CITY OF BELLEVUE
PEDESTRIAN SIGNAL OPERATIONS GUIDELINES

APRIL 2025

PREPARED FOR:

CITY OF BELLEVUE WASHINGTON

DKS

719 SECOND AVENUE, SUITE 1250, SEATTLE, WA 98104 • 206.382.9800 • DKSASSOCIATES.COM

SHAPING A SMARTER TRANSPORTATION EXPERIENCE™

AN EMPLOYEE-OWNED COMPANY

VERSION CONTROL

VERSION NUMBER	DATE	DESCRIPTION OF CHANGE	AUTHOR
1.0	3/30/2023	First Edition of the Final Guidelines	DKS Associates and City of Bellevue
1.1	4/29/2025	Update sections 3.3, 4.8. 4.9 and 5, and other minor corrections and clarifications.	City of Bellevue

PREPARED FOR CITY OF BELLEVUE

Darcy Akers

Daniel Lai

Jay Backman

PREPARED BY DKS ASSOCIATES

Brian Chandler

Dongmei Lin

Pam O'Brien

Eric Shimizu

Veronica Sullivan

Peter Yu

PREFACE

The Transportation Department of City of Bellevue (City) is responsible for operating and maintaining all the traffic signals within the city limits. Currently, the City operates over 200 traffic signals, all on an adaptive signal system called Sydney Coordinated Adaptive Traffic System (SCATS).

The City has adopted *the Manual on Uniform Traffic Control Devices* (MUTCD) as its policy when operating the traffic signals. City has also developed these internal policies and standard operating procedures (SOP) relevant to traffic signal operations.

- Left Turn Phasing Guidelines and SOP
- Signal Timing Worksheet
- Installation of Accessible Pedestrian Signals (APS) SOP
- SCATS Traffic Computer Data Security SOP
- Yellow Change and Red Clearance Intervals SOP
- Traffic Signal Timing SOP
- Right Turn on Red Restrictions SOP

This document intends to provide additional guidelines for internal staff when determining pedestrian operations at signalized intersections. The purpose of this document is to encourage uniform application of relevant guidelines for the operation and maintenance of traffic signals in Bellevue. The guidelines developed in this document aim to align with the Bellevue Vision Zero initiative and the Safe System approach.

The use of the terms "shall", "should", and "may" in this document are intended to be applied in a similar manner to their meanings in the MUTCD.

TABLE OF CONTENTS

1. SIGNAL OPERATIONS RESPONSIBILITIES

The responsibilities of operating the traffic signals are with the Smart Mobility group under the Transportation Department. The Traffic Management Center at City Hall is where traffic engineers work to keep traffic flowing every day. The following staff positions are typically responsible for signal operations, and their responsibilities are described below.

- **Smart Mobility Manager** – Oversees the engineering team that manages the traffic signal system and other ITS applications.
- **ITS Engineer** – Responsible of timing of the traffic signals and updates to the *Sydney Coordinated Adaptive Traffic System* (SCATS) as well as other functions including ITS and signal design, data management, design review, and traffic analysis. There are currently four engineering positions.
- **ITS Engineering Technician** – Supports engineers in updates and maintenance of the traffic signal system and other ITS applications. There is currently one engineering technician position.

The City's Operations and Maintenance group also has a team of signal technicians who operate and maintain the components of the traffic signal system in the field as well as other ITS applications. There are currently three technician positions and one working crew chief position on this team.

2. PEDESTRIAN SIGNAL OPERATIONS GUIDELINES

The following chapters include guidelines for elements relevant to pedestrian signal operations. Chapter 3 discusses guideline for setting pedestrian signal timing parameters, and Chapter 4 discusses the application of signal operations features relevant to pedestrian crossings. The elements discussed in this document include the following.

PEDESTRIAN SIGNAL OPERATIONS ELEMENTS

- Pedestrian Signal Timing Parameters
  - The WALK interval
  - The Flashing Don't Walk (FDW) Interval
  - Leading Pedestrian Interval (LPI)
- Signal Operations Features Relevant to Pedestrian Crossings
  - Pedestrian Countdown Display
  - Application of Leading Pedestrian Interval (LPI)
  - Pedestrian Recall
  - Rest in WALK
  - Pedestrian Reservice and Pedestrian Recycle
  - Exclusive Pedestrian Phase
    - Exclusive All-Way WALK (Pedestrian Scramble Phase)
    - Other Exclusive Pedestrian Phase (Non-Pedestrian Scramble)
  - Left Turn Phasing Mode Considerations
  - Flashing Yellow Arrow Operation and Pedestrians
    - Flashing Yellow Left Turn Arrow (FYLTA) Operation
    - Flashing Yellow Right Turn Arrow (FYRTA) Operation
  - Right Turn On Red (RTOR) Restrictions

3. PEDESTRIAN SIGNAL TIMING PARAMETERS

3.1 THE WALK INTERVAL

The pedestrian phase consists of three intervals: WALK, Pedestrian Clearance (commonly referred to as Flashing Don't Walk, or FDW), and Solid Don't Walk.

