TRANSPORTATION SERVICES STANDARD OPERATING PROCEDURE

TRAFFIC SYSTEMS OPERATIONS

Pedestrian Timing at Signalised Intersections

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Transportation Services Division

Traffic Systems Operations
Traffic Management

DOCUMENT CONTROL

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Amendment History

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2.0	2019/05/06	Section 4.6 amended to include a fourth type of PPP and the types of PPP's were renamed from numerical to alphabetical.

APPROVAL

The final version of this document (Final) dated 2018/11/15 was approved by the Safety and Mobility Committee on 2018/11/15. .

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Abbreviations

APS	Accessible Pedestrian Signal
ATO	Area Traffic Operation
CCG	Canadian Capacity Guide (for Signalised Intersections)
FDW	Flashing Don’t Walk
LPI	Leading Pedestrian Interval
PCS	Pedestrian Countdown Signal
PED	Pedestrian
PPP	Pedestrian Priority Phasing
s	second
SCOOT	Split Cycle Offset Optimisation Technique
SSZ	Seniors Safety Zone
TAC	Transportation Association of Canada
TBOP	Traffic Branch Operating Practice
TCS	Traffic Control Signal
TM	Traffic Management
TSO	Traffic Systems Operations
VZP	Vision Zero Projects

Glossary

Area Traffic Operations (ATO) A unit responsible for speeding complaints, parking complaints, requests for signs related to stopping, parking, all way stops , traffic calming (e.g. speed humps), driveway and other sight obstructions (e.g. fences, hedges).

Assistive Devices Technical aids, communication devices, or medical aids modified or customized for use to increase, maintain or improve the functional ability of a person with disability including but not limited to wheelchairs, walker, white canes, note-taking devices, portable magnifiers, recording machines, assistive listening devices, personal oxygen tanks and devices for grasping. Assistive devices may accompany the customer or already be on the premises for the purpose of assisting persons with disabilities in carrying out activities or in accessing the services.

Capacity The maximum sustainable discharge rate for traffic past a given point for a specific time period and specific geometric conditions. Typically a one hour flow rate.

Delay The additional travel time experienced by a driver, passenger, or pedestrian.

Flashing Don't Walk (FDW) A reasonable time provided for the pedestrian who entered the crosswalk at the very last moment of the walk interval to reach a designated pedestrian refuge. It is also known as the "pedestrian clearance interval".

Older Pedestrians Pedestrians 65 years of age or older.

Pre-emption A type of operation in which the normal operation of traffic signals is manipulated to provide preferential treatment to rail, emergency and transit vehicles. Upon actuation of a pre-defined pre-emption, the traffic signal controller terminates the current phase and serves a pre-defined pre-emption phase.

Signal Coordination The ability to coordinate multiple signalised intersections to enhance the operation of one or more directional movements in a system. Also referred to as "Signal Optimisation".

Senior Safety Zones (SSZ) Areas with higher volumes of older adult pedestrians and higher risk of collision which will feature changes intended to improve pedestrian safety, such as increased crossing time, reduced crossing distance, lower speed limits, improved street lighting, etc.

Traffic Systems, Operations (TSO) A unit within the City's TM section, staffed by City employees who are responsible for day-to-day traffic systems operations. There are three groups within TSO: Congestion Management, Traffic Systems and Vision Zero. TSO provides ATM coverage staff in the TOC.

Vision Zero Project (VZP) A unit within the City's Project Design and Management section that administers the Vision Zero Road Safety Plan, by introducing, supporting and co-ordinating traffic safety programs and mitigating measures.

1. INTRODUCTION

1.1. Background

Pedestrian signal timing methods are designed to provide enough time for pedestrians to safely cross the street. When the "Flashing Don't Walk" (FDW) feature was introduced by the Municipality of Metropolitan Toronto in 1994, Metro Transportation calculated pedestrian signal timing based on a standard walk speed of 1.25 metres/second (m/s). Metro Transportation's Traffic Branch Operating Practice (TBOP) #19 stipulated that a lower walk speed of 1.05 m/s could be used "when site specific observations indicate that the mix of people requires a slower crossing speed". The method required that 5/8^{ths} of the crossing time be provided in the "Flashing Don't Walk" (FDW) display with the remaining 3/8^{ths} in the WALK display.

In 2001 Toronto Transportation Services standardised walk speeds at 1.2 m/s and 1.0 m/s with the 1.0 m/s walk speed being used at Accessible Pedestrian Signals and at all intersections where there is a significant number of any of the following pedestrians:

- senior citizens
- school children under the age of 12 years
- disabled persons
- people with walking aids, strollers and prams

In 2007 Transportation Services adopted a modified form of the Canadian Capacity Guide (CCG) Method that is based on the provision of an absolute minimum WALK duration of 7.0 s followed by a minimum pedestrian clearance (FDW) duration equal to the time required to cross the entire length of crosswalk at a 1.2 m/s walk speed. The total WALK plus FDW must be adequate for a 1.0 m/s walk speed across the entire crossing. The philosophy behind the Modified CCG method is that pedestrians must be provided with enough time to complete the crossing during the FDW interval. This methodology replaced Metro Transportation's 3/8ths - 5/8ths methodology.

The 2007 methodology specified that a value greater than 7.0 s WALK can be used in the following situations:

- At locations where pedestrian volumes are high and pedestrian storage is an issue
- At locations with Accessible Pedestrian Signals (APS)
- At intersections where there is significant number of any of the following pedestrians - senior citizens; school children under the age of 12 years; disabled persons and people with walking aids, strollers and prams

Implementation of the new methodology began on January 1, 2008. As of October 17, 2018, 97% of the intersections in have been upgraded to the current standard.

In 2015, Toronto Transportation adopted the following policy in its *Traffic Signal Operations – Policies and Strategies:*

> The pedestrian minimum WALK and clearance intervals shall be determined in accordance with the modified form of the CCG method. The method is based on the provision of a minimum WALK duration of 7.0 s followed by minimum pedestrian clearance (i.e. Flashing Don't Walk – FDW) duration equal to a 1.2 m/s walk speed across the entire pedestrian crossing. The total WALK plus FDW

interval should equal to a 1.0 m/s walk speed across the entire crossing. The FDW does not extend into the amber or all-red interval.

The 1.0 m/s walk speed must be used to accommodate the general population. The ATO can reduce this 1.0 m/s walk speed across the entire crossing to accommodate older pedestrians or pedestrians using assistive devices. A value greater than the absolute minimum of 7.0 s in the following situations:

- Where pedestrian volumes are high and/or pedestrian storage is an issue (e.g. in the downtown core, city centres or at special events) which results in pedestrian queuing
- Where Accessible Pedestrian Signals (APS) are installed
- Where the pedestrian WALK plus FDW interval equal walk speeds of
  - 0.9 m/s in cases where at least 20% of pedestrians crossing the signalised intersection during a two hour study period are older pedestrians (65 years of age or older)
  - 0.8 m/s in cases where at least 20% of pedestrians crossing the signalised intersection during a two hour study period use assistive devices for mobility.

The purpose of this document is to update the 2007 methodology to provide guidance to City staff and consultants on the procedure to be adopted when designing pedestrian signal timings at signalised intersections.

2. METHODOLOGY

2.1. Modified CCG Method

The modified methodology provides for two walk speeds, v_{fdw} related to the FDW duration and v_{tot} related to the combined WALK plus FDW durations. The pedestrian crossing time, T_{ped} (in seconds) is calculated using Equation 1:

$$T_{ped} = t_w + t_{fdw} \qquad \text{(Equation 1)}$$

If $t_{wmin} + d_w / v_{fdw} \geq d_w / v_{tot}$, then $t_{fdw} = d_w / v_{fdw}$
If $t_{wmin} + d_w / v_{fdw} < d_w / v_{tot}$, then $t_{fdw} = (d_w / v_{tot}) – t_{wmin}$

Where:

t_w is the time (s) during which the WALK signal is displayed
t_{fdw} is the time (s) during which the FDW signal is displayed
T_{ped} is the time (s) to complete the entire crossing during the combined WALK and FDW
t_{wmin} is the minimum time (s) during which the WALK signal is displayed
d_w is the pedestrian crossing distance (m)
v_{fdw} is walk speed during the FDW (m/s)
v_{tot} is walk speed during the combined WALK and FDW (m/s)

The above equations represent the general formula for determining pedestrian crossing times in Toronto. In order to cater for all segments of the population, three situations have been defined as follows:

- Type A caters for the general able-bodied population and is based on an overall pedestrian crossing speed of 1.0 m/s, a FDW pedestrian crossing speed of 1.2 m/s and a minimum WALK duration of 7.0 s.
- Type B caters for the older pedestrians and is based on an overall pedestrian crossing speed of 0.9 m/s, a FDW pedestrian crossing speed of 1.1 m/s and a minimum WALK duration of 8.0 s.
- Type C caters for the pedestrians using assistive devices and is based on an overall pedestrian crossing speed of 0.8 m/s, a FDW pedestrian crossing speed of 1.0 m/s and a minimum WALK duration of 9.0 s.

There are many signalised intersections where, due to capacity requirements, the WALK interval can be greater than the minimum for Type A, Type B or Type C.

The following examples show how the three types can be applied.

2.2. Pedestrian Crossing Time - Types

2.2.1. Type A - Timing for Usual Conditions

Type A provides for a minimum WALK time of 7.0 s and an overall walk speed of 1.0 m/s (based on 1.2 m/s walk speed within the FDW duration).

