TRAFFIC IMPACT ASSESSMENT GUIDELINES

January 2011

Regional Municipality of Wood Buffalo

-Engineering Department-

Regional Municipality of Wood Buffalo

Traffic Impact Assessment Guidelines

Prepared For:

Regional Municipality of Wood Buffalo
Engineering Department

By:

Associated Engineering Ltd.
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Disclosure

This guideline was prepared for the Regional Municipality of Wood Buffalo to address Traffic Impact Assessment requirements within the Municipality including the Urban Service Area, the Fringe Area and the Rural Service Area.

The services provided by Associated Engineering Alberta Ltd. In the preparation of this guideline were conducted in a manner consistent with the level of service ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,

Associated Engineering Alberta Ltd.

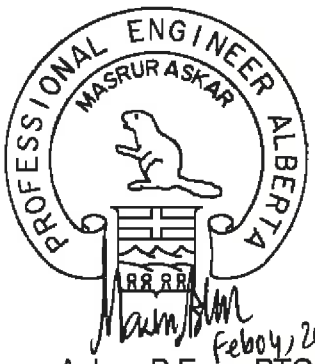

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Table of Contents

1.0 INTRODUCTION

1.1 Introduction of Traffic Impact Assessment Study

The purpose of a Traffic Impact Assessment (TIA) study is to determine the transportation impacts a particular development will have on the existing roadway network system. A TIA study identifies the need for any improvements and mitigating measures to the adjacent and nearby roadway system to maintain a satisfactory Level of Service (LOS) and safety of the roadway network in the vicinity of the proposed development. It also identifies improvements needed to integrate the proposed development within the pedestrian and cyclist pathway system.

1.2 Scope of Traffic Impact Assessment Study

A TIA study is required whenever a development proposal has a significant impact on traffic operations and on other components of the transportation system. The scope of the TIA study may vary depending on the magnitude of the potential impact on the roadway system due to the proposed development. The primary objectives of a TIA study are to assess the transportation impacts of a proposed development, identify the need for any improvements to the affected roadway system to provide satisfactory Levels of Service, and address safety issues.

The TIA study also should address relevant transportation issues associated with a proposed development that may be of concern to neighboring residents, businesses & property owners, identify access management issues, such as appropriate location, spacing, and design of the access(es) for the proposed development and evaluate the internal circulation of the proposed development to/from the adjacent and nearby municipal roadway system to provide safe and efficient internal traffic flow and access.

1.3 Purposes of TIA Guideline

The Engineering Department (The Engineering Department) of Regional Municipality of Wood Buffalo (RMWB) has developed these guidelines for the consultant (The Consultant) responsible to prepare the TIA Study. The purposes of the guideline are to:

- provide a standardized approach and methodology for the study,
- evaluate the impacts of proposed new development in a rational manner,
- ensure consistency and uniformity of the TIA studies,
- assist consultants to adopt assumptions consistent with the accepted standards of the Engineering Department, and
- reduce confusion and delay in processing development proposals.

The Engineering Department encourages the consultants to use the guidelines in the preparation of a TIA. Please see *Appendix A* for a suggested TIA outline.

2.0 TRAFFIC IMPACT ASSESSMENT STUDY WARRANTS

2.1 When a TIA is required

A Traffic Impact Assessment (TIA) study will be required for any proposed development or redevelopment that meets one or more of the following criteria unless otherwise waived by the Engineering Department:

- If the proposed development generates more than 100 trips (inbound + outbound trips) during any one hour of an average weekday, or during any one hour of a design weekend.
- When two or more proposed developments will generate 100 or additional peak direction auto trips to or from the site during the adjacent roadway's peak hour.
- If the proposed development is located within or adjacent to a residential community that has existing parking issues and/or may have a residential parking permit program in place.
- A traffic impact study may also be required even if there are less than 100 peak hour trips, if the proposed development is located in an area of high traffic congestion and is anticipated by the Engineering Department to:
    - significantly reduce the capacity of surrounding roadways or intersections to an unacceptable level during any hour on a design day selected for analysis purposes;
    - create unacceptable adverse operational and safety impacts on the road network, such as inadequate sight distances at access points; substandard access spacing as it relates to intersections and/or driveways; lack of existing turn lane(s) on the adjacent roadway at the proposed access point(s), etc.
    - require access to a provincial highway.

