NMT FACILITY GUIDELINES, 2014

Policy and Legislation

Planning

Design and Operations

transport

Department:
Transport
REPUBLIC OF SOUTH AFRICA

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For: Department of Transport
By: SMEC/UCT
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Authors:
Dr Marianne Vanderschuren
Ms Sekadi Phayane
Mr Arthur Taute
Dr Hubrecht Ribbens
Mr Neville Dingle
Mr Kuben Pillay
Dr Mark Zuidgeest
Ms Sazi Enicker
Ms Jennifer Baufeldt
Ms Gail Jennings

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Foreword by the Minister of Transport
Dipuo Peters, MP

In 1987 and 1993, the Department published manuals to address the needs of cyclists and pedestrians only. These manuals, however, became out-dated due to new technologies and developments in the provision of facilities for non-motorised transport (NMT). The Department decided to evaluate, review and combine these manuals into a practical and user-friendly "*Pedestrian and Bicycle Facility Guidelines Manual" of 2003*.

Since 2003, there has been a significant legislative and policy developments affecting the transport landscape, and it is imperative that the guideline be updated to be in line with these changes. The Department's view is that *NMT Facility Guideline Manual* be aligned with the new technological development so that it effectively addresses the needs of all road users.

The new *NMT Facility Guideline Manual* is therefore a revision and update of the *existing Pedestrian and Bicycle Facility Guidelines (2003) which* does not seek to set out a new policy, but give effect to existing policy by providing guidance for a more balanced approach to the design of towns and cities for the benefit of NMT users.

The main purpose of the new *NMT Guideline* is to provide guidance on the planning and design for safe pedestrian, bicycle, and other alternative low carbon modes of transport, both across and alongside roads and streets. Furthermore, the g*uideline will strengthen the provision of well-designed* bicycle and pedestrian facilities and infrastructure to improve the physical environment and safety of NMT users.

The Guideline is aligned to the Road Traffic Act of 1996, the National Land Transport Act of 2009, the Moving South Africa Action Agenda (2020), Municipal Integrated Development Plan (IDP), Shova Kalula Rollout Plan (2007), and the Road Infrastructure Strategic Framework of 2006 (RIFSA). The new manual is also linked to other planning tools and standards such as the South African and SADC Road Traffic Signs Manual, the South African Road Safety Manual and numerous other standards and guidelines.

In addition, the universal design/access (UD or UA), which involves the provision of infrastructure and services that cater for a wide range of people living with disabilities, is also gaining focus and momentum. This philosophy is adequately addressed in the *NMT Facility Guideline Manual.*

Peters

Minister of Transport

Dipuo Peters, MP

February 2015

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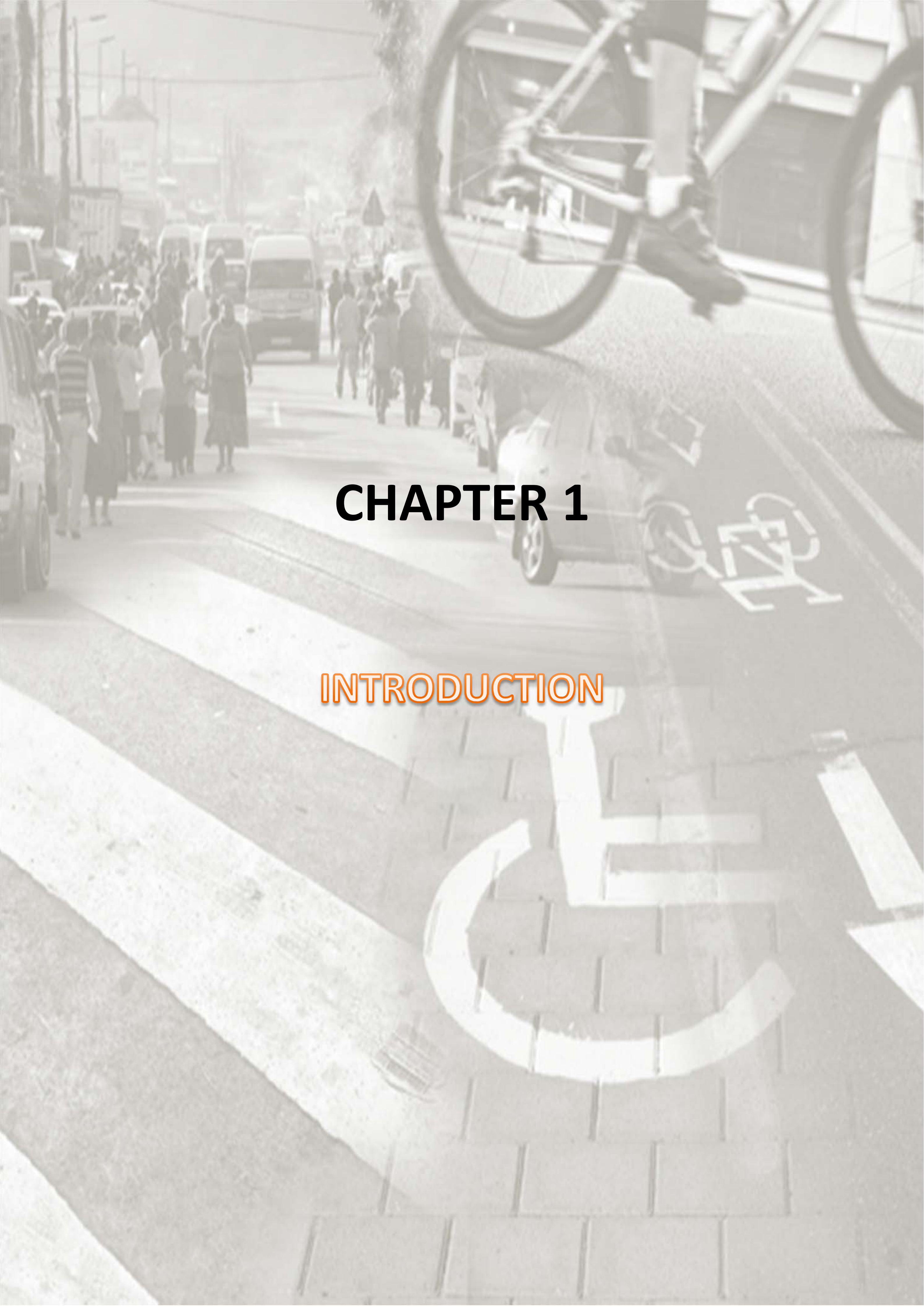
ABBREVIATIONS

AARTO Act	Administrative Adjudication of Road Traffic Offences Act 46 of 1998
ADV	Animal-drawn vehicle
BRT	Bus rapid transit
DoT	National Department of Transport
IDP	Integrated development plan
ITP	Integrated transport plan
MEC	Member of the Executive Council responsible for public transport in the province concerned, or, where applicable, the MEC of another province responsible for public transport
NEMA	National Environmental Management Act 107 of 1998
NMT	Non-motorised transport or transport by any means other than a motor vehicle including, but not limited to, walking, cycling and animal-drawn vehicles and wheelchairs
NLTA	National Land Transport Act 5 of 2009
NLTSF	National Land Transport Strategic Framework
NRTA	National Road Traffic Act 93 of 1996
NRT Regulations	National Road Traffic Regulations, 2000
PAJA	Promotion of Administrative Justice Act 3 of 2000
PLTF	Provincial Land Transport Framework
RTMC	Road Traffic Management Corporation
RTMC Act	Road Traffic Management Corporation Act 20 of 1999
SANRAL	South African National Roads Agency Limited
SANRAL Act	The South African National Roads Agency Limited and National Roads Act 7 of 1998

GLOSSARY

Constitution	Constitution of the Republic of South Africa, 1996
Minister of Transport	National Minister of Transport
NMT infrastructure	Includes bicycle paths, walkways, public open spaces and other buildings and structures used or intended for, or to promote, NMT
Min. Requirements	Minimum Requirements for Integrated Transport Plans published on 30 November 2007 in Government Gazette 30506 (Notice R.1119)
SANRAL Act	South African National Roads Agency Limited and National Roads Act 7 of 1998
Systems Act	Local Government: Municipal Systems Act 32 of 2000



CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1 Motivation for the NMT Guidelines Update

This document is a revision and update of the existing Pedestrian and Bicycle Facility Guidelines (2003). These guidelines do not seek to set out a new policy, but give effect to existing policy by providing guidance for a more balanced approach to the design of towns and cities for the benefit of non-motorised transport (NMT) users.

These new NMT Facility Guidelines aim to improve the lives of all South Africans, a goal that is directly connected to the eight Millennium Development Goals (MDGs) identified by the United Nations in 2000. The goals range from halving extreme poverty rates and stopping the spread of HIV/AIDs to providing universal access to education. Although transportation is not directly mentioned in these people-focused MDGs, 'access' is, and access is provided through the transportation system. Access to food, education, health care and social activities is a direct consequence of improved NMT facilities.

These Guidelines define a new way of thinking about designing South African streets and roads, and re-balancing these to address safety and sustainability issues experienced daily by NMT users. (See **Figure 1-1**)

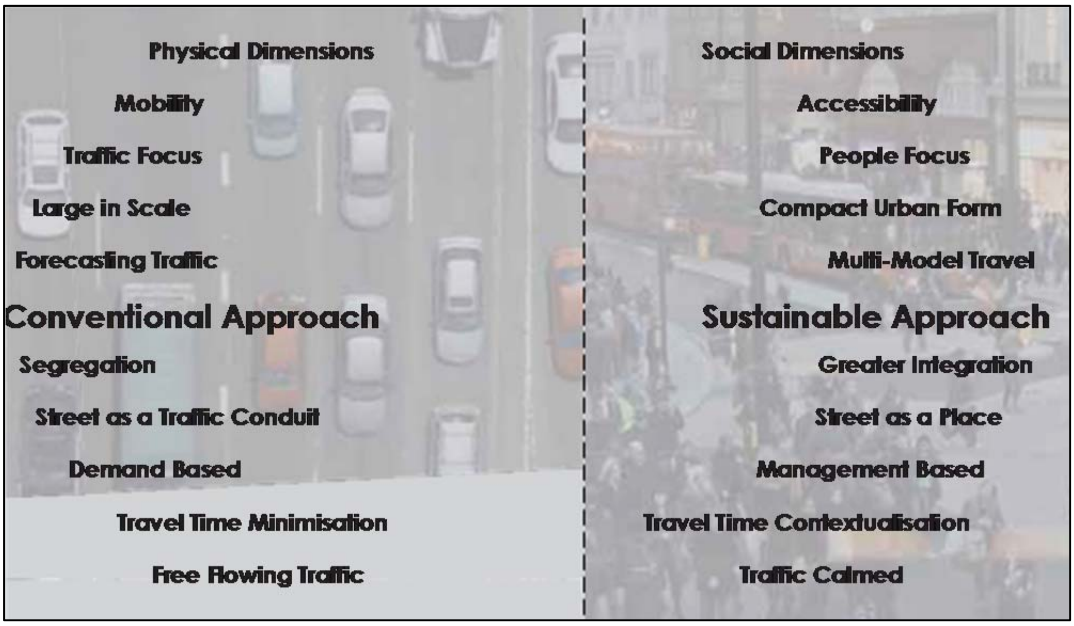


Figure 1-1: New Way of Street Design (DTTS, Ireland 2013)

1.1.1 South Africa's Mobility Status-Quo

Overall, 3 million South Africans walk all the way to work while another 5.4 million use public transport but also walk as part of their trip[1]. **Table 1-1** summarises the main travel modes used by workers (STATSSA, 2013).

Table 1-1 Mode of Transport for Workers, by Provinces, 2013

Province	Main Mode (%)				
	Public Transport	Private Transport		Walking All the Way	Other
		Car/Truck Driver	Car/Truck Passenger		
Western Cape	35.7	34.3	10.9	17.7	1.4
Eastern Cape	32.6	24.5	8.3	34.1	0.5
Northern Cape	15.5	24.7	14.1	43.4	2
Free State	29.7	26.7	7.1	33.7	2.7
Kwa Zulu Natal	44.4	25.2	7.1	21.6	0.9
North West	40.2	22.5	7.7	26.2	2.4
Gauteng	42.4	38.2	5.9	12.5	1.0
Mpumalanga	31.7	24.8	6.9	25.9	1.5
Limpopo	29.8	24.8	8.4	34.8	2.1
RSA	**38.8**	**30.7**	**7.6**	**21.6**	**1.3**

Source: STATSSA, 2013

Rural provinces have higher percentages of workers that walk all the way. In the Northern Cape, the percentage of workers that walk all the way is 43.4%, while the Eastern Cape, the Free State and Limpopo have well over 30% of workers walking to work all the way. In Gauteng (12.5%) and the Western Cape (17.7%), the percentage of workers that walk all the way to work is significantly less than in other provinces as there are more travel options (i.e. public transport routes and frequencies) available in these provinces.

The STATSSA 2013 data shows that cycling to work increased from 0.8% to 1.3% between 2003 and 2013. Again, rural provinces have a larger percentage of individuals riding on bicycle to work, confirming the lack of travel choices. Improved infrastructure is likely to grow the number of bicyclists to work in these areas. Furthermore, if South Africa honours the 'access for all' philosophy that it has adopted, then the current 148,000 people who bike their way to work per day need to be catered for along with the 3 million who walk their way to work.

Around 63% of learners walked the entire distance to educational institutions while those attending tertiary institutions tended to use taxis more than any other mode of transport (STATSSA, 2013). The percentage of learners walking all the way to school varies from 43% in Gauteng to 79% in Limpopo, i.e. the more rural a province the greater the likelihood of learners walking all the way to educational institutions.

[1] The reader should appreciate that STATSSA (2013) did not report on other NMT modes in the document.

1.1.2 South Africa's Road Safety Challenge

South Africa has the second highest road traffic fatality rate at 32 deaths per 100,000 inhabitants after Nigeria. This figure is even made worse by the fact that less than 2% of all registered vehicles in the world are in Africa, which accounts for 20% of global traffic deaths (Kopits and Cropper, 2005).

Increasing levels of motorisation, high speeds, aggressive driver behaviour, coupled with a lack of NMT infrastructure and incompatible land-use and transport planning are amongst the most probable causes identified in this situation. Furthermore, the vast rural areas, although often not very populated, also carry a high road fatality burden caused by similar issues. Unfortunately, no specific road safety data is available for the rural areas, only for some urban areas as per **Figure 1-2**.

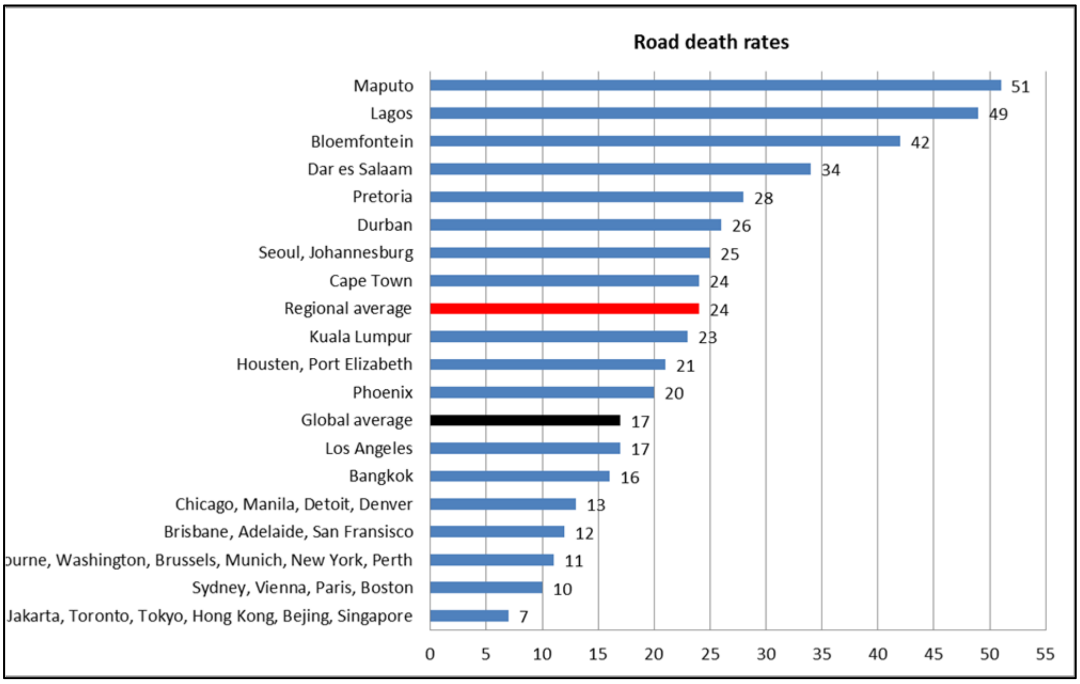


Figure 1-2: Road Fatalities per 100,000 Inhabitants in Various Cities[2]

Various studies have shown that pedestrians account for 60% of the road fatality burden on South African roads. **There is an urgent need to improve safety on South African roads. Better education, improved design and strict enforcement of traffic rules are all measures that should be used to increase road safety**.

[2] Various local sources were used to establish city based fatality rates. Although an attempt was made to use reliable sources, this could not always be verified by the authors. Furthermore, the data has not been standardised for a particular year.

1.1.3 Effects of Speed on Pedestrian Facilities

A study by Dumbaugh and Rae (2009) investigated the relationship between traffic safety and the urban form. The following conclusions and recommendations were derived from the study regarding planning practices:

- Accidents are related to the speed at which cars travel as well as the "systematic design error". By designing wider and straighter roads with the technology of cars being able to travel at very high speeds, chances of accidents are increased.
- Crash incidents were also found to be higher on urban arterials where the roads are wider and straighter and allow for vehicles to drive faster. The study confirmed that these conditions are not favourable in urban areas where cyclists and pedestrians also use these streets. These urban arterial type streets should be designed in a more context-sensitive way to allow for the different users of the street.
- Using land along arterials for retail activities posed a pedestrian safety issue, thus speed reduction measures had to be employed in these areas.

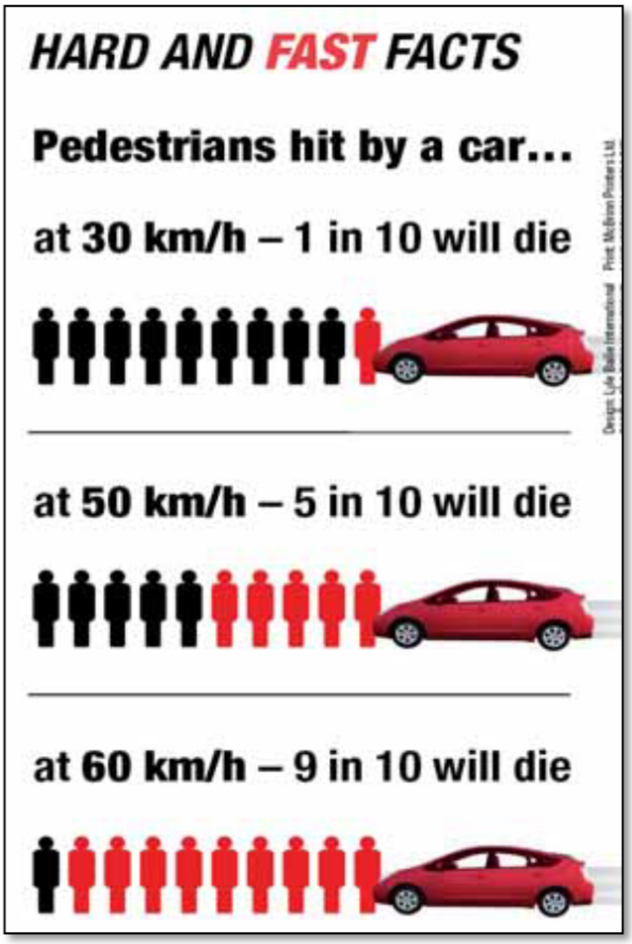


Figure 1-3: Pedestrian Accident Severity

Source: http://www.rsa.ie/en/RSA/Road-Safety/Campaigns/Archived-Campaigns/Mess--Crash/The-statistics/

It is essential that speed limits are lowered in areas where high demand for pedestrian and cycling activities occur. These areas include schools, community facilities, health clinics, and the like.

1.1.4 History of South African Planning

A key issue in land use planning and transportation in South Africa is to reverse the effects of apartheid ideologies through the use of new planning guidelines and performance criteria such as those contained in the 'Guidelines for Human Settlement Planning and Design' (CSIR, 2009). The result of improper land use planning in the past has resulted in urban sprawl and formlessness and land use development, which contradicts some key principles of urban design and transport planning.

This document supports the application of the **transport user hierarchy** when planning and designing settlements should be applied – i.e. *consider the needs of the most vulnerable users first: pedestrians, then cyclists, then public transport users, specialist vehicles like ambulances and finally other motor vehicles.* This can only occur by creating a more '**people focused' environment** through careful NMT network planning and detailed design.

As South Africa is striving to become a more equitable nation, and with the general realisation that **alternatives to car-orientated lifestyle** need to be found to ensure sustainability, road planning practice in South Africa has to gradually change towards a people focused approach, concentrated on the implementation of NMT and PT facilities.

In addition, **universal design/access (UD or UA)**, which involves the provision of infrastructure and services that cater for the widest range of people possible, is also gaining focus and momentum. This philosophy has been included in these revised NMT Facility Guidelines.

Therefore, the NMT Facility Guidelines aim to enhance integrated transport to ensure that the proper movement (or mobility) of people will be able to increase safety, reduce fatalities, produce a universally designed infrastructure and improve equity for all road users.

1.2 Methodology Undertaken

The SMEC/UCT Consortium updated the Pedestrian and Bicycle Facility Guidelines (2003), to create the DoT NMT Facility Guidelines (2014).

The project process involved a stepwise approach shown in **Figure 1-4** based on the 2003 Pedestrian and Bicycle Facility Guidelines.

The key issues included in the 2014 NMT Facility Guidelines are:

- An identification of user needs and road safety concerns,

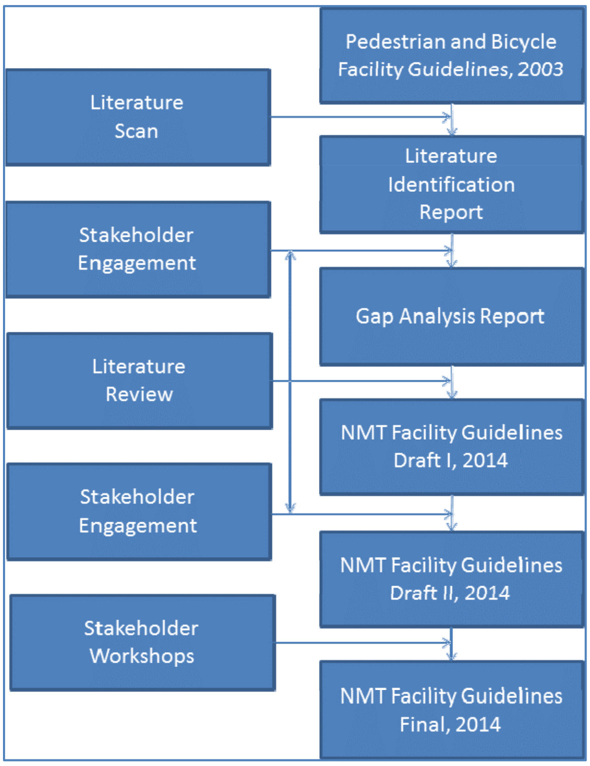


Figure 1-4: Project Process

- A literature review provided an overview of international and national documents that were used to update the Guidelines,

- An overview of legislation informing NMT planning and design,
- Various national and international universal access design standards,
- An overview of intersection (crossing) designs,
- The integration of NMT into specific facilities, such as residential areas, office areas, public transport facilities, bicycle rental and parking facilities,
- The role that road classification plays in planning for and designing for NMT,
- Enforcement as well as appraisal techniques and maintenance of NMT infrastructure, and
- Surfaces and pavement types.

Stakeholder engagement contributed to the development of the NMT Facility Guidelines (2014), first in draft and then in its final draft format. The final draft was verified through nine stakeholder workshops in each of the South African provinces.

1.3 How to Use the NMT Facility Guidelines

The NMT Facility Guidelines aim to provide an easy-to-use guide for practitioners interested in cycling, walking and other NMT uses in urban and rural areas. These guidelines should assist to carry out the planning, design and implementation of facilities as well as maintenance programmes for NMT infrastructure, while encouraging a consist provision of facilities, to the best possible standards.

The guidelines summarise the legal, policy and strategy context of NMT planning and implementation. For users of these Guidelines that are not familiar with this, it is of utmost importance to read **Chapter 2**.

At the core of all-spatial planning is zoning, land-use planning and actual land uses. Bad land-use planning, as well as the development of informal settlements without proper planning, leads to many road safety challenges, such as the need to cross freeways. Land-use planning, however, falls outside the scope of these NMT Facility Guidelines.

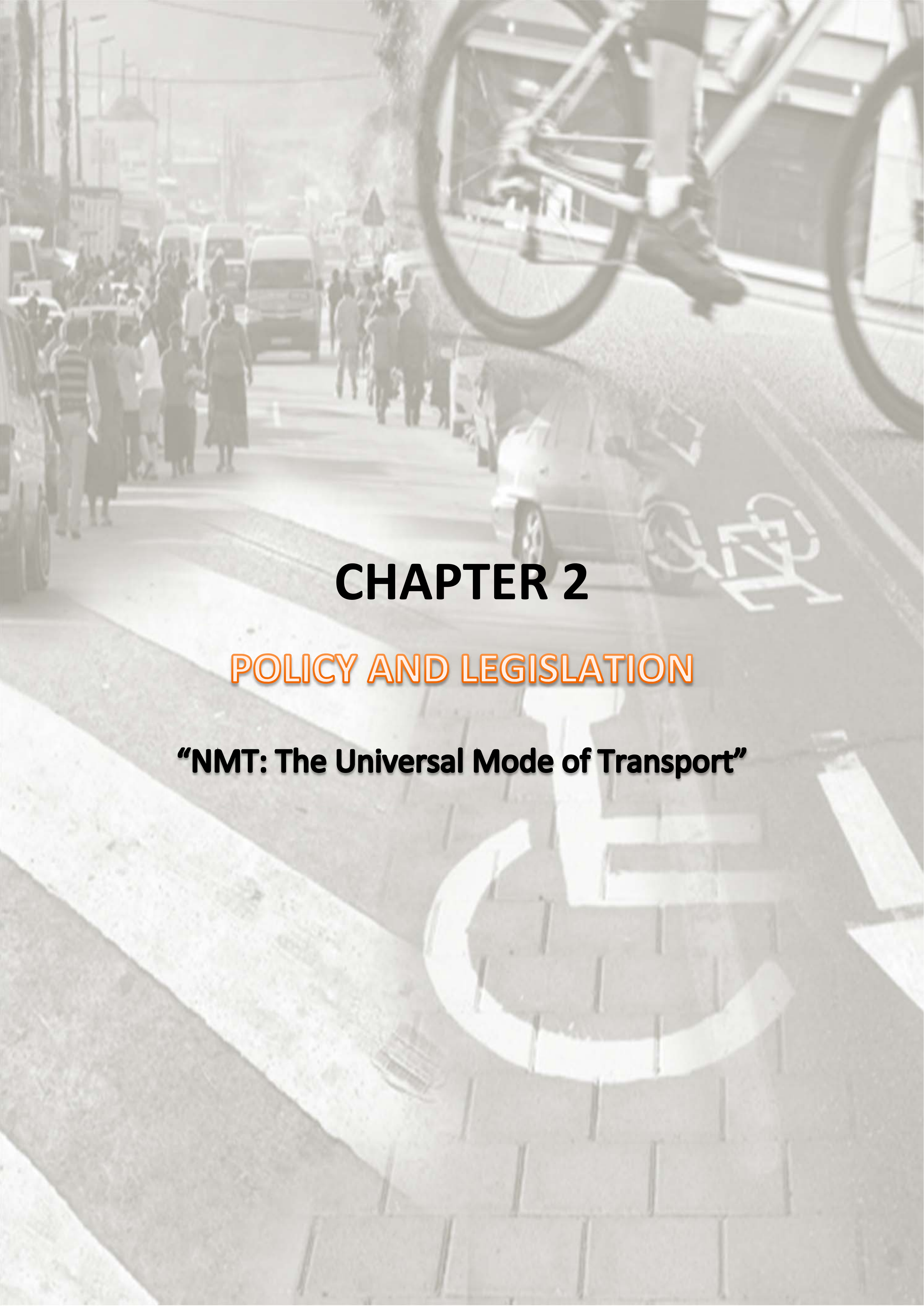
The NMT Facility Guidelines reiterate the importance of connecting national policy goals to a local network and facility level through proper network planning. This is described in **Chapter 3**. Furthermore, a simple network development tool is included.

Once the network and demand is established, the design of facilities needs to follow. **Chapters 4 and 5** provide guidance, designs, descriptions, pictures of various best and worst NMT practices, while **Chapter 6** details NMT facilities at places such as public transport hubs, schools, etc**.** **Chapter 7 and 8** deal with capacity analysis and the pavement design aspects, **Chapter 9** tackles maintenance, and lastly, **Chapter 10** details the operational aspects of NMT facilities.

The NMT Facility Guidelines are not meant to replace the experience of an engineer during local designs, or a transport planner detailing the network. Every situation has specific contextual requirements. The aim of this document is not to provide detailed designs for all possible situations but indicative designs with possible minimum dimensions where applicable. While this guide is comprehensive, it is impossible to predict all challenges encountered in practice when planning and designing NMT facilities.

Lastly, these guidelines should be used in conjunction with other guidelines and standards for road design, such as:

- UTG 7 – Committee of Urban Transport Authorities (Geometric Design of Urban Local Residential Streets),
- Highway Capacity Manual (HCM, 2000 and HCM2010),
- Red Book, Volume 1 and Volume 2,
- South African Road Traffic Signs Manual (SARTSM, Manual),
- South African Pavement Engineering Manual (SAPEM),
- COLTO Standard Specification for Roads and Bridge Works,
- SANRAL Routine Road Maintenance Manual (SARRMM), and
- SANS 10400 Part S and SANS784 – Universal Design Minimum Standards.



CHAPTER 2

POLICY AND LEGISLATION

"NMT: The Universal Mode of Transport"

2. POLICY AND LEGISLATION

"NMT: The Universal Mode of Transport."

2.1 Policy Framework

South Africa has made significant strides in improving the status and attention given to NMT. A summary of the policies guiding NMT are set out below.

2.1.1 White Paper on National Transport Policy, 1996

One of the policy principles of the White Paper is "to encourage, promote and etc.plan for the use of non-motorised transport where appropriate" (Land Passenger Transport Chapter, Strategic Objectives). The White Paper also states that "**the use of more energy-efficient and less pollutant modes of transport will be promoted**. Greater energy awareness will be fostered in both planners and users of land passenger transport through public awareness programmes, differential fuel prices, etc."

2.1.2 National Land Transport Strategic Framework, 2006 (NLTSF)

The framework provides a sound basis for the promotion of NMT, and strategies and actions are provided in order to achieve this.

The NLTSF suggests that planning authorities need to build, expand and maintain continuous networks of formal walkways (sidewalks, off-road paths, safe crossings, and the like.) and dedicated bicycle lanes along lines of high demand.

To achieve this, transport plans should assess the status quo and the needs for NMT infrastructure and plan for its design, implementation and maintenance.

- Planning for NMT needs will consider NMT both as a main mode and as a feeder mode linking communities to public transport facilities.
- In rural areas, off-road footpaths, trails and tracks need to be included in the scope of planned rural transport infrastructure.
- In rural areas, animal-drawn carts and other intermediate means of transport will also be supported in transport plans where appropriate.

The NLTSF also indicates that walking and cycling should be promoted as the preferred modes in South Africa for appropriate distances and this can be realised through the following:

- Government actively promotes walking and cycling with the expanded provision of NMT infrastructure as the preferred modes of transport over the appropriate distance ranges for these modes.
- Where people are walking excessively long distances on their routine journeys, transport plans should assess the scope for measures to support cycling,

particularly for scholars. Both infrastructural measures and supporting services such as bicycle repair services should be considered.

- Successful demonstration projects promoting NMT are initiated and rolled out to other areas.

2.1.3 Public Transport Strategy and Action Plan, 2007

This is a central policy document on public transport, highlighting the creation of integrated rapid public transport networks (IRPTNs), wherein **NMT is the key aspect of the 'first mile' and 'last mile' of a trip.** The intention is to introduce public transport that would reduce unacceptable walking distances and improve NMT links to public transport.

The Public Transport Strategy discusses "high quality non-motorised transport networks". It provides that NMT, particularly walking and cycling, will serve as an important mode of transport in the proposed IRPTNs. It provides that actions to improve NMT linkages fall into typical infrastructure development categories of planning, design, implementation and maintenance.

2.1.4 Rural Transport Strategy for South Africa, 2007

This strategy document shows that it is important to focus on transport in rural as well as urban areas. **One of the goals of this strategy is "the promotion of non-motorised transport".** The provision of rural transport infrastructure and services is a way of creating sustainable economic development, empowering people socially and addressing the issue of poverty. Strategic thrusts include:

- The promotion of coordinated rural modal linkage development
- The development of demand-responsive, balanced and sustainable rural transport systems

2.1.5 Department of Transport Draft Policy Document on NMT

This policy states that **the DoT will cooperate with relevant government departments and stakeholders in developing an institutional and legal framework that responds positively to the needs and implementation of the NMT system.**

This policy states that the primary objectives are, amongst others, to:

- Increase the role of NMT as one of the key transport modes,
- Integrate NMT as an essential element of public transport and provide a safe NMT infrastructure, and
- Allocate adequate and sustainable funding for the development and promotion of NMT.

The document also states that non-motorised transport will be provided on the basis of a number of principles including the need to improve the quality of life, energy conservation and safety. The policy also recognises the main components of non-motorised transport as animal-drawn transport, cycling and walking.

2.2 Legislative Framework

The following sections provide an overview of the main provisions in South African legislation that influence the design and safety of NMT facilities and activities. Areas of focus are pedestrians (including people with prams, pregnant women, children, people accompanying children and walking in groups, elderly people, people with disabilities and people carrying or moving loads), cyclists and Animal-Drawn Vehicles (ADVs).

Legislation in all three spheres of government is considered.

The Constitution of the Republic of South Africa, 1996, provides that the National Parliament may make and administer laws within the functional areas of public transport, environment and road traffic regulation. Provinces may make laws on matters such as provincial planning, provincial roads, traffic and public transport.

The Constitution also provides that a municipality may make and administer by-laws for the effective administration of matters related to municipal public transport, municipal roads, municipal planning and traffic and parking.

In the Bill of Rights, state organisations are mandated to promote a safe and healthy environment for all persons.

Chapter 3 of the Constitution provides for a cooperative government where state organisations collaborate with one another in mutual trust and good faith by coordinating their actions and legislation.

The rights of people with disabilities are also protected by the country's Constitution, which stipulates that governmental departments and state bodies have a responsibility to ensure that concrete steps are taken so that people with disabilities are able to access the same fundamental rights and responsibilities as persons without disabilities.

2.2.1 National Land Transport Act 5 of 2009 (NLTA)

The NLTA provides that the Minister of Transport must facilitate the increased use of public transport and, in taking measures relating to public transport, must promote the safety of passengers, promote a strategic and integrated approach to the provision of public transport and promote the efficient use of energy resources and limit adverse environmental impacts in relation to land transport[3].

Section 36 provides that every municipality must produce an Integrated Transport Plan (ITP). In doing so they must comply with the *Minimum Requirements for Integrated Transport Plans*[4] which require the larger municipalities to produce a Comprehensive Integrated Transport Plan (CITP) including a Transport Needs Assessment that must give due attention to NMT. CITPs must also include an NMT strategy. Municipal ITPs are binding on everyone, including organs of state[5], and can be used as a tool to enforce the provision and maintenance of NMT infrastructure. They must be updated annually and "overhauled" every five years.

The guidelines provide that like the infrastructure required for vehicles, the infrastructure required for NMT consists of a network of routes, or "ways", safe crossings and amenities for the applicable mode. Guidelines are available providing the details for the design and planning of the infrastructure[6].

Section 35 of the NLTA provides that each province must produce a Provincial Land Transport Framework (PLTF). This must be done according to the terms of the *Regulations Relating to Minimum Requirements for the Preparation of Provincial Land Transport Frameworks*, 2011[7]. These Regulations provide that in preparing the PLTFs, non-motorised forms of transport must be taken into account[8]. The Regulations also provide that the PLTFs must contain a chapter on "non-motorised and environmentally sustainable transport"[9] including, amongst others:

- An indication of how NMT is provided for in the general road plan of the province.
- The integration of NMT planning with land transport and land use planning.
- The improvement and expansion of pedestrian sidewalks and dedicated public space to interlink public transport stations, ranks and other facilities in city areas along provincial roads.
- The provision of dedicated NMT facilities and infrastructure along provincial roads (e.g. infrastructure for wheelchairs, pedestrian walkways, foot bridges, overhead bridges and interchanges).
- A detailed strategy to promote and encourage NMT in rural or urban areas if so requested by the relevant planning authority (municipality) which must include an NMT policy, a cycling master plan, a walking master plan and an animal-drawn transportation plan if ADT is significant in the province.

[3] Section 5
[4] Government Notice R.1119 of 30 November 2007
[5] Section 38
[6] See the *DoT Pedestrian and Bicycle Facility Guidelines* dated August 2003 which contain detailed guidelines and recommended specifications for pedestrian and bicycle facilities
[7] Published under Notice R.825 in Government Gazette 34657 of 3 October 2011
[8] Regulation 3(2)(c)
[9] Regulation 6(2)

The PLTF must also include a transport infrastructure strategy.

A section of the PLTFs has been examined, some of which deal quite extensively with NMT issues. Section 11(1) (c) (xvii) of the NLTA provides that all municipalities have the duty of "undertaking functions relating to municipal roads, as well as measures to limit damage to the road system".

2.2.2 The National Road Traffic Act 93 of 1996 (NRTA)

The NRTA deals with issues such as vehicle and driver fitness, rules of the road, traffic signs and signals and related matters.

For example, the NRTA makes it an offence to drive a vehicle recklessly or negligently or in an inconsiderate manner, i.e. without reasonable consideration for any other person using the road[10]. It is also an offence to fail to obey a road traffic sign, unless directed to do so by a traffic officer[11]. Road traffic signs, signals and markings are described in Chapter IX and shown in Schedule 2 of the NRT Regulations (See below).

2.2.3 National Road Traffic Regulations, 2000 (NRT Regulations)

The NRT Regulations have been published by the Minister of Transport in terms of the NRTA and contain various provisions that impact on NMT and its associated facilities, such as public roads used by bicycles, pedestrians and animal-drawn carts, amongst other issues.

They provide that no one may drive a vehicle on a sidewalk[12]. The definition of "vehicle" includes bicycles. This could be a limiting factor in promoting NMT. A sidewalk is defined as that portion of a verge intended for the exclusive use of pedestrians. "Verge" is defined as that portion of a road, street or thoroughfare, including the sidewalk, which is not the roadway or the shoulder[13].

Chapter X of the NRT Regulations deals with rules of the road and related matters. Where a portion of a public road has been set aside for pedal bicycles (bicycles and tricycles propelled by human power – i.e. a bicycle lane), no one may ride a pedal cycle on any other portion of the road[14]. This could be a limiting factor in the design of bicycle paths or lanes on roads.

Animal-drawn vehicles (ADVs) are allowed on public roads[15]. Regulation 314 deals with ADVs, and contains various requirements such as that the name and address

[10] Sections 63(1) and 64
[11] Section 58(1)
[12] Regulation 308(5)
[13] Section 1 of the NRTA
[14] Regulation 311(7)
[15] Regulation 313(2)(a)

of the owner must be displayed on the vehicle. Regulation 315 contains provisions protecting pedestrians at road crossings. Where a pedestrian crossing is situated in an intersection with a traffic signal, pedestrians may not enter the crossing unless the signal allows it. **Drivers of vehicles must yield right of way to pedestrians crossing at pedestrian crossings**. Pedestrians may not enter a pedestrian crossing suddenly so that vehicles are unable to yield to them. **When a vehicle is stopped at a pedestrian crossing, other drivers may not pass the vehicle from the rear. Pedestrian crossings should be designed so as to facilitate these requirements.**

Other duties of pedestrians are set out in Regulation 316. Where a sidewalk or footpath is provided, a pedestrian may not walk on the roadway except to cross the road. Where there is no sidewalk or footpath, pedestrians must walk as near as practicable to the right hand side of the road to face oncoming traffic, unless the presence of pedestrians is prohibited by a road traffic sign. Pedestrians crossing roads must exercise due care for their safety and must not linger on the roadway. Pedestrians may cross roads only at pedestrian crossings or intersections or at a distance further than 50 m from such a crossing or intersection.

Duties of cyclists are set out in Regulation 311. A cyclist must sit astride the saddle of the bicycle. Cyclists must ride in a single file except when overtaking another cyclist, and two or more cyclists may not overtake another vehicle at the same time. A cyclist may not grab hold of another bicycle while in motion. A cyclist may not swerve from side to side. A cyclist may not carry a person, animal or object that obstructs his/her view or interferes with the control of the bicycle. He/she must keep at least one hand on the handle-bar. Both wheels of the bicycle must be in contact with the road/cycle path surface at all times.

Cyclists and passengers on bicycles on a public road must wear a protective helmet which fits them properly and with the chin straps properly fastened[16]. Cyclists have a duty to ensure that passengers on the bicycle who are younger than 14 years old comply with these requirements[17].

Animal-drawn vehicles and pedal cycles may not be operated on a freeway[18]. The same applies to vehicles "specially designed, constructed or adapted for the use of a person suffering from a physical defect or disability" and having a mass less than 250 kg. No one may be on foot on a freeway, with certain limited exceptions[19]. A pedal cycle may not tow another vehicle, such as a trailer, on a public road[20]. This could be a serious limitation where persons riding pedal cycles used as "tuk-tuks" (rickshaws), for example, wish to tow a trailer with luggage or goods for sale.

[16] Regulation 207(2)
[17] Regulation 207(3)
[18] Regulation 323(1)(a) and (b)
[19] Regulation 323(2)
[20] Regulation 330(g)

Appropriate road traffic signs, signals and markings must be used to demarcate bicycle and pedestrian lanes and related infrastructure according to the *Road Traffic Signs Manual* attached to the NRT Regulations. These include, for example, signs reserving bicycle lanes for the exclusive use of bicycles, signs prohibiting vehicles in pedestrian walkways, and the like.

The use of electric scooters, such as segways, standing scooters and chariot scooters has been questioned in relation to NMT facilities. These are included in the definition of "motor vehicle" and "motorcycle" in the NRTA. They are not permitted on public roads at present, because there are no approved SABS specifications for them, which means they cannot be registered and licensed. The NRT Regulations also prohibit the use of motor vehicles on sidewalks.

The DoT has published draft amendments to the NRTA and NRT Regulations to deal with these types of scooters, but the amendments have not been promulgated yet. Based on enquiries, it is unlikely that they will be promulgated this year (2014).

Cycle paths will constitute public roads in terms of the definition in the NRTA if they are commonly used by the public or if the public habitually has access to them. Motor scooters and other motor vehicles can be excluded from bicycle or pedestrian paths by putting up road signs.

2.2.4 Administrative Adjudication of Road Traffic Offences Act 46 of 1998 (AARTO Act)

An important feature of legislation affecting NMT is law enforcement. The AARTO Act provides for a system of administering road traffic offences through an administrative process rather than through the courts. It also provides for a points demerit system for road traffic offenders in terms of which penalties are prescribed, which can include suspension or loss of a driving licence. Regulations have been made under the AARTO Act providing for penalties and points for the various traffic offences.[21]

At present the AARTO system is in force only as pilot projects in the cities of Tshwane and Johannesburg (the points demerit system is not in force anywhere yet). In areas where the AARTO Act is not yet in operation, prosecutions for road traffic offences must be done in terms of the Criminal Procedure Act 51 of 1977. Where the AARTO Act is in force, municipalities may no longer prescribe their own penalties or fines for road traffic offences by means of by-laws, but must use the AARTO system.