2.2.1.1. Examples (Using Calculation)

Case 1

Given: t_{wmin} = 7 s $d_{w\,=}$ 48.4 m v_{fdw} = 1.2 m/s v_{tot} = 1.0 m/s
Then: $t_{wmin} + d_w / v_{fdw\,=}$ 7 + 48.4 / 1.2 = 47 s
d_w / v_{tot}= 48.4 / 1.0 = 48 s
Since ($t_{wmin} + d_w / v_{fdw}$) is less than (d_w / v_{tot}), then t_{fdw} = (d_w / v_{tot}) - t_{wmin} = 48 – 7 = 41 s
Therefore, use t_w = 7 s, t_{fdw} = 41 s
$T_{ped} = t_w + t_{fdw}$ = 7 + 41 = 48 s
Overall walk speed = d_w / T_{ped} = 48.4 m / 48 s = 1.0 m/s (to single decimal)

Case 2

Given: t_{wmin} = 7 s $d_{w\,=}$ 36.0 m v_{fdw} = 1.2 m/s v_{tot} = 1.0 m/s
Then: $t_{wmin} + d_w / v_{fdw}$ = 7.0 + 36.0 / 1.2 = 37 s
d_w / v_{tot}= 36.0 / 1.0 = 36 s
Since ($t_{wmin} + d_w / v_{tot}$) is greater than $d_w / v_{tot,}$ then $t_{fdw} = d_w / v_{fdw}$ = 36/1.2 = 30 s
Therefore, use t_w = 7 s, t_{fdw} = 30 s
$T_{ped} = t_w + t_{fdw}$ = 7 + 30 = 37 s
Overall walk speed = d_w / T_{ped} = 36.0/37 = 1.0 m/s (to single decimal)

2.2.1.2. Examples (Using Tables):

Rather than calculating the values using the Equation 1, the look-up table (Appendix A) for Type A can be used. WALK and FDW values are based on a FDW speed of 1.2 m/s for crossing distances of 6.0 m to 54.6 m. The table is based on rounding up the calculated FDW component if the fractional values are equal or greater than 0.5 s and rounding down if the fractional values are less than 0.5 s.

Case 1

For t_{wmin} = 7 s, d_w = 22.4 m, v_{fdw} = 1.2 m/s, v_{tot} = 1.0 m/s
From Table: t_{ped} = 22 s, t_w = 7 s, t_{fdw} = 19 s, T_{ped} = 26 s
Therefore, use t_w = 7 s and t_{fdw} = 19 s

< --------------------T_{ped} --------------------- >
< ------t_w------ >< ---------t_{fdw} -------------- >

Walk (7 s)	FDW (19 s)

Overall walk speed = d_w / T_{ped} = 22.4/26 = 0.9 m/s (to single decimal)

Case 2

For t_{wmin} = 7 s, d_w = 48.8 m, v_{fdw} = 1.2 m/s, v_{tot}= 1.0 m/s
From Table: t_{ped} = 49 s, t_w = 7 s, t_{fdw} = 42 s, T_{ped} = 49 s
Therefore, use t_w = 7 s and t_{fdw} = 42 s

<--------------------------------- T_{ped} -------------------------- >
< ------t_w---- >< ------------t_{fdw} ------------------------------ >

Walk (7 s)	FDW (42 s)

Overall walk speed = d_w / T_{ped} = 48.8/49 = 1.0 m/s (to single decimal)

2.2.2. Type B - Timing for Older Pedestrians

Type B provides for minimum WALK time of 8.0 s (t_{wmin} = 8 s) and an overall walk speed of 0.9 m/s (based on 1.1 m/s walk speed within the FDW duration).

2.2.2.1. Examples (Using Calculation)

Case 1

Given: t_{wmin} = 8 s, d_w = 48.4 m, v_{fdw} = 1.1 m/s, v_{tot} = 0.9 m/s
Then: t_{wmin} + d_w / v_{fdw} = 8 + 48.4/1.1 = 52 s
d_w / v_{tot} = 48.4/0.9 = 54 s
Since (t_{wmin} + d_w / v_{fdw}) is less than d_w / v_{tot}, then t_{fdw} = (d_w / v_{tot}) - t_{wmin} = 54 – 8= 46 s
Therefore, use t_w = 8, t_{fdw} = 46 s
T_{ped} = t_w + t_{fdw} = 8 + 46 = 54 s
Overall walk speed = d_w / T_{ped} = 48.4/54 = 0.9 m/s (to single decimal).

Case 2

Given: t_{wmin} = 8 s, d_w = 30.0 m, v_{fdw} = 1.1 m/s, v_{tot} = 0.9 m/s
Then: t_{wmin} + d_w / v_{fdw} = 8 + 30/1.1 = 35 s
d_w / v_{tot} = 30/0.9 = 33 s
Since (t_{wmin} + d_w / v_{fdw}) is greater than d_w / v_{tot}, then t_{fdw} = d_w / v_{fdw} = 30/1.1 = 27 s
Therefore, use t_w = 8, t_{fdw} = 27 s
T_{ped} = t_w + t_{fdw} = 8 + 27 = 35 s
Overall walk speed = d_w / T_{ped} = 30.0/35 = 0.9 m/s (to single decimal)

2.2.2.2. Examples (Using Table)

Rather than calculating the values using Equation 1, the look-up table (Appendix A) for Type B can be used. WALK and FDW values are based on a FDW speed of 1.1 m/s for crossing distances of 6.0 m to 54.6 m. The table is based on rounding up the calculated FDW component if the fractional values are equal or greater than 0.5 s and rounding down if the fractional values are less than 0.5 s.

Case 1

For t_{wmin} = 8 s, d_w = 22.4 m, v_{fdw} = 1.1 m/s, v_{tot} = 0.9 m/s
From Table: t_{ped} = 25 s, t_w = 8 s, t_{fdw} = 20 s, T_{ped} = 28 s
Therefore, use t_w = 8 s and t_{fdw} = 20 s

< -------------------- T_{ped} ----------------- >
< ------t_w---- >< -----------t_{fdw}------------ >

Walk (8 s)	FDW (20 s)

Overall walk speed = d_w / T_{ped} = 22.4/28 = 0.8 m/s (to single decimal)

Case 2

For t_{wmin} = 8 s, d_w = 48.8 m, v_{fdw} = 1.1 m/s, v_{tot} = 0.9 m/s
From Table: t_{ped} = 54 s, t_w = 8 s, t_{fdw} = 46 s, T_{ped} = 54 s
Therefore, use t_w = 8 s and t_{fdw} = 46 s

< ------------------------------- T_{ped} --------------------------- >
< ------t_w----- >< -----------t_{fdw}------------------------------- >

Walk (8 s)	FDW (46 s)

Overall walk speed = d_w / T_{ped} = 48.8/54 = 0.9 m/s (to single decimal)

2.2.3. Type C - Timing for Pedestrians Using Assistive Devices

Type C provides for minimum WALK time of 9.0 s and an overall walk speed of 0.8 m/s (based on 1.0 m/s walk speed within the FDW duration).

2.2.3.1. Examples (Using Calculation)

Case 1

Given: t_{wmin} = 9 s, d_w = 48.4 m, v_{fdw} = 1.0 m/s, v_{tot} = 0.8 m/s
Then: t_{wmin} + d_w / v_{fdw} = 9 + 48.4/1.0 = 57 s
d_w / v_{tot} = 48.4/0.8 = 61 s
Since (t_{wmin} + d_w / v_{fdw}) is less than (d_w / v_{tot}), then t_{fdw} = d_w / v_{tot} - t_{wmin} = 61 – 9= 52 s
Therefore, use t_w = 9, t_{fdw} = 52 s
T_{ped} = t_w + t_{fdw} = 9 + 52 = 61 s
Overall walk speed = 48.4/61 = 0.8 m/s (to single decimal)

Case 2

Given: t_{wmin} = 9 s, d_w = 22.4 m, v_{fdw} = 1.0 m/s, v_{tot} = 0.8 m/s
Then: t_{wmin} + d_w / v_{fdw} = 9 + 22.4/1.0 = 31 s

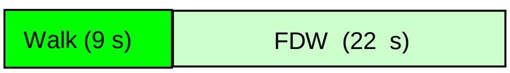
d_w / v_{tot} = 22.4/0.8 = 28 s
Since (t_{wmin} + d_w / v_{fdw}) is greater than (d_w / $v_{tot,}$) then t_{fdw} = d_w / v_{fdw} = 22.4/1.0 = 22 s
Therefore, use t_w = 9, t_{fdw} = 22 s
T_{ped} = t_w + t_{fdw} = 9 + 22 = 31 s
Overall walk speed = 22.4/31 = 0.7 m/s (to single decimal)

2.2.3.2. Examples (Using Table)

Rather than calculating the values using Equation 1, the look-up table (Appendix A) for Type C can be used. WALK and FDW values are based on a FDW speed of 1.0 m/s for crossing distances of 6.0 m to 54.6 m. The table is based on rounding up the calculated FDW component if the fractional values are equal or greater than 0.5 s and rounding down if the fractional values are less than 0.5 s.

