BROWN

Intersection Design and Traffic Assessment

Relocation of Windsor Road / Mt Carmel Road Intersection, Box Hill

March 2014

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Prepared for Mogul Stud/ Jundu

Roads and Traffic Unit

Smart Consulting

COMMERCIAL IN CONFIDENCE

Brown Consulting (NSW) Pty Ltd
Level 2, 2 Burbank Place
Norwest Business Park
PO Box 8300
BAULKHAM HILLS BC NSW 2153

Ph: (02) 8808 5000

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1 Introduction

The proposed development is within Box Hill and the Box Hill industrial precinct included the conceptual design of Mt Carmel Road including the formation of an intersection with Windsor Road. The design was prepared in accordance with the objectives for the Street Network, Design and Hierarchy as set out in the Planning and Infrastructure NSW's Box Hill and Box Hill Industrial Precincts Development Control Plan (DCP). The supporting documentation associated with the proposed development included several conceptual designs, as well as traffic modelling for the intersection of Mt Carmel Road and Windsor Road.

The design of the Mt Carmel Road / Windsor Road intersection which is required by RMS to be signalised, incorporate dedicated bus lanes along either side of Windsor Road and provide connectivity between Box Hill and Riverstone East via the intersection.

The conceptual proposal was supported by Council and RMS subject to detailed design. However, during the detailed design stage, it was revealed that site specific constraints would not permit the intersection to be designed with sufficient sight distance due to the super elevation required from Mt Carmel Road to Windsor Road. As such, it is now proposed to relocate the intersection approximately 300m further west. Several new drawings and analysis were consequently prepared and undertaken and submitted to consenting authorities who have responded by providing feedback, particularly in terms of the design of the Windsor Road / Mt Carmel Road intersection.

Notwithstanding the above, it is currently proposed to relocate the intersection to the west of the gazetted location. The purpose of this report is to provide supporting documentation from a traffic perspective for the relocation of the intersection as well as the consequent rezoning taking into consideration all of the input provided by the consenting authorities.

1.1 Aim

The purpose of this report is to:

- Discuss the background associated with the proposed development;
- Discuss the existing conditions;
- Describe the currently supported road network and traffic conditions particularly associated with Mt Carmel Road and its intersection with Windsor Road;
- Discuss the proposed relocation of Mt Carmel Road and the consequent rezoning of adjacent land;
- Describe the impact on the Strategic Road Hierarchy and Connectivity;
- Describe the likely change in anticipated traffic movements, particularly at the Mt Carmel Road / Windsor Road intersection;
- Assess the intersection's performance on completion of the development as well as during an interim period in which the intersection will consist of a T-intersection configuration and
- Provide recommendations where appropriate.

1.2 Scope of Report

The scope of services for this project is comprised of the preparation of a Design and Traffic Report, combining the following:

- Considerations in relation to the design of the original and new alignments of the entry to Box Hill and the intersection with Windsor Road – road hierarchy, sight distance, super-elevation, coordination between traffic signals; and
- Reassessment of traffic flows and the intersection performance during peak periods; and
- Traffic statement confirming the suitability of the relocation and design.

The redesign of the intersection incorporated RMS' comments dated 12 February 2014. Response to comments are found in Table 4.2.

2 Background

Several studies associated with the Box Hill development as well as several intersection designs have previously been submitted to consenting authorities. This section provides further details of the designs and studies and intends to highlight the framework in which the intersection is being designed. The previous studies, related documents and relevant feedback from consenting authorities are summarised in the following subsections.

2.1 Box Hill & Box Hill Industrial Precincts – Transport & Access Study Report

The Box Hill & Box Hill Industrial Precincts – Transport & Access Study Report dated February 2011 was prepared by GHD on behalf of the Department of Planning. The report forms part of the set of specialist studies involving environmental and urban form analysis at the precinct level that informs the identification of the development footprint and the development of the draft indicative layout plan.

The analysis undertaken as part of the study provides indicative traffic volumes and a road network layout, (including Mt Carmel Road and its intersection with Windsor Road), all of which were informed by detailed traffic modelling undertaken for the area based on an estimated future population growth to 2036.

The information provided in the report was used as the basis for which the Planning and Infrastructure NSW's Box Hill and Box Hill Industrial Precincts Development Control Plan (DCP).

2.2 Box Hill & Box Hill Industrial Precincts – Development Control Plan (DCP)

The DCP provides specific details associated with the proposed road hierarchy, location of roads and associated land use zones adjacent to roads within Box Hill. In addition, the DCP sets out the key objectives in terms of the Street Network, Deign and Hierarchy. The relevant objectives include:

- To provide a hierarchy of interconnected streets that gives safe, convenient and clear access within and beyond the Precincts;
- To ensure that the hierarchy of streets is clearly discernible through variations in carriageway width, on-street parking, street tree planting, and pedestrian amenities;
- To provide an acceptable level of access, safety and convenience for all street and road users within the Box Hill and Box Hill Industrial Precincts, whilst ensuring emergency access and egress, acceptable levels of amenity, and minimising the negative impact of traffic;
- To provide a legible and permeable movement network for pedestrians and cyclists along streets and paths to points of attraction within and adjoining any development;
- To ensure sufficient carriageway and verge widths are provided to allow streets to perform their designated functions within the street network and to accommodate public utilities and drainage systems; and

- To encourage the use of streets by pedestrians and cyclists, and to allow cars, buses and other users to proceed safely without unacceptable inconvenience or delay.

Each of the above items have been taken into consideration to ensure that all DCP objectives are met.

2.3 Windsor Road Primary Access Report - Thompson Stanbury

A report prepared by Thompson Stanbury Associates dated 25th October 2011, titled Primary Access to Proposed Box Hill Precinct Windsor Road, Box Hill assesses the Box Hill Structure Plan on traffic and transport grounds (refer to Appendix A).

The relevant assessment incorporated in the report includes the review of the intersection's proposed location, particularly in relation to its proximity to nearby intersections and the available sight distance, signal co-ordination and road connectivity.

Upon consideration of these concerns, the report concludes that there are significant traffic safety and efficiency advantages associated with the relocation of the primary Box Hill precinct access to Windsor Road approximately 400m to the west of the location exhibited in the DCP.

2.4 Review of Mt Carmel Rd Intersection with Windsor Rd Draft Concept Plan

A review of the intersection of Mt Carmel Road with Windsor Road was undertaken by Brown Consulting in 2013. The analysis focused on the assessment undertaken for the intersection as part of the Box Hill & Box Hill Industrial Precincts – Transport & Access Study Report prepared by GHD.

After a review of the report and modelling, it was found that the configuration of the intersection could be refined in order to provide an improved performance by incorporating the following changes:

1. Reducing the number of right turn lanes for motorists turning right into Windsor Road from the south-western leg of Mt Carmel Road;
2. Introducing an additional fifth phase to the signal phasing during the evening peak period to account for the higher exiting flows from the northern leg of Mt Carmel Road; and
3. Confirming turn bay lengths based on the Sidra Modelling.

A Draft Concept Plan was developed by Brown for the intersection and submitted to the RMS for review / comments.

2.5 RMS response to Draft Concept Plan

An RMS response in respect to the Draft Concept Plan for the intersection indicated their general concurrence to the proposed relocation and design subject to a few minor modifications required to the design particularly associated with lane and median widths. Details of the requirements are provided in Table 4.2 which outlines the concerns raised as well as Brown's response.

It should be noted that the RMS' response stipulates that the relocation appears acceptable with appropriate sight distance available and appropriate distance from two intersections either side (i.e. the Windsor Road / Terry Road intersection and the Windsor Road / Boundary Road intersection).

The response was provided via an email dated 12th February 2014 (refer to Appendix B)

3 Existing Conditions

The currently gazetted location of the section of Mt Carmel Road in question lies within the Box Hill Precinct, North of Windsor Road. The Road is highlighted in the figure below which also shows the proposed future connection to Riverstone East.

Figure 3-1: Mt Carmel Road (Gazetted Location)

(Source: Box Hill & Box Hill Industrial DCP 2013 Part 3).

Design issues were detected in previous stages of design and identified in the Thompson Stanbury report (2011). These issues are summarised below and described in more detail in Section 5:

- Insufficient sight distance
- Super-elevation
- Excel of fill
- Significant removal of vegetation
- Inefficient coordination between traffic signals and intersections' performance along Windsor Road
- Inefficient connectivity with the internal road layout

3.1 Road Hierarchy

The DCP and RMS provide the following definitions and characteristics in terms of traffic volumes for Arterial, Sub-Arterial and Collector Roads:

- Arterial Roads – typically a main road carrying over 15,000 vehicles per day and fulfilling a role as a major inter-regional link (over 1,500 vehicles per hour);
- Sub Arterial Road – defined as a secondary inter-regional links, typically carrying volumes between 5,000 and 20,000 vehicles per day (500 to 2,000 vehicles per hour);
- Collector Road – provides a link between local roads and regional roads, typically carrying between 2,000 and 10,000 vehicles per day (250 to 1,000 vehicles per hour). At volumes greater than 5,000 vehicles per day, residential amenity begins to decline noticeably.

An assessment of the final road hierarchy and connectivity has previously been undertaken. The Box Hill and Box Hill Industrial Precincts DCP 2013 stipulates that Sub-Arterial roads mediate between regional traffic routes and local traffic routes, and link arterial routes to town centres. Vehicular access to property is not permitted along these roads, so rear access should be provided for properties fronting them. Shared paths are provided for pedestrian and cycle use and on-street parking on both sides of the street is generally provided.

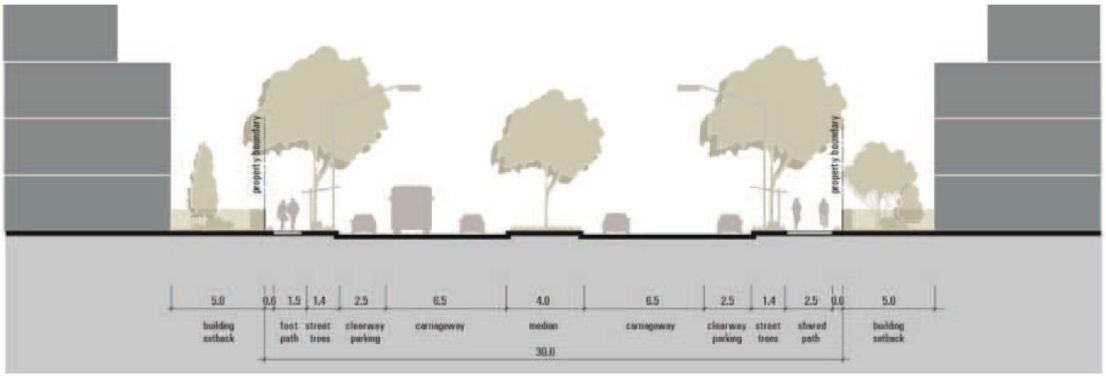
Windsor Road operates as an Arterial Road running from Windsor to Parramatta. There are several Collector and Sub-Arterial Roads intersecting with Windsor Road throughout its entire length. Land adjoining Windsor Road on either side of the proposed intersection location is relatively undeveloped.