2.2.5 National Building Regulations and Building Standards Act 103 of 1977

This Act deals with the erection of buildings and provides for building plans to be approved by local authorities. The Minister of Economic Development may make regulations to be known as the National Building Regulations regarding the

[21] Notice R.753 in Government Gazette 31242 of 16 July 2008

preparation, submission and approval of building plans and to regulate all aspects of buildings[22].

2.2.6 South African National Roads Agency Limited and National Roads Act 7 of 1998 (SANRAL Act) and Other Roads Legislation

According to the SANRAL Act, the South African National Roads Agency (SANRAL) is responsible to plan, construct, maintain and finance national roads. SANRAL is mandated by the Constitution to protect the safety of road users and other affected persons[23]. Under the common law, if SANRAL creates a harmful or potentially harmful situation, or allows such a situation to develop, e.g. potholes, it can be held liable for damages if persons are killed or injured, or there is damage to property.

The same applies to provincial roads based on various legislation on provincial roads such as the Eastern Cape Roads Act 3 of 2003, the Western Cape Transport Infrastructure Act 1 of 2013 and the Gauteng Transport Infrastructure Act 8 of 2001. The principles also apply to municipal roads.

Apart from the statutory duties (i.e. duties set out by legislation) of road authorities to maintain roads and other transport infrastructure, including traffic signals, there is also a duty under a common law for them to maintain roads and other infrastructure under their control to prevent death or injury of persons and damage to property. Road authorities are liable to claims if any person is killed or injured, or if a property is damaged as a result of their failure to do so, e.g. failing to repair potholes or faulty traffic signals. A number of judgements have been made by the Supreme Court of Appeal and the High Court in this regard, and these cases are commonly referred to as the "municipality cases". Basically, liability arises in the two cases that follow:

a) Where the road authority creates a danger which was not there before, e.g. a hole dug in a public road or sidewalk without barriers or signs to warn the public about it or

b) Where the authority allows infrastructure under its control to degenerate into a dangerous condition. For example in *Moulang v Port Elizabeth Municipality*[24], the Municipality was held liable after a person was injured by stepping into a hole that had developed on a sidewalk which was built by and was under the control of the Municipality[25].

[22] Section 17
[23] Section 24(a) – everyone has the right to an environment that is not harmful to their health and well-being
[24] 1958 (2) SA 518 (AD)
[25] See also for example Administrator Cape v Preston 1961 (3) SA 562 (A) relating to provincial roads and Fourie v Munisipaliteit van Malmesbury 1983 (2) SA (C) which related to the duties of a municipality to maintain an airfield under its control (applying the same principles that apply to roads) and Cape Town Municipality v Butters 1996 (1) SA 473 (C) where the relevant duties of the municipality are explained

2.2.7 National Environmental Management Act 107 of 1998 (NEMA)

NEMA requires that environmental implications must be investigated and a public participation process must be carried out whenever certain prescribed projects are undertaken. For example, the building of public facilities and road schemes will usually require an Environmental Impact Assessment (EIA). The same will apply to NMT infrastructure, depending on its nature.

2.2.8 National Heritage Resources Act 25 of 1999

This Act requires certain procedures, including public participation, to be undertaken where a project affects a location or structure of historical significance. The Act establishes the South African Heritage Resources Association (SAHRA), which may identify national and provincial heritage sites and protected areas. This should be kept in mind when designing and building NMT infrastructure which may affect locations or structures of historical significance.

2.2.9 Promotion of Administrative Justice Act 3 of 2000 (PAJA)

PAJA and its regulations provide that where a state organisation undertakes any administrative action as defined in the Act, it must notify affected persons and allow them the opportunity to comment. This can involve either a “notice and comment” procedure or one or more public hearings. Authorities must comply with PAJA when performing administrative actions, e.g. establishing NMT facilities in residential areas that affect the rights of persons.

2.2.10 Legal Requirements for Animal-Drawn Vehicles

National Road Traffic Regulation 187 stipulates that red retro-reflectors be fitted on rear of certain vehicles, and specifically provides that:

(1) No person shall operate on a public road:

- (a) a motor vehicle, other than a motorcycle without side-car or motor tricycle with one wheel at the rear
- (b) a rickshaw or
- (c) an animal-drawn vehicle.

unless these are fitted on the rear of such vehicle at the same height two red retro-reflectors, one on each side, of the longitudinal centre-line thereof and equidistant therefrom and otherwise complying with the provisions of these regulations: Provided that in the case of a combination of motor vehicles, both the drawing vehicle and the rearmost vehicle shall be fitted with such retro-reflectors.

National Road Traffic Regulation 314, meanwhile, enumerates the following additional requirements for animal-drawn vehicles:

(1) No person shall operate an animal-drawn vehicle on a public road unless the name and address of the owner thereof is affixed or painted in a conspicuous

position on the left side of such vehicle in letters not less than 25 millimetres high: Provided that nothing herein contained shall apply in respect of a vehicle used solely for the conveyance of persons otherwise than for hire or reward.

(2) No person shall operate an animal-drawn vehicle on a public road unless the vehicle and the harness and other equipment thereof are in an efficient and safe condition.

(3) The owner of an animal-drawn vehicle shall not cause or permit such vehicle to be used on a public road by any person who is not competent whether by reason of his or her age or otherwise to drive and control such vehicle.

(4) The driver of an animal-drawn vehicle on a public road shall at all times give his or her undivided attention to the driving of the vehicle under his or her control, and if the vehicle is standing on a public road, the driver shall not cease to retain control over every animal which is still harnessed to the vehicle, unless some other person competent to do so takes charge of every such animal, or every such animal is so fastened that it cannot move from the place where it has been left.

(5) No person shall operate on a public road a vehicle drawn by a team of animals not controlled by reins, unless there is a person leading the team and exercising control over such team.

(6) The driver or other person in charge of a vehicle drawn by any animal shall not, on a public road outside an urban area, permit such vehicle to follow any other vehicle similarly drawn at a distance of less than 150 metres calculated from the foremost animal of such first-mentioned vehicle, except for the purpose of overtaking a vehicle travelling at a slower speed or when a vehicle travelling at a greater speed, having overtaken such vehicle, is drawing away from it.

2.2.11 South Africa's Universal Access Regulations

These are currently being drafted.

2.2.12 Municipal By-Laws

The Constitution, read with the Systems Act, empowers municipalities to make by-laws on any issue over which they have responsibility, such as municipal roads, municipal planning, traffic and parking, among others. Some South African cities are drafting by-laws impacting on NMT and NMT users. However, the following issues can still be addressed for inclusion in their by-laws:

(a) Issues for Possible Inclusion in By-Laws

There is a general need for legislation in all three spheres of government to address NMT and, more specifically, NMT infrastructure. Some legislation, e.g. the National

Road Traffic Regulations, have provisions that could hamper the introduction or promotion of NMT. The Minister of Transport should be asked to amend them and remove the restrictions, and possibly introduce measures to promote NMT.

Municipalities need to include the following relevant issues in their future by-laws:

- Modify the institutional structure to accommodate NMT. Policy documents identify that currently the lack of a single point of responsibility within local government for NMT planning, implementation and maintenance is problematic. As part of this package of catalytic interventions, it is proposed that the body accountable for public transport operations and maintenance (i.e. the municipality as planning authority) should include the operations and maintenance of NMT priority routes.
- Make sure that in the planning and development of transport infrastructure, NMT must be considered and promoted, e.g. by means of dedicated bicycle lanes, removal or limitation of obstructions such as road signs in pedestrian walkways, having secure lock-up facilities for bicycles, among others.

Figure 2-1: Ad-Hoc Cyclist Warning Signs

- Provide standards and minimum requirements for NMT in public transport infrastructure.
- Make compulsory the provision of shower facilities for workers who use bicycle, or walk long distances, to work.
- Require the municipality to develop vision, mission and objectives for NMT in the municipal area.
- Make rules for the design of local links and roads as well as the provision of trees, plants, outdoor art, among others, for the beautification of streets.
- Identify streets to be closed for the use of pedestrians and cyclists.
- Provide for rules for the use of pedicabs, bicycle rental systems.
- Make compulsory the inclusion of specified NMT aspects in the municipality's integrated transport plan.
- Encourage by-laws that promote NMT friendly development.

2.3 Connecting Policy and Practice

The above discussion on legislation and regulation provides ample indication of NMT policy considerations and intent. These policies need to be developed and turned into practice. The provision of NMT facilities can be reached by achieving the following broad objectives:

- Establishing facilities that will make NMT transport attractive in terms of comfort, total travel time, cost and safety.
- Ensuring that NMT facilities improve the sustainability and affordability of transport to individuals and society.
- Making NMT form an integral part of communities and society to improve societal interaction and encourage “Ubuntu” (human kindness) values.
- Ensuring compliance with legislation which dictates that NMT facilities should aim to accommodate all potential users including special needs users.

All transport authorities need to consider and set policies and frameworks that will promote NMT usage. These policies should therefore:

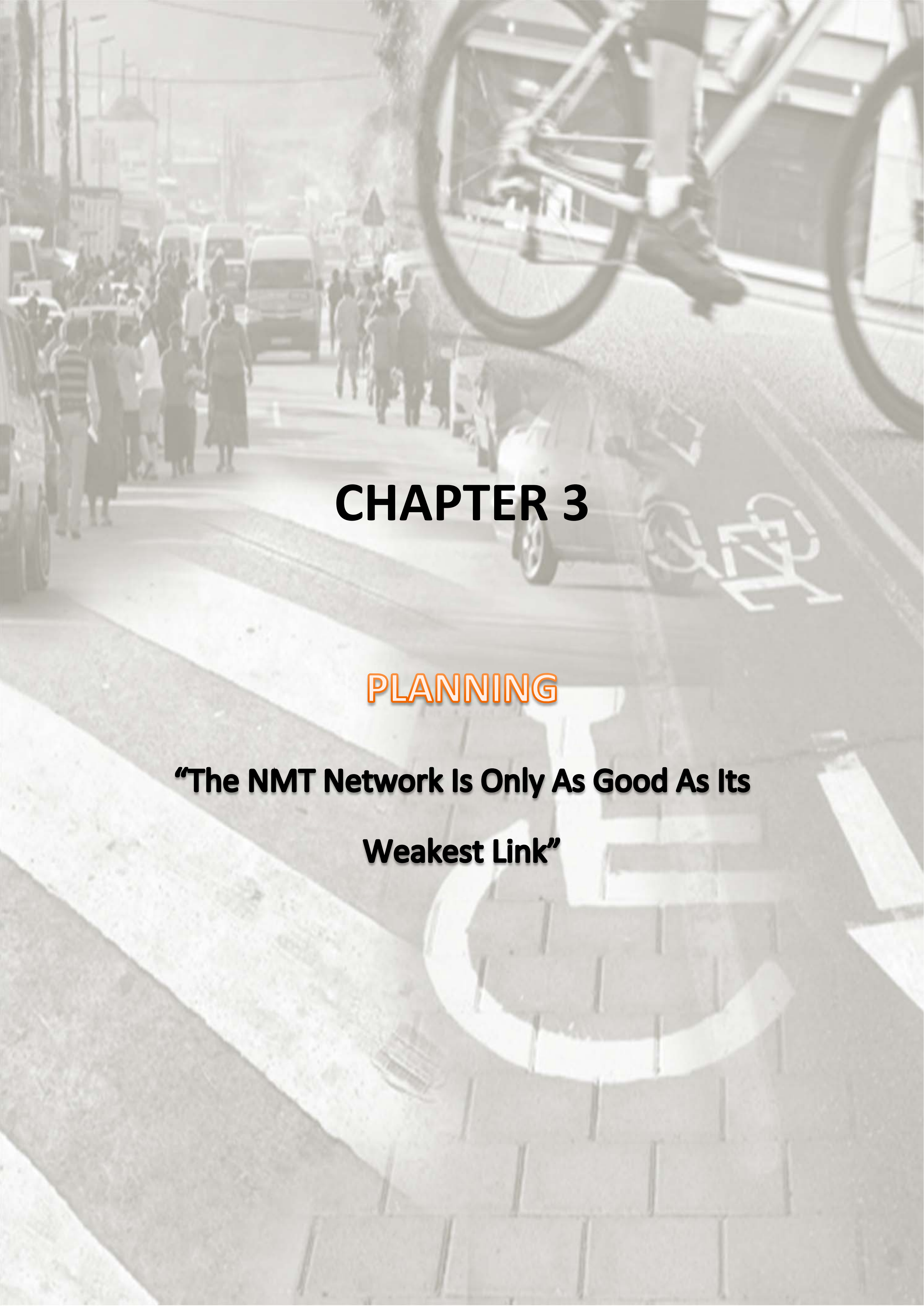
- Be appropriate to the purpose of the organisation and its role in the provision of transport within its jurisdiction.
- Set out the specific scope of NMT provision encompassed.
- Include a commitment to satisfy quality and universal access requirements.
- Be consistent with other relevant organisational policies, budgets and plans.
- A commitment to continual improvement of the NMT systems that do not only meet demand but also aim to increase demand.
- Be available as documented information and be carried into municipal by-laws.
- Be communicated within the organisation and be available to stakeholders.

2.4 Implementation Processes

Several processes involved in implementing NMT are no different from most transport system infrastructure development and implementation processes. These include the distinct development stages of:

- Planning,
- Concepts, viability and sustainability considerations,
- Design,
- Construction, and
- Operations and maintenance.

Guidelines for each of these processes are provided in the following chapters.



CHAPTER 3

PLANNING

“The NMT Network Is Only As Good As Its Weakest Link”

3. PLANNING

"The NMT Network is only as Good as its Weakest Link."

3.1 NMT Detail Planning (Project Level Assessments)

The network and route planning approaches discussed in this chapter are meant to decrease the haphazard provision for walking and cycling by holistically planning networks and routes for NMT. This is done by translating NMT demand estimates (actual or predicted) into a complete network, while also looking at constraints such as existing road classification, user types, among others.

For shorter distances, NMT appears to be the most efficient means of mobility, and for longer distances, public transport or cars offer greater efficiency. Overall, the types of facilities that will attract the most users depend on patterns of land use, land prices, travel needs, topography and the layouts of existing infrastructure and services.

Planning for NMT is mainly about facilitating movement from origins to their destinations or to public transport facilities. This is best done through a system of interconnected routes and networks. This will aid in improvement safety and user functionality.

With the needs assessment complete and a set of draft project and programmes identified, the next step in the planning process is to plan the required facilities in more detail. This includes:

- **Route planning** (layout / separation / NMT facility class)
- **Intersection planning** (finding optimal layouts for different modes)

These are discussed in more detail for various NMT modes below.

3.1.1 Greenfield Planning

While NMT has normally been neglected in the past in planning new urban layouts and developments, this trend needs to be reversed in future using the following simple precepts:

- NMT should be the first input considered in planning as it requires certain fundamentals to be adhered to.
- NMT will be successful if it is located along contour lines to minimise gradients while streets and stands can be placed on a rough east-west, north-south grid to optimise solar conditions in buildings.
- NMT can follow watercourses, where appropriate, to provide mobility at right angles to contours and can be placed within the 1:50 year floodlines in order to maximise mobility without reducing developable land.

- NMT placement needs to consider safety, user function ability and security to ensure good and well-lit sightlines and easily controlled access to facilities and developments.
- NMT should be considered as the primary mode of transport for short trips and scholars.

As long as these precepts are entrenched at the outset, the planning and location of streets, utilities, stands and facilities can follow. For example, schools should be located close to the central contour that passes through the development to minimise the ascending and downhill ride that needs to be overcome by scholars on bicycles.

Most planning is done with some facilities and infrastructure already in place and should proceed on the basis of developing facilities that can promote NMT as being economic, safe and the best form of transport for short (up to 1 km) and medium distance (up to 5 km) trips. Planning should influence developments which are normally arranged around car/vehicle access.

3.1.2 NMT Planning within Developed Areas

A few important guidelines need to be recognised while planning within a system of existing facilities and infrastructure, which includes the following processes:

(i) Status Quo Assessment,

(ii) Situational Analysis,

(iii) Needs Assessment,

(iv) Prioritization Subject to Budget Constraints,

(v) Development of Programmes, and

(vi) Development of Plans.

The above typical planning processes need to be guided by whether the planning involves:

(vii) Long Term Policies and Programmes,

(viii) Strategic Long Range Planning (10 to 20 years),

(ix) Medium Term Planning (5 to 10 years), and

(x) Short Term Planning and Tactics (1 to 3 years).

3.2 Pedestrian Route Network Planning

This section will discuss how to go about designing a pedestrian NMT route network that (1) complies with the network criteria (Section 5.2) and (2) links to form a complete network while retaining current users of NMT and encouraging more people to walk safely. The procedure for NMT network planning can be summarised in six important steps (adapted from LTSA, 2004 and Zuidgeest et al., 2009).

3.2.1 Desire Line Route Assessments

Planning pedestrian routes and networks requires a fair amount of data. Typical questions that need to be answered upfront and information needed are the following:

- Who are the current users and potential users of NMT facilities? Where the desire lines originating from and what are their destinations i.e. what are the facilities that people need to access within 1km – 5km?
- Layout of existing pedestrian desire lines and shortcuts commonly used and where these desire lines intersect or join with public transport routes and major motor vehicle roads.
- What role does walking play in the city framework, in terms of the cost, mobility, comfort and accessibility to various modes of transport?
- What are currently hazardous road sections on existing roads where it is unsafe for people to walk due to various reasons?
- Data that is useful to collect is current and future road traffic volume and speeds; identification of conflict points and crash data; topography as well as the categories of road users.

3.2.2 Base Map to Assess Land Use and Origin and Destinations

Local planning documents map the existing land use, roads and the hierarchy of roads. They often also contain detailed information about land use zones and growth areas, major residential subdivisions, commercial or community developments. They are a most useful source of primary data about likely origins and destinations of pedestrian trips. Trip desire lines (straight lines connecting the main origin and destination location) can then be plotted by directly linking the main origins and destinations using manual or computerised methods (See **Figure 3-1**). This allows for making a qualitative assessment of where, on the network, pedestrian demand is likely to be significant.

A higher concentration of pedestrians can be expected near popular destinations (trip generators). Hence, an origin-destination survey or a simple mapping of important future/current NMT origins and destinations is very useful, amongst them looking at:

- Residential areas,
- Schools and universities,
- Offices and industries,
- Shopping areas and markets,

- Leisure, tourist and entertainment facilities, and
- Natural areas.

An inventory of these locations can be mapped using a basic land use map in a GIS-system. It is also possible to detect existing pedestrian desire lines, based on aerial photography data and site visits to communities, to identify the pedestrian trip needs.

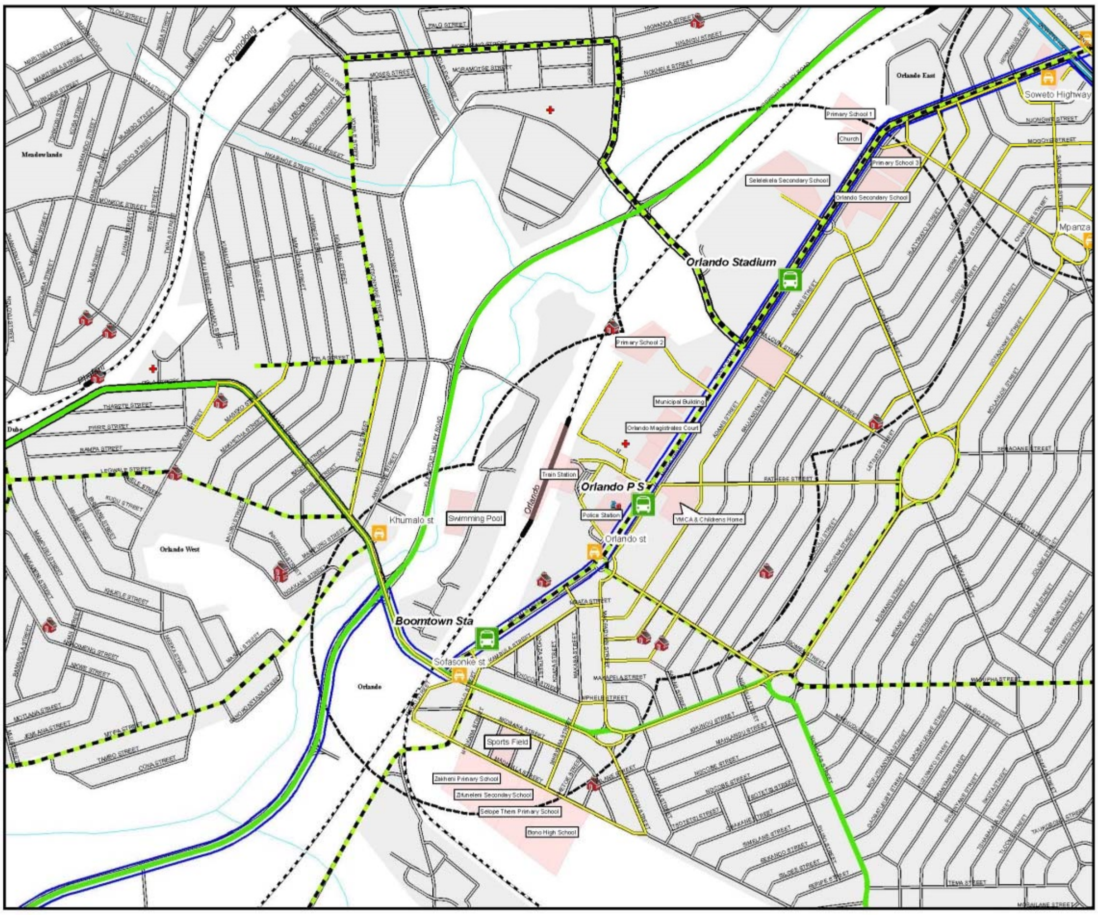


Figure 3-1: Example of Base Map Linking Origins with Destinations,
Source: SMEC

3.2.3 Impact of Transport Environment on Pedestrian Behaviour

The existing transport data in relation to pedestrians must be mapped. This includes information such as public transport routes, accident hotspots involving pedestrians, functional classes of roads and speed limits within the vicinity of the project. The main infrastructure barriers, such as highways, swamps, railway lines, insecure areas, and the like, obstructing logical origin-destination connections should be identified and added to the base map. These barriers can be the cause of missing links in the existing network. As special provision may have to be made to establish the desired pedestrian connections, these barriers require special attention when developing the pedestrian network, through the form of an NMT checklist.

3.2.4 Tested and Refined Network Based on User Requirements

Field and site surveys of roads/streets would then be conducted on site, to determine various issues impacting on the walkability of the draft network. This would determine the value of the draft network, based on the pedestrian user requirements, as set out in **Chapter 4** (Adapted from I-CE, 2000).

(a) Completeness / Coherence

The different route elements should form a coherent unit and link NMT users' departure and destination points. This includes a consistent and complete network from beginning to end. This requires that:

- There must be easy access to main network points of origin and destination.
- The NMT network must be integrated with the public transport network.
- A hierarchical network approach must be followed (i.e. provision of a city-wide, primary and secondary network).
- Routes must not end in the middle of a road corridor i.e. routes must have connectivity. A well-connected network of streets and pedestrian ways means that it is easy for the pedestrian to get around.

(b) Directness

The NMT connections should link NMT users as directly as possible to their destinations. This requires that:

- There must be limited detours.
- Short-cuts must be used as much as possible over natural or man-made barriers (e.g. railway lines, rivers).
- Care must be taken not to plan the NMT route to follow vehicle routes, as NMT users will take the shortest route, where possible.
- The network must offer choice between alternative routes for trips with different purposes.
- There must be adequate recommendation of crossings (pedestrian crossings; traffic light crossings; underpasses and bridges) to satisfy having the shortest route and the need for a continuous route.

(c) Less Conflict

The NMT network design must ensure that:

- Good intersection layouts should be encouraged to avoid conflicts between pedestrians negotiating crossing of roads and streets.
- There should be no obstacles within the NMT paths (poles, parked cars, containers, and the like).

(d) Speed Appropriateness

Due to the amount of vulnerable road users on South African streets, it is imperative to introduce speed control measures to improve road safety. This can either take the form of vehicle speed reductions near pedestrian precincts and walkways, or completely segregating pedestrians from high volume, high speed vehicles. This requires that the pedestrian network should:

- Limit encounters between NMT and high volume, high speed motorised traffic as much as possible through segregation (provision of separate walkways) and traffic calming measures to be employed on collector roads.
- Reduce the friction between motor or bicycle traffic and pedestrians wherever possible either by recommending segregated or separated pedestrian routes, or speed reduction.
- Be aware of any freight routes that it traverses and the safety needs of pedestrians be taken into consideration at intersections or along route links.

(e) Attractiveness

The NMT facilities should be designed, in such a way as to make them attractive and pleasant for walking and cycling, and safe for use by women and children. This requires that:

- Connections should pass through attractive, shaded or green environments that are maintained with gardening services.
- Create a pedestrian friendly environment that has a positive relationship to an area's land use. A mix of complementary land uses and appropriate densities is necessary to make walking a realistic option.
- Adequate waste bins and related cleaning and removal services must be provided.

(f) Barrier Free

Movement and information barriers should be kept to a minimum when planning NMT networks. A movement barrier is anything that restricts an individual's ability to physically move along or within an environment (e.g. travel from one side of a settlement to another). This requires that the planned NMT network should:

- Be cognisant of any difficult terrain (e.g. steep slopes, long distances along difficult terrains).
- Not have sudden and frequent changes in direction.
- Include plans for areas of rest and shelter, especially along long distances.
- Be aware of any future conflict or obstacles along the proposed NMT path (e.g. lamp posts, informal activities, benches, property encroachments).
- Not expose users to potential hazards (e.g. network which makes pedestrians cross at grade on a multi-lane highway).
- Take cognisance of persons who have limited agility, endurance, speed and movement patterns.

- Make appropriate recommendations for information and way-finding systems to prevent barriers caused by lack of information.

(g) Safety

The personal safety of NMT users is of utmost importance in order to maximise usage. The following measures should therefore be adopted:

- Personal safety should be taken into account in terms of potential criminal areas of concealment and have clear sight and splayed building and boundary corners wherever possible.
- Alternative connections should be available to avoid insecure spots.
- Street lights should be provided if not already present.
- All vegetation should be controlled and managed to avoid offering shelter to potential criminals, i.e. no vegetation between 0.4 m and 1.5 m above ground unless security is provided.
- Parking on walkways should not be allowed.

3.3 Cycling Route Network Planning

This section provides a 'systematic' discussion about how to plan and design for cycling routes that (1) comply with the objectives of Chapter 4, (2) link to form a network, and (3) retain current cyclists and encourages more people to bike. In addition, facilities that complement cycling routes will be discussed. The approach is derived from LTSA (2004)[26].

3.3.1 Inventory

Planning bicycle routes and networks requires a fair amount of data. Typical questions that need to be answered upfront are:

- Who are the current and potential cyclists?
- What are the different types of cyclists, their cycling skills and trip motives that the network is designed for?
- What is the demand for cycling in an area (frequencies, origins, destinations, purpose/motive, time of the day)?
- What are currently hazardous road sections on existing roads that might restrain NMT users from cycling?
- Where can cycle routes be developed?
- What type of cycling provisions or facilities do cyclists require to bike safely and comfortably?

3.3.2 Determining Needs of Cyclists

The needs of cyclists may differ quite a bit as they may ride their bicycles for different purposes. In South Africa three types of cyclists are commonly seen: the recreational cyclist, the commuting (or utilitarian) cyclist and the scholar cyclist. The scholar cyclists are younger and less adept on their bicycles than adults and therefore need greater protection and more careful planning to ensure that they are safe in the transport environment. Their 'terms of reference' are different.

Recreational cyclists ride mainly for leisure and place a high value on enjoying the experience, so they place more value on open spaces, boulevards, parks and routes separated from traffic. In South Africa, many recreational cyclists race and bike over long distances at relatively high speeds. They are usually less constrained by time and vary widely in skill and experience.

In South Africa's townships and suburban neighbourhoods, a considerable number of children and adults bike through short distances to schools and/or to the shops.

[26] http://www.nzta.govt.nz/resources/cycle-network-and-route-planning/docs/cycle-network-and-route-planning.pdf

The needs of these three groups of users (neighbourhood/scholar cyclists, commuter cyclists, recreational cyclists) differ quite a bit, as shown in **Table 3-1**.

Table 3-1: Different User Types for Consideration

Neighbourhood Cyclist	Commuter Cyclist	Recreational Cyclist
• The highest degree of safety • Comfort and personal security • Low traffic speeds and traffic volumes • A good separation from traffic on busy roads • Minimal gradients • Facilities for crossing busy roads, such as robots • Secure parking at the destinations • Good street lighting	• High quality road surfaces • Direct and coherent routes • Minimal delays • Facilities that give them their own space • Intersections that minimise conflicts with other traffic • Good street lighting • Secure parking at or very close to destinations • Facilities for changing clothes, lockers and showers at destinations	• Comfort • Good surfaces • Minimal gradients • A high degree of safety and personal security • Routes that are pleasant, attractive and interesting • Screening from weather and wind • Parking facilities where they dismount to use facilities or visit attractions on the journey

Source: Adapted from LTSA, 2004

3.3.3 Mapping Existing Facilities, Routes, Bicycle-Related Accidents and Bicycle Volumes

Cities or areas where there is already (at least some) cycling and where cycling facilities are present, plotting a map indicating the location of these facilities (bicycle lanes, routes, parking, repair shops), may prove very useful. This data may indicate where demand is located, or at least where it has been considered significant in the past. Surveyors can record the numbers of cyclists, their travel direction, and possibly user type. Counting should generally be done during peak hours in the morning or afternoon.

In those cities or areas where some cycling already exists, data sets consisting of cycle accident or conflict data, existing cycling routes and facilities (their quality as well as use), and cyclists' opinions should be mapped. Further on in the process, this information is useful for prioritising decisions (particularly when financial and other resources are limited). Cycle accident data records covering longer periods can point out routes that cyclists have difficulty negotiating safely.

It is also practical to involve local bicycle users as stakeholders when examining existing and/or popular bicycle routes they are familiar with. Bicycle users usually have excellent local knowledge of the routes they use and these routes' associated problems. This can also be a very good way of identifying leisure cycling routes. Individual cyclists, unless they bike on many different routes, can talk accurately only about the routes they know. To cover all areas, it is necessary to speak to a representative group of cyclists or a representative panel directly involved in the different stages of the project or process. It is important to consult not only experienced but a range of user types to gather information on the needs and desires of, for example, less experienced cyclists or others with different needs.

Questionnaires can also be used to administer trip purposes, trip frequency, average or typical trip lengths, preferences and social-economic background, amongst others. This information can also be used to 'identify' the potential for cycling, when asking people whether they would cycle if certain facilities are available.

Special attention should be given to school traffic, as schools may represent points where bicycle users concentrate, making these trips important, as well as relatively easy to survey. Questionnaires and counting parked bicycles are commonly used to assess bicycle demand at schools. By obtaining the number of students attending school on a survey day, the percentage of students cycling to school can be calculated. Questionnaire surveys can also provide information on route choice and (safety) problem areas. The results of the survey can be incorporated into safe routes to school programs.

3.3.4 Mapping Main Infrastructure Barriers and Identifying Missing Connections

The main infrastructure barriers, such as highways, swamps, railway lines, insecure areas, amongst others, that obstruct logical origin-destination connections should be identified and added to the base map. These barriers can be the cause of missing links in the existing network. As special provisions may have to be made to establish the desired bicycle connections, these barriers require special attention when developing the bicycle network.

3.3.5 Assessing and Understanding Potential Demand

Potential demand (also called latent demand) describes potential new bicycle trips, which are currently suppressed, but could take place if cycling conditions were improved. Potential demand can be assessed in relation to specific route improvements or to the whole network. Measuring potential demand requires understanding factors that influence people's choice of the bicycle. Surveys of bicycle users and non-users, which ask about the main constraints (and their order) when they decide to use or not to use a bicycle, are helpful in this case. Decision-makers can bring some of these factors under control. For example, in some situations, potential demand is likely to manifest itself when a sustainable safe bicycle network is constructed, or when promotional activities have been undertaken to take away prejudgements on cycling. Putting a number to this potential is often difficult but a good sense of the potential for cycling can be obtained this way.

3.3.6 Prioritising Bicycle Network Structure including Route Components

Define and establish the priorities for a bicycle network structure using qualitative or quantitative methods. Develop individual bicycle route components that together form routes that are safe, coherent, direct, comfortable and attractive.

3.3.7 Developing Sketch Plan Bicycle Network Structure

The information collected in the previous five steps (base map, facilities, volumes, barriers, demand potential) can be used to develop a strategic outline (I-CE, 2007) or sketch mapping of the main NMT network structure by linking and bundling the main origins and destinations, avoiding and/or overcoming the main barriers. A GIS system or transport model can be used to do this. Alternatively, a very simple, though very interactive method called 'Elastic Thread Method' (Bach, 2006), can be used which works extremely well, basically using a map, a soft board, a transparent sheet and a box of short coloured pins and elastic bands. The pins are used to indicate important demand locations, while the elastic bands provide the desire lines on the map. Eventually different elastic bands can be bundled according to the most logical or shortest routes. A detailed analysis of the remaining network follows in terms of crossing the earlier identified barriers, overlap with existing (bicycle) infrastructure, connections with public transport stops, schools, and the like.

This way the real network design process can start and routes and area connections can be refined, possibly followed by field visits. In some places, bicycle infrastructure is provided throughout the existing road network, with bicycle interventions per class of road or as a dual bicycle network along backstreets only to cross at intersections. In those cases, the sketch planning methodology might be less useful although it would still give useful information on the key routes in the network.

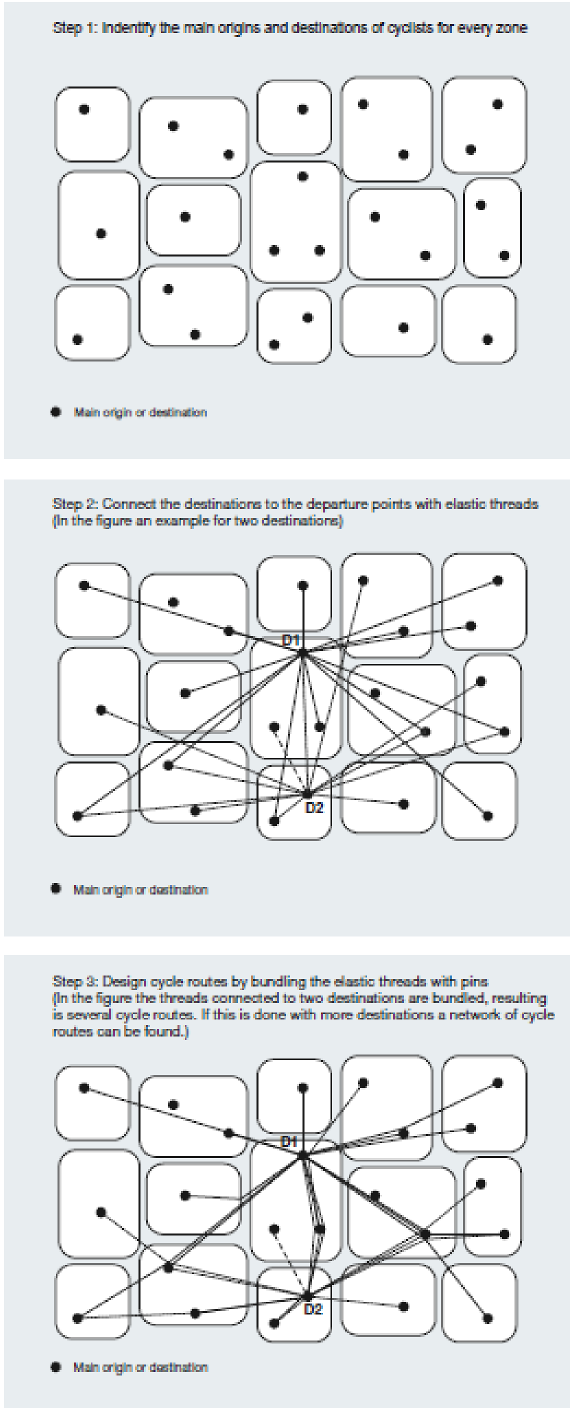


Figure 3-2: Elastic Thread Method Applied

3.4 Inventory and Condition Assessment

The inventory will form the core of the NMT Asset Management System (AMS). In planning activities, the inventory should be assessed for completeness and appropriateness.

High quality satellite and aerial photographs of the area in scope is a useful method of assessing where NMT should be provided.

One of the major problems with NMT assets is that authorities may not be aware that they exist. For example, many areas in the country with informal footpaths cover long distances. A precise cut-off in terms of usage at which the foot path needs to be considered as an asset and included in the AMS is difficult to define and depends on the terrain and soils over which it is located. **Table 3-2** provides an indication of when a footpath should be taken on board as an asset.

Table 3-2: Minimum Daily Usage to Include in Inventory

Location	In-Situ Soil Type	Terrain		
		Flat	Rolling	Mountainous
Rural	Good	40	30	20
	Fair	20	20	10
	Poor	10	10	10
Urban	Good	100	60	40
	Fair	50	30	20
	Poor	20	10	10

Where multiple footpaths exist to similar destinations, consolidation must be considered and a single asset included in the inventory.

Planning and AMS practitioners should work together to ensure that the inventory is as comprehensive as need be for the current planning operation.

Inclusion in the inventory provides a means of monitoring condition and usage so that the footpath can be upgraded in accordance with prioritisation within the authority.

3.4.1 Condition Assessments

Condition assessments will be carried out as part of AMS and the outputs will be condition indices for each asset type as well as consolidated and composite indices to provide information to be used in project identification and system improvement. As expected, planning and maintenance practitioners should work together to consolidate major refurbishment activities with route and capacity improvement activities in order to develop a coherent set of integrated projects.

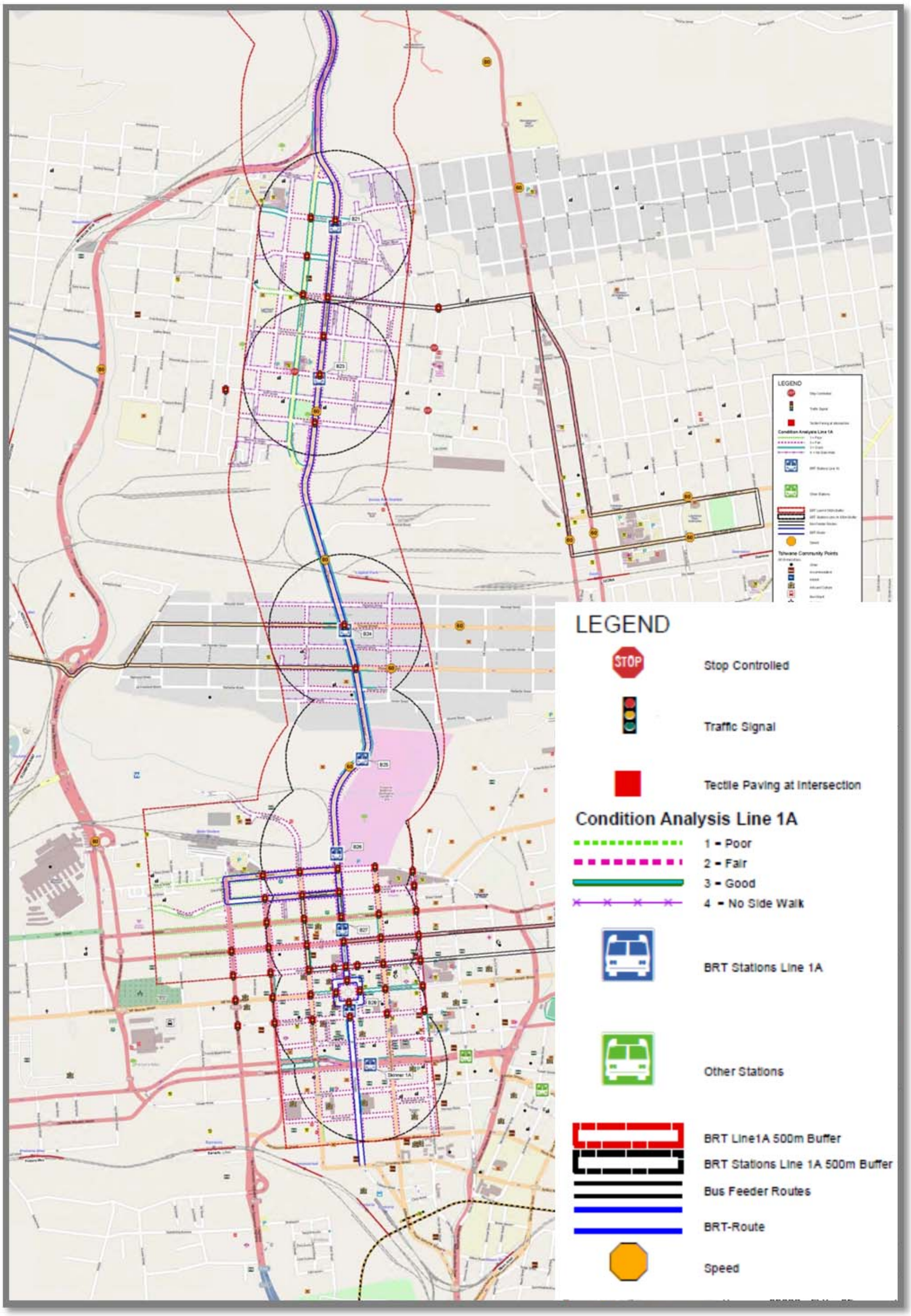


Figure 3-3: Example of NMT Condition Map

Source: SMEC

3.5 Determining the Extent of Improvements Required

The situational analysis carried out as part of the AMS can be added to the above inventory assessment and used as a first input into a needs analysis to determine the extent and cost of improvements required to achieve desired service levels.

The extent of improvements required to accommodate special needs users can also be determined and reported.

Overall, the budget levels for NMT facilities should be:

Urban Areas	R10 per person per year that lives within the scope of the plan
Rural Areas	Depends on public transport interfaces and NMT crossings. An amount of around R1,000 per km of the paved road network can be considered as an initial starting point.

The needs assessment should be converted into a set of identified first draft programmes and projects that will be required to resolve problems.

3.5.1 Prioritisation

Prioritisation should follow the normal project prioritisation processes in use. Two methods are generally used:

- Multi Criteria Analysis, or
- Cost-Benefit Analysis.

For NMT a multi-criteria analysis is normally preferred as it is difficult to determine benefits and costs for NMT in view of the uncertainties associated with quantifying the benefits. In many cases benefits are of a secondary or tertiary nature such as increased speed of public transport if all users can use NMT to get to bus stops, and reduced CO_2 emissions due to fewer car trips.

The criteria used in multi-criteria analysis could include:

- Number of person-km at a CI below the desired intervention level,
- Accident records along the route or at the site,
- Potential to improve public transport and reduce subsidies,
- Compatibility with strategic plans, and
- Degree to which the facility will address stakeholder requirements.

The precise definition of the criteria and analysis will depend on circumstances but will generally involve weighting the criteria and summing the resulting scores.

3.5.2 Programmes

The development of NMT programmes provides a method of prioritisation as dissimilar facilities do not compete for funds individually, but rather as part of a programme. The programmes then need to compete for funds and the projects compete within a programme.

Programmes will be developed as an outcome of the situational assessment. **Table 3-3** provides some examples.