Case 1

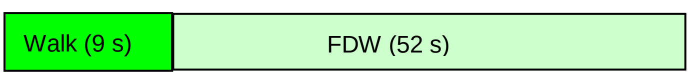
For t_{wmin} = 9 s, d_w = 22.4 m, v_{fdw} = 1.0 m/s, v_{tot} = 0.8 m/s
From Table: t_{ped} = 28 s, t_w = 9 s, t_{fdw} = 22 s, T_{ped} = 31 s
Therefore, use t_w = 9 s and t_{fdw} = 22 s
< -------------------- T_{ped} -------------------- >
< ------t_w---- >< ------------t_{fdw}------------- >



Overall walk speed = d_w / T_{ped} = 22.4/31 = 0.7 m/s (to single decimal)

Case 2

For t_{wmin} = 9 s, d_w = 48.8 m, v_{fdw} = 1.0 m/s, v_{tot} = 0.8 m/s
From Table: t_{ped} = 61 s, t_w = 9 s, t_{fdw} = 52 s, T_{ped} = 61 s
Therefore, use t_w = 9 s and t_{fdw} = 52 s
< -------------------------------- T_{ped} -------------------------- >
< ------t_w------ >< ----------t_{fdw}------------------------------ >



Overall walk speed = d_w / T_{ped} = 48.4/61 = 0.8 m/s (to single decimal)

3. REQUESTS

Requests for walk speed reductions can come from the Vision Zero Projects (VZP) unit as part of a Seniors Safety Zone (SSZ) initiative or from Area Traffic Operations (ATO) after investigation of a public request. The former is categorized as proactive and the latter as reactive in nature.

3.1. Requests from Vision Zero Projects (VZP)

The VZP considers three factors for the creation of a SSZ - the number of "Killed or Seriously Injured" pedestrians (KSIs), proximity to seniors homes (e.g. within 750 m distance), and the number of senior citizen crossings. Generally, a SSZ includes one or two signalised intersections.

If a SSZ is proposed by VZP (proactive), VZP would advise Traffic Systems Operations (TSO) who would then arrange for signal timing changes based on a walk speed of 0.9 m/s.

3.2. Requests from Area Traffic Operations (ATO)

When ATO receives a request for a reduced walk speed at a signalised intersection, ATO checks the list of SSZs approved by VZP. If the intersection is on the SSZ list and the reduced walk speed has not been implemented, ATO checks with TSO for an update and then responds accordingly. If the intersection is not on the SSZ list, then ATO conducts an investigation.

3.3. Field Investigation

The purpose of the two hour field investigation is to confirm the need to reduce walk speeds. Overall walk speeds may be reduced as follows:

- 0.9 m/s when 20% or more of the pedestrians are older.
- 0.9 m/s when older pedestrians and pedestrians with mobility challenges or with low or no vision make a combined total of at least 20% of total pedestrians, and older pedestrians comprising more than 10% of the total pedestrians.
- 0.8 m/s when 20% of pedestrians use assistive devices for mobility.
- 0.8 m/s when pedestrians with mobility challenges or with low or no vision make a combined total of at least 20% of total pedestrians, and pedestrians with mobility challenges or with low or no vision comprising more than 10% of the pedestrians.

ATO staff must conduct manual counts for the intersection to determine the percentage of pedestrians that fall into the older pedestrians or pedestrians with mobility challenges or with low or no vision categories. The study should be conducted during the period being requested and should be of a minimum duration of two hours.

4. OTHER CONSIDERATIONS

4.1. Signal Coordination

When lowering walk speeds, intersections operating close to vehicle capacity (e.g. most intersections in downtown Toronto) will exhibit substantial amount of vehicle delays. Increasing the cycle length to accommodate a reduced walk speed of 0.8 m/s or 0.9 m/s may have negative impacts on traffic flow. A longer pedestrian crossing time can increase the green interval and overall phase time for that approach. The longer phase will require either a reduction in other phase times, resulting in longer delays on those approaches, or an increase in the cycle length. An increase in cycle length may require changes to nearby signals if the affected signal is part of a coordinated route. In such a case, the entire corridor would need to be re-analyzed using a signal optimization software such as Synchro.

4.2. Timing Consistency

Even though a study may show that a reduced walk speed is required during a specific timing plan, the reduced walk speed must be implemented in all timing plans, for all directions of the intersection. This is required to manage pedestrian expectations.

4.3. Different WALK & FDW Values for the Same Movement

If there is a difference of more than five metres between two crossings in the same direction, then "split" pedestrian timings may be provided. For example with Type A, an intersection where the north leg has a 30.0 m crossing distance and the south leg has a 20.0 m crossing distance, would have split pedestrian timings. For an overall walk speed of 1.2 m/s, the north leg requires a minimum t_w duration of 7.0 s and a t_{fdw} duration of 25.0 s whereas the south leg requires a minimum t_w duration of 7.0 s and t_{fdw} duration of 17.0 s.

Assuming that there are no left turn green arrows, the WALK display for both legs will start at the same time. Even though the FDW durations are different, the FDW for the north leg and the FDW for the south leg will end at the same time. Therefore, the actual durations for the north leg will be 7.0 s WALK and 25.0 s FDW whereas the durations for the south leg will be 15.0 s WALK and 17.0 s FDW.

4.4. Split WALK Times during One-directional Arrow

Split walks are also provided where left-turn arrows are installed. For example, an intersection where the northbound left-turn arrow is called, the north/south WALK on the west leg is held back until the beginning of the north/south green. However, the north/south WALK on the east leg is active at the beginning of the northbound left-turn arrow. The minimum WALK time is provided on the west leg, and FDW on both legs terminate at the same time on the onset of the north-south amber display.

4.5. Split WALK Times during Two-directional Arrows

Split walks are also provided where two-directional left-turn arrows are installed. For example, an intersection where the westbound left-turn green arrow is displayed for a shorter period than the eastbound left-turn green arrow, the east-west WALK on the south side starts earlier than the east-west WALK on the north side. However, the FDW on both legs terminate at the same time at the onset of the east-west amber display.

4.6. Pedestrian Priority Phasing

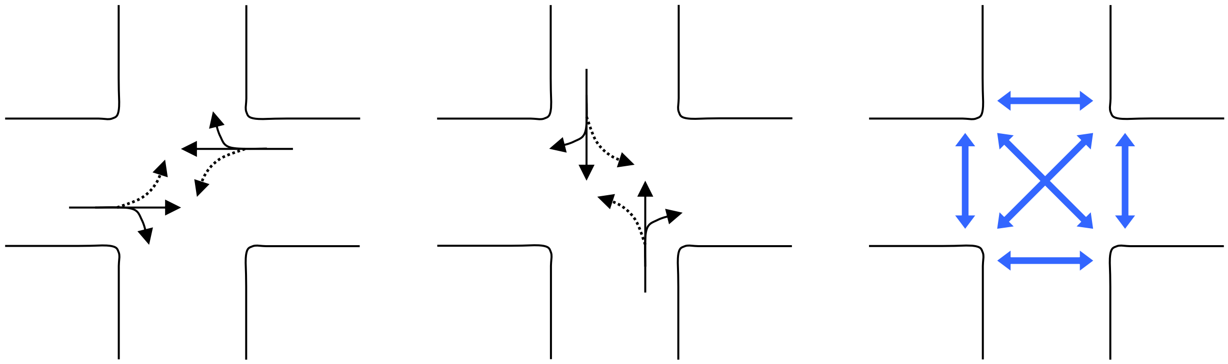
At signals with pedestrian priority phasing (PPP), the FDW duration is based on the longer crossing, which will be the longer diagonal crossing in Types A and C and the longer of the north-south or east-west crossings for Type B and D. (See Figure 4-1). For example, assume the crossing distances at a PPP intersection are:

North-south: 15.0 m
East-west: 13.2 m
Diagonal NE to SW: 23.6 m
Diagonal NW to SE: 21.3 m

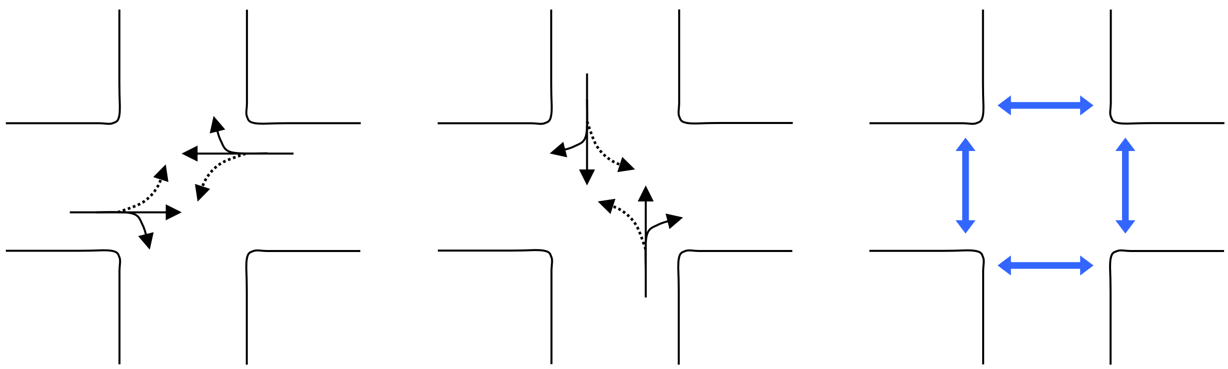
For a Type A and Type C PPP and using Method A, the signals are programmed to provide t_w of 7.0 s and t_{fdw} of 20 s for the diagonal crossing based on the 23.6 m crossing distance. Since a total of 27 s also has to be allocated to the two north-south and two east-west crossings, the 27 s is shown as t_w of 14 s followed by t_{fdw} of 13 s. The WALK displays for all six crossings start at the same time. The FDW displays for all six crossings terminate at the same time.

For a Type B and Type D PPP intersection with the same geometry, t_w of 7.0 s and t_{fdw} of 13 s has to be allocated to all the crossings based on the 15.0 m longer North-South crossing.

