated in figure 5.22.

Figure 5.22: Section Street NMT infrastructure (Source: Google Street View)

Bosmansdam Road has insufficient NMT infrastructure. There is no formal provision for bicycles, and the sidewalk is only 1,5 meters on one side of the road, as shown in figure 5.23.

Figure 5.23: Bosmansdam Road NMT infrastructure (Source: Google Street View)

Regarding important north-south secondary roads within the project site, Montague Drive, like many other roads in the site, does not make any formal provision for bicycles. The sidewalks additionally are insufficient. On one side of the road, the sidewalk is only 1,5 meters wide, whilst on the other, the sidewalk is made from gravel and sand in many parts, as shown in figure 5.24. The road reserve itself however, is wide enough to accommodate bicycle paths along most of the road.

Figure 5.24: Montague Drive NMT infrastructure (Source: Google Street View)

Omuramba Road is dedicated largely to the IRT system. Regarding its NMT infrastructure, a class 2 bicycle path runs along the length of the road on the one side of the road, and a 1,8 meter pedestrian sidewalk runs along the other, as shown in figure 5.25.

Figure 5.25: Omuramba Road NMT infrastructure (Source: Google Street View)

Omuramba Road continues to become Ratanga Road. The class 2 bicycle path continues along the road, as shown in figure 5.26, but comes to an end leading into the Sanddrift neighbourhood, adding little value to the NMT overall connectivity within the site. The sidewalks along the road are sufficient in that they are both 2 meters wide, and on either side of the road, as shown in figure 5.26.

Figure 5.26: Ratanga Road NMT infrastructure (Source: Google Street View)

In terms of NMT infrastructure within the Century City development, there are class 3 bicycle paths (sharing road space with motorized traffic) on the Century City way ring road within the development, as shown in figure 5.27. These are connected with the bicycle paths along Ratanga Road, which is positive regarding overall bicycle connectivity. The sidewalks are also sufficient at 2 meters wide, as shown in figure 5.27 as well.

Figure 5.27: Century Boulevard NMT infrastructure (Source: Google Street View)

Besides the main routes and corridors within the project site, regarding the road structure at the level of the neighborhood, Jones and Novo de Azevedo (2013) contend that a grid structured street network is more easily navigable by NMT and as such is more efficient and favorable overall. As illustrated earlier in this chapter in figure 5.9, many of the neighborhoods within the project site lack this grid structure and thus are inefficient from an NMT perspective. In the NMT as a whole, and regarding bicycle paths in particular, whilst there are some good paths along main corridors and routes, the site is characterized by an overall disconnection in terms of the NMT network, and a lack of bicycle infrastructure along main corridors and routes.

5.5.4 Environmental development constraints

This section considers the environmental aspects of the project site and surrounding areas, and in turn defines areas where development should not occur. Relating to the hydrological aspects of the site area, directly surrounding the Milnerton Vlei, and the area surrounding the Diep River to the west of the site and the area east of Rietvlei, constitute the 50-year floodplain, and thus are identified as areas for

conservation. Whilst there is currently very little development within the floodplain beyond sports fields, it is not advisable to develop within this floodplain.

The Blaauwberg district plan places great importance on retaining and rehabilitating coastal and dune systems in order to act as barriers against storm damage and predicted ocean level rise. This zone must also constitute a 'no-go' area in terms of construction. Regarding biodiversity conservation then, in addition to the riparian areas and areas surrounding the vleis, within the Ysterplaat Air Force Base, a significant wetland area in the north east of the site was identified as a critical biodiversity area. These areas thus constitute 'no-go' areas in terms of development, and are illustrated in figure 5.28.

Figure 5.28: Project site environmentally sensitive and non-developable areas (Source: Author, Data: GIS, UCT Library)

Furthermore, in terms of the topography within the project site, from the perspective of implementing NMT, the project site is largely flat and is therefore well suited to NMT functioning.

5.5.5 Developable land

In moving to developable land within the project site, classification can fall into two categories: namely, land that is largely empty (greenfields), and development that can be intensified (brownfields). Regarding greenfields land within the project site area, the majority of the largely underutilized state-owned Ysterplaat Air Force Base has great development potential, and its development does not constitute any environmental degradation, outside of the identified non-developable wetland in the northeast. The state-owned Wingfield underutilized military site has also been identified as developable land, however, it falls outside of the project site area, and therefore is beyond the scope of this project.

Regarding brownfields development that can be intensified, both the Koeberg and Voortrekker Road corridor have been identified by the city as sites for mixed-use intensification. Additionally, a large portion of the Paarden Eiland industrial area has been identified by the Blaauwberg District Plan as a site for mixed-use intensification. It is particularly suitable, given its proximity to the CBD and to the IRT and NMT infrastructure along Marine Drive/R27 (CoCT, 2012b). The low-density residential areas within the site identified earlier, can also begin to densify through decreasing height restrictions and allowing subdivision of erven. In terms of the overall purpose of this dissertation, there are many linear elements of the site where NMT infrastructure can be improved. Overall, this development potential is illustrated in figure 5.29.

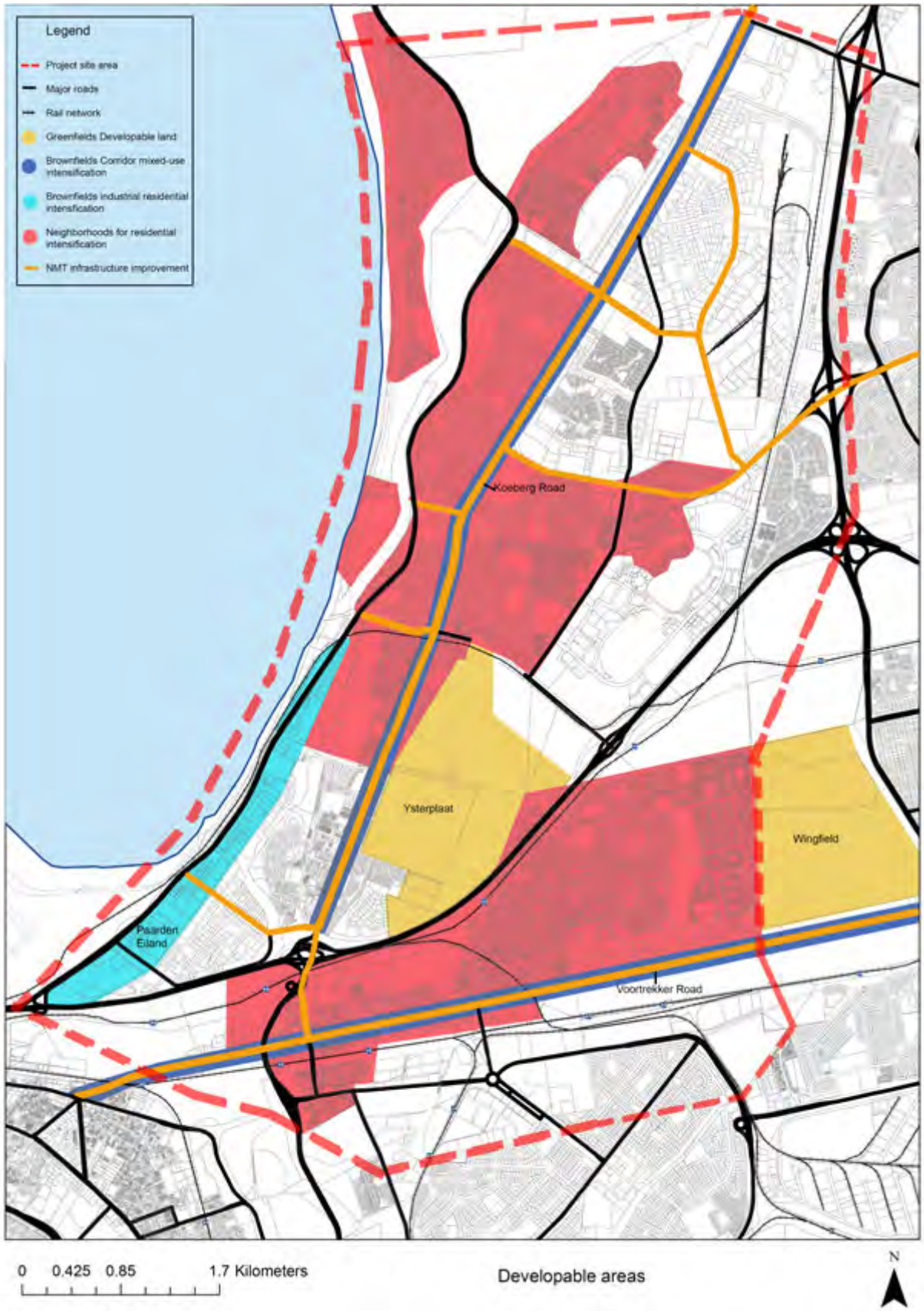

Figure 5.29: Project site developable areas (Source: Author, Data: GIS, UCT Library)

5.5.6 Blaauwberg District Plan

The Blaauwberg District Plan forms one of eight district plans within the CoCT, aimed at guiding development in the medium term (10 years). The district plans within the CoCT are guided by the municipal SDF. For the Blaauwberg District, there are three main strategies. The first is to improve access to economic opportunities. This includes increasing north-south links to Atlantis in the north of the district through the extension of Koeberg Road and the conversion of the Atlantis goods rail line to a passenger rail line. Intensification of residential, industrial and commercial activities along Koeberg Road is proposed, particularly at intersections with other major roads. It is argued that increased densities will also aid in supporting public transport (CoCT, 2012b). Whilst these goals are positive, particularly in terms of densification and mobility, the district plan provides little in the way of NMT plans for the area beyond recreational mobility.

