



WALKING SPACE GUIDE

Towards Pedestrian Comfort and Safety

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Purpose of the Guide



This Walking Space Guide (Guide) provides a set of standards and tools to assist those responsible for Walking Spaces on streets, to ensure that sufficient space is provided to achieve comfortable environments which encourage people to walk.

The Guide offers a clear, consistent set of standards and processes to be applied in designing, planning and implementing the amount of space to be provided according to the intensity of use. It is intended to ensure that designs are appropriate to the number of people using footpaths. It does not provide space standards for street trees, outdoor dining or street furniture. These other elements are important and extra space should be provided for them.

This guide contains the method for carrying out a Walking Space assessment and offers guidance on how to understand the results. This should be used in conjunction with the accompanying spreadsheet for recording data and calculating results.

Photo credit: Katherine Griffiths

Why Good Footpath Design is Important

Providing appropriate Walking Space is important to encourage walking which:

- enables comfortable flow
- has health benefits for individuals
- promotes social interaction
- provides a sense of safety
- improves accessibility for people with limited mobility
- relieves pressure on public and private transport
- is a spatially efficient way to move large numbers of people
- promotes more sustainable, environmentally friendly travel
- enhances the liveability of the city.

Walking is good for health both physically and by creating social connections that benefit psychological health.

To encourage more people to walk, footpaths should allow for positive social interaction and lack of stress, be usable in a variety of weather conditions and have clear routes that are well connected. People want to be able to walk at an appropriate pace according to their mobility and time constraints, to maintain close proximity with family and/or friends and to pass others in either direction without confusion or uncomfortable proximity to strangers.

What to use the guide for

The Guide should be used to design walking spaces on streets or to assess the level of service of existing facilities. The amount of space to be provided will be determined according to the intensity of pedestrian use predicted for the life of the infrastructure.

For existing footpaths, using the guide to undertake a walking space assessment will help decision makers to understand the spatial Level of Service (LOS) that is currently provided.

The Guide does not address network planning but as a general principle footpaths should be provided on both sides of all streets.

The Guide is not intended to be used for assessing transport facilities or interchanges or for major events or where walking is highly managed.

New standards

The amount of space provided for most existing footpaths is quite low for a variety of historical reasons. It is common when new standards are introduced that old infrastructure does not measure up. In most cases it is not possible to improve everything at once. In this situation it is advisable to create a program of works to move progressively toward good infrastructure standards and to prioritise works that will address acute problems and cause the greatest improvements for the largest numbers of people.

Designing for walking

Large numbers and a high proportion of people walking is considered a key indicator of successful public places and most planning and transport policies aim to increase the number of trips made by people on foot.

Suitably sized, well-designed comfortable footpaths will encourage more people to walk. Inviting, attractive, inclusive walking environments are enhanced by provision of elements like planting, shade, street furniture, drinking fountains and toilets but these are not the focus of this guide.

Fruin and London space guidance

This guide is designed for comfortable walking on streets; this is different from the widely used standards developed by John J. Fruin who studied efficiency of movement within transport facilities for the New York Port Authority in the early 1970s. Fruin supported development of local standards to suit local social norms. This guide is calibrated to Australian urban norms which are different from those more recently developed for London for example. Relatively, Australians have a clear preference for more space.

Standards that benefit everyone

The Guide provide information to ensure that there is sufficient space for able-bodied people to walk comfortably.

The standards are set at levels which ensure that the following groups will also benefit from the improved space allocation to footpath infrastructure:

- people with disability
- people who sustain a temporary injury that limits their mobility
- older people whose mobility and confidence to get around may be impacted as a result of ageing
- families with young children and people using prams
- people using mobility aids
- people delivering goods to buildings
- people sensitive to walking in close proximity to strangers
- people walking with pets.

Managing multiple objectives

Enough walking space is a key determinant of the quality of places. Many jurisdictions have adopted a Movement and Place framework for managing multiple objectives in space and priority allocation. This guide assists in the Movement and Place process by bringing focus to the performance of the Walking Space that can be compared to performance of other aspects of the project. In some situations the balancing of objectives may lead to lower than ideal space provision for walking. This guide will help to understand how that will affect pedestrian comfort.

The importance of trees and shade

In hot climates people will not walk for more than 4 months of the year on footpaths that do not have near continuous shade. With temperatures increasing as the result of climate change, it is important for footpaths to have large spreading tree canopies that provide continuous shade during hot months.

The provision of street trees and continuous shade is even more important than the spatial comfort requirements set out in this guide.

Any existing trees should be protected from damage or removal and spatial allowances made for new trees where shade is not continuous.

Planning for future needs

Planning for future needs requires making predictions about population numbers, changes in through routes and developments in transport. Evidence based predictions of likely population growth and the consequent numbers of people walking and their likely routes, will have implications for Walking Space requirements over the planned life of walking infrastructure.

At the outset of a project, a decision needs to be made about the predicted lifetime of the footpath (typically more than 20 years). Then pedestrian flows will need to be extrapolated accordingly.

Infrastructure must be designed to accommodate future use not only current use.

Reviewing the guide

The effects and usability of the Guide should be reviewed after a period of 2-3 years.

Crossing space guide

A second part to this guide which will provide space guidance for crossings is under development and will be released late in 2020.

Definitions

Walking Space

Walking Space is the term used in this guide for the unobstructed area which is accessible for pedestrians to walk. The walking space is the footpath width excluding obstructions and buffers (see below).

In other contexts other terms are sometimes used for example: pedestrian zone; clear zone or effective footpath width.

Passing Zone

The Passing Zone used for Footpath Type 2 is an area used by pedestrians for overtaking or for passing people coming in the other direction. It must be 0.6m wide. Unlike the Walking Space it may intersect or overlap with the Kerbside Traffic Buffer. The Passing Zone space must occur frequently with at least 1.5m of length available for passing for every 3m of footpath length (i.e. 50%). The width required for the Passing Zone may form part of the Walking Space.



Buffers

Buffers are space allowances made for physical safety and psychological comfort along building edges and kerb lines.

Kerbside Traffic Buffer

This buffer is the area between the Walking Space and the footpath's kerb. The area next to the kerb is usually avoided by people because walking there makes them feel unsafe (as well as being unsafe) due to proximity to fast moving vehicles. The width of the Kerbside Traffic Buffer depends on the speed of traffic in the kerbside lane, presence of a bike lane or kerbside parking lane (see Table 3 for buffer sizes).

Active Building Edge Buffer

People are generally uncomfortable walking very close to Active Building Edges where there is the presence of many doorways to shops or services or shop windows. Where there are Active Building Edges an additional spatial allowance is made for an increased buffer from the building edge (this space is accounted for in Table 4). Additional allowances may need to be made at major building entrances/exits depending on their frequency of use and whether there is regular crowding or queueing in the area.

Photo credit: Sarah Rhodes

Obstructions

Most obstructions should be measured to the outer edges of the element. However, if the obstruction causes people to linger in the vicinity, allow space for these static people. Extra space must also be allowed where there is an associated footpath surface that is not possible to walk on like a tree grate.

Street trees and planting

For street trees, the obstruction should be measured from the base of the trunk (assuming full maturity) or from the edge of the tree pit if it is not suitable to walk on.

Street furniture

There are a large range of permanent objects installed in streets which form obstructions to pedestrian flow. Most obstructions are measured from the outer edges of the element. However, others that generate activity like a public bench should allow an additional buffer for when there are people using it. For a list with recommended buffers, see Appendix B.

Static activity

Static activity can include any gathering of people who are not walking. It can include, for example people waiting at public transport stops, queuing for other purposes, street dining, taking photographs, watching buskers or family and friends waiting to meet or socialise.

Outdoor dining

Outdoor dining is prevalent on many streets where people enjoy social eating in the open air. This is recognised as animating city life. Usually the boundaries of chair and table locations are prescribed.

Other definitions

Peak Hour

The Peak Hour is the one hour period during which the maximum pedestrian flow occurs. It may happen at any time during the day and the time will be affected by local circumstances.

Maximum Flow

The Maximum Flow is the greatest number of people walking in any one hour period.

Site

The Site is the area of investigation.

Level of Service (LOS)

The LOS is a ranking from A (the best) to F (the worst) that correlate to comfort percentiles.

Signage

Free standing street signage takes many forms from traffic speed or parking restrictions to street maps, information guides and advertising boards. The buffers may need to allow for static activity as people stop to read them.

Transport shelters

Shelters for weather protection and for people to sit or lean while waiting for buses or trams require a buffer to allow space for the people using them.

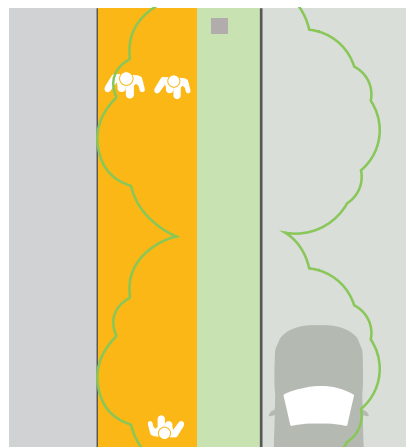
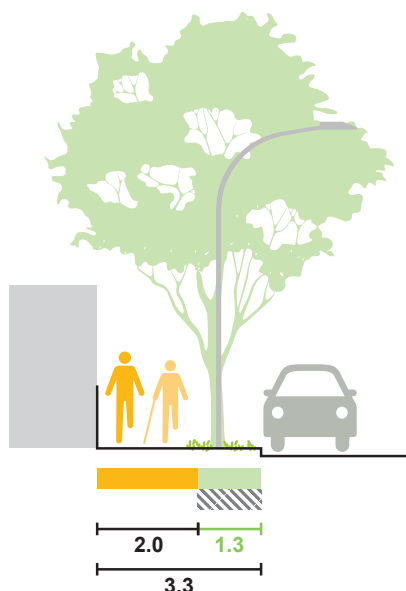
Low planting

Areas of planting not more than 400mm high are considered low planting for the purposes of calculating Walking Space and using the Adjustment Factor.

Walking Space Guide – Footpath Types

Type 1

Local footpath –
Low activity

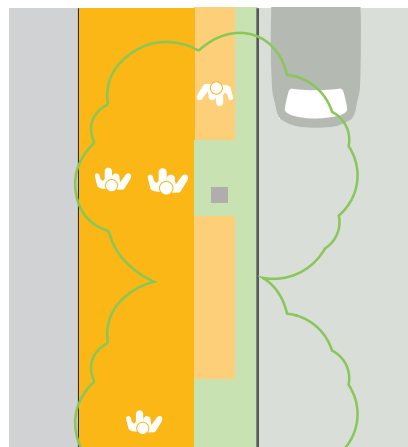
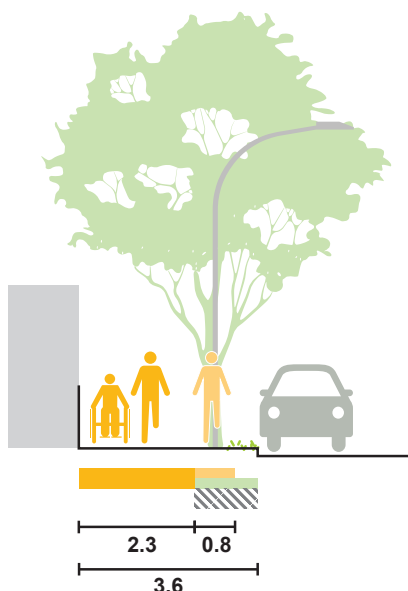


Low activity local footpaths are appropriate where people walking are unlikely to pass people coming the other way.

These footpaths support 2 friends walking together and passing if they walking in single file.

Type 2

Local footpath –
Medium activity

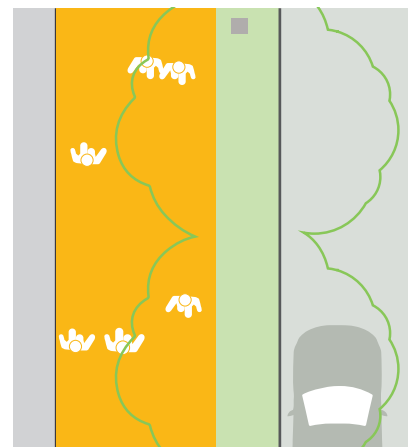
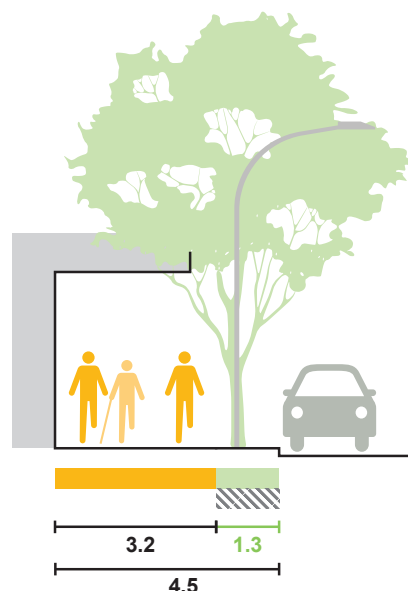


Medium activity local footpaths are appropriate where people walking are more than likely to pass people coming the other way.

