SARF
better roads

TRAFFIC IMPACT STUDIES: A COMPLETE STEP BY STEP TRAINING COURSE ON HOW TO PREPARE TRAFFIC IMPACT STUDIES

Revash Dookhi (PTOE, PR Eng)
2022

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Introduction

- Name
- Company
- Experience
- Expectations

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Background

- What is a Traffic Impact study / assessment (TIA / TIS) ?

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Background

- TIA/TIS – is a technical report that documents the implications of land use development or changes in the transport system on the transport system
- Land use development - conversion of land into construction ready building, e.g. housing, commercial, industrial or any combination thereof
- Transport system – facilities, equipment, people and goods
- TIA/TIS is a planning tool – most instances it is used as a reactive planning tool:
  - focuses on the need to mitigate transportation impacts of single, new development instead of providing a proactive strategy to plan for and fund long-term, area-wide transportation improvements.
  - in many cases, smaller or incremental developments, which cumulatively can have significant impacts, may not trigger the need for required transportation improvements - unfair distribution of responsibility - last developer in pays for all transportation improvements.
  - Approval process can be tedious and time consuming, particularly when multiple developers are involved, road authorities or across municipal boundaries.

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Background

- TIA’s are required by legislation in terms of the National Land Transport Act, 2009 (Act No. 5 of 2009) wherein it is stated that the development of any property or change of land use within the jurisdiction of a planning authority is subject to submission of a TIA (sections 38 (2) b), 38 (3) (b)).
- A TIA is submitted whenever there is a change in land use or a change that may impact on traffic operations. A change in land use or change impacting on traffic operations includes but not limited to the items listed below or combination of these items:
  – Rezoning of land, Special consent application for a change in land use
  – Township establishment, Amendment to town planning controls, Scheme amendments
  – Change to access arrangements, Change to public transport, parking and traffic management
  – Subdivision and consolidation of land
  – Road closure (temporary or permanent), including pedestrianisation of roads
  – Special event

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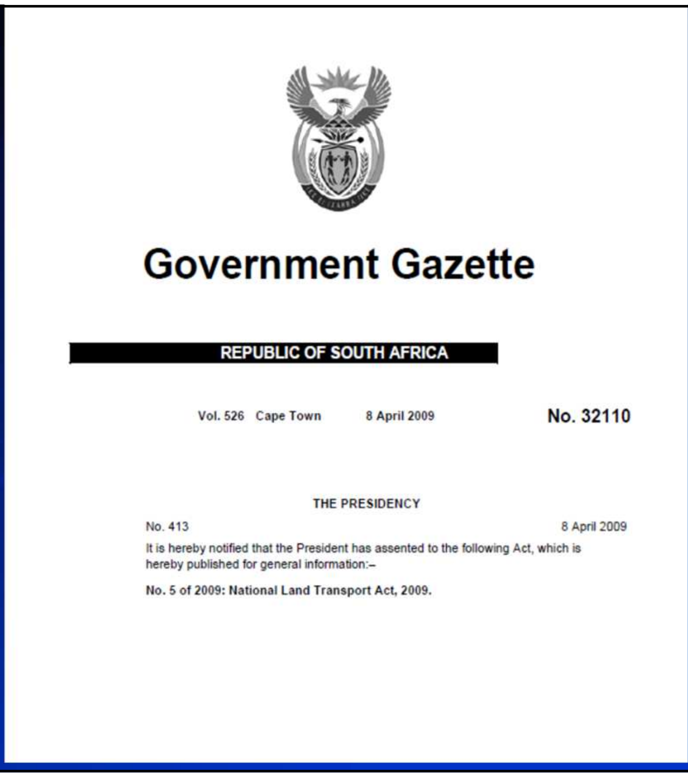

Government Gazette

REPUBLIC OF SOUTH AFRICA

Vol. 526 Cape Town 8 April 2009 No. 32110

THE PRESIDENCY

No. 413 8 April 2009

It is hereby notified that the President has assented to the following Act, which is hereby published for general information:–

No. 5 of 2009: National Land Transport Act, 2009.

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Background

Publication of transport plans and substantial changes in land use and public transport infrastructure and services

38. (1) On approval of the national land transport strategic framework, a provincial land transport framework or an integrated transport plan, the Department, MEC or planning authority, as the case may be, must publish, in the *Gazette*, *Provincial Gazette* or newspaper circulating nationally, in the province or municipality, as the case may be, the prescribed particulars of such plans, which must include particulars of routes for dangerous goods.

(2) All persons, including the State and parastatal institutions, agencies and utilities, are bound by the provisions of integrated transport plans published under subsection (1), and—

(a) no substantial change or intensification of land use on any property may be undertaken without the written consent of the relevant planning authority;

(b) developments on property within the area of the planning authority are subject to traffic impact assessments and public transport assessments as prescribed by the Minister;

(c) where new or upgraded transport infrastructure or services are suggested in such assessments, the costs thereof must be paid by the planning authority, unless it has agreed with a developer or other person to pay those costs; and

(d) no action may be taken that would have the result of substantially decreasing the quantity or availability of land transport infrastructure or services, unless the owner of the land on which the infrastructure is situated, or the holder of the relevant operating licence, as the case may be, has notified the relevant planning authority in writing not less than 30 days before the action is taken.

(3) Despite any law to the contrary, any authority with responsibility for approving substantial changes in land use or development proposals which receives an application for such change or intensification, must—

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Background

(a) within 14 days of receipt of such application and prior to considering or ruling on such application, submit such application to the relevant planning authority for its assessment and determination of the impact of the application on the integrated transport plan and public transport services; and

(b) ensure that such application is accompanied by the required traffic impact assessment and public transport assessment, and has sufficient information for the authority to assess and determine the impact of the application on transport plans and services.

(4) The planning authority must, within 90 days—

(a) approve or refuse an application for a change or intensification in land use or development proposal submitted in terms of subsection (3); and

(b) submit its written decision contemplated in paragraph *(a)* and any objections with respect to such application, including directions or conditions for compliance with the integrated transport plan, to such authority vested with responsibility for considering the application.

(5) The authority must make a decision, but may not approve such application, in conflict with the directions of or conditions required by the planning authority as contemplated in subsection (4)*(b)*.

(6) The planning authority, in accordance with the Promotion of Administrative Justice Act, 2000 (Act No. 3 of 2000), must furnish the applicant with written reasons for its decision.

(7) Where any person is aggrieved by any decision of a planning authority in terms of this section, such person may appeal against the decision in the manner and within the time prescribed, to the tribunal or other entity in the relevant province responsible to hear appeals lodged by persons who are dissatisfied with the decisions of municipalities regarding applications to establish townships or to change land uses.

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Traffic impact assessment

- What are the various steps and procedures for preparing a traffic impact assessment
- Identification and understanding the steps and procedures are key to producing a TIA that meets the various competing requirements
- What are the competing requirements – client / developer, authorities and general public
- TIA's are complex task that seeks to "balance" the client, authorities and general public requirements.
- In addition, TIA's are an iterative process – which is often not understood
- In general, there are some (6 basic steps) 9 major steps in the preparation of a TIA