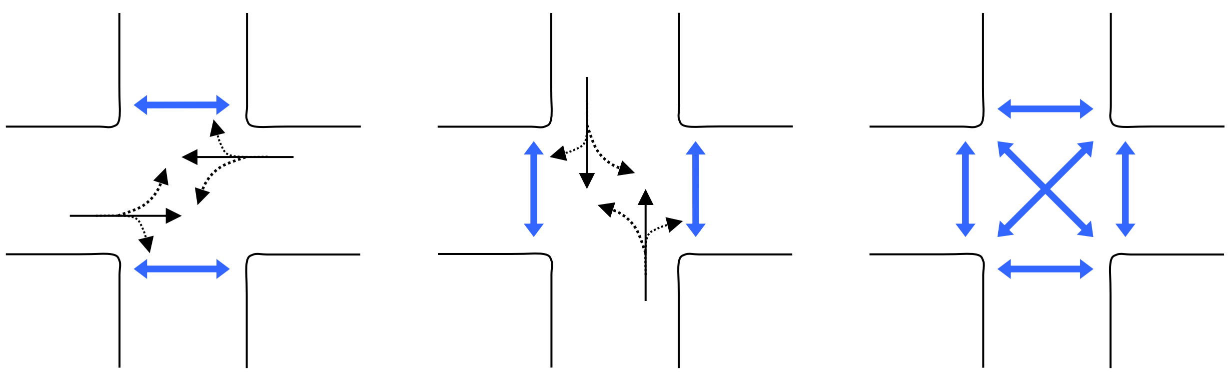
Figure 4-1. Types of PPP: Type A (top), Type B (middle), Type C (bottom)



Type A



Type B



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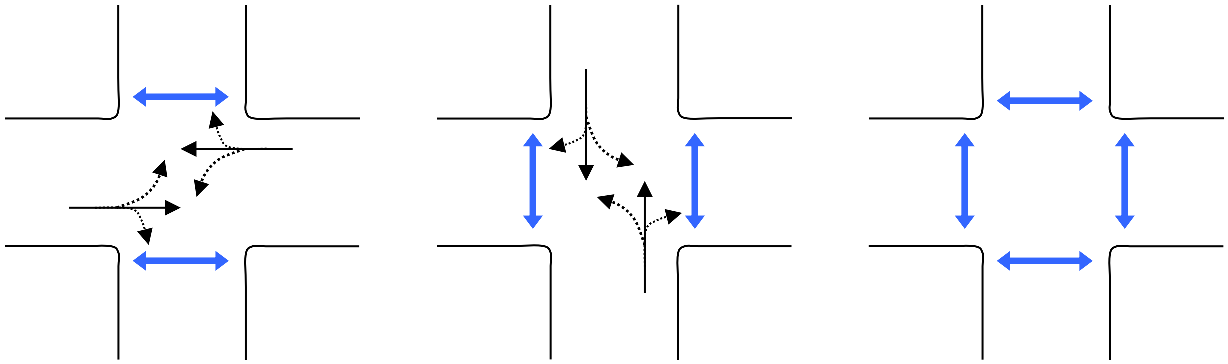


Type D

4.7. Greater Values for Minimum WALK Duration

While this SOP stipulates an absolute minimum WALK duration of 7.0 s, there are many signalised intersections where the WALK duration exceeds the absolute minimum value. A minimum WALK duration in excess of 7.0 s can be used in the following situations:

4.7.1. High Pedestrian Volume

Where pedestrian volumes are high (e.g. in the downtown core or city centers) which results in pedestrian queuing, a longer WALK interval is required to provide enough time for the queue of pedestrians to begin their crossing by leaving the curb before the end of WALK interval. For example, Table 4-1 shows that pedestrians receive 20 – 30 s of "walk" duration at the University Ave/Front St W intersection, depending on the time of day and the crosswalk being travelled.

Table 4-1, Pedestrian Counts and Signal Timings at University Ave/Front S W Intersection (TCS0075)

Time period	Street Side	Pedestrians/Hour	Pedestrians/Cycle	WALK duration (s)
AM Peak	North Side	2048	62	24
	South Side	2372	72	24
	East Side	2760	84	30
	West Side	909	27	30
PM Peak	North Side	1475	45	25
	South Side	1996	60	25
	East Side	2616	79	29
	West Side	1972	60	29
Off Peak	North Side	1076	30	24
	South Side	1891	53	24
	East Side	1894	53	20
	West Side	618	17	20

4.7.2. Limited Pedestrian Storage

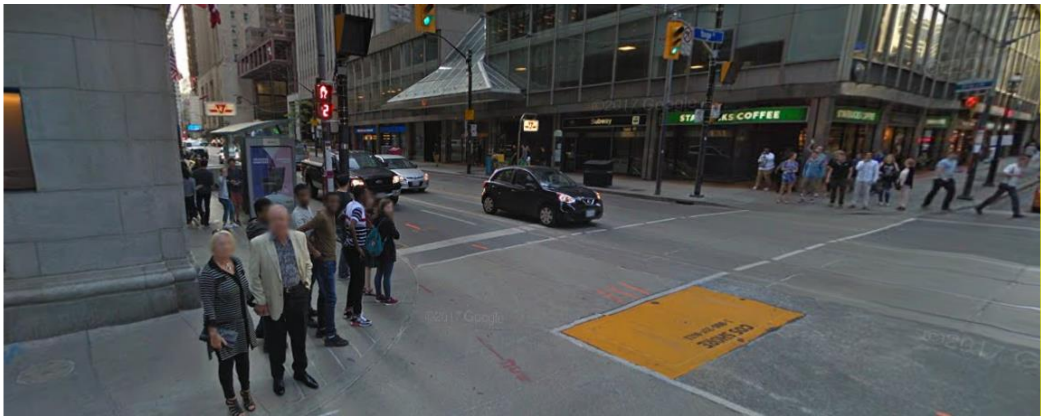
Where there is limited pedestrian storage which may cause queue spillback of pedestrians into the roadway, it may be necessary to use a longer WALK interval to provide the time for the queue of pedestrians to begin their crossing by leaving the curb before the end of WALK interval. For example, Table 4-2 shows that pedestrians receive 17- 23 s of WALK duration at the Yonge St/King St intersection, depending on the time of day and the crosswalk being travelled.

Table 4-2, Pedestrian Counts and Signal Timings at the Yonge St/King St W Intersection (TCS0031)

Time period	Street Side	Pedestrian per Hour	Pedestrians per Cycle	WALK time provided(s)
AM Peak	North Side	1562	35	21
	South Side	1319	29	21
	East Side	1281	28	21
	West Side	1762	39	21
PM Peak	North Side	1206	27	19
	South Side	1012	22	19
	East Side	1271	28	23
	West Side	1388	39	23
Off Peak	North Side	1200	25	20
	South Side	886	18	20
	East Side	1206	25	17
	West Side	1388	29	17

Figure 4-2 shows the limited pedestrian storage at south west corner of the intersection. In this scenario, a WALK time greater than 7.0s may be provided during all time periods.

Figure 4-2, Limited Pedestrian Storage at South-west Corner of the of the King St and Yonge St W (TCS0031) Intersection



4.7.3. Special Events

The volume of pedestrians using the intersections in the vicinity of a special event can be quite high, especially at the end of the event. In such cases, a WALK time beyond 7.0 s would be needed to accommodate the increased pedestrian flow. Examples of intersections where such increased WALK times would be implemented are Front St/Blue Jays Way and Front St/John St for Blue Jays Games and Lake Shore Blvd/Bay St and Front St/Bay St for Scotiabank Centre events.

4.7.4. Older Pedestrians

Older pedestrians need more time to enter the crosswalk. Where at least 20% of pedestrians crossing the signalised intersection during a two hour study period are older pedestrians (65 years of age or older), the minimum WALK time would be increased to 8.0 s and the overall walk speed would be decreased to 0.9 m/s. The pedestrian timings may be calculated using Equation 1 or as per the Type B lookup table in Appendix A. Implementing Type B pedestrian timings would facilitate crossing for older pedestrians.

4.7.5. Pedestrians with Mobility Challenges or with Low or No Vision

Pedestrians with mobility challenges or with low or no vision need more time to enter the crosswalk. Where at least 20% of pedestrians crossing the signalised intersection during a two hour study period use assistive devices, the minimum WALK time would be increased to 9.0 s and the overall walk speed would be decreased to 0.8 m/s. The pedestrian timings may be calculated using Equation 1 or as per the Type C lookup table in Appendix A. Implementing Type C pedestrian timings would facilitate crossing for pedestrians with mobility challenges or with low or no vision.

4.7.6. Combination of Older Pedestrians and Pedestrians with Mobility challenges

Where older pedestrians and pedestrians with mobility challenges or with low or no vision make a combined total of at least 20% of pedestrians, the pedestrian walk speed will be based on the majority of pedestrians in each group. For example, if there is an 11% older pedestrians and 9% pedestrians with mobility challenges or with low or no vision, the pedestrian walk speed will be 0.9 m/s.

4.7.7. Non-standard Pushbutton Locations (APS or Walk Phase Activation)

If a pushbutton, whether for APS or for activation of the WALK interval, is not placed in the standard location directly adjacent to the crosswalk, a minimum WALK duration of 10.0 s can be considered since pedestrians with low or no vision may need more time to orient themselves to the location of the crosswalks.

4.7.8. School Zones

The volume of pedestrians (students) waiting to enter the crosswalk will be high during the period before school opens and during the period after school closes. Similar to Special Events intersections, a longer WALK interval may be required to provide the time for the queue of pedestrians to begin crossing by leaving the curb before the end of WALK interval.