2.2 Exemption of TIA study

Exemption of a TIA study for a proposed development requires consultation with the Engineering Department. A TIA study may not be necessary when, in the opinion of the Engineering Department, an insignificant traffic impact to roadway facilities due to a proposed development can clearly be anticipated without a study.

2.3 Updating an Existing Traffic Impact Study

A Traffic impact study for a proposed development is usually valid for a period not longer than two years. Any development that does not commence within two years will require an updated TIA study. Major changes within the study area or land uses may prompt the need for an updated impact analysis.

3.0 GENERAL REQUIREMENTS FOR A TIA STUDY

3.1 Engineering Department Consultation

It is recommended that prior to commencing a TIA study, the consultant meet with the Engineering Department staff in order to establish the scope of the study, determine data requirements and their availability, and confirm approval process and basic parameters required for a TIA study.

The participants at the meeting shall identify and agree upon the issues and needs prior to the preparation of the TIA. It is also important that the consultant shall submit meeting minutes or a Memorandum of Understanding (MOU) which details the assumptions and methodologies agreed upon regarding the relevant issues of the TIA studies.

3.2 Consultant Qualifications for Traffic Impact Assessment Studies

TIA studies shall be prepared by or under the direction of a registered professional engineer in Alberta with training and experience in traffic engineering and transportation planning. The report must be dated and signed by the same registered professional engineer in Alberta.

3.3 Study Area and Existing Roadway Network

The study area should contain all municipal and provincial roadways that will likely be affected by the traffic volumes generated by the proposed development. In general, a complete TIA study will include all site access points, major intersections and roadway sections within 300m radius adjacent to the site. However, the Engineering Department reserves the right to establish the study intersections and roadway network as may be deemed necessary.

3.4 Horizon Year(s) for Analysis

The specific planning horizons to be used in the study should be discussed with the Engineering Department at the beginning of the study. In general, the horizon year for impact analysis should be twenty (20) years from the date of the traffic impact study unless an earlier date can be identified and justified in consultation with the Engineering Department based on population threshold, phasing plan, development scenario of the area, etc.

For any interim phases of a development, additional horizon years, ranging from a minimum of five (5) years after the study date to a maximum of full build-out might be identified in consultation with the Engineering Department.

3.5 Peak Hours

The design hours to be used in a TIA study will be discussed and approved by the Engineering Department at the initial meeting. In general, the TIA study should include morning (AM Peak) and evening (PM Peak) peak hour analyses based on the location. Other peak hours (noon peak, weekend, holidays, etc.) may also be required to determine the significance of the traffic impacts generated by a project. Consultation between the Engineering Department and the consultant is recommended during the early planning stages of a project to determine the analysis time periods for traffic which is directly associated with the peaking characteristics of the background traffic within the municipality and the proposed development traffic.

3.6 Traffic Counts

Prior to field traffic counts, discussion between the Engineering Department and the consultant is recommended to determine the level of detail (e.g., traffic count locations, period, intervals, pedestrian counts, bicycle traffic counts, vehicle classification counts, etc.) required at each traffic count site. All roadway facilities within the boundaries of the TIA should be considered.

Common practices for counting vehicular traffic include but are not limited to:

- Vehicle counts should be conducted on Tuesdays, Wednesdays, or Thursdays during weeks not containing a holiday and conducted in weather condition that is not abnormal.
- 15 minutes traffic counts should be conducted during anticipated peak hours.
- Typically 3-hour peak flow counts would be conducted once in the morning (AM Peak), once at noon (noon Peak, 2-hour peak flow counts), and once in the evening (PM Peak). Duration of traffic counts should be identified in consultation with the Engineering Department.
- Seasonal and weekend variations in traffic should also be considered to factor the counts.

