Network Technical Guide (NTG)

Supplement to Austroads Guide to Traffic Management Part 9:

Transport Control Systems – Strategies and Operations

Version 2.0

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Document Information

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1.0	October 2015	First Release
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Preface

Under the Transport Integration Act 2010 (Vic) the functions of the Head, Transport for Victoria (**Head, TfV**) include the development and implementation of standards, guidelines and practices for the public transport system, the road system and related matters.

Standards and Guidelines are administered by the Department of Transport and Planning (**DTP**) on behalf of the Head, TfV.

DTP Standards and Guidelines respond to Head, TfV objectives and responsibilities, legislative requirements, Victorian Government policies and guidelines, industry best practice and emerging technologies.

Any reference in this document to another document, standard or procedure that is expressed to be a VicRoads, Roads Corporation, Department of Transport (**DoT**), or DTP document, standard or procedure shall be interpreted and applied as though it was a document, standard or procedure of Head, TfV. Any reference in any such document, standard or procedure to a legal right or obligation of VicRoads, Roads Corporation, DoT or DTP shall be deemed to be a right or obligation of Head, TfV.

Nomenclature

ⓘ This symbol intends the accompanying text to be read as INFORMATION. Common information accompanying this symbol includes RATIONALE and GUIDANCE for the associated requirement.

Disclaimer

Interpretation

In this document, except where the context otherwise requires—

- The words "shall" and "must" denotes a requirement which is mandatory.
- The word "should" denotes a requirement which is not mandatory but recommended.
- The word 'may' denotes a requirement which is not mandatory but is an allowance or suggestion.
- The word "includes" in any form is not a word of limitation. Mentioning anything after "includes" or similar expressions (including "for example") does not limit what else may be included.

Reference to a section, clause, schedule or appendix is a reference to a section, clause, schedule or appendix of this document.

Contents

1 Introduction

1.1 Purpose

All road agencies across Australia are working towards greater consistency between States/Territories in how road networks are managed. In order to achieve this, the Austroads Guide to Traffic Management and Australian Standards relating to traffic management have been adopted to assist in providing that level of consistency and harmonisation across all jurisdictions. This agreement means that these Austroads Guides and the Australian Standards are the primary technical references.

Austroads Guide to Traffic Management Part 9: Transport Control Systems – Strategies and Operations (2020) (AGTM Part 9) is a nationally agreed guideline document outlining the use of traffic control devices on the road network and has been adopted by all jurisdictions, including DTP.

All jurisdictions will be developing their own supplement to clearly identify where its practices currently differ and to provide additional guidance to that contained within AGTM Part 9. This document is the DTP supplement and shall be read in conjunction with AGTM Part 9.

1.2 How to Use this Supplement

There are two key parts to this document:

- **Classification of Supplement Information:** this table classifies supplement information as a Departure, Additional Information or both. This information assists with identifying its hierarchy in relation to the Austroads Guide to Traffic Management.
- **Details of Supplement Information:** this section provides the details of the supplement information.
  - **Departures:** where DTP practices differ from the guidance in the Austroads Guide to Traffic Management. Where this occurs, these differences or 'Departures' will be highlighted in a box. The information inside the box **takes precedence** over the Austroads Guide to Traffic Management section. The Austroads Guide to Traffic Management section is not applicable in these instances.
  - **Additional Information:** all information not identified as a departure provides further guidance to the Austroads Guide to Traffic Management and is read and applied **in conjunction** with the Austroads Guide to Traffic Management section.

Where a section does not appear in the body of this supplement, the Austroads Guide to Traffic Management requirements are followed.

2 Classification of Supplement Information

The classification of each section as a Departure, Additional Information or both is shown in the table below.

Section	Classification
6.5.2	Additional Information
6.5.3	Additional Information
6.12.5	Additional Information
7.2.1	Additional Information
7.2.2	Additional Information
Appendix G.4.1	Additional Information
Appendix G.4.6	Additional Information
Appendix G.5.1	Additional Information
Appendix G.5.3	Additional Information
Appendix H	Additional Information

Austroads Guide to Traffic Management requirements are followed in their entirety for sections not shown in this table.

3 Details of Changes

Section 6.5.2 – Phase Intervals

Pedestrian phase intervals

In Victoria, the pedestrian walk time is calculated using a walking speed of 1.2 m/s.

The overall pedestrian clearance interval is calculated using the allowable higher 1.5 m/s walking speed.

For further details on calculating the walk and clearance times, and how the clearance time can overlap the intergreen, see Appendix G.5.1 and G.5.3 respectively.

Section 6.5.3 – Phasing Design

Fundamentals of right turn signal phasing

In general, right turn vehicle movements can be controlled using one of the techniques described below:

Filter right turn

A right turn movement which operates in the same phase as opposing vehicle (generally through and left turn vehicles from the opposite direction) and/or pedestrian movements. The right turn is therefore required to find safe gaps in the opposing traffic, while facing a green circular signal.

Partially controlled right turn

A right turn movement which operates in two phases:

- in a phase in which it is controlled by a green right turn arrow, and so has priority over conflicting vehicle and/or pedestrian traffic movements; and
- in a phase in which it operates as a filter right turn (refer definition above).

With this type of control, the right turn movement is controlled with either two-aspect (Yellow/Green) right turn arrow displays or three-aspect (Red/Yellow/Green) right turn arrow displays. Generally, these types of lanterns are also associated with normal three-aspect (Red/Yellow/Green) circular displays. The operation with each of the displays is described below.

Partially controlled turn (two-aspect right turn arrow displays)

When controlled by two-aspect right turn displays, the operation is as follows:

- During the right turn phase, the right turn movement is controlled by the green arrow.
- At the end of the right turn phase, the right turn movement goes through the yellow arrow.
- After the yellow arrow has terminated, the right turn movement is controlled by the adjacent normal three-aspect circular display. Generally, that display will be green and so vehicles can conduct a filter right turn (refer definition above).
- The termination of the right turn movement is controlled by the normal three-aspect circular displays.

Partially controlled turn (three-aspect right turn arrow displays – “red arrow drop out”)

When controlled by three-aspect right turn displays, the operation is as follows:

- During the right turn phase, the right turn movement is controlled by the green arrow.
- At the end of the right turn phase, the right turn movement goes through the yellow arrow.
- After the yellow arrow has terminated, the right turn is then controlled by the red arrow. The red arrow will be held on for the following periods:
    - all-red interval of the right turn phase, plus
    - a nominal period of 2 seconds in the next phase; or

- a minimum of 8 seconds in the next phase if there is a conflicting pedestrian movement that has been demanded.

- After the red period, the right turn red arrow goes off (to blank) and the right turn movement is controlled by the adjacent normal three-aspect circular display. Generally, that display will be green and so vehicles can filter right turn (refer definition above).
- The termination of the right turn movement is controlled by the normal three-aspect circular displays, except that the red right turn arrow is activated during the all-red interval of the circular displays.

For the lantern display sequences for the two cases described above, refer to Austroads Guide to Traffic Management Part 10.

The key difference between the two types of operation is that the “Red Arrow Drop Out” operation provides a red period during which opposing vehicle and/or pedestrian movements can be established before the filter right turn movement commences. Within Victoria, the “Red Arrow Drop Out” operation is now the preferred form of partially controlled turn to be adopted. However, it should only be used where the right turn movement is from an exclusive right turn lane.

Fully controlled right turn

A fully controlled right turn is a right turn movement which only operates in a phase in which it is controlled by a green right turn arrow, and so has priority over conflicting vehicle and/or pedestrian traffic movements. However, unlike a partially controlled turn, it is unable to filter during any other phase. At the end of its own phase, the right turn is terminated and held on a red arrow display (until it operates in the following traffic signal cycle or possibly in a repeat right turn phase).