The WALK interval typically begins at the start of the concurrent vehicle green interval and is used to inform pedestrians they can enter the crosswalk.[1] This interval corresponds to the WALKING PERSON indication on the pedestrian signal.

Guidelines

- The minimum WALK interval should be 7 seconds (citywide).
- Adjustment to the minimum WALK time should be used to provide adequate crossing time, when one of the conditions is met:
    - Pedestrian push button is a considerable distance from the curb and requires longer than 7 seconds walk time (see Distance A in Exhibit 1).
    - A cross-check calculation using a 3 feet/sec walking speed indicates a need to increase the WALK interval to provide sufficient crossing time for slower pedestrians (see example calculations in Exhibit 3).
- Longer WALK interval may be provided, based on engineering judgment, if any of the following conditions is met or when the engineer finds it beneficial.
    - At crossings with high pedestrian volumes
    - At crossing with limited storage space which would cause pedestrian queuing
    - At school crossings (e.g., general proximity to school and/or known walk-to-school routes)
    - Other locations/situations where the ITS Engineer finds it beneficial (such as near senior facilities, medical facilities, parks, event spaces, etc.)
- The WALK interval may be reduced to a minimum of 5 seconds on a case-by-case basis if one of the characteristics is met or based on engineering judgment:
    - A shorter WALK interval may be provided for a pedestrian scramble phase, based on engineering study.
    - If an intersection is constrained with a short cycle length and reduced WALK intervals would allow the short cycle length to work.

[1] The WALK interval may begin in advance of the concurrent vehicle green if a Lead Pedestrian Interval (LPI) is implemented.

- WALK intervals may vary by time of day. Examples:
    - School crossings may use a standard 7-second WALK interval during most times of day and a longer WALK interval during peak school pedestrian traffic, such as arrival and dismissal periods on school days.
    - Crossings that connect a specific pedestrian generator and a destination may use a longer WALK interval during the typical peak periods of pedestrian traffic. For example, a crossing that connects a major employment place (e.g., medical facility, factory, etc.) to a nearby bus stop may use a longer WALK interval during the typical shift change periods; a crossing near an event center (e.g., sports stadium, etc.) may use a longer WALK during the arrival and dismissal periods of regularly scheduled events.