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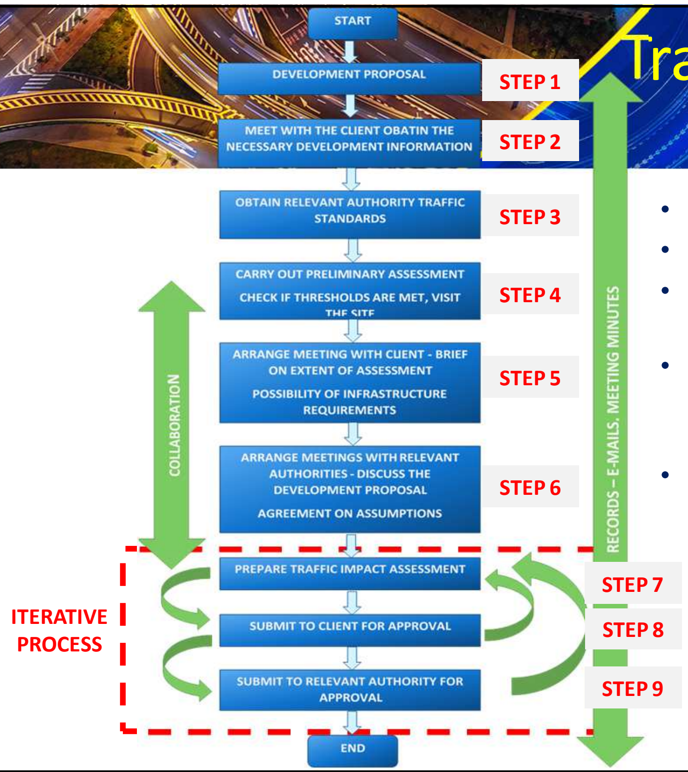
Traffic impact assessment



- 9 major stages in the preparation of a TIA
- Iterative process can occur at any stage
- Iterative process occurs during the study area selection
- The key iterative process often occurs after submitting the TIA to the client and authority for approval
- Each stage will be discussed in detail

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Development proposal

STEP 1

- What is the development proposal for a TIA – mainly related to land use development
- The "development proposal" could also be a non land use development such as: TIA for a closure of a road, special event, changes to traffic operations
- Example of a land use development proposal :
  - The proposal seeks to rezone the subject land located in North Oakville at 407 Dundas Street from Agricultural zone to Commercial 1 zone.
  - The site area is approximately 2.21 hectares (ha), the irregular shaped site has a frontage of approximate 69 meters along Dundas Street West and a depth of approximately 216 meters.
  - The site is currently an undeveloped flat grass pasture that abuts Shannon's Creek on the east side of the parcel.
  - The 30,445 m^2 development will consist of 280 housing units with a varied mix of unit types including condominium units, stacked townhouses and traditional townhouse units.
  - The development will consist of a 4 storey mixed-use condominium building with a 400 m^2 commercial component located off Trailside Drive

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Development proposal

STEP 1

- Location plan – provides overall context for the TIA
- The site size, location
- Always important to visualise the site in context of the broader and local transport system

Example of development proposal

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Meet with the client

STEP 2

MEET WITH THE CLIENT - OBATIN THE NECESSARY DEVELOPMENT INFORMATION

1. **Site address**
2. **Title deed**
3. **Development proposal plans**
4. **Zoning information**
5. **Project timelines / schedule**
6. **Professional team**

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Meet with the client

STEP 2

1. Site address - important reference for the TIA and information for development access
2. Title deed - The document acts as proof of ownership in terms of the Deeds Registries Act 47 of 1937. The document contains all the necessary details and important information about the property such as a comprehensive description and exact size including access / servitudes, special / restrictive conditions which is vital for the TIA .
3. Development proposal plans - key information for the development layout, extent and design necessary for the TIA
4. Land use Zoning information - necessary for traffic demand calculations, parking and loading requirements
5. Project timelines / schedule – what is the developers programme versus realistic time frames for preparing the TIA
6. Professional team - must know the other teams members e.g. architects, town planners – needed to ensure alignment between the development proposal and traffic requirements

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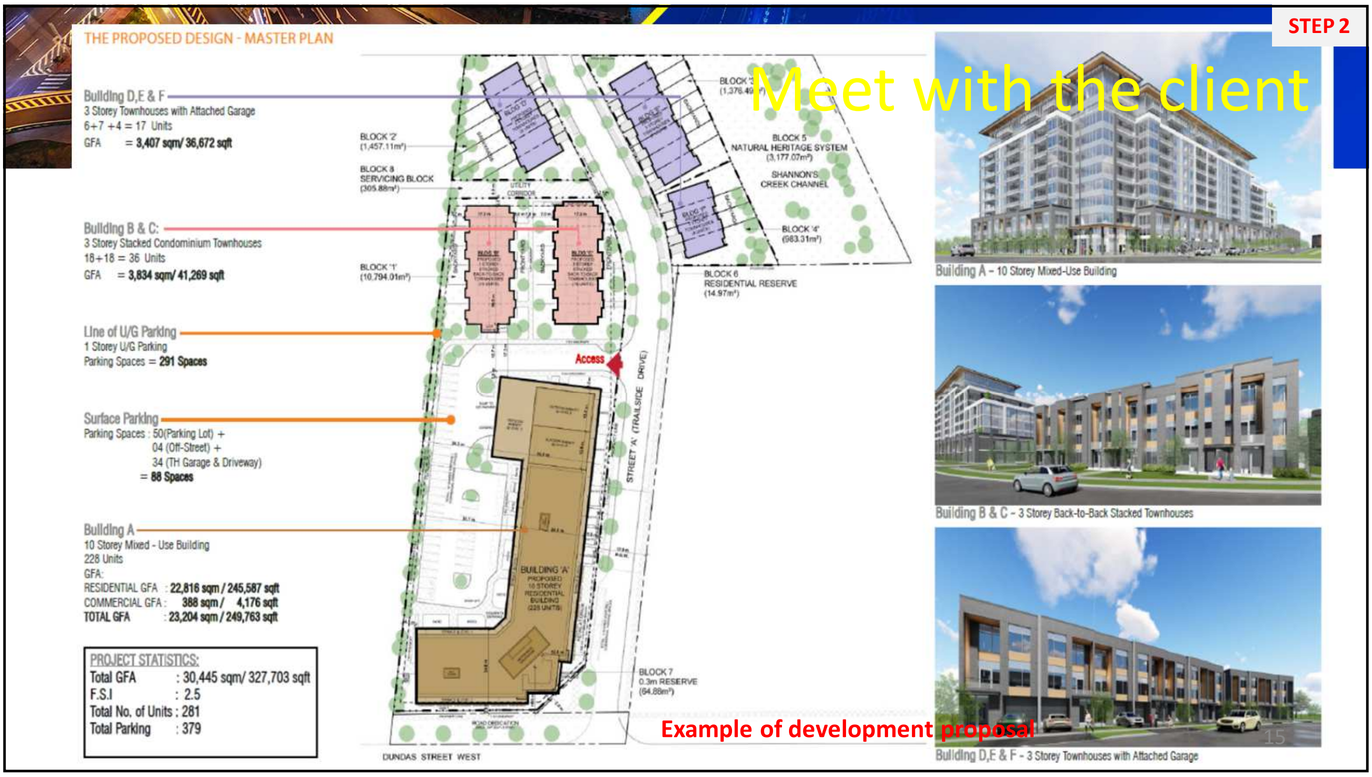

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13.1 AGRICULTURAL ZONE (AG)

Meet with the client

STEP 2

Purpose

The AG zone promotes and protects agriculture on farms as an important economic, environmental and cultural resource. Limited provision is made for non-agricultural uses to provide owners with an opportunity to increase the economic potential of their properties, without causing a significant negative impact on the primary agricultural resource.

Use of the property

13.1.1 The following use restrictions apply to property in this zone:

(a) **Primary uses** are agriculture, intensive horticulture, dwelling house, riding stables, environmental conservation use, environmental facilities, rooftop base telecommunication station and additional use rights as listed in subsection (b).

(b) **Additional use rights**, which may be exercised by the occupant of a property as a primary use are second dwelling and home occupation, or bed and breakfast establishment, or home child care, subject to:

(i) only one of the activities listed as additional use rights shall be conducted from any land unit, provided this does not apply to a second dwelling, and if more than one such activity is required, Council's approval shall be obtained;

(ii) the proprietor of the activity concerned shall live on the property; and

(iii) the development rules stipulated in section 5.1.3, 5.1.4 or 5.1.5, whichever is applicable, shall be adhered to.