Alternative right turn treatments

As congestion increases across the road network, DTP is implementing alternative operations to optimise capacity - and road safety – and to prioritise critical movements (which include sustainable transport modes).

Every second cycle

Operating a fully controlled right turn every second cycle can be considered where:

- The intersection and/or the opposing through movement are/is at or above capacity.
- The right turn volume is low (e.g. < ~100 veh/h/lane).
- The volume of a right turn movement can be accommodated in a relatively short phase.
- The queue length can be accommodated within the available turn lane.

Prior to implementation, traffic analysis (e.g. first principles, SIDRA etc.) shall be completed to confirm the operational benefits.

If the traffic analysis indicates potential over-queuing from the right turn lane into the adjacent through lane, it is possible to install a queue detector near the taper of the right turn lane, whereby the queue detector can be used to dynamically disable the skipping of the right turn phase for the cycle(s).

Signage is required at the intersection to inform drivers of the change to normal operation. At the majority of intersections, the required signage states "RIGHT TURN MAY OPERATE EVERY 2ND CYCLE". At intersections with Red Light Cameras, the sign shall also include supplementary information identifying the days and time periods in which it operates. Refer to DTP Supplement to AS 1742.14:2014 for further details.

Time-based turn bans

Time-based bans on right turning movements can be considered where:

- The intersection and/or the opposing through movement are/is at or above capacity.
- The volume of a right turn movement is minor.
- There are suitable alternative routes for right turn vehicles to reach the desired destination.

Signage is required at the intersection to inform drivers of the change to normal operation in accordance with AS 1742.14:2014.

For advance turn ban signs, refer to DTP Supplement to AS 1742.2.

Time-based full control

Another alternative treatment for a right turn movement is to implement full control at some times of the day and partial control with red arrow drop out at other times of the day.

Determining the method of right turn control

The selection process of the method of control for right turns is typically influenced by the crash history, carriageway configuration, traffic volumes and the potential for right turn vehicles to filter across opposing traffic, and the ability for turn lanes to accommodate queues.

As a guide, the following criteria can be used to aid the selection process. It is noted that the control that is most appropriate has the majority of its criteria met.

Filter control

A filter turn can be considered if there is:

- one turning lane
- three opposing lanes or less
- low-medium right turn volumes
- low-medium opposing through volumes
- low-medium pedestrian volumes
- a speed limit of 70 km/h or less.

Partially controlled

A partially controlled turn can be considered if there is:

- one turning lane
- three opposing lanes or less
- medium-high right turn volumes
- low-high opposing through volumes
- low-high pedestrian volumes
- a speed limit of 70 km/h or less.

Partially controlled (with ‘red arrow drop-out operation’)

A partially controlled turn with Red Arrow Drop Out can be considered if the site is in an urban location and there is:

- one exclusive right turning lane
- three opposing lanes or less
- medium-high right turn volumes
- low-high opposing through volumes
- low-high pedestrian volumes
- a speed limit of 70 km/h or less
- a requirement to control the right turn and opposing through traffic/pedestrian conflict, while still maintaining the capacity of the right turn movement by enabling filtering.

Fully controlled

A fully controlled turn can be considered if there is:

- three opposing lanes or more
- medium-high right turn volumes
- medium-high opposing through volumes
- high pedestrian volumes

- a speed limit of 80 km/h or more
- two or more right turn lanes
- two or more opposing right turn lanes
- road safety issues (e.g. poor sight distance)
- a relevant crash trend (e.g. a significant amount of recorded casualty crashes that would be solved by this method of control, which have occurred over the latest five-year period)
- a tram right-of-way
- linking/capacity benefits, (e.g. where the phasing implemented includes a lagging right turn conflict).

Considerations

When considering the method of right turn control(s) for a site, the following shall also be noted:

- The operational safety of the phasing is the primary factor, followed by efficiency and other factors.
- For new sites, a site investigation shall be conducted to observe local issues (e.g. horizontal and vertical geometry, sight distances, surrounding area development, etc.), as well as consideration of any relevant data (e.g. traffic volumes, crash statistics, etc.).
- In general, partially controlled right turns (with 'red arrow drop-out operation') are replacing the traditional partially controlled right turns at existing and new sites.
- The potential type of right turn control shall be chosen via the criteria above, and then subsequently assessed via a traffic analysis (e.g. SIDRA, etc.) and backed with sound engineering judgement.

Fundamentals of left turn signal phasing

As with right turn movements, signalised left turn movements can be controlled in the following ways:

- Filter left turn
- Partially controlled left turn
    - 2-aspect Yellow/Green display
    - 3-aspect Red/Yellow/Green display with red arrow drop out
- Fully controlled left turn: 3-aspect (Red/Yellow/Green)

Left turns going through slip lanes may be:

- Unsignalised, preferably with a zebra crossing or priority crossing (if it connects to a shared use path), or
- Signalised: with 2-aspect Red/Yellow display

Filter left turn

A filter left turn operates in the same phase as a parallel opposing pedestrian movement. A filter left turn normally operates in a through phase and the left turn movement is controlled by a normal 3-aspect circular display. The left turn is required to find safe gaps in the parallel opposing pedestrian movement before turning.

Partially controlled left turn

In Victoria, partially controlled left turns are usually controlled with 2-aspect (Yellow/Green) left turn arrow displays.

A red left turn arrow is added where it is deemed necessary to hold the left turns on a red arrow while a conflicting pedestrian movement is operating. This is often referred to as "pedestrian protection".

Partially controlled left turn movements can operate from either exclusive left turn lanes or shared left/through lanes. However, they will operate more efficiently from exclusive left turn lanes because there is no possibility of through vehicles blocking the lane.

Fully controlled left turn

A fully controlled left turn is a left turn movement which only operates in a phase in which it is controlled by a green left turn arrow, and so has priority over conflicting vehicle and/or pedestrian traffic movements.

However, unlike a partially controlled turn, it is unable to filter during any other phase. At the end of its own phase, the left turn is terminated and held on a red left turn arrow display.

Left turn slip lane

Left turn slip lanes allow left turning vehicles to “bypass” the signalised intersection. Most left turn slip lanes have a Give Way line where left turners must give way to conflicting vehicle movements. In rare cases where sight lines are restricted, a Stop line may be used.

Under the Road Rules, drivers must give way to pedestrians crossing the slip lane. To reinforce that rule, zebra crossings (or priority crossings) should be provided across left turn slip lanes at signalised intersections, unless the left turn and pedestrian movement are controlled by signals. This has not always been a requirement, so there are still many left turn slip lanes without zebra crossings which should be retrofitted over time.

If the pedestrian movement across the slip lane is signalised, then the left turn should be controlled by 2-aspect (Red/Yellow) displays if the left turn movement has a give way or stop line condition at the intersecting road. If there is no give way condition (e.g. the left turn lanes exit into exclusive lanes), then a 3-aspect (Red/Yellow/Green) display should be used. A green arrow must not be used if the left turns must give way as they enter the intersecting road.

Operation of pedestrian movements

Late Introduction

Pedestrian movements normally introduce at the same time as the adjacent through movement goes green. Sometimes, to allow the pedestrians to establish themselves on the road before any left turners are permitted to filter, the pedestrian movement introduces before the adjacent through movement. This is referred to as a vehicle late start.

Late introduction is where the pedestrian movement is permitted to introduce, on a push-button call, <u>after</u> the adjacent through movement goes green. The time window for Late Introduction is usually constrained so that the pedestrian time does not extend longer than the expected duration of the relevant phase or phases.