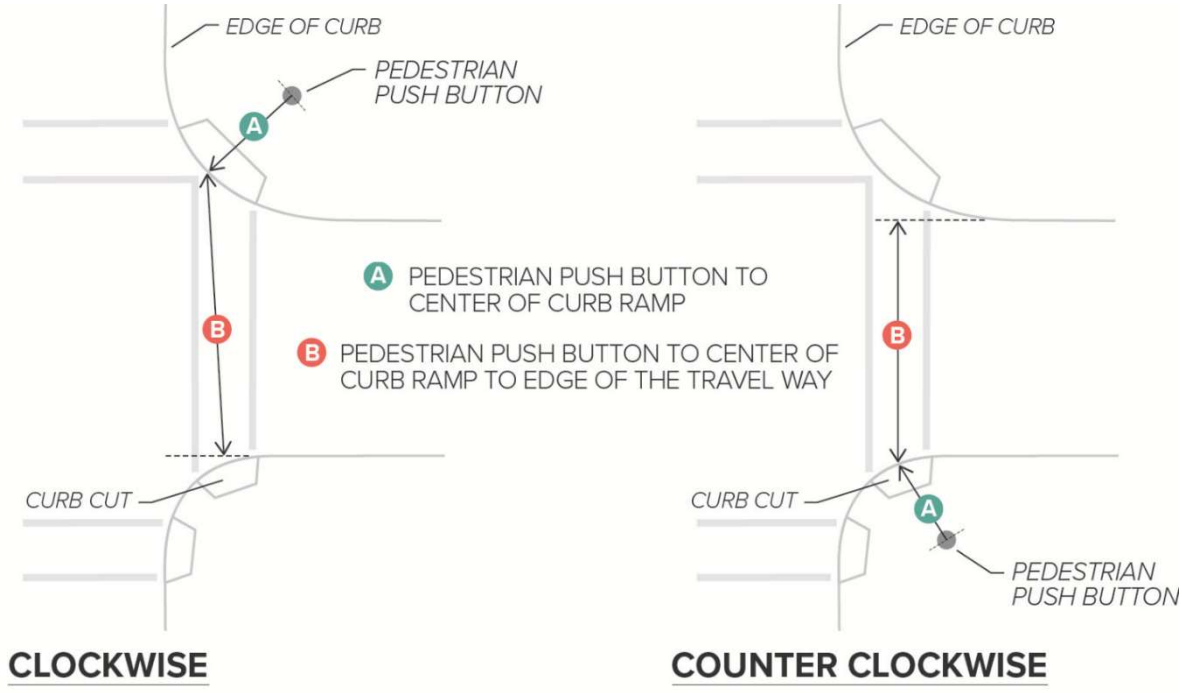

EXHIBIT 1 CROSSING DISTANCE MEASUREMENTS

3.2 FLASHING DON'T WALK (FDW) INTERVAL

The pedestrian clearance interval, commonly known as Flashing Don't Walk (FDW) interval, follows the WALK interval and informs pedestrians the phase is ending. During this interval, the UPRAISED HAND indication flashes on the pedestrian signal.

Figure 4E-2 in MUTCD illustrates the pedestrian intervals (see Exhibit 2).