These footpaths support 2 people passing abreast or 2 friends walking together passing another person using the Passing Zone.

Type 3

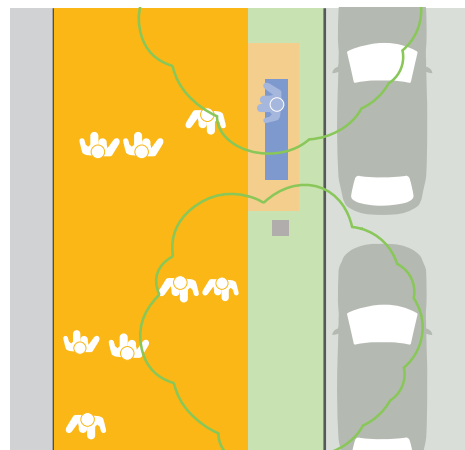
Main street footpath –
Medium activity
/ Local footpath –
High activity



Medium activity main street footpaths are appropriate where people walking are virtually certain to pass people coming the other way.

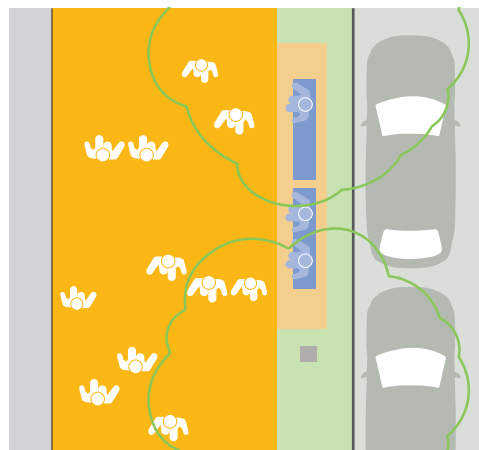
These footpaths support 2 friends walking together and passing another person without having to walk in single file.

Main street footpath –
High activity



These footpaths support 2 friends passing 2 friends coming the other way without either group having to walk in single file.

Main street footpath –
Very high activity



These footpaths provide enough space for large numbers of people to walk comfortably.

Footpath Types

The five Footpath Types used in this document are shown in Table 1.

Table 1 – Footpath Types

Footpath Type	Typical description	Typical minimum level of interaction expected on a short walk	Preferred minimum walking arrangement comfortably supported by this type of footpath
Type 1	Local footpath – Low activity	Unlikely (<33%) to pass someone	2 friends walking together (they may walk single file to pass someone coming the other way)
Type 2	Local footpath – Medium activity	Between likely and virtually certain to pass someone (33-99%)	2 people passing or 2 friends walking together pass one person walking the other way where one person uses the Passing Zone
Type 3	Local footpath – High activity or Main street footpath – Medium activity	Virtually certain to pass someone (>99%)	2 friends walking together passing one person walking the other way
Type 4	Main street footpath – High activity	Virtually certain to meet multiple groups of people	2 friends passing 2 friends
Type 5	Main street footpath – Very high activity	Busy	Enough space for large numbers of people to walk



Photo credit: Katherine Griffiths

COVID-19 Walking Space Requirements

Social distancing is required to keep our community healthy. At least 3.1m of Walking Space is needed on every street.

Medical advice is that everyone should maintain at least a 1.5m separation from other people to limit the spread of COVID-19.

The minimum Walking Space required for social distancing is 3.1m for 2 people to safely pass each other. This must be provided in a way that does not require people to cross the street to the other footpath to pass someone coming the other way. This is impractical and most people will not do it.

3.8m is required for cohabitants walking together to pass a third person.

4.5m is required for two groups of cohabitants to pass each other.

Many of our footpaths are not wide enough to keep people safe.

Most streets should be safe for two cohabitants to pass a third person as this is a very common situation (Figure 2). Busy places should be safe for two groups of cohabitants to pass (Figure 3). As an absolute minimum all streets must be safe for two people to pass (Figure 1).

Practical low cost short term solutions are required to provide enough space. Two example solutions are illustrated on the next page.

Figure 1 – Two people passing safely

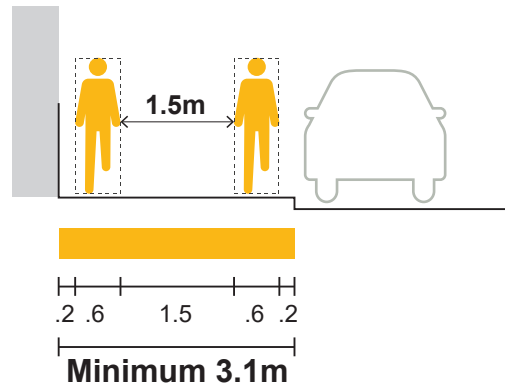


Figure 2 – Two cohabitants passing a third person

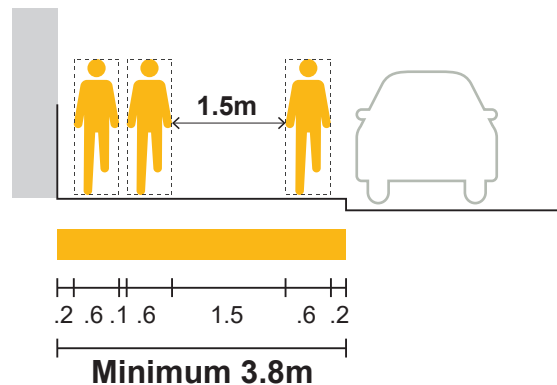
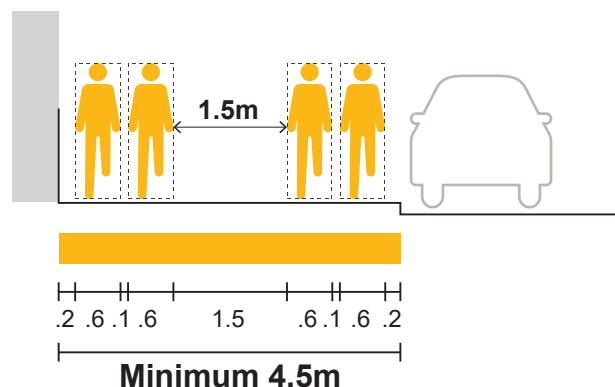
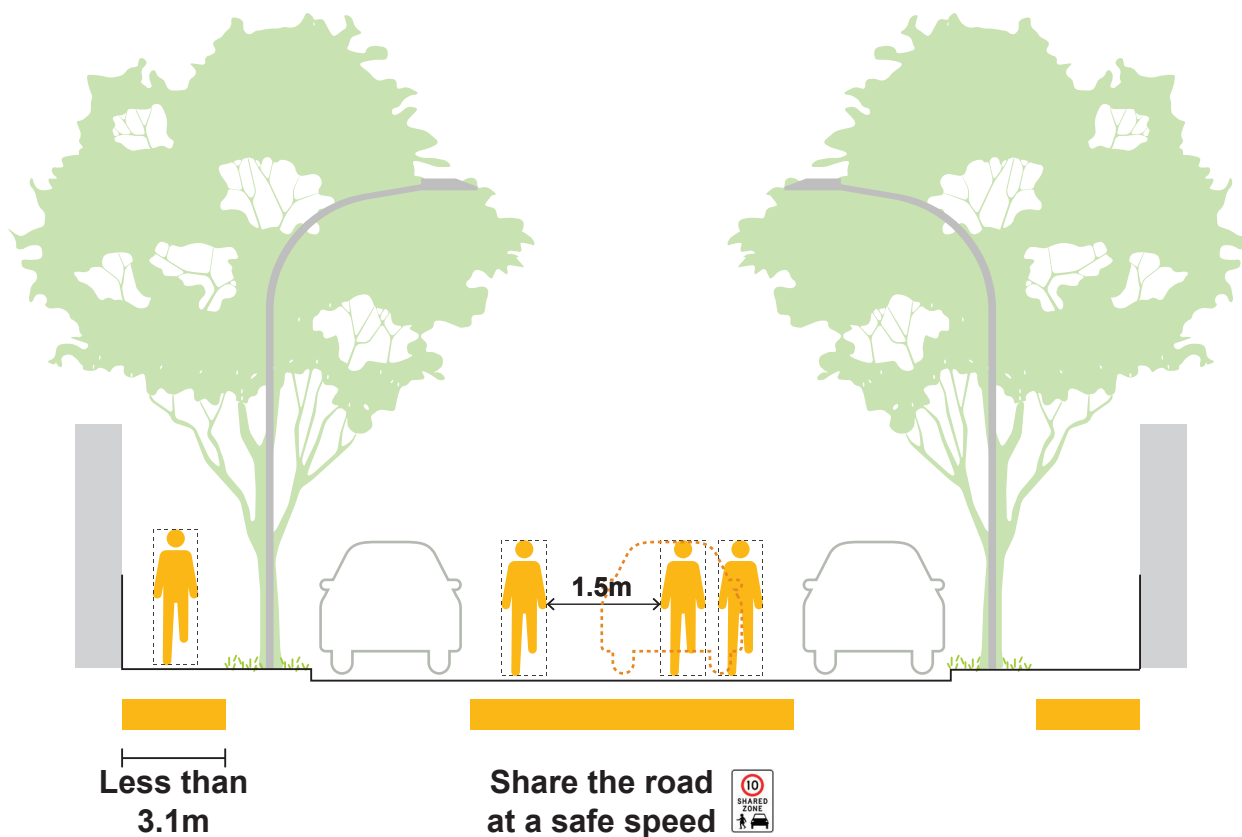


Figure 3 – Two groups of cohabitants passing



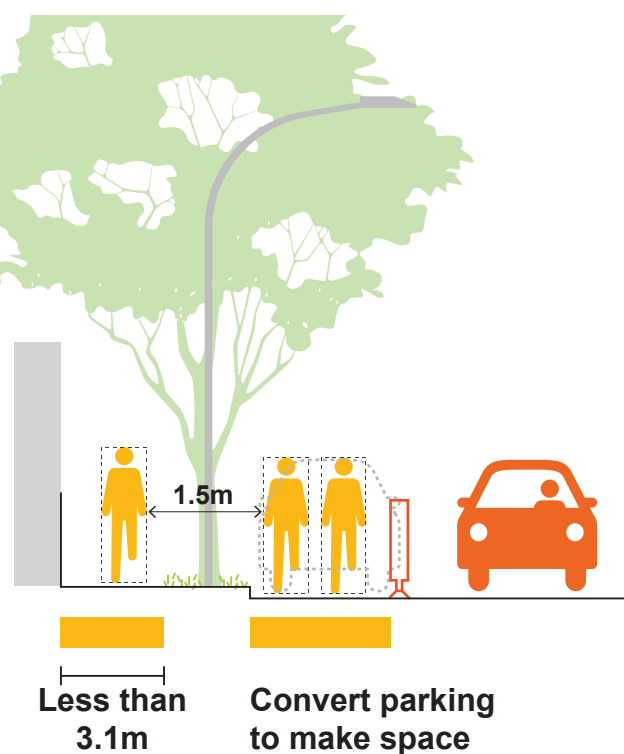
Local streets

On local streets with low traffic volumes the carriageway can be converted to a shared space with safe traffic speeds so people can walk on the road. Signage, line marking and bolt down speed control devices should be used.



Busy streets

Kerb side parking lanes or traffic lanes can be converted to Walking Space. This can be done using bolt down separation kerbs with light-weight posts or with water filled barriers.



