Southgate Institute
for Health, Society
and Equity

The Health Urban Neighbourhood Transition Tool (HUNTT)

A checklist for assessing liveability strengths and weaknesses

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This tool was produced as part of the Healthy South Project (funded by the MRFF through Health Translation SA) which is considering the potential for increased health promotion activity in the southern area of Adelaide within a Health in All Policies framework. An initial focus of this work has been on the potential for urban planning to contribute to neighbourhoods which are supportive of health and well-being and especially which produce low risk environments for non-communicable diseases including diabetes, heart disease and mental illness.

CONTENTS

1 INTRODUCTION AND BACKGROUND

The Healthy South project led by researchers at the Southgate Institute for Health, Society and Equity, Flinders University identified small-scale ad hoc 'infill' and its quality as a potentially important but overlooked mechanism for improving population health and producing low-risk environments for non-communicable disease (NCDs).

As with other high-income countries, life expectancy in Australia has increased significantly over the last 150 years as social and economic conditions have improved and the impacts of communicable disease have receded (Baum, 2016). Non-communicable diseases (NCDs) now constitute the major burden of disease in Australia (Australian Institute of Health and Welfare, 2018). The 12 conditions contributing most to burden of non-communicable disease from highest to lowest are: coronary heart disease, other musculoskeletal conditions, back pain, COPD, lung cancer, dementia, anxiety disorders, stroke, depressive disorders, suicide and self-inflicted injuries, asthma, and diabetes (Australian Institute of Health and Welfare, 2016). The risk factors for NCDs are also on the rise. The impacts of mental, neurological and endocrine conditions have increased (Australian Institute of Health and Welfare, 2016). Around 6% of Australian adults had diabetes in 2018, up from 3.3% in 2001 and 67% of adults were either overweight or obese up from 63.4% in 2014 (Australian Institute of Health and Welfare, 2019). Furthermore, rates of NCDs and key risk factors are not equally distributed in Australia. They are generally higher among lower-income groups and groups subject to other socioeconomic, locational, or cultural disadvantages.

1.1 The relationships between NCDS and urban environments as social determinants

Long term NCD risk is strongly influenced by social determinants attached to the urban environments in which people live, work and recreate (Friel and Global Research Network on Urban Health Equity, 2010, Baum, 2016, Friel, 2009). The form of the city profoundly effects the life of the city, and this in turns effects resident and population health and wellbeing. Consequently, urban planning policy settings and their effective implementation have significant effects on health and/or health inequities (for good or ill) by affecting known determinants of health. These include but are not limited to personal mobility, access to services, food, education and recreation, housing affordability, security and comfort, employment adaptation to climate change, as well as existential needs such joy, social connectedness, autonomy and belonging, and real and perceived safety (Baum, 2016, Friel, 2009).

With roots in Appleyard's (1980) definition, recent health and urban planning research have used the term 'liveable' to encompass the combinations of traits that make cities, suburbs, neighbourhoods and places healthy, equitable, convivial and complete environments in which to live (Arundel, 2017, Hooper et al., 2015b, Lowe et al., 2015). As such, the term liveable will be used with this definition in mind throughout this document.

1.2 The importance of neighbourhoods

A foundation stone of city liveability and locational advantage or disadvantage are the form and function of neighbourhoods. The starting point of this research is the notion that healthy districts, regions and cities are formed from the bottom up; therefore, ensuring every neighbourhood has all the elements required of liveability produces the liveable city. As a result, this research is focussed on transitioning neighbourhoods and their idiosyncratic strengths and weaknesses towards liveability.

Although there are a number of definitions of neighbourhood (Galster, 2001) the most spatially relevant for liveability, health and health equity is that directly related to pedestrian access, the 'home area neighbourhood'. The 'home area' definition of the neighbourhood consists of shared physical, social and civic elements that residents can access on foot from their homes (Kearns and Parkinson, 2001).

These elements have the potential to satisfy instrumental and existential needs, and the degree they do so affects the health and wellbeing of residents (Kearns and Parkinson, 2001, Mehta and Bosson, 2009).

The home area definition of a neighbourhood used in this research is a walkable geographically connected or potentially connected home area of 2500 to 3500 households that share diverse physical, social, and civic elements. This would include at a minimum a central activity centre, where diverse destinations are connected and agglomerated into a neighbourhood gathering place/commons, within walking distance of the 2500-3500 households. In southern Adelaide, the neighbourhoods meeting this definition are currently rare; therefore, the neighbourhood boundaries used in the HUNTT are based upon potential to reach this definition as an objective rather than the current situation.

1.3 The expanded traits of a healthy liveable neighbourhood

Liveable neighbourhoods are not only healthy they are complex. They are well connected by pedestrian oriented infrastructure, contain a diverse mix of connected and integrated housing, places, spaces and uses, and are safe and perceived as safe (Adkins et al., 2012). They have a diverse and comprehensive mix of high-quality neighbourhood destinations such as parks, schools, and public transport stops. They have social, commercial, civic, cultural, and recreational places and spaces agglomerated and integrated within an identifiable centre (activity centre). They have balanced endogenously driven and complex local economies that provides destinations, employment and business opportunities (McGreevy and Wilson, 2017, McGreevy, 2017a). They are connected to the rest of the city by safe and convenient networked bicycle infrastructure and public transport (Grengs 2005, Newman and Kenworhy 2015, Piatkowski et al., 2015).

At its most rudimentary, a healthy liveable neighbourhood is one where residents walk often, routinely and in significant numbers. Regular incidental walking is recognised as the easiest, cheapest and most applicable means of gaining recommended levels of physical exercise for the broadest cross section of social demographics and personal circumstances (Frumkin et al., 2004, Heart-Foundation, 2014, Manson et al., 2002, Pikora et al., 2003, Zapata-Diomedi et al., 2016). Research suggest that transitioning automobile oriented suburbs into liveable neighbourhoods could potentially increase the odds of people walking for more than 60 minutes a week for transport or recreation by twenty fold or more (Hooper et al., 2015a, Handy, 1996, Boarnet et al., 2008, Boulange et al., 2017, McCormack et al., 2008, Hooper et al., 2015b).

Furthermore, walking regularly and predictably puts people into public places. Drawing people to public places such as activity centres and parks, regularly and predictably increases public interaction and connection. In parks, this includes opportunities for diverse activities for many age groups which provides prospects for physical activity, reduces stress and anxiety and improves mood (Carver et al., 2008, Timperio, 2004, Giles-Corti et al., 2005). In activity centres, it includes opportunities for diverse necessary, social, recreational and resultant activities (Gehl, 2013). Furthermore, increasing activity in public places enhances their drawing power leading to still greater levels of walking, perceived safety and public life (Ewing and Cervero, 2010, Handy and Clifton, 2001).

Based upon an 800m walking distance and a minimum of 2500 households, it is argued neighbourhoods require a minimum household density of around 15 per hectare to make a diversity of destinations viable (Frank and Engelke, 2005, Newman and Kenworthy, 2006, Calthorpe, 1993, Newman and Kenworthy, 2015, Boulange et al., 2017). Although 15 dwellings per hectare is not particularly high by global standards, it does require housing diversity within a single neighbourhood. Housing diversity (size, tenure, style, and cost) also contributes to health and equity in other ways as it helps facilitate organic social and demographic mixing (Morris et al., 2012, Wood, 2003). The architecture and orientation of housing also effects the health and wellbeing of residents and the walkability and safety of the public sphere.

In a metropolis, liveable neighbourhoods are self-reliant not self-sufficient. Residents in all neighbourhoods need to connect to diverse destinations across the city for expanded social, recreational, educational, commercial and employment opportunities. From a health and health equity perspective the mode order of metropolitan wide access should be cycling and public transport first and motor vehicles last, the latter accommodated in ways that do not reduce walking, cycling or public transport convenience (Handy, 2005, Pucher and Buehler, 2008, Piatkowski et al., 2015, Giles-Corti et al., 2016, Mees, 2009).

In Australia today, only a minority of people live in suburbs that would achieve all or even most of the attributes required for optimal liveability (Arundel, 2017, Boulange et al., 2017). In addition, liveability tends to be higher in inner-urban and coastal suburbs. The automobile-oriented middle and outer suburbs of cities and towns predominantly developed over the last sixty years are also where socioeconomic disadvantage is also often concentrated (Arundel, 2017). Therefore, a transition program to retrofit the automobile oriented suburbs of Australian cities and towns into a healthy, liveable form would improve population health and health equity significantly (Frank et al., 2004, Newton et al., 2010, Frumkin et al., 2004, Giles-Corti et al., 2005, Gehl, 2013, Foster et al., 2012, Morris et al., 2012). The aim of the Healthy Urban Neighbourhood Transition Tool (HUNTT) is to provide impetus for, and information to assist such a transition.

1.4 Change in established suburbs

Neighbourhood change is already occurring in the established suburbs of most Australian cities including Adelaide. At the micro level, infrastructure and local services are continually being managed, maintained, upgraded, and changed. Another common driver of transition in older middle and outer suburbs, where obsolete or underutilised commercial land holdings and detached houses on large allotments are common, is small scale ad hoc infill via knock down rebuild (KDR) (Wiesel et al., 2013, Newton and Glackin, 2014). KDR is where detached suburban houses or small brownfield sites (car yards, petrol stations, warehouses, retail outlet etc.) are demolished and redeveloped as new housing (Pinnegar et al., 2015, Wiesel et al., 2013). This type of development is the most common form of development in southern Adelaide and will continue to be so in the future (Figure 1). In Adelaide, approximately 3000 KDRs occur annually (approximately 0.5% of total metropolitan stock); however, with an extremely low replacement rate of 1:1.85 producing a net increase of 0.85 dwellings per demolition. In addition, the average size of units constructed from infill is 154 m^2 (Figure 2), more than double that required for a two-bedroom unit (State planning Commission, 2019). This means KDR is not currently increasing housing diversity or affordability. If the average net yield could increase to a still modest 5 per KDR, far fewer demolitions would be required annually, all new housing could be developed within the current urban footprint, and housing diversity and affordability would likely increase. In addition, larger strategic sites are often redeveloped as single use residential buildings rather than for mixed uses that could add to diversity.

Figure 1:

Figure 2:

Unlike broadacre developments, KDR is incremental and occurs without master planning or coordination (Pinnegar et al., 2015). It is instead instigated by happenstance and the desires of diverse land owners, and its form is regulated by local government administered land use ordinances with a site specific focus (Legacy et al., 2013). This means the funds, coordination and strategic control that can be utilised to adopt liveability enhancing design interventions at a street or neighbourhood wide level are usually absent from the approval process (Newton et al., 2011).

Due to its prevalence across Adelaide, ad hoc KDR provides an opportunity to improve the health and health equity of suburbs if it is managed and coordinated with liveability as a goal.

1.5 Transition management: improving health, housing affordability and sustainability

The Australian Housing and Urban Research Institute (AHURI) has made recommendations for a 'transition management' approach to ad hoc infill redevelopment. Their focus is on managing the transition to improve two aspects of liveability, environmental sustainability and housing affordability, not the entire liveability suite (Newton et al., 2011). However, transition management can be undertaken to simultaneously advance the objectives housing affordability, sustainability within the overarching goal of liveability. AHURI advocates that suburban areas attractive to ad hoc infill be strategically prepared to maximise benefits and reduce the costs of incremental change (Newton et al., 2011). An adapted approach with liveability as the goal would include the following.

- The mapping and assessing of all suburbs for KDR or small-scale brownfield redevelopment potential
- Undertaking assessments to ascertain current liveability strengths and weaknesses
- Adopting land use regulations to ensure redevelopment addresses weaknesses
- Introducing inclusionary regulations and incentives to optimise housing yields and encourage well designed low-rise medium density dwellings and mixed-use buildings in strategic locations to maintain strengths overcome weaknesses
- Making off the shelf architectural plans available free to households for favoured redevelopment

- Ensuring incremental development is accompanied or preceded by changes that benefit both new and old residents such as:
    - upgrades to the public realm
    - improved pedestrian infrastructure
    - upgraded parks and open spaces
    - Improved public transport infrastructure and services
    - new and improved local public and private service provision
- Using government purchasing guarantees to underwrite finance for small scale developers
- Attaching developer levies to individual projects but not individual dwelling to raise funds for public realm changes within the neighbourhood alone
- Proactive engagement with residents in transition management and ensuring they have a say in and benefit from service and public realm changes
- Accompanying KDR with the brownfield redevelopment of shopping centres, commercial areas, or strategically central sites into transit oriented mixed use and complex activity centres.

1.6 The role of the Healthy Urban Neighbourhood Tool (HUNTT)

A key prerequisite of successful transition management is a comprehensive assessment of the existing liveability strengths and weaknesses of individual neighbourhoods. A review of existing urban development related health or liveability guidelines undertaken as part of this project revealed that existing ‘tools’ and guidelines tended to focus on a single aspect of health, most notably active transport, and/or the master planning of broadacre development not ad hoc infill and change in existing car oriented neighbourhoods. In addition, some of the guidelines are not evidence based and others do not provide the fine-grained design detail required for implementation; therefore, design detail is left to other guidelines, checklists or codes which mightn’t prioritise liveability. Nevertheless, there is evidence-based information available to inform transition planning. However, it is spread over dozens of unrelated documents and requires expertise to assess its veracity. The HUNTT is designed to bring all the information required for liveability transition planning and management together in a single user-friendly checklist. The specific design guidelines provided in the tool are based upon evidence from peer reviewed scholarly research related to specific determinants of liveability, health, and health equity.

Within the remainder of this document, the elements of liveability and social determinants of health are captured under the headings below. In each of the sections below there will be a summary of the evidence and a checklist of the attribute. The checklist includes details of the design, data source, healthy range, and current situation to provide a practical guide for assessing a neighbourhood’s current liveability strengths and weaknesses. The attributes under these headings and subheadings overlap and reinforce one another. The attributes in their complexity, interrelationships and synergies produce the best health outcomes. Therefore, liveability and health hinge upon having the complete range of requirements. This means there are no silver bullets; transition requires attention to fine grained detail over space and time.

Public realm	**Transport and access**	**Housing**	**Social Inclusion**	**Food**
Safety Walking Streets Open space Green cover Climate and energy Connection Destinations Heritage	Walking Cycling Public transport Cars Destinations Social inclusion Access for people with disability or mobility issues Employment Public realm	Design Diversity Climate and energy Transport and access Density	Employment Housing diversity Public realm Public life Transport and access Destinations Safety Gender Recognition of Aboriginal heritage Activity centres community meeting places Services	Purchasing Growing Consuming Transport and access Open space Social inclusion

The HUNTT is intended to assist and encourage policy makers and local communities to take control and coordinate the incremental redevelopment of their neighbourhoods in order to ensure it occurs in manner that improves liveability and therefore the health and health equity of new and existing residents. The checklist is contained in 11 friendly tables. The tables:

- highlight the broad determinant,
- various measurable and/or observable design or data details required for that determinant
- how the detail can be measured or found (observational surveys, data bases etc.)
- The range required for each detail to strengthen and/or not weaken liveability.