The second strategy is to manage the pressures of urbanization in a coordinated manner, and in a way that is environmentally sustainable. This involves developing important biodiversity conservation areas, creating ecological corridors along rivers, and limiting coastline development to be nodal, in order to protect the coastal environment and limit the negative effects of sea level rise. Additionally, a coastal edge line must be created in order to specifically limit coastal development, and to prevent sea level rise as far as possible (CoCT, 2012b). This coastal management is however, not illustrated spatially within the plan.

The third strategy is focused around building an inclusive, integrated and vibrant city: namely, transforming the apartheid city, and encouraging more integrated settlement patterns. These strategies involve increasing coastal access (particularly NMT links) for recreational purposes, and developing an integrated green network offering amenity value to residents. In addition, the strategy is around identifying developable areas within the district and creating public housing facilities, whilst simultaneously increasing overall densities (CoCT, 2012b).

At the ‘Greater Milnerton’ sub-district level within which the project site falls, the overall strategies are laid out more specifically. In terms of the first strategy for future development, the Ysterplaat site is identified as an urban infill opportunity and high-density mixed-use precinct. Within the Paarden Eiland industrial area, an increase in the residential footprint is encouraged in order to reinforce the IRT system already in place along Marine Drive. In addition, it is stated that densification should take place along the IRT system, and the Koeberg Road corridor in particular (CoCT, 2012b).

With regard to the second strategy, the plan states that development should take into account sea level rise and mitigate future impacts. With regard to the third strategy, the interface between Zoarvlei and Rietvlei are identified for improvement and safer usable interfaces with the built environment and public. Furthermore, several heritage sites were identified for protection within the sub-district according to the National Heritage Act (CoCT, 2012b). The strategies at the sub-district level are spatialized in figure 5.30.

Figure 5.30: Blaauwberg sub-district 1 strategies- not to scale (Source: CoCT, 2012b)

5.6.7 Conclusion

This chapter has explored the CoCT at the metro scale with a focus on current development trends, income-based segregation and difficulties in terms of mobility for many residents. The project site area was then explored in terms of existing economic opportunities and land use, the current mobility context in general and NMT context in particular, environmentally sensitive areas, and areas for potential development. Finally, the main goals and strategies of the Blaauwberg District Plan were explored. The following chapter will make NMT-specific proposals for the project site informed by the above analysis.

Chapter 6: Project site proposal

6.1 Introduction

Based on the opportunities and constraints identified in the previous chapter, this chapter makes a proposal for the equitable and efficient future functioning of the project site. Given that the guiding focus of this dissertation is NMT, an integrated movement network of NMT is proposed within the site. The focus then turns to proposals for the preconditions of integrating NMT into the area, as identified generally in the literature review chapter earlier in this dissertation. It is important to note that the proposals in this chapter are to guide planners in terms of future development within the site, and thus the aim is not to create a comprehensive plan, but rather to propose the project site as a case study for both well-functioning NMT and equitable access to socio-economic opportunities. The interventions in this chapter are guided by the values guiding this dissertation as a whole.

6.2 Principles guiding interventions

The primary focus of this dissertation is on creating equitable and sustainable mobility with the main focus being on NMT. Infrastructure that is user-friendly, safe, sufficiently proportioned in terms of the overall road network, accessible, and that provides a continuous network is therefore a key concern of this dissertation. Added to this, densities that are high enough to support NMT and the increasing investment in IRT are key. Given the widespread reliance on NMT, the importance of NMT in getting to public transport facilities, and the equitable capacity inherent in it, it is important that the often-neglected NMT be given equal presence in terms of planning in relation to other modes of transport.

Furthermore, planning interventions that aim towards equitable mobility must consider the broader range of socio-economic and spatial factors involved. Thus in the broader quest for equitable and sustainable access to socio-economic opportunities in addition to mobility, housing that is both well-located and accessible, particularly to poorer residents, is key. The project site can therefore function as an important case study for future equitable mobility, and future NMT development within the CoCT.

6.3 Project site proposal

This section will begin by proposing an NMT movement network within the project site, whilst proposing the role of the site within the metro as a whole.

6.3.1 Development within the project site

The project site, currently characterized by significant industrial activities and corresponding low-skilled employment opportunities, is a very important well-located area within the CoCT. The sizable and varied opportunities for development on the site identified in the previous chapter present a strong opportunity to address the spatially inequitable and unsustainable current functioning of the city outlined in the previous chapter by bringing poorer residents closer to employment opportunities. The project site can accommodate poorer residents on the site through both an intensified and increased residential footprint on the Ysterplaat Air Force base, portions of the Paarden Eiland industrial area, along Koeberg and Voortrekker Road Corridors, and within the low-density neighbourhoods within the site.

NMT infrastructure that is continuous and integrated with public transport is key on the site to allow equitable, accessible and efficient mobility. In terms of the project site, the conceptual NMT movement routes largely for employment opportunities both within and surrounding the project site are illustrated in figure 6.1. The primary NMT routes into the CBD are along Marine Drive/R27, the Koeberg Road corridor, and the Voortrekker Road corridor. The Marine Drive/R27 and Koeberg road corridor constitute the main north-south links through the project site. These routes are significant in terms of being IRT and taxi routes respectively. It is proposed that both routes will provide sufficient NMT infrastructure, with the Marine Drive/R27 in particular facilitating travel via bicycle to and from the CBD.

Figure 6.1: Conceptual NMT movement (Source: Author, Data: GIS, UCT Library)

The Voortrekker Road corridor constitutes the primary east-west NMT link in the site extending to the CBD in the west and the Bellville CBD in the East. Voortrekker road is significant in terms of taxi routes, and links with Koeberg Road. It is proposed that it will function as NMT links to both CBDs, and bicycle links in particular. In addition to the site's location in relation to the Cape Town and Bellville CBDs, the site is comprised of significant industrial activities and employment opportunities. It is therefore important that NMT connectivity is prioritized within the project site.

The secondary NMT routes therefore function to connect the primary routes with the employment opportunities situated along them, as well as to connect neighbourhoods and areas on a smaller scale. These secondary routes are largely smaller east-west routes linking areas such as Paarden Eiland, Montague Gardens, and Century City with Koeberg Road and Marine Drive/R27. Additionally, north-south secondary routes are proposed to provide links with Maitland, Ndabeni and Epping industrial areas and corresponding employment opportunities. The secondary routes also serve the function of connecting the existing, proposed intensified and proposed mixed-use area of Ysterplaat to the primary routes for overall connectivity both within the site, and to destinations beyond the site itself such as the CBDs mentioned above.

This chapter will now make specific proposals on a range of preconditions for successful functioning on NMT, and for equitable development in the project site, but to benefit the city as a whole. These interventions are guided by the literature explored in the literature review chapter, and by guiding values of this dissertation.

6.4 Factors relating to the built environment

The current development patterns in the city identified in the previous chapter are neither supporting equitable access to socio-economic opportunities, nor creating environments that are conducive to well-functioning NMT. Zhao (2013) contends that single land use environments lead to the decreased likelihood of NMT functioning well. Compact urban forms and high densities allow for greater proximity between origins and destinations (particularly residence and employment opportunities) and thus create more favorable conditions for walking and cycling (see Cervero and Duncan, 2003; Pucher and Beuhler, 2006; Schwanen et al, 2004;

Zhao, 2013).The areas where greenfield mixed-use densification, brownfield corridor mixed-use intensification, brownfields industrial mixed use infill, and pure residential densification should take place are illustrated in figure 6.2.