In regards to Mt Carmel Road, the Box Hill and Box Hill Industrial Precincts – Transport and Access Study report prepared by GHD in February 2011 on behalf of the Department of Planning provides forecast traffic flows for the year 2036 at full development, including Mt Carmel Road. The report indicates that the peak hour traffic volumes in 2036 will be approximately 2,735vph and 2,536vph during the morning and evening peak periods respectively. Given that the peak hour volumes generally represent between 8% and 12% of the daily traffic volumes, it was assumed that Mt Carmel Road will carry up to 21,960vpd, thereby indicating that it will operate towards the upper notional limit of a Sub-Arterial. The road is therefore considered to be either a Sub-Arterial or Arterial road between Windsor Road and the Killarney Chain of Ponds and has been designed accordingly (refer to Figure 4-1).

Mt Carmel Road will be designed as a collector road north of the Killarney Chain of Ponds. Collector Roads collect traffic from local streets and carries a higher volume of traffic, linking neighbourhoods and centres and accommodating public transport routes. Amenity and safety is to be maintained by restricting vehicle speeds through traffic-calming measures and intersection design. Intermittent parking with landscaping is provided on both sides of the street. The GHD report (2011) references Mt Carmel Road as sub-arterial road. The section of Mt Carmel Road between Windsor Road and Killarney Chain of Ponds has an additional median and carriageway to accommodate traffic flows as a major collector road (refer to Figure 4-2).

The following two figures are taken from the DCP and illustrate the required cross section for Mt Carmel Road between Windsor Road and The Killarney Chain of Ponds and a Typical Collector Road.

Figure 3-2: Mt Carmel Road Between Windsor Rd and the Killarney Chain of Ponds



(Source: Box Hill & Box Hill Industrial DCP 2013 Part 3).

Figure 3-3: Mt Carmel Road North of the Killarney Chain of Ponds (Typical Collector Road)

(Source: Box Hill & Box Hill Industrial DCP 2013 Part 3).

3.2 Intersection Design and Performance

Brown Consulting prepared a brief statement dated 18th June 2013, titled Review of Mt Carmel Road intersection with Windsor Road. The statement detailed an assessment of the intersection analysis undertaken by GHD as part of the Precinct Transport study. The statement provided the following modifications from what was proposed in the GHD study:

- Reduce the number of right turn lanes on the southern leg of Mt Carmel Road from two to one;
- Reduce the length of slip lanes and turn bays on all legs of the intersection; and
- Increase the number of signal phases during the evening peak period from four to five in order to allow both right turn movements and through movements out of Mt Carmel Road.

A Sidra analysis was undertaken to incorporate the above changes. The analysis indicated that the intersections performance would remain relatively unchanged during the morning peak period, however, the intersection's performance would be improved during the evening peak period. The

final conceptual layout as well as the results of the Sidra analysis which were submitted to the RMS are shown in Figure 4-3 and Table 4-1.

Figure 3-4: Conceptual Intersection Layout Supported by RMS

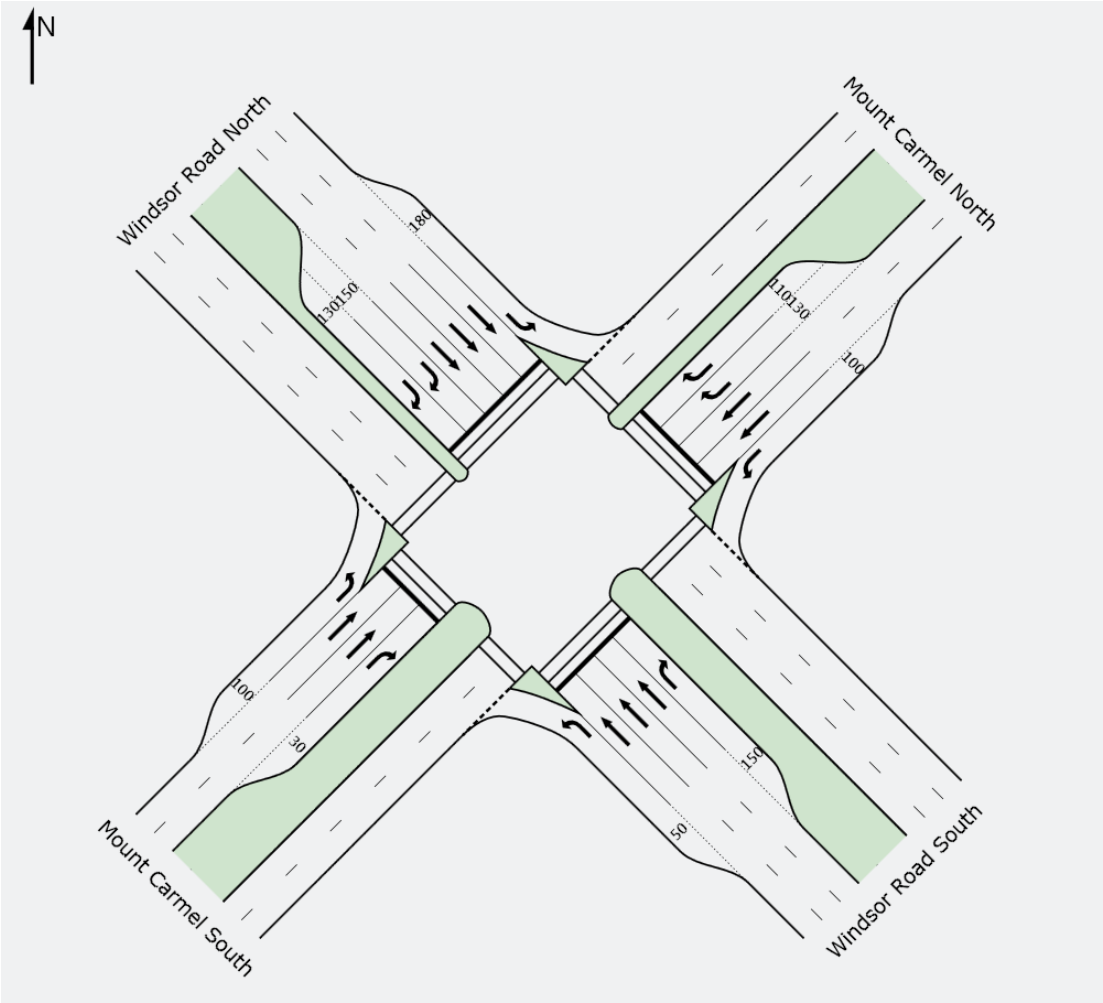


Table 4-1:Intersection Performance (Based on the above Configuration)

Peak Period	Level of Service (LOS)	Average Delay (secs)	Degree of Saturation (DOS)
AM Peak	D	48.4	89.1
PM Peak	D	49.9	89.5

In response to the proposed layout, the RMS provided several comments. All comments have been incorporated into the current design. The comments and respective response are tabulated below.

Table 4-2:RMS' Comments & Response

No.	RMS' comments	Response
1	Median widths of 1.2m in Windsor Road are too narrow, the desirable width is 2.4m. If staged crossings in Windsor Road are required 3.6m. Also the median width in the side road on the northern side should be 2.4, and the width of the median on the side road on the southern side should be 2.4m, 2.0m from the nose. These widths are to cater for signal posts/ push buttons and refuges for pedestrians	Median widths amended accordingly
2	There is no provision for bus jump starts or bus stops on the departure side of the intersection in Windsor Road. It should be noted that both the Garfield Road/ Windsor Road and the Boundary Road/ Windsor Road have bus jump starts and bus stops	Bus jumps starts and bus stops have been provided in design
3	No provision for on road cyclists to travel through the intersection. The preferred option is to have a 4.5m wide left turn lane, with the existing shoulder running into this 4.5m lane and an area of 1.5m in width between the traffic island and the bus jump start	Provision for on road cyclists incorporated into design
4	The two islands on the northern side are to be of sufficient size to cater for all traffic signal furniture i.e. mast arms, pram ramps etc. This especially applies to the island on the north eastern corner. There should also be sufficient room to cater for the scenario where the zebra crossing across the left turn lanes are signalised to cater for cyclists. Where a proposed shared path connects to the signals the crossings across the left run lanes have to be signalised	The two islands are of sufficient size to cater for the signal furniture, including the scenarios mentioned by RMS
5	Lane widths in Windsor Road vary from 3.25m to 3.5m. Lane widths of 3.2m for both through lanes and right turn lanes are acceptable	All lanes have been redesigned to 3.2m
6	Ensure that all merge and diverge tapers are appropriate for the design speed. Which I assume is 90kph as the posted speed is 80kph	Tapers are appropriate for the design speed
7	Will the proposed Mt Carmel Road become an arterial road and handed to the RMS in the future?	Mt Carmel Road is proposed to operate as a Sub-Arterial Road from Windsor Road to the Killarney Chain of Ponds and as a collector road further north

4 Constraints Associated with the Supported Development

This section provides the arguments in favour of relocating the subject intersection further west. A number of constraints are associated with the design of Mount Carmel Road. They were identified in Thompson Stanbury Report (2011) and are described as follows:

- During the detailed design stage it was revealed that the first two proposed locations for Mount Carmel Road raised safety concerns – insufficient sight distance - , particularly at its proposed intersection with Windsor Road. This is a direct result of the road level of Windsor Road being super elevated in a sweeping left hand bend travelling west. As a result, an excess of 5m of fill would be required to align the intersection, the requirement to remove a significant amount of vegetation in the riparian corridor as well as an adverse effect to the available sight distance and general safety at the intersection;
- Traffic signal coordination along Windsor Road between the proposed signal and the ones at Boundary Road and Terry Road/ Garfield Road East could be jeopardised due the unbalanced distances between these intersections and thus reduce the intersection's performance and ability to effectively provide for a sharing of the Box Hill precinct access demands;
- Through the design process it was noted that the preferred arrangement would include two right turn movements for motorists turning right from the southern leg of Windsor Road into Mt Carmel Road in order to match the existing northbound through lanes on Windsor Road. In addition, it was noted that the additional lane would improve the performance of the intersection, particularly during the evening peak period;
- A relocated primary precinct access road would more effectively integrate with the internal road layout of the precinct. This would provide a link to a north-south internal access road approximately to the south-west of the planned sporting fields; and
- The location of Mt Carmel Road is only dependent of its functionality; that is, to provide maximum lot yield for the southern precinct. As such, its location can "float" to provide the best alignment with Windsor Road.

The intersection has been redesigned and modelled accordingly.

5 Proposed Relocation of Mt Carmel Road

This section provides the elements to support the proposed new location of the intersection.