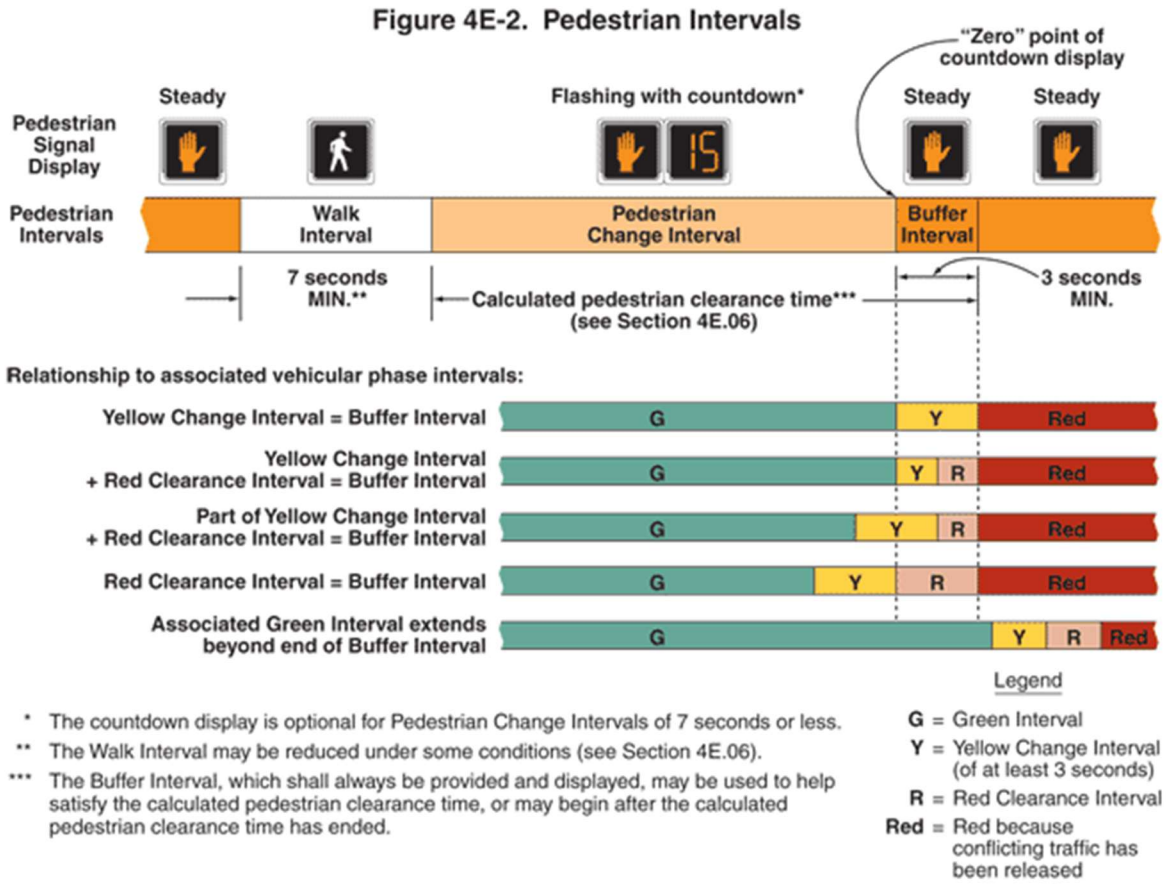

EXHIBIT 2 PEDESTRIAN INTERVALS

Guidelines

- FDW shall be calculated as the pedestrian clearance time minus a buffer interval:
  FDW = calculated pedestrian clearance time – buffer interval
- The calculated pedestrian clearance time shall be computed as the crossing distance divided by the walking speed:
  Calculated pedestrian clearance time = crossing distance / walking speed
- The crossing distance shall be measured from the center of the curb ramp to the edge of the travel way (See Distance B in Exhibit 1) for both directions of the crosswalk. The larger distance of the two directions of the crosswalk shall be used.
- A maximum walking speed of 3.5 feet/second shall be used.

- The walking speed may be reduced to 3.0 feet/second, based on engineering judgment, if any of the following conditions is met.
    - Near facilities where a large proportion of pedestrians have been observed walking at a slower speed.
    - Other locations/situations where the ITS Engineer finds it beneficial (such as senior facilities, medical facilities, parks, event spaces, etc.).
- The buffer interval shall be at least 3 seconds.
- The buffer interval should be equal to the length of yellow change interval.
- The buffer interval may equal to the total length of yellow change interval and red clearance interval, if the calculated pedestrian clearance time uses a walking speed slower than 3.5 feet/second.

Cross-Check Example Crosswalk distance = 55ft, PPB to curb = 8 ft. Ped clearance time (PCT) at 3.5 ft/s = 16s Total crossing time (TCT) at 3 ft/s = (55+8)/3 = 21 s Cross check : (WALK + PCT@3.5 ft/s) >= TCT@3 ft/s (7s + 16s = 21s) = 21 s ✓	**Cross-Check Example** Crosswalk distance = 120ft, PPB to curb = 6 ft. Ped clearance time (PCT) at 3.5 ft/s = 34 Total crossing time (TCT) at 3 ft/s = (120+6)/3 = 42s Cross check : (WALK + PCT@3.5 ft/s) >= TCT@3 ft/s (7s + 34s = 41s) < 42 s ✗ --> **Add 1s to WALK**

EXHIBIT 3 PEDESTRIAN TIMING CROSS-CHECK EXAMPLE USING 3 FT/SEC WALKING SPEED

3.3 LEADING PEDESTRIAN INTERVAL (LPI)

For guidelines related to when to apply LPI at a crosswalk, see Section 4.2. This section only discusses how to set the LPI timing parameter.

A leading pedestrian interval (LPI) is a traffic signalization strategy that gives pedestrians an exclusive period of time to begin entering the crosswalk at an intersection before vehicles are given a green indication. They are also known as Pedestrian Head Start or Ped Jump. Pedestrians can establish their presence in the crosswalk, increasing their conspicuity to other road users, before vehicles are provided a green indication for permissive turns.

Guidelines

- .
- The minimum duration of the LPI shall be 3 seconds, or the time to allow pedestrians to walk from the push button and cross at least one lane of traffic, whichever is longer.
- For locations with very high pedestrian volumes, the LPI time should be in addition to the minimum walk time of 7 seconds to provide additional time for pedestrians to clear.

- The duration of LPI may vary between 3 and 7 seconds and may vary by location. Engineering judgment should be used to determine the appropriate duration of LPI. Factors to consider may include:
    - Lane width. Examples:
        - A shorter LPI value may be provided if the vehicle lane most adjacent to the curb is narrow in width and does not require 5 seconds to cross.
        - A wider lane (typically a channelized right-turn lane) most adjacent to the curb may necessitate a longer LPI value.
    - Intersection size and the impact to intersection operations. Example:
        - If an intersection is large in size and reduced LPI values would reduce the overall delay to road users and improve intersection efficiency.
    - Intersection geometry. Example:
        - A skewed intersection with limited sightline or set back crosswalk
        - A vertical sightline limitation resulting from crest in the roadway
    - Pedestrian volumes. Example:
        - Larger LPI may be provided at locations with high pedestrian volumes.
    - Pedestrian walking speed. Example:
        - Larger LPI may be provided at locations where a large portion of the pedestrians have slower walking speed, such as near an elementary school or a senior facility.

4. SIGNAL OPERATIONS FEATURES RELEVANT TO PEDESTRIAN OPERATIONS

4.1 PEDESTRIAN COUNTDOWN DISPLAY

A pedestrian countdown signal consists of a standard pedestrian signal head with an added display showing a countdown of the remaining crossing time. The countdown timer displays the number of seconds left until the solid Don't Walk phase appears and opposing traffic receives a green light. A pedestrian who has just arrived in the queuing area can use this information to decide whether to start crossing.