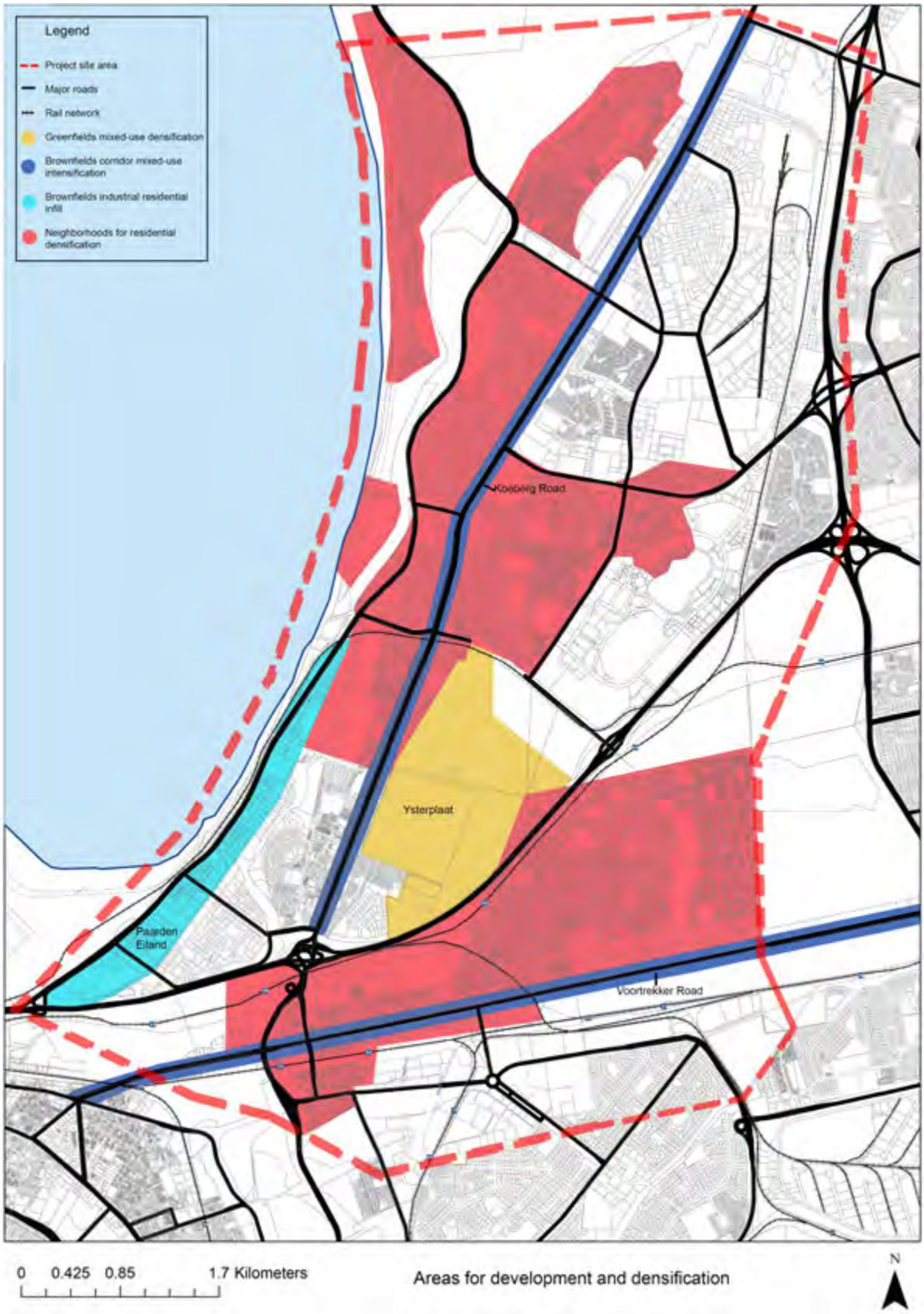

Figure 6.2: Areas for development and densification (Source: Author, Data: GIS, UCT Library)

It is important to state that within a city characterized by low densities, this dissertation seeks to increase densification substantially. This dissertation works from densities laid out in the CSIR 'red book' Guidelines for Human Settlement Planning and Design as a starting point from which development within the project site should be conceptualized. The proposed density above which public transport services with 5 to 10 minute intervals is feasible is at 37 du/ha gross (CSIR, 2000). This is however the minimum, and as such this dissertation proposes development at densities higher than this minimum. The nature of the proposed development will be explored in the following sections.

6.4.1 Greenfield mixed-use densification

The Ysterplaat site as a largely greenfield site has great potential to create well-located housing opportunities for many poor residents of the city who otherwise may not have had the opportunity to live in a well-located area given the current development and settlement patterns of the city. It is proposed that a high density social and gap housing mixed-use development is built on the site.

Whilst the current Blaauwberg district plan does not make a proposal for the development of the entire Air Force base site, this dissertation proposes development of the entire Ysterplaat site within the developable areas identified in the previous chapter. Developing the site would thus include the removal of the existing runway, airplane hangers, and other airfield infrastructure and buildings. The developable area within the site is therefore roughly 110 hectares.

The site should be developed at a minimum of 50 du/ha. This falls between the densities of the neighborhoods of Rosebank (43 du/ha gross) and Sea Point (60 du/ha gross) within the city (CoCT, 2012c). Given that the average household size for the CoCT is at 3.3 people according to the 2011 census data, the Ysterplaat site will therefore be able to house a minimum of 18 000 people (Stats SA, 2011). It is

In developing a greenfield site, there is the opportunity to design a road network that is most favorable for NMT. Jones and Novo de Azevedo (2013) contend that a grid structured street network is more easily navigable by NMT than the 'cookie cutter' road network and cul-de-sac design often used in modern residential

developments. As such, it is proposed that the road network be developed in a grid structure on the Ysterplaat site, making NMT functionality a top priority. Figure 6.3 conceptually illustrates the design of small residential blocks in proximity to activity routes, and public transport interchanges. Whilst it remains conceptual, it is beyond the scope of this dissertation to apply this concept to the Ysterplaat site.

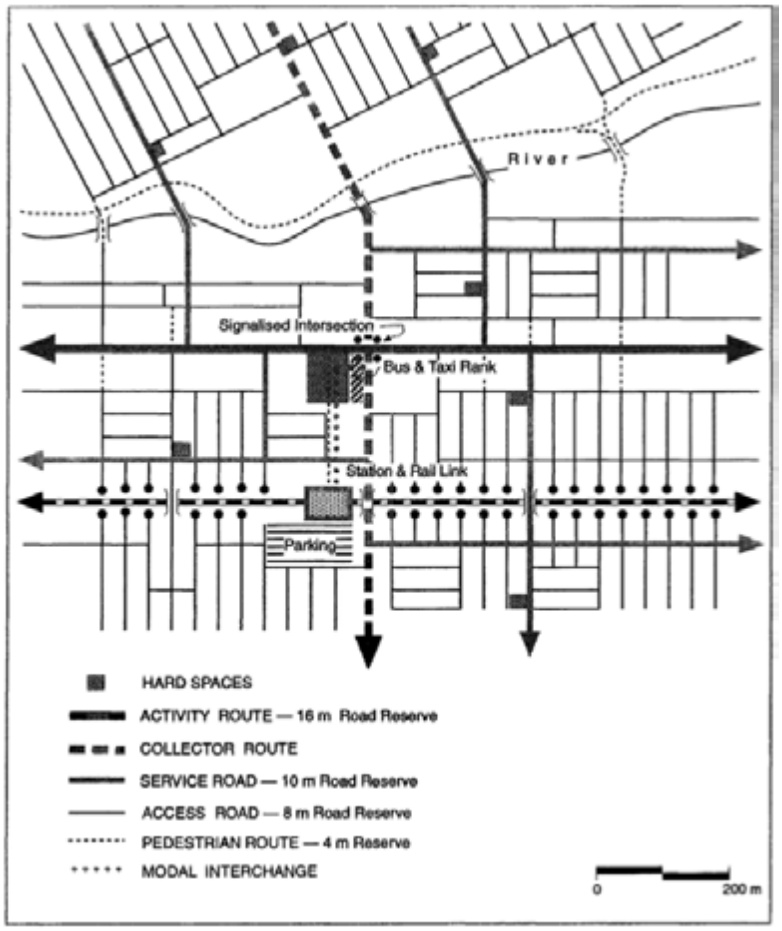

Figure 6.3: Proposed greenfield development road network

(Source: Behrens & Watson, 1996)

Precedent: Social housing project in Cape Town

The Steen Villa social housing complex is an example of a well-functioning social housing project. It is located on Military Road in Steenberg, a lower-middle income area in Cape Town. The complex is adjacent to the Steenberg train station, and in proximity to bus and taxi routes. Economic hubs, educational and community facilities are thus in close proximity. Regarding the building typologies and housing units, the complex consists of 1, 2 and 3 story blocks that are situated around courtyard spaces. There are 700 units comprised of 30m^2 studio apartments, 33-37m^2 1bedroom units, and 42-47m^2 2 bedroom units. The density of the development is at roughly 95 du/ha nett. Rentals of the development are calculated at 30% of household income and thus range from R800 per studio apartment to R2200 for a 2-bedroom apartment. The target market is therefore low-income households (SOHCO, 2015; Hogarth, 2015).

Steen Villa has proven successful overall largely due to its location allowing savings on both time and money on daily commuting, with up to 1,5 hours saved per day and up to R600 saved per month. Additionally its location amongst surrounding middle-income areas has allowed a changing of perceptions regarding existing negative perceptions of social housing in general (Hogarth, 2015).

Figure 6.4: Steen Villa social housing project (Source SOHCO, 2015)

6.4.2 Brownfield corridor mixed-use development

Both Voortrekker and Koeberg Road have been identified as sites for mixed-use intensification. By increasing residential, retail and general commercial activities along these corridors many benefits for the area can be achieved. In terms of residential development, an increased number of residents can move to main NMT corridors, improving mobility, whilst increasing the density, which can support public transport in general and IRT in particular. Furthermore, mixed-use intensification allows greater proximity of origins and destinations, and retail activities in particular, which allows shorter trips and in turn provides more favorable conditions for NMT, as argued by Cervero and Duncan (2003).