(c) **Consent uses** are additional dwelling units, guest house, hotel, tourist accommodation, tourist facilities, intensive animal farming, harvesting of natural resources, mine, utility service, freestanding base telecommunication station, wind turbine infrastructure, aquaculture, animal care centre, farm shop and agricultural industry.

Development rules

13.1.2 The following development rules apply:

(a) Floor space

Example of land use zoning information

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(i) The total floor space of all dwelling units on the land unit, including accommodation for bona fide agricultural workers employed on the property, shall not exceed 1 500 m²; provided that with the approval of Council this requirement may be relaxed if such accommodation is required for persons who are genuinely engaged for their livelihood in agricultural activities on the land unit;

(ii) Any farm shop shall not exceed a floor space of 100 m².

(b) **Building lines**

(i) The street and common boundary building lines are determined in accordance with the area of the land unit, as shown in the following 'Table of building lines in Agricultural Zone'.

(ii) The general building line encroachments in section 18.1 shall apply.

Table of building lines in Agricultural Zone

LAND UNIT AREA	STREET BOUNDARY BUILDING LINE	COMMON BOUNDARY BUILDING LINE
>20 ha	30,0 m	30,0 m
≤20 ha	15,0 m	15,0 m

(c) **Parking**

Parking and access shall be provided on the land unit in accordance with Chapter 19.

(d) **Height**

(i) The maximum height of a dwelling house, measured from the base level to the top of the wallplate, shall be 9 m and to the top of the roof shall be 11 m.

(ii) Agricultural buildings other than the dwelling houses shall not exceed a height of 12 m measured from the base level to the top of the roof.

(iii) Earth banks and retaining structures which in the opinion of Council are associated with bona fide agricultural activities are exempt from the requirements of section 18.6.

(e) **Minimum subdivision size**

No new subdivision or any remainder that is zoned and intended to remain zoned Agriculture shall be less than:

(i) the minimum subdivision size specified in terms of an approved local area overlay zone, or

(ii) 20 ha if no such overlay zone exists, unless the new subdivision or remainder concerned is consolidated with a property zoned Agriculture, so as to make up a consolidated land unit of at least the minimum required subdivision size and provided that compliance with this requirement does not limit the Council's powers to refuse a subdivision application that it considers to be undesirable.

Meet with the client

STEP 2

Example of land use zoning information

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8.2 LOCAL BUSINESS ZONE 2: LOCAL BUSINESS (LB2)

Purpose

The LB2 zone provides for low-intensity commercial and mixed-use development which serves local needs for convenience goods and personal services. Limitations are placed on the scale of such development so that it is capable of integration into the adjacent residential neighbourhood without adversely affecting the amenity of the neighbourhood.

Use of the property

8.2.1 The following use restrictions apply to property in this zone:

(a) **Primary uses** are shop, office, dwelling house, second dwelling, boarding house, bed and breakfast establishment, flats, place of instruction, place of worship, institution, clinic, guest house, service trade, utility service, rooftop base telecommunication station, private road and open space.

(b) **Consent uses** are place of assembly, informal trading, restaurant, sale of alcoholic beverages, place of entertainment, adult shop, business premises, supermarket, plant nursery, hotel, conference facility, motor repair garage, service station, authority use, freestanding base telecommunication station, wind turbine infrastructure transport use and multiple parking garage.

Development rules

8.2.2 The following development rules apply:

(a) Floor factor

The floor factor on a land unit shall not exceed 1,0.

(b) Coverage

The coverage for all buildings on a land unit shall not exceed 75%.

(c) Height

(i) The maximum height of a building, measured from base level to the top of the roof, shall be 12 m.

(ii) Earth banks and retaining structures are subject to section 18.6.

Meet with the client

STEP 2

Example of land use zoning information

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Meet with the client

STEP 2

(d) Street centreline setback

Council may require a street centreline setback, in which case:

- (i) all buildings or structures on the land unit shall be set back 8,0 m from the centre line of the abutting public street or streets; and
- (ii) the provisions of section 18.2 shall apply.

(e) Street boundary building line

The street boundary building line is 0 m, subject to:

- (i) the street centreline setback restriction;
- (ii) minor architectural and sunscreen features may project beyond the street boundary building line provided that such features do not project more than 250 mm beyond the street boundary; and
- (iii) for service stations the street boundary building line is 5 m subject to the general building line encroachments in section 18.1.

(f) Common boundary building line

The common boundary building lines are 0 m.

(g) Canopy projection

Council may approve a canopy projection over the street boundary in accordance with the following conditions:

- (i) The canopy shall not project nearer than 500 mm to a vertical plane through the kerb line or proposed kerb line;
- (ii) No portion of a canopy projection shall be less than 2,8 m above the pavement;
- (iii) Council may lay down more restrictive requirements relating to the dimensions, design and materials of the canopy; and
- (iv) The owner shall enter into an encroachment agreement with Council.

Example of land use zoning information

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Meet with the client

STEP 2

(h) **Street corners**

Council may require that the owner of a building which is to be situated at a public street corner, and which Council considers to be significant, shall incorporate in the building architectural features which focus visual interest on the corner, and which emphasize the importance of pedestrian movement around the corner; and such features may include building cut-offs, walk-through covered arcades, plazas or other elements.

(i) **Parking and access**

Parking and access shall be provided on the land unit in accordance with Chapter 19.

(j) **Loading**

Loading bays shall be provided on the land unit in accordance with section 19.4.

(k) **Screening**

Council may require screening in accordance with section 18.5.

Example of land use zoning information

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Local authority standards

STEP 3

- It is vital that you obtain the authority standards which forms the basis for preparing the TIA – sometimes authorities apply different standards – better to check than to assume that some other standard that you are familiar with will be applicable
- Avoid rework and delays
- Authority threshold for TIA's sometimes varies from authority to authority
- May have specific trip generation rates
- Specific acceptable software tools
- Specific reporting formats
- Road geometric and site / building plan standards are specific
- Authority also indicates need for TIA – e.g. A TIA shall be submitted whenever an application is made for a change in land use rights, subject to certain thresholds provided…

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Relevant authority traffic standards

STEP 3

OBTAIN RELEVANT AUTHORITY TRAFFIC STANDARDS

1. **Standards and guidelines used for traffic studies including transport design guidelines**
2. **Currently in South Africa;**

COTO Manuals (2012/2013):

- **TMH 16, Volume 1: South African Traffic Impact and Site Traffic Assessment Manual, COTO, 2012**
- **TMH 16 Volume 2 South African Traffic Impact and Site Traffic Assessment Standards and Requirements Manual**
- **TMH 17 Volume 1 South African Trip Data Manual**
- **TMH 15 South African Engineering Service Contribution Manual for Municipal Road Infrastructure**

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STEP 3

Relevant authority traffic standards

OBTAIN RELEVANT AUTHORITY TRAFFIC STANDARDS

1. **Design guidelines**

Road classes	Manual or guideline
Class 1 to 3	CUTA UTG 1 (1986) & CSRA TRH 17 (1988) AASHTO (2018), Geometric Design Guidelines (SANRAL)
Class 4	Engineering Services Guidelines (1994) CUTA UTG 5 (1988) & CSRA TRH 17 (1988)
Class 5	Engineering Services Guidelines (1994) CUTA UTG 7 (1989) & CUTA UTG 10 (1990)
Commercial and Industrial roads	CUTA UTG 10 (1990)

2. **Public transport facilities, traffic signals – specific to authority**
3. **Parking / loading standards and requirements – specific to authority**

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Local authority standards

STEP 3

2.6 Traffic assessments thresholds

2.6.1. Requirements on when Traffic Impact Assessments and Site Traffic Assessments must be undertaken and submitted are provided in this section.

2.6.2. A Traffic Impact Assessment shall be undertaken and submitted when an application is made for a change in land use and when the highest total *additional* hourly vehicular trip generation (including pass-by and diverted trips) as a result of the application exceeds 50 trips per hour.