Walking Space Level of Service Assessment Process

- | | |
|--|--|
|  Step 1 –
Select and Assess the Site | Collect information about the site and select a range of representative locations for assessment |
|  Step 2 –
Classify the Footpath Types | <p>Use Table 2A – Footpath Type Classification to identify the Footpath Type/s</p> <ul style="list-style-type: none">• If a pedestrian count has been undertaken use Column A• Otherwise for the desktop process use Columns B-D and Table 2B |
|  Step 3 –
Determine the Walking Space | <p>To determine the Walking Space for each selected location, measure the overall footpath width less:</p> <ul style="list-style-type: none">• the Kerbside Traffic Buffer using Table 3• the width of obstructions and associated buffers and• any static activity |
|  Step 4 –
Assess the Walking Space Level of Service (LOS) | <p>Use Table 4A – Walking Space Level of Service to assess LOS:</p> <ul style="list-style-type: none">• for Footpath Types 1 – 4 by cross referencing the Footpath Type from Step 2 with the Walking Space width from Step 3.• for Footpath Type 5 by using both a Peak Hour flow rate (expressed as PPMM) and a minimum Walking Space width in metres.• adjust the LOS using any relevant Walking Space Adjustment Factor by using Table 4B |
|  Step 5 –
Understanding the LOS Rating, Targets and Mitigation Measures | <p>Use Table 5 to understand the comfort level</p> <p>LOS C is the minimum target level and LOS F is the intervention trigger</p> |

Step 1 – Select and Assess the Site Including Spatial Measurements

Define the site for assessment at the outset of the process. The selection may be for a planned new area or an existing site.

Undertake a site visit and agree the boundaries of the site and the locations for assessments. If a site visit is not possible, a desktop study can be undertaken using available street information from street and aerial surveys or other suitable data.

If the scheme is in development and a site visit is impossible, or new elements of the scheme are going to significantly change the pedestrian flow and activity profile in the area (for example a new shopping centre), assumptions for modelling should be agreed and documented before the assessment begins.

When assessing the site it is important to determine whether or not the footpath is an important local walking route to or from a transport hub or place(s) of interest (see Table 2B for a list of common places).

Once a site is selected, answer the following questions. This will affect the classification of the Footpath Type in subsequent steps:

- is the footpath now (or likely to become) a walking route to or from a transport stop (bus or light rail stop or train station)?
- does it connect major destinations?
- are there places of interest like schools in close proximity?
- are there any locations with high numbers of people waiting (static activity) that may require a static activity survey?
- are there any other issues about pedestrian activity and behaviours that may be relevant?

Choose representative footpath locations for assessment

Because footpath conditions change due to obstructions like street furniture and planting or variations in overall footpath width, a number of locations along a footpath are assessed. The LOS will then be calculated for each location, allowing a review of the whole footpath as well as individual problem areas.

The number of locations assessed will be specific to each footpath, but are to include (where applicable):

- locations that are representative of the typical footpath width for the site which include typical street furniture, street trees or other obstructions
- locations where the footpath width changes
- locations where there are more obstructions
- locations where there are bus stops, cafes or other places which have high levels of people waiting
- locations with different kerbside conditions (for example parking or traffic lane).

Example

Figure 4 – Example measurement locations

The information required at each assessment location is:

- the overall width of the footpath
- the kerbside conditions (traffic lane, parking lane, cycle lane etc) and the posted speed limit where there are active traffic lanes adjacent to the kerb
- location of active building edges like shop windows and entry/exit points
- the width occupied by kerbside obstructions for example street trees, planting, signs
- the width occupied by building or property line obstructions for example seating, electricity pillars or goods display
- the location and dimension of any other obstructions.

When collecting the measurements, you must mark up a plan including any buffers around obstructions as shown in the example below. This allows any space between obstructions and object buffers that is less than 0.8m (standard body ellipse plus 0.1m either side) to be identified as this should not be included in the Walking Space.

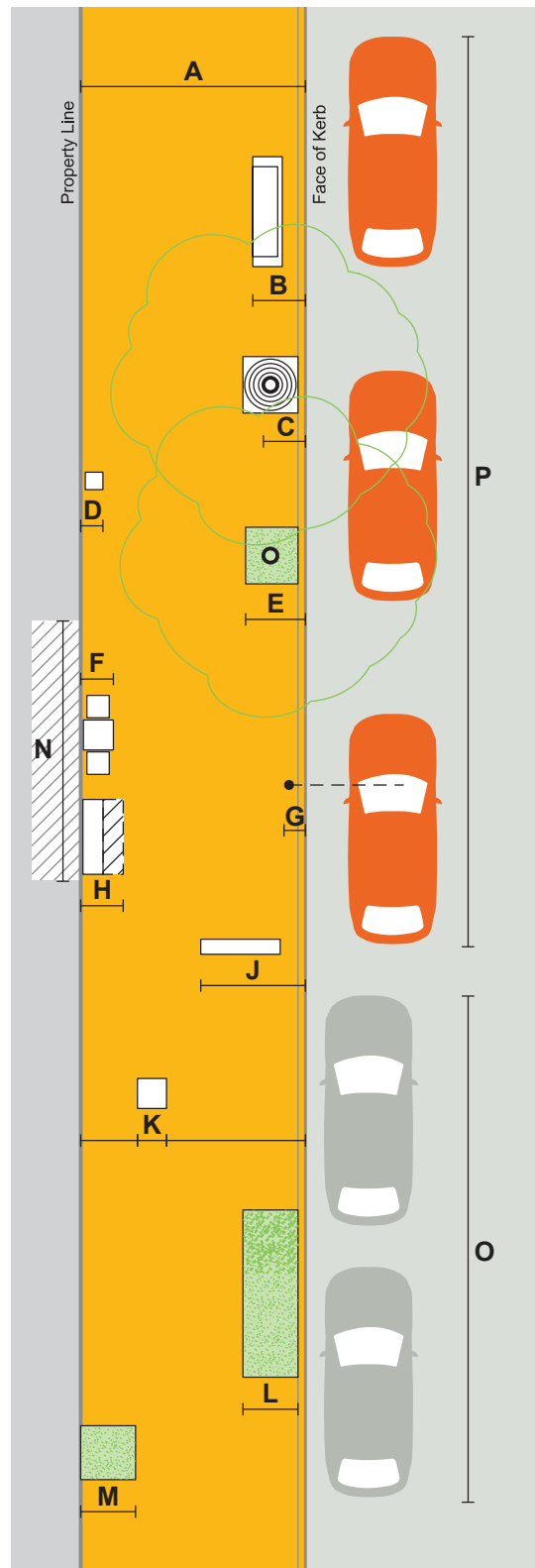


Figure 4 – Key

- A** Measure the total perpendicular width of the footpath from the face of the kerb to the building line. Take measurements at regular intervals as the width varies.
- B** Measure the obstructed width of any street furniture from the face of the kerb. Some street furniture will have associated buffers to account for the space needed for people to use it, for example the legs of a seated person extending out from a bench.
- C** For street trees with trafficable grates measure from the face of the kerb to the inner face of the trunk (or any protrusions up to 2m from footpath level like low branches or tree guards).
- D** Measure obstructions near the building line from the property line to the outer face of the element.
- E** For street trees with non-trafficable pits measure from the face of the kerb to the inner alignment of the tree pit.
- F** Measure outdoor dining elements from the face of the property line to the maximum extent of the licenced area.
- G** Measure the obstructed width from street lights, traffic sign poles and the like from the face of the kerb.
- H** Measure the dimension of street retail elements like shelves or signage frames including buffers for where people are likely to stand.
- J** Measure the extent of other street furniture like outdoor advertising or payphones from the face of the kerb.
- K** Measure the dimension of any obstructions that are within the Walking Space including the minimum clearance to the property line (or property line obstructions) and to the face of the kerb (or any kerbside obstructions).
- L** Measure the width of any verge planting from the face of the kerb and note if the planting is trafficable or not and the height of the planting (greater or less than 400mm).
- M** Similar to (L) above, measure the width of planting against the property line.
- N** Note the location and extent of Active Building Edges with associated buffers for people standing (Static Activity).
- O** Note the location and extent of kerbside parking lanes, bike lanes and dedicated bus stopping lanes.
- P** Note the location, extent and posted speed limit of kerbside traffic lanes.

Step 2 – Classify the Footpath Type

In this guide the Walking Space LOS is determined relative to the intensity of use of the footpath. Intensities of use are classified on a grade from Type 1 to 5 with 5 being the most intense.

There are two options to determine the intensity of use and hence the Footpath Type, either:

1. Pedestrian Peak Hour walking counts extrapolated for the life of the infrastructure (Table 2A Column A)
or
2. Desktop analysis (Table 2A Columns B-D and Table 2B)

Classify at the peak hour

In this guide LOS is determined using the peak one hour pedestrian flow. The target LOS has been set at 50% comfort at this peak period.

On average the peak one hour relates to the top 5% of flow rates, but is only approximately 50% higher than the lowest 5% of flow rates during the 7am-7pm period. This means that in most situations the average of the Peak Hour is reasonably representative of crowded periods throughout the day.

Notes:

- The Footpath Type classification derived from a Peak Hour pedestrian count is more reliable than the desktop analysis method and is preferred in all situations. If the desktop analysis is used and the results do not seem correct, then use of counts is required to correctly classify the Footpath Type.
- The desktop method is not able to reveal important local walking routes. Where the footpath has been identified as possibly forming part of an important local walking route then a count must be undertaken.
- Classify the footpath on each side of the street separately as their features and levels of use may be different.
- The highest classification is applied to the footpath on that side of the street for the length of the street block.
- If the classification result is Type 5 (the most intense type) then a Peak Hour count is required to determine the LOS.
- For either pedestrian count or desktop method, project the peak number of people forward 20 years to allow for growth. Use local planning documents to establish likely growth and increase the Peak Hour flow rate accordingly. This is not required if the aim is to understand the current performance.

Classification based on pedestrian counts – preferred method

Count the number of people walking to determine the Peak Hour and the Maximum Flow rates of people walking on the footpath. The specific peak period will be different for every location (which may be 4.15-5.15pm for example). The best approach to determine the Peak Hour is to count for the entire day.

Where resources are constrained and it is not possible to count for the entire day the counts must cover the likely peak periods. Do at least one 5 minute count every 15 minutes over these periods.

Cover at least these peak periods where they apply:

- eating and drinking and retail areas, 12-1.30pm & 5-7pm
- transport interchanges and walking routes, 8-9am & 4.30-6.30pm
- office areas, 8-9am & 5-6.30pm
- near institutions, an hour either side of opening and closing times
- everywhere else, 4.30-6.30pm. The activity after mid-day is likely to be higher than the morning and the late afternoon period will most often capture the peak number of people.

Convert the 5 minute counts to hourly rates. If four 5 minute counts are collected (for example at 4.30, 4.45, 5, and 5.15) then the assumed 1 hour peak flow from 4.30-5.30 would be derived by adding the counts together and multiplying them by 3.

Escalate the counts to allow for future growth.

Use Column A in Table 2A to establish the Footpath Type.

Classification based on desktop analysis – less reliable method

If resources do not permit Footpath Type classification using actual counts then a desktop analysis can be used.

The desktop analysis requires consideration of three factors:

- adjacent land use characterisation (Table 2A, column B)
- proximity to public transport (and retail) (Table 2A, column C)
- proximity to places of interest (Table 2A, column D – also reference Table 2B for associated lists)

The classification should be made by considering which row from each column is applicable and then using the highest Footpath Type classification given. For example, if 'land use characterisation' indicates Type 2, and 'proximity to public transport' indicates Type 4, and 'places of interest' indicates Type 3, then the classification will be Type 4 (the highest).

Note that if the classification is Footpath Type 5 then the LOS assessment will require Peak Hour flow rate data to be collected.

When using the desktop method answers must allow for future growth.

The desktop method is conservative

The desktop method tables have been designed to be conservative to ensure activity is not underestimated. Using a count is always preferred. If the desktop method gives an unexpected result then a count must be undertaken to classify the Footpath Type with certainty.