A recent study by Rode and Lottering (2014) on the development potential of the Voortrekker Road Corridor found that the entire area could accommodate 550 000 m2 of retail space, 250 000m2 of office space (equivalent to the entire office space in Century City), and 250 000 residents (Rode and Lottering, 2014). The Greater Tygerberg Partnership (GTP) which has placed much focus on the Voortrekker Road corridor regeneration and development argued that if all the properties and all the public land public land alongside Voortrekker Road were to be built up to the density of Sea Point (60 du/ha gross), then over 300 000 people could be accommodated in well-located housing by 2040 (GTP, 2014).

Given that Koeberg Road and parts of Voortrekker Road constitute IRT routes, and that both are significant public transport routes, it is important that building guidelines stipulate that densities along both corridors are built up to between 50 and 60 du/ha gross, at similar densities to Sea Point, in order to support public transport. Moreover, in order to develop and maintain intensity and densities required for well-functioning corridors, building guidelines should stipulate that streets must be defined with continuous building frontage, and defined public spaces, avoiding lost space such as parking lots directly along the corridors.

Precedent: Corridor development in Melbourne

Swanston Street in Melbourne, Australia is a major corridor in the center of the city. Within the context of rapidly increasing urbanization, the city of Melbourne was under pressure to accommodate an increasing population. In response the zoning of the height allowances in the street were changed and densification of the corridor was encouraged. Swanston Street features a tramline that extends into the city center. Densification along tramlines has been encouraged in Melbourne in order to discourage sprawl, and to create a greater ease of mobility (Adams, 2010).

Many of the buildings along the corridor exceed four stories with continuous frontage on the street and interaction of buildings with street life. Beyond the corridor, the building heights drop back down to two or three stories on either side of the street. The corridor has thus been able to maintain its intensity. Swanston Street is also significant in terms of its mixed-use character, and in terms of the prioritization of NMT. Of the average width of the street at 30 meters, roughly half of the space is dedicated to pedestrians and bicycles, with the remainder dedicated to trams and infrequent private cars.

Figure 6.5: Swanston Street, Melbourne (Source: swanstonstreet.com/au)

6.4.3 Brownfield industrial mixed-use infill

Parts of the Paarden Eiland industrial area within the project site have been identified as sites for residential infill. This is largely the area between Marine

Drive/R27, and the IRT and bicycle path that runs through the area. Residential densification along these routes in particular is key for a number of reasons. Firstly, increased numbers of residents can move in close proximity to key NMT and IRT routes, thus increasing the density in order to support the IRT system in particular. Furthermore, increased numbers of people can move to a well-located and accessible area.

McClintock (2002) contends that increasing densities surrounding NMT infrastructure increases surveillance and thus creates safer infrastructure from the perspective of crime levels (McClintock, 2012). Muggings and bike theft levels along the NMT route have been reported to be high (see Mervis, 2015), and increased mixed-use development along the route will thus aid in reducing overall crime levels.

It is proposed that development within Paarden Eiland be between 45 and 60 du/ha, similar to the densities of Rosebank (43 du/ha) and Sea Point (60 du/ha). The majority of residential development must take the form of social and gap housing in order to allow poorer residents the opportunity to live in well-located housing. It is important that residential development takes place strategically between existing industrial and retail development so as not to lose the significant employment and industrial opportunities that Paarden Eiland currently provides.

6.4.4 Neighborhoods for residential densification

The neighborhoods identified for residential intensification within the project site identified in figure 6.2 are largely low-density and characterized by single dwelling units. Given the current unsustainable development patterns identified in the previous chapter whereby similar low-density single dwelling unit, largely middle income neighborhoods are being developed on the peripheries of the city, the current low density well-located neighborhoods should rather be allowed to move towards incremental densification as a means to combat current unsustainable growth patterns.

Such densification should not drastically change the character of neighborhoods but instead should occur incrementally through subdividing properties, building extensions and consolidating adjacent plots in order to allow larger buildings. This can be supported through municipal zoning (Turok, 2009). Examples of this can be

found in Mitchells Plain where the city is currently piloting a project to support such densification processes, and in Du Noon where some households have demolished housing provided by the state in order to build rental accommodation that is of a higher density (McGaffin et al, 2015).

This chapter will now move to proposals regarding the need to integrate NMT with other modes of public transport in order to develop a successful NMT system.

6.5 Creating intermodality

In terms of the conceptualization of NMT users, Barnfield and Plyushtiva (2015) contend that it is important that users are not defined in binary thinking, but rather must be understood in terms of their interrelationships with other modes of transport (Barnfield and Plyushtiva, 2015). The UN Habitat report (2013) on urban mobility states that in the developed world, walking and cycling tend to function as feeder modes in order to serve public transport facilities. In general, the maximum distance that people tend to walk is roughly 1,5 km's whilst for cycling the maximum distance is roughly 8 km's (Cervero and Duncan, 2003).

Within the project site, it is thus proposed that both walking and cycling function as a means of transport to get directly between residential origins and employment or retail related destinations in cases where residents live within the radii mentioned above. However, in cases where the distance between origins and destinations is greater than that mentioned above, it is proposed that NMT functions as a feeder mode in order to access the variety of public transport modes within the site. It is consequently very important that the interconnection between NMT and cycling in particular be facilitated at public transport stops and interchanges within the site, and where possible on public transport itself.

Regarding the transporting of bicycles on public transport, bicycles are currently allowed to be carried on all IRT busses free of charge, provided that they are stored in the designated areas on the busses, and that they do not cause any inconvenience to other passengers, as shown in figure 6.6 (Myciti, n.d.).

Figure 6.6: Bicycles on a Myciti bus (Source: Myciti, n.d.)

Bicycles are also allowed to be carried on trains. However, the times at which they can be on trains are limited to off peak times, namely between 09:00 and 15:00, and after 19:00 on weekdays and any time on weekends. Additionally, there is a R20 charge to take a bicycle on a train per trip, which increases travel expenses significantly (Mervis, 2013).

It is proposed that trains operating along the northern and central lines create bicycle storage infrastructure on board as a pilot project for other trains operating around the city. Additionally, as with the IRT system, the price for transporting bicycles on trains should be removed in order to facilitate a more equitable system.

Precedent: Storing bikes on trains

In 2014 the National Passenger Rail Corporation in the USA initiated a project to equip all inter-city trains with 'Roll-on-bike' storage in response to increasing demand from consumers (Schmitt, 2014). The storage system is illustrated below.

Figure 6.7: Bicycle storage facilities on a train (Source USA Streets Blog, 2014),

In addition to allowing bicycles on public transport, secure lockup provisions for bicycles at public transport interchanges are very important for intermodal facilitation as a whole. It is proposed in keeping with the CoCT NMT policy and strategy document that bicycle parking and storage facilities are highly visible and secure (CoCT, 2005b). These facilities should be at IRT stops and stations and train stations within and directly surrounding the project site. Given that all train stations have security and Metrorail staff present, monitoring and securing storage facilities can be undertaken, provided the facilities are in visible locations close to passengers and staff surveillance. For IRT stops and stations however, storage facilities should only be created on busier roads, particularly where pedestrian activity is more constant. Storage should also be in close proximity to IRT stops themselves. The locations of these storage facilities are illustrated in figure 6.9. It is important that bicycle racks are well anchored to the ground in order to avoid theft and vandalism and are covered to allow protection of bicycles from rain. There should be sufficient space (1,2 meters) between racks in order to fit two bicycles side-by-side. Furthermore, parking facilities should be well signposted.

Precedent: Bicycle parking facility

The bicycle parking facility at the Kuilsriver train station is an example of effective facilities. The facility is undercover, well signposted, able to accommodate up to 80 bicycles, and is protected by security staff from 6am to 6pm.

Figure 6.8: Bicycle parking facilities at Kuilsriver train station (Source: Rideyourcity,2011)

Figure 6.9: Bicycle parking facilities at train stations and Myciti stops

(Source: Author, Data: GIS, UCT Library)

This chapter will now move to proposals for the creation of NMT infrastructure that is sensitive to the high levels of crime within the CoCT.

6.6 Crime

Within the context of the CoCT, which like many other South African cities faces high levels of crime, it is important the NMT facilities are built with personal safety as a priority. Behrens (2005) emphasizes the need for surveillance on and visibility of NMT infrastructure. Similarly, McClintock (2002) emphasizes the need for NMT infrastructure to be surrounded as far as possible by high-density areas both to increase the surveillance on infrastructure, and to increase volumes of users on the routes. The proposed residential densification in Paarden Eiland, the mixed-use intensification along the corridors, and densification within neighbourhoods in the project site will aid in increasing densities along NMT routes within the site. Additionally, pedestrian and bicycle infrastructure should be situated side-by-side as far as possible in order to facilitate these higher concentrated volumes of NMT users.

Precedent: combined NMT traffic

The Sea Point promenade in Cape Town is a well-functioning NMT zone, frequently used by joggers, walkers, and cyclists. The high volumes of combined non-motorised traffic create a safe space with ample surveillance.