Late Introduction should only be used when the following conditions are met:

- There is no conflict with filtering right turning vehicles (e.g. the right turn is banned or fully controlled or does not run in the relevant phase); and
- There is no conflict with left turning vehicles (e.g. the left turn is banned or goes through a slip lane or does not run in the relevant phase); OR
- There is minimal safety risk associated with filtering left turning vehicles, assessed on a case-by-case basis after consideration of:
    - left turn volume being low throughout a typical day
    - left turn traffic mix – eg low proportion of heavy vehicles
    - modal priorities as per DTP’s Movement & Place framework
    - types of pedestrians and other users (e.g. cyclists) using the crossing
    - the likely speed of left turners when they get to the crosswalk, which is influenced by:
        - distance from the left turn stop line to the crosswalk
        - radius of the left turn
        - grade of the approach road
    - left turn driver’s visibility of pedestrians on the crossing or waiting to cross
    - impact of delays on pedestrian behaviour.

Rewalk is the introduction of a pedestrian movement on a push-button demand when the controller is resting in the pivot phase with no demands for other phases. The alternative to Rewalk is to “call away” to another phase then back to the pivot phase to service the pedestrian.

The choice between Rewalk or “call away” operation should be assessed using the same criteria as Late Introduction (see above). Rewalk should not be permitted if there is a right turn filter across the crosswalk.

Automatic introduction

An automatic introduction of the pedestrian movement may be considered where there is a high volume of vulnerable pedestrians (e.g. school children, the elderly, etc.) and/or within areas of significant pedestrian activity during peak pedestrian times. The impact of the automatic introduction of pedestrian movements on other modes should also be considered to ensure compliance with Movement & Place.

The automatic introduction of pedestrian movements should not be implemented ad-hoc, as it may reduce the effectiveness of the pedestrian lantern and how motorists use it as an indication of the presence of pedestrians at the crosswalk.

Automatic introduction can be implemented by time of day, as is done in the Melbourne CBD. Elsewhere it is generally implemented conditional on the prevailing cycle time or phase times, so that the pedestrian does not hold a phase longer than its expected duration.

Where late introduction is not appropriate, the facility to implement automatic introduction should be programmed into the traffic signal controller for optional use.

Extended walk times

For each pedestrian crosswalk, a design decision needs to be made between:

- restricting to the minimum walk time, as programmed into the local controller
- allowing an extended walk time
- allowing the walk time to stretch up to the phase(s) time minus clearance time.

Where there are no turning vehicles conflicting with the pedestrian movement, and the phase is non-gappable, a stretch walk is generally appropriate.

Otherwise, the choice needs to consider:

- the level of service for the pedestrians
- the level of safety for the pedestrians
- the effect of longer walk times on intersection efficiency and safety for other modes.

Section 6.12.5 – Railway Level Crossings

For the method used in Victoria for interlinking traffic signals with railway level crossings, refer to DTP Supplement to AGTM Part 10.

Section 7.2.1 – Lane Use Management Systems

Lane control signals are overhead signals which permit or prohibit the use of specific lanes of a road. These systems are rarely used, but when they are, it is typically to support:

- ‘Tidal flow’ with a greater number of lanes allocated to travel in one direction at the expense of the number of lanes in the opposite direction.
- Part time bus priority schemes, which may change direction or not occur at all at different times during a day.
- They may also be used to control contra-flow lanes on freeways or other divided roads, although they have not been used for this purpose in Victoria to date.

These schemes are referred to as ‘reversible lane’ control (see Section 7.2.2 – Reversible Lanes). Other terms often used for ‘reversible lane’ control are ‘tidal flow’, ‘off-centre’ operation or 'contra-flow'. Permitted use of a lane is indicated by a downward pointing arrow and prohibited use of a lane is indicated by a red cross (refer to AS 1742.14). The downward pointing arrow shall be white, as green may be mistaken for an intersection signal.

Lane Use Management Signs on freeways

Information regarding Lane Use Management Signs on Freeways can be found in the following documents on the DTP/VicRoads website at https://www.vicroads.vic.gov.au/business-and-industry/technical-publications/traffic-engineering:

- Managed Motorway Design Guide
- Managed Freeways - Handbook for:
  - Lane Use Management
  - Variable Speed Limits
  - Traveller Information
- Managed Freeways – DTP/VicRoads Policy

Other overhead lane control

Overhead lane control can also be used to allocate lanes for different combinations of through and turning traffic from the same direction approaching and at an intersection. In this case, the arrows are pointing up and the displays are referred to as Variable Use Lane Signs. The intention is that these displays look like signs which give directional information. For guidance on Variable Use Lane Signs, refer to AS 1742.2.

Section 7.2.2 – Reversible Lanes

Rule 152 of the Road Safety Road Rules 2017 sets out the obligations of drivers in relation to overhead lane control devices.

Reversible lane controls are typically applied to arterial roads of limited width, which experience a heavy flow of vehicles in one direction during peak hours. The existing number of lanes may be retained or increased as part of the scheme. Two schemes in Melbourne (Queens Road and Johnston Street) have succeeded because each road was wide enough to permit it to be marked as five lanes, rather than the pre-existing four lanes.

There is nothing in principle to prevent use of reversible lane controls on tram routes. However, the cost of providing multiple tracks and the difficulties with providing safe tram stops will typically preclude such schemes.

Similarly on divided roads, the strong visual cue created by the median is likely to prevent a reversible lane control scheme from operating safely, unless it is reinforced with temporary bollards or similar devices. Banning the use of right turn lanes is also likely to be needed. The high cost of managing such a system will limit its application to situations where the benefits are very high and the disbenefits can be safely managed.

The following applications are intended for undivided roads without trams.

Any scheme for reversible lane control signals will need to include:

- Part time or full time clearways on both sides of the road
- A plan to manage right turns. Isolated right turns can seriously disrupt a through traffic lane and negate the potential improvements a reversible lane control scheme achieves for capacity. Right turns will need to be banned or catered for (e.g. possible use of a 'median turning lane' for turns from opposing directions).

The use of lane control signals to achieve reversible lane operation may be considered in relation to an arterial road where all of the following apply:

- Peak period traffic volume in the peak direction is currently equivalent to at least 1200 veh/h/lane.
- Peak period traffic volume in the counter direction is less than one third of the flow in the peak direction (for a four or five lane road).
- Peak period traffic in the peak direction is encountering substantial delays.
- Clearway restrictions have been implemented on both sides of the road during the applicable periods through the day.

- Other traffic management measures aimed at alleviating the problem (e.g. right turn restrictions, improved or coordinated traffic signal timings, relocation of bus stops, etc.) have been investigated and either implemented or rejected as being inappropriate.

Municipal councils considering the possibility of installing lane control signals are required to contact DTP with a brief outline of the proposal, having regard to the points mentioned above. If there is prima facie justification for lane control signals, DTP will assist the municipal council with the collection and analysis of data required to make a thorough assessment of the proposal.

Following in-principle agreement for the installation of lane control signals, detailed plans and specifications will need to be prepared and these will be referred to the municipal council (and other authorities, as appropriate) for comment.

AS 1742.14 sets out the requirements for reversible lane control schemes and plans for the installation of lane control signals shall follow that Standard.

The plans and specifications for any reversible lane control scheme shall include all signs and linemarking associated with the scheme. All such signs and road markings form an integral part of the overall design and shall not be removed or varied without consultation with DTP. After completion of the plans and specifications, arrangements for their installation will require DTP's involvement.

As 'overhead lane control signals' come within the definition of 'traffic signals' in the Road Safety (Traffic Management) Regulations 2019, they are Major Traffic Control Devices, requiring DTP's written consent to erect, modify or remove.

Where the lane control signal system requires new or modified clearway restrictions on arterial and municipal roads, it is the responsibility of DTP to approve these changes in consultation with the municipal council and in accordance with the Road Management Act 2004 – 'Code of Practice for Clearways on Declared Arterial Roads (2004)'. On arterial roads, DTP is responsible for the supply and installation of clearway signs.