Table 3-3: Examples of NMT Programmes

Situation	Problem	Programme
Urban - Low CI	Narrow sidewalks	Sidewalk widening Pedestrianisation One Ways
	Unpaved sidewalks	Paving sidewalks
	Lack of continuity	Dedicated walkways and bicycle lanes Bicycle lanes Pedestrianisation Priority bicycle streets Gravel walkways within floodlines
Urban - Rural Pedestrian Casualties	Dangerous crossings	Slow cars down and remove freight
	Dangerous crossings	Signalised intersection
	Poor quality and dangerous public transport interfaces	Improve public transport interfaces
Urban Decay	Traffic congestion	One Ways with improved sidewalks and walkways Continuous bicycle lanes
Low Utilisation	Low take up of bicycle transport	Dedicated bicycle lanes
	Low take up of bicycle transport	Bicycle sheds at PT Interfaces
Rural - Low CI	Poor quality footpaths	Footpath improvement
	Dangerous river and road crossings	Pedestrian/bicycle bridges

3.5.3 Viability

Viability concerns the institutional and financial viability of the facilities. This relates to the cost of sustaining the programme relative to the available budget and the people available to manage the development, operations and maintenance of the facilities.

Typically, totally or partially separated paved facilities will cost around **R450/m^2** while unpaved facilities with gravel wearing courses will cost approximately **R50/m^2** to develop.

Maintenance costs, around **R10/m^2 per year**, must be added.

Unfortunately, South Africa does not have readily available funds to implement all NMT infrastructure requirements and improvements. Government will, therefore, have to **prioritise identified projects**. Funding should be spent first in areas where the need is the highest and where the largest number of people will benefit.

Government needs to use national and local policies and legislation, as well as local conditions (context, attractions and demand) to **identify criteria and key performance indicators** that will be used to inform financial decision making. All planned investments require a calculation of anticipated benefits and costs to ensure limited funds are allocated to viable projects.

Traditionally, project prioritisation primarily used Cost-Benefit Analysis (CBA). CBA reduces all the project effects that will occur over time into monetary terms and compares these with the capital and maintenance costs. CBA uses a discount rate to take the time value of money into account. While CBA provides a good and objective numerical indication of the viability of the project, it suffers from the disadvantage that R1 is deemed to have the same real value to the rich as well as to the poor. Therefore savings of R1 to many rich people will be deemed to deliver the same benefit as a R10 saving to 1/10 as many poor people. It therefore assumes that social equity exists across the spectrum of projects being considered.

An equity analysis or audit is an even more recent approach to prioritisation, concerned with providing equitable conditions of safety, affordability, comfort, efficiency, travel time, and a pleasant environment to all.

An equity analysis prioritizes non-drivers over drivers, or people who are transport disadvantaged over those who own private cars, and ensures that a fair share of resources are provided to those who do not own their own vehicles.

3.6 Developing Design Concepts

The planning process will identify corridors, routes and access points of the NMT network. These networks need to be developed into a coherent set of NMT routes that allow for both mobility and access. In order to achieve this, the project level plans need to be developed into design concepts for each route and facility. These concepts must allow for integration with other modes of transport and also provide a network where mobility routes and access walkways and bicycle lanes complement each other and can function within the context of their location and to form a coherent and sustainable mode of transport.

The concepts should firstly consider the function (mobility, accessibility, or both) that the particular facility will play in a manner similar to road functional classification.

3.6.1 Functional Classification

Roads are primarily provided either for mobility or for access. However, in the South African context, many roads fulfil both functions. The concept of a clear distinction between mobility and access roads has been given further impetus in the South African Road Classification and Access Management Manual (TRH26: SARCAMM (COT, 2012)) by classifying roads in accordance with their primary purpose i.e. mobility or accessibility. Mobility roads have higher speeds with intersections spaced far apart while access roads have lower speeds with closely spaced intersections. This is shown in **Figure 3-4** and **Table 3-4**

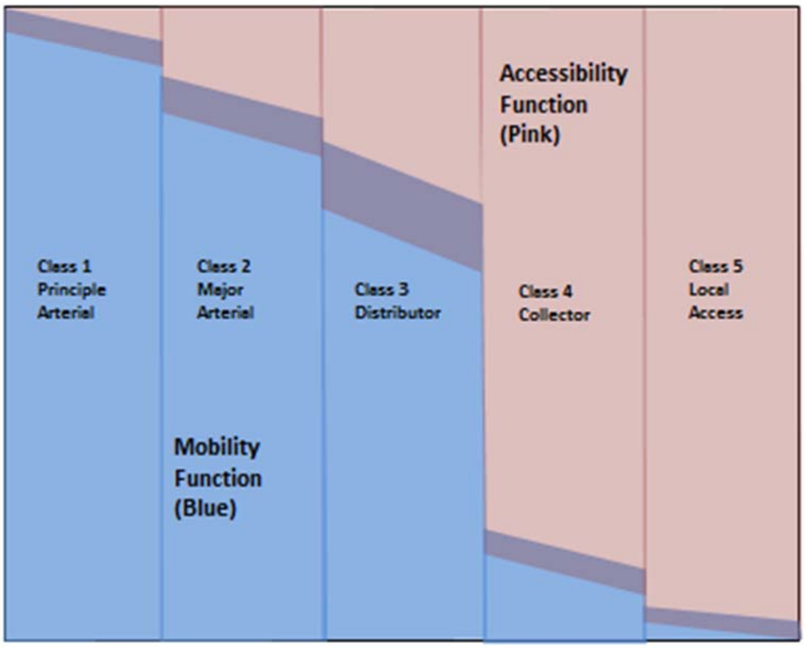


Figure 3-4: Road Classification for Mobility/ Accessibility

The South African road functional classification system and typical speeds and widths of the right of way is shown in **Table 3-4**.

Table 3-4: South African Road Classification

Class	Function	Description	Rural		Urban	
			Design Speed (km/h)	Typical Width (m)	Design Speed (km/h)	Typical Width (m)
1	Mobility	Principle Arterial	120	62	120	60
2		Major Arterial	120	48	80	40
3		Minor Arterial	100-120	30	70	30
4	Access/ activity	Collector Street	80-100	25	50-60	20-25
5		Local Street	60-80	20	40	14-22
6		Walkway/ Bicycle lane	N/A	N/A	N/A	N/A

Source: Based on COTO, 2012

Although the above is theoretically correct, in practice South Africa has a tremendous amount of NMT used for mobility or accessibility purposes and therefore this guideline allows for three classes of NMT facilities, namely:

- Mobility Spine (Classes 2 and 3),
- Collectors (Class 4),
- Access (Class 5).

The classes match those for roads in terms of function of the facility.

Conflict severity between motorised traffic and NMT increases as the speed deferential increases, which therefore necessitates that mode separation requirements are put in place, particularly for higher road classes.

Therefore, NMT designs need to take the typical speeds and urgencies of drivers of motorised vehicles into account to reduce dangerous potential conflicts and serious collisions and also channel road users out of conflict lanes.

3.6.2 Land Use

In addition to the functional class of the facility, the design concepts also need to consider the context of the road, i.e. land use within which it is located. For example, a simple unpaved pathway may be quite adequate in a rural context involving long distances and low volumes while a wide partially separated facility may be required within an urban commercial centre to accommodate the volumes in a safe and comfortable manner.

Table 3-5: NMT Concept Designs below sets out typical concepts that will be associated with each class within the context of land use.

The concepts will differ with land use as this affects the space available, the length of the NMT trip and the volumes and speeds of motorised traffic.

Table 3-5: NMT Concept Designs

NMT Class	Land Use / Context	Type of Facility	Conceptual Layout
Mobility Spine - Corridors to bus stations and commercial centres.	Rural	Pedestrian Bicycle	Totally separated, narrow, probably unpaved or gravel. Bicycles and Pedestrians can share if wide enough. Possibly some river bridges. Alternatively, totally separated alongside arterial roads.
		Animal Drawn	Separate facility adjacent to arterial roads. Facility can be shared with pedestrians and cyclists.
	Suburban	Pedestrian Bicycle	Preferably totally separated facility to provide mobility through parks, along watercourses and/or partially separated adjacent to arterial roads.
	Commercial /Retail	Pedestrian Bicycle	Partially separated adjacent to arterial streets - located along wide street sides. Many crossings of busy streets. Potentially some overpasses and underpasses
Collector - Routes to bus stops, schools and arterials	Rural	Pedestrian Bicycle	Totally separated, narrow, probably unpaved or gravel. Bicycles and Pedestrians can share if wide enough. Possibly some river bridges. Alternatively, partially separated alongside collector roads.
		Animal Drawn	Separate facility adjacent to collector roads. Facility can be shared with pedestrians and cyclists.
	Suburban	Pedestrian Bicycle	Sidewalks with paved walkway Partially separated adjacent to collector streets roads or marked separation along suburban streets or collectors if wide enough.
	Commercial /Retail	Pedestrian and Bicycle Bicycle	Partially separated (sidewalks) adjacent to collector streets roads. Marked separation along streets if wide enough. Bicycle priority streets – 40 km/h
Access – Short distance access to bus stops, collectors and arterials	Rural	Pedestrian and Bicycle	Totally separated, narrow, probably unpaved earth. Bicycles and Pedestrians can share if wide enough. Alternatively, partially separated alongside collector and access roads.
	Suburban	Pedestrian Bicycle	Unpaved sidewalks. Mixed traffic along suburban streets.
	Commercial/ Retail	Pedestrian Bicycle	Paved sidewalks Partially or marked separation along streets depending on street and street side widths.

3.7 Sustainability

Chapter 3 discusses a wide range of issues related to the planning of NMT routes and the development of NMT concepts that need to be considered to ensure viability and to be able to sustain the facility. NMT is a major contributor to the concept of sustainability, and in the South African context, can be explained as:

3.7.1 Social Progress and Economic Development

In South Africa, householders insurance increases with proximity to parks and informal walkways, while at the same time these facilities allow for **greater accessibility of job opportunities and in themselves present further job creation opportunities**. This situation needs to be reversed through careful consideration of operations and maintenance issues discussed later and through ensuring that NMT facilities are much more than just a few walkways and bicycle lanes but involve a comprehensive facet of the day-to-day lives of many South Africans.

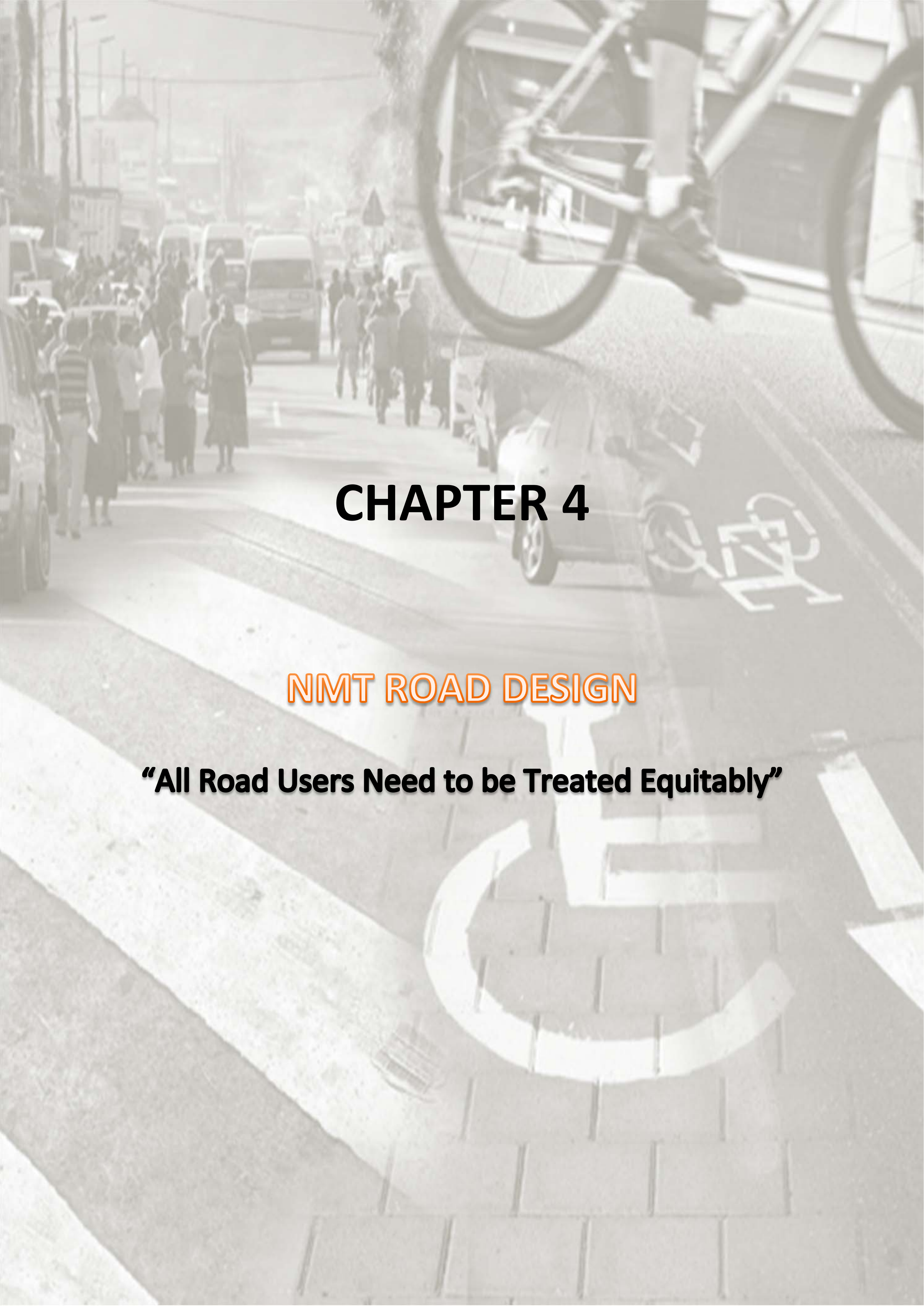
For example, the following set of job opportunities can be associated with NMT facilities:

- Labour-intensive construction opportunities,
- Manufacturing opportunities for bricks, kerbs and the like,
- Gardening opportunities along NMT facilities,
- Security jobs related to, for example, policing facilities and bicycle shed wardens,
- Facility maintenance and cleaning, and
- Ablution facilities including maintenance and security.

Therefore, NMT is eminently suitable to **advance social progress and job creation**.

3.7.2 Environmental Progress

NMT, by its nature, is an environment-friendly form of transport with almost zero carbon emissions. Therefore, this will always have a positive effect.



CHAPTER 4

NMT ROAD DESIGN

"All Road Users Need to be Treated Equitably"

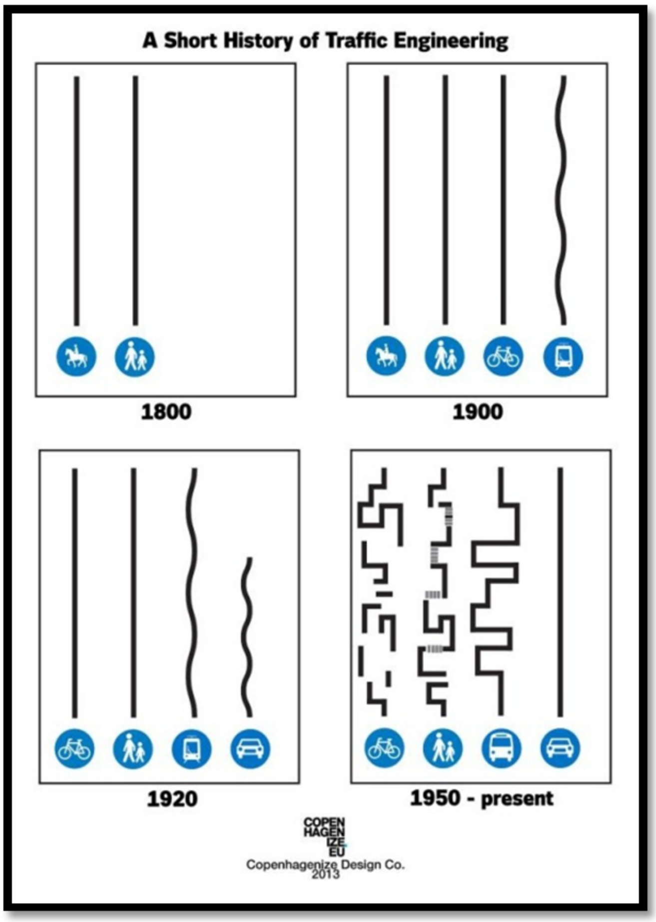
4. NMT ROAD DESIGN DETAILS

"All Road Users Need to be Treated Equitably."

4.1 Introduction

The South African Constitution stipulates that all people have to be treated equitably in transport situations. There is always conflict between NMT and vehicular traffic and this conflict needs to be minimised through good design and transport management.

The road network contains **two main elements**: **links and intersections** which are normally designed to promote mobility for vehicles along the higher order roads and access for vehicles on lower order roads, typically with little attention being paid to NMT. However, the road right of way needs to accommodate all modes of transport and users (freight, private and public transport and NMT users) in a safe and comfortable manner. Principle issue in planning safe transport is to separate freight traffic from NMT wherever possible, while being strict regarding speed limit enforcement.



The road network in urban and rural areas cannot be considered in isolation and needs to be referenced to the surrounding development in terms of purpose and function. Where the purpose or function is unsuitable for the classification of the road, a long-term plan may be required to align them.

4.2 Design Criteria for Universal Access

While the above functional classification relates to the use of the road and typical motorised vehicle speeds that require separation form NMT users, the design also needs to consider the functional aspects of human beings and ensure they can be mobile within their environments. Universal design relates to the ease with which all people can access transport-related activities. In terms of universal access, mobility relates to how people move around and access relates to the ease with which a person can use infrastructure.

The basis of universal design arises from the premise that human beings function in a certain way in order to perform basic activities. These activities support a person in carrying out his/her daily tasks, and effectively result in the individual being able to be part of society or excluded from it. In this context, mobility refers to the movement of individuals rather than the vehicle speeds required to reach distant destinations.

Guaranteeing the ease of movement for all people including those who are sighted, blind, or partially sighted, those who use a wheelchair, pushchair or pram – is paramount. People who are deaf, people with learning disabilities, children and the elderly are the most vulnerable road users. Mobility patterns are age-related and governed by cognition, in addition to personal circumstance created by disability.

The universal design movement has been active in South Africa for the past 40 years or so and resulted in the South African Constitution that acknowledges disability and gender as issues in the Bill of Rights. Now additional emphasis has been given by South Africa when it signed the United Nations Convention on the Rights of People with Disabilities (2007). This action requires the engineering profession to become aware of the problems that traditional approaches to planning and constructing the built environment cause people in their everyday lives.

However, it will take time to achieve the optimal solution given the scale of the problem. The following set of NMT design guidelines will ensure that NMT facilities created will promote universal access:

(a) Equitable

The built environment, which the NMT facilities are a part of, must promote equal access to opportunities for people with diverse abilities.

(b) Flexible

The NMT facilities should accommodate a wide range of NMT users with different abilities.

(c) Simple and Intuitive

The NMT facilities should be easy to understand, regardless of the user's experience, knowledge, language skills and concentration levels.

(d) Perceptible Information

The necessary information should be communicated to the user regardless of the users' sensory abilities.

(e) Tolerant for Error

The NMT facilities should minimise hazards for the users and the adverse consequences of accidental or unintended actions.

(f) Low Physical Effort

The NMT facilities that are provided should be used efficiently, be comfortable and cause the most minimum fatigue.

(g) Appropriate Size and Space

The NMT facilities should be appropriate for the size and space requirements, i.e. they should be within easy reach, approach, and use irrespective of the user's body size, posture or mobility.

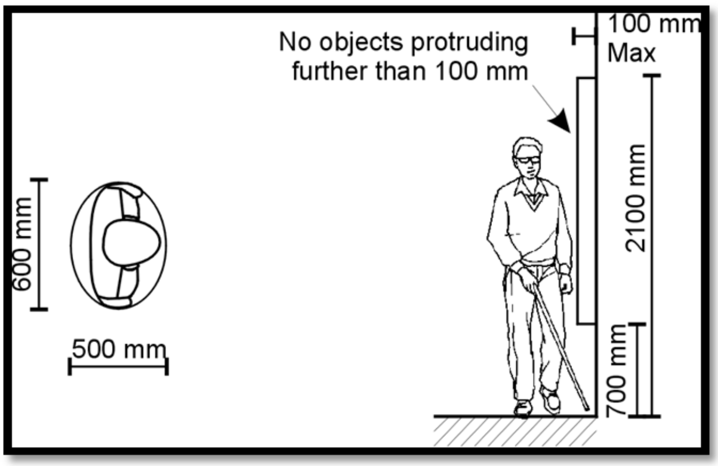
4.2.1 Sidewalk Related Universal Access Requirements

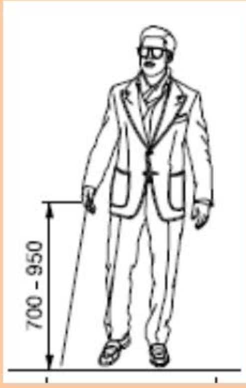
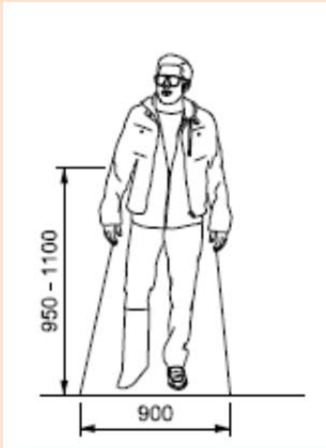
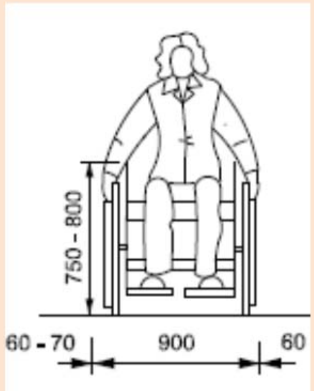
The universal access design requires a good understanding of the physical space requirements of people as shown in the following figures. A pedestrian has a physical space need of 600 mm x 500 mm, and a free height requirement of 2,100 mm **(Figure 4-1)**. However, the engineer needs to keep in mind that more space is required if a large portion of the population is overweight. Also, if pedestrians carry luggage they might require more width, or more height if carried on the head.

The various sidewalk elements for people with various mobility needs are provided in **Figure 4-2**.

There is an international trend towards motorised wheelchairs which often have a larger space requirement than traditional wheelchairs, i.e. 1,100 mm x 1,300 mm. Assuming the uptake of motorised wheelchairs in South Africa, accommodating these larger space requirements is recommended.

Figure 4-1: Space Requirements for NMT Users



Basic dimensions of people and equipment		Example
Minimum passage width – stick user	750 mm	
Minimum passage width – double crutch user	900 mm	
Minimum passage width – adult and child	1100 mm	
Minimum passage width – wheelchair	900 mm	

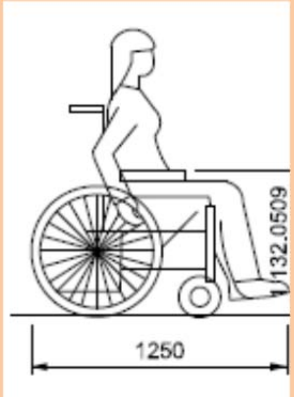
Basic dimensions of people and equipment		Example
Length of space for wheelchair and user – conventional seating	1250 mm	
Length of space for wheelchair and user – legs outstretched	1500 mm	
Length of space for wheelchair and assistant	1750 mm	
Length of space for adult and assistance dog	1500 mm	
Length of powered scooter / electric pavement vehicle	1500 mm	
Manoeuvring space for wheelchair at 90 degree turn	1500 mm x 1500 mm	
Manoeuvring space for wheelchair at 180 degree turn	1600 mm x 2000 mm	

Figure 4-2: Requirements for NMT Users with Special Needs, (DoT UK, Inclusive Mobility (2002)

4.2.2 Universal Design Requirements for Bicycle Facilities

Universal design aspects related to bicycle facilities are the space requirements for cyclists (height and width) that are shown in **Figure 4-3** and **Figure 4-4**.

Extraordinary non-motorised transport, such as tricycles and bicycles with trailers, has greater space requirements.

Lastly, there are extraordinary users of bicycle facilities, such as skateboard and roller blade users. Although the movement of these users is different to bicycle users, the space requirement is equal or less than the space requirement for extraordinary bicycles.

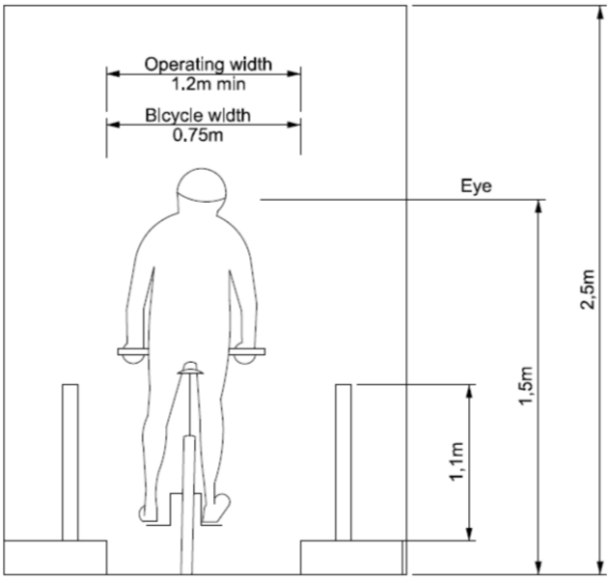


Figure 4-3: Space Requirements for Bicycle Users

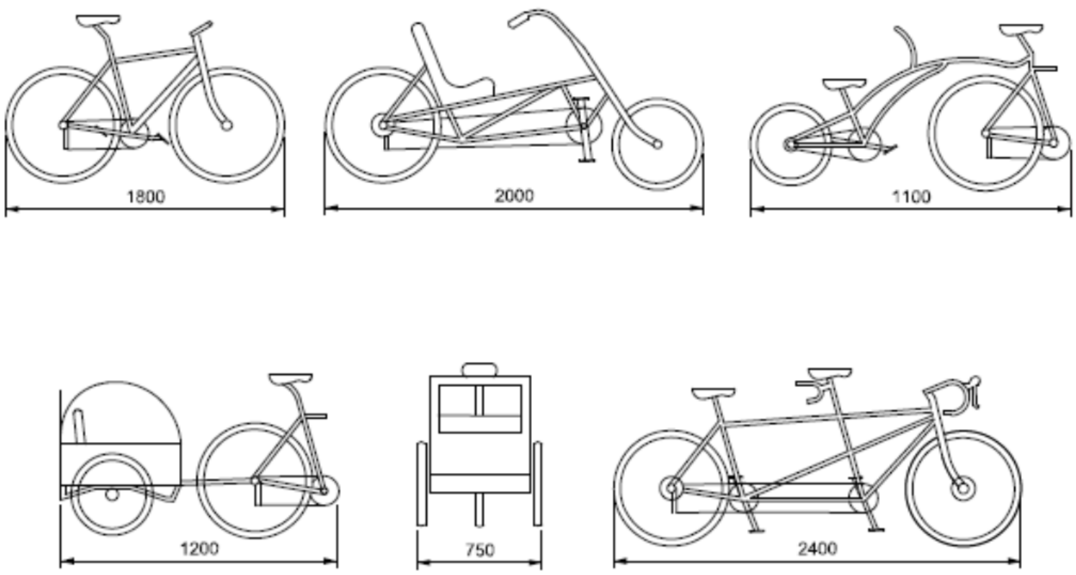


Figure 4-4: Space Requirements for Extraordinary Bicycle Users

4.2.3 Separation

The degree of separation between the NMT facility and vehicles is one of the most important elements of safety of NMT facilities. The six degrees of separation provided in **Table 4-1** are used in these guidelines.

Table 4-1: NMT Degrees of Separation

NMT Separation	Description
1: NMT Only	The NMT facility is separate and removed from vehicular traffic over most of its extent.
2: Total	No conflict will occur between motorised and NMT even in the event of loss of control of the motorised or NMT vehicle. A heavy barrier or sufficient separation of 1 to 9m can be provided between the shoulder breakpoint and the NMT lane.
3: Partial	No conflict can occur under normal operating conditions. This is generally achieved by means of a level difference between the travelled ways such as a kerb and sidewalk or by means of light barriers.
4: Road Marking	Motorised and NMT traffic run on the same surface but are separated by means of continuous road marking and signage to identify the lane as a bicycle lane or pedestrian walkway.
5: Priority	A section of road where NMT has priority and slow speeds are mandatory - no continuous road markings only signage.
6: None	NMT competes with motorised vehicles for space on the road.

Mode separation can be achieved as shown in **Table 4-2**:

Table 4-2: Mode Separation Requirements

Road Classification		Bicycle	Pedestrians
1	Freeway	Total Separation	Total Separation
2	Major Arterial	Total Separation	Total Separation
3	Minor Arterial	Partial Separation	Total Separation
4	Collector	Marked Separation	Partial Separation
5	Local Street	Priority Streets / Mixed Shoulder (Rural)	Partial Separation / Mixed Shoulder (Rural)

The following aspects of **Table 4.2** should, however, be noted:

- The classes above refer to the class of the road, which may differ from the class of the NMT facility.
- Mixing of bicycles with motorised traffic is an option on local streets where speeds and speed differentials are low.
- It is recommended that the speed limits on access streets with significant bicycle and pedestrian volumes be reduced from 60 km/h to 40 km/h, in line with the design speed, as the impact of accidents reduces vastly at this speed.

4.3 General Design Parameters and Criteria

Design criteria for NMT facilities can have a wide range of requirements, many of which are “non-negotiable”. In view of the relative slow pace of NMT users to move around and past one another, pedestrians can use cyclist’s space for passing and vice-versa where volumes are low. **Table 4-3** provides a set of values that can be used in design.

Table 4-3: Design Criteria for NMT Facilities

Facility	Parameter	Accepted Minimum	Recommended Minimum	Optimal
Pedestrian walkway - total separation	Min width	1.2 m	1.5 m	2.0 m subject to capacity requirements
Pedestrian walkway - partial separation	Min width	1.2 m	1.5 m	3.0 m subject to capacity requirements
Bicycle lane - total separation - two way	Min width	1.5 m[1] (assure adjacent walkway space)	1.8 m	2.0 m subject to capacity requirements
Bicycle lane - partial separation - two way	Min width	1.5 m[1] (check sight distances)	1.8 m	2.5 m subject to capacity requirements
Bicycle lane - marked separation - one way	Min width	1.5 m	1.8 m	1.8 m subject to capacity requirements
Pedestrian walkway	Max gradient	1:15	1:20	1:25
Bicycle lane - Animal drawn	Max gradient	1:15	1:25	1:50
Pedestrian walkway	Min corner splay[2]	2 m	3 m	5 m
Bicycle lane	Min radius	3 m	5 m	5 m
Crossfall / Camber	Max gradient	1 : 50	1 :50	
Both	Total separation: Distance from shoulder beak point	120 km/h – 5 m 80 km/h – 2 m 60 km/h – 1 m	120 km/h – 7 m 80 km/h – 3 m 60 km/h – 1 m	120 km/h – 9 m 80 km/h – 4 m 60 km/h – 2 m

Notes:

1. *Assume some space on adjacent walkway to be used for passing.*
2. *Splay to provide sight distance.*

For cycling, the gradient is more complex, than the 1:15, 1:20 and 1:50 as indicated in **Table 4-3**. For short distances, the maximum gradient is acceptable, while for longer distances, the recommended minimum might be challenging. **Figure 4.5** Provides an overview of acceptable gradients, compared to the distance (AUSTROAD, 1993).

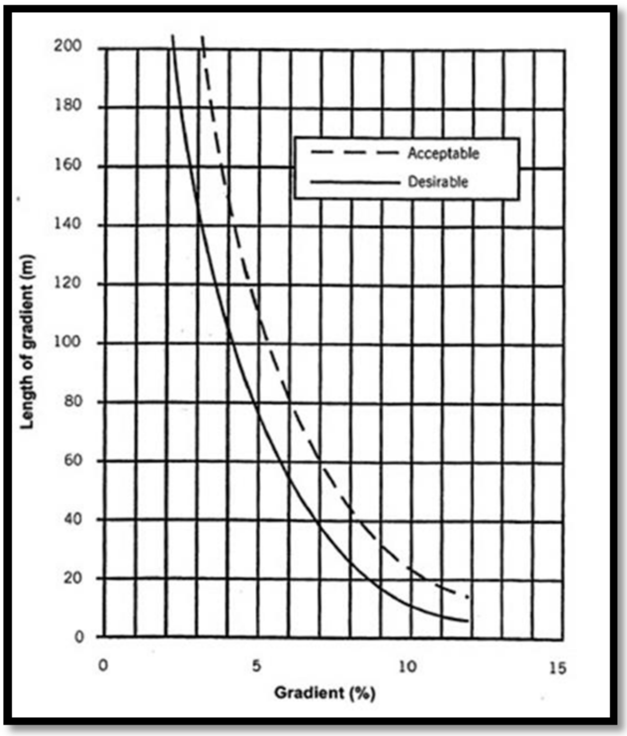


Figure 4-5: Acceptable gradients for cycling (Austroad, 1993)

In summary, when designing NMT facilities, all design aspects must be taken into account, especially the design features, such as speeds, volumes, conflicts etc. **Table 4.4** provides a summary of design requirements.

Table 4-4: Design Principles for NMT Facilities

Road Type	Motorised Transport				Conflict Risks		Non-Motorised Transport					
	Speed		Volume				Desire lines	Volume		Dimensions		Design requirements
	High	Low	High	Low	High	Low		High	Low	Walkway	Cycleway	
NMT Only	N/A	N/A	N/A	N/A	NMT right of way	NMT right of way	Follow direct lines	No mixing of NMT	Mixing of NMT possible	1200mm to 2500mm	1500mm to 2500mm	• Levelling of NMT facilities always • Walkway and cycleway can be placed next to each other to minimise earthwork
Highway	Very high road safety risk	N/A	Very high road safety risk	High road safety risk	Grade separation is required	Warning signs are required	Bridges and tunnels need to be placed strategically	No mixing of NMT	Mixing of NMT possible	1500mm to 1800mm	1500mm to 1800mm	• Barriers between MT and NMT • Wheelchairs and prams passing space
Arterial	High road safety risk	N/A	High road safety risk	Road safety risk	Separation of cycling via kerb **and** road marking/ colour	Separation of cycling via kerb **or** road marking/ colour	Facilitate NMT at intersections or create crossing infrastructure	No mixing of NMT	No mixing of NMT	1500mm to 1800mm	1500mm to 1800mm	• Partial separation of cycling via kerb or colour • Appropriate drop kerbs at all crossing facilities
Distributor	Road safety risk	Low road safety risk	Road safety risk	Low road safety risk	Crossing facilities at attractions, such as schools and PT stops	No special infrastructure is required	Facilitate NMT at intersections or create crossing infrastructure	No mixing of NMT	No mixing of NMT	1500mm to 1800mm	1500mm to 1800mm	• Marked separation of cycling • Cycleway width can be less for short distances • Appropriate drop kerbs at all crossing facilities
Access Road	Design speed is 40km/h		Road safety risk	Low road safety risk	No special infrastructure is required		Traffic calming might be required	No mixing of NMT	No mixing of NMT	1800mm/ preferably more	N/A Cyclists in roadway	• All UD users accommodated in the walkway • Appropriate drop kerbs at intersections and traffic calming

4.4 Drainage Designs

The addition of NMT facilities to roads generally complicates drainage designs and requires attention to detail to ensure free drainage at all locations. In addition, any water that ponds on the road is likely to be splashed onto NMT users and discourage the use of NMT.

Figure 4-6: Water Ponding Along a Sidewalk

Proper management of road run-off is also important and needs to be designed to ensure that sidewalks are always passable and do not get flooded or littered by soil and debris during the rainy season.

Various options are available to solve drainage problems and this section is intended to highlight the importance of good drainage on, and alongside, NMT facilities. The following aspects are noteworthy:

- When the sidewalk is adjacent to the roadway, vertical kerbs will assist in channelling storm water to the nearest drain.
- Where no subsoil drainage system is present, mitre drains will assist to channel storm water to specific locations along the roadway and across the walkway.
- A maximum crossfall of 2% (1:50) must be provided along a paved walkway to ensure proper drainage and to accommodate persons with disabilities.
- Where gravel road shoulders are used by learners and cyclists, a crossfall of 4% (1:25) must be maintained along the road shoulder to ensure proper drainage along the entire road shoulder.

Figure 4-7: Good Drainage Along a Sidewalk

4.5 NMT Only Facilities (Exclusive)

The first choice option for NMT is to have exclusive NMT facilities if possible. These facilities should form the most direct and shortest route between most origins and destinations and should be routed along contours and through "porous" city blocks.

Figure 4-8: NMT Underpass Using River Bridge

These facilities could range from maintained earth footpaths right up to wide paved walkways and bicycle lane arterials.

Where gravel is used as a wearing course it should be contained within concrete longitudinal side supports on steeper terrain to prevent washaways.

Landings must be provided at maximum 20 m spacings if the maximum gradient is greater than 5% (1:20).

The natural vegetation should be maintained for 3 m on either side of the facility to present a safe and secure environment.

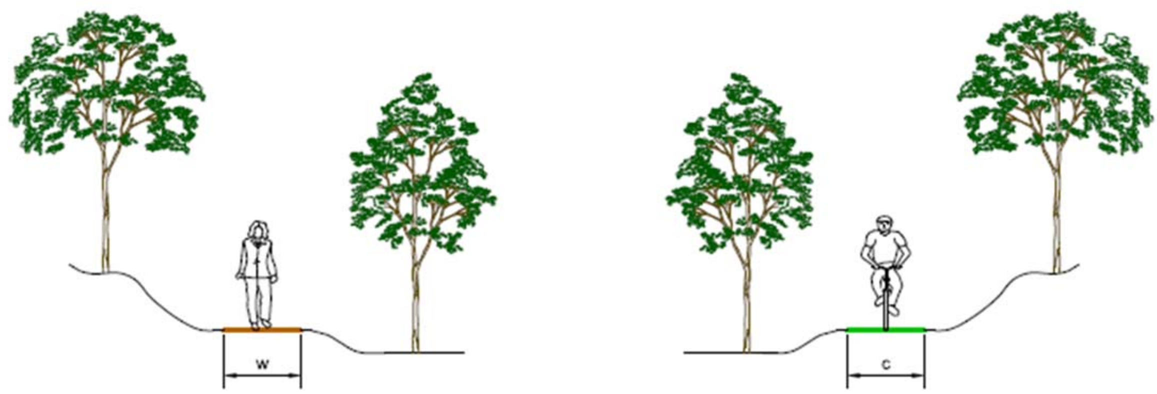
Figure 4-9: Exclusive Bike Trail at the Cradle of Humankind

Lighting should be provided where the facility can potentially have significant volumes at night and where facilities intersect to motorised roads and streets.

Bridges and culverts should be provided at watercourses.

Where the facilities are routed along watercourses the road bridges over the watercourse could provide an underpass for the walkway/bicycle lane.

NMT Only



Dimensions:

w = 1,200 mm min to 2,500 mm to suite capacity requirements

c = 1,500mm to 2, 500mm to suite capacity requirements.

Drainage:

Paved facilities - 2.5% crossfall or camber

Unpaved - 4% crossfall or camber

Principles:

- NMT only
- Cycling and other NMT modes should not be mixed, due to differences in levels of speed.
- Promotes shortest route principle
- Walkways and bicycle lanes can be placed next to one another on long distance low volume routes to minimise earthworks.

Positive Aspects:

- 100% safe for NMT.

Negative Aspects:

- Security can become an issue.

4.6 NMT along Roads

Regardless of whether people use private cars or public transport, all are pedestrians for the first and last part of their journey; therefore all need an environment that supports NMT.

In the case of motorised transport, high volumes and long distances translate freeways, motorways and mobility spines into high speed corridors. Although planning principles and legislation prevent NMT users from using these roads, in the South African practice, NMT users have no other option but to use these high speed corridors. It is, therefore, necessary to accommodate NMT on all South African roads without jeopardising safety for both, motorised and NMT users.

NMT facilities are required to be provided within the right of way of all roads where NMT users are significant. While designs should strive to achieve total separation, particularly along high classes of road, this is not always possible.

The following sections provide guidelines for acceptable practices for the following NMT conditions:

- NMT along Highways with Controlled Access,
- NMT along High Speed Highways,
- NMT along Kerbed Arterials,
- NMT along Urban Distributors and Collectors,
- NMT along Access Roads, and
- Bicycle Priority Streets.

4.6.1 Highways with Controlled Access

Mobility spines should not be public transport corridors. As a rule, NMT alongside highways with controlled access **should be avoided,** due to high speeds and the need to prevent people from crossing the road or using the road reserve. The layout and locations of interchanges alongside these roads also makes it difficult to provide continuous flat gradients.

Where there are no alternatives and the NMT facility can be fenced off from the motorised vehicles in a sustainable manner, while not detracting from safety related to accidental run-off-the road accidents, an adjacent NMT facility can be considered. In most successful cases, the NMT facility is placed close to the outside of the right of way or at a different level to the highway where it also uses the highway crossings of rivers and watercourses to allow the NMT users to pass safely under the road when the rivers are not in flood.

If NMT users are to cross the river using the highway bridge, a pedestrian walkway can be suspended below the cantilever portion of the bridge.

Figure 4-10: Pedestrian and Bicycle Facility Adjacent to and Below a Highway Section (Seoul)

Figure 4-11: Walkway Suspended on Highway Bridge (Vienna)

Figure 4-12: Walkway below Highway Bridge (Bratislava)

4.6.2 High Speed Highways

This section describes the facilitation of NMT facilities on roads with relatively high speeds and high traffic volumes. The design of the highway will normally include the provision of a forgiving roadside that allows drivers to recover or avoid serious injury in the event of a run-off-the-road accident. Therefore, NMT users should be **totally separated preferably** from motorised vehicles to prevent serious accidents from occurring. This can be achieved by placing the NMT ways at an appropriate distance from the edge of the road or by using a heavy barrier (guardrail) to provide protection in the event of loss of control. In this situation, the walkway should preferably be placed around 1 m back from the guardrail to prevent it from encroaching on the walkway if damaged. Alternatively, a double guardrail could be used.

Figure 4-13: Walkway behind Guardrail with Light Barrier on High Fill

One of the problems with setback NMT ways is that in rolling terrain, NMT users will have to manage with all the gradients while the motorised vehicle has a flat and "easy ride". This is best managed by bringing the NMT ways closer to the road in cuts and fills but to separate the two with a guardrail.

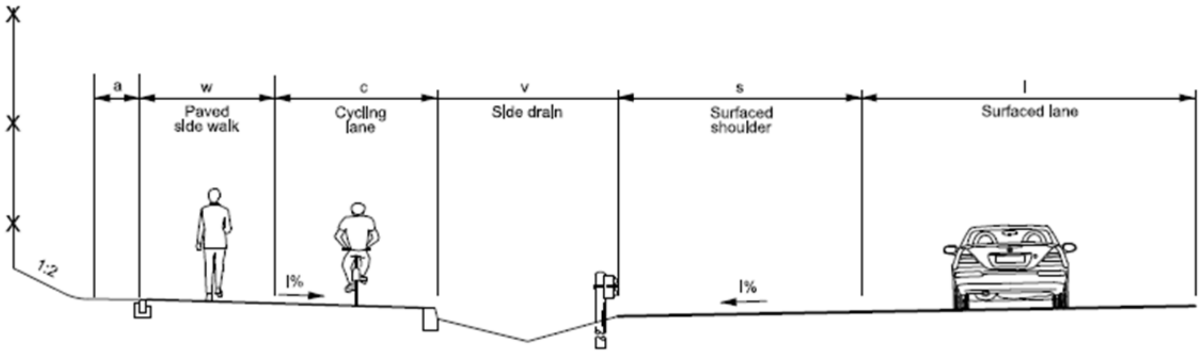
Figure 4-14: Unprotected Walkway too Close to the Road is Unacceptable

Where this is not possible, partial separation through kerbs and lighter barriers should be implemented.