Table 2A – Footpath Type Classification

	Column A	Column B	Column C	Column D
Footpath Type	Peak Hour number of people on the footpath (People Per Hour – PPHr)	Land use characterisation	Proximity to public transport	Proximity to places of interest (where a block is measured to a major pedestrian dispersal point like a street intersection)
Type 1	Less than 7 PPHr	Residential areas with detached housing, or low intensity employment areas (eg industrial land), isolated 3 storey flat building	-	-
Type 2	7-69 PPHr	Residential areas that include row or town houses or up to 3 storey residential flat buildings/mixed use residential buildings or medium intensity employment areas (up to 3 storey campus model business parks), hotel/motel, one or two shops	Adjacent to regional cycle lane 0-200m from a bus stop (excluding stops with less than 10 services per day) 0-600m from a LR/Bus Rapid Transit (BRT) stop 400-800m from a train/metro station	Within two blocks of a local place of interest (Table 2B List 1)
Type 3	70-399 PPHr	Streets with shops, food and drink premises, entertainment uses or services, residential areas that include residential flat buildings/mixed use residential buildings greater than 3 storeys or medium employment industrial areas	0-400m from a train/metro station <i>Footpath adjacent to retail – 0-200m from a bus stop 0-300m from a LR/BRT stop</i>	Within one block of a local place of interest (Table 2B List 1) or Within two blocks of a regional place of interest (Table 2B List 2)
Type 4	400-2000 PPHr	Streets with more than 200m of shops, food and drink premises, entertainment uses or services, Late night trading/management areas, Mixed use or employment areas	<i>Footpath adjacent to retail – 0-100m from a train/metro station</i>	Within one block of a regional place of interest Table 2B List 2 or Within two blocks of a metropolitan place of interest (Table 2B List 3)
Type 5	Greater than 2000 PPHr	Very high intensity mixed use, employment, retail, transport or entertainment areas, significant public places or buildings with very large numbers of people, transport interchanges and associated waiting areas, entries and overflow areas	0-50m from a transport interchange including at least 2 modes	Within one block of a metropolitan place of interest (Table 2B List 3)

Table 2B – Places of interest

List Number	Places of interest types
List 1 Local places of interest	bakery, childcare, church or place of public worship, community centre, entertainment facility (local), general practitioner, grocer, leisure centre (local), library, medical centre (local), park (local), places that support temporary creative activity in the public domain all year round (eg stalls, art, music), police station, public eating and drinking areas, public facility (local), recreation facility (local), regional cycle route, school (<200 students), shopping centre (<1000sqm), sports field (local), supermarket (<1000sqm), swimming pool, town hall, walking route (major local)
List 2 Regional places of interest	cinema, convenience store (regional importance e.g. serving a town), entertainment facility (regional), gallery, hospital, information or visitor centre, leisure centre (regional), markets, medical centre (regional), music hall or performance space, park (regional), public facility (regional), recreation facility (regional), school (>200 students), shopping centre (>1000sqm), sports field (regional), tertiary education, theatres, university, walking route (regional)
List 3 Metropolitan places of interest	metropolitan or international place of interest, e.g. state art gallery/museum, sports stadium, metropolitan park, large shopping centre



Step 3 – Determine the Walking Space

The Walking Space that is used to determine the LOS is defined as the overall footpath width less:

- the Kerbside Traffic Buffer
- the width of obstructions and associated buffers
- any static activity
- spaces less than 0.8m wide

Some obstructions like street trees or static activity may fall within the Kerbside Traffic Buffer area which is measured extending back over the footpath from the face of the kerb and should not be “double discounted”.

To determine the Walking Space first determine the extent of the Kerbside Traffic Buffer set out in Table 3 (right), subtract it from the overall footpath width and then subtract the width of any obstructions that are not within the Kerbside Traffic Buffer. An example is set out below.

Make sure measurement points are selected to capture all obstruction locations. For example individual assessments should be made wherever infrastructure reduces the Walking Space like electricity pillars or street lights.

Areas of low planting must be noted. For Footpath Types 1 and 2 the Walking Space may include up to 200mm wide areas of low planting not more than 400mm high.

Determining the Kerbside Traffic Buffer

For each location to be assessed determine the relevant Kerbside Traffic Buffer from Table 3. This buffer accounts for the space that most people will not comfortably use because of the proximity to moving vehicles.

Table 3 – Kerbside Traffic Buffer

Speed limit up to and including (km/hr)	Kerbside Traffic Buffer (m)
15 or cycle lane or parking lane	0 (1.25)*
20	0.2 (1.25)*
25	0.45 (1.25)*
30	0.7 (1.25)*
35	0.95 (1.25)*
40	1.2
45	1.4
50	1.65
55	1.9
more than 55	2.15

*See notes, value in brackets is advisory - space that should be left for street tree planting

Notes:

- At lower speeds the Kerbside Traffic Buffer dimension is smaller than the space required to plant a street tree. It is recommended that space be allowed for street trees on all footpaths by providing at least 1.25m, shown in brackets in Table 3.
- If the adjacent kerbside traffic lane is observed to have lower traffic speeds during the pedestrian peak hour than the posted speed limit then the 85th percentile speed may be used in reference to Table 3. For example where there is an adjacent dedicated kerbside low speed turning lane (but not a slip lane) or dedicated bus stopping zone it is appropriate to assume up to 20km/hr lower than the posted speed limit. Where the adjacent lane is a bus lane, the posted speed limit must be used even if the observed speeds are lower to account for the frequent presence of very large vehicles causing discomfort.
- In some situations it is possible to walk on parts of a footpath that are close to fast moving kerbside traffic, however this is not safe or comfortable for most people and it is appropriate that these situations reflect a reduced LOS by deducting this area from the Walking Space.

Figure 5 - Example of Kerbside Traffic Buffer



Example

Figure 6 - Determining Walking Space

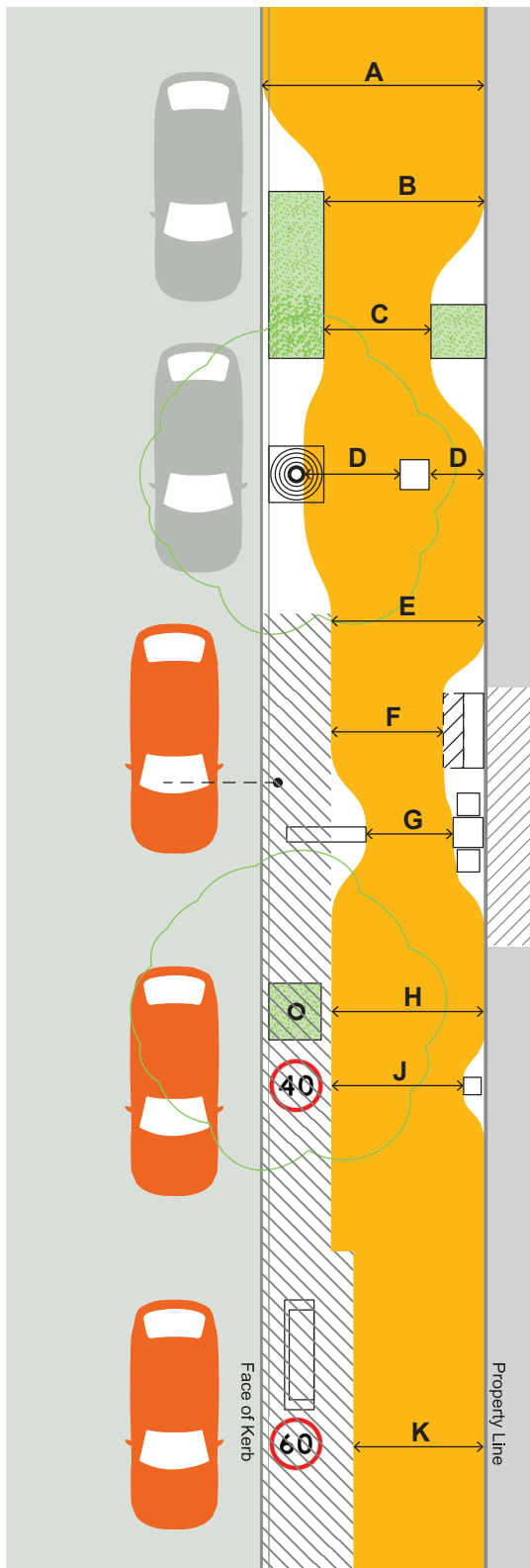
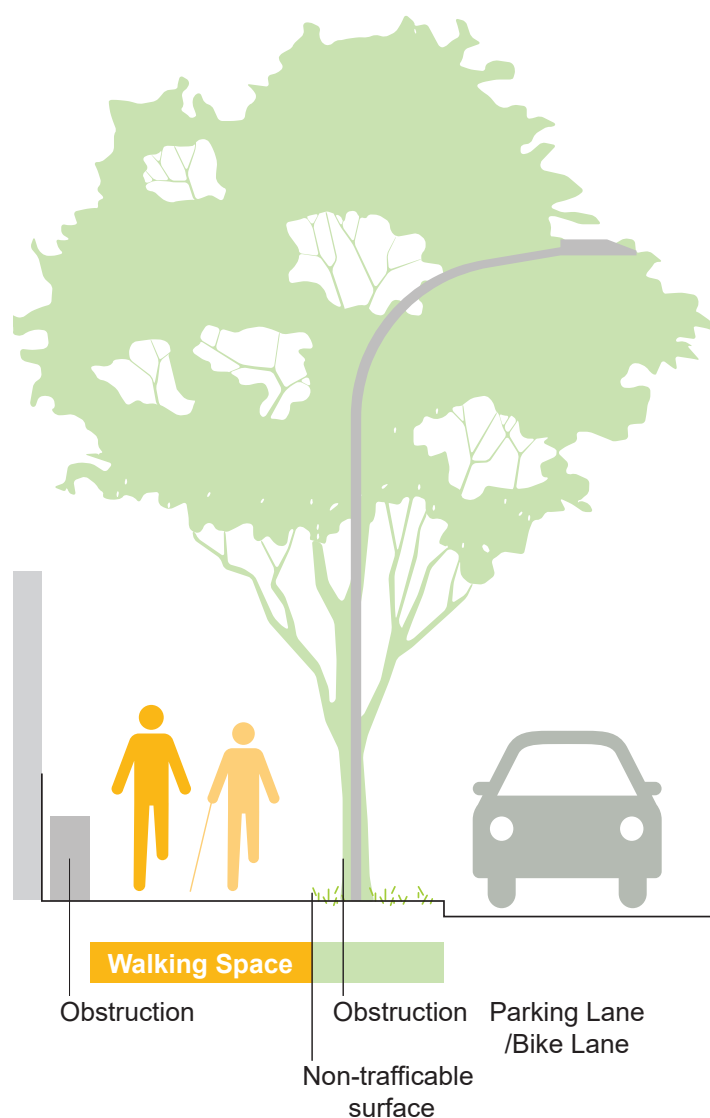


Figure 6 – Key

- A** Where there is kerbside parking and no footpath obstruction the Walking Space is the full width of the footpath
- B** Kerbside verge obstructs the Walking Space
- C** Kerbside and property line verges obstruct the Walking Space
- D** Kerbside street tree trunks obstruct the Walking Space however this one has a trafficable tree grate so the Walking Space extends to the trunk. A mid footpath obstruction splits the Walking Space. In this case both parts are more than 0.8m wide so both parts are considered part of the Walking Space
- E** A kerbside traffic lane creates a Kerbside Traffic Buffer (shown hatched) that narrows the Walking Space
- F** A footpath display at the property line and associated stationary activity buffer creates an obstruction. The light pole is a kerbside obstruction but is within the Kerbside Traffic Buffer. The adjacent building has an Active Building Edge (shown hatched) but the Walking Space is not adjacent to it because of the presence of property line obstructions.
- G** An advertising board creates a kerbside obstruction that extends further than the Kerbside Traffic Buffer. There is also outdoor dining creating a property line obstruction. Near G part of the Walking Space is adjacent to the Active Building Edge.

- H** A kerbside street tree with a non-trafficable planted tree pit creates an obstruction but is fully within the Kerbside Traffic Buffer
- J** A property line electricity pillar creates a property line obstruction
- K** The Kerbside Traffic Buffer has increased because the posted speed limit is higher in this location. There is a kerbside bench seat creating a kerbside obstruction but it is fully within the Kerbside Traffic Buffer

Figure 7 – Section showing obstructions



Step 4 – Assess the Walking Space Level of Service (LOS)

Having established the Footpath Type using Tables 2A and 2B, assess the Walking Space LOS using Table 4A as follows.

Assessing Footpath Types 1 and 2

Using Table 4A cross reference the Footpath Type from Step 2 with the Walking Space width from Step 3. This will return a LOS rating for that footpath location.

The Passing Zone

Footpath Type 2 requires a spatial allowance to be made for a Passing Zone. This zone can be located either within the Kerbside Traffic Buffer (see definitions) or can be an unimpeded part of the Walking Space.

Low Planting

Low planting may partially overlap the Walking Space for Footpath Types 1 and 2 – see Step 3.



Assessing Footpath Types 3 and 4

Using Table 4A cross reference the Footpath Type from Step 2 with the Walking Space width from Step 3.

For footpaths where the Walking Space is immediately adjacent to Active Building Edges like shop windows refer to the dimensions in the row noted as “Adjacent” in the Adjacent to Active Edge column to determine the LOS. Otherwise where the Walking Space is not next to an Active Building Edge refer to the dimensions in the row noted as “Not Adjacent” in the Adjacent to Active Edge column to determine the LOS.