Appendix G.4.1 – Late Start Setting

In addition to the example late start setting given in the AGTM Part 9, Appendix G.4.1, a late start time (or delay time) can be applied to the start of a pedestrian movement, where the pedestrian crossing is significantly offset (greater than 6 m to 8 m) from the parallel vehicle movement that commences in the same phase.

Generally, the reason for applying this late start is to allow a reduction in all-red time between phases where that time is dictated by a conflict between a vehicle movement and an offset pedestrian movement.

However, if a filtering left turn or right turn starts in the same phase as the pedestrian movement, the pedestrian should <u>not</u> have a late start. Where a turning movement filters through a pedestrian movement, the pedestrian walk signal and the green circular signal for parallel traffic should start simultaneously so that pedestrians can establish themselves on the crossing.

When calculating the all-red interval for a particular phase, the length of the vehicle path distance from the stop line to the conflict point with a pedestrian and/or vehicle movement which is starting up in the next phase is required to be used. When a pedestrian crossing is set well back from the intersection, the vehicle path to that movement is longer and so a longer all-red time is required.

However, if a late start is applied to the start of the pedestrian movement in the next phase, the all-red of the phase can be calculated based on the vehicle path distance to the conflicting vehicle. The late start to the pedestrian movement is then calculated as the difference between the time to travel to the vehicle/pedestrian conflict and the time to travel to the vehicle/vehicle conflict.

The benefits of providing a late start to a pedestrian movement are:

- The all-red time between critical vehicle movements is reduced in all traffic signal cycles, resulting in less "lost time", and therefore an increased intersection capacity
- Reduced frustration for drivers waiting to start in the following phase (i.e. drivers will not be waiting at the stop line unnecessarily)

- Reduced temptation for drivers clearing the intersection to “run the red”. This can become an issue over time as drivers realise there is always an extended period before conflicting vehicles start up.

A late start time for a vehicle movement can also be used to benefit pedestrians and/or cyclists at a signalised intersection (refer to AGTM Part 9, Table 6.5 and Table 6.6). This treatment may be used in a location such as a high pedestrian activity area.

Appendix G.4.6 – Vehicle Clearance Settings

Yellow time

The calculation of yellow time values is detailed in Appendix G.4.6 and Table G2 of AGTM Part 9.

Yellow time values are to be calculated from the equation which is duplicated here for completeness:

$$t_y = t_r + 0.5 \times \frac{(v_D / 3.6)}{(a_d + 9.8\,G)}$$

where:

t_y	=	yellow time (s)
t_r	=	reaction time (s), commonly taken in these circumstances as being between 1.0 s and 1.5 s
v_D	=	design speed (km/h)
a_d	=	the deceleration acceptable to the majority of drivers (m/s^2), commonly taken as 3.0 m/s^2, but in the case of heavy vehicles a lesser value may be appropriate
G	=	average approach grade over the stopping distance (per cent grade divided by 100; negative value for downhill grade and positive value for uphill grade, e.g. -0.05 for 5% downhill grade)

The following guidelines shall be applied in Victoria:

Design speed

For through movements, the design speed is taken to be the speed limit.

Yellow time values can be considered as any design speed +/- 5 km/h of the design speed in the table. For example, yellow time values for a design speed of 60 km/h can be used for any design speed between 55 km/h and 65 km/h.

If there is a variable speed limit on an approach, the yellow time should normally be based on the higher speed limit – i.e. the higher yellow time should be adopted. However, where the change of speed limit occurs at fixed, preset times and days throughout the year, it is acceptable to change the yellow time by time-of-day to match the active speed limit. Variable yellow times may be implemented in shopping precinct speed zones where warranted, but not in school speed zones.

If the intersection is on a raised platform, the design speed for the yellow time should normally be based on the speed limit. However, it may be reduced if a speed survey shows that the 85th percentile speed at the critical distance on the approach to the intersection is lower.

Minimum and maximum yellow times

The minimum yellow time to be used is 3.0 seconds.

The maximum yellow time is 6.4 seconds. This is a requirement of SCATS controllers.

Reaction Time

DTP adopts a reaction time (t_r) of 1.0 seconds, unless there are exceptional circumstances. This is in accordance with AGTM Part 9 which states that it is appropriate to adopt a value of 1.0 second as a minimum value for the calculation of yellow times.

Yellow for Right Turn Vehicles

A design speed of 45 km/h shall be adopted for vehicles turning right, rather than the posted speed limit. This design speed is generally reflective of intersection geometries and investigations undertaken by the Australian Road Research Board for VicRoads/DTP.

The yellow time for right turn vehicles shall be:

- 3.0 seconds for level grades
  As described above, grades are considered to be level (i.e. 0.0%) in the following scenarios:
  - All uphill grades
  - Downhill grades less than 5.0% (i.e. -5.0%)
- For downhill grades ≥ 5.0% (i.e. -5.0%), the yellow shall be calculated using 45 km/h as the design speed.

Determination of Approach Grade

As described in the formula for the calculation of yellow, approach grade is to be considered.

For sites with downhill grades that may require longer yellow times, accurate grade information should be determined and used.

Grade must be determined for each intersection approach. The determined grade must then be applied to the calculation of the yellow time for the affected phases (left turn phase, through phase, and/or right turn phase).

Grade information for each approach should be provided on the Traffic Signal Plan for the intersection. The Approach Grade information should be provided on each approach as “APPROACH GRADE +/-X%”, surrounded by a border and located and orientated so that it is clear as to which approach the Approach Grade applies.

If grade information is not available on the Traffic Signal Plan, then the grade should be determined from feature survey data. If this is not available, then elevation data can be obtained from commercial mapping sources (e.g. Near Maps or Google Earth). However, practitioners should be aware of the potential accuracy limitations (e.g. elevation rounded to the nearest metre) of these mapping sources and must apply engineering judgement with its use.

A procedure for using Google Earth Pro to determine approach grade is provided below.

Procedure for calculating approach grade from elevation data

To calculate the approach grade, the general philosophy of the following procedure should be followed:

1. Determine the elevation at the stop line
2. Determine the elevation at the Approach Grade Distance (see Table 1 to determine the Approach Grade Distance for all design speeds)
3. Determine approach grade using the following formula:

$$\frac{\text{(Elevation at the Stop Line - Elevation at the Approach Grade Distance)}}{\text{Approach Grade Distance}}$$

4. The value determined is then multiplied by 100 to get a % grade

Note: Elevations points should be measured from approximately the middle of the approach through lane(s).

The “Grade Calculations” table of the Controller Operation Specification templates are not setup to accept the elevation points as described in the procedure above.

Procedure when using Google Earth Pro

The Google Earth Pro application may be used for the determination of approach grade if grade cannot be determined from any other source. The suggested procedure when using Google Earth Pro is as follows:

(Note: This procedure is repeated in all Controller Operation Specification templates)

1. Open Google Earth Pro and search for the required site where grades are to be determined.

2. Using the add path function, draw a path from the approach grade distance (see Table 1 to determine the Approach Grade Distance for all design speeds) to the middle of the stopline of the relevant approach
3. Save the path by clicking “OK”
4. Locate the path in the "My Places" pane
5. Right click the path and select "Show Elevation Profile".
6. The total Elevation Gain/Loss values for the path will be shown in the "Elev Gain/Loss" cells
7. Verify the distance of the path in Google Earth is appropriate for the design speed of the approach (check Distance cell under Range Totals)
8. Enter the Elev Gain (+) & Elev lost (-) values in their respective cells in the “Grade Calculations” table of the Controller Operation Specification template (Page 5)
9. Ensure the path starts at the approach grade distance and ends at the stopline so that downhill grades are calculated as negative values
10. Within the Controller Operation Specification templates, the calculated approach grade will automatically be calculated.
11. The calculated grade should then be entered into the appropriate cell(s) of the “INTERGREEN TIMES” and/or “PHASE SPECIAL ALL REDS AND SPECIAL MOVEMENT ALL REDS” tables of Page 5 (Design of Intergreen and Pedestrian Times)

Irrespective of the procedure used for the calculation of approach grade, because of the potential accuracy limitations, the calculated approach grade value should be rounded to the nearest first decimal point (e.g. -5.55 rounds to -5.6, -5.54 rounds to -5.5). This rounding automatically occurs in the Controller Operation Specification templates.