Figure 6.10: Sea Point Promenade (Source: IOL, 2016)

Pedestrian and cycle paths should be out in the open and not concealed by vegetation or walls for example. Moreover, for night time usage on NMT infrastructure, 'smart lighting' should be designed in order to illuminate both NMT paths and the surrounding areas where potential criminals could hide.

Precedent: NMT infrastructure lighting

In Melbourne, Australia, stand-alone street light-style solar lighting has been provided for many bicycle and pedestrian paths. In this particular path in South Melbourne (figure 6.11), the lighting is sufficiently bright to light up the path and the surrounding areas.

Figure 6.11: Well-lit NMT infrastructure (Source: Bicycle Network Australia, 2015)

6.7 Equitable infrastructure and facility provision

Regarding users of NMT, Pirie (2013) contends that within Anglophone Sub-Saharan African (ASSA), cities tend to have a high dependence on NMT and walking in particular. Unfortunately despite this dependence, the infrastructure within many of these cities does not reflect the needs of the majority of the populations (Pirie, 2013). An interview with the CoCT NMT department echoed this claim whereby it was stated that the majority of poorer residents within the city are dependent on NMT and walking in particular for the 'first mile' of the daily commute (CoCT NMT department, 2016). Pirie contends that on the street level, this inequality often

manifests as sacrificing the welfare of NMT users in order to ensure the efficient flow of motorized traffic (Pirie, 2013).

Whilst cycling and walking are often largely utilized by the poor in developing world cities, Salon and Aligula (2012) contend that the provision of equitable NMT infrastructure in relation to motorized traffic infrastructure, and good interconnection of NMT with efficient public transport, can broaden the attractiveness and user-friendliness of NMT for all income and socio-economic groups. It is therefore essential that NMT infrastructure and facilities be equitably provided in relation to the motorized traffic infrastructure. Such infrastructure shall now be explored for a variety of roads and intersections within the project site.

It is proposed that major NMT routes within the project site are defined in terms of primary and secondary routes. This section will thus propose equitable NMT infrastructure as a guide for implementation of the respective routes, as well as guidelines for NMT provision at intersections. The CoCT NMT Policy and Strategy guidelines explored in the policy review chapter form the basis for the infrastructural specifications that will be proposed.

6.7.1 Primary NMT routes

As mentioned earlier, it is proposed that primary NMT routes within the project site function as the main movement corridors both within and beyond the site. The overall traffic (both NMT and motorized) along these routes is thus likely to be higher than the secondary routes.

In terms of the primary routes within the site, the nature of Marine Drive/R27 is significantly different to the Koeberg and Voortrekker Road corridors. Marine Drive/R27 is not confined by buildings or boundary walls to the same extent as the Voortrekker and Koeberg Road corridors. The speed limits and nature of the roads are also very different as Marine Drive/R27 functions more as an arterial road with a speed limit of between 60 and 70kmph in relation to the proposed corridor functioning of Koeberg and Voortrekker roads. As such, the nature of NMT infrastructure proposed between the Marine Drive/R27 and Koeberg and Voortrekker Roads is different.

Figure 6.12 illustrates the proposed NMT infrastructure to take place on Marine Drive/R27. The proposed increase in the residential footprint along the road within Paarden Eiland, and within the proposed neighbourhoods along the length of the road will result in increased volumes of commuters along the road. It is thus likely that NMT traffic along the road will increasingly become multi-directional. It is thus proposed that class 2 bicycle paths are increased from the current unidirectional functioning, to accommodate simultaneous, safe and multi-directional bicycle traffic, with each lane at a minimum of 1,5 meters in width, and with a minimum clearance height of 2,5 meters.

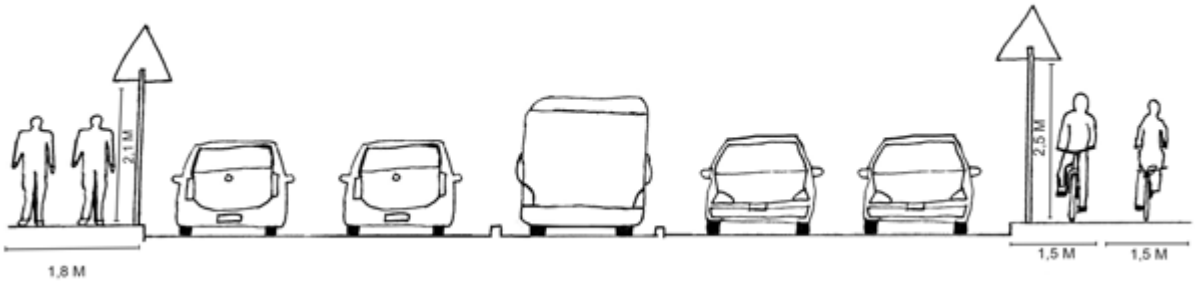

Figure 6.12: Marine Drive/R27 primary NMT route in section (Source: Author)

Precedent: Multi-directional NMT traffic

In Bogota, bicycle paths are commonly separated from motorized traffic on the sidewalk in class 2 multi-directional design. As shown in the figures below, it is important that respective cycling directions are clearly marked.

Figure 6.13: Multi-directional NMT traffic in Bogota (Sources: Lavidaesloca,2012 ; 3.bp.blogspot 2013)

Given that there is little activity along Marine Drive/R27 in relation to the corridors (for example) and hence less frequent destinations along the route, class 2 lanes are well suited to the route as they allow the fastest and most efficient bicycle travel given that they are separate to the road network. On the opposite side of the road, infrastructure wide enough to accommodate multidirectional pedestrian traffic (1,8 meters with 2,1 meter clearance) is proposed, where it is currently largely non-existent. Furthermore, for both sidewalks and bicycle paths, it is essential that curb ramps are present to facilitate the continuous and easy flow of pedestrians, disabled persons, and bicycles. It is proposed that the width of such ramps be 3 meters in length for bicycles and 1,8 meters for pedestrians and disabled persons along Marine Drive/R27.

For the corridors of Koeberg and Voortrekker Roads, the proposed NMT road layout is divided into two broad categories: corridors with IRT and those without IRT. Corridors such as Koeberg road with IRT routes are illustrated in section in figure 6.14. In keeping with Salon and Aligula (2012), this proposal takes seriously the need to begin reducing the number of private cars and corresponding congestion on the roads, and subsequently encouraging NMT and public transport as far as possible. As such, it is proposed that private cars are only allocated one lane within the road reserve, whilst provision is made for multidirectional IRT. Parking for cars is proposed down side streets off the corridor, or behind the continuous frontage on the corridor.

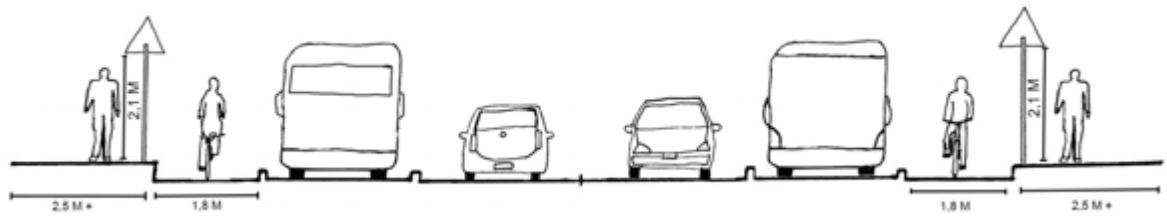

Figure 6.14: Primary NMT corridor with IRT in section (Source: Author)

In terms of bicycle infrastructure, class 3 bicycle paths are proposed within the road reserve at the recommended 1,8 meters width, rather than on the sidewalk in a class 2 design. This is a means to encourage increased street-level pedestrian activity on sidewalks, and to make allowance for informal economy (see Khayesi et al, 2010). The 1,8 meter width is sufficient for two bicycles to pass, whilst strategically too narrow for cars to park in it. Furthermore, formally facilitating bicycles within the

road reserve of a busy corridor increases the 'symbolic value' and visibility of the bicycle in relation to other modes of transport (see Williams & Arkaraprasrtkul, 2016). It is important that there is a clear division between the lanes for motorized traffic and those for bicycles. As such, both painting the lane a different color to the road reserve (see the case of Bree Street earlier in figure 4.17) and placing studs on the outside of the lane to divide from motorized traffic (see figure 4.17), are proposed.

Precedent: Safe NMT within the road reserve

The Green Lane Project in San Francisco is a well functioning example of class 3 bicycle lanes separated from motorized traffic both with physical barriers and the use of color.

Figure 6.15: NMT infrastructure safely separated from motorized traffic
(Source: People for Bikes, 2015)

For pedestrians in the corridors, on sidewalks a minimum 2,1 meters clearance height is proposed, as well as a minimum width of 2,5 meters. This width can be increased if there is sufficient space in order to allow increased street-level activity. Where sidewalks cross side streets, it is proposed that curb ramps are built at a minimum width of 2,5 meters.

Regarding corridors without IRT, such as the current majority of Voortrekker Road, the proposed NMT functioning is the same as the proposal for corridors with IRT. The proposed layout is illustrated in figure 6.16 in section. The difference for motorized traffic however is the absence of dedicated IRT lanes. In such cases, an extra lane

can be provided for taxis and busses, or future IRT. Alternatively, the sidewalk width can be increased to promote increased pedestrianisation of the street.