This will return a LOS rating for that footpath location.

Photo credit: Paul Patterson

Assessing Footpath Type 5

Type 5 footpaths are rated using both a Peak Hour flow rate expressed in People Per Metre (of Walking Space width) per Minute (PPMM) and a Walking Space width in metres.

To determine the PPMM first reduce the Peak Hour flow rate to a “per minute flow” by dividing the Peak Hour number of people on the footpath (see method in Step 2) by 60. Then convert this gross flow to a flow per metre of Walking Space by dividing it by the Walking Space dimension from Step 3.

For example if the Peak Hour flow is 3000 people and the Walking Space is 4m then the PPMM is $(3000/60)/4 = 12.5\text{PPMM}$.

Using Table 4A cross reference the Footpath Type from Step 2 with the Walking Space width from Step 3. This will return the first part of the LOS rating. Then check the PPMM rate (note that for each LOS the noted PPMM is a maximum rate unlike the Walking Space widths that are minimums). The lower of the two LOS ratings is the final rating.

For example if the footpath had a Walking Space width of 3.0m (LOS E) and an 8.0PPMM (LOS C) then the LOS rating would be E.

A note about PPMM rates

The PPMM rates used in this guide are 5 minute averages for ease of data collection. These 5 minute averages have been correlated to comfort levels and from there to levels of service.

Instantaneous flow rates vary from the 5 minute average by a significant margin. In most situations the peak instantaneous 10 second flow rate that is experienced about 10% of the time is double the 5 minute average. This is indicative of the fact that the instantaneous crowding that each individual experiences fluctuates as they walk along the footpath passing groups of people coming in the other direction. This fluctuation has a more or less smooth distribution of instantaneous crowding rates but very high peaks for a small proportion of the time.

Walking Space Guide – Walking Space Level of Service

Table 4A – Walking Space Level of Service

Footpath Type	Adjacent to Active Edge	Walking Space and LOS					
		Types 1-4 Minimum Walking Space in metres (m)					
		Type 5 Minimum Walking Space in metres (m) and Maximum Peak Hour flow rate in PPMM					
		LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
Type 1	-	2.7	2.3	2.0	1.6*	1.3*	Less than 1.3*
Type 2	-	3.0 + 0.6 Passing Zone	2.7 + 0.6 Passing Zone	2.3 + 0.6 Passing Zone	1.9 + 0.6 Passing Zone	1.6 + 0.6 Passing Zone	Less than 1.6 + 0.6 Passing Zone
Type 3	Not Adjacent	3.9	3.5	3.0	2.6	2.2	Less than 2.2
	Adjacent	4.3	3.8	3.2	2.8	2.3	Less than 2.3
Type 4	Not Adjacent	4.8	4.3	3.7	3.2	2.7	Less than 2.7
	Adjacent	5.2	4.6	3.9	3.4	2.9	Less than 2.9
Type 5	Min. width (m)	5.2	4.6	3.9	3.4	2.9	Less than 2.9
	Max. PPMM	4.0	6.0	9.5	13.5	18.0	Greater than 18.0

* Note well: equal access issues - see page 33

Adjustment Factor for Footpath Types 1-4

An Adjustment Factor may be applied to increase the effective Walking Space for Footpath Types 1-4 that accounts for an Allowable Buffer Overlap with the Kerbside Traffic Buffer or low planting on the kerb side but not with other types of obstructions. The adjustment amount varies according to the Walking Space LOS and is set out in Table 4B.

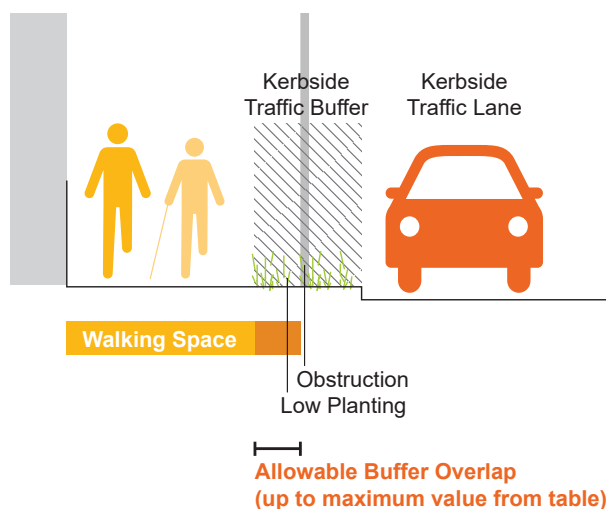
To use the Adjustment Factor, first determine the LOS using Table 4A following the above process, then add to the Walking Space width any Adjustment Factor which is an Allowable Buffer Overlap value up to the maximum shown in Table 4B. This Adjustment Factor may only be added to the Walking Space if it represents an Allowable Buffer Overlap which may exist with the Kerbside Traffic Buffer and/or low planting but not an overlap with other types of obstructions. Use the resulting adjusted Walking Space width to recalculate the LOS. This may result in an improvement of one LOS class in some cases.

Table 4B – Walking Space Adjustment Factor

Walking Space LOS	Maximum Allowable Buffer Overlap Adjustment Factor for Footpath Types 1-4 (m)
B	0.5
C	0.4
D	0.3
E	0.2
F	0.1

For example, if the unadjusted Walking Space for a Type 1 footpath is 1.8m (LOS D), there is a maximum Allowable Buffer Overlap of 0.3m (from Table 4B). In this hypothetical case there is 0.2m of low planting that has not been included in the Walking Space and then a light pole. This means the Allowable Buffer Overlap is slightly less than the maximum 0.3m given in Table 4B; being 0.2m because of the distribution of the different types of obstructions. Then $1.8 + 0.2$ gives an adjusted Walking Space of 2.0m resulting in an increase to LOS C.

Figure 8 – Walking Space Adjustment Factor



Step 5 – Understanding the LOS Rating, Targets and Mitigation Measures

The Walking Space Levels of Service relate to comfort percentiles at that intensity of use.

For example LOS A is the 85th comfort percentile. i.e. more than 85% of people would be expected to be comfortable given that amount of Walking Space at that level of intensity of use during the Peak Hour.

LOS comfort percentiles are given in Table 5.

Table 5 – LOS Targets and Comfort Percentiles

Level of Service	Target	Comfort percentile (base of band)
LOS A		85th
LOS B		66th
LOS C	Minimum Target	50th
LOS D		33rd
LOS E	At Risk	15th
LOS F	Intervention Trigger	less than 15th



Key guidance – Target

In all situations the aim should be to achieve at least LOS C.

This means that where a project is being undertaken that affects the allocation of space and priority within a street that the minimum design target is LOS C.

Where a footpath is being rebuilt due to adjacent development the target is LOS C.

Where more than 20m of a footpath is being re-surfaced the target is LOS C.

Key guidance – At Risk and Intervention Trigger

LOS F is categorised as an “Intervention Trigger”.

Performance at this level is very poor and a project must be initiated urgently to increase the amount of Walking Space.

For the purposes of equal access there are three additional potential intervention trigger considerations. Where the clear path of travel is less than:

- 1.8m, there is insufficient space for two wheelchairs to pass
- 1.5m, there is insufficient space for a wheelchair to turn, if the length exceeds 6m action must be taken
- 1.2m, there is insufficient space for a wheelchair to navigate safely, action must be taken.

LOS E is categorised as “At Risk”

At high flows this category coincides with most people actively expressing a desire to avoid the area. At low flows it is uncomfortable for individual people to pass without having to walk in single file.

Areas recording LOS E must be monitored annually to ensure that the situation has not deteriorated to LOS F. Project planning to improve the amount of Walking Space must begin.

LOS D bordering on “At Risk”

In existing situations LOS D does not trigger the need for a project or intervention, however it is not a desirable state.

Where a project is being undertaken LOS D is not a desirable design outcome.

Mitigation measures

Once the assessment is complete, it may be necessary to consider mitigation measures to ensure the footpath is as comfortable as possible. This should be done for individual locations (e.g. relocate or remove a post) but it is important to consider how consistent the comfort level is as people progress along the street. This section summarises some of the types of actions that may be considered.

All locations are comfortable

If all the locations within each street block meet the recommended minimum LOS C for that Footpath Type, the footpath on this site should be comfortable for its intended use at most times. However you need to reassess the site in the future if:

- temporary obstructions such as road blocks or hoardings are erected
- significant changes occur in land use or pedestrian activity
- new street furniture is installed
- kerbside uses or speeds change

A single location is uncomfortable within a street block

If a single location does not meet the recommended LOS C, the first action is to create additional footpath space by either removing or repositioning street furniture or increasing the Walking Space width. This is especially important if the LOS is E or F as the footpath will be very uncomfortable at this location.

If it is not possible to increase the Walking Space, it is important that the footpath in the immediate area (6m length on either side) is clear of obstructions to ensure this pinch point is not perceived as a reason to avoid the area.

Multiple locations are uncomfortable within a street block

If more than one location does not meet the recommended LOS C, people's perception of comfort at the site will be very low. A review of the adjacent kerbside uses and street furniture must be undertaken to create as much comfortable Walking Space as possible.

If there are locations where street obstructions cannot be moved (e.g. street trees) it is important to create free space for movement in the immediate area (6m length on either side) and care must be taken to avoid the creation of a "slalom" for walking where pedestrians need to keep adjusting their route to bypass different obstructions.

All locations are uncomfortable

If all the locations within a street block are any combination of LOS D, E and/or F Walking Space must be increased by widening the footpath, decluttering it and adjusting adjacent kerbside traffic lane conditions as required.

If the inadequate Walking Space is caused by static activity (people standing, sitting or queuing) the footpath width must be increased. If this is not possible, then the footpath must be kept clear of street furniture. In addition, soft measures must be used to reduce the amount of static behaviour e.g. the operation of a queue could be discussed with the owner of an attraction to find an alternative e.g. creating a meeting point in a less busy area.

Café seating that creates a LOS D is acceptable as people's perception is that the vitality provided by cafe seating compensates for a lower LOS at that section of footpath. However, even in this situation the LOS must not be lower than E at peak times.

Trees

In all circumstances street trees must be provided and mature trees must not be removed however new trees may need to be planted in a different alignment.

Local streets with low traffic volumes

For local streets with low traffic volumes the preferred way to provide additional Walking Space is to make it safe for people to walk across the whole street reservation including the carriageway by reducing speed to less than 30km/hr and providing signage noting pedestrian activity and priority.

This strategy may require implementation of traffic, parking and speed management but can avoid the need to move kerb lines and stormwater infrastructure.

Assessing design options

The above method can be used to assess design options but care must be taken to allow for increased walking activity over the projected life of the infrastructure being designed.



**If you plan for people and places,
you get people and places**

Enough space for people to walk is not the only thing that makes good places but it is foundational. No amount of beautiful paving can substitute for enough space to walk with your friends and family.





Appendix A: About the Research

This research was undertaken as a joint project between Transport for NSW (TfNSW) and the City of Sydney (CoS). TfNSW identified a need for a consistent guide to what footpath widths should be provided to achieve comfortable pedestrian movement in different situations.

The work and research was undertaken by a cross disciplinary team. A range of new and innovative methods were used to understand and analyse pedestrian comfort.

Detailed studies of 30 sites were undertaken to measure the following aspects of pedestrian behaviour:

- detailed pedestrian flow information of 475,400 pedestrians. This provided information on the level of pedestrian movement throughout the day, how the groupings and direction of movement changed throughout the day and what peaks were experienced
- a survey of 5,527 people was undertaken to assess people's perception of comfort and trip purpose. The survey was time-coded to the pedestrian flow data
- the speed of pedestrians was measured throughout the day to assess the impact of the number of people and the direction in which they were travelling
- the preferred size of social groupings formed between families, friends or colleagues walking together and passing others
- the number of people who experienced restricted movement was recorded. Restricted movement is when people had to change their speed, route, experienced 'shoulder brushing' or bumped into other users

- the distance people leave between each other and between street furniture, the "passing space", was measured accurately using photo-matching software and a detailed survey.

The results of these studies were used in a comprehensive assessment of comfort. The studies quantified people's tolerance of different crowding levels, the passing distances people left between each other and when passing street furniture and the space people left to the building line. This was then used to determine the recommended standards in this document.

The studies were undertaken using CCTV footage and through on-site surveys of pedestrian perceptions.

Although the research was focused on streets in Sydney, the results and methods are transferable across other parts of Australia as the guide is organised and applied on an intensity of use basis.