5.1 Road Hierarchy

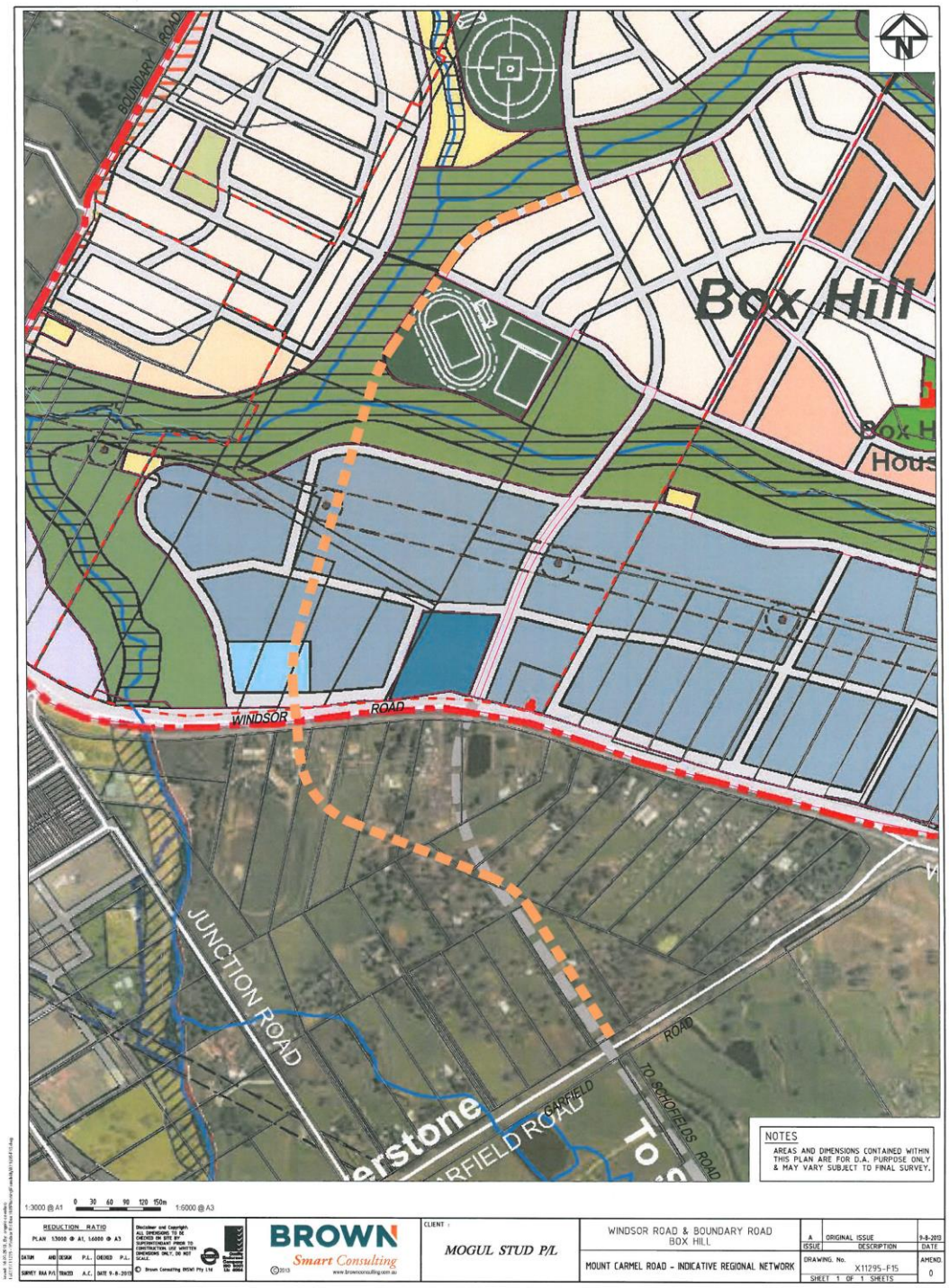
The currently proposed location of Mt Carmel Road is substantially further west than suggested in the DCP (approximately 300m at its intersection with Windsor Road). Nevertheless, the proposed location results in no significant impact in terms of the proposed hierarchy. Mt Carmel Road is again proposed to operate as a Sub-Arterial Road from Windsor Road to the Killarney Chain of Ponds and as a collector road further north. The proposed relocation will continue to provide a connection from Box Hill to Riverstone East.

The proposed relocation is not anticipated to have any significant impact in terms of traffic volumes on Mt Carmel Road or at the Mt Carmel Road / Windsor Road intersection. As such, the analysis previously undertaken in terms of traffic volumes along Mt Carmel Road still stands, and it is considered acceptable to adopt the previously used traffic volumes in re-modelling the intersection.

Given that part of the intended function of Mt Carmel Road was to provide a Sub-Arterial function to commercially zoned land, its relocation still proposes access for the commercially zoned land remains adjacent to Mt Carmel Road. It should be noted that this document intends to support the relocation from a traffic perspective, and that additional supporting documentation will be provided concurrently supporting the rezoning from a Town Planning perspective.

The proposed relocation of Mt Carmel Road is shown in the Figure 5-1 and provides a clearer picture of the items discussed above.

Figure 5-1: Proposed Intersection Relocation



5.2 Mt Carmel Road / Windsor Road Intersection Relocation

The constraints in design identified in Section 5 have been assessed and incorporated into the design of the proposed location of the intersection of Mount Carmel/ Windsor Road. They are discussed as follows:

- The new intersection location provides for a significantly improved arrangement with minimal fill on a straight section of Windsor Road, with minimal loss of vegetation;
- The new location will not impact in the road hierarchy system;
- The new intersection location allows for the provision of adequate sight distance to ensure the safety of motorists. The sight distance has been assessed and supported by the RMS;
- The new location provides sufficient distance from the Windsor/ Boundary Road intersection and the Windsor/ Terry Road intersection offering a more efficient coordination between the traffic signals at the proposed intersection and the existing at these two intersections. The distance between intersections has been assessed and supported by the RMS;
- The new intersection design incorporates bus jumps along Windsor Road;
- In terms of its performance, the relocation has no adverse impact in terms of traffic volumes, queuing, Degree of Saturation (DOS) or average delay. Section 6 provides more details regarding the performance of the intersection; and
- The intersection has been remodelled in order to incorporate the comments provided by the RMS.

6 Intersection analysis

The performance of the existing road network is largely dependent on the operating performance of key intersections, which are critical capacity control points on the road network. The SIDRA Intersection Analysis model has been used to assess the existing peak hour operating performance of both surveyed intersections.

The 'Level of Service' (or LoS) is the standard used to measure the performance of the intersection operation. This is defined as the qualitative assessment of the quantitative effect of factors such as speed, traffic volume, geometric features, delays and freedom of movement. The level of service concept is applied to intersections through measures of effectiveness, as summarised in the table below.

Table 6-1:Intersection Performance Indicators

Intersection Control	Measure of Effectiveness
Sign or merge control	Average Delay (sec / vehicle)
	Delay to critical movements
	Queue length for critical movements
Traffic Signals	Average Delay (sec / vehicle)
	Delay to critical movements
	Degree of Saturation
	Cycle Length
	Queue length for critical movements
Roundabout	Average Delay (sec / vehicle)
	Delay to critical movements
	Degree of Saturation
	Queue length for critical movements

The criteria for evaluating the operational performance of intersections are provided by the Guide to Traffic Generating Developments (RTA 2002). The table below presents the equivalent Level of Service thresholds based on the RTA Guide. The boundary values for average vehicle delays for each Level of Service category as used in the SIDRA intersection modelling is also provided. These boundary values are used in the assessment of intersection operational performance.

Table 6-2:Performance Criteria at Intersections

Level of Service	Average Delay (sec / vehicle) RTA Guide	Sidra Boundary	Traffic Signals / Roundabouts	Give-Way & Stop Signs
A	less than 14	AVD ≤ 14.5	Good Operation	Good Operation
B	15 to 28	14.5 < AVD ≤ 28.5	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	28.5 < AVD ≤ 42.5	Satisfactory	Satisfactory but accident study required
D	43 to 56	42.5 < AVD ≤ 56.5	Operating near capacity	near capacity and other accident study required
E	57 to 70	56.5 < AVD ≤ 70	At capacity; at signals incidents will cause excessive delays	at capacity and requires other control mode
F	Greater than 70	AVD > 70	Roundabouts require other control mode	Unsatisfactory. Excessive delays requires other control mode

RMS Guide to Traffic Generating Developments (Version 2.2, October 2002)

The average delay assessed for signalised intersections is for overall movements. For roundabouts and priority control intersections (with Stop and Give Way signs or operating under the T-junction rule), the critical criterion for assessment is the movement with the highest delay per vehicle. Average delay is expressed in seconds per vehicle.

6.1 Mt Carmel Rd / Windsor Rd Intersection Assessment (Final Arrangement)

The Mt Carmel Road / Windsor Road intersection has been remodelled to include the comments provided by the RMS (as detailed in Table 4.2) and all additional constraints (as listed in Section 5) including a total of two right turn lanes for motorists turning right from the southern leg of Windsor Road. No changes have been made to the traffic volumes adopted in the previous analysis. The latest proposed layout, phasing arrangement during each peak period and the results of the Sidra analysis are presented in the following figures and Table 6-3.