4.0 TRAFFIC ANALYSIS

The following types of traffic should be considered in the traffic analysis:

4.1 Background Traffic

Background traffic volumes are composed of existing volumes, accepted general growth of traffic, and traffic generated by previously-approved new developments in the study area. Background traffic volumes should be obtained either from the RMWB's traffic count data bank, traffic model (for future background traffic) or by traffic counting.

The growth in background traffic should be established in consultation with the Engineering Department staff through one of the following methods:

- Historical traffic growth;
- Estimation of traffic growth factors from a calibrated traffic forecast model;
- A growth rate based on area transportation studies.

A diagram showing the background traffic volumes and turning movements for roadways and intersections in the study area must be included for each analysis horizon.

4.2 Development Traffic

The number of trips due a proposed development shall be calculated using the latest edition of "Trip Generation" report as published by the Institute of Transportation Engineers (ITE) or based on special studies of unique land-uses as approved by the municipality. The development should be categorized by specific land-use type consistent with classifications contained in the ITE Trip Generation report. The proposed number of development, units, etc. should be provided.

The trip assignment of the proposed development may need to be adjusted to account for pass-by trips, diverted trips, internal trips, etc. These trips can be estimated using the methodology contained in the most current version of the ITE Trip Generation report. However, the Engineering Department shall approve the trip estimates for each development on a case-by-case basis due to the lack of sufficient information of these trips in the trip generation manual, and reserves the option of not allowing trip reductions if sufficient supporting data is absent.

Pass-by trips – Pass-by trips are those made as intermediate stops on the way from an origin to a primary trip destination. They do not affect the driveway or site access volumes but do affect the amount of traffic added to the adjacent street system.

Diverted trips – These are similar to pass-by trips but they are attracted from the traffic on roadways within the vicinity of the generator but require a diversion from that roadway to another roadway to gain access to the site. Diverted trips add traffic to the roadways adjacent to a site.

Internal trips – For a mixed-use development, it is important to know how much of the trip generation uses the public street system to reach off-site destinations and how much stays within the development without using external roads. The ITE definition of "multi-use development" requires that some trips between on-site land uses to be made without travel on the off-site street system. The trips, which have both ends (origin and destination) within the site, are known as internal trips. It is the portion of trips that stay totally within the development.

4.3 Combined Traffic

A summary of the future traffic demands for each peak period and horizon year for site combined traffic must be provided in the report. Combined traffic for a particular time period is a summation of the background traffic and development traffic due to the proposed development.

5.0 TRAFFIC DEMAND ANALYSIS STEPS

The following steps should be clearly described in the TIA study:

5.1 Trip Generation

Trips generated by the proposed development shall be calculated using the most current edition of the Institute of Transportation Engineers (ITE) "Trip Generation" report. Methodologies contained in the Trip Generation Handbook shall be used for the calculations of internal trips, pass-by trips, etc. Consultation with the Engineering Department is suggested to ensure that appropriate and agreed upon trip generation rates are being used in the traffic impact study.

A table must be provided in the study report identifying the categories and quantities of land uses, with the corresponding trip generation rates or equations and the resulting number of trips. The table also needs to identify the pass-by and internal trip percentages and the associated number of vehicle movements.

5.2 Trip Distribution

The directions from which traffic will enter and exit the development site may depend on several location-specific factors, including:

- Surrounding land uses, growth areas, population and employment distributions;
- Existing traffic distribution patterns on the existing street system;
- Size and type of the proposed development.

The assumed trip distribution pattern is to be displayed on an exhibit indicating the percentage values on the adjacent arterial and collector road network.

5.3 Mode Choice

Mode choice is the step for traffic demand analysis where trips between a given origin and destination are split into trips using transit, trips by car pool or as automobile passengers and trips by automobile drivers. To incorporate this step in any TIA, the study needs to show the calculations that compare the attractiveness of travel by different modes to determine their relative usage.

Good engineering judgment and current and historic modal split data are needed for the reductions in automobile travel to the site to account for travel to/from the site by public transit. Prior discussions for considering Transit ridership (for plant bus or Municipal transit) for existing and future condition will be required by the consultant. RMWB will accept a maximum of 20% trip reduction due to municipal transit or plant buses based on available service. Additional justification will be needed for any trip reduction higher than 20%.