Core Project Team

TfNSW: Sara Stace, Tegan Mitchell, Christina Papadopoulos

CoS: Jesse McNicoll, Grace Wolstencroft, Peter John Cantrill, Tim Wise, Tamara Winikoff

Cardno: Dean Rance, Chris Slenders

Appendix B: Street Furniture Buffers

Street furniture has a substantial impact on people's behaviour. People gather around street furniture.

ATMs

ATMs are not perceived to be a problem by users, probably as they expect these areas to be busy and the impact on movement is highly localised. However, queues around the ATM can reduce the clear footpath width by between 1.5 - 3.0m of space depending on the area and number of machines available.

The buffer should be decided following a site visit, and if necessary a static survey.

Public seats or benches

Seats reduce the clear footpath width by the seat width, plus an additional 0.5m in the direction of seating when in use (legs, bags etc). Note that for the seat to be attractive to people there needs to be room for two people to pass between the seat zone and the kerb or building line (1.5 - 2.0m clear footpath width).

If people can sit facing either way, the buffer would be 0.5m on either side.

Bus Stops

Individual bus stops are not perceived as causing crowding problems. However there are some points to note about the queuing patterns around each bus stop type as queuing is not restricted to the bus stop area.

Bus stop with flag only

Queues around this type of Bus Stop form around the sign parallel to the road, and at busy sites parallel to the building line as well. The impact depends on how busy the bus stop is but it was seen to be in the range of 1.6 - 2.2m at the kerbside and one person deep (0.46m) at the building edge.

Bus stop with shelter (back of shelter to Walking Space)

Queues around this type of Bus Stop form predominantly between the shelter and the kerb leaving the remainder of the footpath clear for free movement.

Bus stop with shelter (back of shelter to property line)

Queues around this type of Bus Stop form between the stop and the kerb edge as well as on either side of the stop (see dark grey zone around stand). The impact depends on how busy the bus stop is but was seen to be in the range of 0.6 - 1.2m.

Bus stop with shelter (back of shelter to kerb)

This has a similar queuing pattern as back of shelter to Walking Space stops but the queue was seen to stretch between 0.6 - 1.3m outside of the stop.

Multiple Bus Shelters

Groups of bus stops create crowding pressures on footpaths. It is important that there are no other blockages, e.g. signs, that block sight lines, as this encourages people to queue further from the shelter in order to see the bus approaching.

Cafes

Cafe seating areas act like a low wall obstruction, so the usable footpath width is the width from the kerb to the edge of the outdoor dining zone including barriers for licensed areas.

Note that the area around café seating is flexible - tables may be intended for two but extra chairs may be introduced by both customers and vendors to seat a larger group. It is also important to consider additional obstructions such as advertisement boards as these can further reduce footpath width.

Bicycle Parking

Parallel Bicycle Parking

If parallel to the road, bicycle parking forms a barrier and is treated by pedestrians as a wall, so the usable footpath width is the width from the building to the edge of the cycle stands.

Diagonal Cycle Parking

If the cycle stand is positioned diagonally to the road, the reduction in clear footpath width is approximately 2.0m

Perpendicular Cycle Parking

If the cycle stand is positioned perpendicular to the road, the reduction in clear footpath width is approximately 2.5m.

Guard Rail

For a guard rail, a 0.2m buffer should be added from its placement on the footpath. At some locations people wait around the guard rail (e.g. near building entrances) and this static activity can further reduce the clear footpath width.

Loading Bay

Segregated Loading Bay

Where loading bay stops are delimited with a kerb, pedestrians only use the main footpath section. Therefore the clear footpath width is from the building line to the kerb defining the bay.

Loading Bay Shared Surface

Where loading bays share the same surface as the footpath, pedestrians tend to use the full footpath width. The assessment of the Walking Space should be carried out with and without a vehicle parked in the space. This is because the bay may be operational during peak pedestrian movement hours or, if it is not, there may be non-compliance with the operational times.

Posts

The guide for posts is suitable for similar items of street furniture such as signal boxes and bins.

Individual Posts

Individual posts have a limited effect on clear footpath width. Posts and bollards should be aligned with other street furniture to minimise impact.

If the posts are located in the middle of the footpath it creates a visual interruption and re-siting should be considered. The clear footpath width on either side should be checked to ensure that there is sufficient space for free movement (at least 0.8m).

Multiple Posts

Where there are multiple posts within a length of 3.0m they form an obstruction, similar to guard rails.

If the posts are placed near the road or the wall edge, a 0.2m buffer should be added from its placement on the footpath.

If the posts are located in the middle of the footpath the buffer should be the width of the post plus 0.2m either side.

Street Vendors

Market Vendors

Where there is an on-street market or concentration of vendors, the clear footpath width is reduced by the stall footprint plus an additional 1.4m to reflect people browsing and queuing around the stall.

Individual Vendor

The impact of individual street vendors is less than in a market but the clear footpath width is still reduced by the stall footprint plus an additional 0.5m to reflect people browsing and queuing at the stall.

Tree

For a kerbside tree refer to the guidance within the main document.

For a single tree planted within the walking space the buffer is either the width of the trunk plus 0.2m either side or the width of the pit (unless it is trafficable) whichever is greater.

Appendix C: Measuring Pedestrian Activity

Introduction

This section explains the method for collecting pedestrian data. This method is suitable for Level of Service (LOS) Assessments.

Site Visit

Before carrying out data collection and the LOS assessment you should first visit your site. When on site you should assess:

- is the site the area type you thought it was?
- do the peak hours seem appropriate for the full survey?
- are there any locations with high static activity (meeting friends, queuing, taking photographs) that may require a static activity survey?
- are there signs that the site is a route to and from a transport node or place of interest?
- any other notes about pedestrian activity

Footpaths

A number of factors should be taken into account when conducting a pedestrian activity survey for a footpath:

- decide how many locations and where:
Pedestrian flows can vary significantly over short sections, especially in areas with high levels of demand such as shopping centres, or near transport connections. Ideally samples will be taken in 2-3 locations on both sides of the road. Moreover, it is important to avoid areas with conflicting movements, such as a bus stop or train station exit

- recording the location:
An exact reference for the sample location(s) should always be recorded on a map with a text description (e.g. stand in front of X facing Y) and photograph for future reference
- performing the counts:
The counts should be taken using the 'stationary gate method' whereby all pedestrians who cross an imaginary line perpendicular to the footpath are counted. Ideally the direction that pedestrians are walking in is also noted. It is advisable to use tally counters to record this information, particularly on busy sites. Weather conditions and unusual activity should be recorded throughout the survey hours. For example, 'a short spell of rain at 16:00, large tourist group passed at 13:30.' The person conducting the count should try to stand so that they do not disrupt normal activity
- sample length and hours of survey:
This will depend on the purpose of the study. Suggested sample periods and survey hours suitable for LOS assessments, are found in the Walking Space Guide: Step 2, organised by area type
- conditions:
if there are circumstances that will affect the count (e.g. school holidays, significant public transport disruption, more than light rain) the study should be redone on another representative day.

Static Activity

If there is an unusual amount of static activity for example:

- because a bus stop is served by a large number of services so people are standing and waiting in areas they normally would not, or
- near a guard rail in a tourist attraction or regional retail site where people may linger,

then an additional static activity survey is recommended.

A number of factors should be taken into account when conducting a static activity survey for a footpath:

- deciding how many locations and where:
The initial site visit should have indicated locations where static activity occurs at the site. Locations near street furniture and transport connections are the usual locations. Samples should be taken within a 6m zone on either side of your location
- recording the location:
An exact reference for the sample location(s) should always be recorded on a map with a text description (e.g. stand in front of X facing Y) and photograph for future reference
- performing the survey:
The counts should be taken using the 'snap shot' methodology whereby the observer records with an 'x' on a printed map all pedestrians who are standing still within the survey location. This is like taking a photo of each section and the observer need only note what was happening when they first stopped and looked

- sample length and hours of survey:
This will depend on the purpose of the study but at least must match the flow activity being collected
- calculating the impact of static activity:
Once the data has been collected the impact of the static pedestrians can be considered by either inputting the standing locations recorded into mapping software using scaled people markers - a standard body ellipse (0.6m wide, 0.45m depth) plus 0.2m buffers between the static person and the wall or kerb.

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Appendix D: Research Synopsis

The Walking Space research was undertaken firstly through interviewing key staff from the London pedestrian comfort study team and analysing their research, then undertaking general research. Having established an understanding of the state of the field, a series of parallel studies was then conducted:

- observed discomfort behaviour study
- revealed preference passing distances study
- flow rate and surveyed comfort study
- traffic buffer study

The work also identified a series of additional research topics that were not able to be followed up as part of the project.

Research teams

Observed discomfort behaviour study

Grace Wolstencroft

Garima Mendiratta

Tanvia Rahman

Jeba Tashnim

Revealed preference passing distances study

Jesse McNicoll

Grace Wolstencroft

Steve Kelis

George Politis

Salina Davies

Flow rate and surveyed comfort study

Dean Rance

Chris Slenders

Jesse McNicoll

Grace Wolstencroft

Jeff Cooke

Ravtej Singh

Traffic buffer study

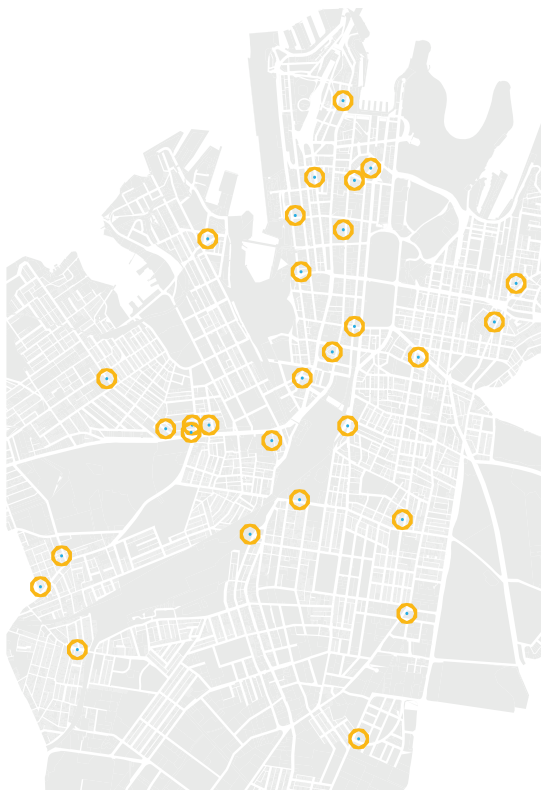
Jesse McNicoll

Grace Wolstencroft

Survey

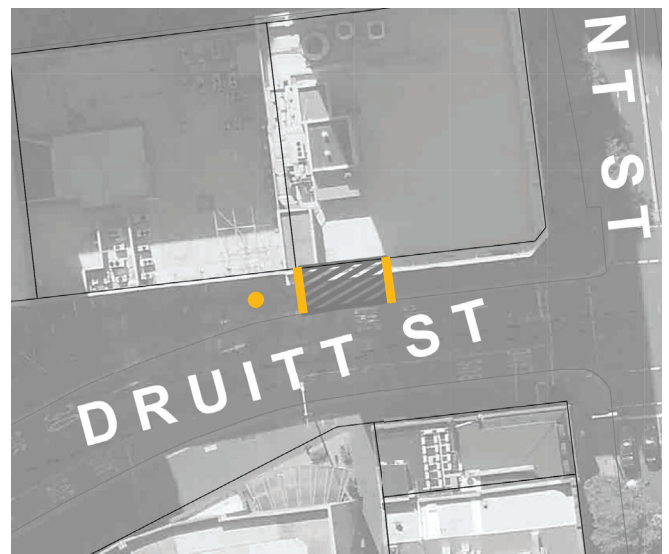
The research drew heavily from a detailed survey data set. Thirty sites were chosen to be surveyed. The sites had a mix of different characteristics: level of pedestrian activity; footpath width; surrounding land uses; adjacent traffic conditions; etc. The sites are shown in Figure 9 – Survey sites (below).

Figure 9 – Survey sites



Each site was physically surveyed and had its characteristics recorded. The sites were then videoed and intercept surveys (interviews) were carried out. The videos were analysed using computer vision to track and record people walking as they passed two virtual “gates” 10m apart (see Figure 10 – Virtual gates). Each pedestrian’s data was individually captured with time stamps and the two virtual gate data points allowed analysis of direction, walking speed and crowding.

Figure 10 – Virtual gates



Surveys were undertaken:

- Tuesday to Thursday
- not during special events or school holidays
- on days with temperatures less than 30 degrees and without rain
- in locations without construction hoardings or street works.