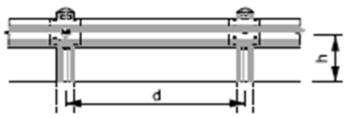
Experience has shown that walkways along the edge of the road reserve are generally not popular because of security reasons and the need to access public transport. Therefore, security and clear sight lines between the walkway and the road must be considered.

Figure 4-15: Walkway with Kerbed Barrier

High Speed Highways



CROSS SECTION



GUARDRAIL : FRONT ELEVATION

Dimensions:

a = varies

w = 1,800 mm (Min: 1,500 mm)

c = 1,800 mm (Min: 1,500 mm)

v = varies – if no barrier, then > 2 m for 60 km/h and > 9 m for 120 km/h

s = varies

l = typically 3,400 to 3,700 mm

i = typically 2%

d = typically 3,810 mm

h = typically 530 mm

Principles:

- Total separation
- Width should ideally accommodate two persons with wheelchairs/ prams.

Positive Aspects:

- Complete safety is guaranteed.

Negative Aspects:

- Wide road reserve

Remarks:

Source:

COTO, 2012

4.6.3 Kerbed Arterials

Kerbed highways have slower operating speeds in the range of 60 km/h to 80 km/h and the kerb represents a barrier between the motorised vehicles and NMT users. In this case, it is normal to place the bicycle lane adjacent to the kerb and the pedestrian walkway just outside the bicycle lane.

Figure 4-16: Combined Bike and Pedestrian Lanes (Vienna)

In some circumstances where the sidewalks and narrow and cannot accommodate a bicycle lane, the bicycle lane is placed on the same surface as the motorised traffic and **partial separation** is effected by a barrier.

Figure 4-17: Bike and Motorbike Lane Behind Barrier (Huangzhou)

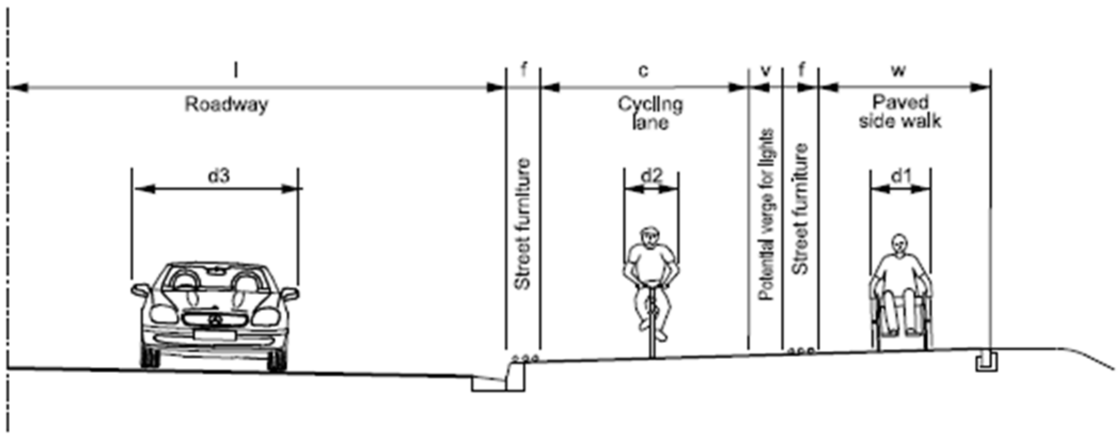
Where there is sufficient space to provide a separate bicycle and scooter lane of at least 3 m, a permanent barrier can be created.

The adjacent photo shows where a bicycle lane and pedestrian walkway have been combined within a 2.5 m total width behind a kerb. The usage is low and it stretches over a considerable distance of around 7 km so a minimal width is required to be cost-effective.

Figure 4-18: Bicycle and Pedestrian Lane (Caiscais)

Linear tactile pavers are required if the sidewalk is too wide for people using a walking cane, to touch the kerb or building line.

NMT Facilities along Kerbed Arterials (80km/hr and above)



Dimensions:

l = varies Min: 3,000 mm

f = 1,000 mm (COTO)

c = 1,800 mm (Min: 1,500 mm)

v = 300 mm

w = 1,800 mm (Min: 1,500 mm)

d1 = 2,500 mm (2,600 mm with mirrors)

d2 = 750 mm (900 mm with manoeuvring)

d3 = 700 mm (900 mm with manoeuvring)

Principles:

- Partial separation
- V = optional

Positive Aspects:

- Safety for all modes of transport is reasonably assured.

Negative Aspects:

- Road reserve needs to be large enough to accommodate all modes.

4.6.4 Urban Distributors and Collectors (60 km/h)

On urban collector with bicycle lanes, the bicycle lane is placed on the road surface and is only separated by road markings and signage.

Urban distributors and collectors are designed to provide access to urban settlements/suburbs. They connect the accessibility spaces with the mobility network. Their emphasis should be on connectivity and not throughput. Urban distributors and collectors have a design speed of 60 km/h. If these roads have one lane per direction, the bicycle lane can be placed on the road surface and only separated by road markings and signage. If there is insufficient road space, road diets can be considered (See **Figure 4-20**).

Figure 4-19: Urban Collector with Bicycle Lane (Portland USA)

Although many residents and the retail industry in general are against road diets during the planning phase, research shows that if turnover and liveability are influenced positively, then motorised transport road allocation can be reduced.

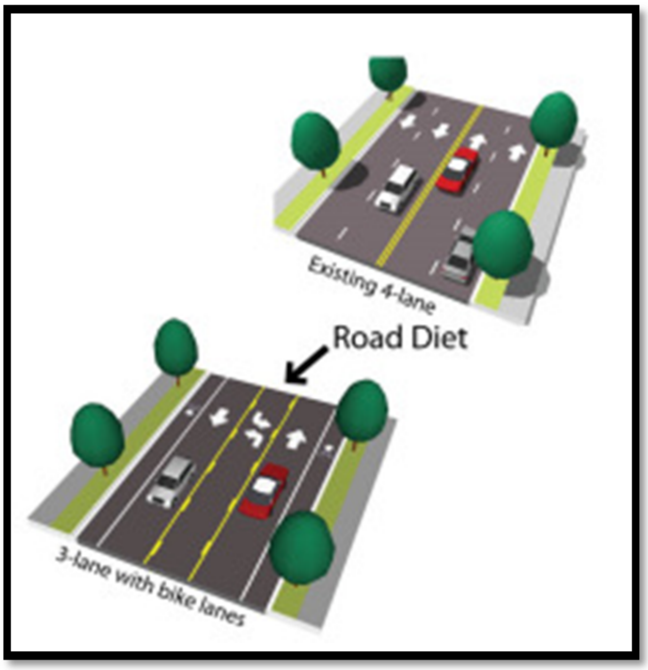
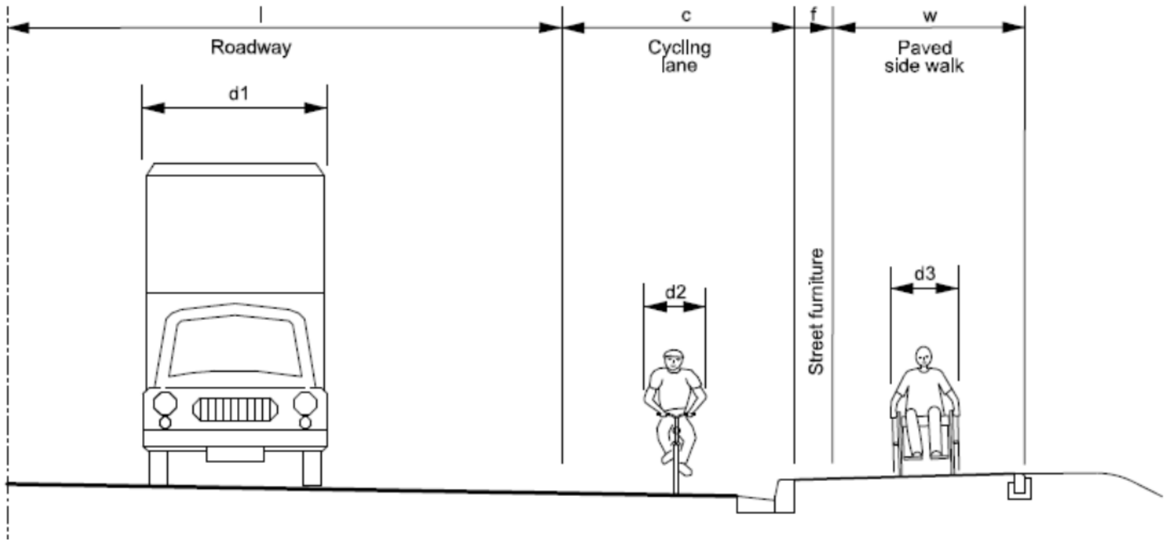


Figure 4-20: Road Diet Example

Linear tactile pavers are required if the sidewalk is too wide for people using walking canes, to assist people not to touch the kerb or building line.

Urban Distributors and Collectors (60 km/h)



Dimensions:

l = Min: 3,000 mm

c = 1,800 mm (Min: 1,500 mm)

f = 1,000 mm (COTO)

w = 1,800 mm (Min: 1,500 mm)

d1 = 2,500 mm (2,600 mm with mirrors)

d2 = 750 mm (900 mm with manoeuvring)

d3 = 700 mm (900 mm with manoeuvring)

b = 1,500 mm (min 1,200 mm)

Principles:

- Marked separation
- Traffic situation is less complex, so bicycles and motorised transport do not need a physical barrier.

Positive Aspects:

- Road reserve requirements are reduced.

Negative Aspects:

- Road safety risk increases if drivers are not disciplined.

4.6.5 Access Roads

According to COTO (2012), the design speed in urban local access roads is 40 km/h. Given that all design elements, of which the most important is sight distances, are influenced by the design speed, it is recommended to reduce the posted speed (maximum speed) to 40 km/h, legally allowing faster speeds than the design speed, can result in a road safety risk. Although the design speeds for rural roads are different, the same approach is suggested.

Figure 4-21: Access Road (Netherlands)

The design of an access road should focus on the creation of pedestrian and bicycle-friendly environments, keeping the overall aim of 'access for all' in mind. Careful planning of various design elements, including parking, is required.

Figure 4-22: Access Road (Miami)

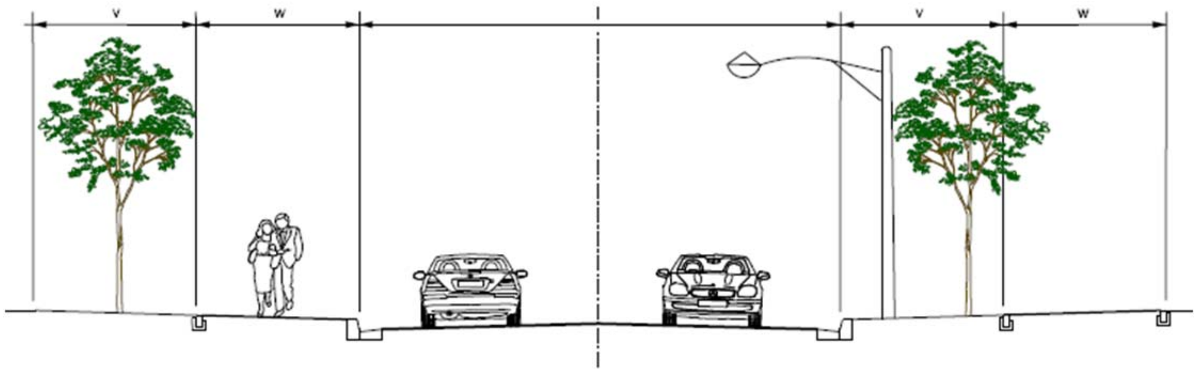
Financially, posting lower speed or changing legislation is more cost efficient than adding infrastructure, such as traffic calming.

In cases where speeds cannot be reduced, road marking is suggested for the implementation of safe bicycle facilities.

If walkways are wide and people using a walking cane cannot be guided by the building edge or the kerb, linear tactile pavers are required.

Figure 4-23: Access Road (Soshanguve, City of Tshwane)

Access Roads



Dimensions:

v = 1,000 mm

(combination of verge and furniture)

w = 1,800 mm (preferably more)

l = 5,500 mm (for both directions, including cyclists, trolleys, etc.)

Principles:

- Slow moving traffic
- Design speed is 40 km/h.
- Motorised and NMT (cycling) can be mixed.
- Pedestrians, cycling children, peoples with wheelchairs or prams are catered for on the walkway.

Positive Aspects:

- Limited road space required.
- Low speeds increase safety.

Negative Aspects:

- If speeds exceed the design speeds, unsafe environments might be created.

4.6.6 Bicycle Priority Streets

Bicycle priority streets in urban areas are used to maintain continuity of bicycle routes where this is not possible alongside collectors or arterials due to inadequate space at major intersections or the like.

In this event a short section of access road is designated and signed as a bicycle priority street and bicycles have right of way over motorised vehicles. The speed limit on the street is reduced to 25 km/h and motorists may not overtake bicycles.

While this concept is not yet accepted and legislated in South Africa, it is included here as an option to consider where it can be of use in maintaining continuity of a bicycle lane that would otherwise be very difficult and expensive to achieve.

Figure 4-24: Bicycle Priority Street (London)

4.7 Bridges and Underpasses

NMT bridges and underpasses provide much needed access and mobility for pedestrians, cyclists and other NMT users to cross highways, arterials and other busy roads. If designed and implemented correctly, bridges and underpasses become an important part of desire lines of the surrounding areas. If poorly designed, these facilities are rarely used and do not justify the cost of construction and maintenance.

It is important to consider issues surrounding bridges and underpasses in terms of social factors and human travel behaviour rather than just a facility that will connect areas. This will ensure that the facility that is built can be utilised safely and effectively.

The selection between a bridge and an underpass should be carefully considered, taking into account local context and the available resources. Having a facility that is appropriate to the local context is important in ensuring that the accessibility and mobility issue is resolved.

4.7.1 Principles of Bridge and Underpass Location and Design

Several issues regarding bridges and underpasses need to be addressed in order for them to be successfully implemented. The main concerns regarding bridges and underpasses include:

- Bridges and underpasses will be poorly utilised if users **do not feel safe or if the facility is ill-placed**. In areas with high volumes of NMT users, care should be taken to ensure that enough space is allocated to the different modes. This will ensure that when high volumes of pedestrians use the facility, other NMT users, such as cyclists, will not be impeded.
- Bridges and underpasses need to be **accessible to all types of users**, most notably to people with disabilities. Special care should be taken to ensure gradients of ramps meet the standards that are required for the safe usage of wheelchair users. Handrails, seating and sufficient resting space should also be considered and provided where appropriate. Tactile paving should be correctly installed so that the bridge or underpass does not become a barrier for the people who are partially sighted.
- **Placement of bridges and underpasses** should be as close to the current or potential desire lines as possible to ensure that users take the most preferable route that includes a safe crossing using the bridge or underpass. Special attention should be paid to areas that have large informal settlements next to busy highways. The behaviour of users that have recently moved to urban areas differs significantly from urban users. In order to prevent fatalities and injuries of these new urban dwellers, care should be taken to provide the most appropriate placement of bridges and underpasses (Behrens, 2005). Places of attraction should be taken into account when considering the location of the bridge or

underpass. Social factors that affect the way users walk in these areas should also be taken into consideration. These should be correctly identified by engaging with the surrounding communities and having sufficient stakeholder engagement processes in place.

- The **frequency of bridges and underpasses** should be sufficient to ensure that users do not travel excessively long distances to cross barriers. Due to the financial cost involved with bridges and underpasses, care should be taken to optimise the crossing potential for all users along the length of a particular barrier. This is especially true for informal settlements which are adjacent to highways and arterials.
- For bridges and underpasses that are multi-modal, care should be taken to prioritise NMT users above other road users to **ensure sufficient space and separation** from motorised transport modes. Due to the confined nature of these facilities, balance between ensuring the protection of users and catering to the needs of motorised vehicles has to be heavily tilted towards protecting the vulnerable users.
- In all areas, particularly in places with high levels of violent crimes, care should be taken to ensure that areas in and around bridges and underpasses have **sufficient lighting**. This will help users to feel safe when taking the bridge or underpass after dark. All underpasses should be tiled with white reflective tiles and provided with sufficient lighting to ensure safety and security.
- Another important aspect of making people feel safe while using bridges or underpasses is to ensure that there is **good visibility before the user enters them** while using it and exiting the bridge or underpass. Whenever possible, wide splays and clear lines of sight should be created around bridges and underpasses. This creates an urban facility that has an increased number of “eyes on the street” which will raise the level of perceived safety for the users.
- While bridges are often perceived as preferable to underpasses in view of better visibility, the NMT surface will be located between 6 m and 7 m above the road which means a **considerable change in elevation that must be achieved at 1:20 gradient if universal access is provided.** In contrast, the NMT surface of an underpass only needs be located around 3 m below the road surface which means a considerable saving to achieve the required grade separation.

4.7.2 Bridges

Bridges can be used to provide safe crossing facilities when at-grade crossing is forbidden or deemed too dangerous.

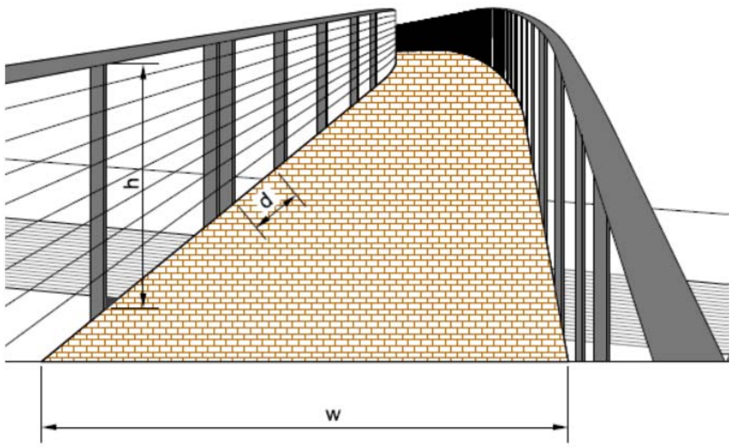
A serious concern regarding bridges is the total metres that need to be overcome while 'climbing' a bridge. In urban areas, the distance is typically 5 m. NMT bridges on highways, typically add a meter, i.e have a 6 m height difference that needs to be overcome.

From a bicycle and universal design perspective, the described height distances are considered vast. Even if the people in the picture (See **Figure 4-26**) are happily riding on the bridge, children and the elderly often struggle with these height differences. The approach slopes need to also have acceptable gradients to be universally accessible.

Figure 4-25: Bicycle Lane Under Bridge (Salzburg)

Figure 4-26: NMT Bridge (Lelystad)

Bridge Design



Dimensions:

w = 2,000 mm

h = railing height

Source:

COTO, 2012

Principles:

- Grade separation
- Width needs to accommodate at least two persons with wheelchairs/prams passing.
- Cyclists will also need to use these facilities.

Positive Aspects:

- Safety for all modes of transport is guaranteed.

Negative Aspects:

- Construction is expensive.
- Security can become an issue.
- People need to be encouraged to use the facilities; otherwise, it will only create a road safety burden if these facilities are in an inconvenient location.

4.7.3 Underpasses

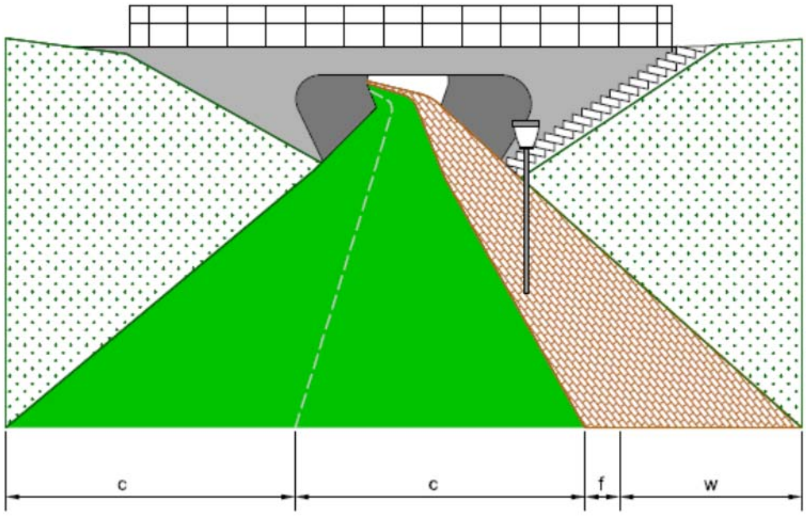
Underpasses are a further design element that can create the road safety that is required on high volume and speed roads.

The clearance required in underpasses is 2.5 m, so the approach slopes will be less than those for bridges. In **Figure 4-28**, the motorised transport road is raised by 1 m, leaving only a 1.5 m height difference for NMT. This height difference is easy to overcome by cyclists with all capabilities and ages. Furthermore, people in wheelchairs also can use these facilities with ease.

Figure 4-27: Wide, Well-Lit Underpass (Seoul)

Figure 4-28: NMT Underpass (Lelystad)

Underpass Design



Dimensions:

c + c = 2,500 mm (Rec: 3500; COTO)

f = Min:1,000 mm (COTO)

w = 1,800 mm

Clearance height = 2,500 mm

Gradient: Min = 1:15

Preferred = 1:20

Source:

COTO, 2012

Principles:

- Grade separation
- Underpass elements need to support good sight vision.
- Width needs to accommodate two persons with wheelchairs/prams passing.

Positive Aspects:

- Safety for all modes of transport is guaranteed.

Negative Aspects:

- Construction is expensive.
- Security can become an issue.

4.8.1 NMT River Bridges in Rural Areas

The use of narrow road bridges on high speed rural roads by pedestrians without a proper barrier as specified in bridge design manuals is unacceptable and must either be remedied through widening and the addition of a pedestrian walkway or through the construction of a separate NMT bridge.

Figure 4-29: Suspension Bridge Across the Esiphongweni River in KZN

Furthermore, in rural areas, full rivers often hinder learners from accessing schools and many rural communities are cut off from basic socio-economic facilities and jobs. Deliberate efforts have been introduced through the Integrated Rural Mobility and Access (IRMA) programme of the Department of Transport to link learners, and rural communities in general, to schools and other community services during the rainy season.

A number of options are available to safeguard rural persons across road bridges and rivers as shown in **Figure 4-29.**

Figure 4-30: Wading through Rivers due to Lack of Bridges

Road Bridges and Separate NMT Bridge Structures on Roads

Example of a separate NMT bridge structure next to the roadway

Dimensions:

Min width: 2 m

Min handrail height: 1 m with vertical styles at min 100 mm spacing

Principles:

Adjacent to Roads

- Approaches to the NMT bridge structure must be the same width as the bridge structure and flush with the sidewalk.
- Danger plates should be displayed on the road way for vehicular traffic on both approaches to the structure.

General

- Ramped access with gradient not more than 1:20 is required to make these bridges accessible for all users.
- Pedestrians and cyclists are sensitive to movement and deflection of suspension bridge structures. The design of the structure should therefore limit the amount of deflection under a live load.
- Entrances of these bridges must be designed to prevent animals or motorcycles from entering the bridge structure.

4.9 Intersection Design

The needs of all road user groups should be considered and balanced when planning and designing road intersections, including those of pedestrians and cyclists.

According to the National Road Traffic Regulations (2000), a legal pedestrian crossing exists at all road intersections, whether they are marked or not. Pedestrians have priority at such crossings (except when they are specifically prohibited from crossing, and subject to some conditions), and drivers must yield to pedestrians, whether the crossing is marked or not.

Appropriate link and intersection design will contribute towards the reduction of road crashes, resulting in less fatalities and/or injuries. However, given the needs for road users to cross roads and intersections, there will always be conflicts between different road users (See **Figure 4-31**). These conflicts need to be managed. At signalised intersections, this management can happen by a separate pedestrian (and other NMT users) phase. At intersections without signalisation, roundabouts can be considered, as they reduce conflict points. However, these benefits might be jeopardised by NMT users crossing to the centre island as a shortcut.

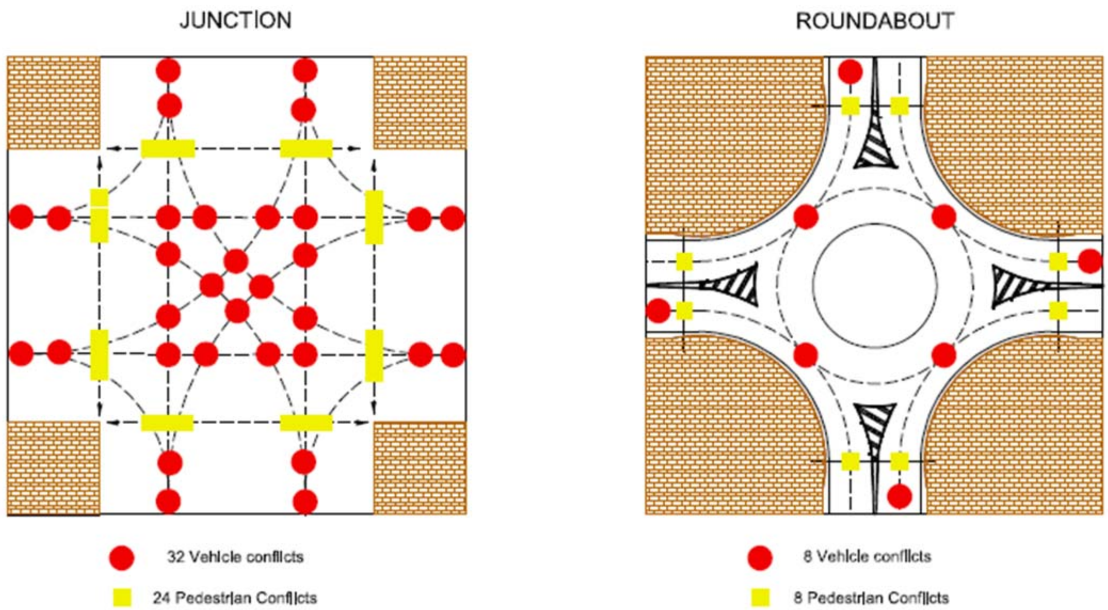


Figure 4-31: Conflict Points

4.10 Pedestrian Crossing Facilities

Pedestrian crossings should be located within a natural path of travel, and wide enough to accommodate the number of people using the facility. Crossings should be located on the desire lines that would serve the majority of pedestrians.

Pedestrian crossings should not be located so near to other midblock crossings or road intersections that drivers do not have sufficient time to react to the presence of pedestrians. Drivers may need as much as 2.5 seconds to perceive and react to hazards and dangers. Many drivers compound problems for themselves by driving at speeds that are too fast for built-up areas. This can be a problem for freight vehicles. Designs to limit speeds in areas with high densities are therefore extremely important, as well as other means of speed restriction enforcement.

The separation distances given in **Table 4-5** should be provided between pedestrian crossings and other important elements of the road network that can distract the attention of the driver. These include elements such as other midblock crossings, road intersections, merge areas, bus and mini-bus stops, and the like.

Table 4-5: Minimum Distances Between Crossings/Road Elements

Operating Speed or Speed Limit (km/h)	Separation Distance (m)
20	15
30	20
40	30
50	35
60	45

Source: DOT, 2003

Having smaller radii, rather than larger ones, at intersections is better from a pedestrian view as these cut sight distances and force drivers to navigate corners at reduced speeds.

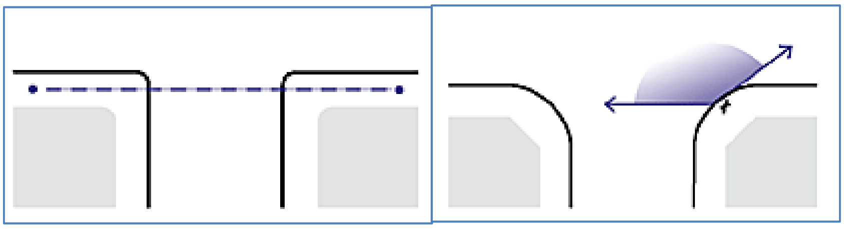


Figure 4-32: Tight Radii Limits Desire Lines and Sight Distances
Source: Deven Country Council

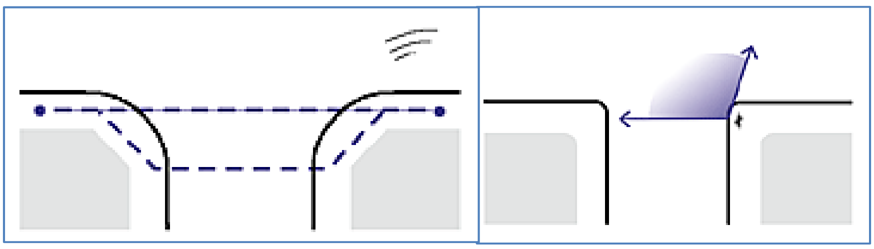
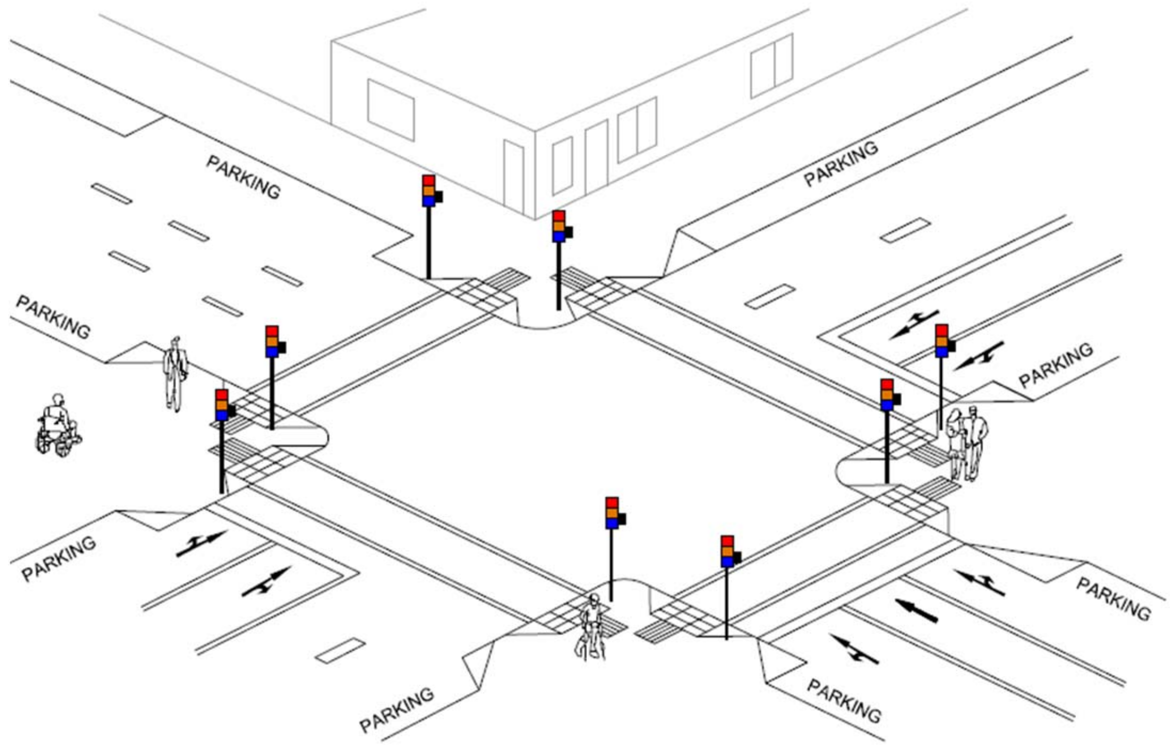


Figure 4-33: Large Radii Increases Desire Lines and Sight Distances
Source: Deven Country Council

Pedestrian Facilities for Controlled Intersections



Dimensions:

- Depending on local situation
- Kerb and tactile paving dimensions provided in **Chapter 5**

Principles:

- Tactile paving must be laid at controlled and uncontrolled crossing points.
- At all pedestrian crossings, the tactile surface must be laid in line with the angle of crossing.
- Where the footway is so narrow that a 1:12 gradient is not possible, an alternative route should be identified, or the full width of the footway should be lowered and 1:12 ramps be installed stretching along the footway.

Principles (continued):

- Care must be given during the implementation stages, and the manner and methodology in which kerb ramps are constructed on site.
- Tactile tails are provided on the side of the signal push button.
- Linear tactile pavers are required if the sidewalk is too wide for people using a walking cane, to tough the kerb or building line.
- The application of grates needs to be avoided at places where drop kerbs are implemented.

Source: **GIBB, 2010**

4.10.1 Pedestrian Facilities at Controlled Midblock Crossing

Midblock crossings are applied on roads with high volumes or speeds of motorised transport to reduce the road safety risk for NMT. Enough holding space should be provided for NMT users. Preferably, the midblock island is constructed in such a way that the kerbs are only required at the sidewalks. People using wheelchairs do not face any further obstacles, once they are at street level. Rows of tactile bubble paving are recommended for the whole area. This implementation is possible for controlled and uncontrolled intersections. Detailed designs for drop kerbs can be found in **Chapter 5**.

Figure 4-34: Tactile Paving at Dropped Midblock Facility
Picture courtesy of GIBB

When NMT demand is high, it is not possible to implement this user friendly option and staggered midblock crossings are required. A design of a midblock crossing is provided on the next page.

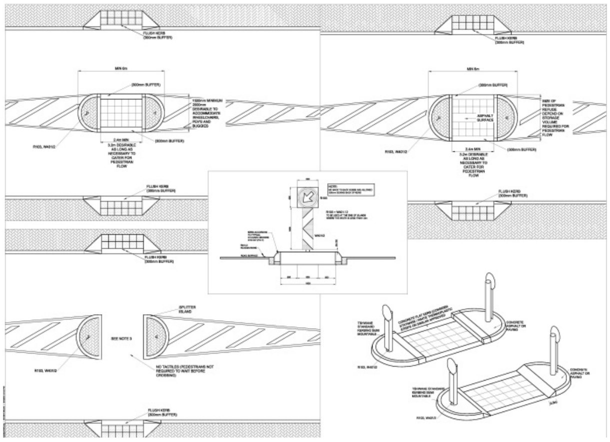
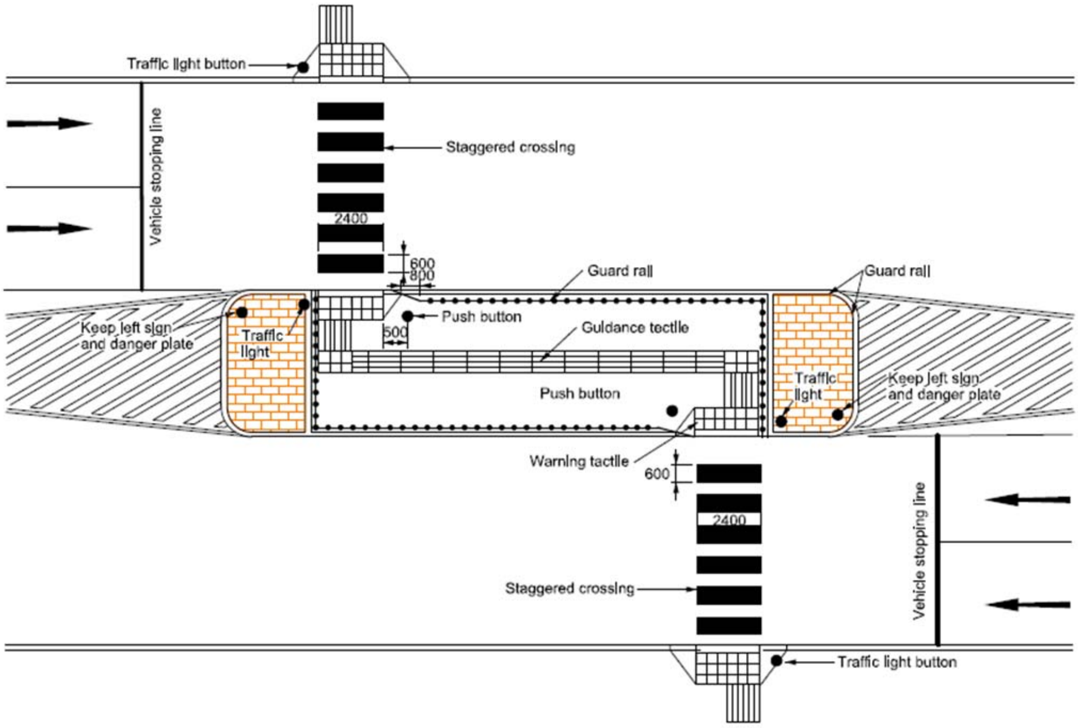


Figure 4-35: Midblock Crossing Detail
Picture courtesy of GIBB

Pedestrian Facilities for Controlled Midblock Crossing



Dimensions:

- Depending on local situation
- Kerb and tactile paving dimensions provided in **Chapter 5**
- Landing of 1,5m needs to be provided

Principles:

- Staggered crossing layout does not follow pedestrian desire lines and should only be implemented if a substantial safety risk is detected.
- At all pedestrian crossings, the tactile surface must be laid in line with the angle of crossing
- Where the footway is so narrow that a 1:12 gradient is not possible, an alternative route should be identified, or the full width of the footway should be lowered and 1:12 ramps be installed stretching along the footway.

Principles (continued):

- Care must be given during the implementation stages, and the manner and methodology in which kerb ramps are constructed on site.
- Tactile tails are provided on the side of the signal push button.
- Linear tactile pavers are required if the sidewalk is too wide for people using a walking cane, to tough the kerb or building line.
- The application of grates needs to be avoided at places where drop kerbs are implemented.

Negative Aspects:

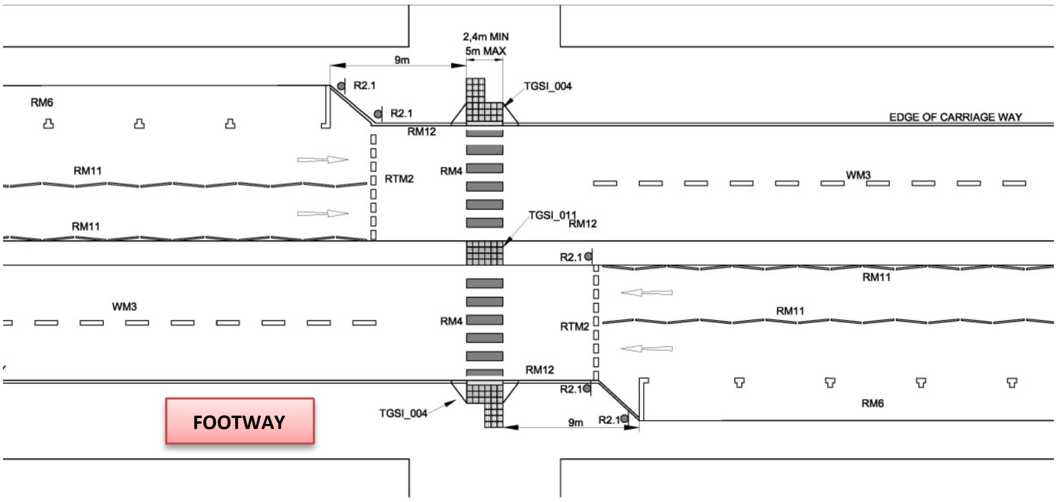
- Staggered crossing adds inconvenience to NMT users.

Source: **GIBB, 2010**

4.10.1 Pedestrian Facilities at Uncontrolled Intersections

At uncontrolled intersections it is of utmost importance that corner radii are kept to a minimum, as to reduce the speed of the cars. Drop kerb and tactile paving are to be installed differently at uncontrolled intersections. Tactile paving is also recommended. The tail of the tactile paving, using linear pavers, is placed in the corner that coincides with the direction of oncoming motorised transport.

Midblock Crossing (Yield Controlled)



YIELD-CONTROLLED MIDBLOCK CROSSING - PARKING ALLOWED WITH EXTENDED SIDEWALK

Dimensions:

As provided in drawing

Effectiveness:

Unknown

Principles:

The application of grates needs to be avoided at places where drop kerbs are implemented.

Positive Aspects:

- Safe for pedestrians

Negative Aspects:

- Inexperienced drivers can be a danger to cyclists. Painted bicycle path is therefore required.

Source: **GIBB, 2010**

4.11 Bicycle Crossing Facilities

4.11.1 Bicycle Facilities at Controlled Intersections

Traffic becomes complex when entering an intersection. Due to the complexity experienced, NMT users are quite vulnerable when approaching intersections.

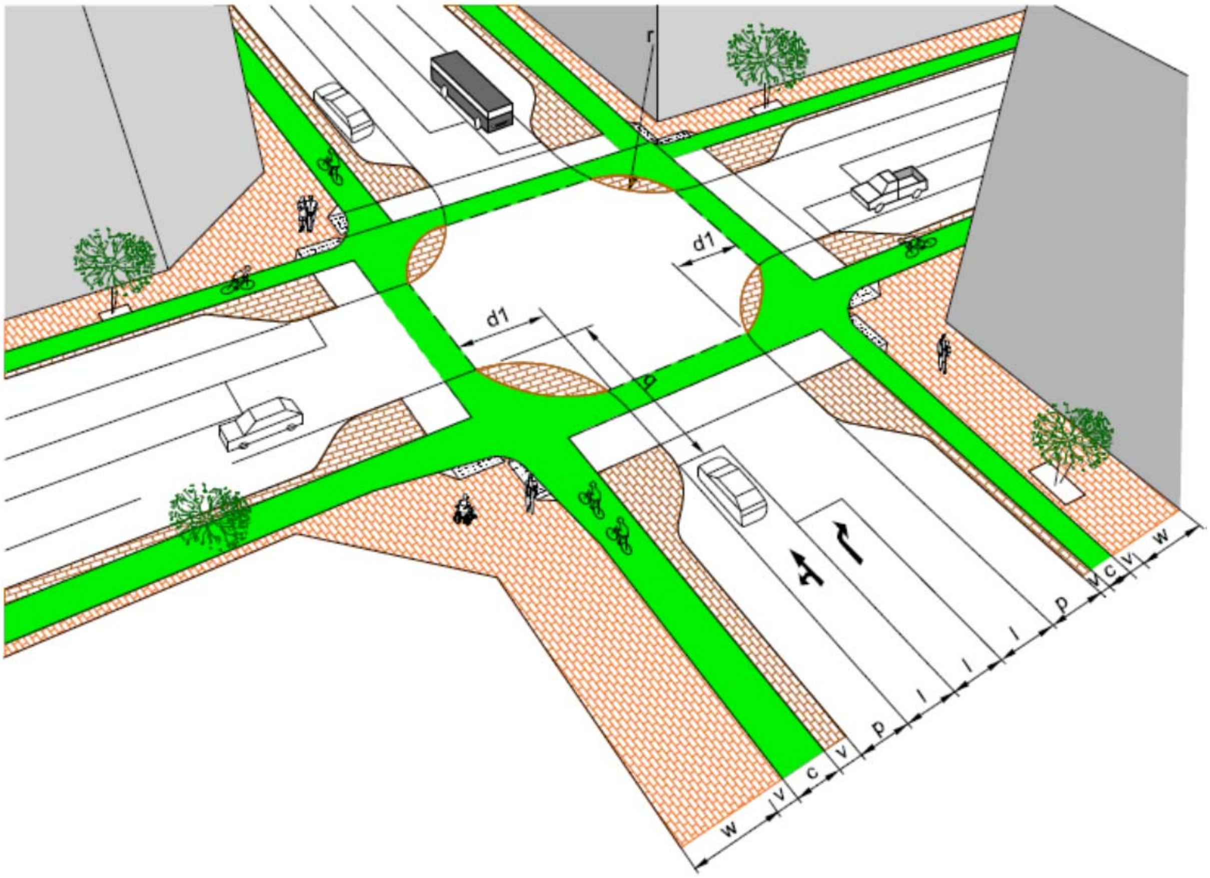
As indicated, intersections have many conflict points, i.e. places where road users with different desire lines intersect. Currently the low number of cyclists does not remind motorised road users to 'watch out for them', therefore special infrastructure measures are required.