Once the survey has been undertaken it can be used to developed liveability transition focussed spatial plans, land use regulations, and standards to build upon the idiosyncratic strengths and ameliorate the idiosyncratic weaknesses of individual neighbourhoods. It can also be used at a broader local or state government level to produce minimum liveability standards for the development, redevelopment and ongoing maintenance of infrastructure and common elements of the public realm such as footpaths, verges, intersections and park facilities.

2 THE PUBLIC REALM

Other overlapping and relevant chapters: Housing, walking, cycling, social inclusion

2.1 Streets

Streets form the great bulk of public outdoor space in neighbourhoods and cities and to a major extent determine the interplay between human activity and physical space. As such, their amenity, comfort, attractiveness, liveliness, real and perceived safety play a significant role in how people perceive and use their neighbourhoods. In the opening sentence of his book, Great Streets, Allan Jacobs (1993) articulated the obvious in all these respects ‘some streets are better than others’. Some streets are hives of human activity and draw people from private spaces into the public realm others do the exact opposite. In neighbourhoods made up of ‘great streets’ people spend more time outside walking for recreation and active transport, playing, socialising and diversely engaging in public life (Gehl, 1986, Sauter and Huettenmoser, 2008, Biddulph, 2012, Veitch et al., 2006).

Great streets are pedestrian oriented, accessible to the least physically mobile, and accommodate cars on those terms (Newton et al., 2010, Aghaabbasi et al., 2017, Aghaabbasi et al., 2019). They provide ease of accessibility and movement for pedestrian along convenient, comfortable connected paths, protected from motor vehicles by shy zones of green attractively landscaped verges (See Walking & Cycling 3.1). They have features scaled and legible to humans as pedestrians and are lit at night to around 2 lux (Uttley et al., 2017, Calthorpe, 1993, Gehl, 2013). Shared streets, dead ends, low speed limits, parked cars and trees all contribute to traffic calming and help prioritise walking and cycling (Figure 3 & 4).

Figure 3:

Figure 4:

The liveability of the public realm of residential streets is substantially determined by the balance between the four elements that make up the street area; (1) the sealed motor vehicle carriageway; (2) on-street car parking; (3) pedestrian paths; and (4) landscaping. A liveable street minimise the proportion allocated to the carriageway, maximises the proportion devoted to landscaping and pedestrian paths, and uses on street parking as a means of slowing motor vehicles and protecting pedestrians. A traditional street form that achieves this has a carriageway of less than 8 metres wide and a pedestrian area of more than 3 metres, and forces moving vehicles to manoeuvre slowly between parked cars on both sides (Figure 5). Another less common street configuration that does this are shared streets (Figure 6).

Figure 5: A 7-metre-wide carriageway and parking calms traffic on this residential street

Figure 6:

2.2 Main roads

The form and integration of arterial and secondary roads can make them either barriers or seams between residents, destinations, and communities on either side. Obstacles or facilitators of integrated seams include the width of the road area and the types of elements contained in that width, the frequency of corners along the road, and the orientation and interestingness of the form along the edge of the corridor. Facilitators of seams are features which turn potentially hostile environments into more comfortable, calmer, and safer spaces for pedestrians. They include:

- minimum areas devoted to motor vehicle traffic (8-10 metres for two lane secondary roads and 14 to 16 metres for four lane arterials (Figure 7 & 8)
- Street intersections every 100 metres or less (they can be blocked for motor vehicles but traversable for pedestrians and cyclists)
- Pedestrians crossings every 200-400 metres and at or on the routes to major destinations such as schools, activity, centres public transport stops and parks.
- narrowing road carriageways to 6-7 metres (two lane) and 12-14 metres (four lanes) at major intersections.
- optimum space and protection for pedestrians and cyclist comfort and safety
- landscaped verges/shy zones/furniture zones (Figure 8)
- extensive tree canopies (Figure 7)
- on-street parking used to slow traffic and place a barrier between moving traffic and pedestrian areas (Figure 8)
- Off street parking, unobtrusive undercroft or at the rear of buildings
- edges of human scale buildings oriented towards the road with windows, balconies, and doors with minimal setbacks. (Figure 8)

Figure 7: Tree produces enclosure via a canopy 'roof' and human scale edge on a largely residentially lined arterial

Figure 8: A combination of narrow carriageway, on street parking, streetscaping, regular pedestrian crossings, minimum building setbacks and active edges creates human scale and pedestrian friendliness on a very busy (29,300 vehicles per day) stretch of road

On the other hand, interventions to speed up traffic such as multiple wide traffic lanes, fly overs, infrequent street intersections and pedestrian crossings, slip lanes, wide buffers and median strips, as well as car oriented features such as surface level car parks speed legible signs (Figure 9-12) produce uninteresting, uncomfortable, hostile and seemingly unsafe environments for pedestrians and therefore create barriers rather than seams between households, destinations and communities on either side (Jacobs, 1993, Adkins et al., 2012, Gehl, 2013, Makarios et al., 2011).

Figure 9

Figure 10: A two-lane road becomes 4 lanes plus slip lanes, and a four-lane road becomes six lanes plus slip lanes, creating an unnecessary hostile pedestrian environment

Figure: 11

Figure 12: Road plus median and buffers lined by rear fences creates major barrier between households, destinations, and communities on either side and encourage speed

2.3 The edge and landscaping

Private spaces (dwellings, businesses, shops etc.) provide neighbourhood destinations, and also form the visual framing of the public sphere, providing its human scale, legibility, pleasures, comfort, and interestingness (Ewing and Handy, 2009, Adkins et al., 2012, Hillsdon et al., 2006, Gunn et al., 2017, Ewing and Cervero, 2010, Moudon et al., 2006). Built form should be oriented towards the street and public places with detailed, attractive, and interesting facades of windows, doors, verandas balconies and shallow transparent transition zones or semi-private front yards (Figure 13 & 14). Residential transition zones should be around 3- 5 metres, shallow enough to provide enclosure, but deep enough to allow signs of life and personality. In activity centres windows and doors should abut footpaths and squares to form a continuous transparent edge (Figure 8). Human scale means the height of the building is proportionate to the width of the street or square of which they form the perimeter edge (Figure 13 & 14). This should range from 1:1, where the building height is around the same as the distance between opposite building frontages, to a maximum of 1:5, where the height of the built edge is around a fifth of the distance between building frontages (Gehl, 2013, Gehl, 1986, Jacobs, 1993).

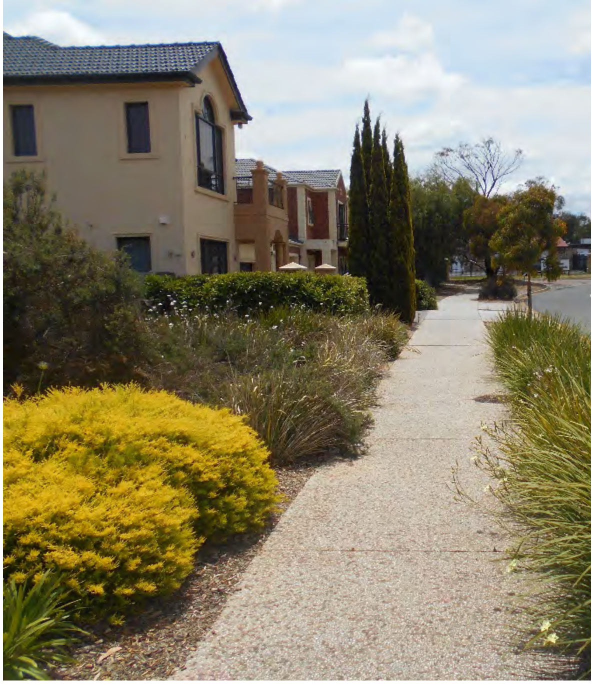


Figure 13: Human scale 1:4

Figure 14: Humans scale 1:1.5

Table 1: Street checklist			
Determinant	**Design detail**	**Data source**	**Healthy range**
Safety	(See Table 3: Safety)		
	Number of intersections per km^2.	GIS	>30
	Block perimeter sizes	GIS	<640m circumference
	Width of side street carriageways	GIS	3-10m
	Width of main road corridors	GIS	8-10 metres (two lane) 14 to 16m (Four lanes) 4m footpath (2 metres both sides) 3m cycle path (1.5 metres both sides) 4-8m shy zone (verge) (2-4 metres both sides)
	Intersections on main roads		Every 100 metres or less
	Side street width at intersections	Observation	<7m
	Main road width at intersections	Observation	6-7 metres (two lane) and 12-14 metres (four lanes)
	Pedestrian prioritised crossing points along main roads	Observation	Every 3-400m at destinations and along desire lines
The edge	Human scale (building height compared to corridor width)	Observation Development Plans	Height: distance ratio= 1:1 to 1:5 along residential streets, 1:1 to 1 :3 in activity centres.
	Dwelling setbacks	Observation Development Plans	3-5 metres
	Building frontages of doors windows, balconies oriented towards pedestrian areas		100%
	Proportion of pedestrian areas fronted by surface level car parks, walls, high fencing, buffers, or non-functional land.	Observation GIS	0%
	Shop frontage transparent with setbacks <1 metre.	Observation	all
	Garage doors and driveways	Observation	<30% of dwelling frontages
Landscaping	Off-street short-cuts, such as mid-block connections and passages through car dead-ends or neighbourhood parks	Observation	Regular
	Distance between street trees	Observation	5-10m
	Extent of tree canopy	GIS	30%
	Understorey plants in verges	Observation Development Plans	Diverse and green (low/mid/high)
	Transition zone landscaping (front yards)	Observation	Diverse and green (low/mid/high)

2.4 Open space: The environmental and health benefits of urban ecological services (UES)

In the latter part of the twentieth century, the previously overlooked ecology of urban environments became an area of scientific and academic study under the term of urban ecology. Urban ecology refers to the study of the flora, fauna, habitats, and ecosystems that exist amongst the built form of the city. The thesis of urban ecology is that cities are ecological systems consisting of buildings, infrastructure, and public and private spaces between them which give rise to complex human and non-human activity (Steiner, 2014).

Areas of 'green space' between the hard surfaces of built form have the potential to deliver social, economic, environmental and health and wellbeing benefits to urban residents in the form of urban ecological services (UES). UES include habitats for flora, fauna and ecosystems, soil formation, bio-diversity refuges, and pollination. They can directly mitigate the effects of pollution via water and air filtration and absorption, noise abatement, and microclimate moderation and reduce hazards from fire, flood, and landslides (Larondelle and Haase, 2013, Gómez-Baggethun and Barton, 2013, Wu,). They also provide spaces for diverse human activities many of which directly affect health and wellbeing.

2.4.1 The UES of the street

Significant UES can be delivered at the level of the street. Verges, shared streets (Woonerf streets), pocket parks and transition zones (private land between the street and buildings) are able to provide space and habitats for flora and fauna (Figure 15 & 16). They provide soft surfaces which help mitigate heat island effects and absorb storm water runoff and pollution. Soft surfaces are particularly preferable to large expanses of hard impermeable surfaces of roads and surface level carparks which trap road dust (compounded particulates from exhausts, tyres, and mechanical wear) from motor vehicles which eventually wash into water courses and the natural environment via stormwater. They also calm traffic and make the public realm safer and more attractive (Norton et al., 2015, Mahdjoubi and Spencer, 2015, Hand, 2007). As such 'green streets' can help reduce, anxiety and fear, increase walking for both recreation and transport, and activate the street for diverse uses (Gehl, 1986, Sauter and Huettenmoser, 2008, Biddulph, 2012, Veitch et al., 2006).

Figure 15:

Figure 16:

Trees and shrubs along verges and adjacent to pedestrian areas (Figure 15-17) separate pedestrians from motor vehicles, calm traffic, enhance perceptions of safety, improve ambient air quality, and can help provide humans scale to streets when the built form does not (See walking 3.1 and safety 2.5). They add psychologically comfort and beauty to the street and attract birds which do likewise (Astell-Burt and Feng, 2019). They add significantly to the interestingness, and sensual stimulation and greenness of the neighbourhood which increases neighbourhood satisfaction and social cohesion and can improve mental wellbeing (Hartig et al., 2014, Hartig, 2008 , de Vries et al., 2013). Street trees make the greatest contribution when they are deciduous and 5m to 7m apart, This allows them to form a canopy that modulates light, allowing sunlight to reach paths in winter and provide shade over paths, roads and houses in summer (Figure 18). In doing so they help moderate the temperatures of the street and adjacent buildings (Norton et al., 2015, Kleerekoper et al., 2012, Mohajerani et al., 2017).

Figure 17:

Figure 18:

2.4.2 Neighbourhood parks

Living in close proximity to green open spaces such as neighbourhood parks and reserves provides several potential health befitting UES. It provide views and destinations able to provide cultural and spiritual pleasures and recreational opportunities (Breuste, 2013, Larondelle and Haase, 2013). Being able to walk a short distance (400m or less) to a park offering diverse recreational activities encourages regular walking, public gathering and social connection (Giles-Corti et al., 2005, Hooper et al., 2015b, Wood et al., 2017). Large and small green spaces carry out recreational, psycho-spiritual, and social roles to a maximum extent when they are conveniently accessible, integral, and conspicuous within surrounding built form. They are safe and perceived as safe, they show obvious signs of care, have some landscape complexity, and offer tranquillity (Figure 19) (Giles-Corti et al., 2005, Colabianchi et al., 2011, Nordh and Østby, 2013). Parks are also used more frequently, for longer and by greater numbers of people when they provide diverse facilities and equipment aimed at a diversity of ages that lead to a diversity of activities (Figure 20) (Francis, 2003, Giles-Corti et al., 2005, Colabianchi et al., 2011). Equity also demands accessibility be available for the most mobility disadvantaged such as people without independent access to private motor vehicles, the aged, very young and disabled.

Figure 19:

Figure 20:

The location and maintenance of parks and open space effects access, levels of use and potential health benefits. Parks and open spaces within 150 metres of high-volume roads exposes users to high concentrations of toxic air and particulate pollutants and traffic noise, all of which produce negative physical and mental health outcomes (Zhang and Batterman, 2013, Karner et al., 2010, Goines and Hagler, 2007). Both exhaust and noise pollution reduce the tranquillity and comfort of parks potentially effecting attractiveness and levels of uses (Wolch et al., 2014, Zannin et al., 2006). In addition, parks are viewed as unsafe, when they lack diverse quality amenities and are poorly maintained and underused (Figure 19 & 20) (Luymes and Tamminga, 1995). Poor park maintenance and subsequent lack of use also can make them no go zones; this not only deters their utility but reduces perceptions of safety in surrounding streets as well (Foster et al., 2012, Eicher and Kawachi, 2011).