2.6.3. A Site Traffic Assessment shall be undertaken and submitted whenever:

a) An application is submitted for the erection of a building or other structure (roads and other) on a site for which a Site Development Plan (SDP) is required.

b) Proposals are made for transportation facilities (roads and other) in a township during Township Establishment.

Single dwelling units are exempted from this requirement when access is obtained from a Class 5 road and the access is to the satisfaction of the Municipality. However, the Municipality may require an assessment when there is concern regarding the safety of the access.

2.6.4. Requirements for the undertaking and preparation of the different levels of traffic assessments are provided in Appendix A to this manual.

Example of TIA Thresholds

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Local authority standards

STEP 3

The thresholds for submission of TIA's are as follows:

- *A TIA shall be undertaken and submitted when an application is made for a change in land use when the highest total additional hourly vehicular trip generation (including pass-by and diverted trips) exceeds* ~~***11 vehicle trips.***~~ ***50 vehicle trips***

The thresholds for submission of STA's are as follows:

- *A STA shall be undertaken and submitted when an application is made* for the erection of a building or other structure (e.g. roads and other) on a site for which a Site Development Plan is required when *the highest total hourly vehicular trip generation (including pass-by and diverted trips) exceeds* ~~***11 vehicle trips***~~. ***50 vehicle trips***

Notwithstanding the thresholds, the ETA may require a TIA / STA to be undertaken having considered factors peculiar to the application and/or its impacts in terms of the environment, road network, and persons directly affected by the application.

Applications for changes in land use that result in additional vehicular trip generation that are below the threshold values are not exempt from the provision of transport infrastructure where such infrastructure is deemed necessary by the ETA.

Applications for which a site development plan is required and where the vehicle trip generation values are lower than the thresholds for STA's shall not be exempt from the provision of transport infrastructure where required such infrastructure is deemed necessary by the ETA.

Example of TIA Thresholds 25

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Town planning

- TIA's are mainly submitted as part of a town planning process for a change in land use / redevelopment (rezoning, special consent)
- It is therefore necessary to understand the current town planning process and regulations currently in place - SPLUMA

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SPLUMA

What is SPLUMA?

- SPLUMA is “The Spatial Planning and Land Use Management Act 16 of 2013” and came into operation on 1 July 2015.
- SPLUMA sets the principle that all land development applications must be submitted to the municipality as the authority of first instance – without actually prescribing in detail how spatial planning and land use management issues are to be dealt with within municipal areas.
- SPLUMA seeks to promote consistency and uniformity in procedures and decision making for all land development within its authority.
- SPLUMA is a national regulation however, local authorities have the right to promulgate their own SPLUMA by-laws and therefore requirements can vary according to the local authority by-laws

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SPLUMA

Government Gazette

REPUBLIC OF SOUTH AFRICA

Vol. 578 **Cape Town** **5 August 2013** **No. 36730**

THE PRESIDENCY

No. 559 5 August 2013

It is hereby notified that the President has assented to the following Act, which is hereby published for general information:–

Act No. 16 of 2013: Spatial Planning and Land Use Management Act, 2013

AIDS HELPLINE: 0800-123-22 Prevention is the cure

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SPLUMA

PLANNING FUNCTIONS OF THE THREE SPHERES OF GOVERNMENT

- Municipal - the compilation, approval and review of the components of an IDP prescribed by legislation and falling within the competence of a municipality, including a spatial development framework and a land use scheme
- Provincial - the compilation, approval and review of a provincial spatial development framework, approval, review and implementation of land use management systems;
- National - National planning, as provided for in SPLUMA, consists of the following elements: (a) the compilation, approval and review of spatial development plans and policies or similar instruments, including a national spatial development framework

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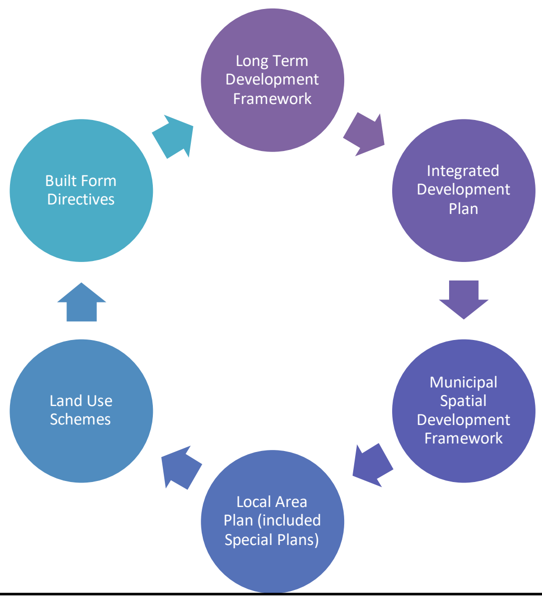
SPLUMA



The Long Term Development Framework provides for the strategic, economic, social and environmental objectives of the Municipality in order to inform its strategic development direction

The IDP provides for the strategic implementation direction and imperatives of the Municipality

The Municipal Spatial Development Framework provides for the strategic spatial development objectives of the Municipality based on the Long Term Development Framework and IDP

The local area plan is a detailed physical plan which provides for– (a) physical planning directives refining land use, transport, environment and infrastructure to levels that inform the preparation of a land use scheme;

The land use scheme provides for zoning and development control regulations and is the detailed land use management tool and provides for the allocation of potential development rights to public and privately owned land.

A Built Form Directive is a plan which may include– (a) site specific details, including three dimensional modelling; and (b) built form directives, including but not limited to, coverage, floor area ratio, parking and planting.

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SPLUMA

Plan Type	Scope	Purpose
Local Area Plan	Detailed Physical Plan	Detailed Physical Planning Directives for the City and the Municipality Refining Land Use, Transport, Environment, Infrastructure to a level that informs the preparation of a Land Use Scheme. Also includes Urban Design Directives for Public and Privately owned Land. May include implementation proposals
Precinct Plan/Special Area Plan	Detailed Physical Plan for special areas	Detailed Physical Planning Directives for the City and the Municipality for areas with special environmental, economic, heritage etc characteristics. Detailed Urban Design Directives and / or Proposals. May include implementation proposals
Land Use Scheme	Zoning and Development Control Regulations	Detailed Land Use Management Tool for the Municipality and Allocation of Potential Development Rights to private and publicly owned land.

TIA

Land use scheme must include—
scheme regulations setting out the procedures and conditions relating to the use and development of land in any zone;
a map indicating the zoning of the municipal area into land use zones; and
a register of all amendments to such land use scheme.

Legal effect of land use scheme
An adopted and approved land use scheme—
has the force of law, and all land owners and users of land, including a municipality, a state-owned enterprise and organs of state within the municipal area are bound by the provisions of such a land use scheme;

SPLUMA

Land development applications

- No person may commence, carry on or continue with any land development without the prior written approval having been granted in terms of the municipal by-law.
- All land development applications must be submitted to the Municipality, as the authority of first instance.
- Notwithstanding the above, where any authorisation is required from an organ of state, such authorisation must accompany the submission of the land development application to the Municipality.
- Categorisation of land development applications

SPLUMA

Category 1 land development determinations

A Category 1 determination must be considered, approved and adopted by the Municipal Council and includes the following: (a) the adoption of the land use scheme; and (b) the amendment or review of the land use scheme.

What is a land use scheme?

It is a document that :

- enables the comprehensive management of all erven (both private and public sector) within the municipality;
- to promote and implement the applicable planning and development legislation and principles as adopted by the relevant National, Provincial and Municipal spheres of government from time to time; and
- to promote and implement the Vision and Strategies of the Integrated Development Plan in the realization of quality environments
- to manage land-use rights, to provide facilitation over use rights, to manage urban growth and development, and to manage conservation of the natural environment, in order to:
- Achieve co-ordinated and harmonious development in a way that will efficiently promote public safety, health, order, convenience and to protect the general welfare of the inhabitants of the Municipality;
- Promote integrated and sustainable development through-out the area of jurisdiction;
- Promote sustainable environmental management, conserve and protect environmentally sensitive areas; Promote all forms of development and growth through sound Planning principles that would support a mix of land-uses managed in an appropriate manner.