Figure 6-1: Windsor Rd / Mt Carmel Rd Final Intersection Layout

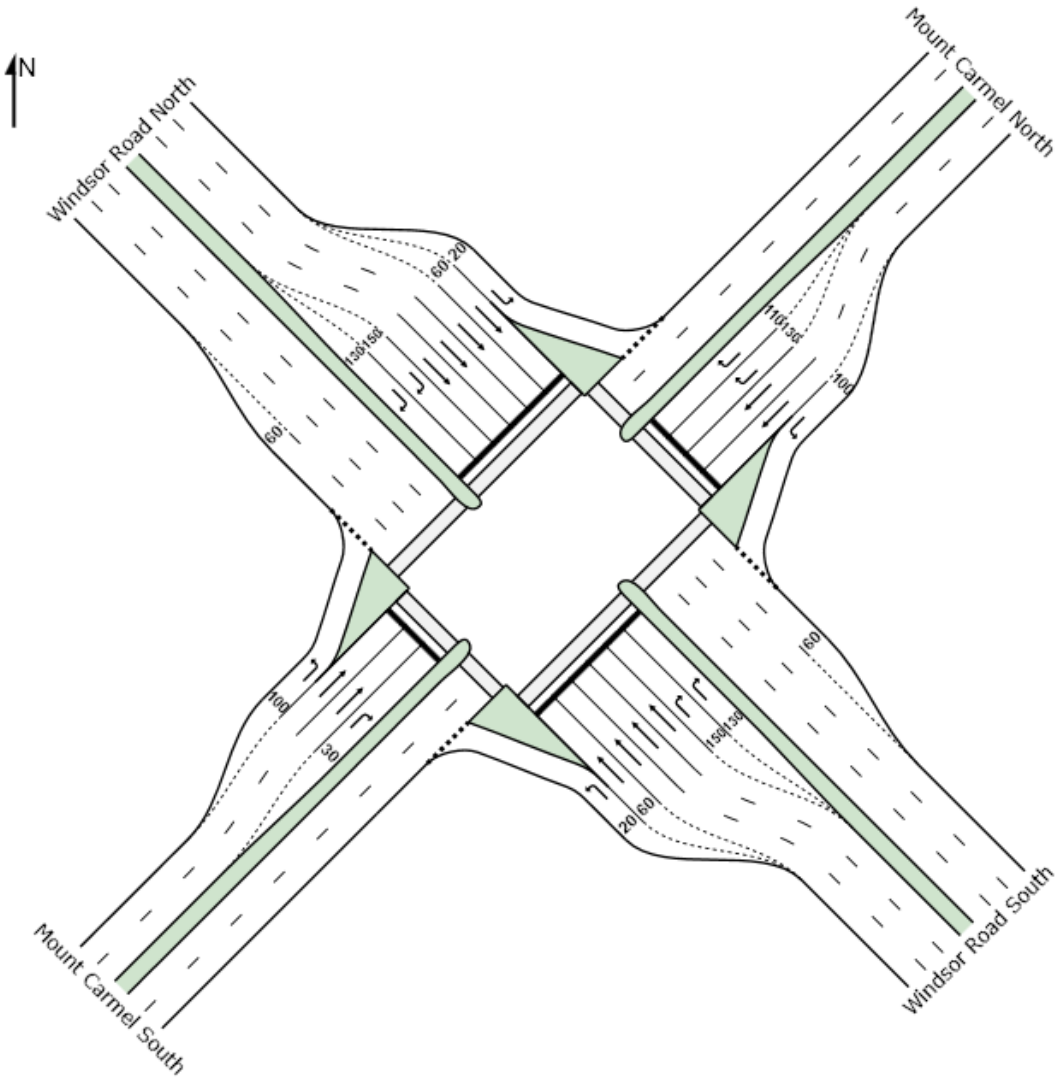


Figure 6-2: Final Layout AM Peak Phasing Arrangement

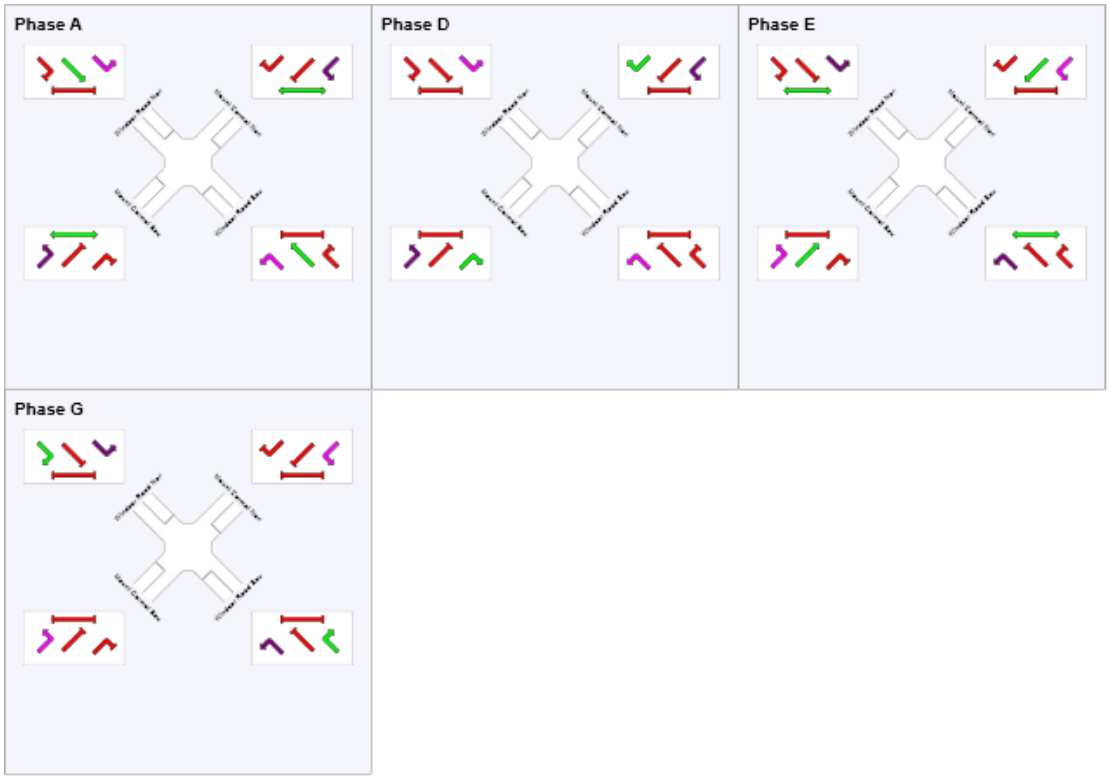
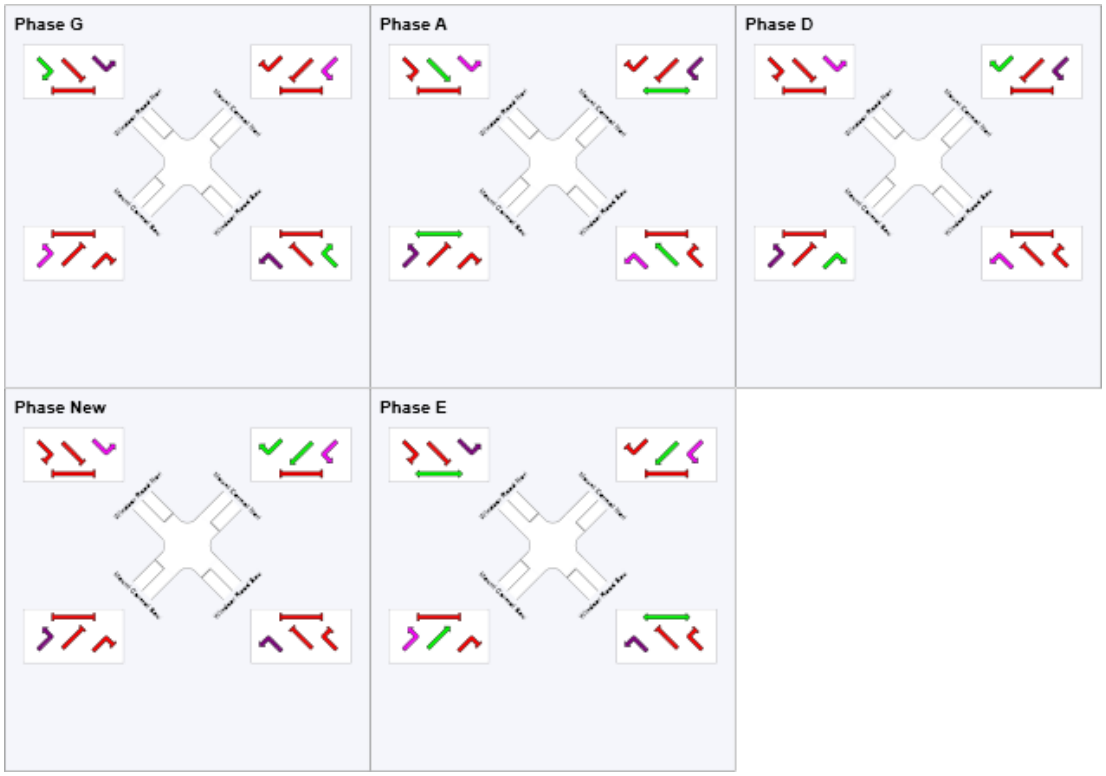


Figure 6-3: Final Layout PM Peak Phasing Arrangement



The results of the analysis indicate that the intersection will operate within its notional capacity post development with acceptable queue lengths and delays. The performance of the intersection based on the adopted layout and phasing arrangement is superior to the anticipated performance based on the GHD report.

Table 6-3:Windsor Rd / Mt Carmel Rd 2036 Intersection Performance (GHD vs Modified)

Peak Period	Level of Service (LOS)	Average Delay (secs)
GHD Intersection		
AM Peak	D	48.4
PM Peak	E	69.2
Modified Intersection		
AM Peak	D	47.2
PM Peak	D	51.7

6.2 Mt Carmel Rd / Windsor Rd Intersection Assessment (Interim Arrangement)

It is envisaged that the Box Hill Precinct will be developed prior to the Riverstone East area. This would result in a T-intersection being provided for an interim period. As such, Sidra Analysis has been undertaken to determine the intersection layout required to ensure a satisfactory level of performance for the intersection.

The volumes adopted for the intersection include the volumes used in modelling the full intersection post-development, minus the movements out of the southern leg of Mt Carmel Road. In addition, all through movements from the northern leg of Mt Carmel Road have been distributed between the left and right turn movements based on the proportion of left and right movements observed in the analysis of the full intersection.

The layout facilitates the redesign of the intersection to incorporate the fourth leg to the intersection, acknowledging that the final layout may consist of a different arrangement based on more detailed analysis that may be undertaken in the future. The adopted volumes, the intersection configuration and the results of the analysis are shown in Figures 6-4, Figure 6-5 and Table 6-4.

Figure 6-4: Windsor Rd / Mt Carmel Rd Interim Intersection Layout

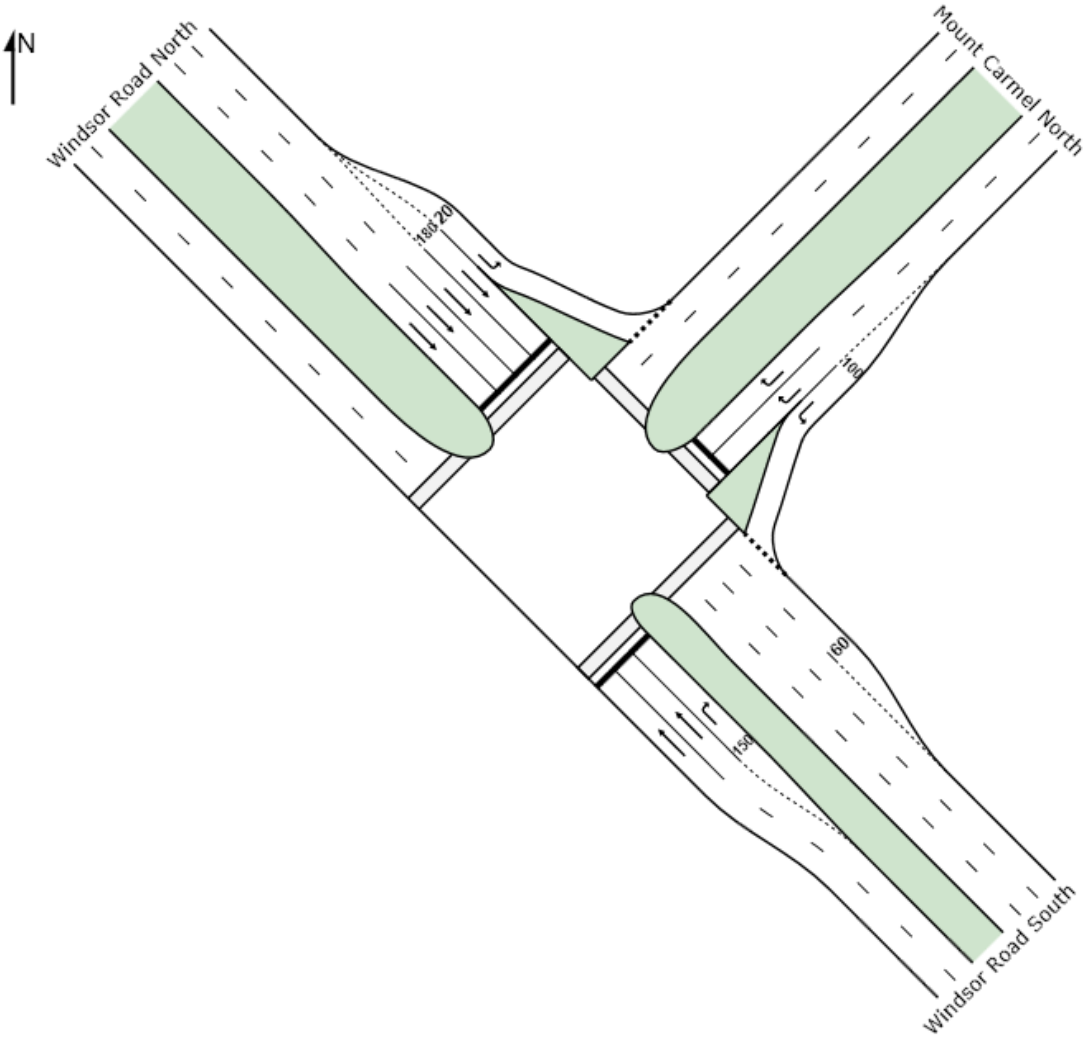


Figure 6-5: Interim Layout Phasing Arrangement (AM & PM Peak)