Figure 21:

Figure 22:

A key component of maximising health related UES is the integration of open spaces with streets, buildings, and infrastructure. The perimeter of open spaces and the paths leading to them are imperative (See the edge and Landscaping 2.3). Open space with perimeters of impervious fences, featureless walls, car parks busy roads etc. that lack obvious and convenient pedestrian connection into surrounding streets are likely to be underutilised and perceived as unsafe (Figure 21 & 22). On the other hand, perimeters lined by human scale buildings (3-5 storeys) and overlooked by signs of life from windows, doors and balconies enhance integration and perceptions of safety (Figure 23 & 24). In return open space provides extensive views and cooling for building residents, and facilitates regular visits from them; all of which positively affect health and wellbeing (Bolleter and Ramalho, 2014, Van den Berg et al., 2016, Gehl, 2013, Bolleter and Ramalho, 2014, Van den Berg et al., 2016, Gehl, 2013, Sullivan and Chang, 2011, Hartig et al., 2014).

Figure 23:

Figure 24:

People with access to private or communal green spaces in allotments or backyards for gardening, communion with nature, socialising and relaxing also have better reported health and wellbeing than their neighbours without such access (Cervinka et al., 2016, Freeman et al., 2012, Van den Berg et al., 2010). An outdoor area attached to housing of 25 m^2 (5m x 5m) is large enough for passive activities, while a rectangular are of $75m^2$ with a minimum depth of 10 metres is enough space for active activities such as children's' play and gardening as well as growing trees (Hall, 2010). Gardening as a past time is a valuable source of physical exercise, purpose and relaxation, particularly for those who have a lot of time on their hands such as people who are retired, unemployed or underemployed (Freeman et al., 2012). Growing some of one's own food consumption in yards or community gardens is also a means of obtaining fresh fruit and vegetables locally and inexpensively (Larder et al. 2014). Furthermore, undertaking gardening in social settings such as community gardens or grouped allotments (Figure 25) helps facilitate social interaction providing both physical and mental health benefits (Firth et al., 2011, Kingsley et al., 2009).

Figure 25

Figure 26

2.4.3 Large reserves and parks

Large areas of open space can have recreational, ecological, buffering, or combined focus. Large areas of land contained in riparian corridors, lakes, wetlands, urban forests and coastal areas that follow the natural hydrology of an area and contain complex ecosystems (Figure 27 & 28) are particularly good at providing UES, such as climate regulation, air and water filtration, rainwater dispersion, flow and drainage, and noise and pollution reduction. They also tend to provide greater landscape complexity and serenity due to a lower density of users and distances from noise (Van den Berg et al., 2010). Living within 1600m of large areas of biodiversity and natural beauty such as coasts, riparian corridors, lakes, and urban forests encourage and increase the likelihood of frequent and long recreational walking and cycling journeys and quiet communion with nature, all of which are positively associated with physical and mental health (Hooper et al., 2015b, Giles-Corti et al., 2005, Astell-Burt and Feng, 2019). Therefore, integrating such spaces into urban areas provides significant environmental and health benefits.

Figure 27:

Figure 28:

Recreational parks provide facilities for diverse recreational and sporting activities which benefit physical and mental health. However, there can also be tension between environmental UES and recreational UES. For example, lawned areas and courts provide opportunities for sport and play, however, there lack of biological complexity minimises their environmental service provisions, and in some cases the chemical fertilisers, herbicides and insecticides used to maintain them can have negative environmental impacts on the greater urban ecology (Figure 29 & 30).

Figure 29:

Figure 30:

2.4.4 Integrating green space to deliver UES

Parks are one of the most difficult liveability features to retrofit into established suburbs due to their land requirements. Nevertheless, where there is a shortage of parks, school ovals and the like can be shared. In addition, streets themselves can be remodelled as shared streets (Woonerf streets) or blocked to produce car dead ends and pocket parks (Figure 6). These can have as many benefits as larger parks; in particular, children who live within close proximity (200m) to shared streets or pocket parks play outdoors and interact socially with neighbours more regularly and for longer than those who live in more conventional car oriented streets (Gehl, 1986, Sauter and Huettenmoser, 2008, Biddulph, 2012, Veitch et al., 2006). Shared and blocked streets also calm traffic and by doing so make the public realm safer and more attractive for diverse uses and provide soft surfaces for trees and plants (Norton et al., 2015, Mahdjoubi and Spencer, 2015, Hand, 2007).

Successfully, integrating the various components of urban ecology is not simple even where significant amounts of land exists and often requires deft and thoughtful planning to maximise both environmental and social UES. Urban areas are difficult and often dangerous habitats for flora and fauna survival and ecosystem sustainability. Plants and animals and urban and peri-urban based ecosystems are constantly under threat from human activity and invasive species, carnivorous pets, are easily overwhelmed and degraded by air and water pollution or lost to urban development. The result is a loss or reduction of urban ecosystems services with major effects on the physical and mental health and wellbeing of urban residents (Gómez-Baggethun and Barton, 2013, Balfors et al., 2016) Breuste, 2013. Even those that from the outside look natural often require care to protect and maintain their complex biodiversity. Green spaces maximise environmental UES when they connect and incorporate an areas preurban hydrology and topography able to slow, capture, store, and filter stormwater runoff (Figure 31 & 32).

In new developments this end is sometimes advanced via Water Sensitive Urban Design (WSUD) principles. However, the d incorporation natural hydrology or topography into urban development via WSUD is relatively new and unevenly applied and was never applied to the vast majority of urban areas established over centuries. Therefore, in most cities incorporating natural hydrology requires significant environmental restoration (Figure 33 & 34). Nevertheless, numerous cites have successfully undertaken the rehabilitation of watercourses (Hwang, 2015).

Figure 33:

Figure 34:

Table 2: Open space checklist			
Determinant	**Design detail**	**Data source**	**Healthy range**
Safety	(See Table 3 Safety)		
Access	(See Table 4: Walking & Cycling)		
	Proportion of dwellings within a 400m walk, uninterrupted by main roads, of a quality neighbourhood park, pocket park or shared street.	GIS	100%
	Proportion of dwellings within an 800m walk, uninterrupted by main roads, of a quality neighbourhood park, pocket park or shared street.	GIS	100%
	Size of neighbourhood parks	GIS	1-5 ha (around 2000m^2 retrofitted pocket parks)
	Proportion of dwellings within a 400m walk, uninterrupted by main roads, of a neighbourhood park.	GIS	100%
	Size of district or regional parks.	GIS	>20 ha
	Proportion of dwellings within 1600m of a large bushland or recreational park, beach or riparian corridor with walking and/or cycling paths.	GIS	100%
	Minimum Private outdoor space small dwellings (passive)	GIS	>25 m^2
	Minimum depth of rear yards. Large dwellings (active)	GIS	>10 metres
Condition	Maintenance	Observation	Low/mid/high (irrigated, fertilised, mowed, weeded, pruned etc.)
	Landscape complexity	Observation	Low/mid/high (trees & canopy, understorey, grasses, and small plants)

Table 2: Open space checklist (contd)			
Determinant	**Design detail**	**Data source**	**Healthy range**
Amenities	Total number of amenities	Observation	>8
	Irrigated and maintained areas for ball games etc.	Observation	
	Playground, numbers of equipment	Observation	>4
	Basketball/ netball rings	Observation	
	Tennis courts	Observation	
	Gym equipment	Observation	
	Seats and tables	Observation	
	Unstructured play areas	Observation	
	Trees for shade and climbing	Observation	
	Public toilets	Observation	
	Water fountains	Observation	
	Barbecues	Observation	
	Kiosks or cafes	Observation	
	Community gardens	Observation	
	Skate areas	Observation	
	Other		
	Cycling and walking paths	Observation	
Perimeter edge & integration	Paths along desire lines linking destinations in and across park	Observation	Yes
	Integral to surrounding areas and seamlessly connected	Observation	Yes
	Location (noise & pollution exposure)	GIS	>150 metres from high volume traffic
	Pedestrian oriented streets and footpaths leading to open space. (See Table 1 streets)	Observation	Yes
	Back or side fences, featureless walls, or car parks along perimeter	Observation	0% ideally but less than 25%
	3-5 storey dwellings with balconies and windows along and around park perimeters	Observation	100% ideally but more than 75%

Table 2: Open space checklist (contd)			
Determinant	**Design detail**	**Data source**	**Healthy range**
Policy	Minimum rear boundary setbacks for detached and semidetached housing and blocks of flats.	Development Plans	10m
	Minimum dimensions for private outdoor space (active recreation).	Development Plans	$90m^2$
	Minimum dimensions for private outdoor space (outdoor room)	Development Plans	$25m^2$ (5x5m)
	Minimum dimensions for balconies	Development Plans	3m x 2m
	Dwelling frontage setbacks	Development Plans	3-5 metres
	Flats and apartments encouraged on the perimeter of open space.	Development Plans	Yes

2.5 Safety

Safety and perceptions of safety place major restrictions on time spent in public, whether for walking, cycling or stationary activities (Foster et al., 2012). The two great concerns in this regard are traffic and crime (Foster et al., 2012).

Safety from traffic is contingent on the quality of streets and roads and their relationship with the public realm. Motor vehicles moving rapidly and unhindered along side streets, fast moving traffic on main roads, inadequate protection between footpaths and moving traffic and infrequent pedestrian crossings all contribute to feelings of discomfort and unsafety (Adkins et al., 2012). In addition, speeds of over 30 km/h on side streets and 50 km/h on major roads significantly increase road trauma. Speed limits, liveable streets (See Streets 2.1, Main Roads, 2.2 and the Edge and Landscaping 2.3), traffic calming devices (Figure 35), and features that prioritise walking and cycling (See walking 3.1 and cycling 3.2) all increase real and perceived safety (Figure 36).

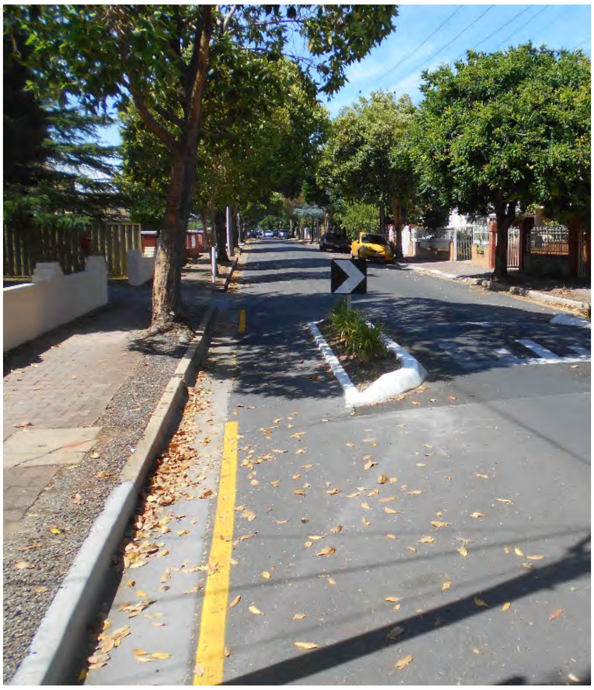


Figure 35:

Figure 36:

The form and function of the public realm also raises real and perceived safety from crime (Gehl, 2013, De Donder et al., 2013, Foster et al., 2011). A lack of safety or perceived safety greatly reduces an adults' propensity to walk and engage in public life and allow their children to do so (Weir et al., 2006, Carver et al., 2008, Foster et al., 2012). The number of people on the streets during the day and night, which is determined by both design quality and the density of people living and working in an area, adds considerably to perceptions of safety and attractiveness (See Streets 2.1 and Walking 3.1). On the other hand, poor lighting, featureless structures and spaces such as blank walls, high impervious fences, wide garage doors and expansive car parks or non-functional land (Figure 9-12) poorly maintained or unoccupied buildings, narrow lanes lined by fences, narrow tunnels, non-functional and/or poorly maintained land (Figure 37 & 38) lower perceptions of safety; therefore, reduce pedestrian activity and public life (Foster et al., 2012, Ziersch et al., 2007, Adkins et al., 2012, Gehl, 2013).

Figure 37:

Figure 38:

Open space such as parks of various sizes, squares, riparian corridors and beaches provide important UES (Hooper et al., 2015b, Giles-Corti et al., 2005). However, open space can be an asset or a deterrent subject to its condition. Poorly maintained non-functional open space can become no-go zones that reduce perceptions of safety for it and surrounding streets which negatively effects willingness to walk (Foster et al., 2012). Therefore, their integration, design and quality are an imperative factor in neighbourhood liveability (See Open space 2.4).

Table 3: Safety Checklist			
Determinant	**Design detail**	**Data source**	**Healthy range**
Streets	(See table 1: Streets)		
	(See table 4 Walking and Cycling)		
	Speed limits on side streets	Observation	30 km/h
	Speed limits on arterial roads	Observation	50 km/h
	Road length with > 1m verges (shy zone) between footpath and roads on low traffic side streets.	GIS Google Earth Observation	Both sides of all streets.
	Road length with 2-3m verges (shy zones) between footpath and roads on busy roads.	GIS Google Earth Observation	Both sides of all major roads
	Night pedestrian area illumination	Meter	2 lux
Crime	Dwelling setbacks from footpath	Observation	3-5 metres
	Proportion of foot and cycling paths visible from building edge of windows, entrances, porches, and balconies	Observation	100% ideally but more than 75%
	Proportion of open space perimeters visible from windows, entrances, and balconies	Observation	100% ideally but more than 75%
	Proportion of transaction places/public places framed by human scale buildings and overlooked by windows and balconies	Observation	100% ideally but more than 75%
	Proportion of streets, roads and paths lined by walls, high impervious fencing, cyclone fencing or visible barbed wire	Observation	0% ideally but less than 10%
	Proportion of streets, roads and paths lined by surface level car parks	Observation	0% ideally but less than 10%
	Proportion of streets, roads and paths lined by featureless walls or impervious fencing 1.2 m or higher	Observation	0% ideally but less than 10%
	Proportion streets, roads and paths lined by unused or poorly maintained public or private spaces	Observation	0%
	Proportion of open spaces lined by walls, high impervious fencing, cyclone fencing or visible barbed wire	Observation	0% ideally but less than 25%
	Proportion of open spaces without activity and unmaintained	Observation	0%

3 TRANSPORT AND ACCESS

Other relevant chapters: Streets, Safety, Destinations, Employment

3.1 Walking

A healthy neighbourhood is one where residents walk often, routinely and in significant numbers. Regular incidental walking is recognised as the easiest, cheapest and most equitable means of gaining recommended levels of physical exercise for the broadest cross section of social demographics and personal circumstances (Frumkin et al., 2004, Manson et al., 2002, Heart-Foundation, 2014, Pikora et al., 2003, Zapata-Diomedi et al., 2016). Walking is also the most equitable and least expensive means of accessing daily and weekly needs. Furthermore, walking as a substitute for car journeys or public transport reduces noxious gases and particulates from exhausts going into the atmosphere as well as climate altering greenhouse gases from exhausts and the embodied energy in individual vehicles and the infrastructure required to keep them viable (Zhang and Batterman, 2013, Tayarani et al., 2016, Schindler and Caruso, 2014). Research shows that residents who live in neighbourhoods of pedestrian oriented streets within walking distance of a diversity of destinations are significantly more likely to regularly walk for both recreation and active transport and obtain minimum recommended levels of moderate exercise by doing so than residents in car oriented suburbs (McCormack et al., 2008, Boulange et al., 2017, Hooper et al., 2015b, Moudon et al., 2006).