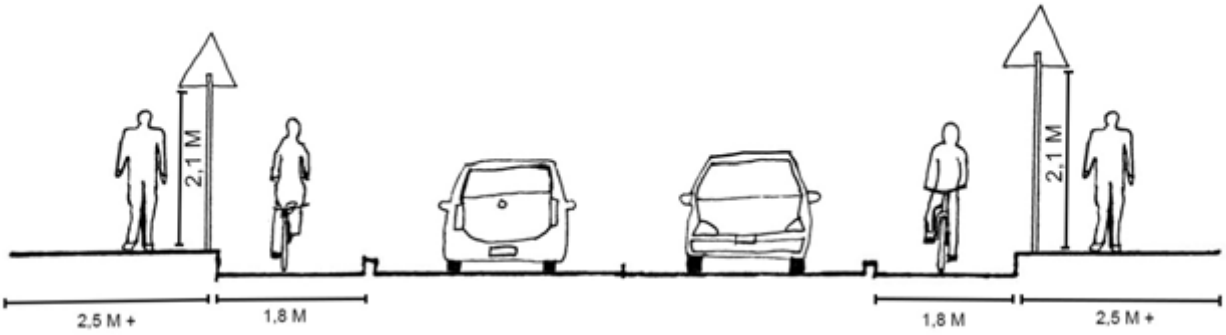

Figure 6.16: Primary NMT corridors without IRT in section (Source: Author)

6.7.2 Secondary NMT routes

Proposed secondary NMT routes within the project site, are also divided into two main categories, namely routes with IRT, and those without IRT. Secondary NMT routes with IRT, such as Racecourse and Omuramba are illustrated in section in figure 6.17. On these routes it is proposed that one lane in either direction be dedicated to IRT and other motorized traffic respectively. Parking along such roads will occur along side streets as far as possible, as IRT and NMT should be given first priority.

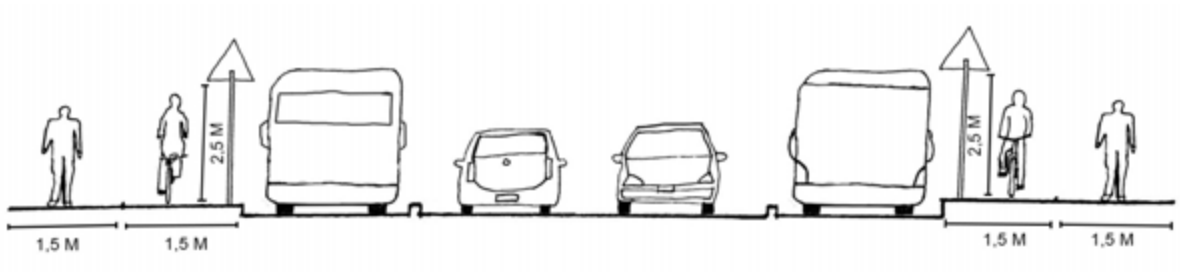

Figure 6.17: Secondary NMT routes with IRT in section (Source: Author)

It is proposed that both pedestrian and bicycle paths are on the sidewalks corresponding with the direction of motorized traffic. This is important in relation to the proposed multidirectional path on Marine Drive/R27, as there is generally activity along both sides of the road, and greater access is needed to bicycle infrastructure from larger numbers of feeder routes. These bicycle paths constitute class 2 infrastructure. They are generally safer, as they are separate from motorized traffic, particularly along roads with less traffic and corresponding lower levels of

driver alertness. Such paths again allow fast and efficient bicycle travel, which is significant given that secondary routes are largely feeder routes to primary routes, and as such do not have the same level of intensity and subsequent destinations along them, as are present on primary routes and corridors in particular.

The positioning of bicycles closest to the motorized traffic on sidewalks is proposed in order to make them most visible to motorized traffic, particularly when approaching intersections and driveways. For cars exiting driveways and entering road the road network, the position of bicycles a minimum of 1,5 meters away from driveways allows for greater visibility of cyclists, and increased reaction time for both motorists and cyclists. It is proposed that both bicycle and pedestrian paths are both 1,5 meters wide with 2,5 meters vertical clearance for bicycles and 2,1 meters vertical clearance for pedestrians. Furthermore, curb ramps must be built for both pedestrians and bicycle paths at a minimum of 2 meters in width.

Figure 6.18 illustrates secondary routes without IRT such as Boundary and Bosmansdam Road. It is proposed that NMT infrastructure remains the same on secondary routes both with and without IRT. It is proposed that one lane be dedicated to motorized traffic in each direction, with additional road reserve space being used for future IRT lanes, or parking, depending on the activities along the route.

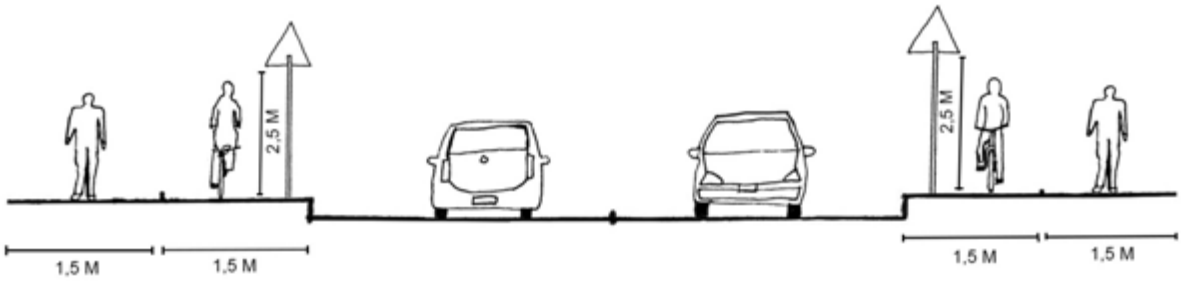

Figure 6.18: Secondary NMT routes without IRT in section (Source: Author)

6.7.3 Intersections

As the most likely position for collisions between NMT users and motorized traffic, intersections require important and careful design. It is important the NMT users (as the most vulnerable in relation to motorized traffic) are given priority at

intersections. Visibility of cyclists, pedestrians and disabled persons for motorists is very important for design, and thus the clear continuation of NMT infrastructure through intersections is key.

Figure 6.19 illustrates the proposed intersection design. It is based upon the design of intersections in the Netherlands whereby NMT is given preference and the flow of NMT traffic is efficient. It is important and thus proposed that bicycle and pedestrian traffic follows the direction and flow of motorized traffic on corridors and secondary routes. In instances, however, where motorized traffic turns across bicycle and pedestrian paths, cautionary design is required. In the proposed design, extra curbs are created in order to connect bicycle lanes and protect them from turning motorized traffic.

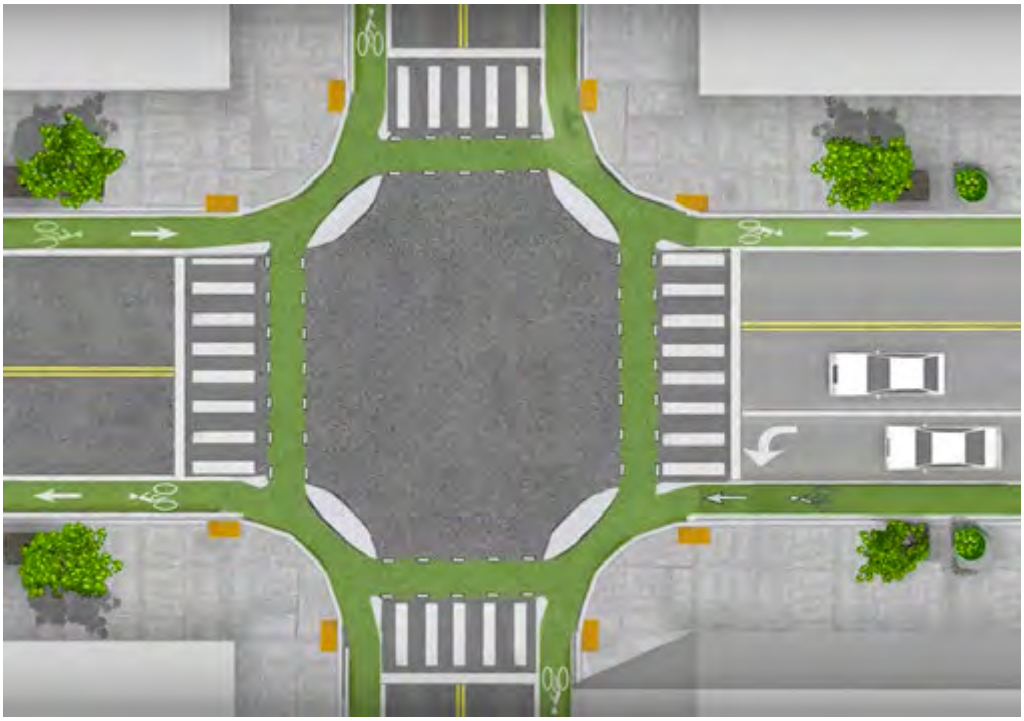

Figure 6.19: NMT-prioritized intersection (Source: Adapted from Bicycle Dutch, 2011)

Figure 6.20 illustrates where both cyclists and pedestrians would stop when crossing an intersection. The visibility of cyclists in relation to left turning motor vehicles at the potential point of contact is effective in this design. This design will function for both class 2 and 3 bicycle lanes.