At high speed and volume roads, total separation is required. An example of an intersection of two high speed, high volume road intersections is given on the next page.

A single carriageway is sufficient for motorised transport. A so-called advanced stop line (or 'bike box') can be installed.

As indicated, cyclists are especially vulnerable on South Africa's roads. Painted lanes or dyed bitumen are used internationally to emphasise the fact that cyclists use an intersection (or lane).

Intersection with More Than Two Lanes



Dimensions:

w = 1,800 mm

v = 300 mm

c = 1,800 mm (Min: 1,500 mm)

p = Min: 2,000 mm

l = Min: 3,000 mm

d1 = 6,000 mm

Principles:

- d1 is based on 1 car length and creates improved sight vision.
- If buses or a lot of heavy vehicles turning at this intersection, d1 needs to be 12,000 mm.
- It is recommended to have a separate NMT signal phase.

Positive Aspects:

- NMT is protected.

Negative Aspects:

- Road reserve needs to be large enough to accommodate all modes.

Once motor vehicles catch up to the cyclists' holding area, space is created to turn the vehicle and improve sight vision. Warning signs or lines minimise conflicts between pedestrians and cyclists.

On smaller roads, with less traffic but with motor vehicles able to drive at still relatively high speeds, it is recommended to create an advanced stop line (or 'bike box'). At controlled intersections, a bike box is highly recommended. It is possible to create bike boxes that cover more than 1 lane. All cyclists should approach the bike box via the special lane created on the left hand side.

Although internationally the approach to the bike box, e.g. for turning cyclists, is sometimes adjacent to the turning lane for motorised transport, this is not supported in the South African context.

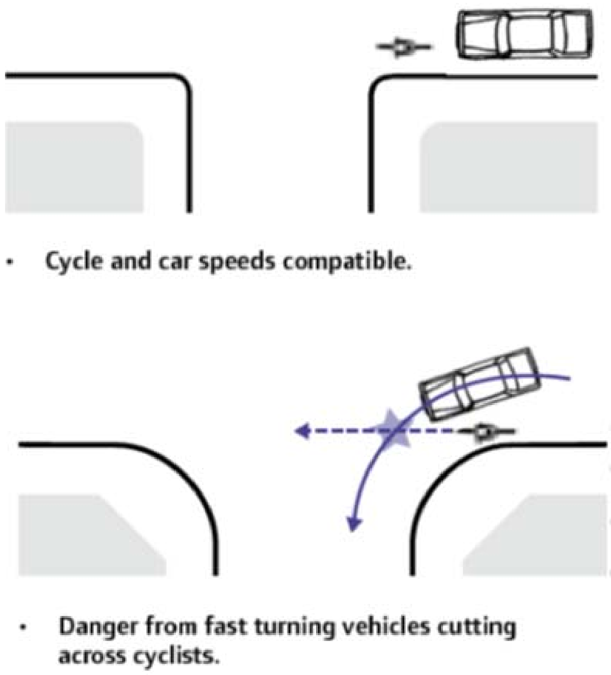
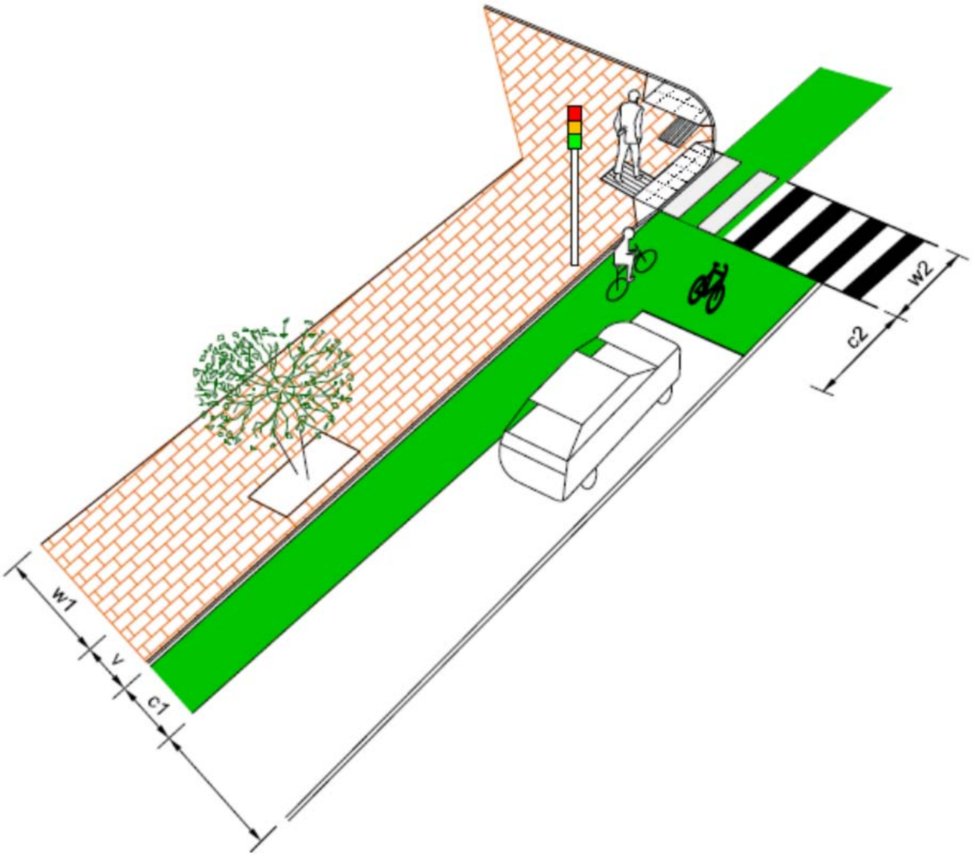


Figure 4-36: Radii Creates Safety Risk
Source: Devon Country Council

Linear tactile pavers are required if the sidewalk is too wide for people using a walking cane, to tough the kerb or building line.

The application of grates needs to be avoided at places where drop kerbs are implemented.

Bike Box



Dimensions:

w1 = 1,800 mm (Min: 1,500 mm)

v = 300 mm

c1 = 1,800 mm (Min: 1,500 mm; 900 mm is acceptable for short distances)

c2 = 2,500 mm (includes some manoeuvring space)

Principles:

- Bicycle waits in front of motorised traffic.
- Cyclist is less exposed to pollution.
- Cyclist accelerates faster, so motorised traffic is not inconvenienced.

Positive Aspects:

- Improves road safety and livability for cyclist

Negative Aspects:

- Inexperienced drivers can be a danger to cyclist-painted bicycle path is therefore required,
- 900 mm does not provide overtaking opportunities for cyclists,

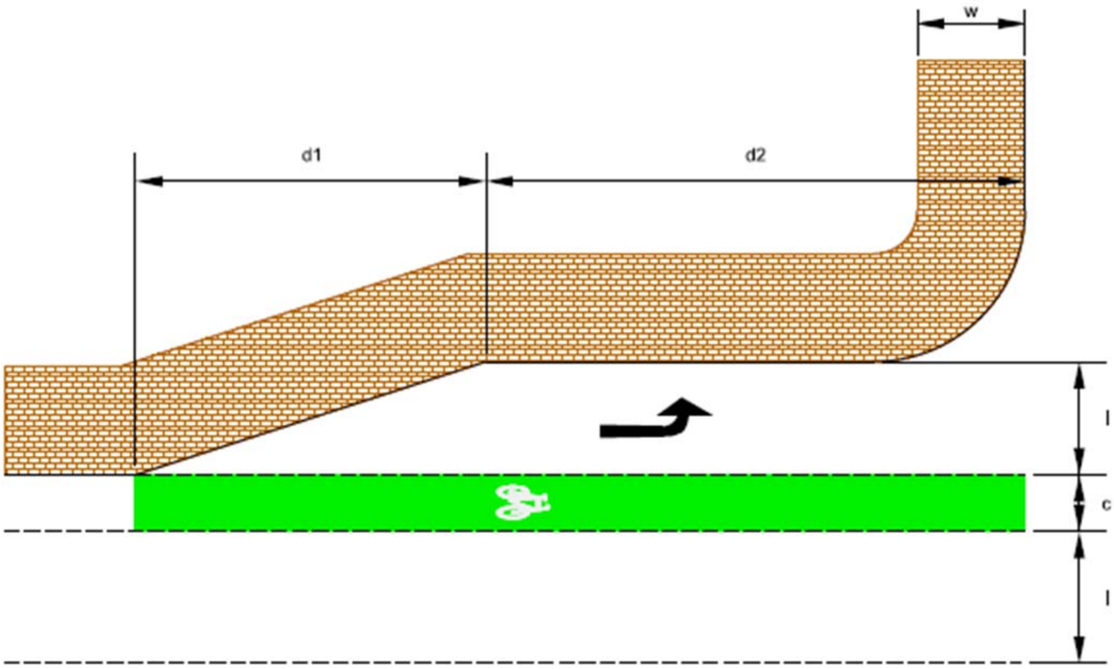
4.11.2 Bicycle Facilities at Uncontrolled intersections

A bike box could be considered at uncontrolled intersections. However, this is not normally required due to motorised traffic volumes and speeds, as well as NMT volumes and speeds.

If a bicycle facility is provided on the same level as the carriageway, the intersection design needs to provide a continuation of the facility. An option is provided on the next page. Implementing these options needs to be assisted by signage to warn turning drivers that cyclists have ‘right of way’.

Turning cyclists can bike on the left hand side of the turning lane. No conflicts should occur, so painted or dyed infrastructure is not required.

Accommodating Large Numbers of Through Cyclists



Dimensions:

w = 2,000 mm - 3, 000mm

l = 3,000 mm (3,400 mm if accommodating turning cyclists)

c = 1,800 mm ((Min: 1,500 mm; 900 mm is acceptable for short distances)

d1 = accommodate comfortable turn

d2 = depending on turning volume

Principles:

- Turning motorised traffic gives way to cyclist

Positive Aspects:

- Cyclist is not required to detour or make difficult manoeuvres.

Negative Aspects:

- Inexperienced drivers can be a danger to cyclists. Painted bicycle path is therefore required.
- 900 mm does not provide overtaking opportunities for cyclists.

4.11.1 Bicycle Priority Intersection

In the case of an NMT-only facility, intersections might still occur. In this case, however, NMT should receive priority.

The whole intersection is raised. Drop kerbs are, therefore, not required. The infrastructure is extremely comfortable for all NMT users, including people in a wheelchair, pushing a pram or trolley, etc. Pedestrians and cyclists have right of way.

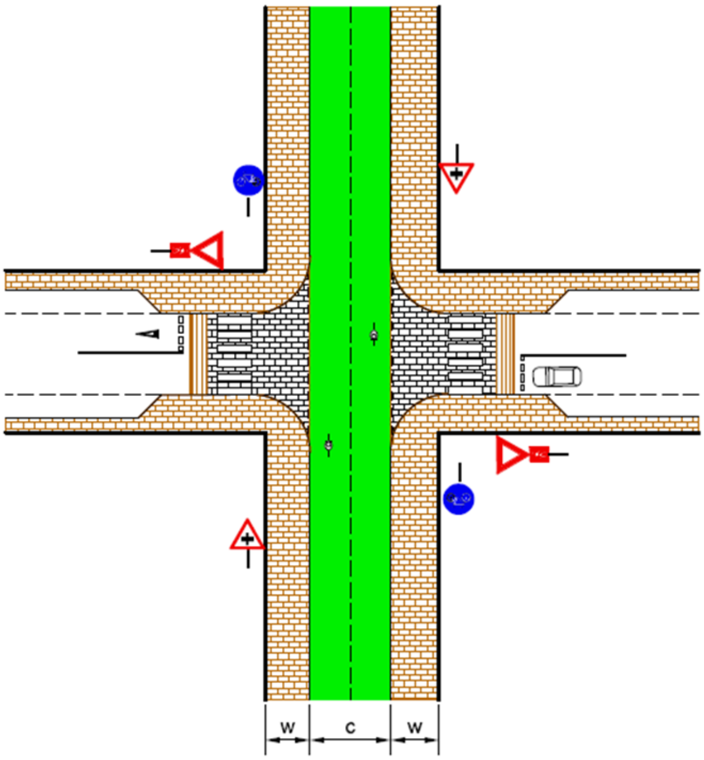
Linear tactile pavers are required if the sidewalk is too wide for people using a walking cane, so that they do not touch the kerb or building line.

Figure 4-37: Raised Bicycle Priority Intersection (Lelystad)

Picture by Marianne Vanderschuren

Drop kerbs are required, depending on pedestrian desire lines. Linear tactile pavers are required if the sidewalk is too wide for people using a walking cane, to tough the kerb or building line.

Bicycle Priority Crossing



Dimensions:

w = 1,800 mm (Min: 1,500 mm)

c = 2,500 mm (preferably more)

Principles:

- NMT has right of way; motorised transport yields).
- Cycling infrastructure should cater for long distances.
- Raised pedestrian crossings, and TGSI's should be used leading to the crossings

Positive Aspects:

- Promotes road safety
- Cyclists can achieve high speeds

Negative Aspects:

- Inexperienced drivers can be a danger to cyclist. Painted bicycle lane is, therefore, required.

4.12 Railway Crossing Facilities

Intersections with railway come with a safety risk for motorised transport, as well as NMT. Trains have right of way at any intersection and given the high speeds that trains travel at, sight distances for other road users are often not sufficient, and physically impossible to create

Figure 4-38: Warning at Rail Crossing

Source: Utah DOT, 2013

Railway crossings can be controlled and uncontrolled. Given the vast amount of accidents, controlled intersections or grade separation are recommended.

Internationally, offset crossings are applied. Again, given the safety risk in the South African context, such facilities are NOT recommended. A 90-degree crossing is the only recommended railway intersection.

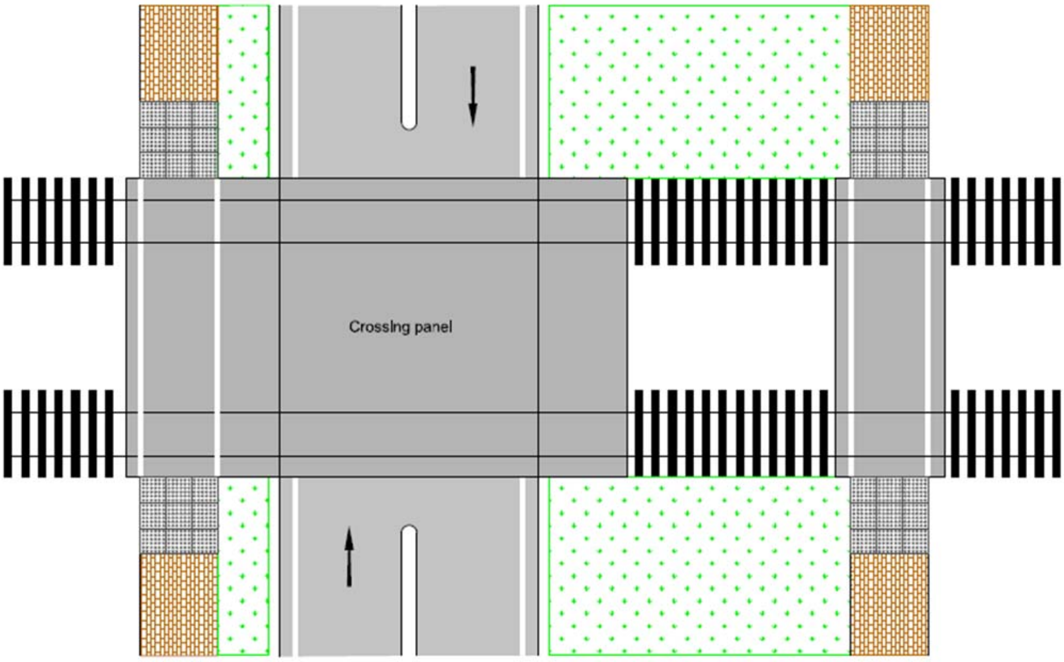
NMT railway crossings can be combined adjacent to the motorised transport carriageways on one, but preferably two sides, or exclusively for NMT users. An example of both options is included. Design principles can be found too.

If non-controlled NMT railway crossings are implemented, warning signs need to be added. **Figure 4-38** provides a Utah example of painted STOP signage on the road surface.

Tactile crossing delineation is required at controlled and uncontrolled railway crossings. It is also important to have a clear path in order to efficiently navigate an at-grade rail crossing. People with vision impairments should not have to make decisions as to the appropriate direction of travel after entering an at-grade rail crossing.

Figure 4-39: Example of Delineation Requirements

Railway Crossing Facilities

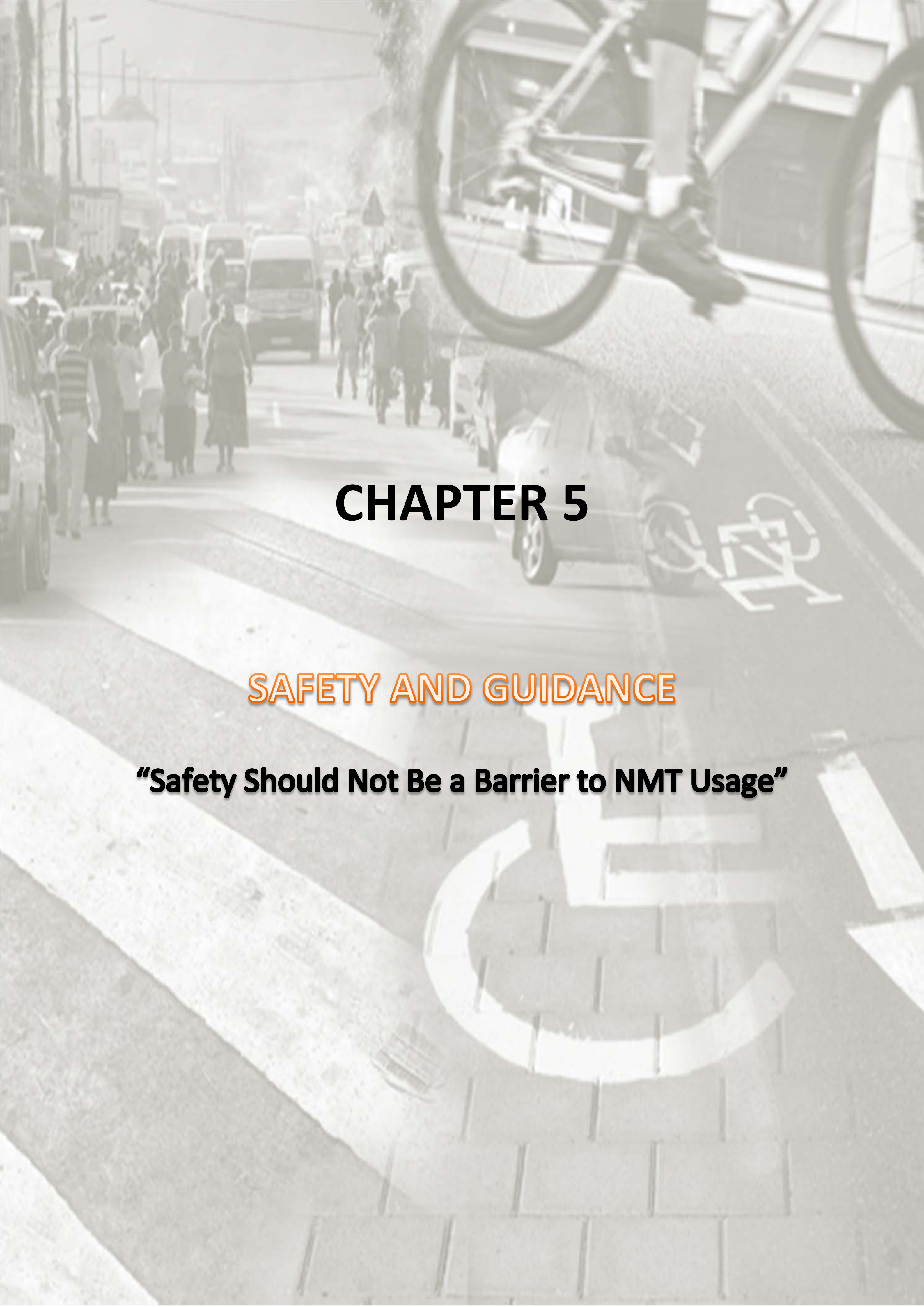


Dimensions:

Depending on the local situation. All principles of minimum widths, demand planning etc. are valid for railway crossings

Principles:

- Train always has right of way.
- Controlled intersections are preferred.
- Booms are required.
- At high demands, grate separation should be considered.
- Only stiff materials that are not influenced by weather conditions should be used at and adjacent to the railway track.



CHAPTER 5

SAFETY AND GUIDANCE

"Safety Should Not Be a Barrier to NMT Usage"

5. SAFETY AND GUIDANCE

5.1 Signage

The South African Road Traffic Signs Manual (SARTSM) provides a range of signs that are suitable for use with NMT facilities. However the SARTSM does not cater for all eventualities and additional signs and road markings that need to be considered to ensure that NMT facilities are safe and user-friendly.

In addition to the types of signs shown in the adjacent figure, the SARTSM also provides for guidance signs for directions to facilities.

The designer can use the SARTSM guidelines and names and numbers provided for facilities to direct NMT users to the appropriate facilities.

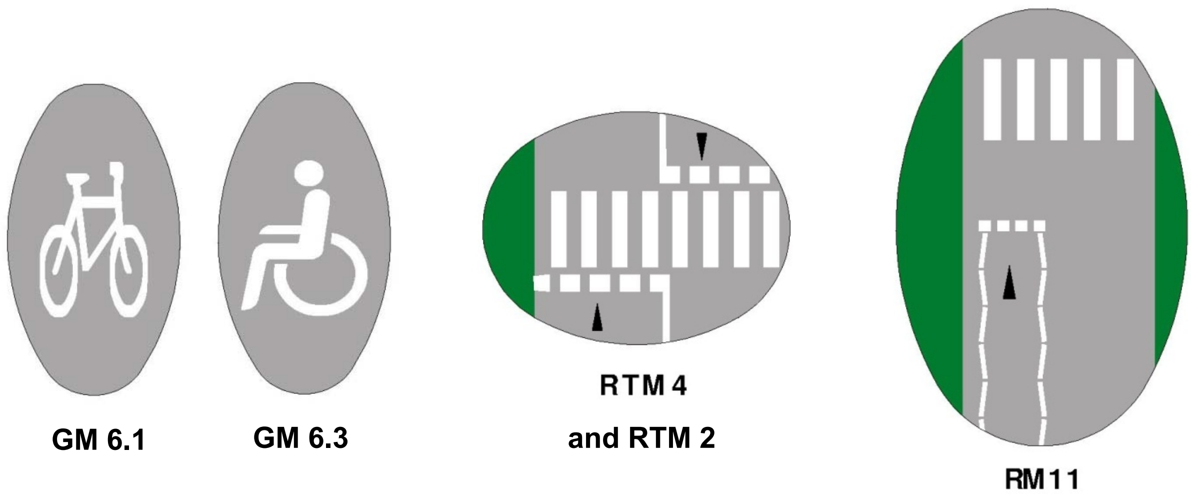
Note that the SARTSM provides many examples of layouts and use of signs such as shown below and these should be used to guide sign and road marking placement. However, some of the pedestrian crossings layouts are outdated and the manual should mostly be used for road marking guidance only.

Warning Signs – Provide warning of pedestrian and bicycle movements

(Reference: SA Road Traffic Signs Manual)

Regulatory Signs – Control the use of NMT facilities and gives priority to NMT

Road Markings – Pedestrian crossings and lanes



Dimensions:

As per SARTSM

Principles:

- Signs to be used as directed by SARTSM.
- Ensure motorist receives fair warning of NMT movements.
- Signs for pedestrians includes all pedestrians, including people in wheelchairs or pram users etc.

5.2 Road Markings

Road markings should provide a clear and unambiguous indication to NMT users and motorists as to their lanes and rights. The following set of road markings are used with NMT facilities placed on roadways:

Table 5-1: Line Markings for NMT

Line Code	Description	Line Width	Line Length	Gap Length
RM 9	Exclusive Use Lane	150 mm	750 mm	750 mm
RTM 2	Yield Line	300 mm	600 mm	300 mm
RTM 4	Pedestrian Crossing	2,400 mm	600 mm	600 mm
GM 5	Bicycle Crossing	300 mm	300 mm	900 mm
RTM 11	Zig-Zag Zone	100 mm	2,000 mm	150 mm

The lines should be used together with the GM6.1 markings as appropriate to demarcate bicycle lanes.

Where the bicycle lane approaches a busy intersection or where a "bike box" is created, the bicycle lane should be painted green to improve motorist awareness,

Figure 5-1: RTM 9 Lines Delineating Bicycle Lane

Where bicycle lanes are placed on sidewalks or on dedicated NMT facilities the normal RM1, 100 mm wide solid no overtaking line can be used to demarcate the lane.

Neon marking would need to be put on the pole.

Figure 5-2: RM 1 Line Marking Highlighting Obstruction

5.3 Way Finding

Information for transport system users can be communicated in numerous ways. It is possible to provide simple printed maps and timetables, static directional signage, variable message signs that update in real-time, internet websites, or oral instructions. It can even be argued that aspects of physical infrastructure, e.g. tactile paving, can be classified as part of the information provision system that aids the understanding and usage of the transport network. Aids to wayfinding can include elements of urban form (street grids, public squares, etc.)and architecture (landmark structures, internal building circulation routes, etc.) (Williams, 2006) and the usage of the built environment.

Table 5-2: Type of Information Aids

The Transit Cooperative Research Program (TCRP, 1999) identifies what is and what is not provided when using various information systems.

Information Aid	What They Provide	What They Don't Provide
Oral instructions **(Telephone information, bus operator, garage petrol attendant, other passengers)**	• Straight-forward and personalised information • Simplicity for new users and those who have difficulty reading maps	• An overall picture of the transport system • Reference material for future or continued travel • Flexibility or easy error correction; if a user misses a step in the process; his or her frame of reference is lost unless he or she can converse further with the information source
Map System or Locality Maps	• "Bird's-eye" view of the transport system, routes and connections • Flexibility for changing trips plans supportive information during a trip • "Portable" information, useful for pre-trip and in transit	• Instant accessibility. Not only is the map a physical object that a potential user must obtain before trip planning can begin, but map reading presents difficulties for many people.
Signs at Destinations and at Locations	• Information at "decision points" along the route • Supportive information	• Detailed information and explanations • Portable information. No help during pre-trip or on-board planning.

Source: Adapted from TCRP, 1999

The examples of the '*Type of Aids*' provided in **Table 5-2** are for public transport users (Based on TCRP, 1999). However, the information is seen as relevant, as all public transport users, in part, are also NMT users.

Figure 5-3 gives a summary of good examples of how signage should be, especially for people who are partially sighted.

Good Examples

Note: Yellow-on-Black pictogram should be larger

Figure 5-3: Colour Choices for Pictograms and NMT Road Signs

5.4 Lighting

Well-lit walkways and bicycle lanes are crucial for safety and visual comfort for pedestrians and cyclists. In some cases “spill” light from adjacent streets or roadways is sufficient for walkways and bicycle lanes. If this spill light does not supply the recommended average maintained illuminance levels to allow visual identification of other pedestrians, cyclists or objects, revisions or additions to the roadway lighting will be required. This identification task is dependent largely on proper vertical surface illumination to model faces and objects.

5.5 Personal Security

For walkways and bicycle lanes that pass through parks, it is recommended that the area bordering the way on each side be lighted to a luminance level of at least one third the level suggested for the way itself. Minimising shadows in marginal areas makes it difficult for potential criminals to hide.

5.6 Traffic Calming

Table 5-3 provides an overview of the applicability of traffic calming facilities on highways, mobility spines and access roads.

Table 5-3: Traffic Calming Types, Application and Impacts

Type	Application			Impacts	
	Highway	Mobility Spine	Access Road	Impact on Traffic Volumes	Impact on Vehicle Speed Reduction
Grade separation	√	√	-	Possible	Yes
Speed hump/table	-	-	√	Possible	Yes
Raised crosswalk	-	With caution	√	Possible	Yes
Raised intersection	-	With caution	√	Possible	Yes
Textured pavements	-	√	√	Possible	Yes
Rumble strips	√	√	√	No	Yes
Traffic (mini) circle	-	-	√	Possible	Yes
Roundabout	-	√	-	Not likely	Yes
Chicanes	-	-	√	Yes	Yes
Realigned intersection	-	√	√	Possible	Yes
Tight radii	-	√	√	Possible	Yes
Neckdowns	-	√	√	Possible	Yes
Centre island narrowing	-	√	√	Possible	Yes
Chokers	-	√	√	Possible	Yes
‘Road diets’	-	√	√	Yes	Yes
Bicycle lanes	-	√	√	Possible	Possible
Speed limits	√	√	√	Yes	Yes
Perceptual design	With caution	√	√	Possible	Yes
Full closure	-	-	√	Yes	Yes
Half closure	-	√	√	Yes	Possible
Diagonal diverters	-	√	√	Yes	Possible
Lateral shift	-	√	√	No	Yes
Median barriers	√	√	-	Yes	Yes

Various options can be used to assist with reducing vehicle speed. Some of these options and their effects are shown in **Table 5-4**.

Table 5-4: Measures to Reduce Speed

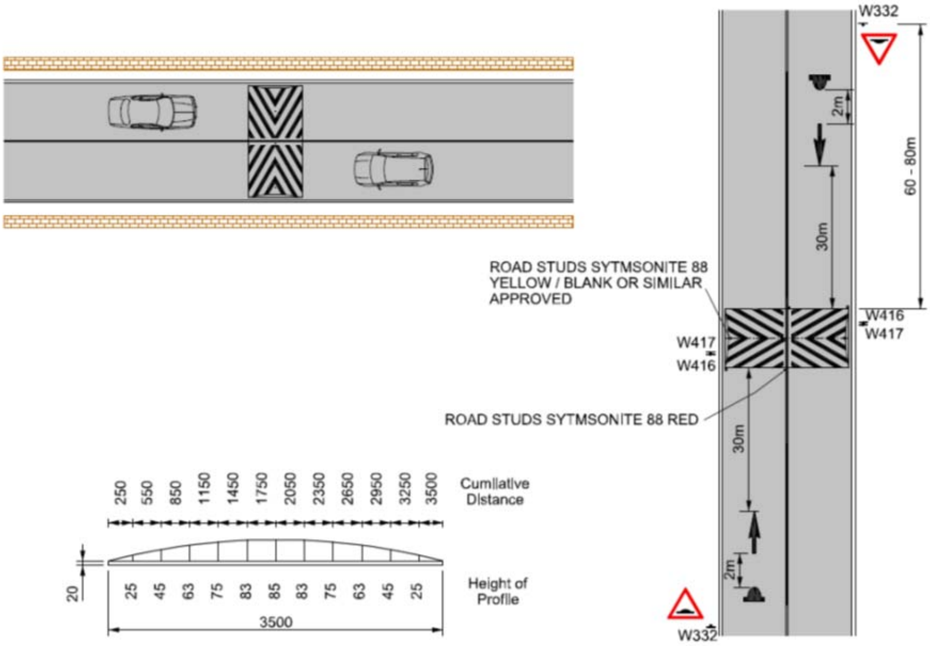
Speed Reduction Measures	Comments
Lower speed limits, 30 km/h zones, school zones	Encourage drivers to reduce their speed, thus making conditions more comfortable for other road users. Should be enforced to be effective.
Reallocating road space to NMT users	Can be achieved by reducing the width of the motor vehicle lane to create room for NMT lanes.
Low radius corners and narrower carriageways	Can reduce speeds and are often appropriate on residential access roads where flows are light.
On-street parking bays	Groups of parking bays at intervals on alternating sides of the road can create an indirect carriageway alignment to reduce speed.
Remarking the road to encourage lower speeds	Includes changing the road to make it appear narrower or removing the centre line marking. The latter needs to be carefully assessed, as it is not appropriate for all roads.
Textured surfaces	Block paving can reduce traffic speeds and generally is acceptable for NMT use. Cobbled surfaces are less suitable for NMT users.
Physical traffic calming features such as speed humps or cushions, build-outs and other road narrowings	While any reduction in motor vehicle speeds is welcome, physical traffic calming measures should be properly designed and universally accessible.

Source: Welsh Department of Transport Cycling Facilities Design, 2008

5.6.1 Speed Humps

The role of speed humps is to reduce speed, although it can have an effect on motorised traffic volumes. In area where bicycle volumes are high, the design needs to be comfortable for them too. Speed humps are not pedestrian crossing facilities, and, therefore, do not have to be aligned with universal design principles.

Traffic Calming – Speed Hump



Dimensions:

As provided in drawing

Effectiveness:

- Average of 22–23% decrease in the 85th percentile travel speeds,
- Average of 14% decrease in accidents (www.trafficcalming.org)

Positive Aspects:

- Relatively inexpensive
- Relatively easy for bicycles to cross if designed appropriately
- Very effective in slowing travel speeds

Negative Aspects:

- Cause a “rough ride” for all drivers, and can cause severe pain for people with certain disabilities
- Force large vehicles, such as emergency vehicles, to travel at slower speeds which may increase noise and air pollution
- Questionable aesthetics

5.6.2 Speed Tables

The role of speed tables is to reduce motorised traffic speeds and to take into account the presence of pedestrians and other sidewalk users. These users have a desire line across the carriageway.

One of the major concerns when installing speed tables is drainage. A well installed speed table provides a good drainage without jeopardising the comfort of people including those in wheelchairs or with prams/trolleys.

Figure 5-4: Example of a Good Speed Table (Germany)

The implementation of a PVC pipe as a drainage measure has been trailed, but fails when debris such as can collect in front of the pipe opening.

Figure 5-5 provides a retrofit example that is effective but not attractive.

Figure 5-5: Drainage and Access for People in Wheelchairs Provided (Cape Town)
Picture by Lisa Kane

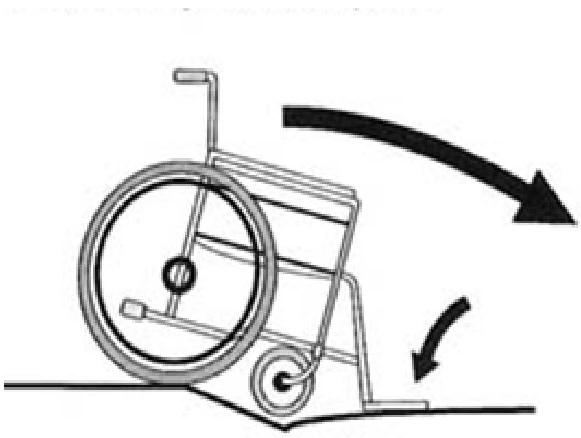


Figure 5-6: Badly Implemented Speed Tables can Cause Wheelchairs to Hit the Street Surface and Tip Over

Speed Table

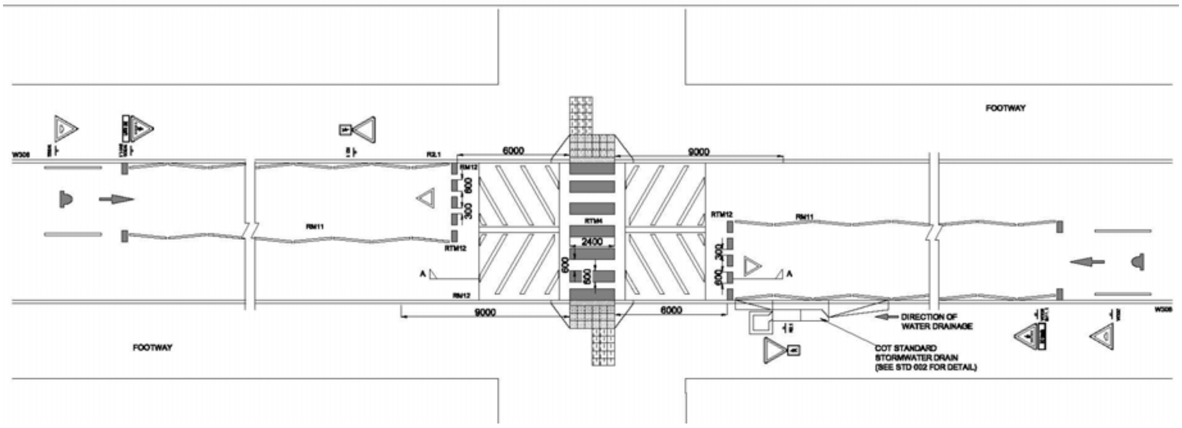
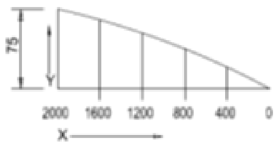
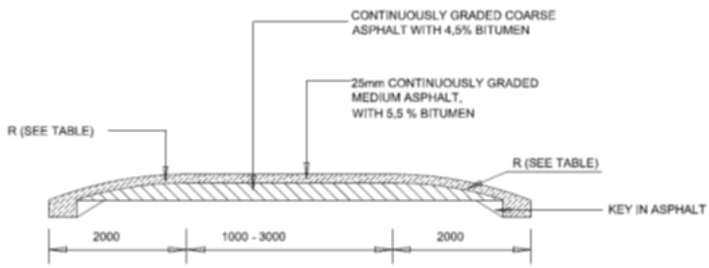


TABLE R

X(mm)	Y(mm)
0	0
400	27
800	46
1200	63
1600	72
2000	75



DETAIL OF CURVE



Dimensions:

As provided in drawing

Effectiveness:

- Average of 18% decrease in the 85th percentile travel speeds
- Average of 45% decrease in accidents (www.trafficcalming.org)

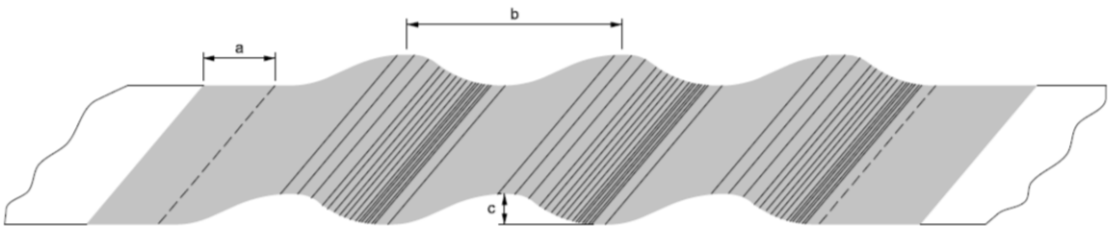
Positive Aspects:

- Smoother on large vehicles (such as fire trucks) than speed humps
- Effective in reducing speeds, though not to the extent of speed humps

Negative Aspects:

- Questionable aesthetics, if no textured materials are used
- Textured materials, if used, can be expensive
- May increase noise and air pollution

5.6.3 Rumble Strips



Rumble strips are an effective road safety measure. The warn drivers when they have to pay extra attention to the road situation. In South Africa, rumple strips are mostly used in rural areas where pedestrians can be expected on high speed roads. Rumble strips are noisy and can affect farms and rural neighbourhoods negatively.

Dimensions:

a = 1,000 mm

b = 350 mm

c = 6–7 mm

Effectiveness:

Unknown

Positive Aspects:

- Reduces the road safety risk
- Reduces fatigue and increases driver alertness

Negative Aspects:

- May increase noise pollution

5.6.4 Roundabouts and Traffic Circles

Roundabouts and traffic circles are effective traffic calming measures. Badly installed speed humps and tables damage vehicles lead to additional noise and air pollution. Roundabouts and circles do not have this negative impact.

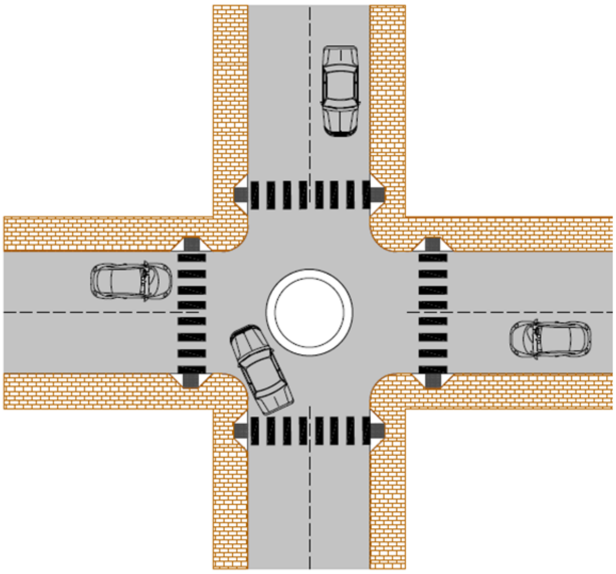
Roundabouts have less conflict points than intersections. Road safety, therefore, improves when intersections are replaced (assuming correct driver, walking and cycling behaviour).

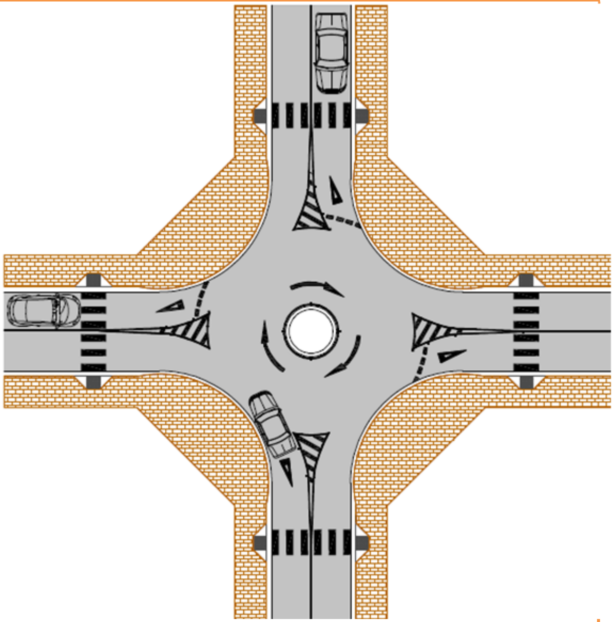
If cyclists are combined with motorised traffic on roundabouts, only multi-lane or high speed/volume circles require a separate bicycle lane.

If speeds and/or volumes are high, it is recommended to create a setback which is at least 1 car length (6 m), or more is there is a high percentage of heavy vehicles.

The application of grates needs to be avoided at places where drop kerbs are implemented.

Traffic (Mini) Circle/Roundabout





Dimensions:

- Depending on local situation
- Distance between crossing/drop kerb and start of taper should be 1 car length (6,000 mm if there are limited heavy vehicles otherwise should be more)

Positive Aspects:

- Can moderate traffic speeds
- Aesthetically pleasing if well landscaped
- Enhances safety compared to traffic signals
- Less expensive to operate than traffic signals

Effectiveness:

- Average of 11% decrease in the 85th percentile travel speeds
- Average of 29% decrease in accidents
- Average of 29% decrease in accidents (www.trafficcalming.org)

Negative Aspects:

- May be difficult for large vehicles
- Must be designed so that the circulating lane does not encroach on the crosswalks
- May require the elimination of some on-street parking
- Landscaping must be maintained,
- Care should be taken that roundabouts and circles are well designed, as they can be bad for pedestrians if they do not know when and where to cross.