3.1.1 Pedestrian design and infrastructure

Propensity to walk is highly influenced by the perceptual qualities of the public realm (See Streets 2.1). Route connectivity and permeability (block size), path quality, safety and aesthetics are all determinants of average propensity to walk, as is having a diversity of destinations within close proximity to one's home (Frank and Engelke, 2005, Ewing and Handy, 2009, Moudon et al., 2006, Steiner, 2006, Pikora et al., 2002, Pikora et al., 2003, King et al., 2015, Hooper et al., 2015b). On the other hand one of the greatest deterrents to walking are busy roads full of unobstructed traffic (Adkins et al., 2012). In addition, dense pedestrian activity encourages emulation. For example, in the simple but important practice of getting children to walk to school or the local park, parents are much more likely to perceive it as safe and permissible if they observe many other children doing so (Carver et al., 2008, Frumkin et al., 2004, Timperio et al., 2006).

Walking begins with the design of physical infrastructure. High quality pedestrian infrastructure alone can increase average walking by 2-300% (Hooper et al., 2015b). Health requires infrastructure be designed to maximise routine walking, while health equity demands it provide 'universal design' access, i.e. it needs to be designed to accommodate those with the most limited mobility, slow walkers due to age, disability or injury, people with prams or shopping trollies, and people who require mobility devices such as wheel chairs, gophers and walking frames. If these pedestrians are designed for as a priority, all other pedestrians will also be accommodated (Newton et al., 2010, Aghaabbasi et al., 2017, Aghaabbasi et al., 2019).

To maximise both walking and equity neighbourhoods need to be connected and permeable in order for residents to move from any point to any point via safe, comfortable, and direct routes. A combination of block circumferences of under 640 metres and more than 30 intersections per hectare produces permeability (Figure 39) and reduces walking distances to neighbourhood destinations (WAPC, 2015, Steiner, 2006, Frank et al., 2010).

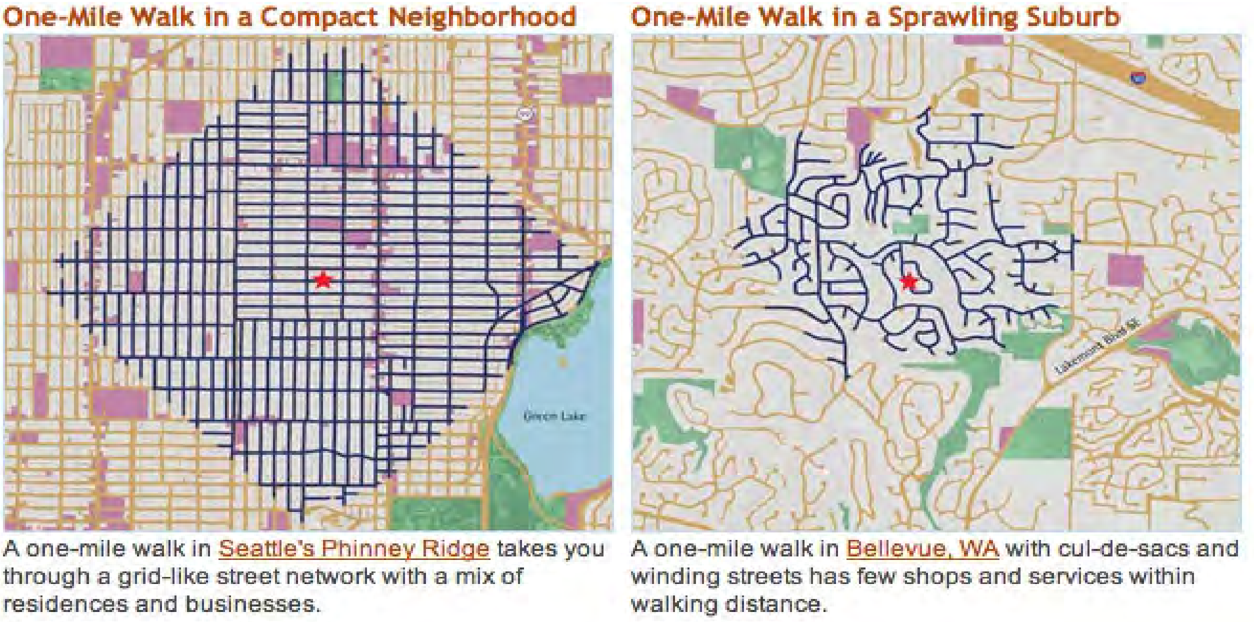


Figure 39: Maps courtesy of Lawrence Frank & Co. and the Sightline Institute.

Another important factor is the ability of the least mobile to cross roads comfortable and safely. To enhance both pedestrian safety and connection, roads should be narrowed to around 6 metres on a two-lane street at all intersections and the turning radii kept to 1.5 metres (Figure 40 & 41) in order to slow vehicle traffic and reduce road crossing length for pedestrians (NACTO, 2016).

Figure 40:

Figure 41:

In addition, pedestrian crossings should be provided at intervals of 300 to 400 metres across busy roads and major barriers such as railway lines and riparian corridors with an emphasis on strategic placement to provide direct routes to and from major destinations such as public transport stops, schools, parks and activity centres (Kostanjsek and Lipar, 2007, NACTO, 2016). Narrow pedestrian allies should be avoided for safety reasons (See Safety 2.5); however, pocket parks, shared streets, and woonerf streets that are traversable to pedestrian and cyclists but not motor vehicles and are lined by dwellings oriented towards them should be encouraged (See Open Space 2.4). Finally, inappropriate ramps (Figure 42) can significantly reduce the mobility of people with impeded mobility or in need of mobility aids; therefore, wheelchair accessible ramps should be provided on all corners, at pedestrian crossings and at regular intervals along streets (Figure 43). While Arterial roads and their intersections should be pedestrian friendly, integrated compact and therefore, acts as seems not barriers between residents and uses on opposite sides of them (See Main Roads 2.2).

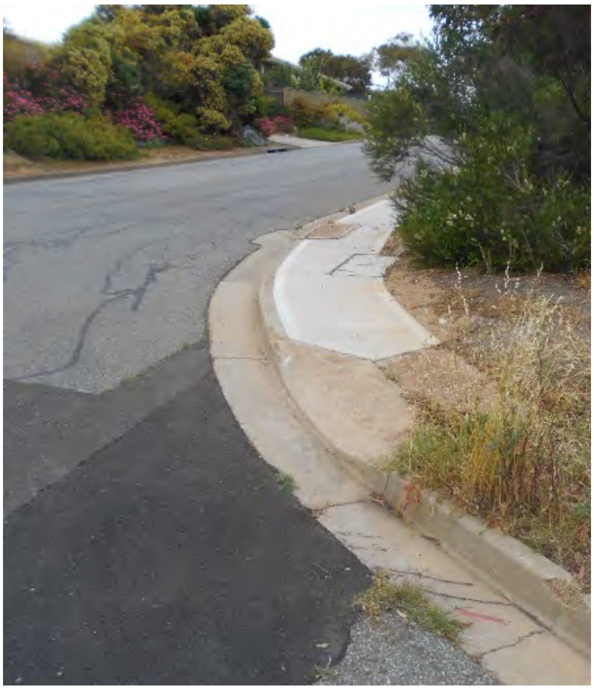


Figure 42:

Figure 43:

Designing to maximise walking and equity also means sealed footpaths need to be on both sides of streets and provide direct routes through parks and open spaces. 'Universal design' requires footpaths unobstructed and level, and wide enough for two adults to walk side by side and/or pass one another comfortably, and for a pram, gopher or wheelchair to manoeuvre comfortably (Aghaabbasi et al., 2019, Hooper, etal. 2015b, Zandieh, 2016). These criteria mean footpaths need to be on both sides of all streets, and the sealed area of a footpath needs to optimally be 1.8 metres wide and at a bare minimum 1.5 metres (Figure 44) (Gunn, 2014, Aghaabbasi et al., 2019, NACTO, 2016, Steiner, 2006). Furthermore, the busier the pedestrian traffic the wider the path needs to be to maintain comfort, therefore paths should be 2-3 metres wide in higher density neighbourhoods (>100 residents and jobs per hectare) and approaching popular destinations such as schools, public transport stops and activity centres (Figure 45). In addition, footpath should include a 'shy zone' verge between the path and the road. Verges enhance perceived comfort and safety and vulnerability by placing protected space between the pedestrian and passing traffic. They also provide spaces for infrastructure, furniture, plants, and trees and allow footpath to remain level where they are crossed by driveways. The width of verges is subject to the business of the vehicle traffic. On residential streets with fewer than 10,000 cars per day, landscaped verges should be a minimum of one metre and optimally around 1.5 metres wide on both sides of the road (Figure 44). On busy roads with more than 10,000 vehicles per day, 1.5 to 3 metres (Figure 45) is the minimum necessary to enhance pedestrian comfort and perceptions of safety (Steiner, 2006, WAPC, 2015, NACTO, 2016).

Figure 44:

Figure 45:

In addition, streets need to be calm, safe, and perceived as safe (See Safety 2.5) integrated into an attractive built environment (See Streets 2.1) and have quality landscaping (See Streets 2.1). They should also be shaded by trees in summer, lit to 2 lux at night and provide regularly spaced primary and secondary seating (Steiner, 2006, Uttley et al., 2017, Aghaabbasi et al., 2017).

3.1.2 Neighbourhood destinations

While the design of pedestrian infrastructure has the ability to increase the odds of walking 2 or 3 times, multiple and diverse destinations within the home area are able to increase it ten times or more (Handy and Clifton, 2001, Cervero and Kockelman, 1997, McCormack et al., 2008, Hooper et al., 2015b). Important destinations in Australia in the 21st century include supermarkets, small retailers, medical centres, public transport stops, schools, child care centres, and personal service providers such as hairdressers (Lund, 2003, McCormack et al., 2008, Ball et al., 2009). They also include private social spaces such as cafes, restaurants, and bars as well as public social spaces such as libraries, community centres and swimming pools. Social spaces (third places) are particularly good at getting people to walk more frequently (King et al. 2015). In particular, a diverse and comprehensive mix of neighbourhood destinations within an identifiable high street or precinct activity centre has a significant multiplier effect compared to planned shopping centres (See Activity Centres 5.2) (Hooper et al., 2015b). Neighbourhood walking trips increase significantly when there are at least nine destinations in an identifiable centre (Handy and Clifton, 2001). Then every additional destination beyond nine increases walking by around 10-20% or 5-12 minutes per week with social destinations increasing it the most (Boarnet et al., 2008, Boulange et al., 2017, McCormack et al., 2008, Hooper et al., 2015b).

3.1.3 Residential Density

The minimum densities required for a 'walkable' neighbourhood is contentious but highly related to that required to produce optimum destination viability within a home area neighbourhood. In an Australian metropolitan area 2500 households or around 6000 people is the minimum required to support a large supermarket (>1500 m^2); the principle outlet for affordable healthy food and anchor for a viable 21st century neighbourhood activity centre (Ball et al., 2009, Black et al., 2012). 2500 households can also potentially support 40 or more commercial destination (McGreevy and Wilson, 2017, McGreevy, 2017b). It is also around the minimum required to support a primary school, kindergarten and child care centre (McDonald, 2008).

Walking is undertaken for both recreation and transport. Recreational journeys are typically undertaken occasionally for long distances, whereas transport journeys are undertaken frequently for short distances. Health from walking is optimised when residents live in neighbourhoods that facilitate both. Walking for transport is argued to be highly constrained by distance to destinations. In general, walking distance for transport defines 400m (5 minutes) as an easy walk, 400-800m (5-10 minutes) as optimum walking distance for regularity, inclination, and average distance covered. and 1200m (15 minutes) as the distance where walking ceases to be regarded as an active transport option for most destination. However, these distances are most often referred to in the context of inducing those with cars to use walking as an alternative. There is also the less referred to distance people without cars are comfortable and conveniently able to walk to destinations before it becomes a significant insurmountable barrier to access. This distance varies based on individual circumstances such as physical fitness, the ability to use mobility aids, and time available. It is also significantly determined by both the quality of pedestrian infrastructure and the public realm. However, 1200 metres or a 30-minute return journey in a quality pedestrian environment is considered a reasonable if flexible maximum.

The mathematics of walkability (enough households within an 800m pedestrian catchment to ensure optimum destination viability) is routinely argued to require a minimum residential density of 15 dwellings per hectare or more (Frank and Engelke, 2005, Newman and Kenworthy, 2006, Calthorpe, 1993, Newman and Kenworthy, 2015, Boulange et al., 2017). However, research undertaken as part of this project in metropolitan Adelaide shows that residential densities as low as 10 dwellings per hectare spread over catchments up to 1200 metres are enough to facilitate the viable diversity required for liveability and enough to begin a liveability transition. Nevertheless, 15 dwellings are also the minimum density advocated by Calthorpe (1993, p 64) for a neighbourhood level transit-oriented development. Residential density also determines the viability and frequency of public transport, the number of people on the streets, in parks and public places at any one time, as well the number of ratepayers to provide money for the maintenance of parks, streets and public places (Cervero and Kockelman, 1997). Therefore, 15 dwellings per hectare is a worthy goal for transition planning for multiple reasons, however, not a prerequisite for initiating it.

3.2 Cycling

Cycling is undertaken for both active transport and recreation by people of diverse ages. Regular cycling can provide major benefits to population health (Pucher et al., 2010, Piatkowski et al., 2015, Mytton et al., 2016). In the Netherlands, where cycling is common, it is estimated that cycling adds 6 months to life expectancy (Schepers et al., 2017). Furthermore, cycling as a substitute for car journeys or public transport reduces noxious gases and particulates from exhausts; as well as climate altering greenhouse gases from exhausts and the embodied energy in individual vehicles and the infrastructure required to keep them viable. Cities where people cycle regularly and in great numbers have networked cycling infrastructure that can take people from anywhere to anywhere quickly, conveniently, safely, and stress-free (Pucher et al. 2010, Schepers et al. 2017).