4.7.9. Construction Zones

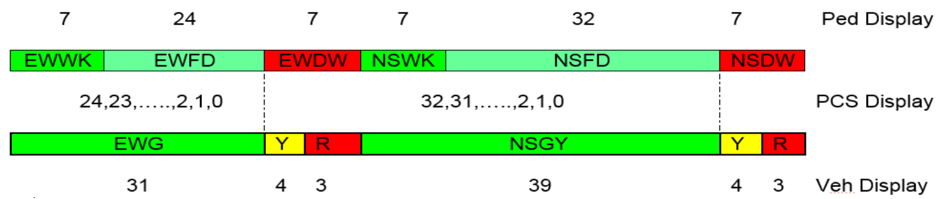
During the construction, storage space may be limited for the pedestrians due to the presence of construction hoarding. In such cases, a WALK time beyond 7.0 s may be needed dependent on the pedestrian diversion route.

For all situations listed above, the ATO must conduct a field investigation before recommending an increase in the minimum WALK time. If the site observations show that the pedestrians who arrived before the end of walk time cannot enter the crosswalk, and the

WALK time is at the minimum value, the ATO may request TSO to increase the WALK time beyond the minimum value.

4.8. Pedestrian Countdown Signals (PCS)

Pedestrian countdown signals start counting down at the beginning of the FDW and end at the start of the "Don't Walk" (DW) interval.



4.9. Leading Pedestrian Interval (LPI)

The City of Toronto standard for duration of the LPI is as follows:
LPI = greater of 5 s, or (TL/2 + PL)/W
Where:

- LPI = number of s from the onset of the WALK signal for pedestrians and the green indication for vehicles
- TL = distance on the crosswalk to clear the total width of all moving lanes between the curb and the centreline, not including the parking lane
- PL = distance on the crosswalk to clear the parking/merging lane, if any, and
- W = walk speed

Reducing walk speed to 0.9 or 0.8 m/s may result in a higher LPI which can result in an increase in cycle length and possible impacts on signal coordination – refer to Section 4.1.

4.10. Emergency Vehicle Pre-emption (PE)

Emergency pre-emption (PE) may be provided to Fire Services vehicles at signalised intersections adjacent to or within close proximity of fire halls. If a PE call is received in the WALK interval and 7 s of WALK has not been served, the controller will ensure that the minimum WALK and clearance times are not violated. If a call is received during the FDW interval, the full pedestrian clearance time will be served without any truncation.

At fire PE locations, the message "Emergency vehicle approaching, clear intersection immediately" will be emitted from APS buttons only during the relevant WALK interval and when the pre-emption is active. The message stops when the signal returns to normal operation.

4.11. Rail Pre-emption

Rail PE is designed to always provide the full FDW duration i.e. the FDW duration must not be shortened. Depending on when the train arrives in the signal cycle, there is a possibility that the WALK time can be truncated to a value less than 7.0 s.

4.12. Field Measurements

Appendix B shows typical pedestrian crossings that may be encountered. With the exception of scenario G, all pedestrian crossing distances are measured along the centre line of the crosswalk. In scenario G, the distance is measured from centre of curb-cut to centre of curb-cut. The longest pedestrian crossing distance is used for calculating T_{ped} for each direction. For example, if the north-south crossing distance is 25.0 m on the east leg and 27.2 m on the west leg, then the west leg distance is used to calculate the north-south pedestrian crossing time.

4.13. Implementation of Timings

Signals on the TransSuite Traffic Control System (TCS) have the same timing plans at the system and controller level. Controller timing plans can be updated from TranSuite TCS if there is communication between TransSuite TCS and the intersection. If there is no communication, the controller timing must be updated in the field by TSO staff.

Signals on the Split Cycle Offset Optimisation Technique (SCOOT) TCS can have different timing plans at the system and controller level due to the traffic adaptive nature of SCOOT. A change in walk speed requires changes at the controller with simultaneous changes on the SCOOT database. Depending on the controller type, the Electrical Maintenance Contractor (EMC) may be required to undertake modifications in the cabinet.

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APPENDIX A. PEDESTRIAN CROSSING TIME TABLES

Type A - Overall Walk Speed 1.0 m/s {1.2 m/s in FDW (& PCS)}

d_w = pedestrian crossing distance (m)
t_{ped} = total pedestrian crossing time based on 1.0 m/s walk speed
t_{walk} = walk component fixed at 7.0 s
t_{fdw} = flashing "don't walk" (& PCS) component = d_w/1.2
T_{ped} = total pedestrian crossing time based on t_{walk} + t_{fdw}

d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)	d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)	d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)	d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)
6.0	6	7	5	12	18.2	18	7	15	22	30.4	30	7	25	32	42.6	43	7	**36**	43
6.2	6	7	5	12	18.4	18	7	15	22	30.6	31	7	26	33	42.8	43	7	**36**	43
6.4	6	7	5	12	18.6	19	7	16	23	30.8	31	7	26	33	43.0	43	7	**36**	43
6.6	7	7	6	13	18.8	19	7	16	23	31.0	31	7	26	33	43.2	43	7	**36**	43
6.8	7	7	6	13	19.0	19	7	16	23	31.2	31	7	26	33	43.4	43	7	**36**	43
7.0	7	7	6	13	19.2	19	7	16	23	31.4	31	7	26	33	43.6	44	7	**37**	44
7.2	7	7	6	13	19.4	19	7	16	23	31.6	32	7	26	33	43.8	44	7	**37**	44
7.4	7	7	6	13	19.6	20	7	16	23	31.8	32	7	27	34	44.0	44	7	**37**	44
7.6	8	7	6	13	19.8	20	7	17	24	32.0	32	7	27	34	44.2	44	7	**37**	44
7.8	8	7	7	14	20.0	20	7	17	24	32.2	32	7	27	34	44.4	44	7	**37**	44
8.0	8	7	7	14	20.2	20	7	17	24	32.4	32	7	27	34	44.6	45	7	**38**	45
8.2	8	7	7	14	20.4	20	7	17	24	32.6	33	7	27	34	44.8	45	7	**38**	45
8.4	8	7	7	14	20.6	21	7	17	24	32.8	33	7	27	34	45.0	45	7	**38**	45
8.6	9	7	7	14	20.8	21	7	17	24	33.0	33	7	28	35	45.2	45	7	**38**	45
8.8	9	7	7	14	21.0	21	7	18	25	33.2	33	7	28	35	45.4	45	7	**38**	45
9.0	9	7	8	15	21.2	21	7	18	25	33.4	33	7	28	35	45.6	46	7	**39**	46
9.2	9	7	8	15	21.4	21	7	18	25	33.6	34	7	28	35	45.8	46	7	**39**	46
9.4	9	7	8	15	21.6	22	7	18	25	33.8	34	7	28	35	46.0	46	7	**39**	46
9.6	10	7	8	15	21.8	22	7	18	25	34.0	34	7	28	35	46.2	46	7	**39**	46
9.8	10	7	8	15	22.0	22	7	18	25	34.2	34	7	29	36	46.4	46	7	**39**	46
10.0	10	7	8	15	22.2	22	7	19	26	34.4	34	7	29	36	46.6	47	7	**40**	47
10.2	10	7	9	16	22.4	22	7	19	26	34.6	35	7	29	36	46.8	47	7	**40**	47
10.4	10	7	9	16	22.6	23	7	19	26	34.8	35	7	29	36	47.0	47	7	**40**	47
10.6	11	7	9	16	22.8	23	7	19	26	35.0	35	7	29	36	47.2	47	7	**40**	47
10.8	11	7	9	16	23.0	23	7	19	26	35.2	35	7	29	36	47.4	47	7	**40**	47
11.0	11	7	9	16	23.2	23	7	19	26	35.4	35	7	30	37	47.6	48	7	**41**	48
11.2	11	7	9	16	23.4	23	7	20	27	35.6	36	7	30	37	47.8	48	7	**41**	48
11.4	11	7	10	17	23.6	24	7	20	27	35.8	36	7	30	37	48.0	48	7	**41**	48
11.6	12	7	10	17	23.8	24	7	20	27	36.0	36	7	30	37	48.2	48	7	**41**	48
11.8	12	7	10	17	24.0	24	7	20	27	36.2	36	7	30	37	48.4	48	7	**41**	48
12.0	12	7	10	17	24.2	24	7	20	27	36.4	36	7	30	37	48.6	49	7	**42**	49
12.2	12	7	10	17	24.4	24	7	20	27	36.6	37	7	31	38	48.8	49	7	**42**	49
12.4	12	7	10	17	24.6	25	7	21	28	36.8	37	7	31	38	49.0	49	7	**42**	49
12.6	13	7	11	18	24.8	25	7	21	28	37.0	37	7	31	38	49.2	49	7	**42**	49
12.8	13	7	11	18	25.0	25	7	21	28	37.2	37	7	31	38	49.4	49	7	**42**	49
13.0	13	7	11	18	25.2	25	7	21	28	37.4	37	7	31	38	49.6	50	7	**43**	50
13.2	13	7	11	18	25.4	25	7	21	28	37.6	38	7	31	38	49.8	50	7	**43**	50
13.4	13	7	11	18	25.6	26	7	21	28	37.8	38	7	32	39	50.0	50	7	**43**	50
13.6	14	7	11	18	25.8	26	7	22	29	38.0	38	7	32	39	50.2	50	7	**43**	50
13.8	14	7	12	19	26.0	26	7	22	29	38.2	38	7	32	39	50.4	50	7	**43**	50
14.0	14	7	12	19	26.2	26	7	22	29	38.4	38	7	32	39	50.6	51	7	**44**	51
14.2	14	7	12	19	26.4	26	7	22	29	38.6	39	7	32	39	50.8	51	7	**44**	51
14.4	14	7	12	19	26.6	27	7	22	29	38.8	39	7	32	39	51.0	51	7	**44**	51
14.6	15	7	12	19	26.8	27	7	22	29	39.0	39	7	33	40	51.2	51	7	**44**	51
14.8	15	7	12	19	27.0	27	7	23	30	39.2	39	7	33	40	51.4	51	7	**44**	51
15.0	15	7	13	20	27.2	27	7	23	30	39.4	39	7	33	40	51.6	52	7	**45**	52
15.2	15	7	13	20	27.4	27	7	23	30	39.6	40	7	33	40	51.8	52	7	**45**	52
15.4	15	7	13	20	27.6	28	7	23	30	39.8	40	7	33	40	52.0	52	7	**45**	52
15.6	16	7	13	20	27.8	28	7	23	30	40.0	40	7	33	40	52.2	52	7	**45**	52
15.8	16	7	13	20	28.0	28	7	23	30	40.2	40	7	34	41	52.4	52	7	**45**	52
16.0	16	7	13	20	28.2	28	7	24	31	40.4	40	7	34	41	52.6	53	7	**46**	53
16.2	16	7	14	21	28.4	28	7	24	31	40.6	41	7	34	41	52.8	53	7	**46**	53
16.4	16	7	14	21	28.6	29	7	24	31	40.8	41	7	34	41	53.0	53	7	**46**	53
16.6	17	7	14	21	28.8	29	7	24	31	41.0	41	7	34	41	53.2	53	7	**46**	53
16.8	17	7	14	21	29.0	29	7	24	31	41.2	41	7	34	41	53.4	53	7	**46**	53
17.0	17	7	14	21	29.2	29	7	24	31	41.4	41	7	35	42	53.6	54	7	**47**	54
17.2	17	7	14	21	29.4	29	7	25	32	41.6	42	7	35	42	53.8	54	7	**47**	54
17.4	17	7	15	22	29.6	30	7	25	32	41.8	42	7	35	42	54.0	54	7	**47**	54
17.6	18	7	15	22	29.8	30	7	25	32	42.0	42	7	35	42	54.2	54	7	**47**	54
17.8	18	7	15	22	30.0	30	7	25	32	42.2	42	7	35	42	54.4	54	7	**47**	54
18.0	18	7	15	22	30.2	30	7	25	32	42.4	42	7	35	42	54.6	55	7	**48**	55