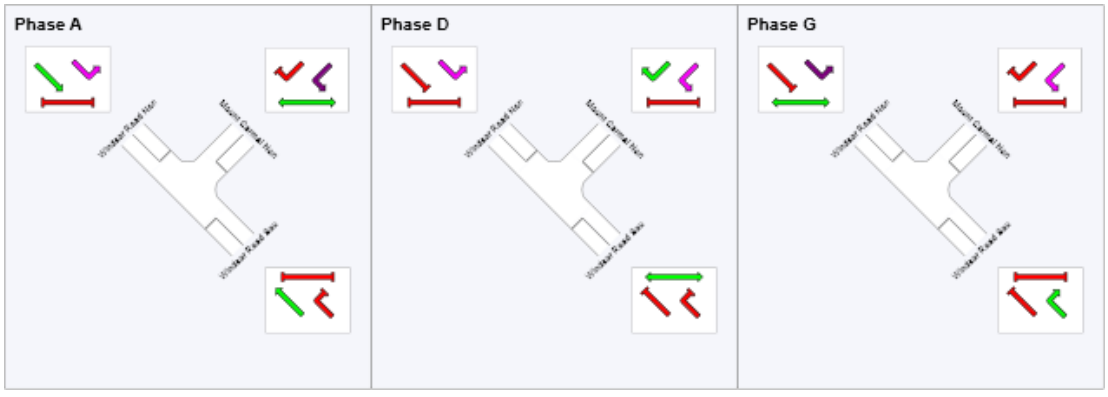


Table 6-4:Windsor Rd / Mt Carmel Rd (Interim Arrangement) Intersection Performance

Peak Period	Level of Service (LOS)	Average Delay (secs)	Degree of Saturation (DOS)
AM Peak	C	29.6	68.8
PM Peak	C	34.8	75.8

The results of the analysis indicate that the intersection will operate within its notional capacity based on the interim intersection layout with the highest delay times of 64.7 seconds for motorists turning right into Mt Carmel Road during the morning peak period and 65.3 seconds for motorists turning right from Mt Carmel Road during the evening peak period.

The detailed Sidra analysis of both scenarios (Final and Interim) are provided in Appendix C.

7 Summary and Recommendations

It is proposed to locate the Windsor Road / Mt Carmel Road Intersection further west than the original proposal. The relocation has been assessed with the main points to note from this assessment listed below:

- The Road Hierarchy and layout as shown within the DCP requires that Mt Carmel Road connect across Windsor Road from Box Hill to Riverstone East and that it be classified as a Sub - Arterial Road;
- The previous analysis of the intersection, based on the originally proposed location, indicated that it would operate within its notional operational capacity, but it would provide insufficient sight distance due to the road level of Windsor Road being super elevated in a sweeping left hand bend travelling west. Its performance could also be improved with greater co-ordination with adjacent intersections if it were located further west. Another constraint included an excess of 5m of fill that would be required to align the intersection, the requirement to remove a significant amount of vegetation in the riparian corridor;
- Through the design process it was noted that the preferred arrangement would include two right turn movements for motorists turning right from the southern leg of Windsor Road into Mt Carmel Road in order to match the existing northbound through lanes on Windsor Road. In addition, it was noted that the additional lane would improve the performance of the intersection, particularly during the evening peak period;
- A relocated primary precinct access road would more effectively integrate with the internal road layout of the precinct. This would provide a link to a north-south internal access road approximately to the south-west of the planned sporting fields;
- The location of Mt Carmel Road is only dependent of its functionality; that is, to provide maximum lot yield for the southern precinct. As such, its location can “float” to provide the best alignment with Windsor Road
- A design of the relocated intersection along with a Sidra analysis was submitted by Brown Consulting to the RMS for discussion. The submission included an assessment of the previous assessment undertaken by GHD in which it was recommended that the intersection be modified to include only one right turn lane. RMS comments were incorporated into the final design;
- Sidra analysis was undertaken for both final and interim arrangements. The performance of the intersection on both scenarios was found to be satisfactory;
- This report has provided the necessary argumentation for the relocation of the subject intersection as well as to its new proposed location, incorporating all care in regards to the identified constraints.

This traffic report supports that the intersection of Windsor Road and Mt Carmel be relocated 300m west from the original design.

Federico Ramos
Brown Consulting

Appendix A: Primary Access to Proposed Box Hill Precinct Windsor Road, Box Hill – Thompson Stanbury Associates

Office:
Suite 15/9 Hoyle Ave., Castle Hill NSW 2154

All Correspondence:
75 Gindurra Ave, Castle Hill NSW 2154

Telephone: (02) 8850 2788
Facsimile: (02) 8850 2799
E-mail: david@thompsonstanbury.com.au
morgan@thompsonstanbury.com.au
www.thompsonstanbury.com.au

MOBILE PHONES: *David Thompson: 0418 262 125* *Morgan Stanbury: 0410 561 848*

THOMPSON STANBURY ASSOCIATES

ABN: 79 943 737 368

25 October 2011

Mogul Stud Pty. Limited and Jundu Pty. Limited
C/- Welsh Property Consulting
125a Pitt Town Road
KENTHURST
NSW 2156

Attention: Bob Welsh

Dear Sir,

PRIMARY ACCESS TO PROPOSED BOX HILL PRECINCT
WINDSOR ROAD, BOX HILL

Reference is made to our recent discussions and your request for this Practice to undertake an assessment of the exhibited Structure Plan with respect to access arrangements to Windsor Road, Box Hill.

BACKGROUND

This Practice has previously been commissioned to undertake preliminary traffic impact assessments of the various iterations of the Box Hill Structure Plan, planned to incorporate approximately 11,000 new dwellings, a number of neighbourhood centres, a Town Centre in conjunction with some recreational and community areas.

It is not known what support has been provided for the exhibited Structure Plan from the relevant authorities however, the Plan provides for primary precinct access to Windsor Road to be located approximately 700m to the west of Terry Road / Garfield Road East and 1,300m to the east of Boundary Road. This Practice has previously reported that such a location has significant disadvantages with respect to the provision of adequate sight distance and the coordination of a new signalised intersection with surrounding signalised intersections.

It has previously been reported that a more desirable location for the primary precinct access connection to Windsor Road in a position approximately 400m to the west of that exhibited. This Practice's view has not altered from that previously reported and the objective of this correspondence is to reiterate the key points previously identified with respect to the safe and efficient connection of the primary precinct access to Windsor Road.

SIGHT DISTANCE

The exhibited location of the Windsor Road precinct access junction is situated within a section of Windsor Road which provides a variable vertical and horizontal alignment which would result in sight distance between the Windsor Road approaches and the precinct access road (and indeed the associated junction traffic signals) being limited. The prevailing speed of Windsor Road through traffic in the vicinity of the subject land is such that sight distance to possible conflict points such as intersections is of critical importance, particularly during non-peak periods.

The previously supported primary Windsor Road precinct access road location intersects with Windsor Road at the approximate midpoint of a 400m long section of Windsor Road with consistent vertical and horizontal alignment thereby providing significantly improved sight distance characteristics to that of the exhibited Structure Plan access location.

SIGNAL COORDINATION

The important State Road functions carried out by Windsor Road and Garfield Road East result in the intersection of Windsor Road, Garfield Road East and Terry Road accommodating significant traffic demands during peak periods. The traffic demand accommodated by the above intersection is projected to significantly increase following the redevelopment of the Box Hill Precinct and accordingly, greater priority in terms of signal phasing is anticipated to be required to be given to the Terry Road approach.

The abovementioned alterations to the signal operation are envisaged to result in a reduction in the overall level of service provided at the important intersection and particularly to the Windsor Road and Garfield Road East approaches to a point where it may operate in an unreasonably congested manner. The planned provision of a new signalised spinal precinct access road connection to Windsor Road between Boundary Road and Terry Road / Garfield Road East however has the ability to effectively provide for a sharing of the Box Hill precinct access demands.

The effectiveness of this sharing of Box Hill precinct demands is however considerably reliant on the ability of the new intersection to be efficiently coordinated with signalised intersections of Windsor Road with Boundary Road and Terry Road / Garfield Road East. Effective coordination of the signalised intersections will allow for a spreading of the Box Hill traffic demands but also provide for efficient through Windsor Road traffic flow past the precinct during peak periods.

Generally speaking, the coordination of a series of signalised intersections is most effective when the distance between the intersections is consistent. The exhibited Plan provides for the distance between the primary precinct access road and Boundary Road to be approximately double that of the distance between the access road and Terry Road / Garfield Road East. The previously supported primary Windsor Road precinct access road location intersects with Windsor Road at the approximate midpoint between Boundary Road and Terry Road / Garfield Road and is therefore considered to have significant advantages in terms of future signal coordination along Windsor Road and the overall integration of the Box Hill precinct into the surrounding road network.

INTERNAL PRECINCT CONNECTION

A review of the exhibited Precinct Plan indicates that the supported relocated primary precinct access road can integrate with the internal road layout of the precinct, linking with a north-south internal access road approximately to the south-west of the planned sporting fields. Notwithstanding this, it is acknowledged that some minor alterations to the internal design will be required to accommodate the altered precinct access location to ensure efficient connection of the access route to medium density residential precinct to the east of the sporting fields. However, it would not appear that the altered precinct access location will necessitate significant internal redesign of the internal precinct layout.

SOUTHERN CONNECTION

It is not known what factors were considered in determining the location of the planned southern link connecting with the Riverstone area however it would not appear from inspections that there have been any geographical factors or connection to existing road systems considered in the selection of the link route. It is therefore assumed that this link would be located such as to provide maximum lot yield for the southern precinct and therefore could well be subject to more detailed analysis. In any case, it is our view that this link is not necessarily fixed in its location and could well 'float' to align with any link from the subject development parcel to Windsor Road.

CONCLUDING STATEMENT

In consideration of the contents of this correspondence, it is concluded that there are significant traffic safety and efficiency advantages associated with the previously supported relocation of the primary Box Hill precinct access to Windsor Road approximately 400m to the west of the location exhibited.

It would be appreciated if the information contained within this correspondence could be forwarded on the Growth Centres Commission to assist in its ongoing formulation of the Precinct Plan.

Submitted for your consideration.

