CBD TRAFFIC SIGNAL CYCLE TIME

Division          Sustainability and Regulatory Services

Presenter        Haig Poulson, Principal Engineer, Traffic Engineering

Purpose

1. To advise on the qualitative assessment of the impact of reducing the cycle time of traffic signals across the Central Business District (CBD), in order to reduce public transport, cyclist and pedestrian waiting times.

Recommendation from Management

2. That the Planning Committee:

   2.1. agree to the objectives of introducing 75/80 second traffic signal cycle times in the CBD; and

   2.2. instruct the administration to utilise the Department of Transport’s Integrated Transport Model, when available, to confirm that a 75 or 80 second cycle can be implemented, and if so, to take the necessary steps to implement it.

Background

3. Councillor Brindley had requested a report regarding the development of the CBD integrated transport model. This report was provided at the April 2008 Planning Committee meeting.

4. At the 8 April Committee meeting, a motion was passed requesting that a report be brought to the June 2008 Planning Committee meeting outlining the opportunities for the shortening of the traffic signal cycle times in the entire CBD.

Key Issues

5. This report is based on the experience of traffic engineers who have managed traffic in the CBD. Committee should note that this report is not the definitive assessment of the impact of reducing traffic signal cycle times. The task is too complex without the use of an integrated transport model such as that being developed by the Department of Transport. Most intersections within the CBD currently operate with a 90 second cycle during the peak periods. The exception to this is King and Spencer Streets as they are classified as Arterial Roads under the control of VicRoads and operate at higher cycle times (between 110 and 120 seconds during peak periods) as they carry heavy traffic flows. Any consideration of shortening cycle times on King and Spencer Streets would require significant involvement and input by VicRoads. Accordingly, in order to simplify this assessment, this report only considers the intersections bounded by Spring Street, William Street, Flinders Street and La Trobe Street during the peak periods.
6. This report focuses on simple two phase intersections (such as Collins Street and Russell Street). Other complex multi-phase intersections such as Swanston Street and Flinders Street have not been assessed in detail as a 90 second multi-phase cycle has already been optimised and could not be reduced further without adversely impacting on pedestrian safety and service levels. The detailed discussion of the reducing cycle times in attached in Attachment 1.

7. Shortened cycle times across the CBD could potentially provide benefits to pedestrians, tram, buses, cyclists and vehicles through:

7.1. decreased waiting times for pedestrians;

7.2. reduction to pedestrian “crowding” at intersections;

7.3. decreased waiting times and faster progression for trams and buses;

7.4. improved tram throughput (by increasing the number of cycles per hour);

7.5. decreased waiting times for cyclists; and

7.6. increased opportunities for turning vehicles (including hook-turns and left-turns).

8. In addition to the potential benefit for tram services, a number of other issues need to be considered to determine whether decreased traffic signal cycle times are appropriate, and whether adverse impacts may result. The impacts have been considered in the context of the following road user groups:

8.1. trams;

8.2. bicycles;

8.3. pedestrians; and

8.4. vehicles.

9. The reduction in cycle time from 90 to 80, 75 or 60 seconds would enable more signal cycles to occur each hour, which provides more opportunities for pedestrian, cyclist and public transport movements to occur at an intersection. However with an increase in the number of cycles per house there is also an increase in the time taken to change between successive the phases of a cycle, which is manifested as the inter-green (amber and all-red) periods between phases and cycles. Currently there is 400 seconds of inter-green time per hour using a 90 second cycle time. The addition of 20 cycles per hour through the adoption of a 60 second cycle would result in around 200 seconds of additional inter-green time each hour.

10. The traffic signal cycle time analysis in Attachment 1 is a basic assessment of the impacts of reducing the traffic signal cycle time from 90 seconds to 80, 75 and 60 seconds at a discrete two phase intersection. It does not attempt to assess the impacts such reductions would have on the whole CBD network. Given the need to retain 90 second cycle times at complex intersections which have three or more phases, there could be significant impacts on signal linking in the CBD if many intersections were converted to a lower cycle time but the complex three-phase intersections were left at 90 second cycle times.