*** t_{fdw} values in bold have been increased to maintain an overall walk speed of 1.0 m/s**

**** All the values in the Table are rounded down for fractions less than 0.5 and rounded up for fractions equal or more than 0.5.**

Type B - Overall Walk Speed 0.9 m/s {1.1 m/s in FDW (& PCS)}

d_w = pedestrian crossing distance (m)
t_{ped} = total pedestrian crossing time based on 0.9 m/s walk speed
t_{walk} = walk component fixed at 8.0 s
t_{fdw} = flashing "don't walk" (& PCS) component = d_w/1.1
T_{ped} = total pedestrian crossing time based on t_{walk} + t_{fdw}

d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)	d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)	d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)	d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)
6.0	7	8	5	13	18.2	20	8	17	25	30.4	34	8	28	36	42.6	47	8	**39**	47
6.2	7	8	6	14	18.4	20	8	17	25	30.6	34	8	28	36	42.8	48	8	**40**	48
6.4	7	8	6	14	18.6	21	8	17	25	30.8	34	8	28	36	43.0	48	8	**40**	48
6.6	7	8	6	14	18.8	21	8	17	25	31.0	34	8	28	36	43.2	48	8	**40**	48
6.8	8	8	6	14	19.0	21	8	17	25	31.2	35	8	28	36	43.4	48	8	**40**	48
7.0	8	8	6	14	19.2	21	8	17	25	31.4	35	8	29	37	43.6	48	8	**40**	48
7.2	8	8	7	15	19.4	22	8	18	26	31.6	35	8	29	37	43.8	49	8	**41**	49
7.4	8	8	7	15	19.6	22	8	18	26	31.8	35	8	29	37	44.0	49	8	**41**	49
7.6	8	8	7	15	19.8	22	8	18	26	32.0	36	8	29	37	44.2	49	8	**41**	49
7.8	9	8	7	15	20.0	22	8	18	26	32.2	36	8	29	37	44.4	49	8	**41**	49
8.0	9	8	7	15	20.2	22	8	18	26	32.4	36	8	29	37	44.6	50	8	**42**	50
8.2	9	8	7	15	20.4	23	8	19	27	32.6	36	8	30	38	44.8	50	8	**42**	50
8.4	9	8	8	16	20.6	23	8	19	27	32.8	36	8	30	38	45.0	50	8	**42**	50
8.6	10	8	8	16	20.8	23	8	19	27	33.0	37	8	30	38	45.2	50	8	**42**	50
8.8	10	8	8	16	21.0	23	8	19	27	33.2	37	8	30	38	45.4	50	8	**42**	50
9.0	10	8	8	16	21.2	24	8	19	27	33.4	37	8	30	38	45.6	51	8	**43**	51
9.2	10	8	8	16	21.4	24	8	19	27	33.6	37	8	31	39	45.8	51	8	**43**	51
9.4	10	8	9	17	21.6	24	8	20	28	33.8	38	8	31	39	46.0	51	8	**43**	51
9.6	11	8	9	17	21.8	24	8	20	28	34.0	38	8	31	39	46.2	51	8	**43**	51
9.8	11	8	9	17	22.0	24	8	20	28	34.2	38	8	31	39	46.4	52	8	**44**	52
10.0	11	8	9	17	22.2	25	8	20	28	34.4	38	8	31	39	46.6	52	8	**44**	52
10.2	11	8	9	17	22.4	25	8	20	28	34.6	38	8	31	39	46.8	52	8	**44**	52
10.4	12	8	9	17	22.6	25	8	21	29	34.8	39	8	32	40	47.0	52	8	**44**	52
10.6	12	8	10	18	22.8	25	8	21	29	35.0	39	8	32	40	47.2	52	8	**44**	52
10.8	12	8	10	18	23.0	26	8	21	29	35.2	39	8	32	40	47.4	53	8	**45**	53
11.0	12	8	10	18	23.2	26	8	21	29	35.4	39	8	32	40	47.6	53	8	**45**	53
11.2	12	8	10	18	23.4	26	8	21	29	35.6	40	8	32	40	47.8	53	8	**45**	53
11.4	13	8	10	18	23.6	26	8	21	29	35.8	40	8	33	41	48.0	53	8	**45**	53
11.6	13	8	11	19	23.8	26	8	22	30	36.0	40	8	33	41	48.2	54	8	**46**	54
11.8	13	8	11	19	24.0	27	8	22	30	36.2	40	8	33	41	48.4	54	8	**46**	54
12.0	13	8	11	19	24.2	27	8	22	30	36.4	40	8	33	41	48.6	54	8	**46**	54
12.2	14	8	11	19	24.4	27	8	22	30	36.6	41	8	33	41	48.8	54	8	**46**	54
12.4	14	8	11	19	24.6	27	8	22	30	36.8	41	8	33	41	49.0	54	8	**46**	54
12.6	14	8	11	19	24.8	28	8	23	31	37.0	41	8	34	42	49.2	55	8	**47**	55
12.8	14	8	12	20	25.0	28	8	23	31	37.2	41	8	34	42	49.4	55	8	**47**	55
13.0	14	8	12	20	25.2	28	8	23	31	37.4	42	8	34	42	49.6	55	8	**47**	55
13.2	15	8	12	20	25.4	28	8	23	31	37.6	42	8	34	42	49.8	55	8	**47**	55
13.4	15	8	12	20	25.6	28	8	23	31	37.8	42	8	34	42	50.0	56	8	**48**	56
13.6	15	8	12	20	25.8	29	8	23	31	38.0	42	8	35	43	50.2	56	8	**48**	56
13.8	15	8	13	21	26.0	29	8	24	32	38.2	42	8	35	43	50.4	56	8	**48**	56
14.0	16	8	13	21	26.2	29	8	24	32	38.4	43	8	35	43	50.6	56	8	**48**	56
14.2	16	8	13	21	26.4	29	8	24	32	38.6	43	8	35	43	50.8	56	8	**48**	56
14.4	16	8	13	21	26.6	30	8	24	32	38.8	43	8	35	43	51.0	57	8	**49**	57
14.6	16	8	13	21	26.8	30	8	24	32	39.0	43	8	35	43	51.2	57	8	**49**	57
14.8	16	8	13	21	27.0	30	8	25	33	39.2	44	8	36	44	51.4	57	8	**49**	57
15.0	17	8	14	22	27.2	30	8	25	33	39.4	44	8	36	44	51.6	57	8	**49**	57
15.2	17	8	14	22	27.4	30	8	25	33	39.6	44	8	36	44	51.8	58	8	**50**	58
15.4	17	8	14	22	27.6	31	8	25	33	39.8	44	8	36	44	52.0	58	8	**50**	58
15.6	17	8	14	22	27.8	31	8	25	33	40.0	44	8	36	44	52.2	58	8	**50**	58
15.8	18	8	14	22	28.0	31	8	25	33	40.2	45	8	37	45	52.4	58	8	**50**	58
16.0	18	8	15	23	28.2	31	8	26	34	40.4	45	8	37	45	52.6	58	8	**50**	58
16.2	18	8	15	23	28.4	32	8	26	34	40.6	45	8	37	45	52.8	59	8	**51**	59
16.4	18	8	15	23	28.6	32	8	26	34	40.8	45	8	37	45	53.0	59	8	**51**	59
16.6	18	8	15	23	28.8	32	8	26	34	41.0	46	8	**38**	46	53.2	59	8	**51**	59
16.8	19	8	15	23	29.0	32	8	26	34	41.2	46	8	**38**	46	53.4	59	8	**51**	59
17.0	19	8	15	23	29.2	32	8	27	35	41.4	46	8	**38**	46	53.6	60	8	**52**	60
17.2	19	8	16	24	29.4	33	8	27	35	41.6	46	8	**38**	46	53.8	60	8	**52**	60
17.4	19	8	16	24	29.6	33	8	27	35	41.8	46	8	**38**	46	54.0	60	8	**52**	60
17.6	20	8	16	24	29.8	33	8	27	35	42.0	47	8	**39**	47	54.2	60	8	**52**	60
17.8	20	8	16	24	30.0	33	8	27	35	42.2	47	8	**39**	47	54.4	60	8	**52**	60
18.0	20	8	16	24	30.2	34	8	27	35	42.4	47	8	**39**	47	54.6	61	8	**53**	61

* t_{fdw} values in bold have been increased to maintain an overall walk speed of 0.9 m/s
** All the values in the Table are rounded down for fractions less than 0.5 and rounded up for fractions equal or more than 0.5.