Guidelines

- Pedestrian countdown display shall be installed on all new signals and signal modifications.

4.2 APPLICATION OF LEADING PEDESTRIAN INTERVAL (LPI)

For guidelines related to how to set LPI timing parameter, see Section 3.3. This section only discusses when to consider and/or apply LPI at a crosswalk.

Guidelines

- LPI should be evaluated on a location-by-location basis and determined by engineering judgment.
- LPIs may be considered as a treatment at new, rebuilt, and modified signals with pedestrian crossing meeting at least one of these criteria:
    - Located in high pedestrian activity areas:
        - Type 1 and Type 2 Performance Management Areas (PMA) areas in the Mobility Implementation Plan.
        - At major transit transfer points (i.e., intersections of two Major Transit Streets.
        - Near schools.
    - Side street approach with 3 or more vehicles lanes and permissive left turns
    - T intersections and one-way streets where permissive left turning movements have no opposing through vehicular traffic.
    - Street approaches with parallel dual permissive turns across a pedestrian crossing.
    - Crash or conflict history: crash patterns or other identified conflicts (e.g., "near-misses" discovered during video analytics studies) that may be mitigated by implementing LPI.
    - Poor visibility: Pedestrian waiting areas are not easily viewed by turning motorists.
    - High pedestrian volumes, and/or with high conflicting turning volumes.

    - Illumination conditions: Lighting on sidewalks or adjacent to the roadway may not illuminate the pedestrian as well as lighting within crosswalks, and the use of LPI may mitigate this scenario (a lighting study should be conducted).
- LPIs are less appropriate at signalized crossings with at least one of these features:
    - With protected-only left turns and/or right turns for all approaches
    - Minor street crossings where the crossings are shorter and have a low percentage of vehicles turning from the major street.
    - Locations with large vehicle stop line setbacks (like protected intersections).
    - Locations with a high degree of turning vehicle conflicts (which would be better served with fully protected turn movements).
- LPIs may be implemented by time of day, particularly when there are expected operational impacts (such as impacts and delay of other modes, impact of change in cycle length). Example:
    - At a crosswalk near a school, LPI may be implemented only during the peak school traffic periods.
- When implementing LPIs, Accessible Pedestrian Signal (APS) buttons should exist or be added.
- When implementing LPIs, edge-lit pedestrian signs may be used.

4.3 PEDESTRIAN RECALL

The pedestrian recall is a phase recall mode that causes the controller to place a continuous call for pedestrian service on a specified phase each time the controller is servicing a conflicting phase, regardless of the presence of any detector-actuated calls for the phase. This results in the controller timing the WALK and FDW operation for the specified pedestrian phase.

Guidelines

- Pedestrian recall shall be used at crosswalks where pedestrian detection does not exist.
- At locations where the conflicting left turn movements are not coupled with the Ped Minus feature, main street pedestrian movements should be programmed with pedestrian recall during coordinated operation so pedestrians traveling along the main street are not required to push the button to receive a WALK display.
- Main street pedestrian movements should be programmed with pedestrian recall during free operation or Ped Minus feature if there is a high likelihood that one or more pedestrians will be present to be served on most cycles of the signal.
    - Definition of "high likelihood":

        - The main street pedestrian movement parallels a multi-use path.
        - Pedestrians cross at least 60% of signal cycles for the evaluation period.[2]
- Side street pedestrian movements may be set in pedestrian recall at high pedestrian volume locations during times of day when there is a high likelihood that one or more pedestrians will be present to be served on most cycles of the signal.
    - Definition of "high likelihood": Pedestrians cross at least 60% of signal cycles for the evaluation period.

4.4 REST IN WALK

Rest in WALK is a coordination mode which causes a specified phase of a signal to dwell in the pedestrian walk interval while awaiting the yield point.

Guidelines

- Rest in Walk should be used in conjunction with Pedestrian Recall at crosswalks where pedestrian detection does not exist, during coordinated operations.
- Rest in Walk should be used for a main street pedestrian movement paralleling a multi-use path, during coordinated operations.
- Rest in Walk may be used at locations with high pedestrian volumes, such as in downtown environments or near schools as students are arriving or leaving school for the day, either during coordinated or free operations.
- Rest in Walk may be used by time of day.

4.5 PEDESTRIAN RE-SERVICE / PEDESTRIAN RECYCLE

Pedestrian re-service and pedestrian recycle are terms used interchangeably that refer to a signal operations feature that allows the pedestrian interval of a phase to start after the beginning of green for the concurrent vehicular phase if the pedestrian clearance times can still be serviced in their entirety.