11. That is, the attached assessment has not looked at the impact of reducing cycle time limits on a network level. Such a task is beyond the resources assigned to the preparation of this report and given the multitude of calculations required to assess such a significant change to signal operations at a network, such a task is best undertaken by an integrated computerised transport model. Consequently a decision to alter traffic signal operations without a full analysis by the Department of Transport’s integrated transport model would be unwise.
12. From the assessments undertaken in this report it would appear that, subject to a full analysis, a 75 second or 80 second cycle time would be an extremely desirable outcome for the CBD, as it would lead to improved travel time for trams and decreased crowding and waiting times for pedestrians and cyclists and dependent upon the outcome of the full analysis, such a reduction in cycle times should not have an overwhelmingly negative impact on vehicle capacity. In fact a full analysis by the transport model could also determine that a daily dynamic maximum cycle time be introduced into the CBD network. This could result in a 60, 75, 80 or 90 second maximum cycle time operating at different times of the day.

Time Frame

13. While reduced cycle times could be implemented in a short timeframe the decision to reduce cycle times is subject to reaching agreement with VicRoads. As part of any detailed implementation strategy a more detailed intersection by intersection assessment should be performed.

Relation to Council Policy

14. The comments made in this report are in line with Council’s 2006-2020 Transport Strategy “Moving People and Freight” by improving pedestrian service and safety and improving tram and bus reliability by reducing delays caused by traffic signals.

Consultation

15. This matter has been discussed with VicRoads’ traffic signal engineers.

Finance

16. The shortening of cycle times could have some cost implications to Council for each site as VicRoads will be required to implement these changes.

Legal

17. The recommendation made in this report has no direct legal implications.

Sustainability

18. Possible improvements in the traffic signal operations in the CBD would assist Council in developing a more sustainable traffic operation plan in the CBD.
ASSESSMENT OF THE IMPACTS OF REDUCING THE TRAFFIC SIGNAL CYCLE OF A SIMPLE TWO PHASE 90 SECOND CYCLE CBD INTERSECTION

This assessment only considers the operation of simple two phase intersections bounded by Spring Street, William Street, Flinders Street and La Trobe Street, where pedestrian volumes and tram movements are at their peak in the CBD.

As stated in paragraph 7 of the main report the shortened cycle times across the CBD could potentially provide benefits to pedestrians, trams, buses, cyclists and vehicles through:

- Decreased waiting times for pedestrians
- Reduction to pedestrian “crowding” at intersections
- Decreased waiting times and faster progression for trams
- Improved tram throughput (by increasing the number of cycles per hour)
- Decreased waiting times for cyclists
- Increased opportunities for turning vehicles (including hook-turns and left-turns)

The following discussion analyses the impact the cycle time reductions would have on trams, bicycles, pedestrians and vehicles (note: for the purpose of the analysis, vehicles also covers route service buses, where bus lanes are not provided). Where bus lanes are provided it would be reasonable to assume that the impacts on buses would be similar to those that would be experienced by a tram, as both modes of transport would be travelling along their own road reserve.

1. **Trams**

Trams play a major transport role within the CBD, moving large numbers of passengers throughout the day. Minimising their delay at intersections helps improve the reliability of the service and assists in reducing congestion on the road network.

In the context of this discussion of shorter cycle times, key issues relevant to trams are:

- The desire to minimise delay at intersections through the reduction of “red” time;
- Maximise opportunities to cross an intersection.

The capacity of tram lines at an intersection is irrelevant as only a few trams need to cross a given intersection in a single phase. The green time available under either 60 or 90 second cycle is therefore well in excess of the time actually needed to move a few trams across an intersection.

**Tram Impacts**

Tram delay was assessed to determine if shorter cycle times reduced overall delay. Shorter cycle times will result in more cycles per hour which gives more opportunities for north-south and east-west movements. As such, if a tram arrives at an intersection at the end of their green phase they will have less time to wait (up to 35 seconds) with shorter cycle times compared to existing cycle times (up to 50 seconds). This equates to a saving of approximately 30%. The following table shows locations where maximum tram waiting times are likely to decrease under a 60 second cycle. The comments relating to trams can also be referred to bus services in the CBD, where the buses operate in an exclusive bus lane.
2. Bicycles

Melbourne has a steadily growing network of dedicated bike lanes which increase safety and encourage bicycle use. However there are less formal bicycle facilities within the CBD due to limited road space. As such, the amenity of cyclists within the CBD should be optimised wherever possible. Maintaining sufficient time for a cyclist to cross an intersection is an important safety consideration.

Bicycle Impacts

Bicycles are expected to benefit from a reduction in traffic signal cycle times due to more crossing opportunities at intersections each hour. This results in a higher level of service for cyclists through the CBD. Shorter cycle times would also help to reduce the “bunching” of cyclists at intersections, which is currently an undesirable outcome given the scarcity of storage space within the CBD environment.