Inducing cycling begins with the public realm of the neighbourhood (See Public Realm section 1). Walkable residential streets are equally encouraging of cycling, particularly for short trips due to their perceived safety and comfort (See walking 3.1); permeability, street safety and comfort and quality destinations increases cycling for both active transport and recreation (Beenackers et al., 2012, Steiner, 2006, Heesch, 2015).

For journeys further afield, safety and convenience are the most important factor in encouraging cycling (Mytton et al., 2016, Pucher et al., 2010). There are large increases in cycling where destinations such as major activity centres, public transport stops, educational institutions, recreational facilities, and open space are within 5 kilometres of dwellings and connected to residences and one another by protected bike lanes and paths, and there are end of trip facilities at major destinations (Pucher et al., 2010, Steiner, 2006). In addition, connected bike paths along coasts and riparian corridors (Figure 46) increase cycling for recreation (Beenackers et al., 2012, Piatkowski et al., 2015, Mytton et al., 2016).

Figure 46:

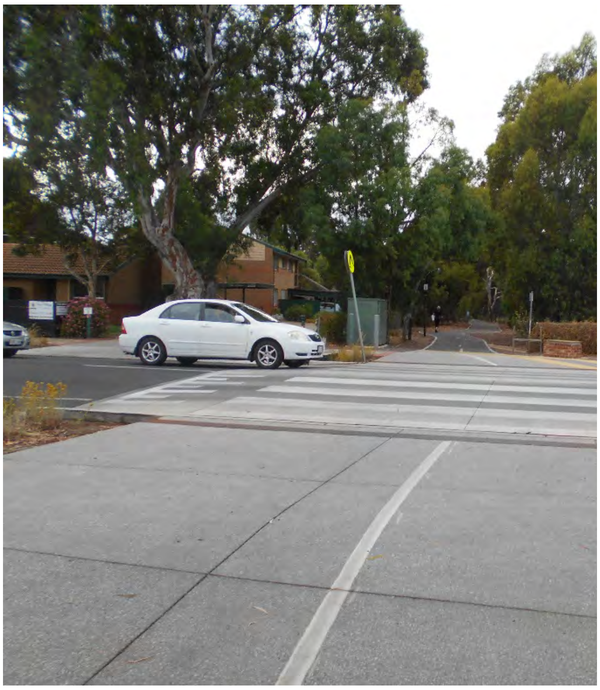


Figure 47:

On busy roads those (more than 10,000 vehicle movements per day), bike lanes need to be separated or protected from traffic in order to enhance safety and perceptions of safety and broaden cycling participation (Figure 48 & 49). On the other hand, no or unprotected bike lanes deter significant numbers of people from cycling for transport and commuting. Bike paths along riparian corridors, through open space and along designated corridors are used more when the have human scale edge (See open space 2.4). One-way bike lanes and shared paths should be a minimum of 1.5 metres wide and two-way paths a minimum of 2.5 metres wide (Figure 41). In addition, bike paths should incorporate crossings that prioritise cyclists and pedestrians when they intersect with roads (Figure 47).


Figure 48:

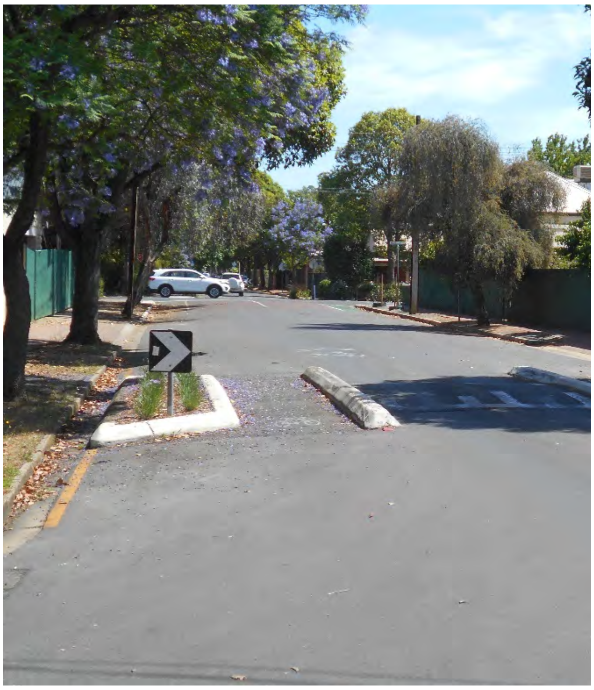


Figure 49:

Table 4: Walking & Cycling checklist			
Determinant	**Design detail**	**Data source**	**Healthy range**
Permeability	Intersections per Km^2	GIS	>30
	Block perimeter sizes	GIS	<640m circumference
	Pedestrian crossings across major barriers such as high traffic roads (>10,000 vehicles per day), rail corridors, & riparian corridors	Observation GIS	Every 3-400 metres (Situated at desire lines and corners)
Pedestrian areas	Extent of seeled footpaths (sidewalks)	Observation	Both sides of all roads and streets and along desire lines through open space
	Unobstructed footpath width	Observation	Side streets 1.8m optimum, (1.5m minimum) 2-5m in high foot traffic areas
	Green verges per kilometre of road.	Observation	1.5 metre optimum (0.75m minimum) width on side streets (<10,000 vehicles per day). 1.5-3m on main roads (>10,000 vehicles per day) Approx. 2 km per 1km of road (both sides)
	Landscape complexity of verges	Observation	Low/mid/high (trees & canopy, understorey, grasses, and small plants)
	Maintenance of verges	Observation	Low/mid/high (irrigated, fertilised, mowed, weeded, pruned etc.)
	Frequency of narrow protected pedestrian right of ways with ramps curb extension and good sightlines	Observation	Along desire lines and at all pedestrian corners
Comfort	Street trees per 100m of road	Observation	20
	Distance between street trees	Observation	Every 5-10m
	Extent of tree canopy	GIS	30%
	Street light night illumination	Lux meter	2 lux
	Quality of landscaping	Observation	Low/mid/high (irrigated, fertilised, weeded, pruned etc.)
	Public seating	Observation	Every 2-300m
	Water fountains	Observation	Every 2-300m
Traffic calming	Road carriageway width on side street corners	Observation	<6m
	Road carriageway width at arterial corners	Observation	6-7 metres (two lane), 12-14 metres (four lane) no slip lanes
	Speed limits on side streets	Observation	30 km/h
	Speed limit on main roads	Observation	50 km/h
	Traffic calming obstacles	Observation	Regular
	Turning radii at corners	Observation	1.5 m

Table 4: Walking & Cycling checklist (contd)			
Determinant	**Design detail**	**Data source**	**Healthy range**
Connection	Paths along desire lines through open space (connecting streets and major destinations on either side).	Observation GIS	Sealed and more than 2.5 metres wide
	Pedestrian prioritised crossings at desire lines leading to destinations (activity centres, parks, schools, public transport stops).	Observation	Always
	Off-street short-cuts, such as mid-block connections and passages through car dead-ends, pocket parks or neighbourhood parks.	Observation GIS	Regular
The edge	Human scale (building height compared to corridor width)	Observation	Height: distance = 1: 1 to 1: 5
	Depth of transition zones		3-5 metres
	Building frontages of doors windows, balconies oriented towards street		100%
	Proportion of streets fronted by surface level car parks, walls, high fencing, buffers, or non-functional land.	Observation GIS	0%
Walking destinations	Number of destinations within 800 metres (shops, services, parks, gathering places).	Observation	>40
	Access Percentage of households within 400m, 800m, 1200m of 10 destinations	Observation	(100% within 800m optimum, 1200 maximum)
	Activity centre with a supermarket	Observation	(100% within 800m optimum, 1200 maximum)
	Neighbourhood park	Observation	(100% within 400m)
	Large recreational park, nature reserve, coast	Observation	(100% within 1600m)
	Community centre	Observation	(100% within 800m optimum, 1200 maximum)
	Community garden	Observation	(100% within 800m optimum, 1200 maximum)
	Library	Observation	(100% within 1200m, optimum, 1200 maximum)
	Primary school	Observation	(100% within 800m, optimum, 1200 maximum)
	Childcare/ kindergarten	Observation	(100% within 800m optimum, 1200 maximum)
	Bus stop	Observation	(100% within 400m optimum, 800m maximum)
	Rapid transit station	Observation	(100% within 800m optimum, 1200 maximum)

Table 4: Walking & Cycling checklist (contd)			
Determinant	**Design detail**	**Data source**	**Healthy range**
Bike Lanes and paths	Kilometres of protected bike lanes per kilometre of high traffic road	GIS Google Earth	2 km (both sides)
	Bike priority at intersections	GIS Google Earth	All major
	Minimum width of bike lanes	GIS Google Earth	1.5m (one way) 2.5m (two way)
	Shared pedestrian and bike paths along coasts, rail lines and riparian corridors	GIS Google Earth	100% where possible
	Minimum width of shared paths	GIS Google Earth	>2.5m (two way) subject to traffic
	Bike lanes and paths incorporating safe crossing points at road junctions.	GIS Google Earth Observation	All aerial and secondary road intersections
Cycling destinations	Major destinations with bike racks	Observation	All
	Number of racks at destinations such as schools, activity centres, public transport stops, parks.	Observation	>20
	Population and jobs per hectare	Census	>35
	Proportion of dwellings within 5 km of a district and regional activity centre	GIS	100%
	Proportion of dwellings within 5 km of a rapid transit interchange	GIS	100%
	Proportion of dwellings within 5 km of a beach, riparian corridor or major recreation park or national park	GIS	100%
	Proportion of dwellings within 3 km of a high school	GIS	100%
	Proportion of dwellings within 5 km of a major commercial/ industrial employment area.	GIS Census	100%
	Proportion of dwellings within 5 km of a tertiary institution	GIS	100%
Regulations & Guidelines	Bike paths widths	Austroads	>1.5m (one-way) >2.5m (two-way)
	Crossings	Austroads	Bike prioritised over cars at intersections
	Protection	Austroads	Bike lanes protected
	End of trip facilities	Development Plans	Yes

3.3 Public transport

Public transport improves health via the incidental walking usually required at each end of the journey. In addition, public transport, is another substitute for car journeys which reduces greenhouse gas emissions and noxious gases and particulates from exhausts going into the atmosphere (Newman and Kenworthy, 2015, Kenworthy, 2006, Tayarani et al., 2016).

Cities where public transport is used regularly and routinely by most people as have complex networked systems of multiply connected subsystems that make travel comparatively faster, more reliable, convenient and inexpensive than cars (Mees, 2009, McIntosh et al., 2014, Newman and Kenworthy, 2015). They allow residents and visitors to access a broad spectrum of destinations across the city freely and inexpensively for any reason. In doing so, they maximize public transport use via universal access. This allows households to live without the considerable expense of purchasing and maintaining cars (Cervero and Kockelman, 1997, Grengs, 2005, Handy, 2005).

The main inducers of public transport use are the convenience, frequency, cost, speed, and reliability of the service compared to car use, and the walkability, density of activity, and cost of parking at destination. Nevertheless, the design of the home neighbourhood contributes to the propensity of residents to use public transport. The quality of the pedestrian infrastructure leading to stops and stations, the real and perceived safety of the home neighbourhood, and the comfort, aesthetics and perceived safety of stops and stations can encourage or discourage public transport use (Ewing and Cervero, 2010, Stevenson et al., 2016, Ding et al., 2017). As Such, stops and stations should be integrated into the quality public realm of surrounding streets, be observable from houses and businesses, and where possible be in places of intense activity. They should have shelter, lighting, bins, and seating, and have ramps and direct access across adjacent roads. On busy roads with more than 10,000 vehicle movements per day all stops should incorporate pedestrian crossings.

Transit oriented development (TOD) proposes a neo-traditional form where traditional liveable neighbourhoods and their activity centres are integrated with public transport (Calthorpe, 1993, Newman and Kenworthy, 2015). Calthorpe (1993) advocated two levels of TOD: the urban TOD and the neighbourhood TOD. Together they form a suburban network of neighbourhood bus services attached to neighbourhood TOD feeding into larger urban TODs incorporating rapid transit services. These networks emulate the networked city approach common to cities with high public transport use.

Facilities such as park and ride, and kiss and ride, get more people onto public transport (Mees, 2014). However, they eliminate incidental walking, and result in more cars and less pedestrians on neighbourhood streets. They also often turn stations into isolated islands surrounded by moats of car parking, reducing direct walking to the station and encouraging even those who live quite close to drive. They undermine the place making required of high intensity mixed use urban TODs (Calthorpe, 1993, Calthorpe and Fulton, 2001, Mees, 2014, Cervero and Hansen, 2002). Therefore, they should be around 400m from the station and minimised in favour of connecting bus services and cycling access.

Table 5: Public Transport checklist			
Determinant	**Design detail**	**Data source**	**Healthy range**
Stop access	(See Table 1: Streets, Table 3: Safety & Table 4: Walking & cycling)		
Convenience	Proportion of dwellings within 400m of a bus stop	GIS	100%
	Proportion of dwellings within 800m of rapid transit	GIS	100%
	Proportion of dwellings within 1200m of a rapid transit interchange	GIS	100%
	Proportion of dwellings within 5 km of district level activity centre (TOD) connected by public transport	GIS	100%
	Bus frequency every 30 minutes or less 7am -9pm	Adelaide metro	100%
	District and regional destinations accessible without interchange	Adelaide metro	50%
	Number of regional and metropolitan destinations accessible with a single interchange	Adelaide metro	100%
	Urban TOD commercial density	Observation	>200 premises within 400m of stop
	Length and hours of priority lanes for buses	Observation	>4 hours per day
	Rapid transit frequency	Adelaide metro	Every 30 minutes or less 7 am to 9 pm.
Destinations	(See table 9: Social Inclusion & Table 10: Employment)		
Stop safety and comfort	Bus stops integrated with streets and surrounding area	Observation	Yes
	Transit stops and interchanges integrated into high intensity commercial areas	Observation	100%
	Car parks and car and bus drop off areas unobtrusive and well away from station core.	Observation	100%
	Pedestrian crossings at bus stops across main roads	Google Earth	100%
	Proportion of bus stops shaded, sheltered, well lit, and integrated with commercial, civic, or social activity	Observation	100%
	Bicycle parks at stops and stations	Observation	100%

3.4 Cars

In Australian cities, private motor vehicles are a major means of mobility. Private motor vehicles without the hindrance of congestion enable people to move from point to point across the metropolitan area and beyond quickly and directly at any time. However, while they are efficient for many metropolitan journeys when it comes to time, they are highly inefficient when it comes to land, resources, and energy. In car dependent cities vast areas of land are required for the roads, car parks and other supporting infrastructure to make mass car mobility viable (Cervero and Hansen, 2002, Ewing and Cervero, 2010, Newman and Kenworthy, 2015, Shoup, 2017). This requires considerable investment of public and private capital to first acquire the land and then build and maintain infrastructure. It also covers vast tracts of cities with hard dark surfaces which produces contaminated storm water runoff and heat island effects, both of which have negative effects on health (Frank and Engelke, 2005). In addition, the cost of car parking contributes around 15-30% to the cost of a dwelling which reduces affordability, while regulations demanding businesses provide minimum numbers of car parks add to the costs of doing business (Shoup, 2017). In addition, car park availability and cost are one of the greatest inducers of car ownership and use (Ding et al., 2017). Therefore, minimising the numbers of carparks available and demanded by regulation at the neighbourhood level can shift the balance of travel away from cars to walking, cycling, and public transport.