Guidelines

- Pedestrian re-service/recycle should be used for mainline movements during coordinated operations where the typical split allows the pedestrian phase to be served twice (because ped recall is recommended for such movements).

---

[2] https://trid.trb.org/view/1760071#:~:text=Results%20showed%20that%20pedestrian%20recall,cycle%20is%20greater%20than%200.9

- Pedestrian re-service/recycle shall not be allowed when the conflicting turn movement is operated by a FYA with Ped Minus operation except with First Come First Serve operation (see Section 4.8).

4.6 EXCLUSIVE PEDESTRIAN PHASE: SCRAMBLE AND NON-SCRAMBLE

4.6.1 EXCLUSIVE ALL-WAY WALK (PEDESTRIAN SCRAMBLE PHASE)

An exclusive all-way WALK, also known as a pedestrian scramble phase, or Barnes Dance, is a type of traffic signal movement that temporarily stops all vehicular traffic, thereby allowing pedestrians to cross an intersection in every direction, including diagonally (though not required), at the same time.

Guidelines

- Exclusive all-way walk (pedestrian scramble) phase should be evaluated on a case-by-case basis and determined by engineering judgment. Factors to consider include:
    - Pedestrian and vehicular volumes.
    - Crash or conflict history: crash patterns or other identified conflicts (e.g., "near-misses" discovered during video analytics studies) that may be mitigated by implementing an exclusive pedestrian phase.
    - Potential ramifications to signal operations for other road users.
    - Intersection geometry. For example, skewed intersections may not be a good candidate for pedestrian scramble.
- The pedestrian clearance time should be calculated as described below:
    - If the intersection is designed with pedestrian scramble phase to operate all the time (with diagonal-angled pedestrian signal heads, diagonal crosswalk striping, and/or signs promoting diagonal crossings), the calculation of pedestrian clearance time shall use the length of the longest diagonal crosswalk at such intersection.
    - If the pedestrian scramble phase is operated by time of day and the intersection does not include diagonal-angled pedestrian signal heads, diagonal crosswalk striping, or signs promoting diagonal crossing, then the calculation of pedestrian clearance time may consider only the standard crosswalk lengths and not the length of diagonal crossings. The longest pedestrian clearance time of all the **considered** crosswalks at such intersection shall be used as the pedestrian clearance time of the scramble phase.

4.6.2 OTHER EXCLUSIVE PEDESTRIAN PHASE (NON-PEDESTRIAN-SCRAMBLE)

A non-scramble exclusive pedestrian phase is a portion of a traffic signal cycle that stops all vehicular movements and allows pedestrians in a certain crosswalk or certain crosswalks (though

typically not all the crosswalks) at an intersection to cross without any conflicting vehicular movements.

Guidelines

- Exclusive pedestrian phase may be implemented based on characteristics of an intersection. Factors to consider include:
    - Crash or conflict history: crash patterns or other identified conflicts (e.g., "near-misses" discovered during video analytics studies) that may be mitigated by implementing an exclusive pedestrian phase.
    - At T intersections, the crosswalks to cross the major road may be operated as an exclusive phase to eliminate the conflicts between crossing pedestrians and the protected side-street turning movements.
    - Volumes of pedestrians and conflicting vehicular movements.
    - Potential ramifications to signal operations for other road users.

4.7 LEFT TURN PHASING MODE CONSIDERATIONS

Left turn phasing mode is a key component of the design and operation of a traffic signal, with impacts on safety and operations for all users of an intersection. Left turns can operate using one of the following phasing modes:

- **Permissive-only**, where left turns are usually served by a circular green or flashing yellow left turn arrow signal indication. Permissive left turns may only be made after yielding to opposing traffic and conflicting pedestrians. During a permissive left turn movement, a pedestrian phase can be served across the left-turn movement's receiving lanes. Left-turning drivers are required to yield to pedestrians in the parallel crosswalk when making a permissive left turn.
- **Protected-only,** where left turns can be made only on a green left turn arrow indication. During a protected left turn movement, no conflicting traffic or pedestrian phases may be served, and no phases may be served that use the same receiving lanes, unless sufficiently channelized. **Split phasing** is a special case of protected-only phasing mode in which the green indications for all movements on a single approach always start and end at the same time.
- **Protected-permissive,** where both modes may be used on the same approach during the same signal cycle.

Guidelines

- City shall continue to use the established Left Turn Phasing Guidelines to determine the appropriate left turn phasing.