5.4 Trip Assignment

Traffic assignment should be estimated using an acceptable assignment algorithm, and if applicable, based on the existing traffic pattern, proposed development and future road network.

Traffic assignment process involves the calculation of the path with the least impedance from each origin to all destinations. Usually the minimum time path is used for determining the shortest path. Trips for each origin and destination pair are then assigned to the links in the minimum path and the trips are added up for each link. The assigned trip volumes are then compared to the capacity of the link to see if it is congested. If a link is congested the speed on the link needs to be reduced to result in a longer travel time on that link. Changes in travel times mean that the shortest path may change. Hence the whole process is repeated several times until there is equilibrium between travel demand and travel supply. Trips on congested links will be shifted to uncongested links until this equilibrium condition occurs.

6.0 CAPACITY ANALYSIS

The most current edition of the "Highway Capacity Manual", Transportation Research Board, National Research Council should be used for capacity analysis of study intersections and roadway sections.

6.1 Methodology

Capacity and level of service calculations shall be performed for each study intersections and roadway sections for following scenarios:

1. Without proposed development on existing roadway system:
   (a) Existing background traffic conditions (i.e., current traffic volumes).
   (b) Future background traffic conditions (i.e., future traffic volumes in design horizon).
2. With proposed development without improvement of roadway system:
   (a) Existing combined traffic conditions (i.e., current traffic volumes).
   (b) Future combined traffic conditions (i.e., future traffic volumes in design horizon).
3. With proposed development with improvement of roadway system:
   (a) Existing combined traffic conditions (i.e., current traffic volumes).
   (b) Future combined traffic conditions (i.e., future traffic volumes in design horizon).

The TIA must provide capacity analysis results in a tabular form for all study intersections, study peak hour periods, and study horizon years listing the Level of Service (LOS), delay, queues and v/c ratio for individual directional movement for the above mentioned scenarios. The parameters to be considered for the capacity analysis for an intersection are attached as Appendix B.

6.2 Capacity analysis of the Study Intersections & Roadway Sections

The standard criterion used to define quality of traffic flow is "Level of Service" (LOS). A comprehensive capacity analysis of the study intersections and roadway sections must be included in the TIA study including delay, queue length and volume to capacity (v/c) ratios for overall intersection operations and individual critical movements for all analysis periods, time horizon and scenarios mentioned in section 6.1. Full documentation of the results of all level of service analyses must be provided in an appendix.

6.2.1 Existing Condition Analysis

Capacity analyses for existing study intersections and roadway sections should be included in the report using "Highway Capacity Manual" methodology. Where unacceptable levels of services are calculated for background or "no-build" conditions,

the applicant is responsible for fixing the deficiency where practical to maintain at least the same level of service when site traffic is added to the roadway element.

6.2.2 Acceptable Level of Service

In general, capacity analyses for study intersections and roadway sections should show an overall minimum LOS D as well as individual movement minimum LOS of 'D' using "Highway Capacity Manual" methodology.

Improvement of study intersections and roadway sections should be recommended where:

- Overall LOS of intersections as well as individual movement LOS is worse than 'D'.
- LOS of roadway sections is worse than 'D'.
- Volume/capacity (v/c) ratios for overall intersection operations or any individual movements (through, turning or shared through/turning movements) are 0.85 or above.
- Queues for an individual movement are projected to exceed available turning lane storage based on the 95th percentile queue criteria.

6.2.3 Hierarchy of Intersection Control

When considering intersection improvements, it should be recognized that there is a hierarchy related to the control at intersections and types of improvements. The intersection improvement hierarchy includes, in order of preference:

- Two-way Stop control;
- Multi-way Stop control when used as an interim step subject to further improvements;
- Roundabout; and
- Traffic signals.

In some cases the Engineering Department may select improvements not necessarily following the hierarchy above based on site conditions of the land use, roadway and intersection geometrical parameters.

6.2.4 Computer Programs

Generally accepted software programs, such as VISSIM, HCS or Synchro should be used for capacity analysis of intersections and roadway sections. Prior approval for using software package for roundabout capacity analysis must be obtained from the Engineering Department.