Type C - Overall Walk Speed 0.8 m/s {1.0 m/s in FDW (& PCS)}

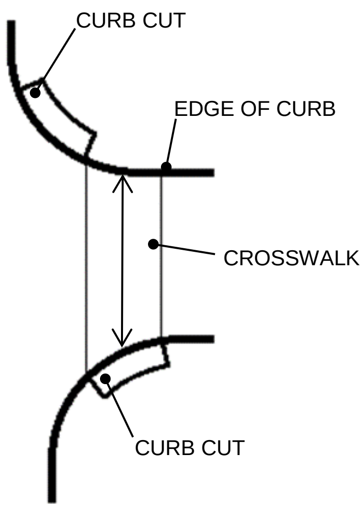
d_w = pedestrian crossing distance (m)
t_{ped} = total pedestrian crossing time based on 0.8 m/s walk speed
t_{walk} = walk component fixed at 9.0 s
t_{fdw} = flashing "don't walk" (& PCS) component = d_w/1.0
T_{ped} = total pedestrian crossing time based on t_{walk} + t_{fdw}

d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)	d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)	d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)	d_w (m)	t_{ped} (s)	t_{walk} (s)	t_{fdw} (s)	T_{ped} (s)
6.0	8	9	6	15	18.2	23	9	18	27	30.4	38	9	30	39	42.6	53	9	**44**	53
6.2	8	9	6	15	18.4	23	9	18	27	30.6	38	9	31	40	42.8	54	9	**45**	54
6.4	8	9	6	15	18.6	23	9	19	28	30.8	39	9	31	40	43.0	54	9	**45**	54
6.6	8	9	7	16	18.8	24	9	19	28	31.0	39	9	31	40	43.2	54	9	**45**	54
6.8	9	9	7	16	19.0	24	9	19	28	31.2	39	9	31	40	43.4	54	9	**45**	54
7.0	9	9	7	16	19.2	24	9	19	28	31.4	39	9	31	40	43.6	55	9	**46**	55
7.2	9	9	7	16	19.4	24	9	19	28	31.6	40	9	32	41	43.8	55	9	**46**	55
7.4	9	9	7	16	19.6	25	9	20	29	31.8	40	9	32	41	44.0	55	9	**46**	55
7.6	10	9	8	17	19.8	25	9	20	29	32.0	40	9	32	41	44.2	55	9	**46**	55
7.8	10	9	8	17	20.0	25	9	20	29	32.2	40	9	32	41	44.4	56	9	**47**	56
8.0	10	9	8	17	20.2	25	9	20	29	32.4	41	9	32	41	44.6	56	9	**47**	56
8.2	10	9	8	17	20.4	26	9	20	29	32.6	41	9	33	42	44.8	56	9	**47**	56
8.4	11	9	8	17	20.6	26	9	21	30	32.8	41	9	33	42	45.0	56	9	**47**	56
8.6	11	9	9	18	20.8	26	9	21	30	33.0	41	9	33	42	45.2	57	9	**48**	57
8.8	11	9	9	18	21.0	26	9	21	30	33.2	42	9	33	42	45.4	57	9	**48**	57
9.0	11	9	9	18	21.2	27	9	21	30	33.4	42	9	33	42	45.6	57	9	**48**	57
9.2	12	9	9	18	21.4	27	9	21	30	33.6	42	9	34	43	45.8	57	9	**48**	57
9.4	12	9	9	18	21.6	27	9	22	31	33.8	42	9	34	43	46.0	58	9	**49**	58
9.6	12	9	10	19	21.8	27	9	22	31	34.0	43	9	34	43	46.2	58	9	**49**	58
9.8	12	9	10	19	22.0	28	9	22	31	34.2	43	9	34	43	46.4	58	9	**49**	58
10.0	13	9	10	19	22.2	28	9	22	31	34.4	43	9	34	43	46.6	58	9	**49**	58
10.2	13	9	10	19	22.4	28	9	22	31	34.6	43	9	35	44	46.8	59	9	**50**	59
10.4	13	9	10	19	22.6	28	9	23	32	34.8	44	9	35	44	47.0	59	9	**50**	59
10.6	13	9	11	20	22.8	29	9	23	32	35.0	44	9	35	44	47.2	59	9	**50**	59
10.8	14	9	11	20	23.0	29	9	23	32	35.2	44	9	35	44	47.4	59	9	**50**	59
11.0	14	9	11	20	23.2	29	9	23	32	35.4	44	9	35	44	47.6	60	9	**51**	60
11.2	14	9	11	20	23.4	29	9	23	32	35.6	45	9	36	45	47.8	60	9	**51**	60
11.4	14	9	11	20	23.6	30	9	24	33	35.8	45	9	36	45	48.0	60	9	**51**	60
11.6	15	9	12	21	23.8	30	9	24	33	36.0	45	9	36	45	48.2	60	9	**51**	60
11.8	15	9	12	21	24.0	30	9	24	33	36.2	45	9	36	45	48.4	61	9	**52**	61
12.0	15	9	12	21	24.2	30	9	24	33	36.4	46	9	**37**	46	48.6	61	9	**52**	61
12.2	15	9	12	21	24.4	31	9	24	33	36.6	46	9	**37**	46	48.8	61	9	**52**	61
12.4	16	9	12	21	24.6	31	9	25	34	36.8	46	9	**37**	46	49.0	61	9	**52**	61
12.6	16	9	13	22	24.8	31	9	25	34	37.0	46	9	**37**	46	49.2	62	9	**53**	62
12.8	16	9	13	22	25.0	31	9	25	34	37.2	47	9	**38**	47	49.4	62	9	**53**	62
13.0	16	9	13	22	25.2	32	9	25	34	37.4	47	9	**38**	47	49.6	62	9	**53**	62
13.2	17	9	13	22	25.4	32	9	25	34	37.6	47	9	**38**	47	49.8	62	9	**53**	62
13.4	17	9	13	22	25.6	32	9	26	35	37.8	47	9	**38**	47	50.0	63	9	**54**	63
13.6	17	9	14	23	25.8	32	9	26	35	38.0	48	9	**39**	48	50.2	63	9	**54**	63
13.8	17	9	14	23	26.0	33	9	26	35	38.2	48	9	**39**	48	50.4	63	9	**54**	63
14.0	18	9	14	23	26.2	33	9	26	35	38.4	48	9	**39**	48	50.6	63	9	**54**	63
14.2	18	9	14	23	26.4	33	9	26	35	38.6	48	9	**39**	48	50.8	64	9	**55**	64
14.4	18	9	14	23	26.6	33	9	27	36	38.8	49	9	**40**	49	51.0	64	9	**55**	64
14.6	18	9	15	24	26.8	34	9	27	36	39.0	49	9	**40**	49	51.2	64	9	**55**	64
14.8	19	9	15	24	27.0	34	9	27	36	39.2	49	9	**40**	49	51.4	64	9	**55**	64
15.0	19	9	15	24	27.2	34	9	27	36	39.4	49	9	**40**	49	51.6	65	9	**56**	65
15.2	19	9	15	24	27.4	34	9	27	36	39.6	50	9	**41**	50	51.8	65	9	**56**	65
15.4	19	9	15	24	27.6	35	9	28	37	39.8	50	9	**41**	50	52.0	65	9	**56**	65
15.6	20	9	16	25	27.8	35	9	28	37	40.0	50	9	**41**	50	52.2	65	9	**56**	65
15.8	20	9	16	25	28.0	35	9	28	37	40.2	50	9	**41**	50	52.4	66	9	**57**	66
16.0	20	9	16	25	28.2	35	9	28	37	40.4	51	9	**42**	51	52.6	66	9	**57**	66
16.2	20	9	16	25	28.4	36	9	28	37	40.6	51	9	**42**	51	52.8	66	9	**57**	66
16.4	21	9	16	25	28.6	36	9	29	38	40.8	51	9	**42**	51	53.0	66	9	**57**	66
16.6	21	9	17	26	28.8	36	9	29	38	41.0	51	9	**42**	51	53.2	66	9	**57**	66
16.8	21	9	17	26	29.0	36	9	29	38	41.2	52	9	**43**	52	53.4	67	9	**58**	67
17.0	21	9	17	26	29.2	37	9	29	38	41.4	52	9	**43**	52	53.6	67	9	**58**	67
17.2	22	9	17	26	29.4	37	9	29	38	41.6	52	9	**43**	52	53.8	67	9	**58**	67
17.4	22	9	17	26	29.6	37	9	30	39	41.8	52	9	**43**	52	54.0	67	9	**58**	67
17.6	22	9	18	27	29.8	37	9	30	39	42.0	53	9	**44**	53	54.2	68	9	**59**	68
17.8	22	9	18	27	30.0	38	9	30	39	42.2	53	9	**44**	53	54.4	68	9	**59**	68
18.0	23	9	18	27	30.2	38	9	30	39	42.4	53	9	**44**	53	54.6	68	9	**59**	68