4.8 FLASHING YELLOW ARROW (FYA) OPERATION AND PEDESTRIANS

4.8.1 Flashing Yellow Left Turn Arrow (FYLTA) Operation

When the left-turn movement is protected during one part of the cycle and permissive during another part of the cycle, the left turn operation mode is referred to as protected-permissive mode. Protected-permissive left-turn (PPLT) mode with a flashing yellow left turn arrow (FYLTA) signal head is typically used in situations where geometric conditions allow permissive left turns and one or more of the following conditions is met:

- Left Turn traffic volumes are high enough that a left-turn phase is required for capacity reasons.
- Safety analysis has indicated a need to add a protected left-turn phase.

Flashing yellow arrow left turn operation can also be done in conjunction with two optional features:

- **Ped Minus:** The flashing yellow arrow is prohibited during the pedestrian Walk and Flashing Don't Walk (remains red). Once the pedestrian phase has timed out, then the flashing yellow arrow be served if there is sufficient time remaining. A pedestrian phase cannot be re-serviced once the flashing yellow arrow is running.
- **First Come First Serve:** The flashing yellow arrow left turn display remains red and the pedestrian signal remains Don't Walk until a demand is placed for either movement as illustrated in Exhibit 4. This allows for the re-service of pedestrian phase when there is no left turn present, even when using Ped Minus.

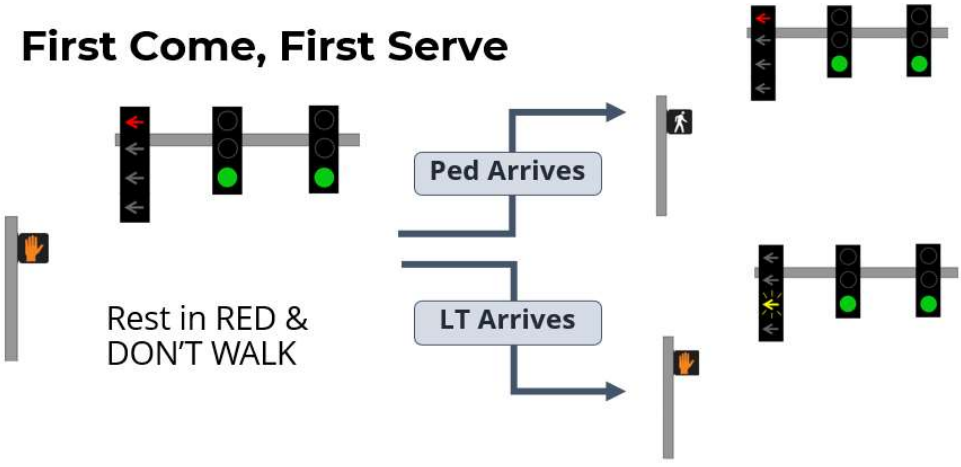

EXHIBIT 4 FIRST COME FIRST SERVE FYA OPERATION DIAGRAM

Guidelines

- FYLTA signal heads should operate in Ped Minus mode where the FYLTA display is omitted in the presence of a pedestrian phase (WALK and FDW) in the conflicting crosswalk.
- FYLTA may operate without Ped Minus in the following conditions:
    - Where the conflicting pedestrian crossing is a minor roadway or a driveway of 30 feet or less, AND
    - Where the left turn conflicts with 2 or less lanes of traffic
- When FYLTA operates without Ped Minus, it may also operate in conjunction with a pedestrian recall and Rest in WALK.
- When FYLTA operates without Ped Minus, the MUTCD R10-15L sign should be installed to alert drivers of the yield-to-pedestrians condition.

R10-15L (TURNING VEHICLES YIELD TO PEDESTRIANS)

- When FYLTA operates with Ped Minus, First Come First Serve should be used to reduce delay unless determined unnecessary by engineering judgement.

4.8.2 FLASHING YELLOW RIGHT-TURN ARROW (FYRTA) OPERATION

When the right-turn movement is protected during one part of the cycle and permissive during another part of the cycle, the mode is referred to as protected-permissive mode. The permissive right-turn operation occurs during the adjacent through movement phase. The protected right-turn operation generally occurs during the complementary left-turn phase on the cross street or concurrently with the adjacent through movement phase when there is no adjacent pedestrian phase present. City of Bellevue operates FYRTA signals as illustrated in Exhibit 5.

EXHIBIT 5 FYRTA PHASING WITH ADJACENT PEDESTRIAN SIGNAL

Guidelines

- FYRTA operation should be used for dedicated right turn pockets where:
    - There is a dedicated right turn lane and a conflicting crosswalk movement with a pedestrian signal head.
- The FYRTA should be accompanied by the MUTCD R10-15R sign to alert drivers of the yield-to-pedestrians condition.