Five locations also had data collected on a Saturday for comparison purposes.

The intercept survey (interview) was kept simple. The surveyors asked two questions.

Q1. Think about how wide this footpath is and the number of people here.

Do you find it:

- very uncomfortable
- uncomfortable
- a little uncomfortable
- just comfortable
- comfortable
- very comfortable

Q2. The reason I am here is:

- shopping
- getting food or drink
- meeting people
- entertainment
- work
- study
- personal errand
- taking someone somewhere
- exercising
- going home
- I am just taking a walk

Based on legal advice the intercept survey did not capture any personal identifiable information so that release agreements would not be needed.

Data was entered into a mobile phone app that recorded a time stamp to allow the data to be associated with the main data file. Approximately 1% of walkers stopped to be interviewed for the survey. Overall data was captured for 475,405 people and 5,527 were interviewed.

Some of the studies relied only on the high definition video data, some on perspective measurement from the video and others from the data that had been extracted by computer analysis from the video correlated with the intercept surveys.

The comfort question in the intercept survey used neutral language and a six point scale that allowed a clear delineation of comfortable versus uncomfortable responses. This was important for later stages of the research.

Observed discomfort behaviour study

A study was undertaken to determine the spatial thresholds for observable discomfort behaviours.

A team of three researchers watched fifty hours of footage to identify behaviours that indicated an observable level of discomfort.

Six behaviours were identified:

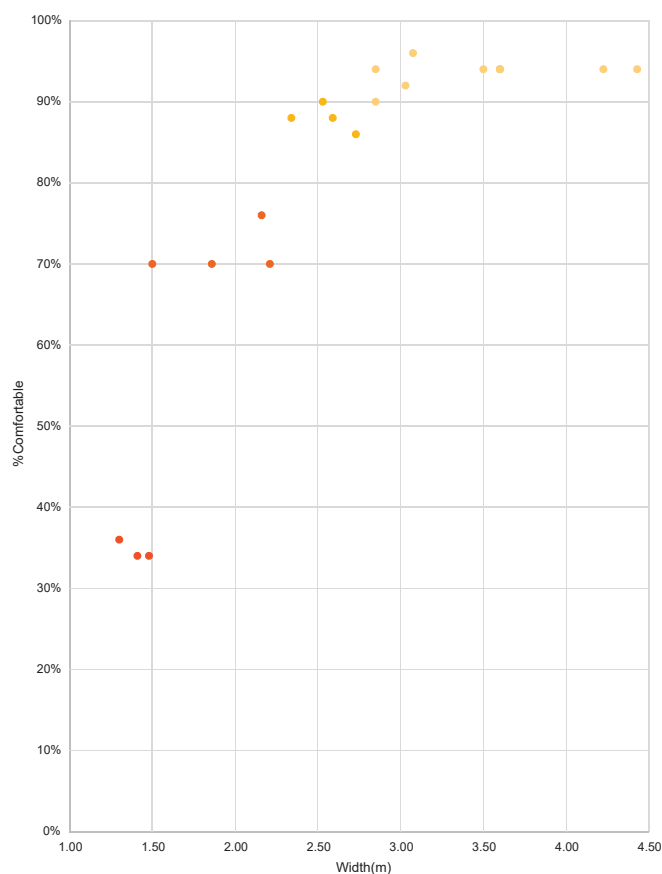
- **Body shift**
Where a pedestrian shifts the orientation of their body (usually by turning the shoulders) to minimise encroachment on another pedestrian's personal space
- **Overtaking in the furniture zone**
Where a pedestrian overtakes a slower moving pedestrian by changing their line of travel into alignment with street furniture and then back again once they have overtaken
- **Overtaking by stepping off the footpath**
Where a pedestrian overtakes a slower moving pedestrian by stepping off the footpath onto the carriageway
- **Weaving**
Where a pedestrian weaves through the available walking area to avoid another pedestrian
- **Stopping**
Where a pedestrian stops to make way for another pedestrian coming in the other direction
- **Changing behaviour in anticipation**
Where a pedestrian adjusts their speed and/or direction to avoid passing another pedestrian at a constrained point.

Nineteen sites were identified for detailed study where there were a high number of two person only interactions and the footpath had a regular shape.

For each site the video footage was viewed to find the first 50 instances where there were just two people passing without the presence of others that might affect their behaviour. Each of the 50 interactions at each location was recorded either as displaying one of the six discomfort behaviours or no observed discomfort behaviour.

The summary is shown below in Figure 11 – Observed discomfort behaviours where each data point represents a site. The data point's location on the X axis represents the clear footpath width (narrowest on the left to widest on the right), and its Y axis location is the % of people who are comfortable, i.e. not displaying observable discomfort behaviours (least comfortable at the bottom and most comfortable at the top).

Figure 11 – Observed discomfort behaviours



The data shows two clear thresholds of observable discomfort. Where the clear footpath width (the Walking Space) is:

- less than 1.5m wide, about 65% of people show observable discomfort behaviours
- less than 2.35m wide, about 30% of people show observable discomfort behaviours.

There may be another weaker threshold at 2.85m; it is also possible that this is a gradient rather than a threshold but that the data is not at a sufficient resolution to show it.

The clear implication from this study is that it is very undesirable to have Walking Spaces less than 1.5m wide as they will lead to very high levels of observable discomfort.

Revealed preference passing distances study

Following the completion of the *Observed discomfort behaviour study* further work was undertaken to determine preferred passing distances through a *Revealed preference passing distances study*.

The study built on the insight from the previous work that more than 85% of people did not show observable discomfort behaviours where the Walking Space was 2.35m or more.

The *Passing distances study* used a revealed preference method to study the spatial arrangements two people prefer when passing (or walking together) given a particular amount of available space. That is, when given a choice, how much passing space do people leave between themselves and others and between themselves and obstructions (street furniture or active building edges). Less space than the revealed preference can be considered to create a degree of discomfort.

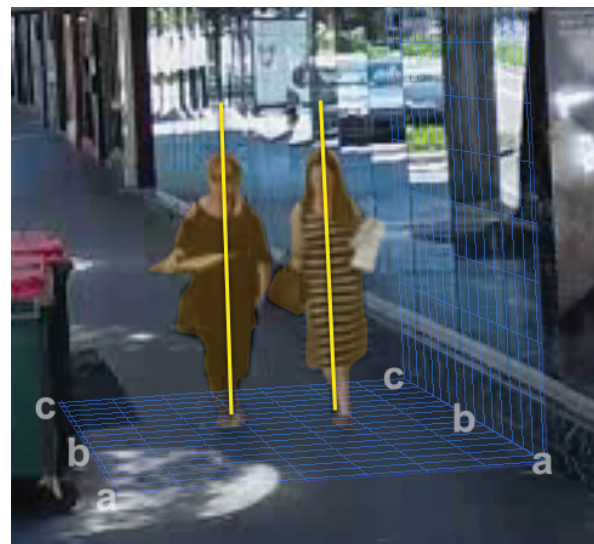
When considering separation from other people the relationship between the people was clearly important. For example two people who are friends walk with a different amount of space between them compared to a parent and a child or two strangers.

To overcome the issue of varied body sizes the measures in the study were taken to the centreline of each person. To make the results more intuitively understandable they are represented as separation distances where the body is assumed to be 0.6m wide.

The study was undertaken by searching the video footage for examples of two people walking abreast through a virtual gate that had been accurately measured. The image was saved and then using perspective matching features of Adobe Photoshop software the distances between the people and obstacles were accurately measured (example shown at Figure 12 – Perspective measurement. These measurements were entered into spreadsheets and the relationship between the two walkers was noted:

- friends
- couple
- parent and child
- strangers walking abreast (usually overtaking)
- strangers walking in opposite directions.

Figure 12 – Perspective measurement



Seven sites were measured: five normal footpaths and two mall conditions (data from six are presented in these graphs, Pitt Street mall is not shown as its data falls off the chart).

The results showed that as the available space increased, the amount of separation people preferred to leave from strangers increased substantially but the separation between friends or partners remained fairly consistent.

The revealed preference percentile outcomes for the base site are presented in Table 6 – Percentile separation distances. Large quantities of data were collected (two examples of this data are shown in the graphs at Figures 13 and 14 – Example separation graphs); the figures in Table 6 represent the most useful data points.

These figures can be combined to create synthetic arrangements for larger groupings representative of different comfort percentiles. For example three friends at the 50th percentile of comfort occupy $(0.6 \times 3) + (0.1 \times 2)$ plus edge buffers.

Example separation graphs:

Figure 13 (top) – Friend separation graph

Figure 14 (bottom) – Stranger separation graph

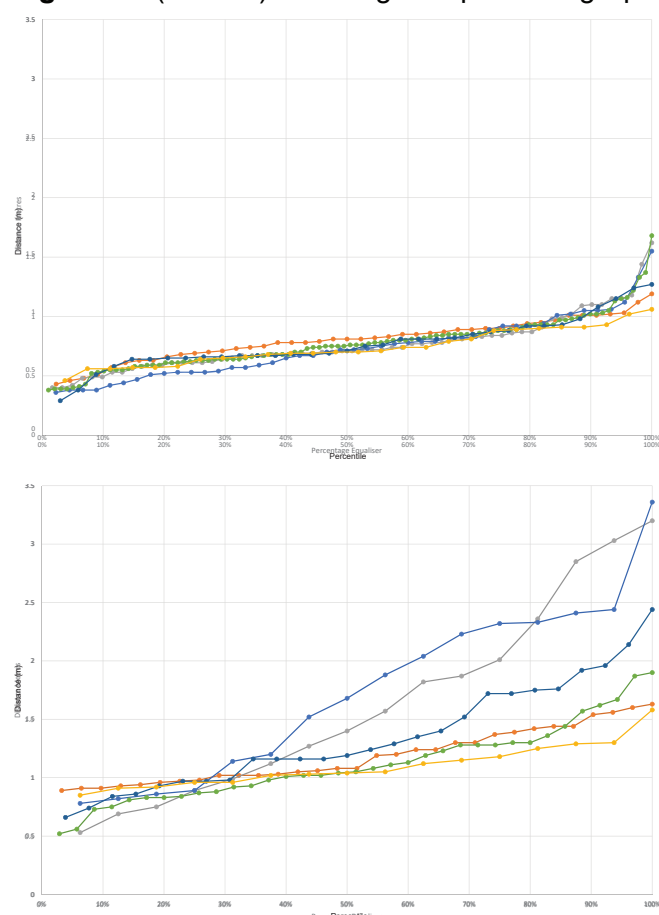


Table 6 – Percentile separation distances

Percentile	Separation distance from a person to a: (figures in metres, separations assume a 0.6m standard body width)				
	Friend	Stranger walking in the opposite direction	Stranger walking in the same direction	Active Building Edge	Non-active building edge or obstruction
85th%	0.3	0.68	0.7	0.96	0.58
50th%	0.1	0.44	0.61	0.52	0.33
15th%	-0.03	0.3	0.61	0.21	0.04

Flow rate and surveyed comfort study

The project's primary purpose was to understand the relationship between crowding and comfort for large numbers of people. The work was undertaken to assess whether the Pedestrian Comfort Guidance for London by Transport for London was applicable for an Australian context with the intention of calibrating it for local use.

The study relied on the survey described previously. It examined the data in many ways looking for correlations with comfort. It examined the following including looking for interrelationships:

- trip purpose
- walking groupings
- directionality of flow
- walking speed
- time of day
- flow averaging periods
- movement and place classifications
- adjacent land use type
- footpath width
- number of pedestrians per period
- kerbside traffic speed.

Clear footpath width to number of pedestrians had a very strong correlation with comfort response. Similarly, kerbside traffic speed correlated to comfort response. A number of other weaker correlations with comfort were also found.