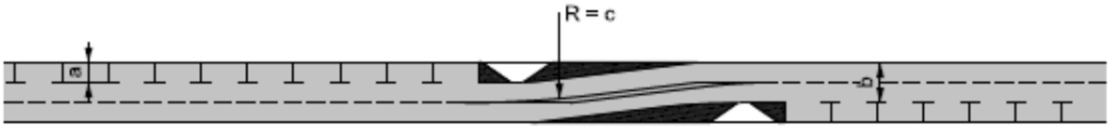
5.6.5 Chicanes

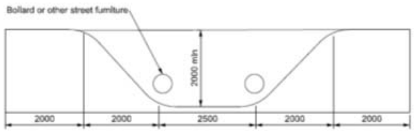
Chicanes reduce the width of a street in order to make drivers slow down. Chicanes involve building out the kerb, usually on alternate sides of the road, to effectively introduce bends into an otherwise straight road.

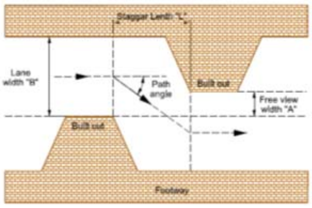
Chicanes have been very effective in slowing down traffic on high volume roads approaching rural towns.

If NMT desire lines exist near chicanes, other types of facilities need to be added.

Chicanes







Dimensions:

As provided in drawing

a = 2,000 mm

b = 6,000 mm

c = 50 m – 100 m

Effectiveness:

Unknown

Positive Aspects:

- Discourage high speeds by forcing horizontal deflection
- Easily negotiable by large vehicles.

Negative Aspects:

- Must be designed carefully to discourage drivers from deviating out of the appropriate lane
- Kerb realignment and landscaping can be costly.
- May require elimination of some on-street parking

5.6.6 Neck Downs

Neck downs are essential traffic calming solutions to improve the cross-ability of intersections. Pedestrians and other sidewalk users are provided with large holding areas. At the same time, the carriage way is reduced to 3,000 mm per lane. If there is parking on the road, this is eliminated, creating better sight distances. In the United States, this is called day-lighting an intersection.

When placing drop kerbs, the desire lines of sidewalk users can be easily accommodated. The application of grates needs to be avoided at places where drop kerbs are implemented.

5.6.7 Chokers

Choker is the name given to a build-out added to a road to narrow it. There are various configurations of chokers, but the philosophy is to narrow a road to change its perception to drivers. When a narrowing is carried out at an intersection the term 'bulb-out' is usually used. The least intrusive choker is a narrowing on either one or both sides of the road which still permits two-way traffic (http://www.trafficcalming.net).

If there are NMT desire lines crossing at, or near, a choker, drop kerbs and tactile pavers are required. **Carriageway lane width is recommended to be 3,000 mm**. The application of grates needs to be avoided at places where drop kerbs are implemented.

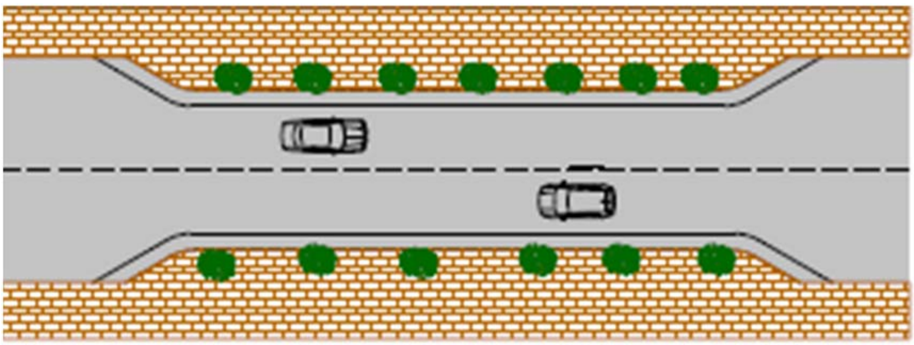
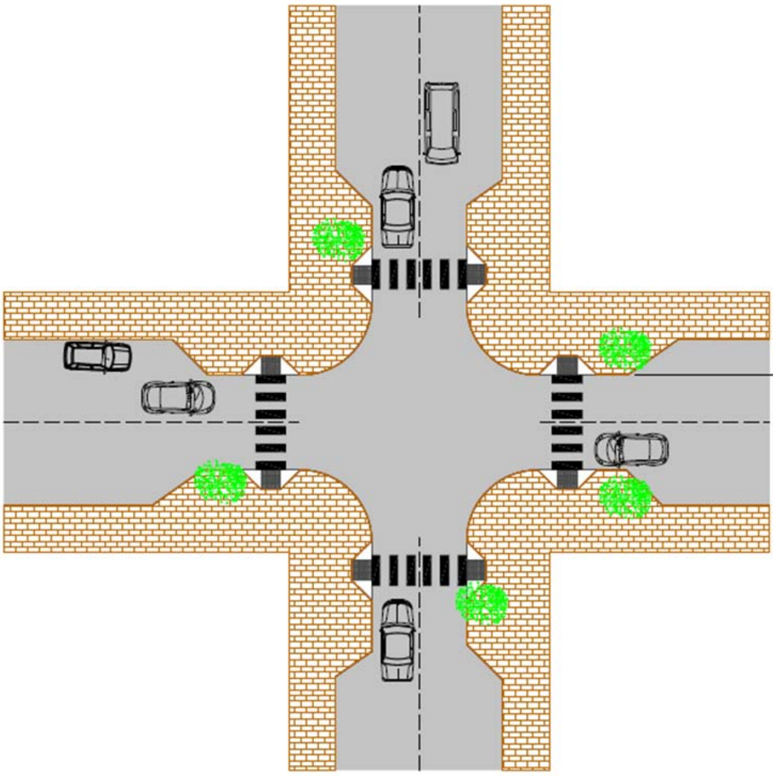


Figure 5-7: Example of a Choker

Neck Downs



Dimensions:

Depending on local situation

Effectiveness:

- Average of 7% decrease in the 85th percentile travel speeds (www.trafficcalming.org)

Positive Aspects:

- Improves pedestrian circulation
- Reduces speeds

Negative Aspects:

- Effectiveness is limited by the absence of vertical or horizontal deflection.
- May slow emergency vehicles
- May require the elimination of some on-street parking
- May require cyclists to briefly merge with vehicular traffic

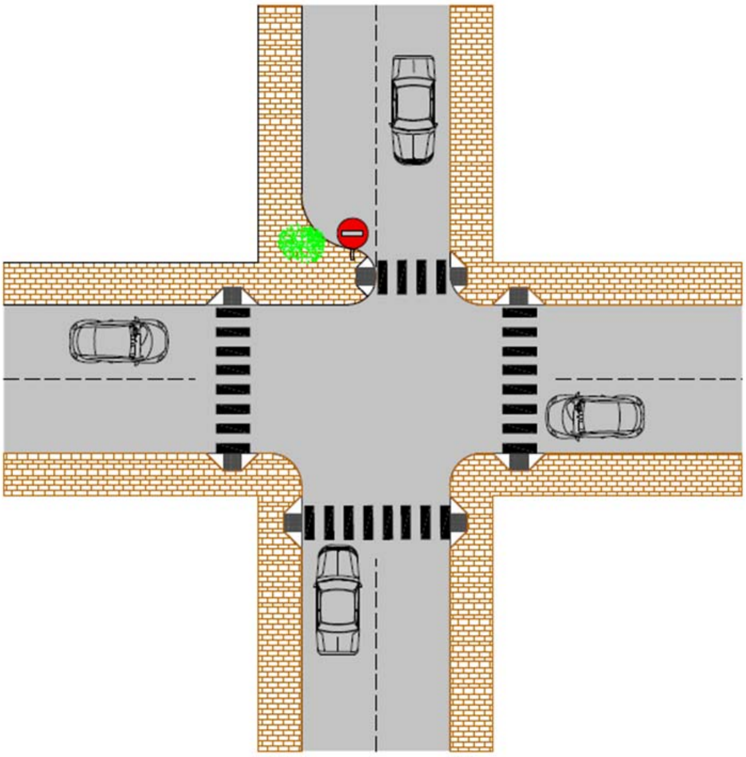
5.6.8 Half Closure

Closures and half closures are typical volume measures. In South Africa a lot of closures can be found at so called estates. From a motorised traffic point of view, road closures are very effective measures, elimination though traffic. However, for the vast amount of pedestrians in the country, a road closure, including fencing, as witnessed around estates, creates long detours and frustration.

A half closure does not have negative impacts for NMT. Cyclists should be allowed to use one-way roads, created by half closures, in both directions. Half closures can be considered around urban primary schools

Sidewalk users should be accommodated, according to their desire lines. The application of grates needs to be avoided at places where drop kerbs are implemented. However, the expectation is that it will be safe for children to play on the street inside and that may not be so as cars go dangerously fast

Half Closure



Dimensions:

Depending on local situation

Effectiveness:

- Average of 42% decrease in traffic volume (www.trafficcalming.org)

Positive Aspects:

- Maintains two-way bicycle access
- Effective in reducing traffic volumes.

Negative Aspects:

- Affects traffic circulation for residence and emergency vehicles
- May limit access to businesses.

5.7 Drop Kerbs and Tactile Paving

The previous sections of this chapter, elaborate on general design principles on links and intersection. Local conditions, minimum requirements and NMT demand expectations, established during the planning phase, will inform the exact dimensions of NMT facilities.

The above is acceptable from a road design principle point of view, as traffic and transport engineers will need to take local conditions into account. It is not possible to come up with solution that fit all circumstances.

Accommodating people in a wheelchair, people pushing prams or trolleys and people with vision impairments cannot be compromised. South Africa has two important documents that legislate tactile paving and drop kerb requirements (SANS 784 and SANS 10400 Part S).

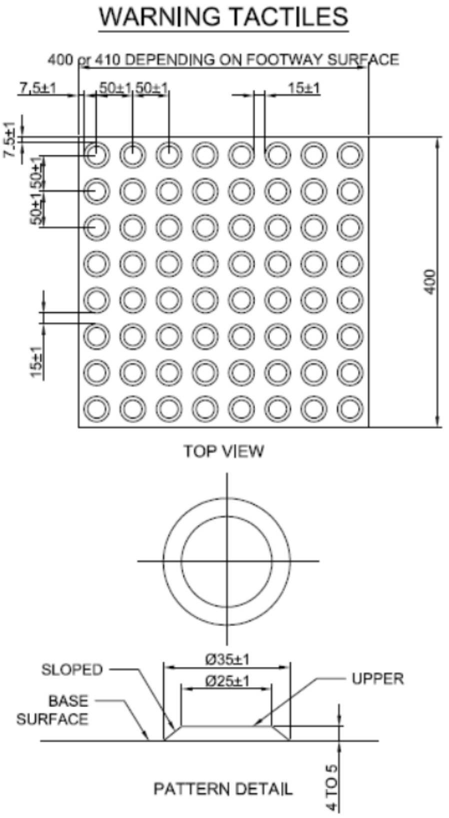
5.7.1 Tactile Paving Principles

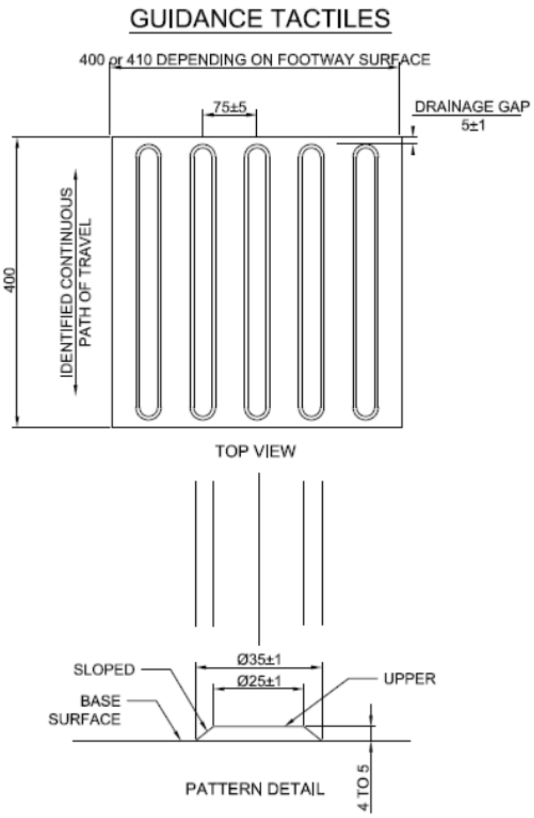
Regarding the implementation of tactile paving, South Africa has chosen to use a simple implementation strategy, based on two paving elements: hazard warning tiles (decision points during the journey of a person with vision impairments) and linear pavers (directional guidance).

It needs to be mentioned that angles, other than 90 degrees, are discouraged.

Figure 5-8: Guidance and Directional Tactile Pavers

Tactile Pavers





Dimensions:

As provided in drawing

Effectiveness:

Unknown

Positive Aspects:

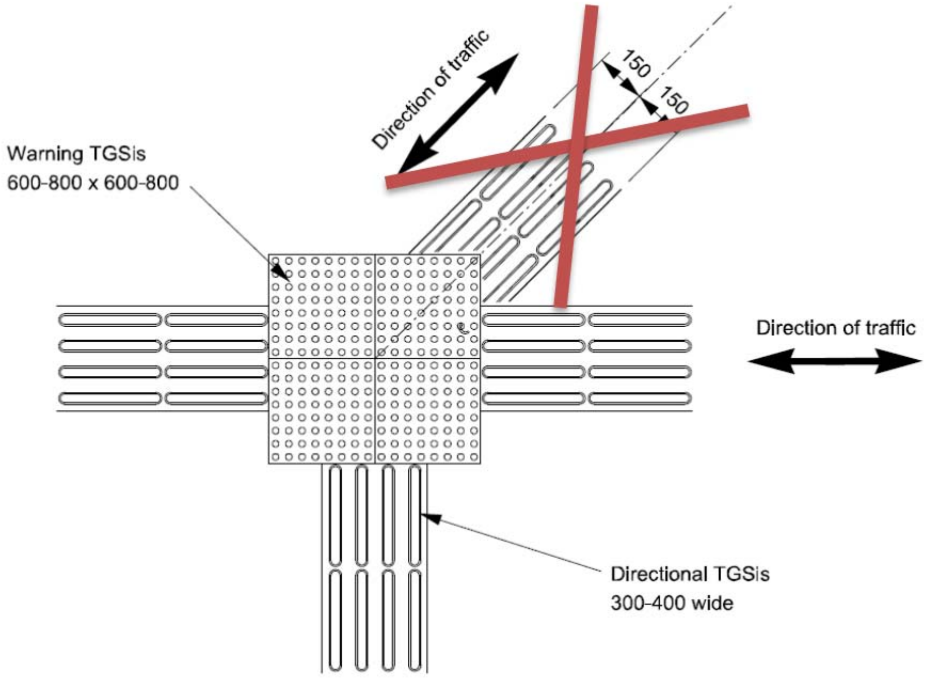
- Improves road safety
- Assists in creating access for all

Negative Aspects:

- If the wrong standard is used, can increase the physical effort required for people using wheelchairs and prams and can create a mobility/accessibility barrier for the users if the wrong standards are used and it is fitted
- Costly to implement

Source: **GIBB, 2010**

Denoting Tactile Changes



Dimensions:

As provided in drawing

Effectiveness:

Unknown

Positive Aspects:

- Improves road safety
- Assists in creating access for all

Negative Aspects:

- Can increase the physical effort required for people using wheelchairs and prams. This may in some cases create a mobility/accessibility barrier for the users.
- Avoids angular direction of travel. All Directional Tactile Ground Surface Indicators (TGSIs) should be at right angles to the Warning TGSIs and the same thickness.

Source: **GIBB, 2010**

5.7.2 Drop Kerbs or Kerb Cuts at Locations without Traffic Signals

When the need for tactile paving has been established, the incorporated into drop kerb design is required. The implementation of tactile paving and drop kerbs is often inappropriate in South Africa. It is, therefore, necessary to follow the guidance provided in this document closely, as the correct implementation of appropriate infrastructure is non-negotiable.

A drop kerb is at least 1,200 mm wide. The full width required hazard warning tiles. Hazard warning tiles should be at least 600 mm deep (2 rows, preferably 3 rows of pavers).

The slope of drop kerbs is ideally 1:20 and cannot be less than 1:12. The latter should only be applied in exceptional circumstances, when space does not allow for a less steep slope.

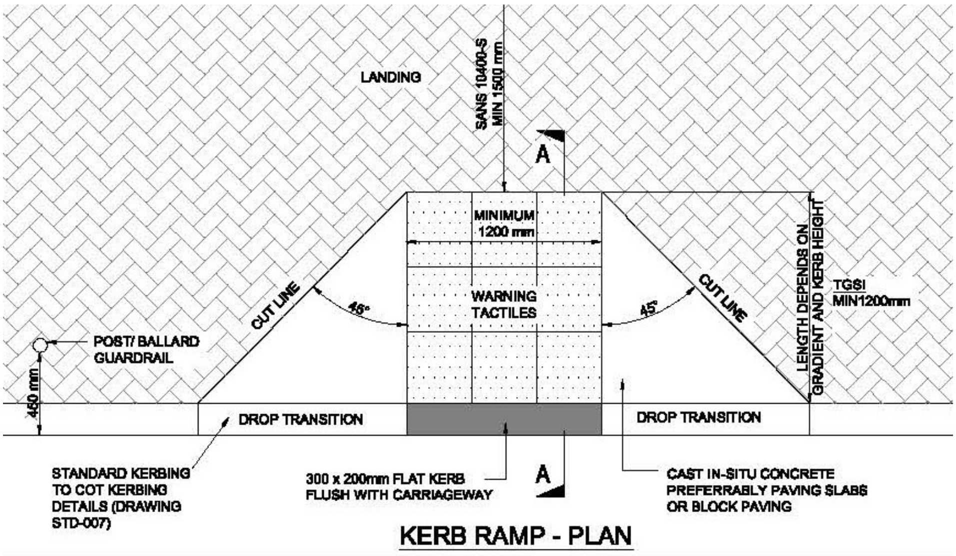
The runoff of rain water needs to be accommodated on all sidewalks, including on the landing off a drop kerb. A slope of 1:50 is required.

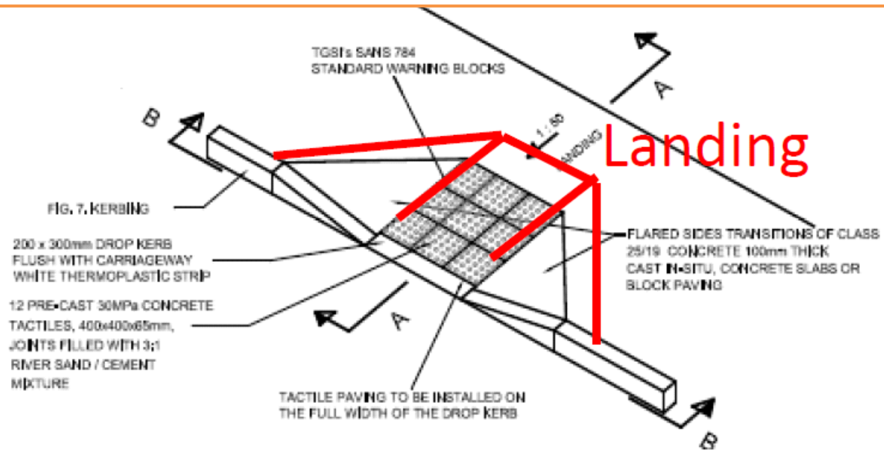
NMT users, including people using wheelchairs need to be accommodated behind the drop kerb on the landing. A passing space is required. If there is a lot of space, a less steep slope can be provided. Design details for drop kerbs at uncontrolled intersections are provided in the figures on the next page.

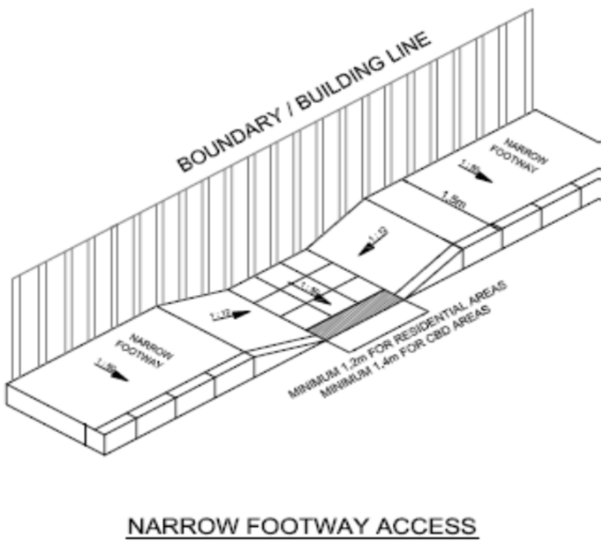
In case a slope of 1:12 is not possible without sacrificing the landing, the whole sidewalk needs to be dropped. An example of a dropped sidewalk is provided in **Error! Reference source not found.**.

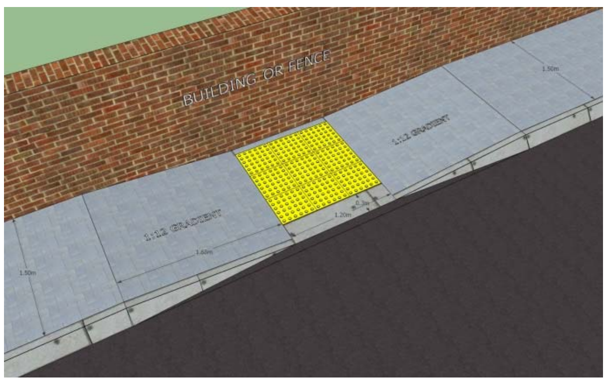
In all cases, a safety buffer (300 mm) is required at the road edge, to avoid unsafe situations while people who are blind or partially sighted are waiting to cross.

Uncontrolled Intersection Drop Kerb Design









Source: **GIBB, 2010**

5.7.3 Angled Drop Kerb Treatment

Local circumstances might require angles drop kerb treatment. All requirements previously mentioned, such as the width and depth of hazard warning tactiles and the required safety buffer, hold for this type of treatment.

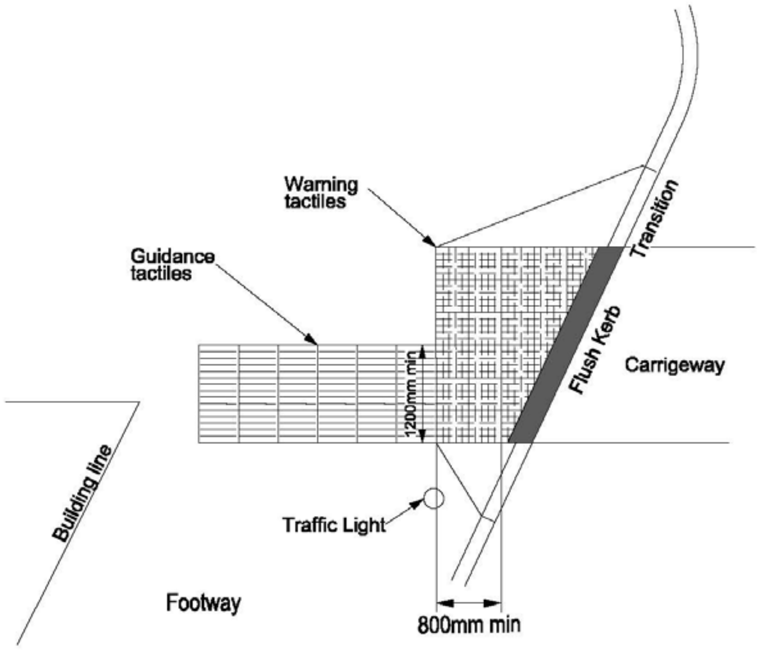
Hazard warning tactiles need to follow the kerb line. No other materials should be used to fill corners, among others, as this undermines the universal access principles.

Hazard warning is required at a controlled crossing. Linear pavers are used to create this tail. The tail is positioned at the corner of the bubble paving. The specific corner is in line with the motorised traffic direction. The tail should be at least two linear pavers wide.

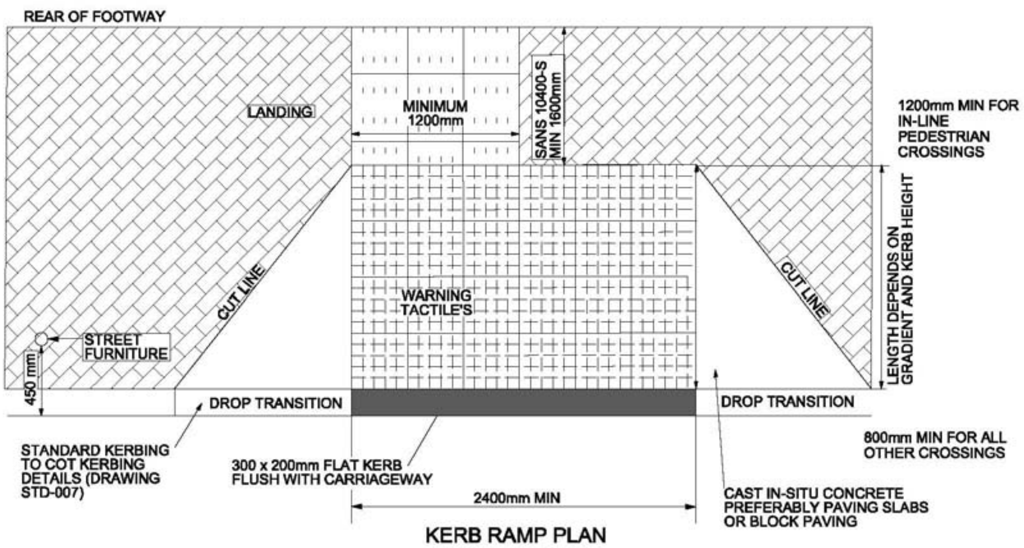
5.7.4 Drop Kerb at Signalised Intersections

The width and depth of hazard warning tactile and the required safety buffer, hold for this type of treatment. Linear pavers are provided up to the building line, to guarantee that people who are blind or partially sighted will locate the guidance paving. Linear paving is positioned in such a way that people who are blind or partially sighted can locate the push button location. Audio signalisation can assist people with vision impairments even further, providing specific sounds for the various traffic controller colours. The buffer strip must not protrude from the road surface.

Angular Treatment Kerb Ramp



Drop Kerb at Signalised Intersection



Source: **GIBB, 2010**

5.8 Construction / Development Sites

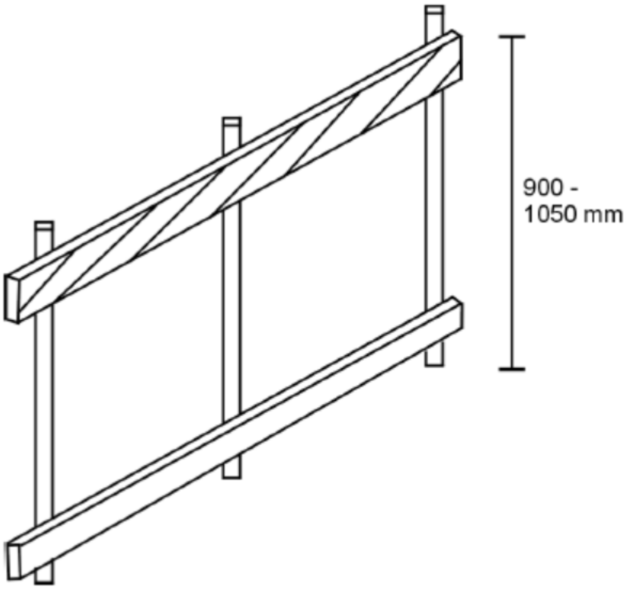
Road works at road construction sites can pose unexpected problems for pedestrians and cyclists. For persons with disabilities, such work can severely limit or even totally preclude travel through the area. Provisions should be made for safe and clearly delineated paths through a construction zone.

5.8.1 Principles of Design

There are a number of basic considerations in planning for pedestrians and cyclists at construction sites:

- **Persons should not be led into conflicts** with work site vehicles, equipment, and operations, as well as into conflicts with vehicles moving through or around the construction site.
- Persons should be provided with a **safe, convenient path** that replicates as nearly as practicable the most desirable characteristics of the existing travel ways.
- Pedestrian and bicycle traffic should where possible be separated from both construction site activity and vehicular traffic.
- A series of road signs have been developed to cater for pedestrians at road construction sites and should be used whenever the appropriate situation arises. According to the **Road Traffic Signs Manual**, it is an important aspect of the safety arrangements of roadworks sites that specific accommodation should be made for pedestrians.
- The manual states that any authority or contractor not making provision for pedestrians could, in the **event of an accident**, find themselves facing serious litigation.
- The **temporary signing of roadworks** in urban areas is commonly influenced by having limited space to accommodate road signs and traffic; high traffic and pedestrian volumes and the need to maintain access to many properties.
- For temporary road signs to be **effective in urban areas**, there must be availability of street lighting; there should be no obstruction of signs by trees, street furniture and large vehicles and the sight distances must be adequate.

Barricades for Construction Sites



Dimensions:

As per Drawing

- Top rail should be mounted at a height of between 900 mm and 1,050 mm with diagonal stripes.
- Barricade support should not protrude more than 100 m beyond the toe rail

Principles:

- Extensive usage required at trenches and excavations.
- Must be strong enough to prevent people from falling into hazardous pits.
- Multi-coloured plastic tape (red and white or black and yellow stripes) can be used to mark off work area.
- Marking tape is not a substitute for a barricade.

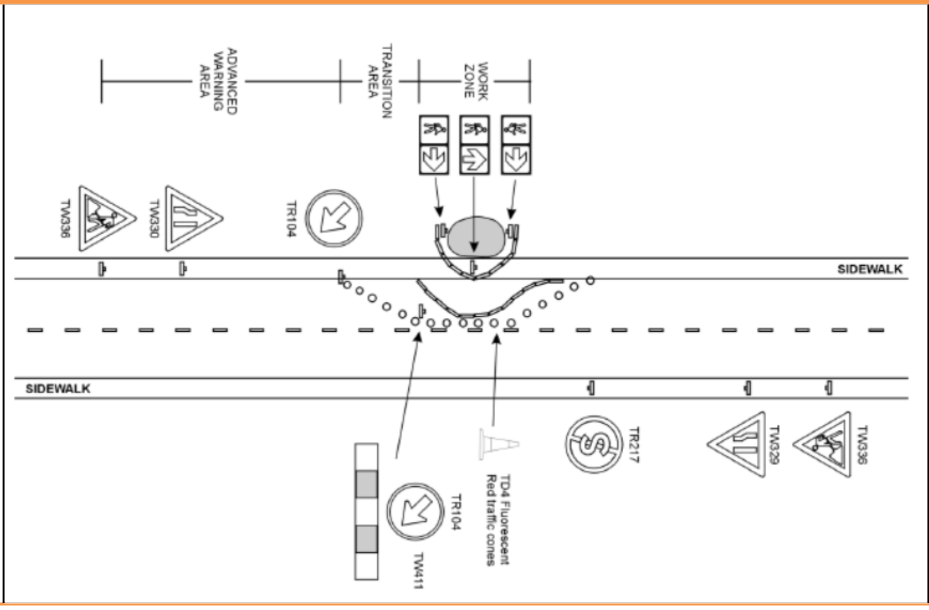
Positive Aspects:

- The tape makes the construction area more conspicuous for people with impaired vision.

Negative Aspects:

- Barricades supported by inverted T supports may create a tripping hazard if they extend too far into the walkway.

Sidewalk Diversions



Dimensions:

As per Drawing

- Top rail to be mounted at a height of between 900 mm and 1,050 mm with diagonal stripes
- Barricade support should not protrude more than 100 m beyond the toe rail

Principles:

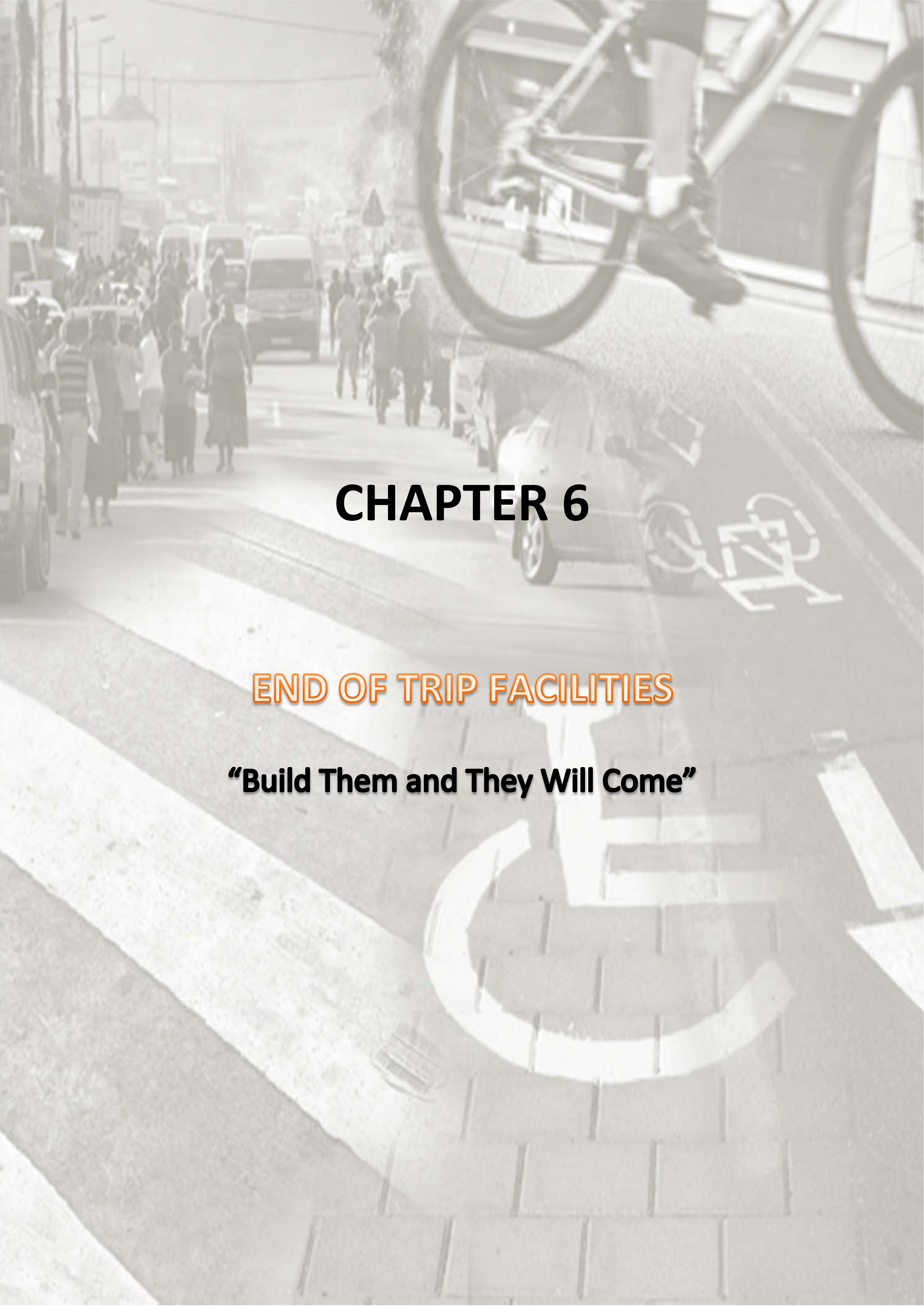
- Provides for isolated excavation with no other roadworks, e.g. local repair to a water main, sewer, electrical cable, etc.
- Signs within a larger site need to be modified where more than one excavation occurs based on site requirements
- More details regarding road signs and markings required at construction work zones are given in the Road Traffic Signs Manual

Remarks:

- The signs given in the figure are typical only and are not intended to be a definitive inventory.

Source:

Road Traffic Signs Manual



CHAPTER 6

END OF TRIP FACILITIES

"Build Them and They Will Come"

6. END OF TRIP FACILITIES

"Build Them And They Will Come."

6.1 Public Transport Hubs

Public transport hubs or interchanges are places where **passengers are exchanged** between vehicles or between different transport modes. An interchange can either be the physical **action** of transferring between services or modes as part of a journey or it can be the **physical location** where this occurs. Public transport interchanges can be bus stops, taxi ranks, multi-modal facilities, train stations, etc.

Interchanges result in flows of people and traffic and they have **strong attraction and repelling activities**. Interchanges are **vibrant urban nodes** with important elements of place making. As a general principle, the public transport facilities should always be **located in places of high accessibility** and make provision for informal trading and markets.

The interchanges must also improve the general environmental quality and **sense of place**, and ultimately afford people that dwell and utilise them, a sense of well-being and dignity.

Figure 6-1: Interchanges Result in Better Flow of People and Traffic

6.1.1 NMT Design at Off-Street Interchanges

Planning for pedestrians within the interchange itself should incorporate the principle of maintaining a **separation** between passengers and vehicles, as well as separating arriving and departing passengers to minimise interference. The public access routes within the interchange should be clearly defined and all pedestrian movements should be focused and clearly defined crossing points constructed to minimise pedestrian and vehicle conflict. The design principles are:

- **One-way** vehicular movements are recommended within the interchanges
- All vehicle movements should be in a **forward direction of travel**. The only exception will be the holding area where reversing in and out of the standard parking bays may be permitted.
- Passengers should have **clearly defined walking and queuing areas**.
- Walkways should preferably be **raised by kerbs** and clearly separated from vehicle movements.
- All pedestrian islands used inside the terminal should be at least **1.2 m** wide and must be raised by a non-mountable kerb to enforce vehicle movement around it to increase safety.
- An over-riding factor in layout design is the provision of **adequate sight distance** between vehicles and pedestrians.
- Particular attention must be given to the location of the pedestrian exit and entrance in relation to the vehicle exit and entrance. As a general rule, it is preferable for pedestrian paths to **cross departing vehicles** rather than to cross entering vehicles, as the latter are usually travelling faster.

Figure 6-2: Pedestrians Remain Level throughout the Interchange

6.1.2 NMT Design at On-Street Facilities

Passenger convenience and comfort is critical to the success of a transport stop. Comfortable and safe waiting areas should be designed to supply the appropriate infrastructure for each level of stop facility, based on the boarding and alighting demand at the location.

These facilities must have a strong presence of sidewalks leading towards the public stop, and preferably a connection to the existing pedestrian route network. Access for special needs passengers is integral to the public stop design. This can be enhanced through wheelchair ramps at the intersections leading towards the public stop. Safe non-motorised transport access must be emphasised by having raised pedestrian crossings in the vicinity of the public stop, where necessary.

All public transport facilities should provide for a seamless and efficient movement of passengers. This includes special needs passengers, elderly people and young children. Some general design considerations:

- **The location of public transport interchanges** is important as special needs passengers cannot walk for long distances. Stops should be placed so that persons with disabilities do not have to walk longer than 400 m along a route.
- A **waiting area** should be provided. The width of the waiting area should not be less than 1.5 m and its length not shorter than 2.5 m.
- It is desirable to provide a **continuous** strip of pavement along the entire length of the bus and mini-bus stop, which is at least 2.5 m wide.
- Access to the public transport stop from the intersection or adjoining property should be **as direct** as possible.
- Bus/mini-bus shelters are recommended at **high volume boarding stops and bays.** A shelter must have:
    - minimum clear floor area of 0.76 m x 1.22 m entirely within the perimeter of the shelter.
    - minimum shelter dimensions of 2.7 m x 1.4 m
    - at least 1.3 m between the back of kerb and the front of the shelter
    - clearance between the back of the shelter and the back edge of the adjacent building of between 0.9 m and 1.5 m.

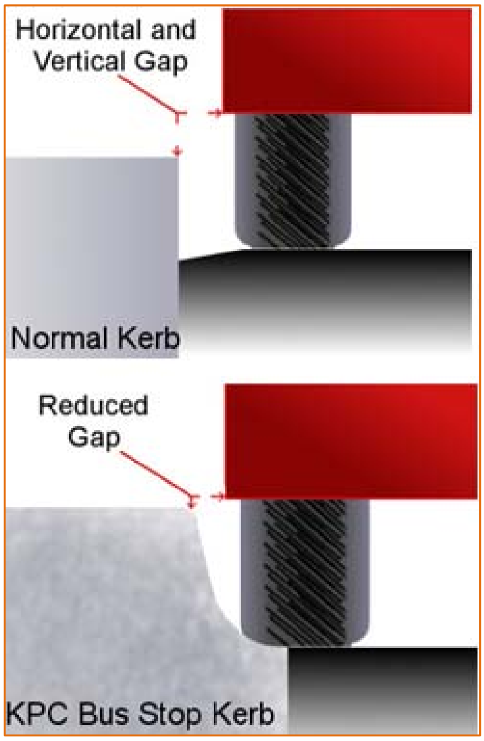
Figure 6-3: Intermediate Bus Stop

Source: TransLink Transit Authority, 2012

- **Tactile paving** makes it possible for people with people with vision impairments to use public transport facilities independently. Linear pavers should provide unobstructed guidance to the shelter and the information signs (which should include braille). Warning tactiles should warn along the full length of the stop (see below).

The public transport stop layout should make provision for ample space for passengers to wait and board without obstructing other pedestrians passing by. The **width of the waiting area** should not be less than 1.5 m and its length not shorter than 2.7 m.

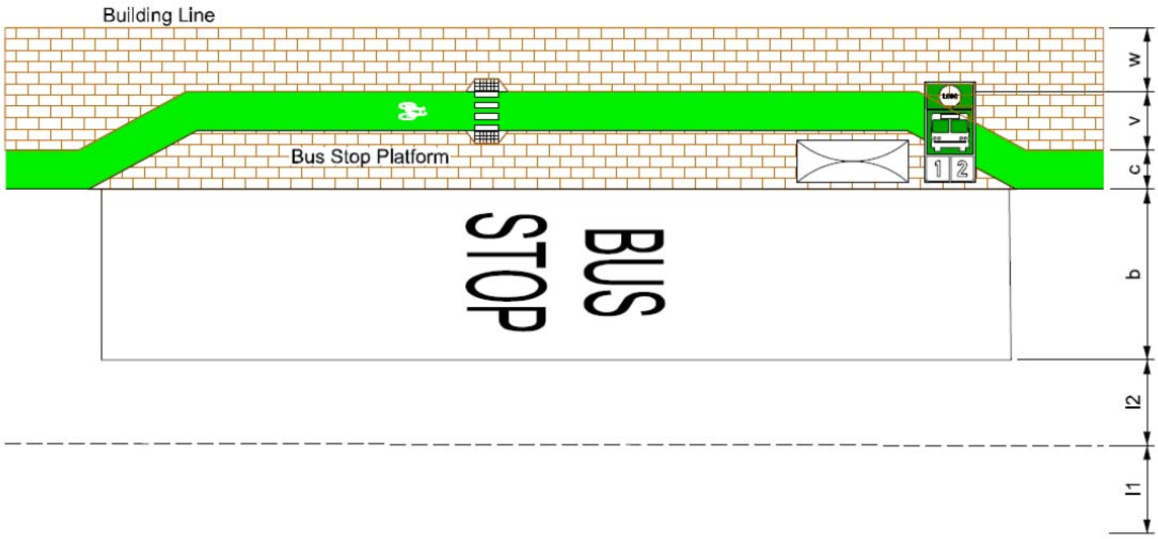
- **Shelters and covered structures** should be provided where feasible to protect passenger waiting from wind and rain. The shelters should be well lit and constructed in such a way that the view out of or into the shelter are not obstructed. A minimum shelter opening width of 0.9 m must be maintained for wheelchair access. Seating should be of a suitable height for people with disabilities
- **Public transport stop poles** are essential as they indicate the spot where the entrance of an arriving bus/mini-bus will be. These are essential for the benefit of the people who are partially sighted passengers. Route numbers and names should be provided on the poles and shelters.
- **Gap reduction** that improve the accessibility of buses and other public transport modes can be achieved by changing the kerb and raising it (See **Figure 6-4**).