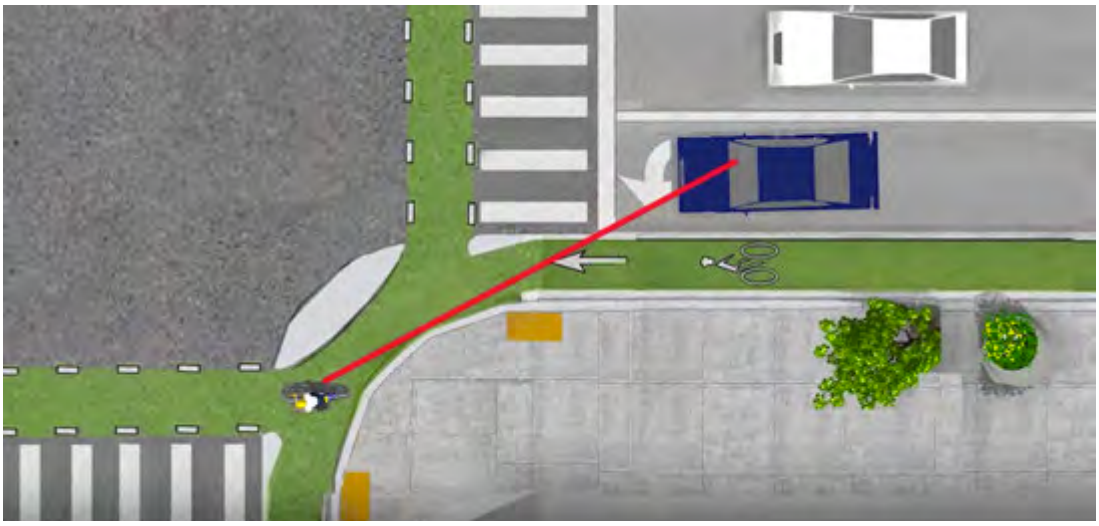

Figure 6.20: Visibility of cyclists in relation to drivers (Source: Adapted from Bicycle Dutch, 2011)

In instances where cyclists are turning left, the proposed design allows uninterrupted movement. In instances where cyclists are continuing straight, they will wait at the proposed point in figure 6.20 until traffic is flowing in the direction they are going. They will then yield to turning vehicles before proceeding straight. In instances where cyclists are turning right, they will again have to wait for traffic to flow to be in the direction they are travelling before yielding to turning motorized traffic and finally proceeding, as illustrated in figure 6.21.

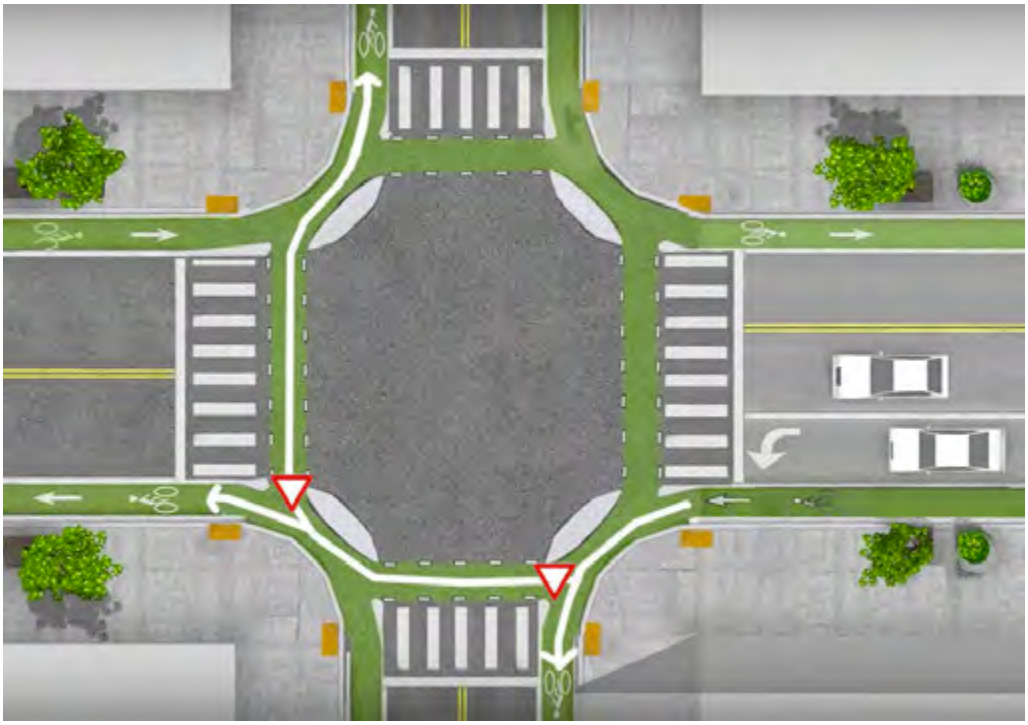

Figure 6.21: Illustration of bicycle usage of intersection turning directions

(Source: Adapted from Bicycle Dutch, 2011)

For pedestrians and disabled persons to cross the street, it is proposed that traffic lights make allowance for the pedestrian crossing in the intersection illustrated in figures 6.19 and 6.21. Whilst traffic lights facilitate pedestrian crossing, bicycles can continue to cross simultaneously as this does not provide any additional points of collision with pedestrians.

Precedent: NMT-prioritized intersections

The Dutch precedent for well-functioning intersections that prioritize NMT (left) is being used in many cities around the world including Davis, California (right).

Figure 6.22: Well-functioning Dutch-style NMT-prioritized intersections
(Sources: Davis Enterprise, 2013; People for Bikes, 2015)

On roads with high activity and high volumes of NMT and pedestrian activity in particular, such as the corridors proposed within the site, it is important to have frequent NMT crossing facilities. Such crossings are illustrated in figure 6.23. These crossings should (with the use of traffic lights) bring both motorized traffic and bicycles on bicycle paths to a complete stop in order to facilitate the crossing of pedestrians, bicycles, and disabled persons. The crossing should facilitate a separation between bicycles and pedestrians.

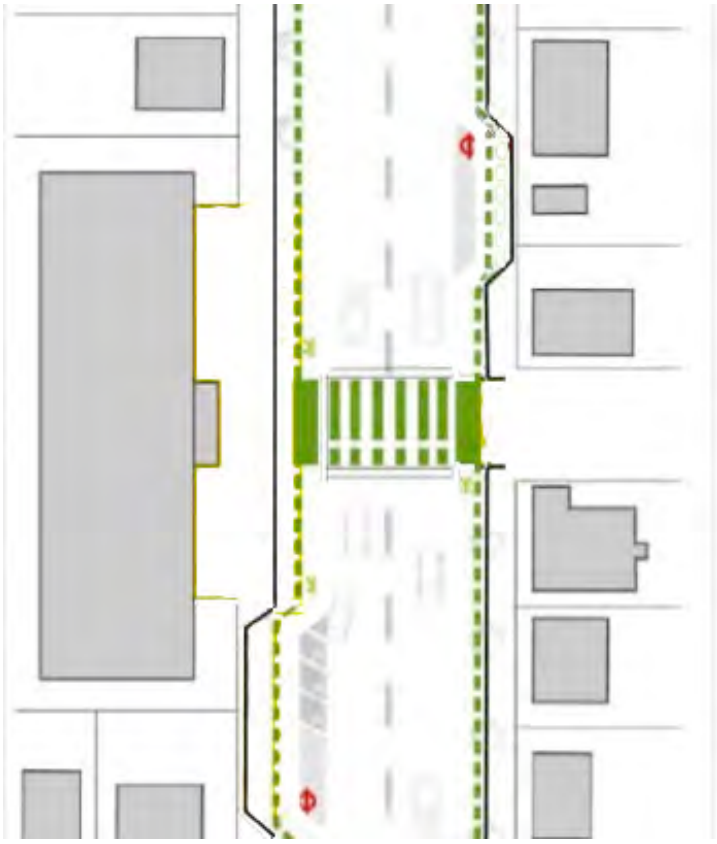

Figure 6.23: Pedestrian and bicycle crossing (Source: CoCT, 2005b)

6.7.4 Tertiary NMT routes

In terms of local roads within the project site that have not been identified for NMT interventions, motorized traffic volumes on these roads tend to be significantly lower than the majority primary and secondary routes identified. As such, it is proposed that these routes function as feeder routes for the primary and secondary routes. In order to increase the visibility of NMT along tertiary routes however, road signs and road markings should be placed on busier tertiary roads to increase awareness of NMT road users. Additionally, as proposed earlier for the development of Ysterplaat, a grid structure of roads at the neighborhood level is most efficient for NMT mobility. The grid structure should therefore be prioritized in new greenfield developments.

6.7.5 Project site NMT network

Figure 6.24 illustrates the overall continuous NMT network proposed for the project site, including the bicycle parking facilities proposed at strategic IRT stops and train stations.