3. Pedestrians

Pedestrian safety may be affected by the reduction of cycle times in some instances if inadequate crossing times are provided to enable pedestrians to safely cross the road. When crossing “major” roads, the pedestrian crossing time can affect the minimum green time and thus the overall cycle time for the intersection. Pedestrian crossing times must also take account of the start-up time, where a crowd of pedestrians is gathered on the footpath waiting to cross. There can often be a delay before all pedestrians are able to get access to the road and begin their crossing. Older pedestrians generally take longer before starting to cross a road due to the perceived dangers, and their slower reaction times.

The key issues relevant to pedestrians are:
- The ability to safely cross a road;
- Minimise waiting time through increased crossing opportunities; and
- Encourage compliance.

Pedestrian Impacts – Able Bodied Pedestrians

An assessment on the impact to pedestrians has taken into consideration the actual “green man” display time which has been increased as a result of the additional number of cycles per hour. The maximum waiting time for pedestrians would decrease by 30%
(in line with maximum tram waiting times from 50 seconds to 35 seconds). The number of pedestrian crossing opportunities per hour (Level of Service) could increase by up to 50% from 40 cycles per hour to 60 cycles per hour. This increase in pedestrian capacity would assist in reducing pedestrian waiting times at intersections and would also reduce the potential of pedestrian crowding. The following table shows the locations where pedestrian capacity would be increased.

<table>
<thead>
<tr>
<th>Increase in Pedestrian Level of Service – Able Bodied Pedestrians</th>
</tr>
</thead>
<tbody>
<tr>
<td>La Trobe</td>
</tr>
<tr>
<td>Lt Lonsdale</td>
</tr>
<tr>
<td>Lonsdale</td>
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<tr>
<td>Lt Bourke</td>
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<tr>
<td>Bourke</td>
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<tr>
<td>Lt Collins</td>
</tr>
<tr>
<td>Collins</td>
</tr>
<tr>
<td>Flinders</td>
</tr>
<tr>
<td>Lane</td>
</tr>
<tr>
<td>Flinders</td>
</tr>
</tbody>
</table>

Legend: reduced capacity | neutral | increased capacity

Pedestrian Impacts – Elderly Pedestrians

Pedestrian crossing times have been assessed using both “fit” and “elderly” pedestrians. These pedestrian classifications have a walking speed of between 1.0 and 1.3 metres per second, defined by the AustRoads Guide to Traffic Engineering Practice Part 13 (1995). A lower walking speed 0.8 metres per second has been adopted for elderly pedestrians to provide a more conservative assessment. A 5 second start up delay has also been applied to elderly pedestrians, as it has been observed that elderly pedestrians tend to wait at the back of the queue when waiting to cross the intersection and hence take longer to reach the start of the crossing. Using these values, an elderly pedestrian would not be able to safely cross all intersections within the CBD if a 60 second cycle was adopted. The following table shows locations where they would not be able to cross the road in the provided time. In the worst case, where the crossing distance is 22.8 metres between footpaths, elderly pedestrians would take a total time of 33.5 seconds (28.5 seconds crossing and 5 seconds start up). Given the maximum ‘green man’ and flashing ‘red man’ time can only be 25 seconds per movement an elderly pedestrian would have a shortfall of approximately 8.5 seconds when crossing one leg of the intersection.
4. **Vehicles**

When assessing vehicle movements within the CBD, there are generally two issues that should be considered, vehicle capacity at the intersection for through and turning vehicles.

**Vehicle Capacity**

Vehicle capacity is also a factor that needs to be considered in order to retain adequate local access and circulation opportunities in the CBD, particularly on heavily trafficked routes. Maintaining signal coordination is also important to ensure that queue formation between adjacent intersections is minimised as this can affect or hinder traffic movements (including trams and pedestrians). Reducing a 90 second cycle time to 60 seconds, would increase the “lost” time on a two-phase cycle (the typical CBD intersection treatments) by approximately 200 seconds each hour (20 more cycles and 10 seconds lost time per cycle), or 6.3% of capacity. At intersections with single through lane configurations, the lost capacity may be in the order of 80 vehicles per hour assuming that vehicles travel at 2.5 second headways. At multiple through lane intersections the capacity reduction will be greater.