- If the grade of an approach is less than 5.0% downhill (i.e. -5.0%), then grade does not need to be considered for the calculation of yellow time i.e. it will be considered as level (0.0% grade)
- For all uphill approaches, grade does not need to be considered for the calculation of yellow time i.e. they will be considered as level (0.0% grade).

Given that the yellow times for an intersection on a grade should be the same for opposite traffic streams, the highest of the yellow values determined should be used.

As a guide, approach grades should be considered for the approach distance detailed below:

Table 1: Approach grade distances

Design Speed (km/h)	Approach Distance (m)*
40	40
50	50
60	70
70	90
80	110
90	140

** Based on approximate distance derived from (design speed x yellow time values for level approach)*

Warning comments regarding calculation of approach grade and therefore yellow time

Some of the issues related to the calculation of approach grade (and therefore yellow time) are discussed below. (Note: The issues stated relate mainly to the use of Google Earth Pro, but similar issues need to be considered when using other methods).

While it has been decided that Google Earth Pro can be used for the calculation of approach grade, as described above, designers should be aware of the potential accuracy limitations of these types of mapping sources.

If the approach for which the grade is being calculated, is on a curve, it can be problematic to determine the “correct” path to use on the approach.

It can often be difficult to “accurately” define the approach grade distance using Google Earth Pro.

The calculated approach grade can differ, dependent on where the start and end of the approach grade distance are defined. For instance, the grade can vary, dependent on where the end of the “path” is located on the stopline.

Therefore, the calculation of approach grade as described in the paragraphs above will almost certainly be subject to a level of inaccuracy. The results from the calculations should be considered very carefully and designers must apply engineering judgement with their use. This is especially valid at “crossover” grade points where it is calculated that the yellow time will change. For instance, when the grade is calculated to be -5.0% rather than -4.9%, the yellow time for most speeds is calculated to increase by 0.5 seconds.

As described above, because of this level of inaccuracy, grade should only be rounded to the nearest first decimal point.

Notwithstanding all of the above, when calculating the yellow time for an approach, the designer should also assess the appropriateness of the calculated time for the approach being analysed. Engineering judgement should be used when considering such factors as environment, land use, width of road, etc.

Yellow for Trams

When trams operate in the same phase as the parallel vehicle movement, the calculated yellow time for those parallel vehicle movements shall be used.

For exclusive tram phases, a yellow time of 3.0 seconds shall be used. For exclusive tram phases, grade should not be taken into account as it is unlikely trams would be travelling at speed in these phases (i.e. they are normally only detected when they are stopped at the stop-line).

Yellow for Bicycles

When bicycles operate in the same phase as the parallel vehicle movement (i.e. at most sites where specific bicycle lanterns are not provided), the calculated yellow time for those parallel vehicle movements should be used.

For exclusive bicycle phases or bicycle special movements, a yellow time of 3.0 seconds should be used. The grade does not need be taken into account as the design speed for bicycles is 20 km/h.

Design Considerations for Calculation of Yellow

As an added safety check in the design process, DTP reviews the adopted yellow time when initially designing the controlled time settings for a new signalised intersection and subsequently when reviewing the operation of existing intersections. During this process, DTP considers the appropriateness of the intergreen times for site specific conditions and can increase the yellow times in exceptional circumstances (e.g. larger proportion of heavy vehicles due to the lower deceleration rate, etc.).

Because yellow times are set per phase rather than per signal group, the yellow times must be determined by the most critical movement which is likely to terminate at the end of the phase.

- The most common case is a through-and-right phase. If the phase is nearly always followed by a through phase and the through movement overlaps, then the yellow time shall be determined by the right turn movement.
- If, on the other hand, the through movement is likely to terminate at the end of the phase, such as a lagging right turn, the yellow time shall be determined by the through movement.
- Phases servicing the stem of “Y” junctions will need to have the yellow time for turning movements with large radii calculated based on the expected approach speed.

At intersections with through phases that have different speed zones on opposite approaches (e.g. north approach is 60 km/h and south approach is 50 km/h) the yellow is based on the higher speed zone.

On-Site Observations

Notwithstanding the values determined via the process described above, the yellow values derived may be reviewed as part of a periodic traffic signal review or if there is a reported trend of stakeholder concerns regarding intergreen timings at a particular site. However, as intergreen times are carefully calculated based on numerous factors, it is important that they are not modified unnecessarily, as this can cause inconsistency and other operational issues.

Yellow Times Summary Table

Calculated yellow times for different speeds and different grades are provided in Table 2.

When calculating the yellow times, the values are rounded up to nearest 0.5 seconds based on the first decimal point. Examples:

- 5.049 rounds to 5.0, therefore use 5.0 seconds yellow
- 5.05 rounds to 5.1, therefore use 5.5 seconds yellow
- 5.549 rounds to 5.5, therefore use 5.5 seconds yellow
- 5.55 rounds to 5.6, therefore use 6.0 seconds yellow

Table 2: Yellow Time (seconds) for Different Speeds and Different Grades

Speed	Gradient Range	Yellow
15	Uphill grades [3]	3.0
	0.0% to -4.9% [2]	3.0
	-5.0% to -15.0%	3.0
20	Uphill grades [3]	3.0
	0.0% to -4.9% [2]	3.0
	-5.0% to -15.0%	3.0
25	Uphill grades [3]	3.0
	0.0% to -4.9% [2]	3.0
	-5.0% to -13.3%	3.0
	-13.4% to -15.0%	3.5
30	Uphill grades [3]	3.0
	0.0% to -4.9% [2]	3.0
	-5.0% to -9.8%	3.0
	-9.9% to -13.9%	3.5
	-14.0% to -15.0%	4.0
40	Uphill grades [3]	3.0
	0.0% to -4.9% [2]	3.0
	-5.0% to -8.3%	3.5
	-8.4% to -12.0%	4.0
	-12.1% to -14.6%	4.5
	-14.7% to -15.0%	5.0
45 (Right Turn Vehicles)	Uphill grades [3]	3.0
	0.0% to -4.9% [2]	3.0
	-5.0% to -5.6%	3.5
	-5.7% to -9.7%	4.0
	-9.8% to -12.6%	4.5
	-12.7% to -14.8%	5.0
	-14.9% to -15.0%	5.5
50	Uphill grades [3]	3.5
	0.0% to -4.9% [2]	3.5
	-5.0% to -7.3%	4.0
	-7.4% to -10.6%	4.5
	-10.7% to -13.1%	5.0
	-13.2% to -15.0%	5.5
60	Uphill grades [3]	4.0
	0.0% to -4.9% [2]	4.0
	-5.0% to -6.6%	4.5
	-6.7% to -9.6%	5.0
	- 9.7% to -11.9%	5.5
	-12.0% to -13.7%	6.0
	-13.8% to -15.0%	6.4
70	Uphill grades [3]	4.5
	0.0% to -4.9% [2]	4.5
	-5.0% to -6.1%	5.0
	-6.2% to -8.8%	5.5
	-8.9% to -10.9%	6.0
	-11.0% to -15.0%	6.4
80	Uphill grades [3]	5.0
	0.0% to -4.9% [2]	5.0
	-5.0% to -5.6%	5.5
	-5.7% to -8.1%	6.0
	-8.2% to -15.0%	6.4
90	Uphill grades [3]	5.5
	0.0% to -4.9% [2]	5.5
	-5.0% to -5.3%	6.0
	-5.4% to -15.0%	6.4