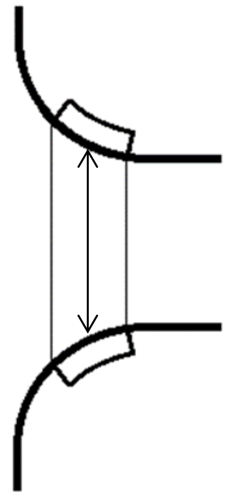
*** t_{fdw} values in bold have been increased to maintain an overall walk speed of 0.8 m/s**

**** All the values in the Table are rounded down for fractions less than 0.5 and rounded up for fractions equal or more than 0.5.**

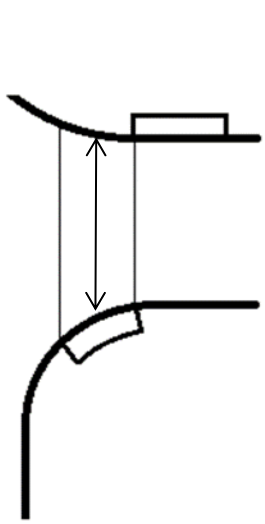
APPENDIX B. MEASUREMENT OF PEDESTRIAN CROSSING DISTANCES



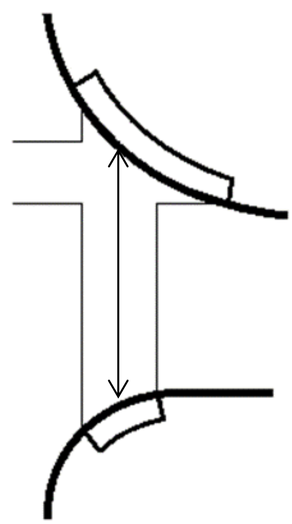
Example A



Example B

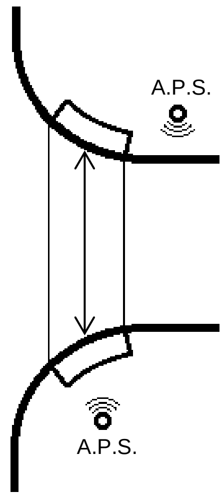


Example C

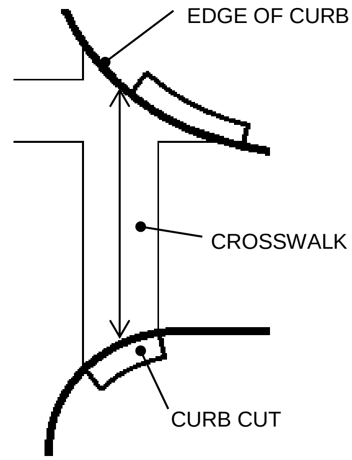


Example D

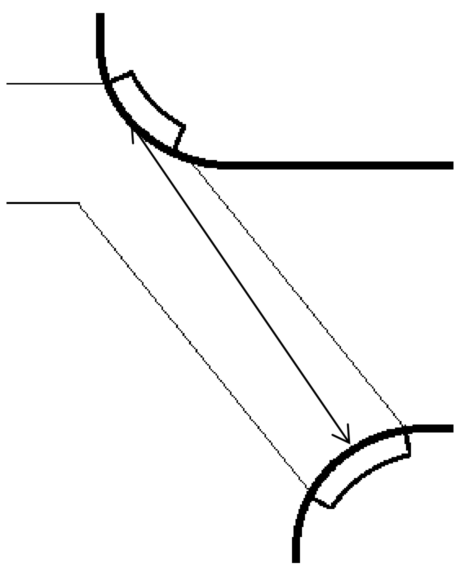
Appendix B: Measurement of Pedestrian Crossing Distances (cont.)



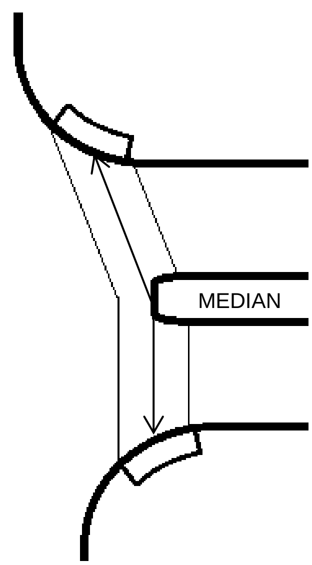
Example E



Example F

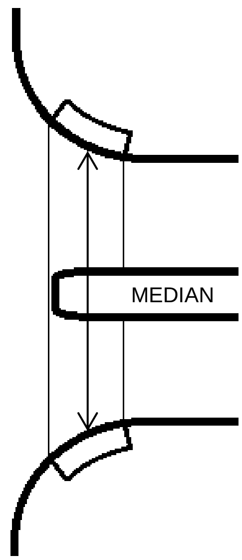


Example G



Example H

Appendix B: Measurement of Pedestrian Crossing Distances (cont.)



Example I

APPENDIX C. ATO INVESTIGATION PROCEDURE

Historical Review:

- Review appropriate files and list dates, investigation numbers and results of previous pedestrian crossing time and other signal timing studies.

Data Acquisition:

- Establish time period(s) and pedestrian crossing(s) that are of concern.
- Acquire timings for the subject intersection; SCOOT timings (minimum, maximum, typical, FDW durations, etc.) should be obtained from TSO; TransSuite timings are the same as shown on timing cards; timing cards, if required, should be obtained from TSO.
- Review pedestrian collision statistics in CRASH over a five-year period; make copies of all pedestrian related collisions; determine if there is any pattern to these collisions and if pedestrian crossing time was a contributing factor in any of the collisions.
- Determine if a crossing guard is provided at the intersection; if a guard is provided, determine what periods the guard is present at the intersection.

Site Visit:

- Confirm that field timings match system timings; highlight any discrepancies and advise TSO as soon as possible.
- Measure subject crosswalks to determine the longest pedestrian crossing distance (as per Appendix B).
- Determine if there is need for additional pedestrian crosswalks if there are no crosswalks on some approaches.
- While on site, if there are any signal malfunctions or signal equipment defects, advise 3-1-1 as soon as possible.
- Confirm presence of crossing guard if one is provided and which leg(s) the guard controls.
- Determine the percentage of older pedestrians and/or pedestrians with assistive devices using the crosswalk.
- Observe pedestrian activity to get a sense of crossing times, difficulties, delays and any safety concerns.
- Enter information in Table C1.

Table C1 - Crossing Pedestrian Volume and Category Study

Intersection: TCS: Date:

Weather: Temperature: Surveyor:

15 min Interval	**Time**		**North side**			**East side**			**South side**			**West Side**			**Comment**
	Start Time	End Time	Total Peds	Older Peds (>65)	Assisted Peds	Total Peds	Older Peds (>65)	Assisted Peds	Total Peds	Older Peds (>65)	Assisted Peds	Total Peds	Older Peds (>65)	Assisted Peds	
1															
2															
3															
4															
5															
6															
7															
8															
Total															

Notes:

a) All pedestrians are counted in the "Total Peds" column regardless of their category.
b) Pedestrian older than or equal 65 years are marked in "≥65" column.
c) All children in strollers and carried and people in wheelchairs are marked in the "Assisted" column.
d) Pedestrians with mobility challenges or with low or no vision are marked in the "Assisted" column.
e) When both conditions a) and b) above are met the "≥65 & Assisted" column is marked.

Analysis:

- Summarize data in the following Table for all time periods:

Table C2 - Data Analysis Table

(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**
Period	Direction	Older Pedestrian %	Pedestrian Using Assistive Devices %	Combined % = **(3)** + **(4)**	Proposed Walk Speed (m/s)	Crossing Distance (m)	Existing WALK(s)	Existing FDW (s)	Total Existing Crossing Time (s)	Proposed WALK (s)	Proposed FDW (s)	Total Proposed Crossing Time (s)

- If column **(5)** is less than 20%, retain the current overall walk speed of 1.0 m/s.
- If column **(3)** is equal to or greater than 20%, 0.9 m/s overall walk speed is recommended. Refer to the Type B table in Appendix A.
- If column **(4)** is equal to or greater than 20%, 0.8 m/s overall walk speed is recommended. Refer to the Type C table in Appendix A.
- If column **(5)** is equal to or greater than 20% and column **(3)** is greater than 10%, 0.9 m/s overall walk speed is recommended. Refer to the Type B table in Appendix A.
- If column **(5)** is equal to or greater than 20% and column **(4)** is greater than 10%, 0.8 m/s overall walk speed is recommended. Refer to the Type C table in Appendix A.

Consultation:

- If signal timing change(s) are required, the ATO sends an email to TSO. The email should include Table C2 and also provide the existing/proposed splits and cycle lengths for all time-of-day signal timing plans. The email must be sent by the ATO Supervisor or Manager. If sent by an ETT1, the email must be copied to the ATO Supervisor and/or Manager; otherwise TSO would not implement.
- If a cycle length change is required, TSO would advise the ATO via email about the impact of the cycle length change on signals in the control area. The ATO would then confirm the extent of changes required at all signals in the control area.

Implementation:

- The timeline for implementation by TSO are:
    - Timing change on TransSuite for a single TCS – one month (includes updating Synchro model)
    - Timing change on TransSuite for 2 - 5 TCS – three months (includes updating Synchro model)
    - Timing change on TransSuite for more than 5 TCS – six months (includes updating Synchro model)
    - Timing change for SCOOT intersection – three months
- On completion of the signal timing change(s), TSO advises the ATO via email. The email will include the updated timing card.