Figure 6.24: Project site proposed NMT network (Source: Author, Data: GIS, UCT Library)

It is important to note that whilst the road layouts proposed are specific in nature, proposing road layouts for the project site is by no means an overarching and conclusive plan taking into account all road level-specific complexities. Instead the proposed NMT network is a guide to inform the overall NMT network plan within the project site.

This chapter will now propose elements in the design of NMT related infrastructure to mitigate the effects of the natural environment.

6.8 Natural environment factors

Factors relating to the natural environment, namely topography and the weather have a significant effect on NMT (see Cervero and Duncan, 2003; Rodriguez and Joo, 2004). Given that the project site is situated on largely flat terrain, topography is not a factor that needs to be taken into account when designing and building NMT infrastructure within the site. As a city with wet winters however, it is important steps are taken to mitigate these effects for pedestrians and cyclists as far as possible. As origins and destinations for many NMT trips are often between home and public transport stops, it is important that shelter from rain is provided at both train stations, and at IRT and bus stops and stations for waiting passengers within the project site.

Precedent: Rain shelter at public transport stops

Annandale stop in Gardens, Cape Town (left) and Mutual station in Maitland, Cape Town (right) are good examples of shelter provided from rain at public transport stops.

Figure 6.25: Myciti stop and train station with sufficient shelter from rain
(Sources: IOL, 2015; EWN, 2016)

Along streets with high levels of pedestrian activities, such as the proposed functioning of the Voortrekker and Koeberg Road corridors, it is proposed that overhangs along continuous frontages provide shelter for pedestrians.

Precedent: Shelter-providing building overhangs

Long Street in Cape Town is an example of a street with well-functioning overhangs that provide sufficient shelter for pedestrians.

Figure 6.26: Long Street building overhangs (Source: Google Street View)

6.9 Social and cultural factors

Beyond the infrastructural aspects related to building NMT into the project site, proposals regarding social aspects must also be considered. Both walking and cycling need to become embedded into the urban fabric in order to become 'visible' in relation to other motorized modes of transport (see Jones and Novo de Azevedo, 2013). The building of class 3 bicycle paths separated from motorized transport visibly through color and physical barriers, as proposed earlier, as well as NMT specific facility provision within intersections will begin to make NMT more visible. Additionally, as proposed earlier, lanes and parking facilities should increasingly be removed from streets in order to encourage the use of both NMT and public transport.

Public awareness campaigns are also proposed in order to create widespread exposure to the functioning and value of building NMT into the city. These

campaigns can also help to 'normalize' NMT as a viable and equitable mode of transport in the public opinion (see Mashiri et al, 2013 and McCarthy, 2010).

Precedent: Encouraging NMT awareness and visibility

The Bogota ciclovia-inspired Open Streets initiative (left) encourages the visibility and usage of NMT by removing motorized transport from particular streets for a day.

The #moonlightmass initiative (right) aims at increasing the overall awareness and visibility of cyclists as road users by cycling around the Cape Town CBD every full moon night.

Figure 6.27: Open Streets and Moonlightmass events
(Sources: Bicycle Cape Town, 2015; Marie Claire, 2013)

6.10 Intervention and implementation recommendations

Given the interconnection between densities, compact urban forms, public transport and NMT infrastructure for creating well functioning NMT, it is important that interventions within the project site take place simultaneously. The pressing need for the city to provide affordable, well-located housing for the poor must be given immediate priority within the overall interconnected NMT interventions. In the case of developing Ysterplaat however, given that the site currently functions as a national Air force Base, acquiring the land for development by the CoCT is likely to take several years before development plans can be made and development can begin.

It is important to note that in 2017, the CoCT's transport authority TCT is set to undergo an overhaul to include both urban development and housing functions. It

will be known as the Transport and Urban Development Authority (TDA). The ultimate goal of the new TDA is thus to create an integrated approach to spatial and transport planning (Dentlinger, 2016). This acknowledgement of the interconnectedness of transport with broader factors is a welcome change. The current NMT policy and strategy documents should also start to move in this direction. The largely infrastructural focus of the documents does not recognize the interconnectivity of compact and dense urban forms with well-functioning NMT, and as such fails to make proposals in this regard.

Furthermore, In terms of the infrastructure proposals, the documents do not make sufficient recommendations regarding the types of environments suited to the specific infrastructure (such as bicycle lane classes) proposed. Given that the stated intent for all CoCT documents relating to NMT is to create more equitable and accessible modes of transport, there is a lack of proposals beyond those relating to infrastructure (public awareness campaigns for example) regarding ways in which NMT can be promoted, and become more visible in relation to motorized transport. In short, CoCT NMT policy and strategy documents need to move beyond largely infrastructural proposals and policies to those that acknowledge the interconnected built environment, social, intermodal and infrastructural interventions needed to accommodate well-functioning and equitable NMT.

Table 6.1 highlights the key development interventions that must be implemented within the project site.

Description	Actors & Funding	Timing
Ysterplaat mixed use development	GTP, CoCT, TDA, Wcape government, National government, SAAF, social housing developers, BEN	To begin within 3 years
Koeberg and Voortrekker Road corridor mixed use intensification	GTP, CoCT, TDA, businesses, informal traders, residents, housing and social housing developers, BEN	Immediate
Paarden Eiland residential densification	CoCT, TDA, businesses, housing and social housing developers, GTP, BEN	Immediate
Neighbourhood residential densification	CoCT, TDA, housing developers, residents, GTP	Within 2 years
NMT priority intersection and NMT crossing development	CoCT, TDA, Bicycle Cape Town	Immediate
Primary NMT route development	CoCT, TDA, Bicycle Cape Town	Immediate
Secondary NMT route development	CoCT, TDA, Bicycle Cape Town	Within 1 year
Bicycle lockup facility development and public transport shelter improvement	Prasa, CoCT, TDA, Bicycle Cape Town	Immediate
Pedestrian and bicycle path lighting	CoCT, TDA, Bicycle Cape Town	Immediate
Public NMT awareness campaigns	Open Streets, GTP, residents, businesses, CoCT, #moonlightmass, BEN	Ongoing

Table 6.1: Key interventions for the project site

6.11 Conclusion

Based on preceding analysis of opportunities and constraints, this chapter began by proposing well-located housing development, and corresponding densification within the project site. It then turned to proposals for the equitable, safe and efficient functioning on NMT, also within the project site.

Chapter 7: Conclusions

This dissertation has explored the current challenges and opportunities for creating well-functioning non-motorized transport (NMT) in the City of Cape Town (CoCT), as well as the range of interventions required in order to overcome these challenges.

The challenges and opportunities were explored through an examination of a variety of literature from around the world, a review of NMT-related policy, and interviews with CoCT officials and an NGO actively involved in promoting NMT within the city. What emerged was that well-functioning NMT is a product of a wide variety of factors beyond the mere provision of NMT-specific infrastructure. These include: the creation of compact city forms; the need for intermodal linkages with other forms of motorized transport; the need to mitigate against crime through infrastructure design; the need to consider climatic and topographic conditions; and the importance of social programs and initiatives in promoting NMT.

Through this framework, a contextual analysis was undertaken in order to ascertain the CoCT-specific challenges and opportunities. The CoCT is characterized by an apartheid-induced inequitable and inefficient sprawling city form, which remains largely entrenched within the city. The majority of poor residents within the city have to travel long distances to socio-economic and employment opportunities in particular, often at great economic and temporal expense. Moreover, current development patterns are largely on the outskirts of the CoCT, further entrenching the inequitable city form. Long-distance commuting, compounded by an overall lack of NMT-specific connected infrastructure, has resulted in conditions that are by no means conducive to NMT functioning within much of the CoCT.

The 'Northern inner' district of Cape Town was selected as the site for interventions to enable well-functioning NMT, which can in turn be tested within other areas in the city. The site is significant as a well-located and accessible area of the city (straddling both the N1 and N7 highways, and the Koeberg and Voortrekker Road corridors), particularly in relation to both the Cape Town and Bellville CBDs, and in relation to significant low-skilled employment opportunities. The site also consists of two large parcels of land with development potential (Ysterplaat Air Force Base and Wingfield Military Base). Key proposals for the project site were firstly to begin

alleviating spatial inequality through improving access to socio-economic opportunities by developing high-density, affordable housing opportunities within project site. This in turn can create more compact city design by reducing the distance between origins and destinations, and in turn create conditions more conducive to NMT.

The equitable provision of NMT-prioritized intersections, and route-specific paths and lanes in relation to infrastructure for motorized transport is also key for well-functioning and safe NMT. Further proposals include weather-resistant intermodal linkages between NMT (cycling in particular) and public transport, reducing crime through strategic placement and design of NMT infrastructure, and promoting visibility and awareness of the value of NMT through public awareness campaigns. Given the multiple interconnected factors involved in creating well-functioning NMT, it is important that the proposed interventions take place simultaneously, and that the forthcoming (in 2017) CoCT Transport and Urban Development Authority (TDA) which aims to integrate transport and urban planning (Dentlinger, 2016), begin from an inter-departmental integrated approach to implement the diverse proposals and interventions for well-functioning NMT.

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