6.2.5 Traffic Signal Design Parameters

RMWB's standard signal timing plans should be used ("Guidelines for the design and Installation of Traffic Signals") and all proposed adjustments to traffic signal timing, phasing and cycle lengths should be evaluated in terms of pedestrian crossing time requirements, clearance intervals, effect on queue lengths, adequacy of existing storage and effects on the existing signal co-ordination.

7.0 TRAFFIC SIGNAL WARRANT ANALYSIS AND TAFFIC SIGNAL DESIGN

Transportation Association of Canada (TAC) Traffic Signal Warrant worksheets must be used for intersection traffic signal warrant analysis. The RMWB will not consider a traffic signal unless the warrants criteria specified in TAC's "Manual of Uniform Traffic Control Devices for Canada" are met. Meeting a traffic signal warrant does not automatically lead to the approval for the installation of a traffic signal. If a signal is shown to be warranted in a horizon year, but is not warranted in the build-out year, estimates shall be made regarding the year that the signal may become warranted. Copies of the worksheets (in digital format) must be included in the Traffic Impact Study final report. The Engineering Department will accept the traffic signal design parameters contained in the RMWB's "Guidelines for the design and Installation of Traffic Signals". The parameters to be considered for the capacity analysis for an intersection are attached as Appendix B.

8.0 INTERSECTION & ROADWAY ILLUMINATION WARRANT ANALYSIS

Intersection illumination warrant analysis should be performed for the study intersections and roadway sections based on Transportation Association of Canada's latest guideline for the "Design of Roadway lighting".

9.0 PROPOSED GEOMETRY OF STUDY INTERSECTIONS AND ROADWAY SECTIONS

Any intersection operational deficiencies that have been identified in the TIA study must be addressed. The requirements for turn lanes should be examined. Adequate spacing should be provided between access points to avoid potential turning lane overlaps. All design standards must be in conformance with RMWB's standards and with those outlined in the TAC Manual. The length of turning lanes must accommodate the 95th percentile queue length.

9.1 Left & Right turn Analysis

Turn lanes at intersections, as part of mitigation, should be provided based on capacity analyses as well as applicable design criteria mentioned in TAC's "Geometric Design for Canadian Roadways and Highways" and Alberta Transportation's "Highway Geometric Design Guide". The left and right turn lane warrant worksheets should be attached to the report.

9.2 Queue Length & Storage Length Analysis, Weaving & Merging lengths

The length of left and right turn lanes should be based on the capacity analysis, the criteria contained in the TAC's "Geometric Design of Canadian Roadways and Highways" and Alberta Transportation's "Highway Geometric Design Guide". Weaving and merging lengths calculations should be based on Highway Capacity Manual.

9.3 Roundabout Feasibility

A modern roundabout analysis must be completed for any potential traffic signal installation or an existing signalized intersection that is or is projected to experience collision patterns, congestion or poor level of service. Neighborhood roundabouts at local/collector road intersections must also be considered as part of the draft plan of subdivision or site plan analysis.

As a general design guideline the consultant can reference the USA based TRB's National Cooperative Highway Research Program (NCHRP) Report 672: Roundabouts: An Informational Guide – Second Edition. The report explores the planning, design, construction, maintenance, and operation of roundabouts and also addresses issues that may be useful in helping to explain the trade-offs associated with roundabouts.

10.0 SAFETY ANALYSIS

Identification of potential safety or operational issues associated with (but not limited to) the following issues, as applicable:

- Sight distance,
- Operational Analysis,
- Traffic Calming, and
- Access management.

10.1 Sight Distance Evaluation

At each access point and at each intersection where a new road is proposed, the sight distance requirements should be determined based on appropriate standards (TAC's Geometric Design Guide for Canadian Roads" or Alberta Transportation's "Highway Geometric Design Guide"). The sight distance should be determined from actual field measurements of drivers' eye height, object height for existing streets and roadway alignment survey data.