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SPLUMA

- The land use scheme from a traffic point of view contains the following information used by traffic engineers:
    - Land use zoning and zoning controls (FAR, coverage, height, etc) – which is used for trip demand calculations
    - Parking and loading requirements and standards for each land use
    - Development standards – applicable to traffic
- Category 2 land development applications - land development applications where there is a departure from the provisions of the Municipal Spatial Development Framework; (a)an application for rezoning of land where objections to the application have been lodged; (c) an introduction of a new area and an existing zone into the land use schemes; (d) zoning of land; and (e) a combined application, which includes one or more of the land development uses set out in (a) to (d) as well as any land uses falling within category 3 and 4.

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SPLUMA

- Category 3 land development applications;
- A category 3 application includes– (a) a special consent application; (b) an application for subdivision; (c) an application for subdivision and consolidation; (d) an application for a township establishment; (e) an application for the **closure of roads** and public open spaces; (f) an application for the **rezoning of land** which is in line with the Municipal Spatial Development Framework; (g) an application for the removal, amendment or suspension of a restrictive condition; (h) an application for the development of land outside of a land use scheme; and (i) a combined application, which includes one or more of the land development uses set out in (a) to (h) above as well as any land uses falling within category 4 land development applications.

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SPLUMA

- Category 4 land development applications
- A Category 4 application includes– (a) an application for a relaxation where the necessary consent or consents have been obtained; (b) an application for an exemption from the provisions of the land use scheme where the necessary consent or consents have been obtained; (c) an application for a notarial tie of adjacent land; and (d) an application for the development of land outside of a scheme in respect of an application for a relaxation or exemption where the necessary consent or consents have been obtained

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SPLUMA

- General definitions for key application types:
  - Consolidation of land: is where two or more Erven are combined together to form one new Erf, with boundaries to be approved by the Surveyor-General and the new properties to be registered with the Registrar of Deeds.
  - The sub-division of land: is when an Erf is divided into more than one Erven. It requires new cadastral boundaries which must be approved by the Surveyor-General, as well as the registration of newly created Erven with the Registrar of Deeds
  - Rezoning of land means: a process whereby the current zoning as indicated on the Scheme Map and the corresponding controls relating thereto in the Scheme regulations are amended
  - Relaxation: Relaxation of Space About Buildings is required when any buildings or structures are proposed in advance of the distances as stipulated in the Scheme.
  - Sometimes parking relaxation if the scheme allows
  - Township- area of land divided into erven, and may include public places and roads indicated as such on a general plan (11 or for evern ?)

SPLUMA

- Special consent (“temporary” approval that can be revoked):
  - the use that is proposed falls within the Special Consent column of the Development Facilitation Table of the Scheme;
  - the use proposed is a Special Building; and in the case of land or buildings which is used in conflict with any provisions of this Scheme;
  - a use that is proposed is a precluded use in terms of the Development Facilitation Table or any proposal that is in conflict with any provisions of this Scheme. It should be noted that the Municipality is bound to refuse such application.
- In considering any Special Consent, the Municipality shall take into consideration the impact of the proposed use on the surrounding area and may impose any conditions it deems necessary to protect the amenities of the area.

SPLUMA

- Types of land development applications which require public participation:
- An applicant must give public notice of a land development application in the manner stipulated for the following types of applications:
  - special consent applications;
  - zoning and re-zoning applications;
  - removal, amendment or suspension of restrictive conditions applications;
  - closure of roads and public open spaces; and
  - any Category 2 application.
- These applications are subject to public scrutiny (objections), consequently, TIA's can and are scrutinised in this process

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SPLUMA

Objections to land development applications

A written objection in respect of any land development application must be served on both the applicant and the Municipality within the 30 day period allowed for the lodging of objections.

- Objections to land use applications occur and one of the main objections are on traffic grounds
- TIA's are "defended" at the Appeal hearing

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NOTICE OF APPEAL HEARING

APPEAL IN TERMS OF THE SPATIAL PLANNING AND LAND USE MANAGEMENT ACT, 2013 (ACT 16 OF 2013) TO APPEAL LODGED AGAINST THE DECISION OF THE Atlanta Municipality TO APPROVE THE APPLICATION FOR SPECIAL CONSENT: 1 PROPOSED PLACE OF PUBLIC WORHSIP 2. PROPOSED CRECHE (RESTRICTED TO A MAXIMUM OF 30 CHILDREN) 3. RELAXATION OF THE SIDE (NORTH EATERN) SPACE FOR A BOUNDARY/RETAINING WALL EXCEEDING 3.0M IN HEIGHT (MAXIMUM HEIGHT 6.1M) 4. RELAXATION OF THE SIDE (SOUTH WESTERN) SPACE FOR A BOUNDARY/RETAINING WALL EXCEEDING 3.0M IN HEIGHT (MAXIMUM HEIGHT 7.1M) ON ERF 205 ATHOLL HEIGHTS SITUATED AT 7 Downing street [redacted] ("THE APPLICATION PROPERTY").

Example of objection

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The Special Consent application for a church at 7 Downing street e and objections thereto, have been reviewed in the above document by an independent Traffic Engineer and the summarised findings are as follows:

4.1 The [redacted] Traffic Impact Assessment (TIA) and indeed the Special Consent application by SA Development Consulants and Planners contain very scant information on the development and this makes it difficult for the public and technical reviewers to make informed decisions on the application. A prime example of this is the matter of the proposed floor area of the church, which is a vital piece of information. This matter not mentioned in the TIA, it is given as 186 m² in the Special Consent application, it is given as 396 m² in the [redacted] review and it is given in as 585 m² in the draft Site Plan.

This is a very serious matter as the proposed floor area is the criteria used to determine the required on-site parking for the church. Of the above areas, **the 186 m² indicates that <u>41</u> parking bays are required,** however it has been shown that the stated 350 seats cannot be accommodated in 186 m². At the other end of the scale, **the 585 m² indicates a logical area for 350 seats and it gives an on-site parking requirement of <u>117</u> bays plus 5 bays for the creche = <u>122 bays</u>, which appears instinctively and logically to be more realistic for a 350-seat church.**

Example of objection

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SPLUMA

4.2 The [redacted] Traffic Impact Assessment was studied and found to be largely in compliance with the [redacted] Manual for Traffic Impact Assessments.

There were two areas where inadequate/inaccurate information was made available and this related to the width of Blairgowrie Road (6 metres and not 7 metres as per the [redacted] report)) and Sight Distances along Blairgowrie Road in both directions for traffic exiting the church access.

This investigation has found that, contrary to what is stated in the [redacted] TIA, sight distance to the east is not achievable which is likely to result in unsafe operating conditions.

4.3 Based on the conclusions discussed in paragraphs 4.1 and 4.2 above:

I can conclude that the Special Consent application and the accompanying Traffic Impact Assessment are fatally flawed and should never have been approved by [redacted]

Example of objection 43

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SPLUMA

- Key definitions of SPLUMA applicable to TIA's
- ''development rights'' means any approval granted to a land development application;
- "development rights" means a development right which is conferred on land by virtue of its zoning; includes a pre-scheme or non-conforming use right and which may be subject to specialist studies;

44

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Rezone

ZONE: SPECIAL RESIDENTIAL 900

SCHEME INTENTION: To provide, preserve, use land or buildings for single residential use in a form of a dwelling house and ancillary uses. Protection of the quality and character of residential neighborhood and the well-being of its residents. Limiting multiple uses of buildings to minimize adverse impact on the residential environment. Business that comply with residential amenity such as a Bed and Breakfast Establishment, Guest House Establishment and Home Business at the discretion of the Municipality.