Notes to Table 2:

1. *See "Yellow for Right Turn Vehicles" subsection above for details of how the yellow time for right turn vehicles is determined.*
2. *If the grade of an approach is less than 5.0% downhill (i.e. -5.0%), then grade does not need to be considered for the calculation of yellow time i.e. it will be considered as level (0.0% grade)*
3. *For all uphill approaches, grade does not need to be considered for the calculation of yellow time i.e. they are considered as level (0.0% grade)*

All-Red Time

All-red times are to be calculated from equation A3 in AGTM Part 9. The formula is duplicated here for completeness:

$$t_{ar} = 3.6\ L_C \ /\ V_D$$

where:

t_{ar} = All-red time (s)

L_C = clearance distance between the stop line and furthest point of potential conflict with vehicles or pedestrians of the next phase (m)

V_D = design speed (km/h)

The following guidelines shall be applied in Victoria:

Determination of Clearance Distance

The clearance distance is measured as follows:

- From the centre of the traffic lane of the movement for which the all-red time is being determined
- From the vehicle stop line to the far side of the kerbside lane of the conflicting vehicle movement, or far side of the pedestrian crossing of the conflicting pedestrian movement
- For multiple through lanes, use the longest travel path
- For a single right turn lane, use the distance measured along the painted turn line (if there is one), as shown in Figure 2
- For double or triple right turn lanes, use the distance measured along the outside painted turn line or the longest turning path.

The clearance distance should be measured as accurately as possible to the nearest 0.5 metre.

Typical examples of determining clearance distances are shown in Figures 1 to 4.

Figure 1: Through movement, measure from stop line to far side of pedestrian crossing

Figure 2: Right turn movement, measure from stop line to far side of pedestrian crossing

Figure 3: Through movement, where conflicting pedestrian movement has a late start and is offset by at least 8 m, measure from stop line to far side of kerbside lane.

Figure 4: Through movement, where no conflicting pedestrian movement exists measure from the stop line to far side of kerbside lane.

Design Speed

For normal vehicular through movements, the design speed for calculating the all-red time shall be based on the posted speed limit. However, a lower design speed can be used if site observations show the free flow speeds through the intersection to be less than the speed limit.

For normal vehicular right turn movements, if the posted speed limit is greater than 45 km/h, then a design speed of 45 km/h shall be used, rather than the posted speed limit. If the posted speed limit is less than 45 km/h, then the posted speed limit shall be used as the design speed.

If there is a variable speed limit on an approach, the all-red should normally be programmed to change by time-of-day and day-of-week to match the expected times that the speed limit changes. Where the times of speed limit changes are not consistent (e.g. for school speed zones) the lower speed limit (i.e. higher all-red period) should be applied during the times of uncertainty. For simplicity, where the all-red variation is small or it is not important to minimise lost time, the lower speed limit may be used at all times.

If the intersection is on a raised platform, the design speed for calculating the all-red time should be based on the advisory speed relating to the raised platform.

All-Red for Trams

When through trams operate in the same phase as the parallel vehicle movement, the posted speed limit shall be used as the all-red design speed.

For special tram phases, the all-red time should be calculated based on the following design speeds:

- Exclusive through tram phases: 45 km/h
- E-Class trams along curves: 25 km/h
- Trams through intersections with crossing tram tracks (i.e. H-crossings): 35 km/h.

For the following circumstances, the tram design speed needs to be determined via on-site measurements or advice needs to be sought from the tram operator:

- Turning trams
- On tram bridges across the tram network
- Tram points

All-Red for Bicycles

For exclusive bicycle phases, a design speed of 20 km/h shall be used.

When bicycles operate in the same phase as the vehicle movement (i.e. at the majority of sites where specific bicycle lanterns are not provided), the vehicle posted speed limit shall be used. This is because cyclists can generally stop more quickly than vehicles (due to their lower speeds) and should be able to come to a complete stop within the yellow time (i.e. the all-red time should not be required).

All-Red at Pedestrian Operated Signals

At pedestrian operated signals, the all-red time for the vehicle movement shall be calculated in the same manner as for a signalised intersection with a minimum value of 2 seconds.

At most pedestrian crossings the minimum value of 2 seconds will be used.

At pedestrian operated signals, an all-red time (Solid DONT WALK) of 3.0 seconds shall be provided at the end of the pedestrian movement (before the vehicle movements receive a green signal).

Further guidelines regarding the calculation of all-red times

All-red times are set for each phase rather than each signal group, so the most critical all-red must be determined for each phase.

The all-red should be determined for each movement in the phase to clear all other movements and pedestrians that could start up next. The longest all-red should then be adopted for the phase (unless a special all-red is used as described below). Where all movements in that phase are designed for the same speed, this process simplifies to determining the longest clearance distance.

Where the all-red is substantially different depending on what signal groups start up next, then *Special All-Reds* can be used to vary the all-red period depending on the next phase. The phase all-red timesetting should be set to the value needed for the most common phase transition. *Special All-Reds* would then apply for other phase transitions.

At intersections where the through phases that have different speed zones on opposite approaches (e.g. north approach is 60 km/h and south approach is 50 km/h), the all-red is based on the lower speed zone.

For situations where the starting traffic must cover a significant distance to reach the conflict point, the time taken to cover this distance at the posted speed limit can be subtracted from the all-red time. To be conservative, this start up time should be calculated as the distance divided by the speed limit applying to the starting traffic. This start up time is not applied to starting pedestrian movements and therefore the subtraction of the start up time is irrelevant for most phase transitions.

On-Site Observations

Notwithstanding the values determined via the process described above, the all-red values derived may be reviewed as part of a periodic traffic signal review or if there is a reported trend of stakeholder concerns regarding intergreen timings at a particular site. However, as intergreen times are carefully calculated based on numerous factors, it is important that they are not modified unnecessarily, as this can cause inconsistency and other operational issues.

All-Red Times Summary Table

Calculated all-red times for different speeds and clearance distances are provided in Table 3.

When calculating the all-red times, the values are rounded up to nearest 0.5 seconds based on the first decimal point. Examples:

- 1.02 rounds to 1.0, therefore use 1.0 seconds all-red
- 1.08 rounds to 1.1, therefore use 1.5 seconds all-red