Private motor vehicles are also the most energy inefficient means of mobility, this includes petrol for propulsion and embodied energy and resources in infrastructure and vehicles (Newman and Kenworthy, 2015). Their land inefficiency also produces congestion in strategic locations and times, continually diverting significant public funds into new infrastructure in attempts to overcome it (Ewing and Cervero, 2010, Cervero, 2002). Significant levels of car use and a focus on relieving congestion also undermines a city's ability to construct and maintain a viable, reliable and convenient public transport system (Mees, 2009). Car dependence also means those without regular access to private motor vehicles can be significantly disadvantaged when it comes to accessing important destinations such as employment nodes and affordable goods and services. This can lead to social isolation, an inability to find employment, or a reliance upon others all of which effect mental health and wellbeing (Grengs, 2005).

Car travel has direct effects upon population health and wellbeing. The greater the average vehicle kilometres travelled the greater the amount of road trauma and the greater the amount of noxious emissions and noise. These adversely affect the health of people walking, cycling, and travelling in cars and public transport along, busy roads. They also adversely affect the health of people who live, work or study within 500m of a busy road. In addition, every hour spent travelling in cars increases the likelihood of obesity and associated health issues (Frank et al., 2004, Garden and Jalaludin, 2009). What is more, motor vehicle infrastructure such as busy roads and buffers, car parks, signs etc. (Figure 50 & 51), create neighbourhood level barriers between homes and destinations, reduce safety and perceptions of safety for pedestrians and cyclist; therefore, significantly reducing the incidence of both (Boulange et al., 2017, Hooper et al., 2015b, Pucher et al., 2010, Frank et al., 2004, Mytton et al., 2016).

Figure 50:

Figure 51:

Transitioning towards liveability requires cars to be given the lowest priority in infrastructure investments and carparks not being mandated in new developments. Neighbourhood destinations should be designed, managed, and regulated to encourage walking and lingering and discourage driving and elements which encourage driving avoided. Residential streets should be designed with walking as the paramount priority (See walking 3.1) and traffic speeds kept below 30 km/h below on quiet streets and 50 km/h on arterial roads passing through residential neighbourhoods to minimise accidents and injuries to pedestrians from accidents.

Table 6: Cars			
Determinant	**Design detail**	**Data source**	**Healthy range**
Public realm	(See Table 1: Streets)		
Safety	(See Table 3: Safety)		
Pedestrians and cyclists	(See table 4: Walking & Cycling)		
Destinations	(See table 9: Social Inclusion)	GIS	
Household car use	Average number of cars per household	Census	
	Percentage of households without a car	Census	
	Percentage of households without 1, 2 or 3 or more cars car		
	Median commuting distances	ABS	<10 km
	Proportion of people commuting by private motor vehicle		
Car parking	Number of car parks per car	Development Plans Google Earth	
	Average size of public car parks	Google Earth	< 1.2 ha
	Cost of car parking	Observation	Not subsidised
	Minimum car parks requirements for dwellings	Development Plans	Discretion of the owner
	Minimum off street car parking requirements for neighbourhood destinations	Development Plans	0
	Minimum shared off street car parking requirements for district or regional destinations	Development Plans	Discretion of owners

4 HOUSING

Housing contributes to health and equity in multiple ways. Housing diversity (size, tenure, style, and cost) helps facilitate organic social and demographic mixing (Morris et al., 2012, Wood, 2003). Housing provides a frame around the public sphere and therefore contributes to its attractiveness, interestingness, and perceived safety (See 2.3 The edge and landscaping). A liveable neighbourhood is estimated to require a density of around 15 dwellings per hectare to ensure destination viability, the quality of the public sphere and the convenience of public transport. Although 15 dwellings per hectare is not particularly high by global standards, it does require housing diversity within a single neighbourhood which in itself has numerous benefits for health and wellbeing. Our research has shown that while the 15 dwellings per hectare is desirable, it is not a prerequisite to begin transition, residential densities as low as 10 per hectare are enough to initiate a successful transition.

4.1 Dwelling diversity

A healthy neighbourhood is one that is able to accommodate the evolving diversity of local residents and the residents of the greater metropolis. As such they have a balanced proportion of housing sizes, styles, and tenures that reflect the demographics and incomes of the greater metropolitan whole. In metropolitan Adelaide today most dwellings house just one or two residents; however, the housing stock is mostly large detached bungalows with three or more bedrooms. This has implications for affordability and demographic appropriateness (ABS, 2016) as housing diversity creates relative affordability and inclusiveness in all neighbourhoods. On the other hand, dwelling homogeneity leads to neighbourhood exclusivity and concentrated areas of poverty, which can lead to an erosion of social solidarity and lack of public and private investment in services and the physical environment for communities of greatest need (Gleeson, 2002, Wood, 2003).

In diverse neighbourhoods, small dwellings in multi-unit buildings (flats and townhouse) are around half the cost of detached or semidetached dwellings in the same neighbourhood (McGreevy, 2018). Furthermore, the land efficiencies provided by multi-unit blocks allow affordable housing to be constructed in organically socially mixed locations (Morris et al., 2012). This can reduce necessary expenditure because of proximity to employment, public and private facilities and services and convenient public transport, making the expense of frequent long-distance travel and car ownership unnecessary. It also allows people to find appropriate accommodation within a single neighbourhood as circumstances change (aging, sickness or disability, loss of income, separation, children leaving home etc.) (Wood, 2003, Morris et al., 2012). They also require less energy to heat, cool and illuminate than detached or semidetached dwellings and apartments in large multi-storey blocks (Myors et al., 2005). Therefore, their existence is a key to neighbourhood affordability, inclusiveness, and demographic responsiveness.

The existence of private rental accommodation for under $200 and $250 per week is also significant. Having options in this price bracket means there is potentially affordable accommodation available for the low-income groups most likely to struggle to find affordable accommodation such as singles or couples on minimum wages, and couples on long-term welfare benefits (Anglicare, 2017, Yates, 2013). For singles and single parent families reliant on welfare payments, even $200 per week rent places them in rental stress, therefore, a proportion of public or community housing is required as part of the housing mix (Anglicare, 2017).

The total social housing stock in SA has decreased from 64,491 dwellings in 1992 to less than 38,000 in 2015 (PHIDU, 2018). In south Australia Exclusionary land use regulations such as minimum allotment sizes and car parking requirements are the norm which force up the cost of multi-unit developments. As they incentivise large and expensive low yield detached and semi- detached housing over small, relatively inexpensive high yield walk up flats and townhouses from ad hoc infill (McGreevy, 2018).

Normally, housing affordability is assessed by way of averages, average household income relative to average house prices or rents. While these provide a rule of thumb, they are an inadequate indicator of the true availability of affordable housing for those seeking them, the number of dwellings available within a price bracket affordable at their income. Therefore, while the HUNTT includes a traditional measure numbers of residents spending more than 30% of their income on rent or mortgages, it also includes figures that best represents the situation faced by perspective purchasers or renters when they are searching for availability, the number of dwellings available within an affordable price range subject to their household income. To this end in the purchasing market, the analysis is of numbers of dwellings sold over a year (as neighbourhoods have different populations the assessment is per 1000 neighbourhood residents) within five price ranges; dwellings sold for under $200,000, from $200-250,000, from $250-307,000 (state governments maximum affordability figure), from $307,000 to $417,000, and over $417,000. In the rental market, the analysis is of numbers of dwellings available for rent on the Realestate.com website on one weekend in four price ranges; dwellings available for rent per 1000 residents for less than $200 per week, from $201 to $275 per week, from $276 to $350 per week, and more than $351 per week. This method is used by Anglicare in its annual affordability analysis. The healthy level is based upon a relatively even split of availability compared to metropolitan incomes and household sizes.

4.2 Dwelling design

Dwelling architecture, location and orientation are determinants of a resident’s health and wellbeing. Access to natural light, fresh air, pleasant views, and outdoor space, as well as noise attenuation increase comfort and reduce stress (Bennett et al., 2016, Carrier et al., 2016). Usable balconies, shallow front gardens, and porches provide transition zones and soft edges between private and public spaces (Figure 23, 24, 31, 36). They provide a space for residents to connect with and contribute to the public realm and provide visual interest and signs of habitation for passers-by (See 2.3 The edge and landscaping).

Table 7: Housing checklist			
Determinant	**Design detail**	**Data source**	**Healthy range**
Housing diversity	Dwellings with one bedroom or bedsits	Census	10-20%
	Dwellings with two bedrooms	Census	30-50%
	Dwellings with three bedrooms	Census	20-30%
	Dwellings with four or more bedrooms	Census	15-30%
	Detached houses	Census	30-50%
	Flats and apartments	Census	30-50%
	Semidetached, terraces, townhouses	Census	30-50%
	Change in detached houses	Census	
	Change in flats and apartments	Census	
Neighbourhood evolution (2006-16)	Change in semidetached, terraces, townhouses	Census	
	Change in dwelling density	Census	
Affordability (Access)	(See table 4: Walking & Cycling)		
	(See table 5: Public Transport)		
	(See table 9: Social Inclusion)		
Affordability (Purchasing)	Households with mortgage payments >30% of income	Census	0%
	Households on lowest 40% of income paying >30% of income	Census	0%
	Dwellings sold per 1000 residents for <$200,000 (affordable)	Valuer General	5-10%
	Dwellings sold per 1000 residents for $200-250,000 (affordable)	Valuer General	5-10%
	Dwellings sold per 1000 residents for $250-330,000 (affordable)	Valuer General	5-10%
	Dwellings sold per 1000 residents for $330-400,000 (unaffordable but below metropolitan median)	Valuer General	20-35%
	Dwellings sold per 1000 residents for >$400-500,000 (unaffordable and near or above median)	Valuer General	<35%
	Dwellings sold per 1000 residents for >500,000 (unaffordable and above median)		
	Households with rents >30% of income	Census	0
	Households on lowest 40% of incomes with rents >30% of income	Census	0%

Table 7: Housing checklist (contd)			
Determinant	**Design detail**	**Data source**	**Healthy range**
Affordability (Purchasing) (contd)	Dwellings sold per 1000 residents for >$400-500,000 (unaffordable and near or above median)	Valuer General	<35%
	Dwellings sold per 1000 residents for >500,000 (unaffordable and above median)		
	Households with rents >30% of income.	Census	0
	Households on lowest 40% of incomes with rents >30% of income	Census	0%
Affordability (Rental)	Dwelling listed per 1000 residents for <$200 per week#	Real estate.com	1-2
	Dwelling listed per 1000 residents for $200 to $274 per week #	Real estate.com	1-2
	Dwelling listed per 10,000 residents for $275 to $350 per week #	Real estate.com	2-3
	Dwelling listed per 10,000 residents for >$351 per week #	Real estate.com	3-4
Land use regulations (Exclusionary)	Multi-unit dwellings illegal or commercially unviable	Development Plans	no
	Minimum average allotment sizes	Development Plans	no
	Minimum car parks per dwelling	Development Plans	No
	Maximum height	Development Plans	Human scale
	Minimum frontage widths	Development Plans	4m
	Minimum allotment depths	Development Plans	20m
	Maximum density	Development Plans	no
	Single use zoning	Development Plans	no
Land use regulations (Inclusionary)	Maximum average allotment sizes	Development Plans	Yes
	Minimum density	Development Plans	Yes
	Mixed use zoning	Development Plans	Yes
	Affordable housing targets	Development Plans	Yes

Table 7: Housing checklist (contd)			
Determinant	**Design detail**	**Data source**	**Healthy range**
Land use regulations (Other)	Maximum site coverage	Development Plans	50%
	Orientation of windows, doors porches and balconies	Development Plans	North and east
	Garage doors as a proportion of frontage	Development Plans	<30%
	Garage door setbacks	Development Plans	2m from frontage
	Size of outdoor space, land	Development Plans	>5m x 10m
	Size of outdoor space, balconies	Development Plans	>2m x 3m
	Tree preservation at demolition	Development Plans	Yes
	Solar access	Development Plans	Yes
	Overlooking	Development Plans	
	Façade detail, interestingness, and symmetry	Development Plans	
	Minimum and maximum setbacks for residential buildings	Development Plans	2-5 metres
	Inclusion of balconies, front yards, and porches	Development Plans	Yes

#. based upon relatively even split of metropolitan average across all neighborhoods (15% higher or lower range).
@. within a 10% range of the metropolitan median of $1265.

4.3 Climate and energy

Housing design, condition, quality and appointments limit a household's ability to respond to both heat and cold with major implications for physical and mental health and wellbeing (Howden-Chapman et al., 2012, Vardoulakis et al., 2014). Dwellings with poor insulation, poorly seeled windows and doors and thermally efficient blinds, curtains and awnings as well as older energy inefficient heaters, air conditioners and appliances are more uncomfortable, unhealthy, and expensive to heat or cool throughout winter and during heat waves (Howden-Chapman et al., 2012, Vardoulakis et al., 2014).

Household energy consumption is a major cost to individual households and major contributor to Australia's greenhouse gas emissions. In addition, the costs of heating and cooling can cause energy poverty. Energy poverty is defined as "an inability of a household to secure a socially and materially necessitated level of energy services in the home" (Bouzarovski and Tirado Herrero, 2017). It has been classified as a household spending more than 10% of their total income on energy from all sources, including gas, electricity, coal, wood etc. (Howden-Chapman et al., 2009). Energy poverty forces low income households and/or those with significant energy needs into financial hardship or results in an inability to maintain dwellings at comfortable temperatures through hot and cold weather.