**Turning Vehicles**

Turning traffic is affected in a number of ways by shorter cycle times. These may in some instances need to be examined on a site-by-site basis. The impacts can include:

- **Hook-turn traffic** – More opportunities are created as these movements are generally capacity constrained to a few vehicles (2 or 3) at the end of each phase. Therefore more signal cycles per hour will result in more capacity for hook turns. This may increase the number of hook turns by 40-60 per hour.
- **Left turn movements** – Greater where left turn movements are generally constrained to the end of each phase (due to high pedestrian movements). Therefore more signal cycles per hour will result in more capacity for left turn movements. This may also increase the number of left turning vehicles by 40-60 per hour.
Vehicle Impacts

An assessment of the capacity impacts at each intersection has been undertaken, assuming a cycle time reduction of 30 seconds from 90 seconds down to 60 seconds. This provides a simplistic whole of city assessment, based on the reduction in the amount of green-time per hour and the increase in the amount of ‘lost time’. The following table highlights impacts on vehicle capacity. It shows that many intersections will have a decrease in vehicle capacity of approximately 6.3%. The intersections which are not adversely affected experience low traffic volumes in at least one direction and turning movements are currently significantly affected by pedestrians.

<table>
<thead>
<tr>
<th>Road User</th>
<th>60 Second Cycle</th>
<th>75 Second Cycle</th>
<th>80 Second Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trams (reduction in waiting time)</td>
<td>4.5% to 30.0%</td>
<td>4.5% to 15%</td>
<td>4.5% to 10%</td>
</tr>
<tr>
<td>Pedestrians (spare elderly crossing time per crossing movement)</td>
<td>8.5 second <strong>shortfall</strong> for a wide CBD carriageway (22.8m) to 3.7 second <strong>shortfall</strong> for narrower CBD carriageways (19.0m)</td>
<td>1 second <strong>shortfall</strong> for a wide CBD carriageway (22.8m) to 3.8 second <strong>spare capacity</strong> for narrower CBD carriageways (19.0m)</td>
<td>1.5 second <strong>spare capacity</strong> for a wide CBD carriageway (22.8m) to 6.3 second <strong>spare capacity</strong> for narrower CBD carriageways (19.0m)</td>
</tr>
<tr>
<td>Vehicles (reduction in capacity)</td>
<td>0.4% to 6.3%</td>
<td>0.4% to 2.5%</td>
<td>0% to 1.6%</td>
</tr>
</tbody>
</table>

Based on the above table, a 75 or 80 second cycle time could provide a balance between a reduction in vehicle capacity and tram waiting time while providing sufficient time for an...
elderly pedestrian to safely cross the road. However, it should be noted that local observations of some CBD intersections indicated occasions where very slow and elderly pedestrians struggled to cross even with the existing 90 second cycle time. The elderly pedestrians used walking sticks to aid their walking and were presumably walking at a much slower speed than 0.8 metres per second which is the assumed walking speed for elderly pedestrians throughout the analysis. Hence, it should be noted that whilst the 75 to 80 second cycle time should be sufficient for the majority of pedestrians to safely cross all roads in the CBD, there will be rare occasions where very slow elderly pedestrians struggle to cross the road. A proposed reduction in cycle time could increase the number of rare occasions where this occurs.

The reduction of the cycle time to 60, 75 or 80 seconds cannot simply be applied across the whole CBD network due to the need to run more complex three-phase signal operations at a number of intersections for safety and vehicle and tram progression reasons. Hence the impact of 60, 75 and 80 seconds cycle times in an area which retains 90 second cycle times at many intersections needs to be assessed via the Department of Infrastructure’s Integrated Transport Model, that is now effectively complete and has the mathematical and computing power to assess the millions of alternative traffic movements motorists may take in response to the changed conditions.
FINANCE ATTACHMENT

DEVELOPMENT OF THE CENTRAL BUSINESS DISTRICT (CBD) INTEGRATED TRANSPORT MODEL

While the report indicates that the shortening of cycle times could have some cost implications to Council for each site if implement, there is insufficient information available at this stage to provide a reliable financial estimate of the costs.

Joe Groher
Manager Financial Services
The recommendation made in the report has no direct legal implications, and is within Council’s objectives and functions.

Section 3C of the *Local Government Act 1989* ("the Act") provides that the primary objective of a Council:

"... is to endeavour to achieve the best outcomes for the local community having regard to the long term and cumulative effects of decisions."

Section 3C of the Act goes on to state that in seeking to achieve its primary objective, a Council must have regard to facilitating objectives, including —

"(c) to improve the overall quality of life of people in the local community;"

Section 3E of the Act provides that the functions of a Council include –

"(a) advocating and promoting proposals which are in the best interests of the local community;"

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**Kim Wood**  
Manager Legal Services