10.2 Operational Analysis

The operational analysis is included in the scope of a TIA study to ensure that the design vehicle is capable of safely maneuvering the intersection without interfering with other traffic movements. Intersection plans should be provided illustrating that the design vehicle can safely maneuver the intersection. If the design vehicle is unable to properly make a specific turning movement with respect to the development, recommended revisions to the intersection geometry is required. Engineering Department accepts using Auto Turn software for operational analysis.

The number of lanes, throat lengths, turning radii and storage lengths should be appropriate to accommodate the estimated traffic demands and minimize conflicts with street traffic and within the site. Throat lengths must be in conformance with those outlined in the Transportation Association of Canada's 'Geometric Design Guide for Canadian Roads, 1999 Edition.

10.3 Traffic Calming

Traffic calming measures should also be discussed with the Engineering Department at the initial consultation meeting. Potential conflicts between vehicle-pedestrian, cyclist-vehicle-pedestrian, heavy truck movements are to be addressed in the TIA where the proposed development is to be located adjacent to a residential community. The Engineering Department may need to include traffic calming measure in the scope of TIA to assess the affect of the increased traffic generation on the streets in the nearby community, reduce the vehicle speed & vehicle-pedestrian conflict, alter driver behavior and improve conditions for non-motorized street users.

10.4 Access Management Issues

The access locations should be adequately spaced from adjacent street and intersections to ensure smooth and efficient traffic operation along the abutting streets. Intersection separation

distances should be in conformance with 'Geometric Design Guide For Canadian Roads', 1999 edition, published by the Transportation Association of Canada (TAC).

Access locations should be evaluated in terms of capacity, safety and adequacy of queue storage capacity and appropriate sight distances. Proposed access should be evaluated to ensure that they are adequately sized, designed and provided with suitable access so that they will not adversely affect traffic operations on adjacent streets.

10.5 Emergency Routes and Exits

The developer will be responsible to provide a sufficient number of suitable emergency routes and exits where necessary in the interests of the health and safety of any person on a construction site, to enable any person to reach a place of safety quickly in the event of danger. An emergency route or exit provided shall be indicated by suitable signs and lead as directly as possible to an identified safe area. For traffic analysis, this emergency route should be ignored.

11.0 OTHER ISSSUES

11.1 Study intersections within Alberta Transportation's Jurisdiction

The TIA study needs to address all relevant issues for the study intersections under Alberta Transportation's jurisdiction following its applicable guidelines and methodology. All intersections within 300m of a Provincial Highway and 800m from an interchange need to be included in the study.

11.2 Review TIA Reports

The timeline for the TIA Reviews by the Engineering Department will follow the Engineering Servicing Standard of the Municipality.

12.0 RECOMMENDATIONS

It is expected that the recommendations related to TIA studies for a proposed development will include following key aspects;

- Improvement of geometry of study roadway sections & intersections,
- Improvement of traffic controls,
- Traffic calming measures,
- Upgrade new or revised pathway connections,
- Improvement of access management issues, and
- Improvement of other aspects recognized by the Engineering Department.

13.0 DELIVERABLES

The consultant must submit 5 (five) copies of the final TIA complete with all supporting documentation for initial review and following Municipal review submit five (5) copies of the TIA incorporating revisions from the review. The consultant must also submit an electronic copy of all analyses contained in Appendices, such as intersection capacity analysis (VISSIM or Synchro files), roundabout capacity analysis (SIDRA, VISSIM files) roadway capacity analysis, traffic signal warrant analysis, illumination warrant analysis, etc. All TIA reports submitted must be sealed by a professional engineer licensed to practice in the province in Alberta.

14.0 APPENDICES

Following documents must be included as appendices:

A. Minutes or Memorandum of Understanding (MOU) of the pre-study meeting;
B. A list of the traffic counts, collision data, traffic signal timings that were used in the traffic signal design including the dates and sources of the counts/data;
C. Capacity analysis results for study roadway sections, intersections and roundabout detailing the traffic volumes, turning movement volumes, LOS, v/c ratios, delays, and queues;
D. Calculations for any auxiliary lane warrants;
E. Roadway or intersection illumination warrant analysis; and
F. Traffic signal warrant analysis.