When on-street bicycle lanes are provided near a bus stop, the bicycle lane should be moved behind the holding area if sidewalk space allows for this. In the case of an off-street bicycle lane, the same principle can be used. Safe passage of people crossing the bicycle lanes to get to public transport should be ensured.

Figure 6-4: Bus Access Gap Reduction
Source: http://killeshalprecast.co.uk/

On-Street Public Transport Stop



Dimensions:

w = 1,800 mm (min 1,500 mm)

v = 1,200 mm (min 300 mm)

c = 1,800 mm (min 1,500 mm)

b = min 2,500 mm

l1 = 3,000 mm

l2 = min 3,000 mm

Principles:

- Shelters and covered structures where feasible to protect passenger waiting areas should be provided.
- Accessibility to persons with disabilities with kerb ramps, detectable warning features and clearly delineated pedestrian spaces should be provided.
- Off-street bicycle lanes should by-pass the bus stop.

Positive Aspects:

- Pavement texture and colour can be used to communicate function and spatial relationships for the people who are blind or partially sighted.

Negative Aspects:

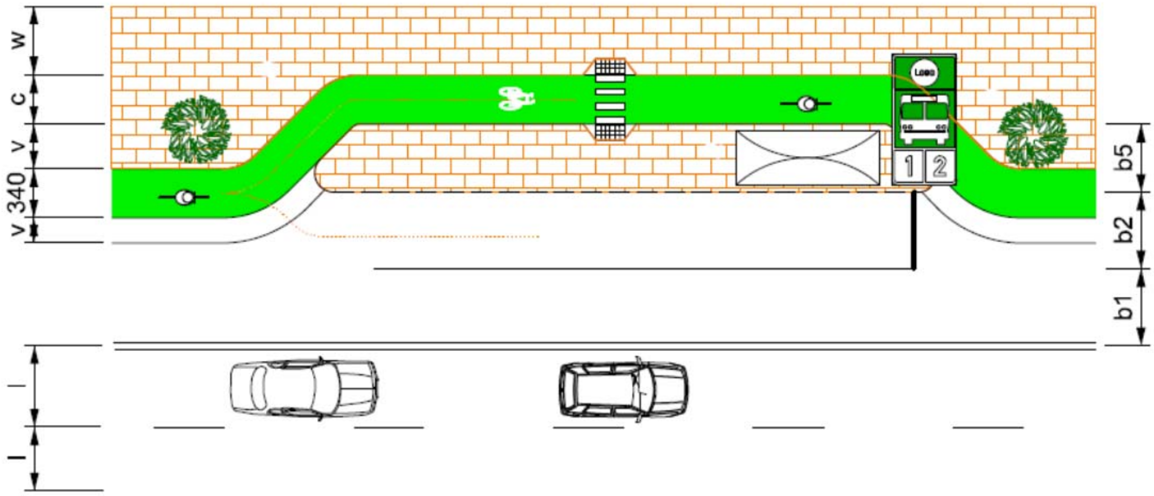
- On-street bicycle lanes may traverse the bus stop.

Other:

- Space adjacent to bus loading area should be free from obstacles.
- Street furnishings should be set back from the kerb.
- Midblock crossings need to be provided at midblock bus stops.

Source: **ARUP, 2014**

Public Transport Lay-By



Dimensions:

w = 1,800 mm (min 1,500 mm)

c = 1,800 mm (min 1,500 mm)

v = min 300 mm

l = 3,000 mm

b1 = min 3,000 mm

b2 = min 2,500 mm

b5 = 1,500 (min 1,200 mm)

Principles:

- Shelters and covered structures where feasible to protect passenger waiting areas should be provided.
- Provides universal access to persons with disabilities with kerb ramps, detectable warning features and clearly delineated pedestrian spaces should be provided.
- Off-street bicycle lanes should by-pass the bus stop.

Positive Aspects:

- Pavement texture and colour can be used to communicate function and spatial relationships for the people who are blind or partially sighted.

Negative Aspects:

Conflict between pedestrians and cyclists will need to be managed. It helps to use the bicycle approach angles to reduce speed.

Source: **ARUP, 2014**

6.1.3 Median Public Transport Stations

In the last few decades, Bus Rapid Transit (BRT) has emerged as a cost-effective, flexible and environmentally sustainable form of public transportation. The world's first BRT was developed in Curitiba, Brazil, which was followed by the development of many other BRTs across South African Cities. The term BRT has come to represent a wide range of bus-based, public transportation systems. Although these systems have commonalities, they may also have some very different features. Often, it is the decision of which BRT feature to include or exclude that determines the success or failure of the system (Road Safety Design Guidelines for BRT in Indian Cities, 2012).

Design Principles

A **minimum station platform width** of 5 m and a minimum entrance length of 15 m to allow for inclusion of ticket kiosks, server rooms, staff ablutions and access control systems.

- Access to a double sided off a signalised intersection, with space provided for **universal access features (ramps).** The tactile paving to the BRT stations should be pronounced, multi-toned and continuously clear. Tactile paving should be added to all stairs and pedestrian bridges.
- There should be a **full array of NMT facilities** along the main trunk line of the BRT. A minimum sidewalk width of 3 m for urban corridors with extensive development is encouraged, with a minimum of 1.5 m for bicycle lanes along the corridor. Adequate space must be provided within the station precinct for bicycle parking facilities. There should be no obstacles in the path of travel, seating and shelter/landscaping should provide a decent waling environment.
- **Traffic signal poles** need to be pulled back to the near side pedestrian crossing line to ensure that the signal poles are no more than 3 m from the stop line. **Pedestrian buttons** should be located on the pedestrian signal pole.
- **Staggered crossings** are more favourable and preferred as they allow greater visibility of the pedestrian crossings at the intersection exit carriageways (and the opposing turning traffic will be moving more slowly at the pedestrian crossing point).

NMT at Median Public Transport Station

Dimensions:

Site dependent

Principles:

- All modes of transport are accommodated.
- Pedestrian crossings preferably have discriminating paving materials/colours.
- Adequate crossing time at signals is required.
- Adequate queuing space on refuge islands is needed.
- If pedestrian flows are very high, staggering of crossing facilities (See staggered midblock facilities) can be considered.
- Channelise pedestrian movement to crossings and using tactile pavers.
- Proper lightings need to be provided at crossings.
- If the bicycle lane is on street, bike boxes need to be installed at intersections.
- Painted or dyed surfaces are recommended, also at the intersection.

Principles (cont.):

- To promote bicycle and public transport integration, bicycle parking needs to be accommodated.
- Provision of travel option on bus with bicycle is welcomed.

www.mediagallery.usatoday.com

Source: **GIBB, 2010**

6.2 Bicycle Parking

Good quality bicycle parking is a key element in developing a bicycle-friendly environment. The absence of secure, convenient bicycle parking can be a serious deterrent to bicycle use. Bicycle parking should be provided at major destinations, public buildings, schools and colleges, hospitals, large employment sites, public transport interchanges and leisure attractions.

Proximity to the destination is the major influence on a cyclist's choice of where to park (Taylor and Halliday, 1997), regardless of the journey purpose. The use of the bicycle as a feeder to public transport can also be a valuable component of a strategy to encourage more people to bike (Taylor, 1996).

6.2.1 Principles of Bicycle Parking Location

- Bicycle racks should be **permanently affixed to a paved surface**, and must be installed in an orderly and neat appearance.
- Bicycle parking facilities should also be encouraged at schools, buildings, public transport facilities and universities within any urban area. Short-term parking facilities should be provided near all IPTN stations and other multi modal interchanges, PRASA, Gautrain stations and municipalities.
- Bicycle parking facilities should **not obstruct the pedestrian walkways** but be located within the vicinity of each public transport station and should be placed outside the accessible path of travel.
- Bicycle parking facilities should be **easy to find and as close to destinations** as practicable. Numerous small clusters of stands throughout the city are generally preferable to one large parking area.
- Cycling facilities should be **fit for purpose and easy to use**. Stands that support the bicycle by gripping the front wheel alone should be avoided, because of the damage they can cause.
- Stands should have **sufficient space around them** to ensure they are convenient to gain access to (parallel stands should be at least one metre apart, for example).
- Public transport interchanges, places popular with tourists and other such attractors should be provided with bicycle **parking facilities appropriate to demand**.
- Long-term parking for regular users should ideally be within a **secure access area and protected from the weather**. The level of weather protection for other parking should be appropriate for the length of stay.

Bicycle Parking at Public Transport Interchanges (Covered)

Dimensions:

Site dependent

Positive Aspects:

- Secure short-term parking facilities for bicycles
- Visible to enough to discourage theft

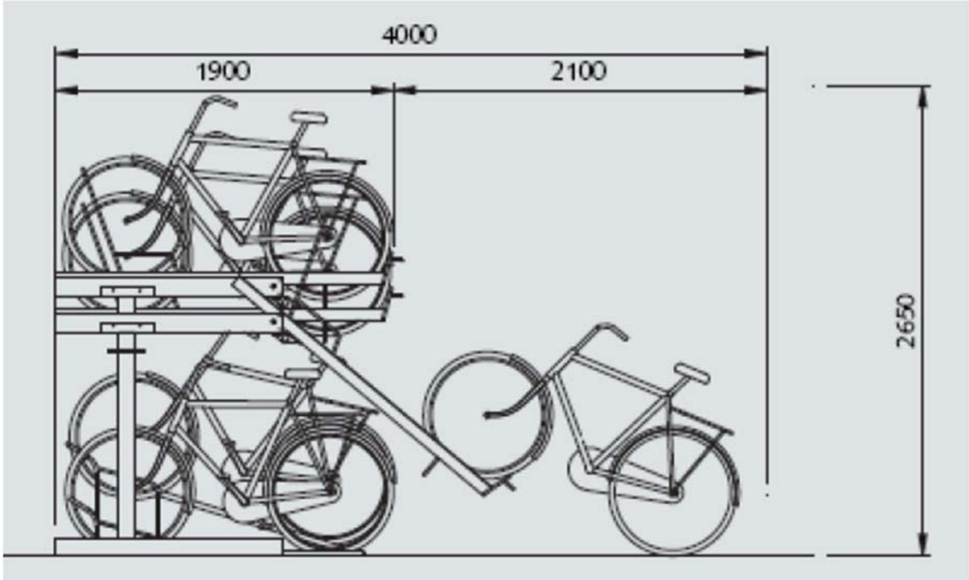
Negative Aspects:

- Not suitable for long-term parking requirements
- Can only accommodate a few bicycles at a time

Principles:

- Should be located within an interchange
- Must not obstruct pedestrian walkways
- Must have anti-theft mechanisms
- Must be secure.
- Must be within the cyclist route
- Bicycle rack must support the frame and must lock the frame and wheels
- Securing frame is preferred over securing wheels, as the latter might lead to damage

Bicycle Parking at Public Transport Interchanges (Covered)



Dimensions:

As provided in drawing

Principles:

- Should be located within interchange
- Must not obstruct pedestrian walkways
- Must have anti-theft mechanisms
- Can be fitted with a canopy/shelter to protect bicycles from the elements
- Bicycle rack must support the frame and must lock the frame and wheels.

Positive Aspects:

- Offers long-term parking solutions
- Can accommodate multiples of bicycles at a time

Source:

Design manual for bicycle traffic (CROW)

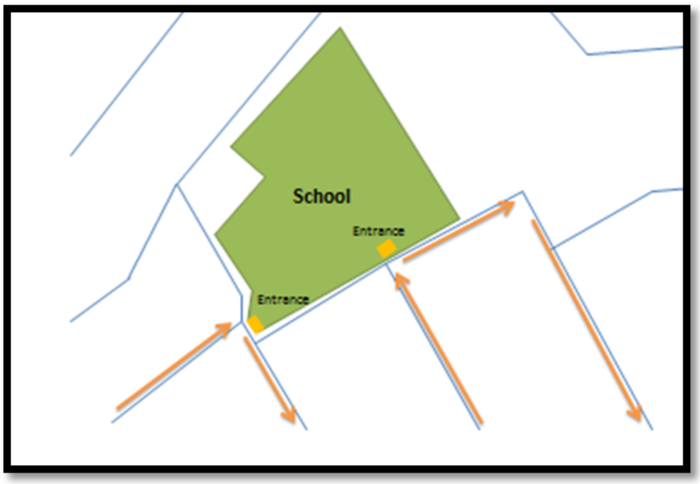
6.3 NMT Facilities at Schools

Access to schools requires special NMT attention because of the presence of both children and very high levels of traffic during drop-off and pick-up times. Traffic around schools can consist of motorised vehicles, public transport and NMT users. Thus specific design features should be employed around schools to improve the safety for all users within the school zone.

As a general norm, the sidewalk should be provided for at least 500 metre from the school entrance along the road in one or more directions (based on an origin/destination survey) after which the children tend to disperse into the rural areas. Counts must be conducted of scholars walking or cycling along the rural road to schools, which will indicate if the paved walkways should be extended beyond 500 m. The minimum width of 1.5 m is also considered as appropriate because it represents the minimum width as well for a bicycle operating lane as well.

6.3.1 School Precinct Access

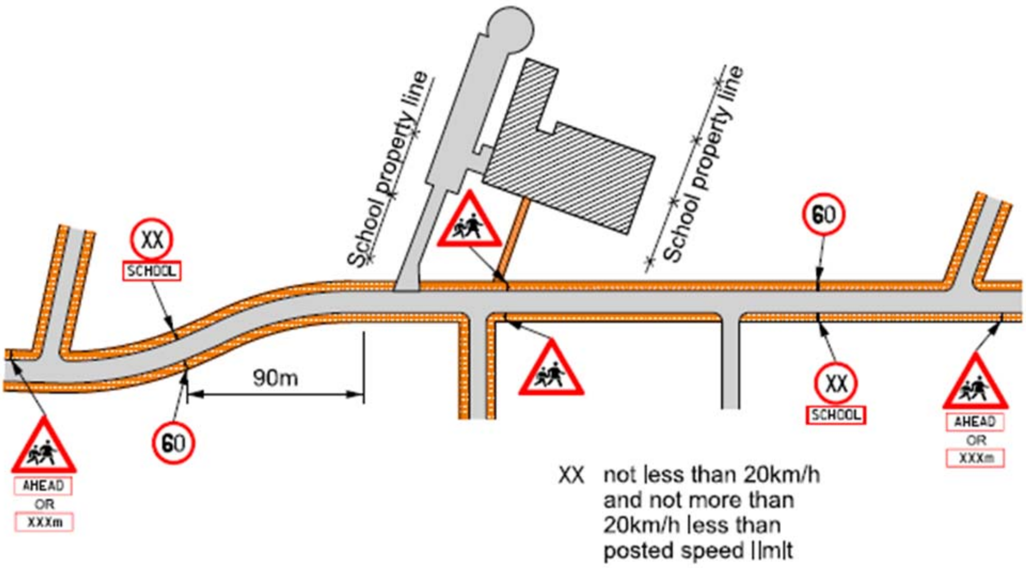
- As far as possible, it is better to have **physical separation of different modes**. The school site needs to have pedestrian and bicycle access from all directions as well as infrastructure connecting to the school property.
- Pedestrians outside the school zone are **clearly directed to crossing points** and pedestrian access by directional signing, fencing, bollards or other elements.
- For **primary schools**, the focus should be on walking and cycling routes as well as sidewalk design requirements leading up the school. One-way directional movements should be provided leading up to the school entrances.



- For **high schools**, the focus should be on connections to public transport, walking and cycling, and the radial area around the school access.
- All school site zones and cycle routes should have a **40 km/h speed limit**.
- **Traffic calming devices** (e.g. raised pedestrian crossings, refuge islands, bulb outs at intersections) are utilised to reduce vehicle speeds in the vicinity of the schools.

- The area around school entrances must be designed in such a manner to **safeguard learners because of the modal mix experienced at schools**. It is important to cater for the different travel modes as some learners will arrive by public transport (buses and mini-buses), others by car and majority on foot or by bicycle.

Schools Precinct Design Features



Dimensions:

Site dependent

Horizontal separation of motorised traffic and non-motorised users at school entrances.

Principles:

- Sidewalks leading towards the location of the school should be provided.
- Crossing facilities at all intersections near schools should be provided.
- Speed limits at adjacent streets should be cut.
- Horizontal separation at entrances should be provided.
- There should be 1 m space between the guardrail and the walkway to prevent injury to NMT users in case rails are deformed during a crash.
- Learners should be protected against sharp drop-offs next to sidewalks using handrails.

Source: Georgia DOT, 2003

6.4 NMT Facilities at Rural Schools

Road safety problems are often encountered at schools along the rural road network. Rural roads have been built as major transport corridors serving rural towns and agricultural active areas and are managed as vehicular mobility routes with little or no accommodation for pedestrians, cyclists or the needs of the rural community.

Road signage mainly serves the needs of motorists and is oblivious to the needs of the rural community, i.e. absence of signage indicating schools and the presence of learners/pedestrians adjacent to roads.

Infrastructure at schools is inappropriate for learners and the transport system requirements serving the needs of the learners such as absence of sidewalks and cyclist facilities, lack of bus shelters and embayment.

Rural speed limits over the rural road network are generally in the order of 100 km/h without any reduction in speed in the immediate vicinity of the rural schools (Cape Winelands District Municipality, Safer Journeys to Schools Strategy, 2009).

6.5 Animal-Drawn Vehicles

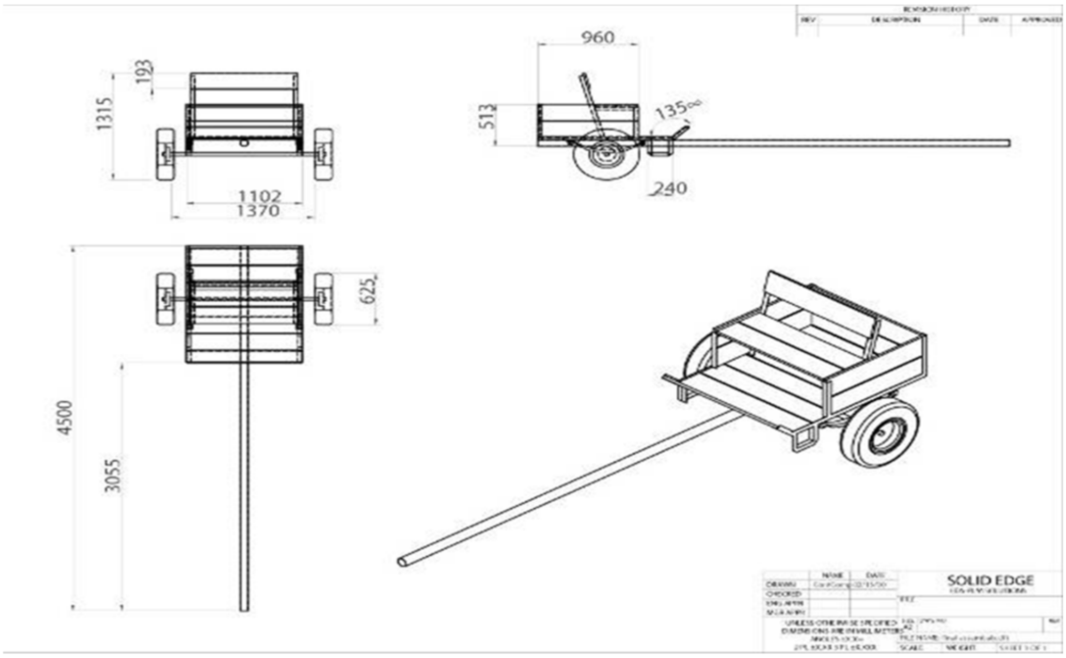
Rural transport development, as covered in the Rural Transport Strategy for South Africa, 2007, focuses on delivering rural transport infrastructure and services. It provides guidelines linking the rural road and transport planning processes with the emphasis on special rural transport initiatives such as public transport, intermediate means of transport (IMT), e.g. 'bakkies' or pick-up trucks and light delivery vans (LDVs), animal-drawn vehicles (ADV) and other low technology transport solutions such as bicycle and pedestrian walkways. Road and river bridges are also promoted in deep rural areas as part of the Integrated Rural Mobility Access (IRMA) strategy to make these areas accessible to all road users during the rainy season or flooding conditions.

In many parts of South Africa, the majority of the people who are poor live in isolated rural areas. A significant proportion of the rural population is adversely affected by badly executed accessibility and mobility. This reflects the skewness of resource implementation in the country and impacts on the quality of life in rural communities. Personal travel consumes a substantial amount of time in such areas and negatively affects potential productivity. Access to shops, post offices, schools, clinics and the greater road network are important. Improved roads in remote areas allow local produce to be sold at the markets. Taxis and buses can provide mobility and health costs can be reduced because of improved access to clinics and for emergency vehicles. Mobile and special needs services can also be introduced. The government has identified a number of deep rural areas where such accelerated service delivery has been given priority. Transport in deep rural areas is characterised by female porterage, treacherous river crossings, seasonal access and an occasional visit by a motorised vehicle. Only with great difficulty can the typical rural household gain access to the most basic services, such as local and regional markets, agricultural extension centres, health clinics, and schools. Mobility and ease of transport are essential to their everyday life and to breaking their isolation and poverty.

The Draft National Non-Motorised Transport Policy of 2008 also states that animal transportation must be seen as part of the existing road infrastructure in rural areas. This implies that:

- ADT implementation necessitates road infrastructure upgrade and improvement.
- Currently there are no or limited park-and-stop sites, and the few park-and-ride sites that exist are located far from business centres.
- The existing sites are not secure and do not have appropriate facilities such as food and water amenities.
- The current signage system is not adequate to address warning for ADV-related traffic management.
- Poor provision for NMT users along transport routes and no access for persons with disabilities.

Design Controls for Animal-Drawn Vehicles



Dimensions:

- The overall length of the cart shall not exceed 8 m in total (including the length of the shaft).
- The overall width of the cart, inclusive of its load shall not exceed 1.8 m.

Principles:

- The travelled path or minimum width of a gravel road shoulder to be used by animal-drawn transport should not be less than 2 m.
- The desirable width of the gravel shoulder on higher speed roads up to 100 km/h where animal-drawn transport vehicles are present should, however, be a minimum of 2.5 m to allow for the aerodynamic force created by faster traffic.

Remarks:

If a ramp and sufficient space is provided for people in wheelchairs to travel at the rear, the ramp should be large enough to create a 1:12 gradient so that the driver or wheelchair user does not injure themselves.

Source: South African Bureau of Standards SANS 1025 Animal Drawn Transport (Draft)

6.5.1 Geometric Design Elements of Roads

(a) Road Access and Usage

The Department of Transport policy document, titled “An Animal Drawn Transportation Policy for South Africa”, 2007, states that because the integration of access points to main roads should be the subject of careful planning, animal-drawn vehicles shall have identified spots where they enter the main road and their access points may be different from those of motor vehicles depending on the volume of traffic and the speed limitations of those access points. Furthermore, no animal transportation shall be allowed on the national freeways and provincial roads/highways where speed limits are between 100 and 120 km per hour.

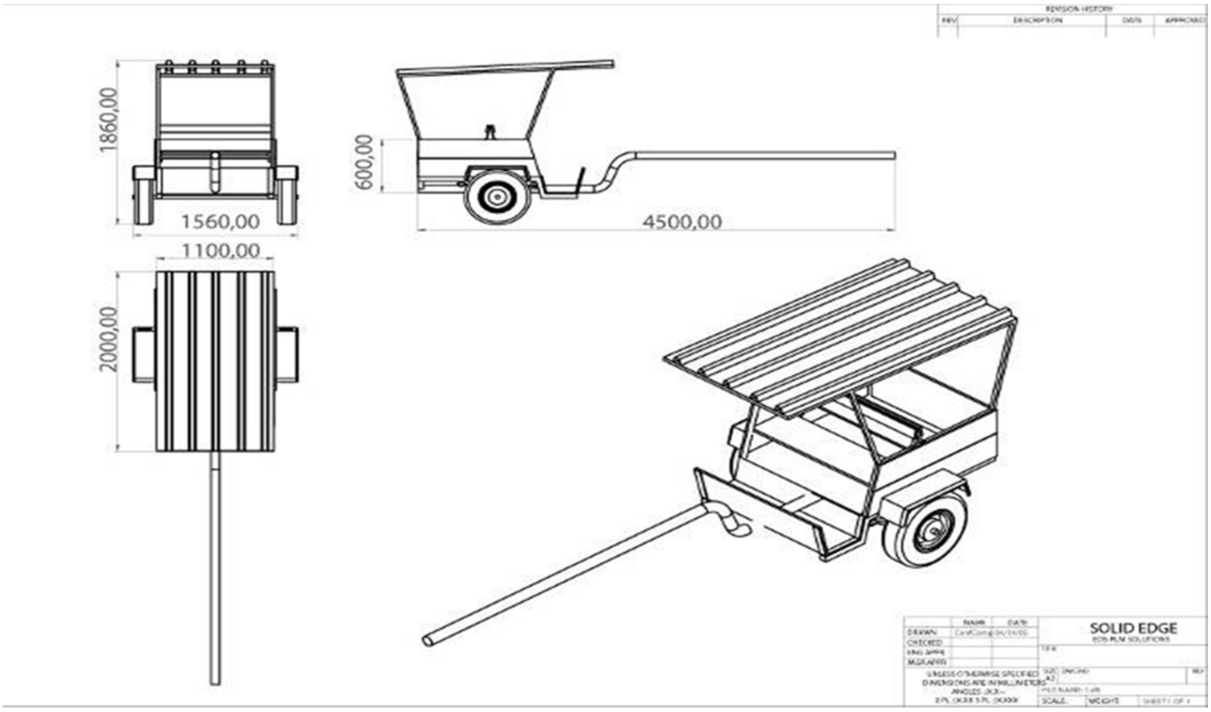
(b) Road Shoulders of Paved Rural Roads

The South African Bureau of Standards SANS 1025 specifies that the overall width of animal-drawn vehicles, inclusive of their load, shall not exceed 1.8 m. This implies that the travelled lane or minimum width of a gravel road shoulder to be used by animal-drawn transport should be 2.0 m. However, the desirable width of the gravel shoulder on higher speed roads up to 100 km/h, where animal-drawn vehicles are present, should rather be from 2.5 m to 3.0 m to allow for some clearance space between the animal-drawn transport on the gravel shoulder and the aerodynamic force of passing vehicles.

Consideration needs to be given to the movement of animal-drawn vehicles either along or across rural roads. Measurements or estimates of such movements should be made, where possible, to give a firmer basis for making decisions on the design. Some guidelines from *TRL Overseas Note 6: A Guide to Geometric Design* regarding road shoulder usage for animal-drawn vehicles and other means of non-motorised transport are:

- At very low flows of motorised traffic, the problem of interaction is likely to be small. However, care must be taken to ensure that adequate sight distances and/or warnings are given to a driver as he approaches any area of high activity such as a village.
- As flows become greater, the conflicts between slow and fast moving traffic will increase and additional widths of both shoulder and running surface may be necessary. The increase in width will vary with the relative amounts of traffic, their characteristics and the terrain and needs of the road. In view of the relatively high costs normally involved in widening, care should be taken to ensure that only those sections of shoulder are widened which are justified by local demand.

Typical Design Dimensions of Two-Wheeled Animal-Drawn Vehicles



Dimensions

- The overall length of the cart shall not exceed 8 m in total (including the length of the shaft).
- The overall width of the cart, inclusive of its load shall not exceed 1.8 m.

Principles:

- The travelled way or minimum width of a gravel road shoulder to be used by animal-drawn transport should not be less than 2.0 m.
- The desirable width of the gravel shoulder on higher speed roads up to 100 km/h where animal-drawn transport vehicles are present should, however, be a minimum of 2.5 m to allow for the aerodynamic force created by faster traffic.

Source: South African Bureau of Standards SANS 1025 Animal Drawn Transport (Draft)

There may be substantial movements of non-motorised vehicles which will generally be attracted by the surface quality and all weather properties of roads. Special provisions should be made in situations where such flows are significant with respect to the level of motorised vehicle movements.

Some localised shoulder improvements may be appropriate as non-motorised traffic generally increases near towns and villages. Where large numbers of non-motorised transport vehicles or users travel on the shoulders, the following features are recommended:

- Shoulders should be sealed.
- Shoulders should be clearly segregated by the use of edge of carriageway surface markings or other measures.
- Special crossing facilities should be provided where possible and necessary.

On high speed roads with substantial flows of motorised vehicles, non-motorised traffic should be given a separate space segregated by a physical barrier such as a kerb. Crossing movements should also be concentrated at specific locations and special crossing facilities provided. Traffic approaching these facilities should be given adequate warning and stopping sight distances which are greater than minimum values should be provided where possible.

The road shoulder along designated animal-drawn vehicle routes must be regularly maintained, well drained and free of undulations or vegetation. Special care should be taken along road sections where road shoulder width is restricted by fills, cuts or narrow bridge structures, so that animal-drawn vehicles are not endangered by other passing traffic.

(c) Service Roads in Settlements

Animal-drawn vehicles must be restricted to service roads in settlements wherever these roads are available next to or near the main road.

(d) Maximum Grade of Roads

Gradients of 10% or over will usually need to be paved to enable sufficient traction to be achieved, as well as for pavement maintenance reasons. While pedestrian and animal movements are possible on very steep inclines, some laden animal-drawn carts may find steep grades difficult to traverse because of a lack of grip. Such grades, therefore, should not be steeper than 10%. *TRL Overseas Note 6: A Guide to Geometric Design, p.20*

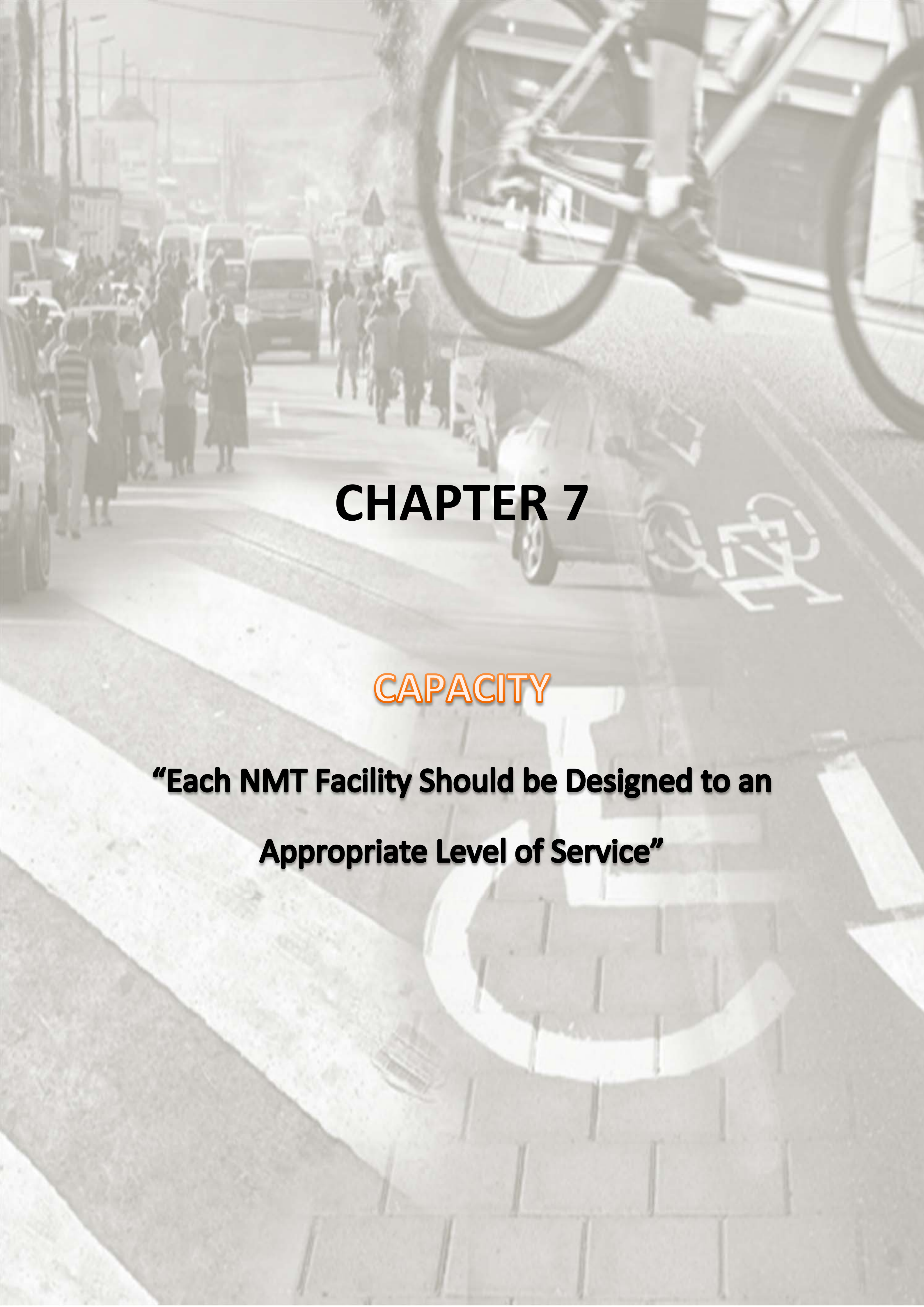
(e) Horizontal and Vertical Curvature

Special care should be taken by road authorities to ensure that in undulating landscape or mountainous areas, horizontal and vertical sight distances on roads used or crossed by animal-drawn vehicles should comply with accepted geometric design standards.

6.5.2 ADV Parking Areas in Towns

The Department of Transport policy document, titled “An Animal Drawn Transportation Policy for South Africa”, 2007, provides the following guidelines with regard to animal-drawn transport parking areas in towns:

- Where possible, towns should provide park and stop sites for the animal-drawn transport that come to their towns. As the spaces in towns may be limited to provide such a spaces and sites, the provision of such facilities should be near the end of the city limits, but not far enough for the people who use this transportation to walk to and from the inner city.
- At this parking site, food water and fodder should be provided for the animals. However, the food to be provided shall be suitable for the animals and shall be free of contamination; the water must be separated from the water to be used for human consumption but shall be potable enough for the health of the animals; and the fodder shall be what the animals are used to.
- Ventilation, if the space is enclosed, shall be provided for the animal parking places. However, enough care should be given for the animals to have as much of its natural habitat as possible and not be disturbed by the life of the city approach.
- If the space is enclosed, there should be enough space for the animal to turn around and sleep and to relax in a manner that will be natural to the animal. The need for space should not be decided on the availability of space in the city or town and the costs related to it, but should consider the natural habitat of the animal concerned.



CHAPTER 7

CAPACITY

"Each NMT Facility Should be Designed to an Appropriate Level of Service"

7. CAPACITY

"Each NMT Facility Should Be Designed To An Appropriate Level Of Service."

7.1 Walkway Capacity

Different walkway widths can accommodate different numbers of pedestrians comfortably. The Highway Capacity Manual (HCM2010) uses the Level of Service (LOS) Criteria to define the comfort in respect of congestion experienced by users.

There are several factors that influence user experience related to LOS and the HCM2010 information has been converted to metric units and is summarised in the box on the next page.

This is further summarised in **Table 7.1**:

Table 7-1: LOS Criteria for Walkways and Sidewalks

LOS	Random Situation				Platoon Situation	
	Space (m^2/p)	Flow Rate (P/min/m)	Avg Speed (m/sec)	V/C Ratio	Space (m^2/p)	Flow rate[a] (p/min/m)
A	>6	<16	1.3	<0.2	>49	≤1.6
B	>4 – 6	16 – 23	1.3	0.2 – 0.3	>9 – 49	>1.6 – 10
C	>2 – 4	23 – 32	1.2 – 1.3	0.3 – 0.45	>4 – 8	>10 – 20
D	>1 – 2	32 – 49	1.1 – 1.2	0.45 – 0.65	>2 – 4	>20 – 36
E	>0.7 – 1	49 – 75	0.8 – 1.1	0.65 – 1.0	>1 – 2	>36 – 60
F	≤0.7	Variable	< 0.8	Variable	≤1	>60

Source: HCM, 2010

The table shows the significant difference between the two situations where platoons are dense within the platoon while needing more space to spread out.

Experience has shown that the most appropriate procedure for assessing congestion is to determine and monitor the V/C ratio over time. Where delays occur at intersections, the average travel speed should also be determined. However, when the LOS is back-calculated using this procedure the result is very often LOS of E or worse. However, users will normally put up with slightly lower levels of service for the short duration spent at intersections and a one level poorer LOS can be allowed.

Pedestrian Capacity Concepts and Calculations

Effective Sidewalk Width = W_E = Total Width – W_O - W_S

W_O = Fixed object adjustment (inside and outside) – example could be up to 1m for a row of trees

W_S = Shy distance adjusment (inside and outside) - 1m for display window, 0.6m for building and 0.4m for fence and kerb - weighted by percentage

Therefore for a 3.5m sidewalk alongside a building/wall with light poles 0.4 back from the kerb

$W_E = 3.5 – W_O\{0.4\} – W_S\{0.6+0.4\} = 2.1$m

Ped Free Flow Speed = S_{FS} = 1.3m/sec for normal situations -reduces to 1.0m/sec for > 20% elderly

Pedestrian Flow Rate = V_P = peds /min/ m of effective sidewalk width in both directions

If pedestrian counts are normally carried out for 15 minute intervals then the above is calculated as:

V_P = (15 minute count in both directions /15) / W_E)

Average Ped Walking Speed = S_P

$S_P = (1\text{-}0.000073 \times V_P^2) \times S_{FS}$ (m/s)

Average Travel Speed = $S_{TP,seg}$ (m/s)

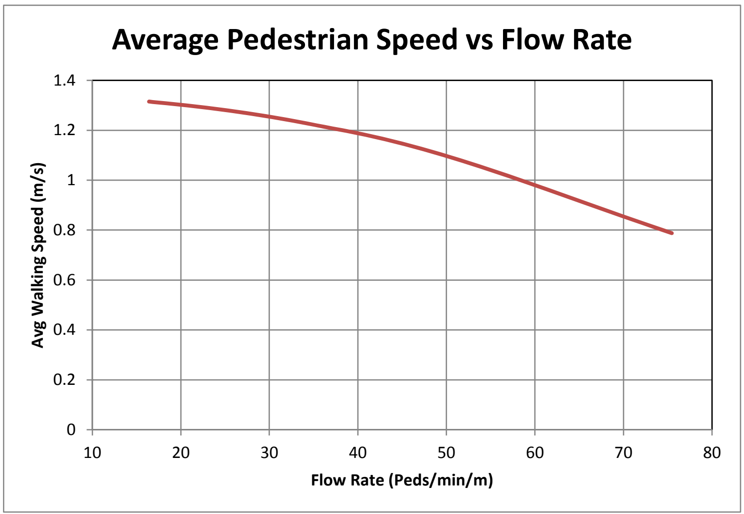
$S_{TP,seg} = L/ (L/S_P + D_{PP})$ where:

L = Segment length (m)

D_{PP} = delay at intersection in the direction of travel. (secs)

Example: 200m segment, 30 sec delay, walking speed = 1.3m/s

$S_{TP,seg} = 200/ (200/1.3 + 30) = 1.1$m/s



Walkway Capacity = Pedestrian flow rate of between 60 and 75 Peds / minute / m depending on whether the situation has extensive platooning such as with traffic lights or Public tranport drop - offs (60) or if the situation represents random flow (75). On stairs this reduces to 50 P/min/m

Pedestrian Space: $A_P = W_E \times L_E$/ Number of Pedestrians on the sidewalk at any one time.

Also $A_P = (60 \times S_P)/V_P$

Example: At Capacity of 60 peds /minute/ metre A_P= 60 x 0.96/60 = 0.96 sqm /Ped

Facility Data = sum of segment data weighted by length.

Pedestrian LOS Score = A HCM system for estimating how pedestians would rate the LOS based on a wider range of physical factors and lined with a midsegment flow rate – HCM2010 Vol 3 page 17-50.

7.2 Waiting Areas

The average space available to pedestrians also applies to walkway service and waiting areas for traffic lights. The LOS thresholds are listed in **Table 7-2**.

Table 7-2: LOS Criteria for Pedestrian Queuing Areas

LOS	Space (m^2/p)
A	**>1.2**
B	**>0.9 – 1.2**
C	**>0.6 – 0.9**
D	**>0.3 – 0.6**
E	**>0.2 – 0.3**
F	**≤0.2**

Source: HCM, 2000

The designer should carry out quick calculations to determine whether there is sufficient space at intersections to accommodate pedestrians waiting for traffic signals. For example:

- assuming a 0.6 minute red signal time, and
- a sidewalk width of 3.5 m,
- a flow rate of 600 p/15 minutes, and
- means that 600/15 x 0.6 = 24 people will arrive at the signal while red.

They will stack into a 2 m deep area at B giving a space per person of:

(2 x 3.5) / 24 = 0.29 m^2 / person - borderline LOS D/E from Table 7-2

There are two types of pedestrian space requirements at street corners. First, a circulation area is needed to accommodate pedestrians crossing (See **Table 7-2**). On the other hand, there is a need for holding areas for people that want to cross the road. Especially on signalised intersections, holding space requirements must be determined.

The methodology used to calculate these three areas can create problems that may require detailed field study and possible remedial measures (Special Report 209, 1994). Corrective measures could include widening the sidewalk, adding a splay across the corner, adding restrictions on vehicle turns, and changing the signal timing.

For further information, the reader needs to refer to the HCM documentation.

7.3 Bicycle Congestion

The HCM2010 provides some guidance in this regard and the following factors need to be considered to come up with a LOS:

- Number of passing events experienced by a cyclist,
- Number of meeting events where two way traffic is allowed, and
- Bicycle demand in the same and opposite directions.

While the HCM2010 makes it clear that there are many considerations to determining bicycle LOS, a simple network level approach is required as shown in the box alongside:

These equations may also be applied to one-way bicycle facilities, with V_O set to zero.