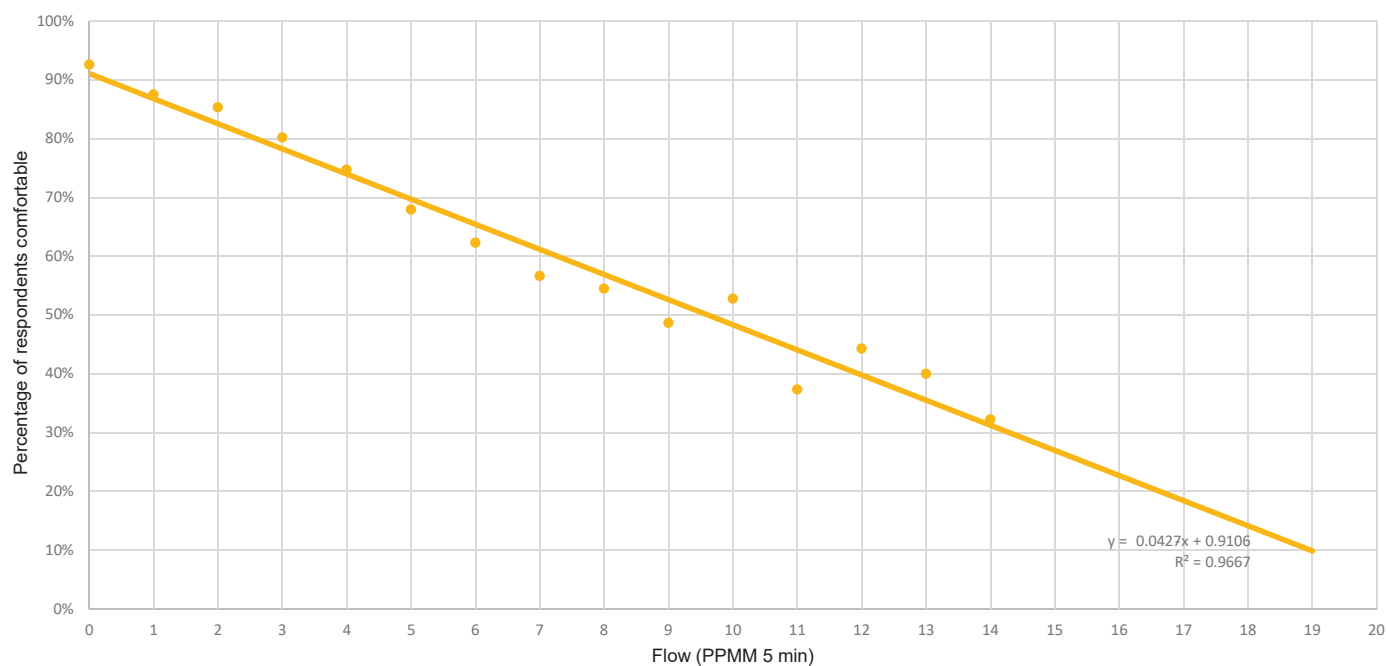
The most important finding of the study was the relationship between the clear width of the footpath to the number of people walking in a 5 minute period correlated to comfort. The first part is expressed as a number of people walking per metre (of clear footpath width) per minute, or PPMM. This is the same primary measure used by John J. Fruin (publishing on pedestrian crowding from 1970) and the Pedestrian Comfort Guidance for London. For normal streets, when the comfort responses divided into either comfortable or uncomfortable were aggregated the relationship was clear, linear and had a very high R squared value (0.9667) indicating that the linear trend line is a very close match to the actual data points. This relationship shows declining comfort as crowding per metre increases. It is shown in Figure 15 – Percentage of people comfortable versus flow.

Malls were excluded because the data was found to be unreliable. Transport interchanges were not included because they exhibited a different comfort relationship which suggested more structured movement at higher flows resulting in a bell shaped comfort curve.

The comfort to flow relationship can be used to predict comfort levels in situations where there are more than 1,500 people walking on a footpath per hour and the walking is not structured. The limitation is that it may not accurately predict comfort at major transport interchanges.

The relationship between kerbside traffic speed and comfort became the subject of a separate study.

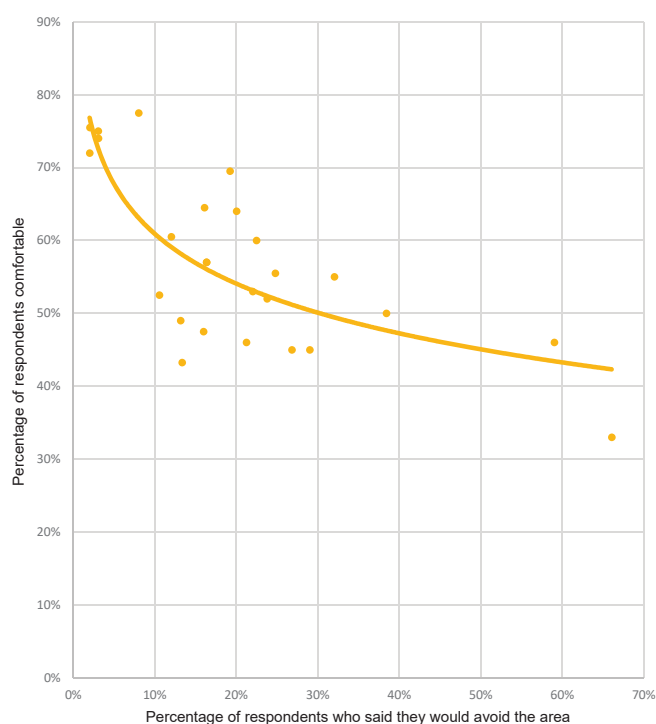
Figure 15 – Percentage of people comfortable versus flow



Additional work was done to understand how comfort affected people's desire to visit or avoid an area. Analysis was undertaken to correlate London's surveyed comfort responses to their data on the desire to avoid an area.

The result was a logarithmic relationship that showed a rapid increase in the desire to avoid areas when the average comfort dropped below 50% shown in Figure 16 – Percentage comfortable versus avoid the area. This relationship strongly suggested that the target comfort level should not be below 50%. This relationship is very likely to be transferable to an Australian context.

Figure 16 – Percentage comfortable versus avoid the area



Traffic buffer study

The *Flow rate and surveyed comfort study* found a clear relationship between kerbside traffic speed and comfort. The process of quantifying this relationship for it to be useful in the design and assessment process required analysis of comfort gradients at different flows, average Walking Space and average buffer sizes. These had to be made comparable through a series of transformations.

The primary relationship showed locations with faster kerbside traffic had lower comfort levels at any given flow rate (in PPMM). This relationship is shown in Figure 17 – Comfort, flow and traffic speed.

Observation of people's behaviour in previous studies had shown that the buffer left between very slow moving vehicles (20km/hr) and parked cars was similar, leading to them being treated as a single category in the analysis.

The flow and average buffer width at each speed were put through a comfort equalisation algorithm to determine the comparable buffer at each traffic speed. This algorithm is given in Table 7 – Equalisation algorithm.

Figure 17 – Comfort, flow and traffic speed

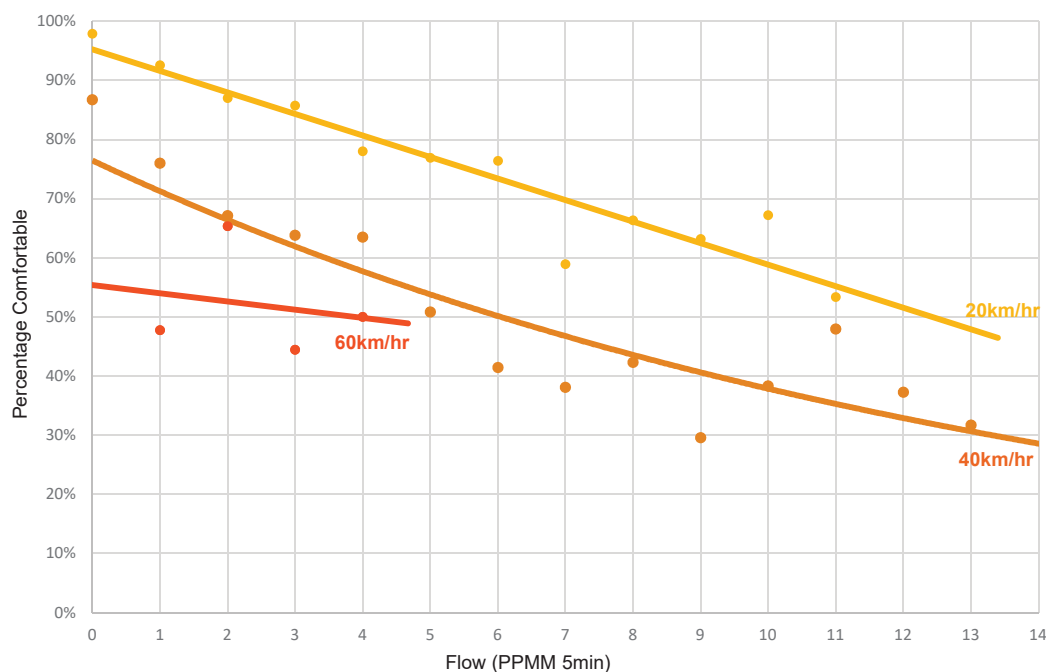


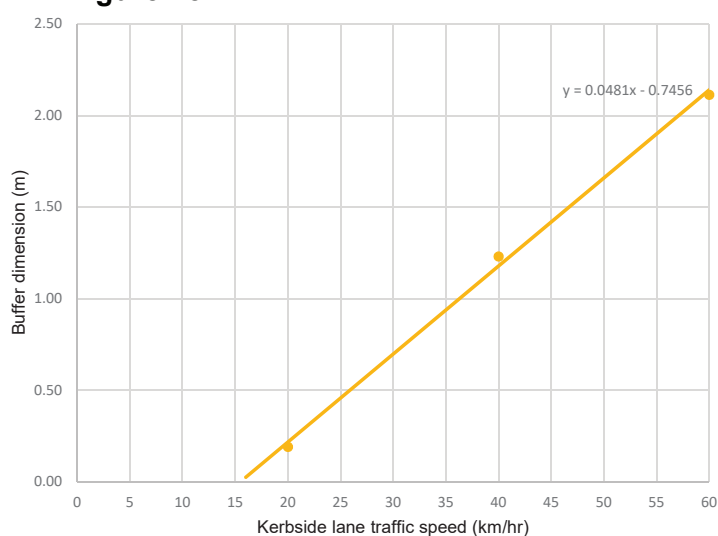
Table 7 – Equalisation algorithm

Column							
A	B	C	D	E	F	G	H
Speed	Average Walking Space for speed category	Average buffer width for speed category	Flow at 50% comfort (from Fig X)	Flow at 50% comfort as a % of maximum	Adjusted Average Walking Space	Ave buffer width adjusted by difference from Benchmark buffer width	Effective Buffer
				[1-(D/12.5)]	[BxE]	[C-0.97]	[F+G]
60	3.00	1.00	3.8	0.696	2.08	0.03	2.11
40	2.86	0.71	6.0	0.52	1.49	-0.26	1.23
20	3.05	1.16	12.5	0	0	0.19	0.19

In Table 7 (above) the *Benchmark buffer width* is given by the lowest buffer width (1.16) less the the difference between the Active Building Edge buffer and the general obstruction buffer (0.19) i.e. $1.16 - 0.19 = 0.97$.

The *Effective Buffer* for each speed from the equalisation algorithm was plotted, shown in Figure 18 – Buffers from traffic. They have an almost linear relationship where the buffer required for equivalent comfort increases with the kerbside traffic speed.

Figure 18 – Buffers from traffic



The buffers are given by the trend line formula [Buffer = (0.0481 x Speed) – 0.7456] and summarised in Table 8 – Kerbside Traffic Buffers by speed.

Table 8 – Kerbside Traffic Buffers by speed

Speed	Buffer	Buffer (rounded)
15	-0.02	0
20	0.22	0.2
25	0.46	0.45
30	0.70	0.7
35	0.94	0.95
40	1.18	1.2
45	1.42	1.4
50	1.66	1.65
55	1.90	1.9
60	2.14	2.15

This study demonstrated that there is a strong relationship between kerbside traffic speed and comfort. It showed that the relationship could be spatially quantified as an amount of space required to achieve comfort and that this followed a predictable linear pattern increasing as speed increased.

Expert review groups

Two walking expert review groups were formed from across government and the private sector.

Two reviews were held. The first was to review data and initial research and direct further work. The second was to advise on policy development and settings. At the second meeting the experts agreed that the guide should establish design targets set to 50% comfort levels (and 50th percentile revealed preference) and intervention triggers set to 15% comfort (and 15th percentile revealed preference). Further, they decided that the measure should be the peak hour of crowding.

The group also agreed a range of footpath types based on level of use and likelihood of pedestrian interaction. They agreed what walking arrangements each footpath type should support. These types form the basis of the guide.

Finally the group agreed that the 85th percentile revealed preference should represent a desirable goal but not be required. This became Level of Service (LOS) A. The target (50%) became LOS C and the intervention trigger (15%) became LOS F.

The core team would like to extend our thanks to the experts for their time and skilled guidance.