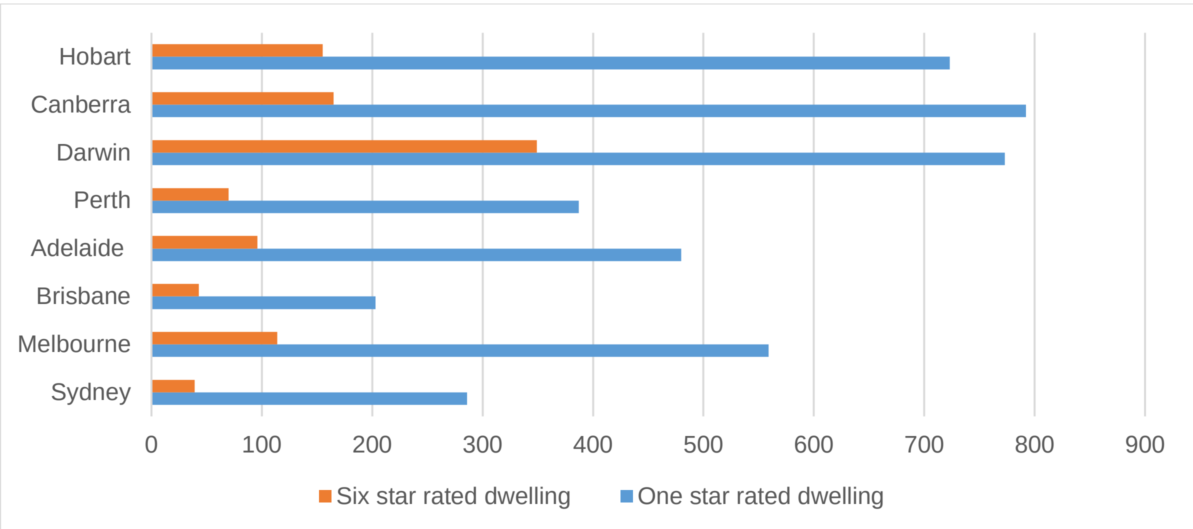
There are four contributing factors that alone or in combination drive energy poverty:

- Low household income
- High energy prices
- Inadequate thermal insulations of houses
- Climate (Bouzarovski and Tirado Herrero, 2017)

Six-star thermal rating standards have been mandated in Australia for new dwellings since 2006. Six star rated dwellings or above are significantly easier and cheaper to heat or cool then a one star rated dwelling. In Adelaide, a one-star dwelling requires almost four times as much energy to keep thermally comfortable as a six-star dwelling (Figure 52). However, it is estimated most dwellings built before 2000, which is the vast majority of Australia's housing stock, would only earn a one star rating (Morrissey and Horne, 2011). In addition, poor enforcement since 2006, means some houses built over the last decade are also likely to be well below a six-star rating (O'Leary et al. 2016). As a result, most of Australia's housing stock is poorly insulated and sealed.

Figure 52: Maximum thermal energy load of Australian housing, MJ/m2/ annum

(Department of Environment and Energy 2017a).

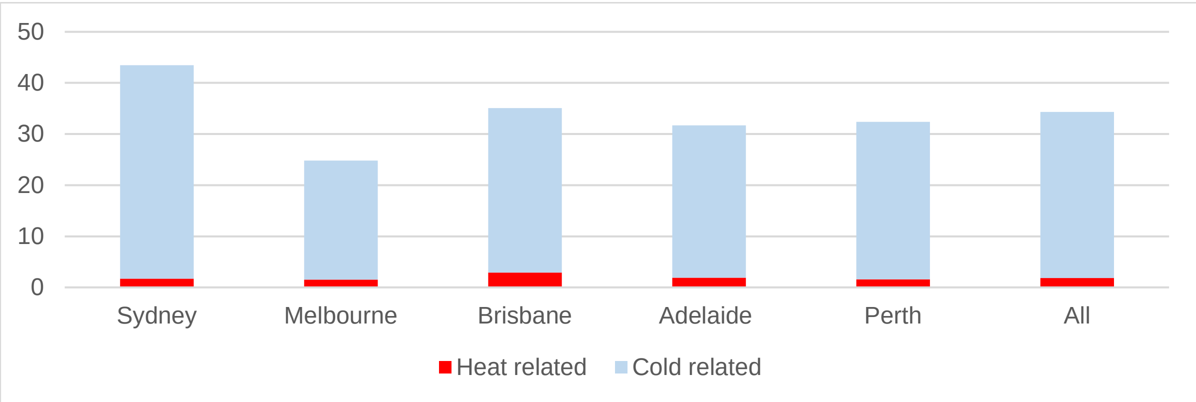


Older, poorly insulated and leaky fibro or wooden houses are particularly difficult and expensive to keep warm (Howden-Chapman et al., 2012). In addition, heating and cooling costs are directly related to dwelling size not the number of residents, the larger the dwelling the greater the cost of thermal control, and the fewer the residents per household the greater heating and cooling costs per capita. Finally, small walk up flats and townhouses are the lowest uses of energy per dwelling and large detached houses and multi-storey apartments the largest (Myors et al., 2005).

Australia's history of low energy prices, lack of enforced thermal efficiency standards and recent sharp rises in energy prices have made many low income households vulnerable to energy poverty and negative health outcomes from hot and cold weather (Bouzarovski and Tirado Herrero, 2017, Santamouris, 2016, Liddell and Morris, 2010). The people most vulnerable to energy poverty are renters living in thermally efficient houses due to the rental paradox. The rental paradox is that while owners are responsible for the thermal efficiency of houses and often the efficiency of heaters and air conditioners, the responsibility for paying for all energy consumed rests with the tenant (Bird and Hernandez, 2012).

The average Australian household consumes 34% of its energy for space heating, 22% for hot water, 7% for lighting and just 4% for space cooling (Clean Energy Council, 2013). In addition, winter cold is a far larger contributor to weather related mortality then summer heat. In Adelaide around 20 times as many people die from cold heat related effects as heat related (Figure 53).

Figure 53: Temperature related mortality per 100,000 (Vardoulakis et al., 2014)



Higher mortality is just the tip of the iceberg; it is also a reliable indicator of broader issues when it comes to the health effects of cold houses (Howden-Chapman et al., 2012, Gasparrini et al., 2015). Constant interior temperatures below 16 degrees cause respiratory stress and those below 12 degrees cause cardiovascular stress (Fay, 2004). In addition, viruses and bacteria are more prevalent in cold damp houses (Howden-Chapman et al., 2012). Living in cold houses causes more frequent illness with resultant increases in absences from work and school, hospitalizations, visits to the doctor and use of pharmaceuticals (Howden-Chapman et al., 2012, Gasparrini et al., 2015). Furthermore, being constantly cold at home is uncomfortable and psychologically stressful. It can also be socially isolating because people living in cold house are often reluctant to invite friends and family to visit (Liddell and Morris, 2010). Although, temperature comfort varies from person to person, in Europe a healthy house is defined as one warmed to a minimum of 21 degrees in the main living areas and 18 degrees in other rooms for 16 hours per day (Howden-Chapman et al., 2012, Fay, 2004).

Although heat related mortality is far less prevalent in Australia than cold related mortality (Figure 53), it does causes short periods of very high morality and produces more deaths than any natural disaster (Stefanon et al., 2012). In addition, heat related mortality is expected to rise with climate change as heat waves become more intense, occur more often, and last longer (Vardoulakis et al., 2014). Heat waves increase heart attacks, strokes, and organ failure and have the greatest negative health effects on the elderly, diabetics, asthmatics, the obese and those with chronic conditions such as heart conditions and MS (Mora et al., 2017). Other negative effects of heat waves are a loss of appetite, general discomfort, and an inability to sleep leading to fatigue, lethargy, nausea, and anxiety. Discomfort levels can also be psychologically stressful (Nicholls L., 2017).

Like cold weather, the effects of heat are reduced or increased by the design and thermal efficiency of dwellings. Thermally inefficient houses heat up quicker at lower temperatures and stay hot longer, negatively effecting the comfort and health of residents and make responding to heat effectively difficult (Nicholls L., 2017). As such well insulated and sealed houses are equally as effective against heat as they are against cold. In addition, summer shade over streets and dwellings in summer from trees and the orientation of windows can reduce indoor temperatures significantly at times of peak temperature. In addition, At the neighbourhood level, hard dark surfaces such as black rooves, roads, surface level car parks raise ambient temperatures in their immediate vicinity, while soft and light coloured surfaces and extensive tree canopies help moderate temperatures (Norton et al., 2015, Kleerekoper et al., 2012, Mohajerani et al., 2017).

The most effective means of reducing household GHG emissions, overcoming energy poverty, and improving health and health equity is to increase the thermal efficiency of established dwellings via insulation and sealing and the instillation of energy efficient space and water heaters. A regulation able to improve the thermal efficiency of established dwellings is compulsory thermal efficiency audits prior to dwelling on sales. Of particular importance for health equity are regulations able to overcome the rental paradox. One means of achieving this is to include thermal efficiency and appliance efficiency as prescribed minimum housing standards. This means rental properties which fail to meet minimum standards have enforced rent reductions until the problem(s) are addressed. Another complementary means are *Environmental Upgrade Agreements* (EUAs) which provide a mechanism for proprietors to invest in energy efficiency upgrades. They are government supported mechanism which property owners are able to acquire to finance to upgrade the energy efficiency of their rental properties and subsequently repay through local council rates notices (Blundell, 2019). These are currently available in SA, NSW, and Victoria for commercial tenancies but not residential tenancies.

Table 8: Climate and energy checklist			
Determinant	**Design detail**	**Data source**	**Healthy range**
Public realm	(See Table 1: Streets & Table 2: Open space)		
	Extent of tree canopy	GIS	>25%
	Distribution of open space	GIS	
	Proportion of hard surfaces, roads, and car parks	GIS	
Mobility	(See table 4: Walking & Cycling, Table 5: Public Transport)		
	(See Table 9: Social Inclusion)		
Thermal efficiency	Average building site coverage	GIS	<50%
	Proportion of dwellings fully insulated	Survey	100%
	Proportion of dwellings adequately sealed	Survey	100%
	Proportion of dwellings with dark rooves	Survey	0%
	Maximum site coverage	Development Plans	
	Orientation of windows, doors porches and balconies	Development Plans National Construction Code (NCC)	
	Minimum size of outdoor space, land	Development Plans	
	Planning permission required for demolition.	Development Plans	
	Size of outdoor space, balconies	Development Plans NCC	
	Significant tree preservation	Development Plans	
	Tree retention post demolition and subsequent redevelopment	Development Plans	
	Solar access	Development Plans NCC	
	Overlooking	Development Plans	
	Inclusion of balconies, front yards, and porches	Development Plans	
	Location of high-density housing	Development Plans	
	Minimum requirements for sealing, glazing and insulation	NCC Development Plans	6 star

Table 8: Climate and energy checklist (contd)			
Determinant	**Design detail**	**Data source**	**Healthy range**
Building Regulations	Size of balconies	NCC Development Plans	>2m x 3m
	Orientation and size of windows and doors	NCC Development Plans	6 star
	Roof colours	NCC Development Plans	Light colours
Other regulations and policies	Appliance efficiency standards	Housing Improvement Act & Regulations 2017	6 star
	Thermal efficiency improvement assistance for established owner occupied dwellings	Housing Improvement Act & Regulations 2017	6 star

5 SOCIAL INCLUSION

Other relevant chapters: Transport and access, safety, food, housing

Major factors behind social conclusion with relevance to urban planning are housing diversity (see Housing diversity 3.1), the quality and diversity of the public realm (See Public Realm 2), walking (see walking 3.1), destinations and employment. Together these maximise walking and improve equity of access.

5.1 Walking and access to local services

The design of neighbourhood streets and pedestrian infrastructure has the ability to double or treble average time spent walking. However, having a diversity destinations within the home area neighbourhood is able to increase it by factors of ten or more (Handy and Clifton, 2001). It has been estimated that every additional destination within a home area neighbourhood increases walking by around 10-20% or 5-12 minutes per week with social destinations increasing it the most (Boarnet et al., 2008, Boulange et al., 2017, McCormack et al., 2008).

In addition, having an array of social, community, civic, education, and health services and premises within walking distance of houses, increases regularity of use and the likelihood of residents walking or cycling to them. Important neighbourhood destinations include quality parks and open space (See Open space 2.4) and public transport (See Public Transport 3.3). Having schools and childcare facilities within the home neighbourhood also saves time for those with other commitments and makes it easier to commute via public transport or active transport. Some civic premises such as libraries and community houses and halls that provide regular social events and classes can be important community hubs, meeting places and sources of information. They are particularly, important when incorporated into complex activity centres (See Activity Centres 5.2). Schools also have valuable recreational and sporting facilities (courts, ovals, halls, playgrounds) that can be shared by the wider community out of hours and like public open space, their grounds are safer when overlooked by an elevated edge of multistorey buildings with windows, doors and balconies. However, schools are extremely difficult to retrofit into an established suburb, so neighbourhood transition needs to focus on routes to school. On the plus side, children are able to walk considerable distances to school (around 1.5 kilometres in 20 minutes) and are more likely to do so if home area neighbourhoods and routes to school are walkable (See Walking 3.1 & Cycling 3.2), safe and perceived as safe (Safety 1.4) (Ewing et al., 2004, Rothman et al., 2014, Timperio, 2004, Timperio et al., 2006, De Vries et al., 2010). A 20-minute walk or cycle to school is enough for a child to obtain their minimum weekly requirements of moderate exercise. High schools tend to be larger and have much wider catchments than primary school; therefore, for many students they will need to be accessed by bike or public transport rather than walked. Therefore, protected bike paths leading to schools are required (See Cycling 3.2).

Walking regularly is not only good for physical health it also places people in public places where they can connect with neighbours. Residents walk most regularly and also partake in 'stationary' optional and social activities such as reading, talking, listening, watching, playing and enjoying the company of strangers in neighbourhoods with walkable streets and where a diversity of destinations are agglomerated and connected in traditional town centres and high streets (Cattell et al., 2008, Gehl, 2013, Mehta and Bosson, 2009, Saelens and Handy, 2008, Hooper et al., 2015b). In addition, Oldenburg (1999) argues socially important part of any urban environment are third places, places beyond the first places of home and family and second places of work and colleagues where people can gather socially. Third places are diverse and might include bars, restaurants, hairdressers, barbershops, libraries, public plazas and neighbourhood parks (Oldenburg, 1999). In the urban environment, public life begets further public life as what attracts people most to places is the assured presence and activity of other people.

This produces complexity and emergent social and optional activities on top of routine necessary activities. Gehl (2013) argues that the most important contributor to public life is not individual destinations but rather their interface with and the quality of the public spaces between them.