15.0 PUBLIC RECORD

All submitted documents, including both reports and data, become public record upon submittal and approval. TIA studies may be released to other consultants preparing similar traffic studies on nearby lands such that information contained in the subject study would be needed for the subsequent analysis.

APPENDIX A

Suggested Outline of the Traffic Impact Assessment Study

An outline of TIA report should include (but not limited to) the following sections:

1. Executive Summary
    a) Site location and study area
    b) Description of Proposed Development
    c) Types of studies undertaken (capacity analysis, signal & illumination warrants, etc.)
    d) Principal findings
    e) Conclusions and Recommendations

2. Introduction
    a) Name of the client and project background
    b) Site Description
    c) Study Area, roadway network & intersections
    d) Design Hours and Design Horizons

3. Traffic Analyses
    a) Existing Traffic Volumes, Peak Hours Traffic Volumes & Design vehicle
    b) Design Hour Traffic Volumes
    c) Site Generated Traffic Volumes
    d) Combined Traffic Volumes in Buildup Year & Design Horizon

4. Capacity Analyses
    a) Capacity analysis for the study intersections for all scenarios
    b) Capacity analysis for the study roadway sections for scenarios

5. Traffic Signal Warrant Analyses

6. Intersection & Roadway Illumination Warrant Analyses

7. Proposed Geometry of Study Intersections and Roadway Sections
    a) Turn lane warrants
    b) Length of turn bays
    e) Turn lane length computations (Acceleration & Deceleration lengths, Queue Lengths, etc)
    a) Roundabout Feasibility (if required)

8. Safety Analysis
    a) Sight Distance Analysis
    b) Operational Analysis
    c) Accident analysis (if requested)
    d) Traffic Calming measures (if required)
    e) Access management Issues

9. Conclusions and Recommendations

10. Appendix
    a) Memorandum of Understanding
    b) Site Plan
    c) Traffic Count Data
    d) Traffic Analyses Worksheets
    e) Capacity Analyses Worksheets,
    f) Signal Warrants Worksheets,
    g) Turn Lane warrants and length Calculations Worksheets

11. Figures (Exhibits)

The following Figures (Exhibits) should be included in the report:

a) Site Location Map with surrounding roadway network and proposed accesses
b) Existing conditions of roadway network
    I. existing lane configurations at study roadway sections and intersections,
    II. traffic controls at study roadway sections and intersections
    III. Speed limits
c) Background and future traffic volumes
d) Site Generated Traffic Volumes
e) Combined traffic volumes
f) Directional distribution of site traffic for each study intersections
g) Existing roadway and intersection geometry
h) Proposed roadway and intersection geometry
i) Proposed traffic control and lane usages

12. Tables

The following Tables should be included in the report:

I. Existing and projected traffic volumes
II. Trip generation tables with land uses, trip rates, directional distribution and generated traffic volumes
III. Level of Service (LOS) summary based on existing condition of roadway & intersection geometry and traffic controls
IV. Level of Service (LOS) summary based on suggested roadway & intersection geometry and traffic controls

APPENDIX B

Parameters to be used Intersection Capacity Analysis

A. Intersection Capacity

Signalized Intersections: The Highway Capacity Manual signalized level of service analysis is based on average vehicle delay. The RMWB has adopted following Level of Service (LOS) rating criteria from Highway capacity Manual (HCM) for Signalized Intersection.

Level of Service (LOS) rating criteria for Signalized Intersection Highway capacity Manual (HCM)	
LEVEL OF SERVICE (LOS)	DELAY (veh/sec)
A	>10
B	>10-20
C	>20-35
D	>35-55
E	> 55-80
F	>80

Unsignalized Intersection: The unsignalized intersection analysis procedures is for analyzing two-way stop controlled intersections where vehicles approaching the primary street must stop and yield to various movement of vehicles. Based on the volume of traffic to make the turn compared to the available number of gaps in the opposing movement, generates an estimated delay which correlates to level of service. The RMWB has adopted following Level of Service (LOS) rating criteria from Highway capacity Manual (HCM) for Un-Signalized Intersection.