Table 3: All-Red Times for Different Design Speeds and Clearance Distances

All Red	Clearance distance (m) for different design speeds (km/hr)										
	15	**20**	**25**	**30**	**40**	**45 (Right Turn Vehicles)**	**50**	**60**	**70**	**80**	**90**
1	0 - 4	0 - 5.5	0 - 7	0 - 8.5	0 - 11.5	0 - 13	0 - 14.5	0 - 17	0 - 20	0 - 23	0 - 26
1.5	4.5 - 6	6 - 8.5	7.5 - 10.5	9 - 12.5	12 - 17	13.5 - 19	15 - 21.5	17.5 - 25.5	20.5 - 30	23.5 - 34	26.5 - 38.5
2	6.5 - 8.5	9 - 11	11 - 14	13 - 17	17.5 - 22.5	19.5 - 25.5	22 - 28	26 - 34	30.5 - 39.5	34.5 - 45.5	39 - 51
2.5	9 - 10.5	11.5 - 14	14.5 - 17.5	17.5 - 21	23 - 28	26 - 31.5	28.5 - 35	34.5 - 42	40 - 49.5	46 - 56.5	51.5 - 63.5
3	11 - 12.5	14.5 - 16.5	18 - 21	21.5 - 25	28.5 - 33.5	32 - 38	35.5 - 42	42.5 - 50.5	50 - 59	57 - 67.5	64 - 76
3.5	13 - 14.5	17 - 19.5	21.5 - 24.5	25.5 - 29.5	34 - 39	38.5 - 44	42.5 - 49	51 - 59	59.5 - 69	68 - 78.5	76.5 - 88.5
4	15 - 16.5	20 - 22	25 - 28	30 - 33.5	39.5 - 44.5	44.5 - 50.5	49.5 - 56	59.5 - 67	69.5 - 78.5	79 - 89.5	89 - 100
4.5	17 - 18.5	22.5 - 25	28.5 - 31.5	34 - 37.5	45 - 50.5	51 - 56.5	56.5 - 63	67.5 - 75.5	79 - 88	90 - 100	
5	19 - 21	25.5 - 28	32 - 35	38 - 42	51 - 56	57 - 63	63.5 - 70	76 - 84	88.5 - 98		
5.5	21.5 - 23	28.5 - 30.5	35.5 - 38.5	42.5 - 46	56.5 - 61.5	63.5 - 69	70.5 - 77	84.5 - 92	98.5 - 100		
6	23.5 - 25	31 - 33.5	39 - 42	46.5 - 50	62 - 67	69.5 - 75.5	77.5 - 84	92.5 - 100			
6.5	25.5 - 27	34 - 36	42.5 - 45	50.5 - 54.5	67.5 - 72.5	76 - 81.5	84.5 - 90.5				
7	27.5 - 29	36.5 - 39	45.5 - 48.5	55 - 58.5	73 - 78	82 - 88	91 - 97.5				
7.5	29.5 - 31	39.5 - 41.5	49 - 52	59 - 62.5	78.5 - 83.5	88.5 - 94	98 - 100				
8	31.5 - 33.5	42 - 44.5	52.5 - 55.5	63 - 67	84 - 89	94.5 - 100					
8.5	34 - 35.5	45 - 47	56 - 59	67.5 - 71	89.5 - 94.5						
9	36 - 37.5	47.5 - 50	59.5 - 62.5	71.5 - 75	95 - 100						
9.5	38 - 39.5	50.5 - 53	63 - 66	75.5 - 79.5							
10	40 - 41.5	53.5 - 55.5	66.5 - 69.5	80 - 83.5							
10.5	42 - 43.5	56 - 58.5	70 - 73	84 - 87.5							
11	44 - 46	59 - 61	73.5 - 76.5	88 - 92							
11.5	46.5 - 48	61.5 - 64	77 -80	92.5 - 96							
12	48.5 - 50	64.5 - 66.5	80.5 - 83.5	96.5 - 100							

Appendix G.5.1 – Pedestrian Walk Time

The walk time is intended to ensure that the pedestrian, once started, will continue crossing the carriageway, rather than return to the starting point (i.e. the pedestrian should be "committed" to completing the crossing). In the case of a divided carriageway with a median of sufficient width, the walk time is intended to enable a pedestrian to be able to reach a point 1 m past the median, and so be able to complete their crossing within the clearance interval.

Within Victoria, the formula from AGTM Part 9 has been modified to include a pedestrian reaction time (t_{pr}).

The formula is as follows:

$$t_{pw} = t_{pr} + \frac{L_{pw}}{v_{pw}}$$

where

t_{pw} = pedestrian walk time (s)

t_{pr} = pedestrian reaction time (s); 2.0 s is generally used

L_{pw} = pedestrian walk distance (m)

v_{pw} = pedestrian walking speed (m/s)

The walk time is calculated in two different ways, depending on the carriageway layout.

- Layout Type A includes:
    - Single carriageways (one-way or two-way) – see Figure 5
    - Divided carriageways with a median that is not wide enough to store pedestrians (i.e. less than 2.5 m between face of kerbs), or if there is no push-button on the median – see Figure 6
    - Staggered pedestrian crossings on divided carriageway (i.e. each stage of the crossing is treated as a separate crossing) – see Figure 7
- Layout Type B consists of a divided carriageway with a median that is wide enough to store pedestrians (i.e. greater than 2.5 m between face of kerbs) – see Figure 8

The walk time is determined as follows:

- Layout Type A
    - Using a walk speed of 1.2 m/s (refer to Figure G6 in AGTM Part 9)
    - The walk distance is measured from kerb line to kerb line
    - A minimum time of 4 seconds
    - A maximum time of 8 seconds, except in special circumstances as defined below.
- Layout Type B
    - Using a walk speed of 1.2 m/s (refer to Figure G6 in AGTM Part 9)
    - The walk distance is defined as the distance across the widest carriageway plus the median width plus one metre past the median
    - A maximum walk time of 15 seconds is generally applied.

Pedestrian walk distances should be measured as accurately as possible to the nearest 0.5 metre.

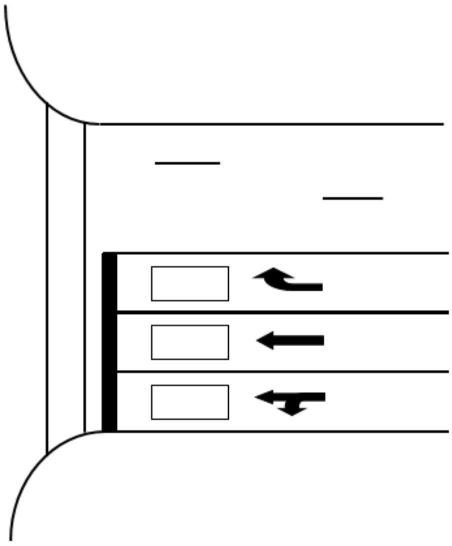

Figure 5: Layout Type A – single carriageways (one-way or two-way)

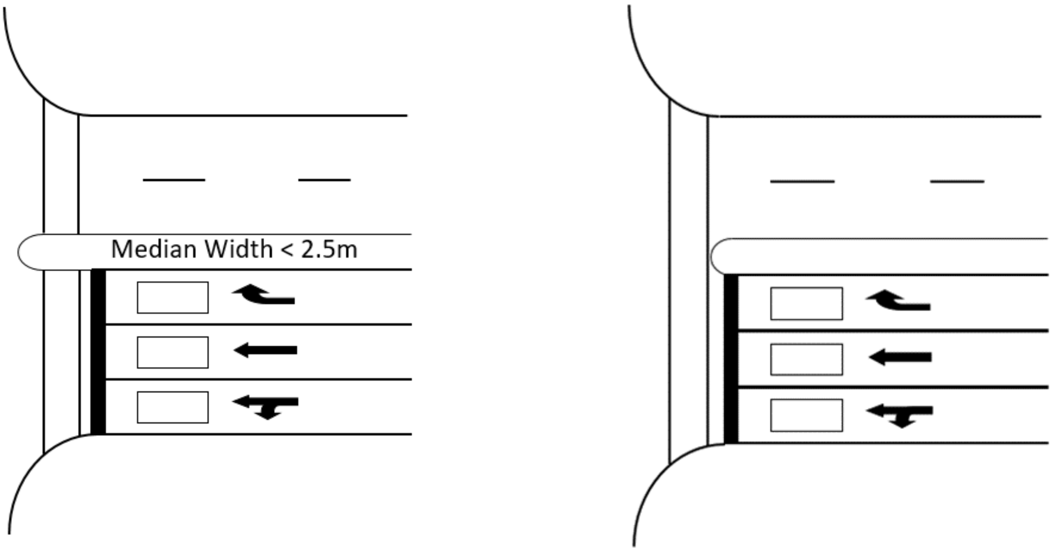

Figure 6: Layout Type A – divided carriageways with median that is not wide enough to store pedestrians (i.e. less than 2.5 m between face of kerbs), or if there is no push-button on the median