The positive effects of being able to walk to local social, recreational and commercial places and public transport are amplified for people who spend a lot of time at home and/or who may not have individual access to private motor vehicles. This often includes retirees, children, people with disabilities, stay-at-home parents, and people who are unemployed or underemployed (Frumkin et al., 2004, Garden and Jalaludin, 2009). For many of these people the ability to access most of what they need locally on foot allows for greater self-reliance and autonomy which enhances feelings of wellbeing. It also gives them the opportunity to regularly and easily engage and connect with others even if it is simply enjoying the company of strangers and/or phatic acknowledgements from familiar faces. This can help alleviate feelings of loneliness and isolation (Frumkin et al., 2004, Strawbridge and Wallhagen, 1999, Alpass and Neville, 2003, Uchino, 2004). In addition, easy proximity to diverse public gathering places helps satisfy wellbeing requirements for relaxation, comfort, excitement, passive and active engagement, discovery, belonging and pleasure (Cattell et al., 2008, Lund, 2003, Wood et al., 2010, Scitovsky, 1992, Aries, 1977). Therefore, it is vital that public spaces are designed and provide the amenities to make them universally accessible such as public toilets, furniture, and accessible building (Newton et al., 2010, Aghaabbasi et al., 2017, Aghaabbasi et al., 2019).

5.2 Activity Centres

Neighbourhood walking trips and stationary, social and optional activities increase most significantly when there are diverse social, retail, health, civic and recreational destinations agglomerated in an identifiable activity centre (Bull et al., 2015, Hooper, 2012, McGreevy, 2018, Mehta and Bosson, 2009, Childs 2010). Neighbourhood activity centres tend to come in three major forms, the traditional town or high street precinct or commons, the planned shopping or the hybrid centre which combines elements of both (McGreevy, 2017). Of the three, the traditional precinct increases average levels of walking the most (Boarnet et al., 2008, Boulange et al., 2017, McCormack et al., 2008).

Gehl (2013), McGreevy, (2017a) Mehta and Bosson (2009), and Childs (2004) argue connected traditional precincts that attract a diversity of people to a single integrated location for a diversity of reasons facilitate symbiotic relationships and emergent economic, social, civic and recreational phenomena. Childs (2009, 131) refers to design able to do this as concinnity or '*the skilful and harmonious adaptation or fitting together of parts to craft a whole'*. (McGreevy and Wilson, 2017, McGreevy, 2017b) argue that connected diversity produces a complex adaptive neighbourhood urban subsystem. They argue complexity at the neighbourhood level produces significantly greater numbers of businesses and local employment than ordered systems such as shopping centres or the disconnected chaos of the arterial strip from similar inputs of exogenous capital via relationships, synergies, efficiencies, cycling and responsive niche exploitation. Furthermore, a number of the design elements fundamental to both shopping centres and hybrids such as large surface level car parks and/or attachment to busy unrestrained arterial roads that isolate destinations from one another and surrounding residents have been shown to be major deterrents of recreational walking (Adkins et al., 2012). The design detail and features required for concinnity and complexity in neighbourhood activity centres are:

- More than 30 premises compactly connected via public footpaths and/or squares.
- A diverse symbiotic balance between social, retail, and service premises.
- Diverse ownership of buildings and businesses.
- A built form that can incrementally adapt, grow, and evolve.
- A Supermarket, these are imperative for the success of neighbourhood activity centres and equity (See Food Retail 6.1). However, their bulk needs to be concealed.
- Human scale: building height to street width of 1:1 to 1:3; or from two to five storeys with upper stories overlooking public spaces with windows and balconies to create a sense of enclosure (Figure 54).

- Vertical integration: premises that provide movement, colour, and interestingness, (small retailers, cafes, bars, and restaurants etc.) at ground level with more passive uses (offices, consulting rooms dwellings etc.) on floors above (Figure 54).
- Horizontal integration; connected frontages of narrow shops (<8 metres wide) with open and transparent windows and doors abutting, spilling out and forming an active transparent edge to public spaces such as footpaths and squares and avoidance of disconnection, blank walls and/or opaque frontages (Figure 55).
- Connected, permeable, compact, and easily traversable public spaces between buildings (Figure 55).
- Footpaths wide enough (4-6 metres) to both accommodate pedestrian traffic and 'furniture zones' which allow premises to spill out into the public space with furniture and goods (Figure 55).
- Squares that are integral and at the area of intense activity and proportionate in size to the numbers of people likely to uses them. At the neighbourhood level this would typically range from range from 10 x 15m to 25 x 25m.
- Pedestrian crossings every 250 metres or less.
- On street parking along busy roads to barricade pedestrian areas and slow motor vehicles (Figure 55).
- shared off street parking hidden undercroft, on top of large format stores or behind buildings.
- Closely grained, pedestrian legible and scaled streetscapes (Figure 55).
- Street furniture, art, fountains and quality paving and landscaping (Figure 55).

Figure 54:

Figure 55:

Table 9: Social Inclusion checklist			
Determinant	**Design detail**	**Data source**	**Healthy range**
Housing	(See Table 7: Housing)		
Mobility	(See Table 4: Walking & Cycling)	GIS	100%
Destinations	Proportion of people living within 20-minute public transport trip or cycle (five kilometres) of a district or regional activity centre.	GIS	100%
	Proportion of people living within 800m of a community centre.	GIS	100%
	Proportion of people living within 1200m of a community centre.		
	Proportion of people living within five kilometres of a community centre.	GIS	100%
	Proportion of people living within 800m of a library.	GIS	100%
	Proportion of people living within 1200m of a library.		
	Proportion of people living within five kilometres of a library.	GIS	100%
	Proportion of people living within 800m of a men’s shed, community garden or the like.	GIS	100%
	Proportion of people living within 1200m of a men’s shed, community garden or the like.		
	Proportion of people living within five kilometres of a men’s shed, community garden or the like.	GIS	100%
	Proportion of people living within 800m of a preschool/kindergarten	GIS	100%
	Proportion of people living within 1200m of a preschool/kindergarten		
	Proportion of people living within 800m of a public primary school		
	Proportion of people living within 1200m of a public primary school	GIS	100%

Table 9: Social Inclusion checklist (contd)			
Determinant	**Design detail**	**Data source**	**Healthy range**
Destinations (contd)	Proportion of people living within 2000m of a public high school	GIS	100%
	Proportion of people living within 800m of a neighbourhood activity centre.	GIS	100%
	Proportion of people living within 1200m of a neighbourhood activity centre.	GIS	100%
Activity centre diversity and intensity	Proportion of destinations agglomerated into an integral identifiable neighbourhood commons	Observation	>70%
	Number of connected premises in the neighbourhood commons	Observation	>30
	Number of supermarkets	Observation	1
	Mix of uses in the precinct and individual buildings (retail, social, office, and residential)	Observation	Diverse and complimentary
	Number of necessary destinations (shops, clinics, offices) in neighbourhoods.	Observation	>5 per 1000 residents
	Number of social places (cafes, restaurants, pubs, bars, libraries, theatres, halls, squares, plazas) in neighbourhoods.	Observation	>3 per 1000 residents
Activity centre (design)	Number of outdoor benches, chairs, and tables	Observation	>10 tables and 40 chairs/benches per 1000 residents
	Proportion of destinations within shopping centres or arcades	Observation	<20%
	Length of active frontage abutting public footpaths and public squares in activity centres.	Observation Google Earth	>80%
	Length of on-street parking per 100m of road in activity centres	Google Earth	>50m
	Length of non-active frontages, walls, fences carparks etc. per 100m of frontage in activity centres.	Observation Google Earth	0
	Footpath width in activity centres	Observation	4-6m
	Human scale (the height of buildings compared to the width of the street) in activity centres.	Observation Google Earth	Height: distance 1: 1 to 1: 3

Table 9: Social Inclusion checklist (contd)			
Determinant	**Design detail**	**Data source**	**Healthy range**
Activity centre (design) (contd)	Number of public squares in neighbourhood commons	Observation	At least one
	Optimum dimensions of human scale public squares.	Google Earth	10 x 15 to 25 x 25m
	Distance between pedestrian prioritised crossing points along high streets	Google Earth	100m
	Quality of landscaping and extent of public art	Observation	High
	Public toilets	Observation	Yes
	Pedestrian legible and scaled signs	Observation	Yes
	Length of on street parking on main roads	Observation	>50 metre for every 100 metres of road
	Pedestrian crossings	Observation	Every 250 metres

5.3 Employment

In metropolitan Adelaide approximately 20% of jobs are found in the CBD, the remaining 80% are suburban (ABS, 2016). However, suburban employment is not spread evenly across the metropolitan whole, it is instead concentrated in inner ring suburbs and some industrial middle suburbs. In the suburbs, areas for small scale light industry and activity centres with connected and adaptable shop and office spaces for service delivery are vital for the development of relationships and synergies which can produce complex local economies. Living in an area with a complex local economy provides many advantages for residents. It broadens the availability of local employment and business opportunities which can reduce commuting distances and the health consequences of time spent in cars and travel costs, and increases the possibility of using active travel modes (McGreevy and Wilson, 2017, McGreevy, 2017b).

The existence of diverse premises, where individuals and families can establish small businesses, is vital for complexity and endogenous business activity. Local businesses make neighbourhoods more interesting, more self-reliant, more dynamic, more responsive to vernacular pluralism and more resilient in the face of exogenously derived change. The density of local businesses also lifts the number, diversity, and range of local destinations. ABS employment data is only available at the district (SA2) and regional (SA3) levels so these will be used not neighbourhood level data. As 20% of employment in metropolitan Adelaide is in the CBD, the survey assesses a suburban region (80-120,000 residents) as having liveability economic strength if local business, employment, and premises are around 80% of the metropolitan average of more. This is 345 jobs, 40 business owner mangers and 12 premises per thousand residents. At the district level (20-30,000 residents) the liveable level is defined as 50% of the metropolitan average or 210 jobs, 25 business owner mangers and 7 premises per 1000 residents.

Even in employment dense areas most people do not work in their local districts or regions. Given the adverse health consequences attached to commuting by car, the survey includes average commuting distances, and commuting modes (cars, public transport, or active transport) as a percentage of journeys. As employment is concentrated in certain areas of the metropolitan area, equity demands residents from all parts of the city have access to these nodes by modes other than the car. Therefore, the checklist assesses a resident’s ability to access diverse employment areas with a single public transport interchange or less from 7 am to 9 pm.

Table 10: Employment checklist			
Determinant	**Design detail**	**Data source**	**Healthy range**
District employment	Local jobs per 1000 residents in in the district (20-30,000 residents)	Census	>210
	Number of retail premises per 1000 residents within district	Retail data base	>7
	Business owner mangers per 1000 residents in the district	Census	>25
Regional employment	Local jobs per 1000 residents in the region (100-120,000 residents)	Census	>345
	Number of retail premises per 1000 residents within the region	Retail data base	>12
	Business owner mangers per 1000 residents the region	Census	>40
Access	(See Table 4 Walking & Cycling)		
	Median commute to and from work	Census	<10 km
	Percentage of commuting by car	Census	
	Percentage of commuting by public transport	Census	>50%
	Percentage of commuting by active transport	Census	>20%
	Ability to access key regional and metropolitan employment destinations with one public transport interchange	Census	100% of residents

6 FOOD ENVIRONMENT

Other relevant chapters: Transport and access, safety, open space

6.1 Retail

Ease of access to premises selling heathy or unhealthy food effects diet. Research in Australia, the USA and GB has shown that supermarkets have a wider range of fruit and vegetables and higher quality at lower prices for similar goods than small convenience stores (Ball et al., 2009, Black et al., 2012). In the USA, the comparatively lower access residents in low socio economic areas have to large supermarkets contributes to the less healthy diets of low income households (Ball et al., 2009). Studies in Australia have not found a similar trend. Using a 2 km distance threshold, research has found that access to large supermarkets, is similar for low, medium, and high SES neighbourhoods. However, from an access perspective the 2 km threshold has no relationship to mobility because it is well beyond walking distance. Greatest equity benefits for access and walking accrue when destinations are less than 800m or 1200 metres in walkable neighbourhoods. Beyond this, equitable access incrementally falls. Therefore, this research assumes equitable food access as having a supermarket within 800m of home and 1200m at most.

Supermarkets are key destinations within any neighbourhood and having one is vital for activity centre viability (Lund, 2003). In addition, each additional food store, café, or restaurant adjacent to a supermarket increases the likelihood of walking and the likelihood of people getting sufficient physical activity (King et al. 2015). On the other hand, distance to and density of outlets selling calorie dense fast food, particularly chains with advertising aimed at children, increase the consumption of unhealthy food and lead to increases in overweightness and obesity. Moreover, children who have fast food outlets on the way home from school or go to schools within 400m of an outlet frequent them more with the subsequent effects upon health and weight (Davis and Carpenter, 2009). In the UK, local governments have introduced regulations preventing new energy dense fast food outlets from opening within 400m of schools; other regulations that have been introduced there include maximum percentages of energy dense food outlets in high streets and shopping. However, it is the absence of fresh food outlets rather than the prevalence of fast food outlets that has most effect on diet (Giles-Corti et al., 2016).

6.2 Food production

Growing some of one's own food consumption in yards or community gardens is also a means of obtaining fresh fruit and vegetables locally and inexpensively (Larder et al. 2014). In addition, gardening as a past time is a valuable source of physical exercise, purpose and relaxation, particularly for those who have a lot of time on their hands such as people who are retired, unemployed or underemployed (Freeman et al., 2012). Furthermore, undertaking gardening in social settings such as community gardens or grouped allotments can facilitate social interaction (Firth et al., 2011, Kingsley et al., 2009). Finally, local food production within the urban environment and close to the city reduces food miles (the distance food travels to market) and the time it needs to be stored before consumption, increasing freshness and nutritional values, and reducing the amount of embodied energy in the food consumed (Larder et al. 2014).

Table 11: Food Environment Checklist

Determinant	Design detail	Data source	Healthy range
Access	(See Table 9: Social Inclusion, Table 4 Walking & Cycling)		
Public realm	(See Table 1: Streets)		
	Proportion of people able to walk to shops (See Table 4: Walking)	GIS and site analysis	100%
	Proportion of people living within 800m of at least one greengrocer selling fresh food	GIS and site analysis	100%
	Proportion of people living within a 20-minute public transport trip or cycle (five kilometres) of a weekly or multi-weekly produce market.	GIS and site analysis	100%
	Number of kilojoule dense fast food outlets per capita	GIS and site analysis	
	kilojoule dense fast food outlets within 400m of schools	GIS and site analysis	0
	Number of schools with kilojoule dense chain fast food outlets within 400m	GIS and site analysis	0
	Proportion of people living within 800m of off licence alcohol outlets	GIS and site analysis	
	Number of off licence alcohol outlets per 1000 residents.	GIS and site analysis	
	Proportion of population with access to land (backyards, shared spaces, community gardens) appropriate for growing food.	GIS and site analysis	100%
	Rear yards deep enough to enable food production and gardening	Google Earth	>10 metres
	Policies in place to protect local horticulture and agricultural production areas.	Development plans	Yes

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