Yours faithfully,

David Thompson
Principal
Transport Planner

Appendix B: RMS (Email) Response to Memo

Peter Lee

From: RATHAN Pahee <Pahee.RATHAN@rms.nsw.gov.au>
Sent: Wednesday, 12 February 2014 4:22 PM
To: Peter Lee
Subject: FW: Box Hill Precinct - Relocation of Mt Carmel Road / Windsor Road intersection
Attachments: Typical Sections.pdf; Delineation Plan Through Intersection.pdf; TCS 4540 Bringelly - Edmondson - Rickard Sheet 1.pdf

Hi Peter

Here are some comments on this proposed intersection for your considerations .

1) Median widths of 1.2m in Windsor Road are to narrow, the desirable width is to be 2.4m. Or if staged crossings in Windsor Road are required 3.6m. Also the median width in the side road on the northern side should be 2.4m and the width of the median on the side road on the southern side should be 2.4m 2.0m from the nose. These widths are to cater for signal posts/push buttons and refuges for pedestrians. Network Operations should be consulted about what would be preferred.

2) There is no provision for bus jump starts or bus stops on the departure side of the intersection in Windsor Road. It should be noted that both the Garfield Road/Windsor Road and the Boundary Road/Windsor Road have bus jump starts and bus stops.

3) No provision for on road cyclists to travel through the intersection. The preferred option is to have a 4.5m wide left turn lane, with the existing shoulder running into this 4.5m lane and a area of 1.5m in width between the traffic island and the bus jump start.

4) The two islands on the northern side are to be of sufficient size to cater for all signal furniture i.e. mast arms, pram ramps etc. This especially applies to the island on the north eastern corner. There should also be sufficient room to cater for the scenario where the zebra crossing across the left turn lanes are signalised to cater for cyclists. Where a proposed shared path connects to the signals the crossings across the left turn lanes have to be signalised.

5) Lane widths in Windsor Road vary from 3.25m to 3.5m. Lane widths of 3.2m for both through lanes and right turn lanes are acceptable.

6) Ensure that all merge and diverge tapers are appropriate for the design speed. Which I assume is 90kph as the posted speed is 80kph.

8) Will the proposed Mt Carmel Road become an arterial road and be handed to the RMS in future? As the lane widths are only 3.0m and are considered to narrow.

The relocation to this site for the intersection appears acceptable. It has appropriate sight distance and is located the more than appropriate distance from the two signalised intersection either side.

I have attached some pdf's of an intersection at Bringelly Road that show the treatment required at an intersection such as this one.

Regards
Pahee Rathan
Senior Land Use Planner
Land Use | Network & Safety
T 02 8849 2219 **F** 02 8849 2918
www.rms.nsw.gov.au

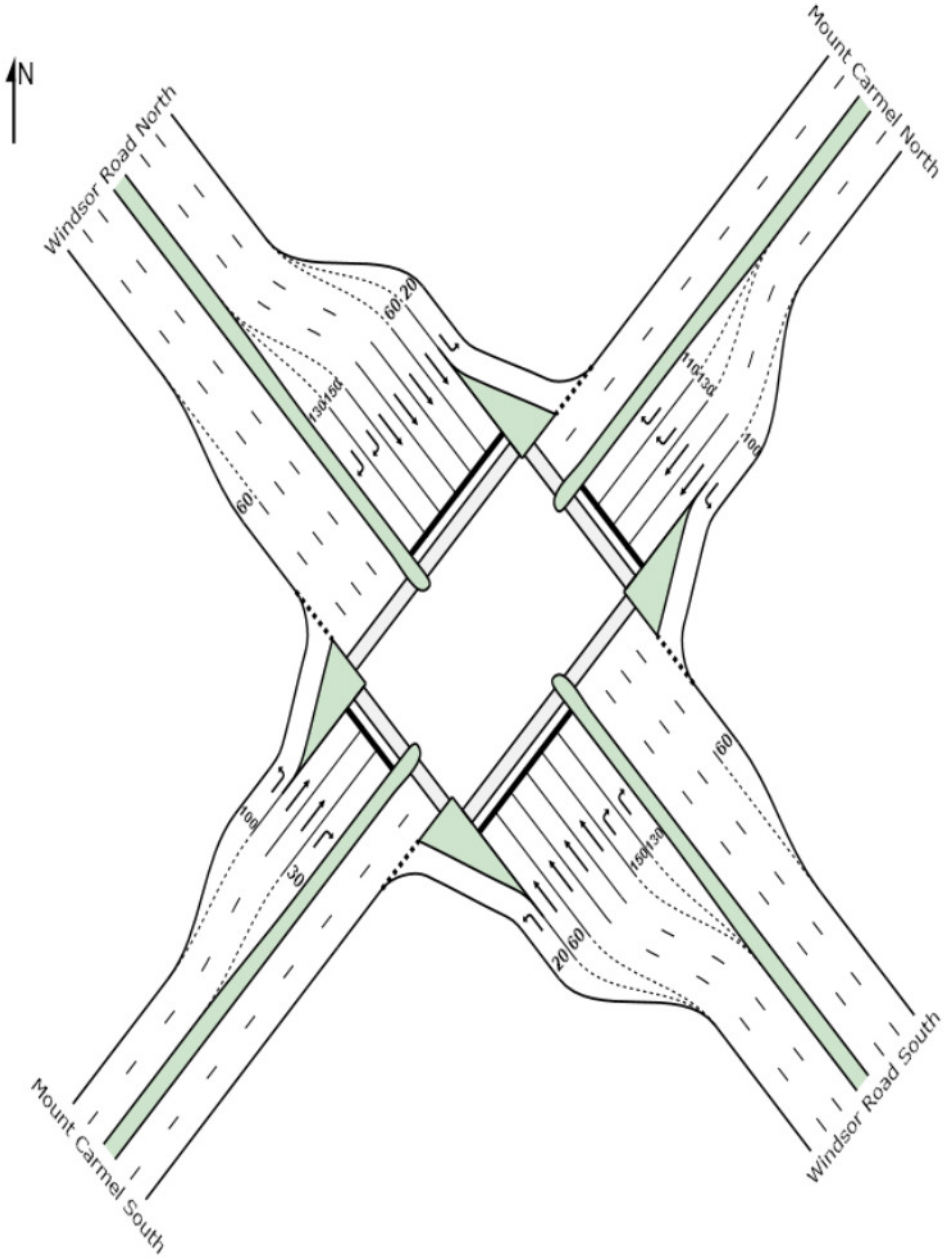
Roads and Maritime Services
27 Argyle Street Parramatta NSW 2150 | PO Box 973 PARRAMATTA CBD NSW 2150

Appendix C: SIDRA analysis

SITE LAYOUT

Site: INT 1103 Windsor Road - Mt Carmel 2036 AM Peak_BC - 2014 Final

Windsor Road - Mount Carmel
2036 AM Peak - Brown Consulting Modified



PHASING SUMMARY

Site: INT 1103 Windsor Road - Mt Carmel 2036 AM Peak_BC - 2014 Final

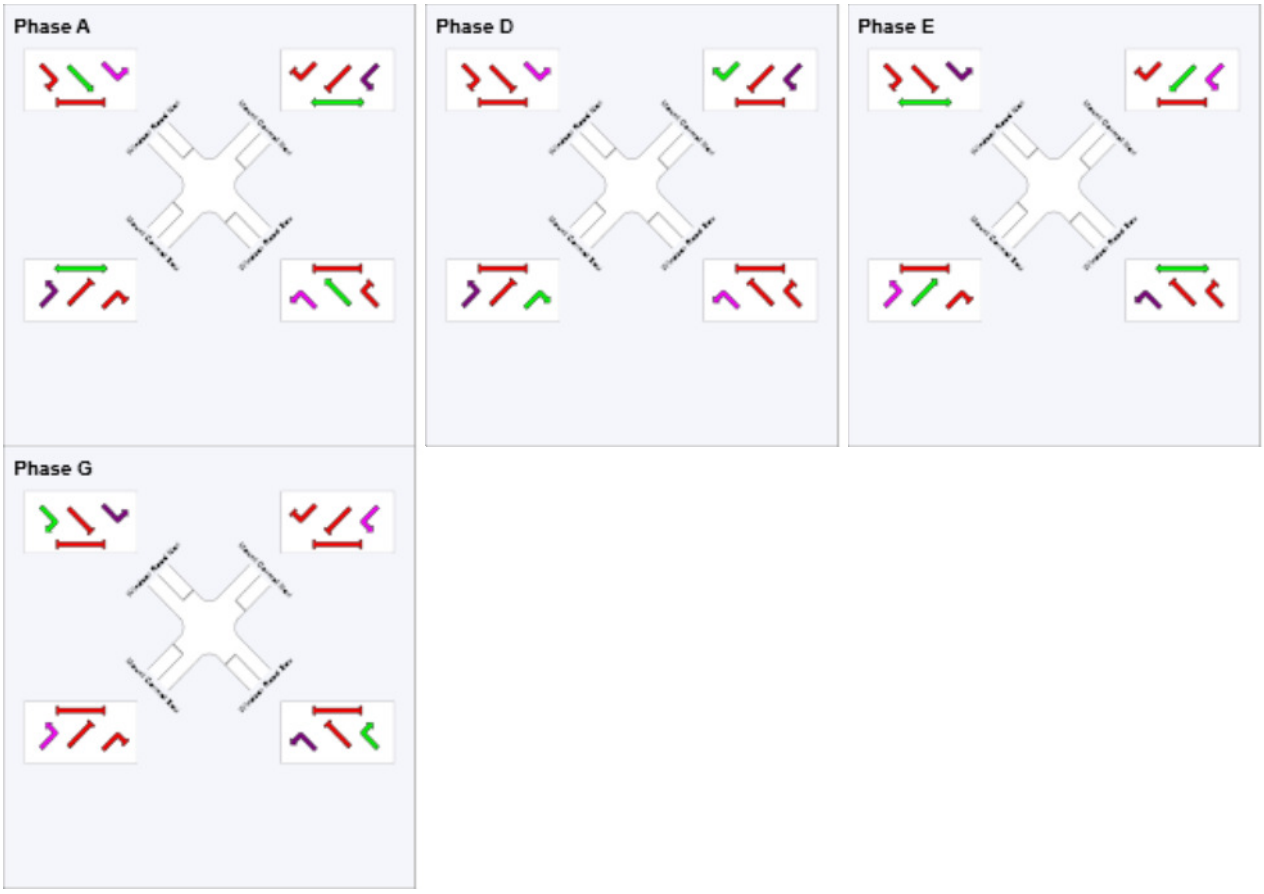
Windsor Road - Mount Carmel
2036 AM Peak - Brown Consulting Modified

Signals - Fixed Time Cycle Time = 105 seconds (Optimum Cycle Time - Minimum Delay)

Phase times determined by the program
Sequence: Four-phase
Movement Class: All Movement Classes
Input Sequence: A, D, E, G
Output Sequence: A, D, E, G

Phase Timing Results

Phase	A	D	E	G
Green Time (sec)	25	6	34	16
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	31	12	40	22
Phase Split	30 %	11 %	38 %	21 %