Level of Service (LOS) rating criteria for Un-Signalized Intersection Highway capacity Manual (HCM)	
LEVEL OF SERVICE (LOS)	DELAY (veh/sec)
A	>10
B	>10-15
C	>15-25
D	>25-35
E	> 35-50
F	>50

Mitigation measures in the form of the addition of lane capacity and/or signal timing/ phasing adjustments will be required where v/c ratios for signalized intersections exceed 0.90. A higher value of v/c ratio might be acceptable based on engineering justification. Where development is anticipated to proceed in phases or stages, projected performance for all intersections must be documented for the end of each phase.

Existing signal timing information such as phasing, pedestrian minimums and clearance intervals must be used as a base to analyze the existing capacity of signalized intersections. This signal timing data should be obtained from the Traffic Operation Department of RMWB. Operational design of the signals analyzed should be in accordance with the RMWB's Guidelines for the Design and Operation of Traffic Signals.

In cases where roadways have closely spaced signals and especially when there are heavy turning movements, the analysis should confirm that storage limitations will not prevent signalized intersections from operating at the predicted V/C ratio.

B. Operational and Timing Standards for Signalized Intersections

Traffic Signal Design parameters	
Maximum cycle length for analysis	120 sec
Minimum Green Time	10 sec for side street through movements. 5 sec for left-turn phases
Minimum Pedestrian walk time	6 sec
Walking speed	1.2 m/sec; 1.0 m/sec if near old age home, school & shopping center
Minimum Initials (Main Street)	20 seconds or the minimum pedestrian interval (sum of walk and the pedestrian clearance), whichever is greater
Minimum Initials (Side Street)	10 seconds or the minimum pedestrian interval (sum of walk and pedestrian clearance), whichever is greater
Storage lane lengths (Left-turn storage)	Left-turn storage lanes must be long enough to accommodate the 95th percentile queue length in the peak hour. Sight distances, acceleration & deceleration lengths must be considered for applicable cases.
Protected only left-turn phasing	Protected only left-turn phasing must be used when conditions are such that an undue hazard might result if permissive phasing were used. This is normally considered to be the case with a double left turn.
Storage lane lengths (Right-turn storage)	Right-turn storage lanes must be long enough to permit right-turning traffic to clear the maximum queue of through vehicles that is anticipated to accumulate during the red indication. Sight distances, acceleration & deceleration lengths must be considered for applicable cases.
Maximum Allowable Volume-Capacity ratio (v/c)	0.85
Ideal Saturation Flow (vphpl)	1800 vehicles per hour per lane
Peak Hour Factor (PHF) (if no intersection traffic count data is available)	0.88

C. Roadway Capacity Parameters

Urban Street LOS is based on average through-vehicle travel speed for the segment, section, or entire urban street under consideration. The average travel speed for through vehicles along an urban street is the determinant of the operating level of service (LOS).

The travel speed along a segment, section, or entire length of an urban street is dependent on the running speed between signalized intersections and the amount of control delay incurred at signalized intersections. As the actual speeds drop in comparison to the free-flow speeds, the level of service drops.

The primary parameter for determining the capacity of a roadway is the number of travel lanes. The ideal width for a roadway is 3.7m. Roadways which have lane widths less than 3.7m impact capacity.

D. Design characteristics of roundabouts.

Design Element	Mini-Roundabout	Single-Lane Roundabout	Multilane Roundabout
Desirable maximum entry design speed	25 to 30 km/h	30 to 40 km/h	40 to 50 km/h
Maximum number of entering lanes per approach	1	1	2+
Typical inscribed circle diameter	13 to 27 m	27 to 55 m	(46 to 91 m
Central island treatment	Fully traversable	Raised (may have traversable apron)	Raised (may have traversable apron)
Typical daily service volumes on 4-leg roundabout below which may be expected to operate without requiring a detailed capacity analysis (veh/day)*	Up to approximately 15,000	Up to approximately 25,000	Up to approximately 45,000 for two-lane roundabout

*Operational analysis needed to verify upper limit for specific applications or for roundabouts with more than two lanes or four legs.