MAP REFERENCE: NS / 05 / 2012 **COLOUR NOTATION:** Black cross hatch with Light yellow background

PRIMARY	SPECIAL CONSENT	PRECLUDED	
• Dwelling House • Private Open Space • Public Open Space	• BTTS* • Boarding House • Crèche • Educational Establishment • Garden Nursery • Health & Beauty Clinic • Institution • Multiple Unit Development* • Pet Grooming Parlour • Place of Public of Worship • Retirement Centre • Special Building • Veterinary Clinic	• Action Sports Bar • Adult Premises • Agricultural Activity • Agricultural Land • Airport • Arts and Crafts Workshop • Betting Depot • Builder's Yard • Car Wash • Cemetry / Crematorium • Chalet Development • Container Depot • Convention Centre • Correctional Facility • Direct Access Service Centre • Display Area • Escort Agency • Flat • Flea Market • Fuelling and Service Station • Funeral Parlour • Government / Municipal • Health Studio • Hotel • Industry - Extractive • Industry – General • Industry – Light • Industry – Noxious	• Institution • Landfill • Laundry • Mobile Home Park & Camping Ground • Mortuary • Motor Garage • Motor Display Area • Motor Vehicle Test Centre • Motor Workshop • Museum • Nature Reserve • Night Club • Office • Office – Medical • Parkade • Place of Public Entertainment • Recycling Centre • Reform School • Refuse Disposal • Restaurant / Fast Food Outlet • Restricted Building • Riding Stables • Scrap Yard • Shop • Transport Depot • Truck Stop • Warehouse • Zoological Garden

ADDITIONAL CONTROLS

1. BTTS shall mean Base Telecommunications Transmission Station
2. For the Design and layout of a Multiple Unit Development refer to Section 9 of this Scheme.

DEVELOPMENT PARAMETERS

DISTRICT	SPACE ABOUT BUILDINGS		DWELLING UNITS PER HECTARE	MINIMUM ERF SIZE	HEIGHT	COVERAGE	FLOOR AREA RATIO
	BUILDING LINE	SIDE & REAR SPACE					
Umhlanga	7.5 m	2.0 m	Not Applicable	900 m²	2	40 %	0.35
All Other Districts	7.5 m	2.0 m	Not Applicable	900 m²	2	30 %	0.3

ZONE: COMMERCIAL

SCHEME INTENTION: To provide, preserve, use land or buildings to accommodate a wide range of recreational, entertainment, residential, shopping and business or economically related activities in such a way that the site contributes the creation of a harmonious well balanced Commercial Centre of the highest aesthetic, landscaping and urban design quality.

MAP REFERENCE: NS / 05 / 2012 **COLOUR NOTATION:** Medium Blue

PRIMARY	SPECIAL CONSENT	PRECLUDED	
• Action Sports Bar • Arts and Crafts Workshop • Betting Depot • Crèche • Display Area • Educational Establishment • Flat • Flea Market • Government / Municipal • Health & Beauty Clinic • Health Studio • Hotel • Laundry • Motor Display Area • Museum • Office • Office – Medical • Parkade • Pet Grooming Parlour • Place of Public Entertainment • Private & Public Open Space • Restaurant / Fast Food Outlet • Shop • Veterinary Clinic	• Adult Premises • BTTS* • Builder's Yard • Car Wash • Convention Centre • Direct Access Service Centre • Escort Agency • Fuelling and Service Station • Funeral Parlour • Institution • Mortuary • Motor Vehicle Test Centre • Motor Workshop • Night Club • Place of Public of Worship • Special Building • Transport Depot • Warehouse	• Agricultural Activity • Agricultural Land • Airport • Boarding House • Cemetry / Crematorium • Chalet Development • Container Depot • Correctional Facility • Dwelling House • Garden Nursery • Industry - Extractive • Industry – General • Industry – Light • Industry – Noxious	• Landfill • Mobile Home Park & Camping Ground • Motor Garage • Multiple Unit Development • Nature Reserve • Recycling Centre • Reform School • Refuse Disposal • Restricted Building • Retirement Centre • Riding Stables • Scrap Yard • Truck Stop • Zoological Garden

ADDITIONAL CONTROLS

1. All landscaping to the satisfaction of the Municipality. BTTS shall mean Base Telecommunications Transmission Station.
2. Where a building is used simultaneously for residential and commercial purposes each floor shall be set aside and used for one or the other purpose but not for both, provided that the residential use may be permitted at ground floor level where the design of a building is such that the residential use is not contiguous with the street.
3. Provision shall made on-site to the satisfaction of the Municipality for a garden and play area which must be kept free of parking space and driveways and which may be wavered in the instance of recreational space being provided in the surrounds of the Erf.
4. Where an Erf is used is used solely for commercial purposes accommodation for a caretaker may be provided to a maximum of 100 m² in extent.

DEVELOPMENT PARAMETERS

DISTRICT	SPACE ABOUT BUILDINGS		MINIMUM ERF SIZE	HEIGHT IN STOREYS	COVERAGE	FAR
	BUILDING LINE	SIDE & REAR SPACE				
La Lucia, Umhlanga, & Somerset Park & Sunningdale	7.5 m	2.0 m	500 m²	3 storeys or 7.6 metres ahngl whichever is the lesser	50 %	0.75
Verulam	7.5 m	2.0 m	450m² for commercial use & 1800m² for composite commercial & residential use	2	50 %	1.0
All Other Districts	7.5 m	2.0 m	500 m²	3	50 %	0.75

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SPLUMA

- Rezone from Special Residential 900 (SR 900) to Commercial
- Development rights in principle implies that the local authority has provided the bulk or external road infrastructure to accommodate the proposed SR 900 zone
- Example – the existing site is 10,000m² - bulk services designed for 2 residential units i.e. 2-3 peak hour vehicle trips
- The rezoning to commercial – what do we design for ? – development scenario –the range of "free entry" uses imposes various design requirements for external (also internal) / bulk infrastructure e.g.
  - Development for floor area of 3000m² (week day peak hour trips):
    - Office = 63 veh trip (2,1 veh/100m²)
    - Medical office = 240 veh trip (8,0 veh/100m²)
    - Shop = 432 veh trips (14,4 veh/100m²)
- How is this dealt with from a town planning approval point of view - in theory a development of 0.75 FAR can be developed i.e. 7500m²
- Does this imply that although the development is for 3000m² once the approval (rezoning) is granted that developer can develop another 4500m² without a TIA ?

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SPLUMA

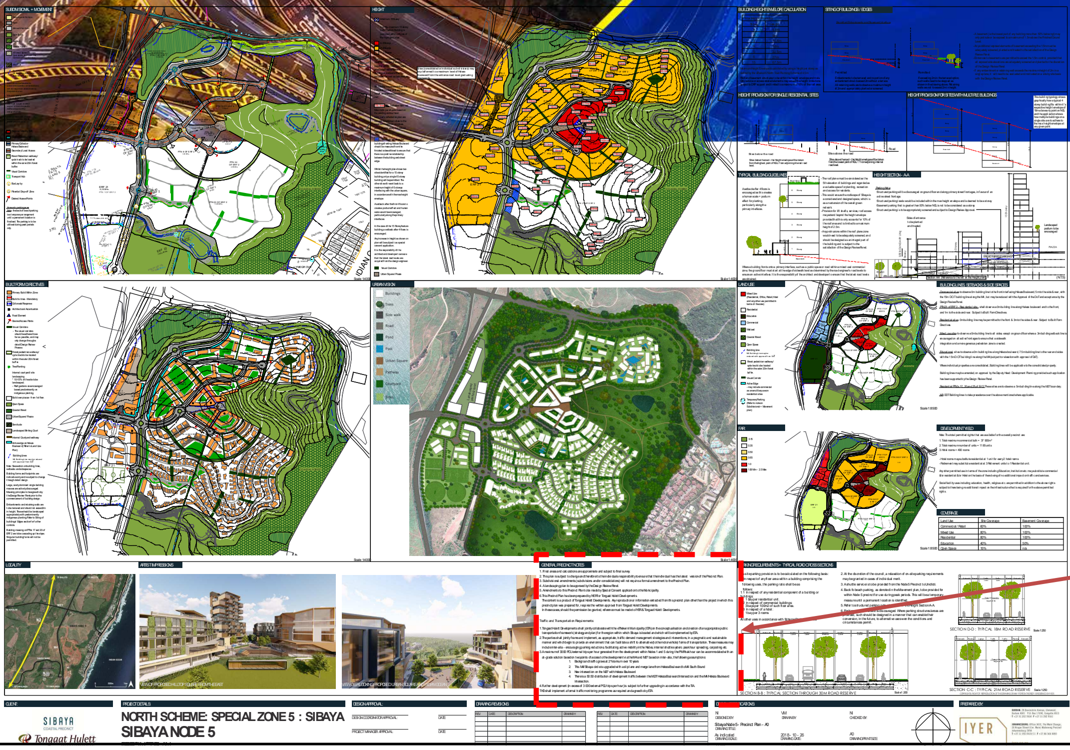
- No – this should not be the case
- SPLUMA allows for conditional approval of applications – conditions must be complied within a maximum of 5 years – approval lapses