MOVEMENT SUMMARY

Site: INT 1103 Windsor Road - Mt Carmel 2036 AM Peak_BC - 2014 Final

Windsor Road - Mount Carmel
2036 AM Peak - Brown Consulting Modified

Signals - Fixed Time Cycle Time = 105 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Windsor Road South											
21	L2	5	2.0	0.006	15.2	LOS B	0.1	0.7	0.42	0.65	42.3
22	T1	1247	2.4	0.908	56.8	LOS E	25.1	178.6	1.00	1.09	22.6
23	R2	232	2.0	0.418	52.3	LOS D	5.5	39.4	0.95	0.79	24.8
Approach		1484	2.3	0.908	55.9	LOS D	25.1	178.6	0.99	1.04	22.9
NorthEast: Mount Carmel North											
24	L2	94	2.0	0.079	11.4	LOS A	1.2	8.9	0.32	0.68	45.6
25	T1	748	2.0	0.603	32.2	LOS C	16.2	115.0	0.90	0.78	30.4
26	R2	141	2.0	0.677	65.1	LOS E	3.9	27.7	1.00	0.82	21.7
Approach		983	2.0	0.677	34.9	LOS C	16.2	115.0	0.86	0.77	29.6
NorthWest: Windsor Road North											
27	L2	394	2.0	0.459	23.0	LOS B	12.7	90.3	0.72	0.83	36.8
28	T1	1232	2.0	0.792	43.3	LOS D	18.6	132.6	0.98	0.90	26.3
29	R2	495	2.0	0.892	67.4	LOS E	14.7	104.8	1.00	1.01	21.1
Approach		2121	2.0	0.892	45.2	LOS D	18.6	132.6	0.94	0.92	26.2
SouthWest: Mount Carmel South											
30	L2	101	2.0	0.088	13.9	LOS A	1.8	12.6	0.40	0.69	43.4
31	T1	1123	2.0	0.915	53.2	LOS D	34.6	246.7	1.00	1.11	23.4
32	R2	5	2.0	0.048	60.4	LOS E	0.3	1.8	0.97	0.64	22.8
Approach		1229	2.0	0.915	50.0	LOS D	34.6	246.7	0.95	1.07	24.4
All Vehicles		5817	2.1	0.915	47.2	LOS D	34.6	246.7	0.94	0.96	25.4

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P5	SouthEast Full Crossing	53	46.8	LOS E	0.1	0.1	0.94	0.94
P6	NorthEast Full Crossing	53	44.9	LOS E	0.1	0.1	0.93	0.93
P7	NorthWest Full Crossing	53	46.8	LOS E	0.1	0.1	0.94	0.94
P8	SouthWest Full Crossing	53	42.2	LOS E	0.1	0.1	0.90	0.90
All Pedestrians		211	45.2	LOS E			0.93	0.93

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

PHASING SUMMARY

Site: INT 1103 Windsor Road - Mt Carmel 2036 PM Peak _BC_Mod Signals_2 - 2014 Final

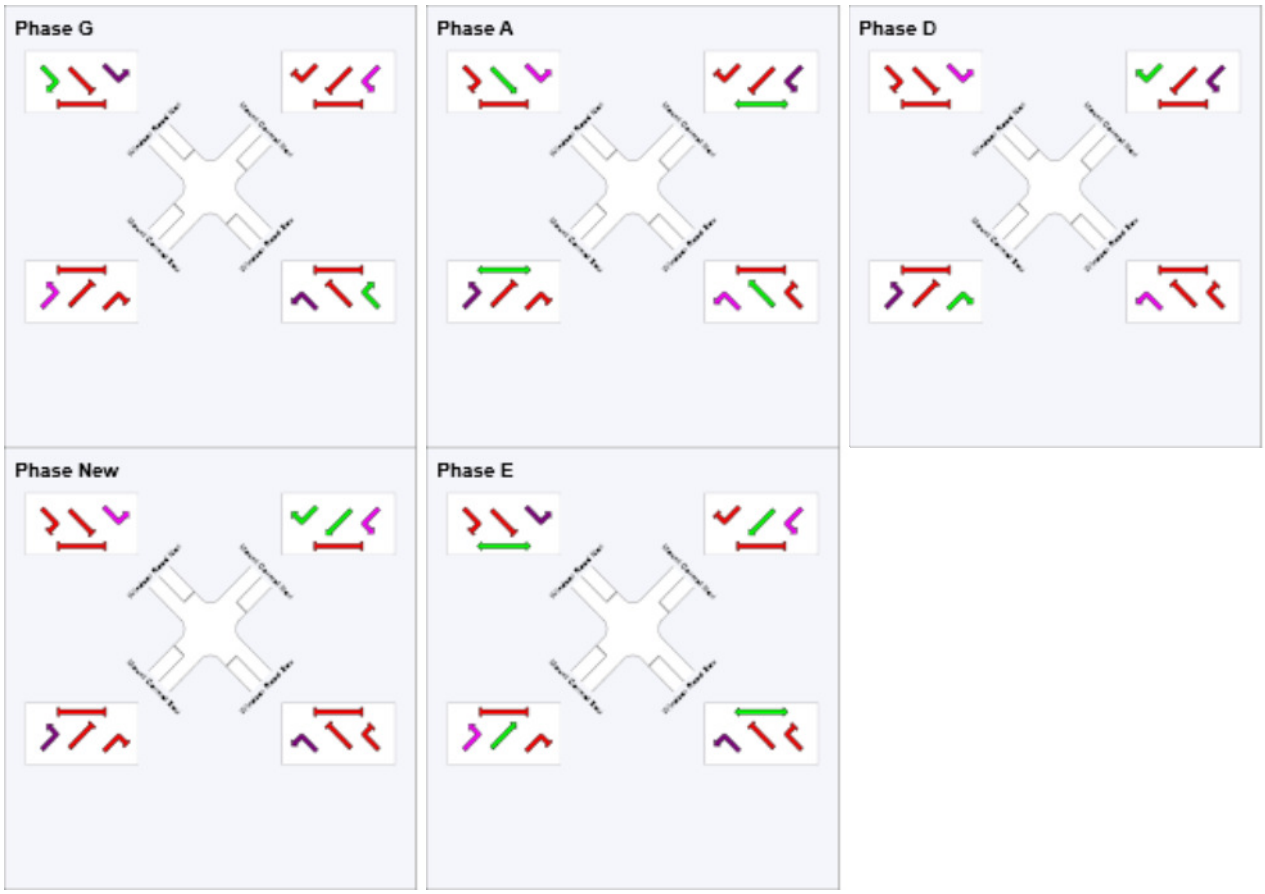
Windsor Road - Mount Carmel

Signals - Fixed Time Cycle Time = 130 seconds (Optimum Cycle Time - Minimum Delay)

Phase times determined by the program
Sequence: Five Phase
Movement Class: All Movement Classes
Input Sequence: G, A, D, New, E
Output Sequence: G, A, D, New, E

Phase Timing Results

Phase	G	A	D	New	E
Green Time (sec)	17	35	6	9	33
Yellow Time (sec)	4	4	4	4	4
All-Red Time (sec)	2	2	2	2	2
Phase Time (sec)	23	41	12	15	39
Phase Split	18 %	32 %	9 %	12 %	30 %



MOVEMENT SUMMARY

Site: INT 1103 Windsor Road - Mt Carmel 2036 PM Peak _BC_Mod Signals_2 - 2014 Final

Windsor Road - Mount Carmel

Signals - Fixed Time Cycle Time = 130 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Windsor Road South											
21	L2	5	2.0	0.006	21.3	LOS B	0.1	1.0	0.49	0.65	37.9
22	T1	1376	2.7	0.883	59.6	LOS E	31.4	223.9	1.00	1.02	21.9
23	R2	92	2.0	0.193	62.8	LOS E	2.6	18.8	0.93	0.74	22.1
Approach		1473	2.7	0.883	59.6	LOS E	31.4	223.9	0.99	1.00	22.0
NorthEast: Mount Carmel North											
24	L2	145	2.0	0.113	10.0	LOS A	1.7	11.8	0.24	0.67	47.1
25	T1	1110	2.0	0.785	39.8	LOS C	31.5	224.5	0.96	0.86	27.4
26	R2	519	2.0	0.882	76.7	LOS F	18.4	130.9	1.00	0.98	19.5
Approach		1774	2.0	0.882	48.2	LOS D	31.5	224.5	0.91	0.88	25.2
NorthWest: Windsor Road North											
27	L2	94	2.0	0.065	8.2	LOS A	0.3	2.1	0.10	0.64	48.9
28	T1	740	3.3	0.472	42.7	LOS D	12.9	91.9	0.89	0.75	26.5
29	R2	421	2.0	0.884	79.6	LOS F	15.0	106.8	1.00	0.98	18.9
Approach		1255	2.8	0.884	52.5	LOS D	15.0	106.8	0.87	0.82	24.1
SouthWest: Mount Carmel South											
30	L2	113	2.0	0.121	21.5	LOS B	3.4	24.2	0.52	0.72	37.7
31	T1	576	2.0	0.592	46.0	LOS D	16.1	114.5	0.93	0.79	25.5
32	R2	5	2.0	0.059	74.5	LOS F	0.3	2.3	0.98	0.64	19.9
Approach		694	2.0	0.592	42.2	LOS C	16.1	114.5	0.87	0.78	26.9
All Vehicles		5196	2.4	0.884	51.7	LOS D	31.5	224.5	0.92	0.89	24.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