R10-15R (TURNING VEHICLES YIELD TO PEDESTRIANS)

4.9 RIGHT-TURN-ON-RED (RTOR) RESTRICTIONS

Right Turn on Red (RTOR) is a movement that permits motorists to come to a full stop, then yield to cross-street traffic and pedestrians prior to turning right on red. RTOR restrictions prohibit this movement, either permanently or on a part-time basis.

Guidelines

The following discussions in this document only include considerations of RTOR restrictions that are relevant to pedestrian operations. For all other non-pedestrian-related applications, refer to the City's Standard Operating Procedures and MUTCD requirements.

- When no other pedestrian-related signal operations features (as listed in Section 4.1 through 4.8) are used, RTOR restrictions may be considered when one or more of the following conditions are met and determined based on engineering judgement:
    - Where exclusive pedestrian phases or high pedestrian volumes are present.
    - Locations with high pedestrian activity in general, such as downtown areas, community centers, and schools.
    - Crash or conflict history: crash patterns or other identified conflicts (e.g., "near-misses" discovered during video analytics studies) that may be mitigated by restricting RTOR.
    - Where there is a high conflict between pedestrians and conflicting right-turn volumes (see Exhibit 6 for reference regarding the crosswalk and the right-turn movement of interest).

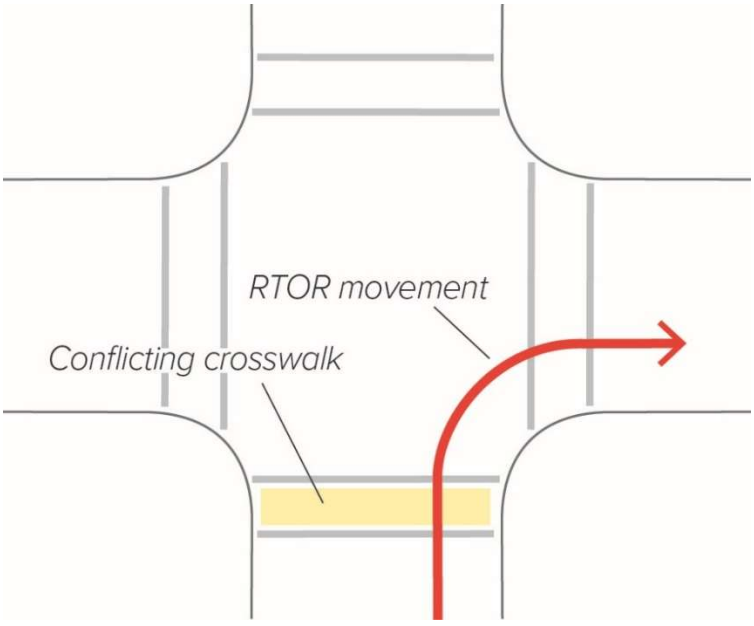

EXHIBIT 6 RTOR MOVEMENT AND CONFLICTING CROSSWALK

- When one or more of the following pedestrian-related signal operations features are being used, right turn on red restrictions should be evaluated based on the following criteria:
    - When LPI is used, RTOR from the parallel approach may be restricted for the duration of the LPI.
    - When Pedestrian Scramble is used, RTOR shall be restricted.
    - When Pedestrian Exclusive Phase is used, RTOR restriction of any movement with a conflicting crosswalk (see Exhibit 6) should be considered.
- When a right turn on red restriction is applicable for only a specific time of day or specific phase of the traffic signal, a dynamic blank out sign should be used.

5. FUTURE CONSIDERATIONS

During the development of these guidelines, the following items were identified as future needs that will require additional research to support additional changes.

PEDESTRIAN COUNTDOWN DISPLAY

Complete the phased-in plan to upgrade all existing signalized intersections, if they are not equipped with countdown timer display, to include a countdown display.

PEDESTRIAN RE-SERVICE/RECYCLE ON SIDE STREETS

Pedestrian re-service/recycle is not currently programmed in SCATS for side streets. Investigate re-service ability for side streets for locations where both streets are major roadways.

CONFLICTING VOLUME THRESHOLD BETWEEN PEDESTRIANS AND VEHICLES

Throughout this document, the conflict between pedestrian and vehicular movements is often a factor to consider for the application of certain pedestrian-related features. However, quantifiable thresholds have not been established and require research to further clarify the following signal operations elements.

- LPI
- Left turn phasing mode
- Non-scramble exclusive pedestrian phase
- RTOR restrictions