__43.__ (1) An application may be approved subject to such conditions as—
(a) are determined by the Municipal Planning Tribunal; or
(b) may be prescribed.
(2) A conditional approval of an application lapses if a condition is not complied with, within—
(a) a period of five years from the date of such approval, if no period for compliance is specified in such approval; or
(b) the period for compliance specified in such approval, which, together with any extension which may be granted, may not exceed five years.

- Development precinct plan:
  - Can fall outside a scheme and have its own zoning, controls, parking, traffic requirements, other requirements

SPLUMA

Site area	**10000**	**m²**					
FAR (50%)	**5000**	**m²**					
Primary land use	**Units**		**Weekday Peak Trip Rate**		**PHF**	**Trip (veh/hr)**	**Transport Requirements**
Action Sports Bar							
Arts and Crafts Workshop							
Creche	150	students	1	per student		**150**	
Display Area							
Education Establishment	400	students	0,9	per student	0,55	**655**	**Additional lane + intersection improvements**
Health and Beauty Clinic							
Health Studio	3500	m²	9,5	per 100m²	0,85	**392**	**Additional lane + intersection improvements**
Laundary							
Motor Display Area	5000	m²	2,3	per 100m²	1	**115**	
Museum							
Office	5000	m²	2,1	per 100m²	1	**105**	
Office medical	5000	m²	8	per 100m²	1	**400**	**intersection improvements**
Parkade							
Pet Gromming Parlour							
Place of Public Entertainment							
Private & Public Open Space							
Restaurant / Fast Food Outlet	1000	m²	50	per 100m²	1	**500**	**Additional lane + intersection improvements**
Shop	5000	m²	11,8	per 100m²	1	**590**	**Additional lane + intersection improvements**
Veterinary Clinic							



Special Conditions

Example of precinct plan

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GENERAL PRECINCT NOTES

1. Final areas and calculations are approximate and subject to final survey.
2. This plan is subject to change and therefore its the individuals responsibility to ensure that the individual has the latest version of the Precinct Plan.
3. Subdivisional amendments (subdivisions and/or consolidations) will not require a formal amendment to the Precinct Plan.
4. A landscaping plan to be approved by the Design Review Panel.
5. Amendments to this Precinct Plan to be made by Special Consent application to the Municipality.
6. This Precinct Plan has been prepared by IYER for Tongaat Hulett Developments.

The content is a product of Tongaat Hulett Developments. Any reproduction or information extracted from this precinct plan other than the project in which this precinct plan was prepared for, requires the written approval from Tongaat Hulett Developments.

In these cases, should the permission be granted, reference must be made to IYER & Tongaat Hulett Developments.

Traffic and Transportation Requirements:

1. Tongaat Hulett Developments shall jointly collaborate with the eThekwini Municipality (ETA) on the conceptualisation and creation of an appropriate public transportation framework (strategy and plan) for the region within which Sibaya is located and which will be implemented by ETA.
2. The parties shall jointly frame and implement, as appropriate, traffic demand management strategies and interventions, in a pragmatic and sustainable manner and which begin to provide an environment that can facilitate a shift to alternative (to the motor vehicle) forms of transportation. These measures may include inter-alia - encouraging parking reductions, facilitating active mobility in the Nodes, internal shuttle system, peak hour spreading, carpooling etc.
3. A maximum of 3000 PCU external trips per hour generated from the development within Nodes 1 and 5 during the PM Peak hour can be accommodated with an at-grade solution based on two points of access to the development via the M4 and M27 based on inter-alia, the following assumptions:
    1. Background traffic grows at 2%/annum over 10 years
    2. This M4/Sibaya circle is upgraded with a slip lane and merge lane from Heleza Boulevard to M4 South Bound
    3. New intersection on the M27 with Heleza Boulevard
    4. There is a 50:50 distribution of development traffic between the M27/Heleza Boulevard Intersection and the M4/Heleza Boulevard Intersection.
4. Further development (in excess of 3 000 external PCU trips per hour) is subject to further upgrading in accordance with the TIA.

THD shall implement a formal traffic monitoring programme as required and agreed to by ETA

Example of precinct plan
Special conditions

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LAND USE

BUILDING LINES, SETBACKS & SIDE SPACES

Commercial sites to observe 0m building line to the front interfacing Heleza Boulevard, 5m to the side & rear, with the 15m D.O.T building line along the M4, but may be reduced with the Approval of the DoT and acceptance by the Design Review Panel.

PTN 23 of ERF 2 – Residential site – shall observe a 0m building line along Heleza boulevard and to the front, and 1m to the side and rear. Subject to Built Form Directives.

Residential sites. 0m building line may be permitted to the front & 3m to the sides & rear. Subject to Built Form Directives.

Mixed use sites to observe a 0m building line to all sides, except on ground floor where a 3m building setback line is encouraged on all active frontages to ensure that a sidewalk integration and a more generous pedestrian zone is created.

Educational sites to observe a 0m building line along Heleza boulevard, 7.5m building line to the rear and sides with the 15m D.O.T building line along the M4 (subject to relaxation with approval of DoT).

Where individual properties are consolidated, Building lines will be applicable to the consolidated property.

Building lines may be amended, on approval by the Deputy Head: Development Planning provided such application has been supported by the Design Review Panel.

Residential PTN's 17, 20 and 25 of Erf 2 These sites are to observe a 5m building line along the M27 boundary.

N.B DOT Building lines to take precedence over the above mentioned where applicable.

FAR

DEVELOPMENT YIELD

Note: The total permitted rights that are available for the overall precinct are:

1. Total maximum commercial bulk = 37 900m²
2. Total maximum number of units = 1185 units
3. Hotel rooms = 490 rooms

- Hotel rooms may substitute residential at 1 unit for every 2 hotel rooms
- Retirement may substitute residential at 3 Retirement units to 1 Residential unit.

Any other permitted use in terms of the zone including Education, Institution etc. may substitute commercial &/or residential &/or Hotel on the basis of there being of no additional impact on traffic and services.

Social facility uses including education, health, religious etc. are permitted in addition to the above rights subject to there being no additional impact on the infrastructure that is required for the above permitted rights.