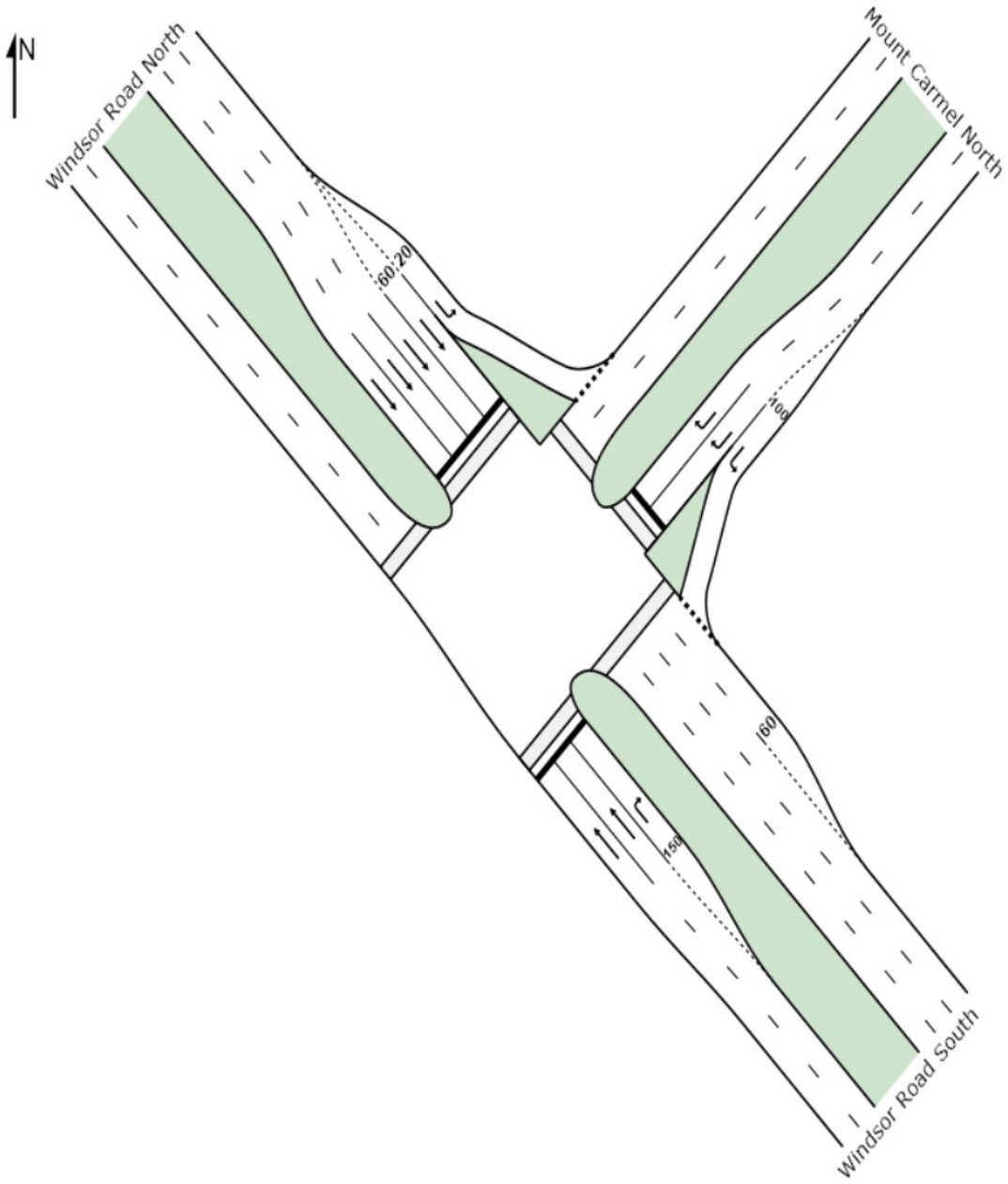
Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P5	SouthEast Full Crossing	53	60.2	LOS F	0.2	0.2	0.96	0.96
P6	NorthEast Full Crossing	53	48.4	LOS E	0.2	0.2	0.86	0.86
P7	NorthWest Full Crossing	53	60.2	LOS F	0.2	0.2	0.96	0.96
P8	SouthWest Full Crossing	53	45.8	LOS E	0.2	0.2	0.84	0.84
All Pedestrians		211	53.7	LOS E			0.91	0.91

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SITE LAYOUT

Site: INT 1103 Windsor Road - Mt Carmel 2036 AM Peak_BC - 2014 - Interim

Windsor Road - Mount Carmel
2036 AM Peak - Brown Consulting Modified



PHASING SUMMARY

Site: INT 1103 Windsor Road - Mt Carmel 2036 AM Peak_BC - 2014 - Interim

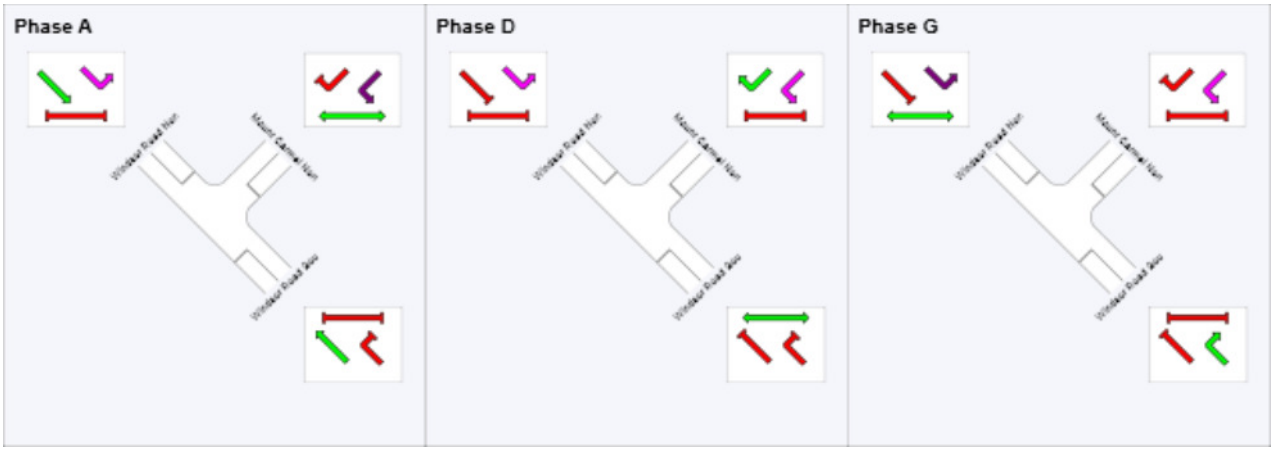
Windsor Road - Mount Carmel
2036 AM Peak - Brown Consulting Modified

Signals - Fixed Time Cycle Time = 140 seconds (Optimum Cycle Time - Minimum Delay)

Phase times determined by the program
Sequence: Four-phase
Movement Class: All Movement Classes
Input Sequence: A, D, G
Output Sequence: A, D, G

Phase Timing Results

Phase	A	D	G
Green Time (sec)	66	29	27
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	72	35	33
Phase Split	51 %	25 %	24 %



SIDRA INTERSECTION 6

MOVEMENT SUMMARY

Site: INT 1103 Windsor Road - Mt Carmel 2036 AM Peak_BC - 2014 - Interim

Windsor Road - Mount Carmel
2036 AM Peak - Brown Consulting Modified

Signals - Fixed Time Cycle Time = 140 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Windsor Road South											
22	T1	1242	2.0	0.688	30.7	LOS C	32.7	232.7	0.84	0.76	31.2
23	R2	232	2.0	0.660	64.7	LOS E	14.8	105.5	0.98	0.83	21.7
Approach		1474	2.0	0.688	36.0	LOS C	32.7	232.7	0.87	0.77	29.1
NorthEast: Mount Carmel North											
24	L2	94	2.0	0.093	11.2	LOS A	1.5	10.5	0.28	0.68	45.8
26	R2	141	2.0	0.187	57.1	LOS E	4.0	28.3	0.86	0.76	23.4
Approach		235	2.0	0.187	38.7	LOS C	4.0	28.3	0.63	0.73	29.1
NorthWest: Windsor Road North											
27	L2	394	2.0	0.272	10.7	LOS A	6.0	42.5	0.28	0.69	46.4
28	T1	1242	2.8	0.456	26.3	LOS B	18.6	132.6	0.72	0.63	33.5
Approach		1636	2.6	0.456	22.5	LOS B	18.6	132.6	0.61	0.65	35.9
All Vehicles		3345	2.3	0.688	29.6	LOS C	32.7	232.7	0.73	0.71	32.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P5	SouthEast Full Crossing	53	64.3	LOS F	0.2	0.2	0.96	0.96
P6	NorthEast Full Crossing	53	28.4	LOS C	0.1	0.1	0.64	0.64
P7	NorthWest Full Crossing	53	64.3	LOS F	0.2	0.2	0.96	0.96
All Pedestrians		158	52.3	LOS E			0.85	0.85

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

PHASING SUMMARY

Site: INT 1103 Windsor Road - Mt Carmel 2036 PM Peak _BC_Mod Signals_2 - 2014 Interim

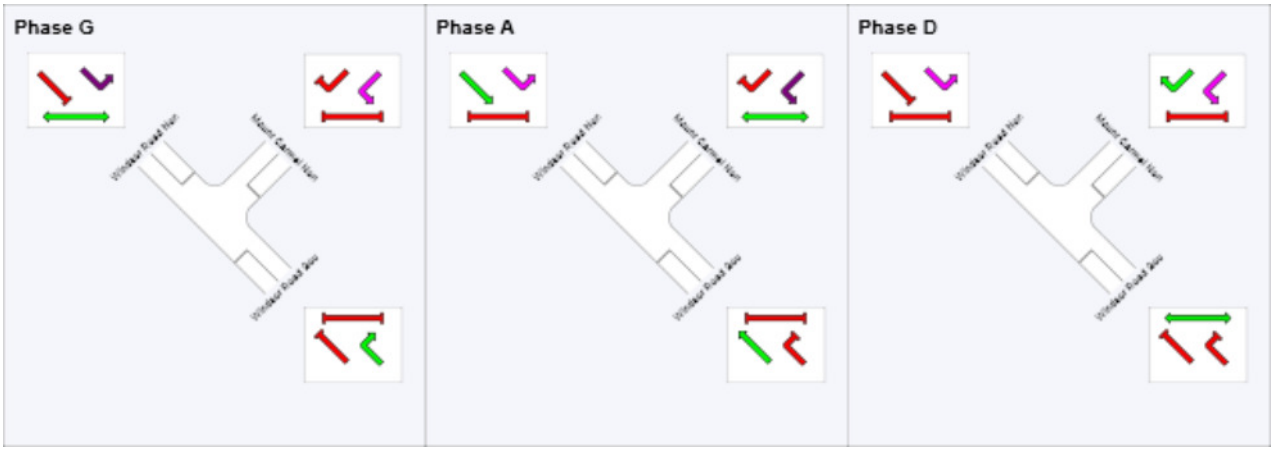
Windsor Road - Mount Carmel

Signals - Fixed Time Cycle Time = 140 seconds (Optimum Cycle Time - Minimum Delay)

Phase times determined by the program
Sequence: Five Phase
Movement Class: All Movement Classes
Input Sequence: G, A, D
Output Sequence: G, A, D

Phase Timing Results

Phase	G	A	D
Green Time (sec)	28	66	28
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	34	72	34
Phase Split	24 %	51 %	24 %



MOVEMENT SUMMARY

Site: INT 1103 Windsor Road - Mt Carmel 2036 PM Peak _BC_Mod Signals_2 - 2014 Interim

Windsor Road - Mount Carmel

Signals - Fixed Time Cycle Time = 140 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Windsor Road South											
22	T1	1366	2.0	0.758	32.3	LOS C	37.9	270.0	0.89	0.81	30.4
23	R2	92	2.0	0.253	58.8	LOS E	5.3	37.8	0.88	0.77	23.0
Approach		1458	2.0	0.758	33.9	LOS C	37.9	270.0	0.89	0.80	29.8
NorthEast: Mount Carmel North											
24	L2	145	2.0	0.125	9.2	LOS A	1.4	9.8	0.20	0.67	47.9
26	R2	519	2.0	0.712	65.3	LOS E	16.9	120.1	0.99	0.85	21.6
Approach		664	2.0	0.712	53.0	LOS D	16.9	120.1	0.82	0.81	24.5
NorthWest: Windsor Road North											
27	L2	94	2.0	0.060	8.5	LOS A	0.5	3.9	0.14	0.65	48.6
28	T1	740	3.3	0.270	23.6	LOS B	9.9	70.2	0.64	0.55	35.1
Approach		834	3.2	0.270	21.9	LOS B	9.9	70.2	0.59	0.56	36.2
All Vehicles		2956	2.3	0.758	34.8	LOS C	37.9	270.0	0.79	0.74	29.8

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P5	SouthEast Full Crossing	53	64.3	LOS F	0.2	0.2	0.96	0.96
P6	NorthEast Full Crossing	53	29.6	LOS C	0.1	0.1	0.65	0.65
P7	NorthWest Full Crossing	53	64.3	LOS F	0.2	0.2	0.96	0.96
All Pedestrians		158	52.7	LOS E			0.86	0.86

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.