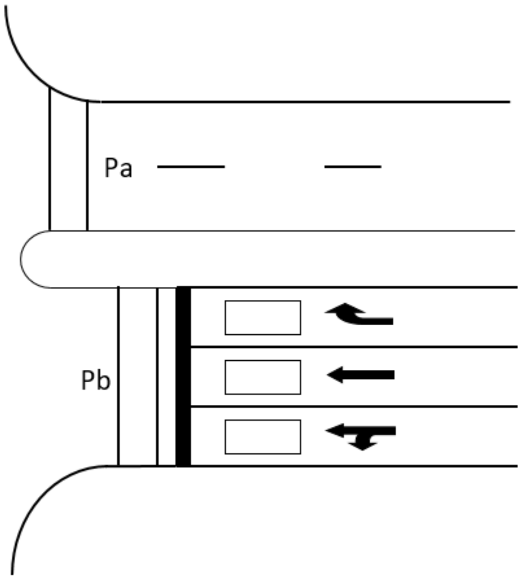

Figure 7: Layout Type A – staggered pedestrian crossings on divided carriageway (i.e. each stage of the crossing is treated as a separate crossing)

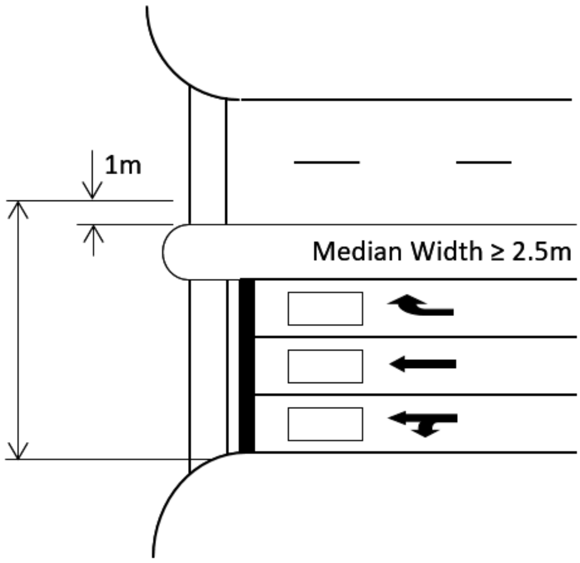

Figure 8: Layout Type B

A maximum walk time setting is employed to reduce the impact on the capacity of critical intersections during peak periods (e.g. reduce the impact of long walk times associated with minor vehicle movements). Long walk times can also significantly affect the capacity of an intersection in off peak periods where shorter cycle times may be desirable.

At school crossing sites where a crossing supervisor is in attendance, the supervisor is obliged to wait until he or she considers it safe, step onto the carriageway, and blow a whistle to start the children onto the carriageway. To cater for this "starting delay", the walk time may be increased by 2 seconds, or in some cases, by 4 seconds.

Near shopping centres, railway stations, schools, etc., the situation can arise where there is a “starting delay” caused by high number of pedestrians thereby causing pedestrians at the rear being delayed by those in front. This effect should be lessened at such situations, if possible, using the following methods:

- Implementing wide cross walks, and/or
- An increase in the walk time by, say, 2 seconds. This should generally be sufficient to ameliorate the problem.

An alternative method of achieving this at times of high pedestrian demand is to allow the walk time to stretch under Masterlink operation. For instance, W1 = 0 or W1 = 12 where local walk time is 8 seconds.

Appendix G.5.3 – Pedestrian Clearance Time

The pedestrian clearance time (flashing red display) is intended to be sufficient to allow a pedestrian who commences crossing at the end of the walk time to safely reach the far kerb or median refuge.

The total clearance time is determined from formula A5 in AGTM Part 9. The formula is duplicated here for completeness:

$$t_{pc} = \frac{L_{pc}}{v_{pc}}$$

where

t_{pc} = total pedestrian clearance time (s)

L_{pc} = pedestrian clearance distance (m)

v_{pc} = pedestrian walking speed (m/s)

In Victoria, the pedestrian walking speed is taken to be 1.5 m/s for clearance time, as per AGTM Part 9.

The pedestrian clearance distance is determined as follows:

- single carriageway – the kerb line to kerb line crossing distance
- divided carriageways (median less than 2.5 m*) – where the median is not wide enough to store pedestrians, or if there is no push-button on the median, then the clearance distance shall be the total kerb line to kerb line crossing distance, including the median
- divided carriageways (median greater than 2.5 m*) – the kerb line to kerb line width of the widest carriageway.

Pedestrian clearance distances should be measured as accurately as possible to the nearest 0.5 metre.

At locations where there are a high proportion of disabled or elderly pedestrians, (i.e. outside hospitals or elderly citizens homes or clubs), it may be considered appropriate to provide an additional 2 seconds clearance time, or to recalculate the clearance time with a lower walking speed (1.0 to 1.2 m/s).

The minimum total clearance time is 3 seconds.

The total pedestrian clearance time (t_{pc}), can be split into Clearance 1 (t_{C1}) and Clearance 2 (t_{C2}).

$$t_{pc} = t_{C1} + t_{C2}$$

Clearance 1 is not permitted to overlap the intergreen, while Clearance 2 is permitted to overlap the intergreen. For this purpose, the intergreen includes the Early Cut Off (ECO) time, if any.

Clearance 2 is calculated as follows:

- Where right turners or significant numbers of left turners can filter across the pedestrian movement during the intergreen period, Clearance 2 is set to zero and the clearance does not overlap the intergreen.

$$t_{C2} = 0$$

- Allowing the clearance time to overlap the intergreen (i.e. Clearance 2 > 0) can be considered when:
    - there is no conflict between pedestrians and right turn vehicles (e.g. the right turn is fully controlled or banned); and
    - there is no conflict between pedestrians and left turn vehicles (e.g. the left turn is through a slip lane or banned); or
    - the volume of left turning vehicles that turn through the pedestrian is low (e.g. less than approximately 100 vehicles/hour) after careful consideration of the risks and benefits.
- Where Clearance 2 is provided, there must be a period of steady Don't Walk time (t_{sw}) prior to commencement of the next conflicting green movement. The minimum steady Don't Walk time should desirably be 4 seconds, but 3 seconds can be considered, depending on the movements that are likely to start next.

$$t_{C2} = \text{Intergreen} - t_{sw}$$

Clearance 1 can then be calculated as follows:

$$t_{C1} = t_{pc} - t_{C2}$$

The above calculations ensure that the potential for conflict between pedestrians and vehicles filtering during through the intergreen is minimised.

*Note: The width of 2.5 m is based on guidelines within *Austroads Guide to Road Design Part 4a: Unsignalised and Signalised Intersections*, which states that the "Desirable minimum width" of a median which has the function "Shelter pedestrians and traffic signals" is 2.5 m.

In previous Victorian guidelines, it was stated that 1.8 m was sufficient width to act as a pedestrian refuge. Consequently, there are a number of existing intersections which have medians between 1.8 m and 2.5 m wide, and their pedestrian times were calculated as if the median was sufficient to act as a refuge. For these intersections, it is **not** intended that the pedestrian times be recalculated to accord with the latest standard, because pedestrians currently using the intersections may be accustomed to the current operation.

Appendix H – Pedestrian Push-button Location

The push-button assembly should be placed on the side of the pole with the face parallel to the crossing and the arrow pointing horizontally towards the crossing. In Victoria, it is also acceptable to place the push-button on the approach side of the pole with the face perpendicular to the crossing and the arrow pointing upwards. Further guidance on the placement is given in:

- AS 1742.14 and DTP Supplement to AS 1742.14.
- DTP Traffic Engineering Manual Volume 3, Part 2-19, Accessibility (DDA) Guidelines for Road Infrastructure.

VICTORIA State Government

Department of Transport and Planning