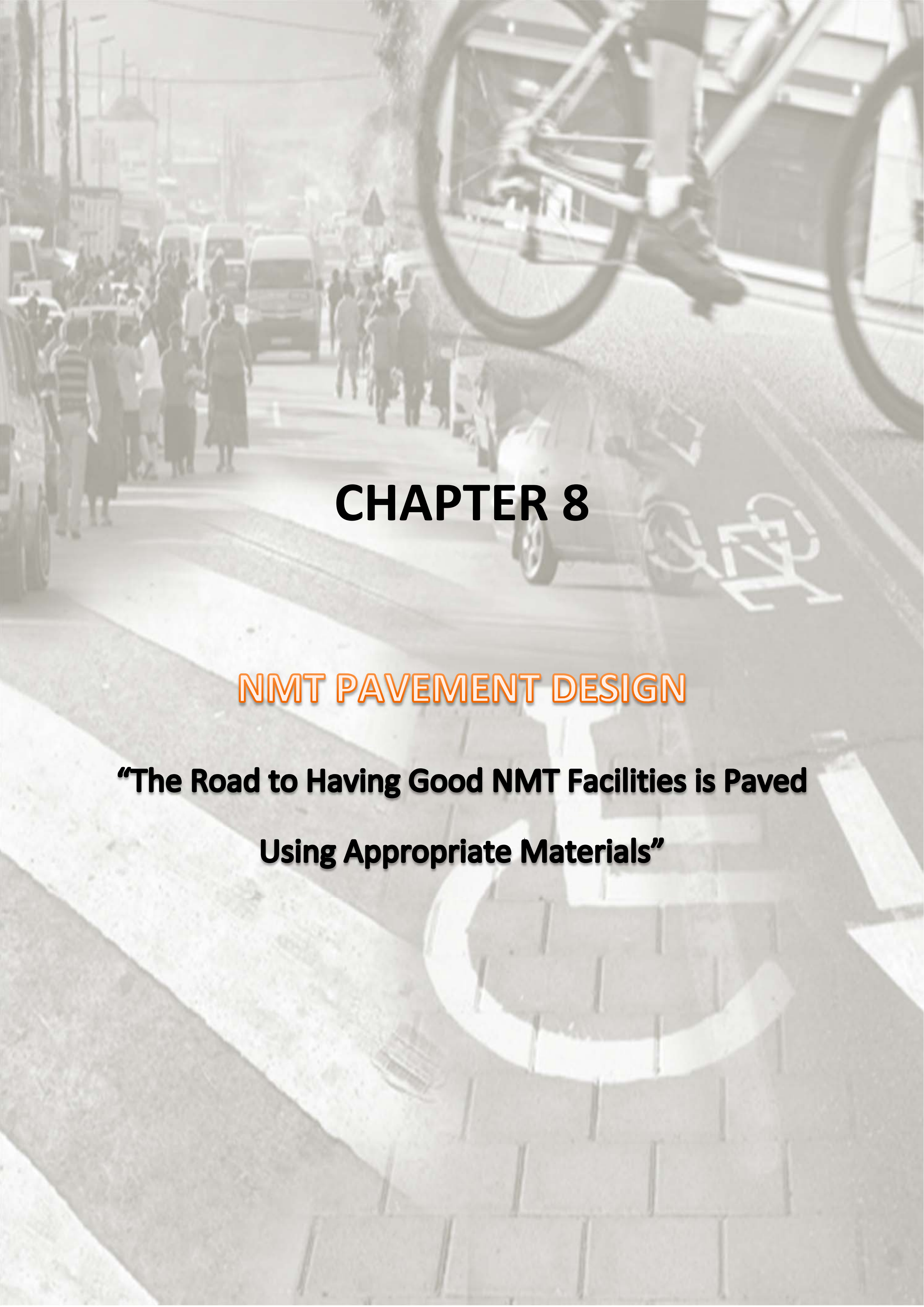
The equations for computing the number of events are based on an assumed normal distribution of bicycle speeds with a mean speed of 18 km/h and a standard deviation of 3 km/h (HCM, 2000). There is currently no research available to verify if these standards are applicable to South Africa.

The results of using these equations are reflected in the table below:

LOS	Total Event Rate /h	Bi-Directional Flow		One-Way Flow	
		Service Flow Rate (Bicycles / hour in both directions)	V/C Ratio	Service Flow Rate (Bicycles / hour)	V/C Ratio
A	<38	<60	<0.1	<200	<0.2
B	38 – 60	60 – 100	0.1 – 0.3	200 – 320	0.2 – 0.3
C	60 – 100	100 – 175	0.3 – 0.6	320 – 550	0.3 – 0.6
D	100 – 145	175 – 250	0.6 – 0.8	550 – 750	0.6 – 0.8
E	145 – 180	250 — 300	0.8 – 1	750 – 1,000	0.8 – 1
F	> 180	Variable	> 1	Variable	> 1

Therefore, a single-lane facility with bi-directional flow has a capacity of around 300 bicycles per hour in both directions, while a one-way, single-lane facility has a capacity of around 1,000 bicycles per hour.

Bicycle Capacity Concepts and Calculations - Single 1.5 m Wide Bicycle Lane Facility		
Active Passings per Hour =	$F_P = 0.188 \times V_S$	Botha (1995)
V_S= flow rate of bicycles in subject direction (bicycles/h)		
Meetings per Hour	$= F_M = 2V_O$	Botha (1995)
V_O= flow rate of bicycles in opposing direction (bicycles/h).		
Total Event Rate per hour	$= F = F_P + 0.5\ F_M$	HCM2010
Therefore, because $V_S = V \times P$ and $V_O = V \times (1 - P)$ where P is the % flow in the subject direction		
Then	$F = 0.188(V \times P) + 0.5 \times 2 \times V \times (1-P)$ and	
The Total Flow Rate at each Total Event Rate F is $V = F/ (1 – 0.812\ P)$		Botha (1995)
Mixed facilites will have higher passings and meeting per hour and lower overall service flow rates		
Research is required to continue to verify the formuli and values shown and to improve overall assessments of levels of service, speeds and conflicts.		



CHAPTER 8

NMT PAVEMENT DESIGN

“The Road to Having Good NMT Facilities is Paved Using Appropriate Materials”

8. NMT PAVEMENT DESIGN

"The Road To Good NMT Facilities Is Paved Using Appropriate Material."

8.1 Introduction

South Africa has significant pedestrian movements in most areas. To maintain and support the growth in the pedestrian demand levels in the country, walkway and crossing facilities need to be comfortable and safe.

Surface finishes and the underlying pavement are an important element in creating appropriate NMT mobility routes and access to services. Requirements for the realisation of appropriate NMT surfaces include:

- Smooth and even surfaces
- Stable pavement structures
- Sufficient surface friction/traction
- Obstruction free
- Well drained
- Appropriate sight lines with clear signage and road furniture
- A welcoming ambiance.

When selecting surfacing materials, user requirements need to be matched to available local materials, budget constraints and maintenance requirements. Although NMT facilities do not carry heavy traffic, the in-situ soil need to be prepared thoroughly to provide adequate support and prevent deformation over time.

Although this chapter refers to maintenance, it is only referenced in terms of the ease with which the surfacing can be maintained and whether or not the materials can be re-used. Lack of maintenance resulting in uneven surfaces, missing pavers and the like can cause hazardous environment for NMT users and is addressed in **Chapter 9**.

Many different materials can be used to surface NMT facilities and these are shown in the following box. The South African Pavement Engineering Manual (SAPEM), COLTO standard specifications, SANS 10400 Part S, and manufacturers guidelines all need to be used when designing and constructing paved surfacings.

Uneven surfaces, steps with irregular risers or open risers on flights of stairs are likely to cause persons with visual impairments to trip and injure themselves. Quality of workmanship is extremely important in avoiding gaps between surface finishes, raised thresholds, and to ensure that all steps have uniform risers.

Environments should be well managed to avoid hazards developing, such as those caused by the disintegration of a surface, or vegetation growing over a pathway.

NMT Paving Materials

Brick Pavers

Cast-in-Situ Concrete

Pre-Cast Concrete (PCC) Slabs

PCC Slabs that Mimic Stone

Gravel

Asphalt

8.2 Clay and Concrete Brick Pavers

Brick pavers are an appropriate surface for walkways and sidewalks and come in a variety of colours and strengths. If implemented well with the correct foundations below the pavers, brick paving creates attractive environments. Laying brick paving is also more labour intensive than some other surface options. In the long-term, maintaining good quality brick paving is cheaper than many other materials, as pavers can be re-laid if deformation of the surfacing takes place or the area needs to be removed and replaced in order to work on an underground service. Pavers can also be re-used multiple times.

The Concrete Manufacturers Association (CMA) guidelines should be consulted when considering brick paving options and specifications.

Substantially bevelled brick pavers are not recommended for bicycle lanes and pedestrian walkways in view of the roughness and noise levels can cause irritation if trolleys are used on brick pavers.

8.3 Cobbles and Natural Stone

Natural stone, from large paving slabs to stone cobbles, can be applied in different ways but are seldom used in South Africa.

8.4 Concrete Slabs

Concrete slabs have been overtaken by concrete bricks in popularity as a form of paving for walkways. Recently, South Africa has even seen the introduction of concrete slabs that look like natural stone which can be obtained in various shapes and sizes.

South African practice uses large concrete paving slabs for the surfacing of NMT facilities. If installed correctly, good levels and stability can be achieved.

Figure 8-1: Deformation at Joints in Concrete Slabs

If the surface becomes uneven, levelling and maintenance operations are difficult and it is very difficult to re-use concrete slabs in the long term. Noise levels on concrete slabs are less than the levels on brick, natural stone and concrete paving.

Concrete slabs are comfortable for all NMT users but must be laid on well-constructed and stable foundations to minimise deformation.

8.4.1 Cast-in-Situ Concrete Slabs

Cast-in-situ concrete is used extensively for NMT paving. Levels and stability are easy to achieve if the correct construction practices are used. Adequate friction/traction is achieved by brooming the surface in the correct manner when wet. If serious damage occurs, parts of the concrete surface will have to be removed and replaced. Recycling will involve crushing of the concrete slabs which requires economies of scale to be viable.

Cast concrete surfaces are very comfortable for all NMT users. Cast-in-situ concrete surfaces are generally less aesthetically pleasing than bricks and natural stone but this can be remedied to a degree by improving the surroundings through gardening and/or by applying special proprietary surface patterns and finishes to the wet concrete.

8.4.2 Cast Concrete Slabs with Patterns

In recent years, applying patterns to concrete/asphalt has become fashionable. Natural stone patterns are most common. By creating these patterns, the aesthetical disadvantage of cast concrete is addressed, while stability and durability is provided. Unfortunately, the discomfort of natural stone paving for users, including increased noise levels, will come back.

8.5 Bituminous Surfacings

Bituminous surfacings can be considered where aesthetics and durability are less important and where large areas are to be constructed. Bituminous NMT facilities are stable and no friction/traction issues have been reported other than on painted road markings.

Typical surfacing adopted are either asphalt or slurries which are both suited to the needs of all NMT users. Asphalt surfaces are highly recommended for cycling facilities as a good surface finish can be achieved through good construction practices.

The use of these types of surfacing requires that greater care be given to the pavement structure than with thicker concrete and brick surfacings.

Bituminous surfacings do not have a high aesthetic appeal and colouring is expensive. A pre-cast concrete edging is recommended to provide good line and level of the pavement.

A pre-cast concrete edging is recommended to provide good line and level of the pavement.

Figure 8-2: Wheelchair and Scooter Wheel Challenges on Bituminous Surfaces

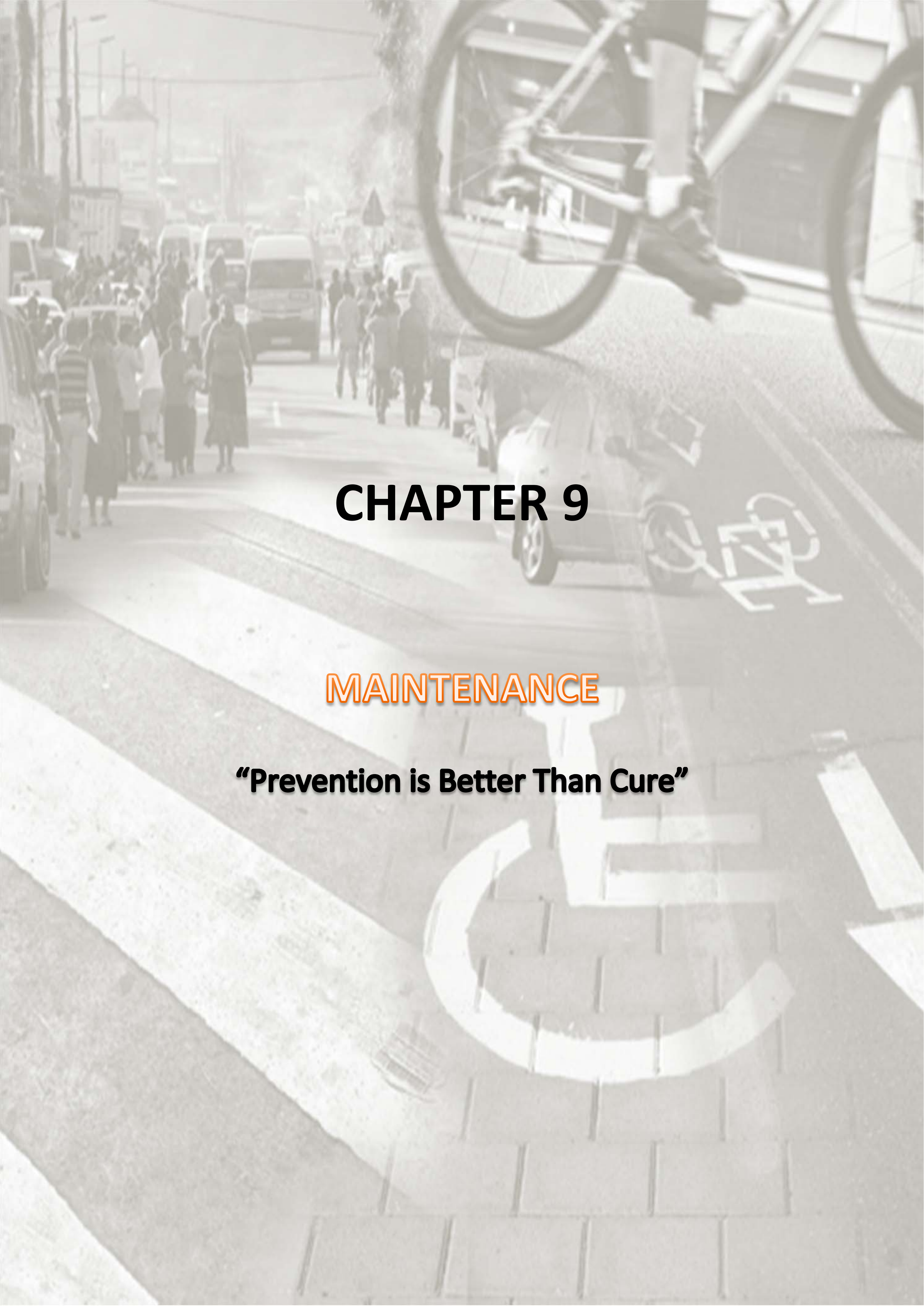
8.6 Resume

This chapter has provided an overview of the characteristics, advantages and disadvantages of surface materials. A summary of the surface characteristics is provided in **Table 8-1**.

Table 8-1: Summary of Surface Characteristics

Type	Levelling	Stability	Friction/ Traction	Comfort	Noise	Recyclable Material	Recommend
Clay pavers	++	++	++	++	--	++	Yes
Cobbles	-	+	+	--	---	++	With Caution
Natural stone[a]	+	++	+	+	--	++	Yes
Concrete pavers	++	++	++	++	--	++	Yes
Concrete slabs	+++ (new) - - (old)	++	++	++ (new) -- (old)	-	---	No
Cast concrete[b]	+++	+++	++	+++	++	--	Yes
Pattern concrete	+	+++	++	--/+[c]	--	--	With Caution
Asphalt	+++	+++	++	+++	++	--	Yes
Unsealed gravel	---	---	---	---	---	+++	No
Sealed gravel	++	++	++	+++	++	+	Yes

a = Friction of granite can be problematic
b = Friction of poured concrete needs to be attended to during installation
c = Depending on the pattern



CHAPTER 9

MAINTENANCE

“Prevention is Better Than Cure”

9. MAINTENANCE

"Prevention Is Better Than Cure!"

9.1 Introduction

When construction has been completed the NMT facility enters various operational stages, including:

- Recording of the asset on the asset register as soon as the capital works are completed.
- Initial bedding in and defects liability period occurring soon after construction.
- Damage and related repairs of underlying pavement layers due to settlement, trees, vegetation, vehicles or heavy equipment.
- Preventative maintenance to guard against moisture ingress and moisture accelerated distress.
- Terminal condition and rehabilitation.

These stages need to be carefully managed to maximise the life of the facility and its performance. Monitoring the performance of assets and the related Asset Management Systems (AMS), as well as project level repair and rehabilitation assessments, provides the tools to identify and prioritise problems and to attend to them timeously.

9.2 Management Systems

Asset management systems represent a range of technical tools used to meet the strategic, tactical and maintenance scheduling needs of the road authority. They form an important element of the greater asset management framework.

Asset management systems take on a variety of forms, with varying complexity and are described more fully in TMH22. An essential element of a modern AMS is a well-integrated database in which to store the road definitions and the related data. The asset definition dataset sets out how the assets are identified and laid out. It forms the basis for storing all other data associated with individual assets.

While the management of road pavements and related maintenance practices are well established, the maintenance of NMT facilities tends to receive less attention. In addition, most NMT facilities are viewed as components of road assets and separate condition monitoring and prioritisation is seldom carried out.

This chapter describes the activities and actions that need to be taken by the parties involved in managing the NMT facilities pavement to ensure longevity and achievement of the expected performance, or better.

9.3 NMT Inventory

The NMT Inventory and asset register will include the many details for each NMT asset or component in the system.

All inventories have a hierarchy and in the context of NMT assets as shown below:

- Facility: Complete bicycle lanes, walkways, bus stops, bicycle sheds, etc.
- Asset: Individual links or separately identified assets that make up the above facility such as shelters, etc.
  - Components: Individual elements of the asset such as sidewalks, walkways, pedestrian crossings, roofs, area lights, benches, etc.

NMT assets that form part of higher order transport assets such as roads and bridges are regarded as components of those assets and are linked to them. For example, a road sidewalk is typically a component of the street and uses the street name to identify the asset. NMT assets that are part of a separate integrated NMT facility are regarded as assets and components of that facility and are linked to it. For example, a bicycle lane from the CBD to a suburb would form a facility with each link being an asset of that facility.

Other minor NMT components include pedestrian crossings of roadways. These are generally located at all intersections as well as at other isolated locations between intersections. It is suggested that this occurs when a separate pedestrian traffic signal is installed such as where pedestrian volumes are high in CBDs, etc.

The inventory details of NMT facilities can be collected in accordance with the guidelines provided in the TMH22 Road Asset Management Manual with the following additional unique attributes.

Sidewalks and NMT facilities are normally classed as components of the associated road asset and are grouped as such in the TMH22. An NMT facility not linked to any adjacent road is regarded as a separate asset.

Typical attributes of the NMT asset that should be captured include:

(a) NMT Traffic Category

- High volume
- Medium Volume
- Low Volume

(b) NMT Asset Types

- Dedicated NMT walkways and bicycle lanes
- Covered walkways
- Bicycle racks and sheds
- Public transport Interfaces specifically for NMT
- Pedestrian and bicycle bridges
- Pedestrian and bicycle underpasses.
- Traffic calming Infrastructure
- Street crossing infrastructure

- Signaling
- Parks
- Seating and street furniture
- Wayfinding or Signage

(c) NMT Component Types

- Sidewalk (component of the adjacent street)
- Cycle path (component of the adjacent street)
- Kerb
- Barriers
- Gardens
- Trees along walkways

The bus stop itself will form part of the public transport assets.

(d) Materials

- Slurry
- Concrete
- Bricks/Blocks
- Earth
- Cast iron

Asphalt
Paving slabs
Gravel
Painted steel

(e) Geometry

- Width
- Thickness
- Pattern

Length
Height

(f) Standard

High - e.g. paved with edge support as required

Medium - e.g. paved with minimal edge support

Low - e.g. unpaved

Very Low - e.g. earth track

(g) Separation

The degree of separation between the NMT facility and vehicles is one of the most important elements of safety of NMT facilities. The six degrees of separation are defined above in Chapter 4 and include:

i. **NMT Only** - a separate asset and removed from vehicular traffic over most of its length.

ii. **Total** - means no conflict will occur between motorised and NMT even in the event of loss of control of the motorised or NMT vehicle. It can be achieved by means of a physical fixed barrier or sufficient separation of >2 to 9 m depending on circumstances.

iii. **Partial** - means no conflict can occur under normal operating conditions. This is generally achieved by means of a level difference between the travelled ways such as a kerb and sidewalk or by means of temporary barriers.

iv. **Marked** - on the same surface but separated by means of continuous road markings or a difference in surface texture, such as on a rural road shoulder, for example.

v. **Priority** - a section of the road where NMT has priority and slow speeds are mandatory but no continuous road markings.

vi. **None** - NMT competes with motorised vehicles for space on the road.

9.4 Condition Monitoring

Condition monitoring of the NMT elements should be carried out in a cost-effective manner. This is often done yearly as an adjunct to the road inspections.

While the TMH9 Pavement Visual Inspection Manual provides guidelines of detailed inspections of roads, these should not be carried out routinely on NMT facilities. The distress on these facilities is not traffic-related but more a function of isolated incidents and occurrences that require occasional rather than routine cyclical maintenance.

Therefore, the TMH22 generic indicators of condition and functional rating for each NMT element should be used. In addition, an ambiance rating is included to assess the attractiveness of the NMT facility. This is shown in **Table 9-1**.

Table 9-1: NMT Asset Condition and Functional Ratings

Rating	1 - Very Good	2 - Good	3 - Fair	4 - Poor	5 - Very Poor
Condition Rating	Asset is still like new and no problems are expected.	Asset is still in a condition that only requires routine maintenance to retain its condition.	Some clearly evident deterioration and would benefit from preventative maintenance or requires renewal of isolated areas.	Asset needs significant renewal or rehabilitation to improve its structural integrity.	Asset is in imminent danger of structural failure and requires substantial renewal or upgrading.
Functional Rating	Good service levels at all times	Mostly good service levels with isolated problems occurring at peak times	Reasonable service but with intermittent poor service	Generally poor service levels with occasional very poor service being provided.	Very poor service levels at most times.
Ambiance Rating	Very attractive facility with visible security that invites usage	Isolated unattractive elements that have only little effect on potential usage	Intermittent unattractive and unsafe elements that should be improved to increase usage	Generally unattractive and unsafe facility that requires substantial improvement to attract users	Very unattractive and unsafe facility that scares away everyone except captured users

9.5 Usage

The usage of NMT facilities is typically measured using 15-minute counts in the peak hour and expanding this to a full day count using a peak hour factor (persons in the peak hour/ persons per day). These counts include the following parameters:

- Count,
- Duration of count,
- ADP: Average daily persons that use the facility measured in both directions over 24 hours,
- Mode (%): Walk, Cycle, Animal, Wheelchair mobility,
- Type of usage: Commuter, School, Recreation,
- Peak Hour Factor: Ratio of peak hour volumes as a percentage of daily volume. Typical default values for this are: Commuter - 15%, School - 20%, Recreational - 20%, General - 12%

The hourly volume should be compared with the capacity of the facility as set out in Chapter 8 to determine the V/C ratio for each asset and assets with V/C ratios in excess of 0.6 should be identified and assessed in more detail for expansion/ upgrading.

9.6 Stakeholder Requirements

This involves formal statistical surveys of stakeholders that could include a number of questions to determine the safety, comfort and convenience of NMT.

9.7 Situational Analysis

A situational analysis can be carried out from the information gathered on the enumerated list above.

9.7.1 General Statistics

The first step in this analysis is to present the data that has been collected in a meaningful manner in order to identify problems and opportunities. This includes providing information such as the following:

- Length and area of each type and class of NMT asset,
- Sum of person-km daily NMT movements on the NMT assets by type, mode, class and degree of separation,
- Summary statistics of stakeholder surveys indicating the degree to which needs are being satisfied,
- Pedestrian accident records and number of pedestrian accidents within the project scope and at individual areas and places,
- Length of assets operating at a V/C > 0.6 (volume and capacity),
- Number of assets that do not cater for universal access,
- Number of people with disabilities and whether their NMT requirements have been accommodated, and

- Maps of NMT facilities and assets overlaid with a set of desire lines that need to be satisfied over time.

9.7.2 NMT Condition and Service Levels

The condition and functional ratings can be used to develop a Condition Index (CI) that expresses the overall degree of comfort being experienced by users that use NMT facilities.

An overall composite condition index (CI) can be established that can be improved over time as more data becomes available with a greater degree of understanding of the problems that exist. As a first approximation, a CI can be calculated as follows:

CI = 100 – 3.33 x (CR x FR x AR) where:

CI = Condition index: (100 for very good and 0 for very poor)

CR = Condition Rating (1 for very good to 5 for very poor)

FR = Functional Rating (1 for high service level to 5 for low service level)

AR = Ambiance Rating (1 for very attractive to 5 for very unattractive)

The number of user experiencing a CI of less than 50, or less than the required intervention levels, can be determined and reported upon.

CI intervention levels can be set for each class of NMT asset with the following initial guidelines. These will need to be adjusted depending on budget constraints.

Arterials: Minimum 50

Collectors: Minimum 40

Access: Minimum 35

Figure 9-1: High Sidewalk Ambiance

9.7.3 NMT Safety

NMT safety includes the number of NMT users on arterial and collector roads that are not at least partially separated from vehicles as set out above.

It also includes NMT accident statistics for the area in scope and individual accident black spots. These can be plotted on the NMT maps discussed.

9.8 Maintenance Needs

Maintenance needs for NMT facilities involve the following:

Table 9-2: Maintenance Categories

Need Category	Description
Routine Maintenance – Cyclical (1 to 3 years)	This involves all routine cyclical activities that are carried out on a daily basis and include: • Garden and vegetation maintenance • Line-marking maintenance • Lighting / signals – lamp replacement
Routine Maintenance – Condition	This involves all condition or event driven repair activities that are carried out at short notice and include: • Repair of NMT components • Crack sealing and patching • Reinstatement of line-marking • Minor repairs • Reshaping
Periodic Maintenance (5–7 years)	This involves longer term cyclical activities such as: • Surfacing rejuvenation and thin slurries • Replacement of road sign faces
Special Maintenance Condition	• Replacement of parts • Major repair of damage
Reconstruction	Reconstruction/replacement of the assets
Expansion	Expansion of the NMT facilities due to increased usage
Upgrading	Upgrading of a NMT facility from one type/ class to another
New Facilities	Construction of entirely new facilities

There are no appropriate norms and standards in South Africa for maintenance needs in terms of annual budget provisions. Fortunately, properly constructed NMT facilities normally require less maintenance than roads in view of lighter loadings. However, NMT facilities have generally been neglected in the past and the new initiatives towards improved public transport will mean more use of these facilities. Hence, greater attention is required to allot a budget for their development, operations and maintenance.

Table 9-3 has been produced to initiate this process.

Table 9-3: Indicative Maintenance Needs

	Arterial	Collector	Access
Maintenance Need (R/sq./year)	R10	R7	R5
Reconstruction and Upgrade Need	Depending on condition		

9.9 Maintenance Activities

While the above sets out the processes related to long term asset management related to NMT facilities, maintenance is carried out on a daily basis by maintenance managers and their maintenance crews. There are several guidelines in respect of maintenance of roads with the SANRAL Routine Maintenance Manual (RRM) being one of the most recent. "The intention of the manual is to provide guidance which will assist the Site Management Team to:

- Appreciate the various aspects of road management, priorities, safety, environmental issues, materials and equipment.
- Identify various problems that need attention.
- Understand the reasons for the problems.
- Select suitable actions or repair methods.
- Prioritise actions required.
- Have a systematic approach to maintenance work which is in step with the other national routine maintenance contracts.
- Provide guidelines as to how maintenance activities should be carried out.

The RRM provides comprehensive maintenance guidelines for roads and should be used as a basis by road authorities to develop their own maintenance practice guidelines in respect of the NMT facilities under their control.

The table of contents of the RRM manual is reproduced below to introduce the various elements of good maintenance practice.

Table 9-4: SANRAL RRM Manual Content

No	Chapter	Content	
1	INTRODUCTION		
2	ROAD MANAGEMENT	Management Duties and Inspections	Pavement Information
		Management Strategy	Contract Rates and Quantities
		Availability of Materials	Maintenance Problems
		Methods for Addressing Problem Area	Community Engagement
		Capacity Building	Special Circumstances
3	PRIORITIES		
4	ROAD SAFETY	Introduction	Hazardous Locations
		Signs and Road Markings	
5	ENVIRONMENTAL MANAGEMENT	Introduction	
		Environmental Management Plan (EMP)	Other Environmental Information
6	OCCUPATIONAL HEALTH AND SAFETY		
7	ROAD PAVEMENT REPAIRS - GENERAL	Introduction	Equipment
		Asphalt Mixes and Mixing	Repair of Road Failures
		Materials	
8	ROAD PAVEMENT REPAIRS - FLEXIBLE PAVEMENTS	Surfacing Failures	Reinstatement – Block Paving
		Pavement Failures	Deformation
		Pumping	Potholes
		Texture	Cracks
		Shoulders – Gravel	Shoulders - Surfaced
9	ROAD PAVEMENT REPAIRS - RIGID PAVEMENTS	Introduction	Loose/Spalled Concrete
		Joints/Open Cracks	Weeds
10	DRAINAGE	Introduction	Drainage Maintenance
		Erosion Control	
11	GEOTECHNICAL AND SLOPE STABILITY	Introduction	Slope Management System
		Response	Soil / Rock problems
12	ROAD RESERVE MANAGEMENT	Introduction	Litter
		Barriers	Fencing
		Rest Areas	Control of Vegetation
		Site Disturbance	Arrestor Beds
13	MAINTENANCE OF STRUCTURES	Introduction	Retaining Structures
		Routine Maintenance Inspections	Inventory of Structures
		Gantries	Graffiti
14	STATUTORY CONTROL	Introduction	Areas of Statutory Control
15	INCIDENT MANAGEMENT SYSTEM	Introduction	Incident Management Guideline Plan
16	QUALITY CONTROL SYSTEMS	Site Management Procedures	Road Safety
		Material Control	Financial control

Some aspects of NMT facility maintenance are very important and should be focused on ensuring user comfort and safety. These include aspects such as:

- Surface maintenance to prevent small potholes and deformation that can be much more serious in the case of NMT than for motorised traffic
- Regular maintenance of areas where tree boles expand and damage the pavement. The use of a light bituminous surfacing can help to manage this situation as shown in **Figure 9.4.**
- Regular re-shaping and compaction of gravel wearing courses to ensure good ability to ride and universal access
- Good and regular maintenance of surroundings and gardens to maintain ambiance and promote a secure environment
- Continuous awareness and intervention on dangerous situations and crossings and traffic conflict zones
- Continuous monitoring of drainage situations and attending to water ponding and erosion
- Continuous monitoring of road signs and road markings to retain awareness by drivers of motorised vehicles
- Continuous awareness of areas where dusk and night-time accidents occur and installation of road studs and lighting to reduce accidents

Figure 9-2: Push Cart Stuck in Small Surface Defect

Figure 9-3: Wheelchair Punctured by Loose Stones

Figure 9-4: Tree Boles Protected with Asphalt (Sydney)

CHAPTER 10

OPERATIONS

10. OPERATIONS

Operation of NMT facilities requires a good understanding of the needs of users and how to ensure continuous improvement and use of the facilities at all times. This chapter describes some aspects of the operations that need to be considered to promote and improve NMT usage and achieve the goals and objectives as set out in Chapter 3.

10.1 Safety

Safety and security of users of NMT facilities is an essential operational element. All high volume facilities should be under constant surveillance by means of CCTV and visible policing.

10.2 Training of Drivers and Pedestrians

Training of NMT users is an important element of NMT usage that requires attention. For example, in South Africa cyclists may not use walkways. This is problematic for users still learning how to bike, such as young children. From a safety perspective it is not recommended that young children learn to bike in the space of road reserved for motorised traffic. A change of the legislation may be required to accommodate the needs of young children. Alternatively, areas within local schools and community facilities should be set aside for this purpose.

The training of users and availability and use of reflective jackets and other safe practices needs to be provided on a regular basis.

10.3 Reflective Clothing

Visibility of NMT users and learners en route to school along roads is an important road safety consideration. The use of reflective bands is an important means to make people more visible along rural roads. Various campaigns have been launched to promote the use of reflective bands and jackets and these should be expanded and continued on a regular basis.

10.4 Rural School Cycling Programme

The **Shova Kalula Bicycle programme** has been introduced to several schools in rural areas across the country to assist learners who live far away to access the nearest school. The bulk of learners walk long distances to school, either because there is no available public transport or because public transport is unaffordable.

Figure 10-1: Bicycle Lockup at Schools

The Shova Kalula (Pedal Easy) project is supplying bicycles to some children in rural, semi-rural and peri-urban areas who walk more than 3 km to get to school. An important consideration is to provide secure lock-up facilities at schools to ensure that bicycles are secure.

10.5 Cycle Rental Schemes

The concept of bicycle rental schemes has existed for several decades in many cities. These bicycle rental schemes have taken into account user needs and characteristics in order to create appropriate schemes (Midgley, 2011). One of the principal reasons for introducing bicycle rental/sharing schemes is to increase the level of accessibility from public transport stops to final destinations (Lin and Yang, 2011; Shaheen, 2010). For South Africans, this could have a positive impact on the appeal of using public transport modes as well as on increasing the acceptance of cycling as a transportation mode.

10.5.1 South African Bicycle Rental Schemes

In South Africa, bicycle rental schemes are relatively limited in scale and application. The few schemes that currently exist are focused on increasing mobility or accessibility, e.g. the University of Stellenbosch and the University of Cape Town that provide bicycles to students or offer rentals for recreational uses ("Rent a Bike", "Cape Town Cycle Hire").

The schemes provide a viable alternative to the existing modes of transport and address gaps in transportation systems typically referred to as the "first/last mile" problem. This is normally the distance between the point of origin and the public transport destination considered too far for walking (Shaheen, 2010).

By providing bicycles for these trips, bicycle rental schemes increase the efficiency of public transport trips. (Quay Communications Inc., 2008).

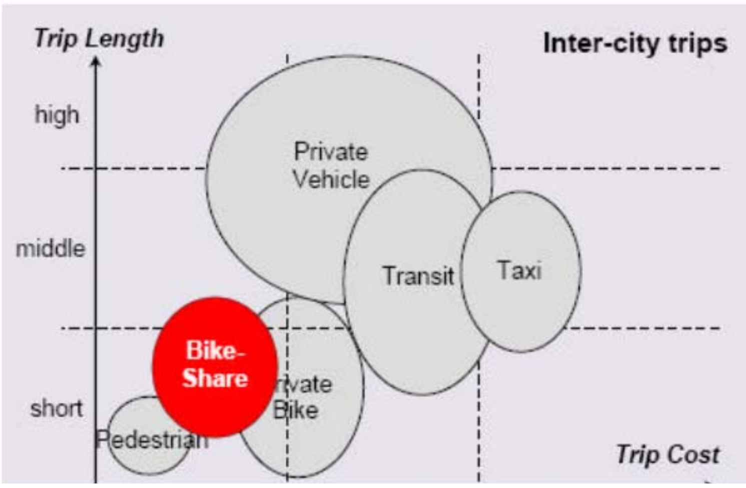


Figure 10-2: Role of Bicycle Rental Schemes

Bicycle rental schemes can provide more transport options for both locals and visitors. Among these are lower travelling costs for individuals who shift to cycling as their mode of transportation. A reduction in travel time can also be a benefit in some cases due to less congestion and more direct routes than motorised modes of transport. Users can also gain a better appreciation of their surrounding environment (Shaheen et al., 2010).

Bicycle rental schemes are also relatively cheaper to implement and operate compared to alternatives such as shuttle services (Shaheen et al., 2010).

10.5.2 Key Aspects When Implementing a Bicycle Rental Scheme

In order for rental/sharing schemes to be successful, the following aspects should be carefully considered:

(a) Cycling Infrastructure

There should be sufficient bicycle infrastructure, such as allocated bicycle lanes/paths in the surrounding areas. This is a key aspect of ensuring that sufficient volume of users of the bicycle scheme is achieved. Alongside, cycling routes and lanes there should be adequate and safe parking facilities for the rental bicycles at key locations that the users may want to park their bicycles at bus stops and other locations.

(b) Type of Bicycle Rental Scheme Systems

Generally, bicycle rental systems are either manual or automated, depending on demand, the technology available and the objectives of the bicycle rental scheme. Manual systems require individuals to rent / collect and return a bicycle to a location that is supervised and with a staff that run the system on a daily basis. Automated systems where bicycles are collected and returned with no supervisor rely heavily on technology and are normally a self-service scheme (Midgley, 2011).

(c) Collection and Drop-Off Points

Public space needs to be available to rental schemes. The collection and drop-off points need to be appealing, safe and convenient. This would encourage users to avail of the bicycle rental scheme and ensure the sustainability of the scheme. This indicates that such schemes could be implemented as a public-private partnership.

(d) Information and Recommended Routes

Recommended routes and areas should be identified for the users. Often users are novice cyclists, do not know the area well and are unfamiliar with the traffic conditions. This is especially true for visitors that wish to use the scheme as mode of transport.

(e) Barriers to Bicycle Rental Schemes

Many of the challenges that face cyclists in general apply also to bicycle rental schemes. Challenges include safety concerns, limited allocated road space to cyclists and inclement weather (Cycling in Cities Report, 2007).

In order for bicycle rental schemes to be effective, cyclists need to move through urban spaces with as few hindrances as possible. Protecting cyclists and making them feel safe in cities is another important aspect of ensuring that there is adequate uptake of the bicycle rental scheme.

(f) Managing and Funding Bicycle Rental Schemes

To sustain bicycle rental schemes, adequate funding is needed for the initial capital and operational costs as well as maintenance thereof. Due to the benefits of bicycle rental schemes to the general public, schemes are often subsidised by public funds. However, users are also required to pay fees for various reasons, which range from covering the costs of maintaining the bicycle rental scheme to providing incentive for the proper care of the bicycles.

Figure 10-3: Advertising on a Public Transport Facility

Several business models can be applied to bicycle rental schemes. These include schemes funded by advertising companies in exchange for advertising rights on the bicycles. Other versions include bicycle schemes for profit; not for profit; local authorities who contract a provider to provide the service or public transport operators who aim to enhance the public transport services.

CHAPTER 11

REFERENCES

11. REFERENCES

AASHO, 1964, *A Guide for Functional Highway Classification*, American Association of State Highway Officials, National Association of Counties, National Association of County Engineers, Washington DC.

AUSTROADS. Guide to Traffic Engineering Practice: Part 14—Bicycles. Sydney, Australia, 1993.

Behrens, R., 2005, Accommodating Walking as a Travel Mode in South African Cities: Towards Improved Neighbourhood Movement Network Design Practices, Planning Practice and Research, 20:2, 163-182, DOI: 10.1080/02697450500414686.

Britton, Eric, 2011, World City Bike Forum.

Committee of Transport Officials, 2012, The South African Road Classification and Access Management Manual, South Africa.

CSIR, 2003, Pedestrian and Bicycle Facility Guidelines: Engineering Manual to Plan and Design Safe Pedestrian and Bicycle Facilities, Department of Transport, 2003, South Africa.

De Maio, Paul. 2009, *Bike-Sharing: History, Impacts, Models of Provision, and Future*, Journal of Public Transportation, Vol. 12, No. 4.

Department of Transport, 1996, *The White Paper on National Transport Policy*, Department of Transport, 1996, Pretoria.

Department of Transport, 2006, *The National Land Transport Strategic Framework*, 2006, South Africa.

Department of Transport, 2007, *The Public Transport Strategy and Action Plan*, 2007South Africa.

Department of Transport, 2005, *The Rural Transport Strategy for South Africa*, 2005, South Africa.

Department of Transport, 2009, *The National Land Transport Act 5 of 2009* (NLTA), South Africa.

Department of Transport, 1996, *The National Road Traffic Act 93 of 1996* (NRTA), South Africa.

Department of Transport, 2000, *The National Road Traffic Regulations*, 2000, South Africa.

Department of Transport, 2000, *The National Land Transportation Act*, 2000 (Act No. 22 of 2000), South Africa.

Department of Transport (DOT), 2007, *Public Transport Strategy: Annexure 1*, 2007, South Africa.

Department of Transport, 2008, *Draft of Non-Motorised Transport Policy*, Department of Transport, 2008, South Africa.

Dhingra, Chavvri, 2010, Public Bicycle Schemes: Applying the Concept in Developing Cities Examples From India.

Federal Transportation Advisory Group (FTAG), 2001, *Vision 2050: An Integrated National Transportation System*, http://www.aeronautics.nasa.gov/docs/FTAG/vision2050.pdf, 2001, United States of America.

Fishman, E. et al., 2012, Barriers and Facilitators to Public Bicycle Scheme Use: A Qualitative Approach, Transportation Research Part F, Pages 686–698.

Gadepalli, S. et al., 2011, *Toolkit for Public Cycle Sharing Systems*, Ministry of Urban Development Government of India, ITDP, 2011, India.

Gauteng Province: Roads and Transport, 2013, *Gauteng 25-Year Integrated Transport Master*, www.itmp25.co.za, South Africa.

Georgia Department of Transport, 2003, *Pedestrian and Streetscape Guide,* USA

GIBB Consulting Engineers, 2010, Standard Construction Detail and Design Standards for Intersection Pedestrian Crossing, Pretoria

Hook, Water, 2003, Preserving and Expanding the Role of Non-Motorised Transport, Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities, Module 3d, 2003, GTZ, Eschborn, Germany.

I-CE, 2000, The significance of NMT for Developing Countries, Nethelands

Jennings, G., 2011, *A Challenge Shared: Is South Africa Ready for a Public Bicycle System?*, 30th Annual Southern African Transport Conference, 2011.

Kopits, E and M. Cropper (2005), *Traffic Fatalities and Economic Growth*, Accident Analysis and Prevention, Volume 37, pages 169–178.

Liebermann, S., et al, 2000, *Making South Africa Safe: A manual for community based crime prevention*, Pretoria: CSIR Publication BOU/E 2 (2000).

Lin, J and Yang, T., 2011, Strategic Design of Public Bicycle Sharing Systems with Service Level Constraints, Transportation Research Part E, Pages 284–294.

Rouphail, N, J. Hummer, P. Allen, and J. Milazzo, 1999, *Recommended Procedures for Chapter 13, Pedestrians, of the Highway Capacity Manual*, Report FHWA-RD-98-107, FHWA, U.S. Department of Transportation, 1999, United States of America.

Midgley, P., 2013, *The Bike-Share Report*, The City Fix

Midgley, P., 2009, The Role of Smart Bike-Sharing Systems in Urban Mobility, Land Transport Authority, LTA Academy, Journeys: Sharing Urban Transport Solutions, Issue 2, Singapore

Midgley, P., 2011, Bicycle-Sharing Schemes: Enhancing Sustainable Mobility in Urban Areas, (2–13 May 2011), United Nations Department of Economic and Social Affairs, Commission on Sustainable Development, New York, United States of America.

New York City, 2009, Bike-Share opportunities in New York City: Commuter Demand Methodology, 2009, New York.

Pardo, C., 2011, *Public Bike Share Information*, ITDP, New York.

Peden, M., et al., 2013, Editorials, *South African Medical Journal*, April 2013, Vol. 103, No. 4

Pucher, J., Dill, J and Handy, S, 2010, *Infrastructure, Programs, and Policies to Increase Bicycling: an International Review*, Preventative Medicine 50(1) S106–S125, United States of America.

Pushkarev, B., and Zupan, Z., 1975, *Urban Space for Pedestrians*, MIT Press, Cambridge, Mass., 1975

SABS, 2011, *SANS 1025: Animal Drawn Carts*, Ed 1, SABS, http://www.store.sabs.co.za/sans-1025-ed-1-00

SABS, 2011, SANS 1031: Animal Drawn Carts, Ed 1, SABS, http://www.store.sabs.co.za/sans-1031-ed-1-00

Servaas, M., 2000, The Significance of Non-Motorised Transport for Developing Countries: Strategies for Policy Development, Interface for Cycling Expertise, Utrecht, The Netherlands.

Statistics South Africa, 2014, National Household Travel Survey, 2013: Technical Report, ISBN 978-0-621-42571-0

Statistics South Africa, 2014, *National Household Travel Survey: February to March 2013*, Statistical release, P0320, South Africa.

National Research Council, 2000, *Highway Capacity Manual,* Transportation Research Board, ISBN 0-309-06681-6, Washington, D.C.

Whitelegg, J., 1987, *A Geography of Road Traffic Accidents*, Transactions Institute of British Geographers, New Series, Volume 12, Pages 161–176, London, Wiley.

Wittink, R., 2000, The Economic Significance of Cycling: a Study to Illustrate the Costs and Benefits of Cycling Policy, Habitat Platform, Interface Cycling Expertise, The Netherlands.

World Health Organization, *Status Report on Road Safety in African Countries*, World Health Organization, 2009.

World Health Organization, 2013, Global Status Report on Road Safety 2013: Supporting a Decade of Action, World Health Organization.

CROW, 1998, Recommendations for Traffic Provision in Built-Up Areas, ASVV, CROW Information and Technology Centre for Transport and Infrastructure, Ede, The Netherlands.