COVERAGE

Land Use	Site Coverage	Basement Coverage
Commercial/ Retail	60%	100%
Mixed Use	80%	100%
Residential	80%	100%
Education	40%	50%
Open Space	15%	n/a

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Example of precinct plan

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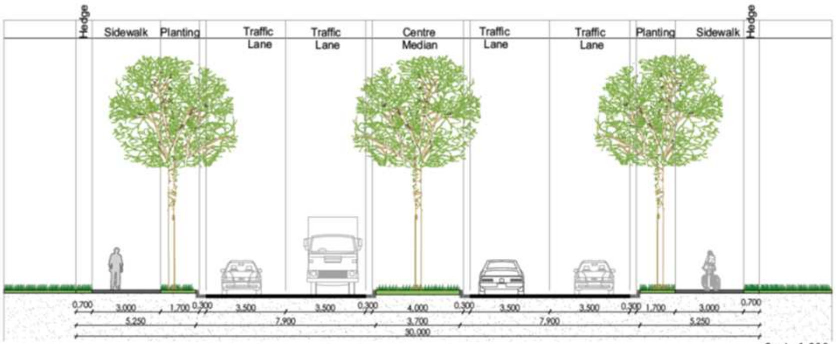
PARKING REQUIREMENTS + TYPICAL ROAD CROSS SECTIONS

On-site parking provision is to be calculated on the following basis:

1. In respect of any floor area within a building comprising the following uses, the parking ratio shall be as follows:
   1.1 In respect of any residential component of a building or buildings:
   1 bay per residential unit.
   1.2 In respect of commercial buildings:
   3 bays per 100m2 of such floor area.
   1.3 In respect of a hotel:
   1 bay per 3 rooms

All other uses in accordance with Scheme Parking controls

2. At the discretion of the council, a relaxation of on-site parking requirements may be granted in cases of individual merit.
3. A shuttle service is to be provided from the Node 5 Precinct to Umdloti.
4. Back fo beach parking, as denoted in the Movement plan, to be provided for within Node 5 precinct for use during peak periods. This will be a temporary measure until a permanent location is identified.
5. Refer to structured parking note above, under the Height Section A-A.
6. Parking provision onsite is discouraged. Where parking structures/areas are provided, such should be designed in a manner that can enable their conversion, in the future, to alternative uses wen the conditions and circumstances permit.



SECTION B-B : TYPICAL SECTION THROUGH 30M ROAD RESERVE

Scale 1:200

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Example of precinct plan

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SPLUMA

- Provision of engineering services :
- ‘‘external engineering service’’ means an engineering service situated outside the boundaries of a land area and which is necessary to serve the use and development of the land area

49. *(1) An applicant is responsible for the provision and installation of internal engineering services.*
(2) A municipality is responsible for the provision of external engineering services.
(3) Where a municipality is not the provider of an engineering service, the applicant must satisfy the municipality that adequate arrangements have been made with the relevant service provider for the provision of that service.
(4) An applicant may, in agreement with the municipality or service provider, install any external engineering service instead of payment of the applicable development charges, and the fair and reasonable cost of such external services may be set off against 30 development charges payable.
(5) If external engineering services are installed by an applicant instead of payment of development charges, the provision of the Local Government: Municipal Finance Management Act, 2003 (Act No. 56 of 2003), pertaining to procurement and the appointment of contractors on behalf of the municipality does not apply.

Road Classification

- Road classification
- The type of road is an important aspect for a traffic impact assessment:
- By type of road we refer to the Functionality or intended purpose that the road is meant to provide to various types of road users : vehicle users, pedestrians, cyclist and public transport
- ***TRH 26 : South African Road Classification and Access Management Manual, Version 1.0 August 2012*** provides the Functional Classification of roads
- Two categories of road
    - Mobility
    - Access/activity roads
- Two categories are further disaggregated into six classes

Class number	Function	Description
Class 1	Mobility	Principal arterial
Class 2		Major arterial
Class 3		Minor arterial
Class 4	Access/activity	Collector street
Class 5		Local street
Class 6		Walkway

Road Classification

Primary class	Trip generator	Reach of Connectivity	Travel stage
Mobility Roads	Large or strategic generators	Longer travel	Through, destination not reached
Access Street	Individual properties	Short connection	Local, stop at destination

- Mobility roads are those that comply with ANY one of the three criteria listed in the above table. The generator need not be large if long travel distances are involved. Roads that predominantly carry through traffic should be mobility roads and not be used for providing access.

- Access/Activity streets are those that meet ALL three criteria listed in the table. The streets should only serve local traffic to and from individual properties with short travel distances to the nearest mobility road. If a street does not meet all three criteria, then it should be classified as a mobility road.

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Road Classification

- Urban and Rural road classification:

- Rural roads have longer reaches of connectivity and therefore require higher levels of mobility than urban roads
- An urban area is defined as an area that has been subdivided into erven, whether formal or informal. It includes areas on which townships have been formally declared as well as informal settlements. Rural settlements of one hectare or less are also included in the urban definition
- A rural area is an area which is not an urban area. The areas are characterized by sparse development, mainly given over to nature or farming activities.

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Road Classification

Why classify road ?

- Improved capacity and traffic flow (more efficient private and public transport)
- Improved safety (for all road users, whether vehicles, cyclists or pedestrians)
- Efficient use of scarce resources (less road construction needed)
- Equality for all users
- Planning certainty for developers
- Integrated land use and transport
- Social benefits
- Environmental quality
- Economic benefits

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Road Classification

- Planning certainty for developers
    - Roads pre-classified, accompanied by strictly enforced access management, will give planners certainty, in that all the mobility roads will be declared and the allowable intersections and accesses determined before an access application is made.
    - Applications not meeting the requirements for access will be refused and the official making the ruling will have the backing of the authority's policy and the THR 26 manual.
    - The benefits of certainty and equity to the planning and implementation of projects should not be underestimated

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Road Classification

- Integrated land use and transport
  - Roads must be provided to suit land use and not the other way around. The road network is determined by the land use, and the functional classification makes it clear that it is the size, importance and density of destinations that need to be served that determine the number and class of road required to serve them.
  - Access management provides the means to ensure that the designated roads are able to serve land uses in an appropriate and efficient manner.
  - Land use and transport integration thus means that the hierarchy and protection of the different road Classes appropriate to their function is an integral part of enabling efficient and sustainable land use. It definitely does not mean however that every piece of land should be given full access to any road. The process of land use and transport integration and the identification of nodes and corridors must therefore be a joint exercise of the town planning and engineering departments.

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Road Classification

- Social benefits
  - A significant advantage of access control is that it can contribute to the quality of living in residential neighbourhoods. The public has always been concerned about the impact of traffic upon their neighbourhoods, and has become less tolerant of the noise and general disturbance caused by traffic in their streets
  - Managing access in a way that accords with the function of the road will allow acceptable mobility on through routes (arterials) and reduce speeds in residential areas (activity streets). This, together with appropriate design, will reduce if not eliminate intrusion of through traffic into residential areas.

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Road Classification

- Environmental quality
    - Access management benefits the natural environment by ensuring a more effective utilisation of existing resources.
    - Improving the flow of traffic on major roads not only leads to a reduction in vehicle emissions, but also to a reduction in the need for new road construction and road building materials. Improved transportation also supports higher development densities aimed at curbing urban sprawl, which allows for more open spaces.
    - Traffic congestion, queues, noise and pollution make for unpleasant living and working conditions. Access management helps relieve congestion and reduces “rat running”, therefore contributes greatly to the environmental quality of liveable townships.

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Road Classification

- Economic benefits
    - Improved accessibility leads to greater access to economic opportunities for both businesses and individuals
    - Accessibility also leads to improved productivity resulting from improved transportation efficiency. Reduced travel times have the following economic advantages:
    - Better accessibility realizes increased land values
    - Improved accessibility can significantly improve economic viability:

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Road Classification

Table B: Rural Functional Road Classification

Function			Description		Mobility				
Basic Function	Alternate functional descriptions	Determining function	Class No (R_)	Class name	Origin / destination	Through traffic component	Reach of connectivity	% of built km	AADT (average annual daily traffic)
Mobility	Vehicle priority, vehicle only, long distance, through, high order, high speed, numbered, commercial, economic, strategic; route, arterial road or highway.	Movement is dominant, through traffic is dominant, the majority of traffic does not originate or terminate in the immediate vicinity, the function of the road is to carry high volumes of traffic between urban areas	1	Principal arterial*	Metro areas, large cities, large border posts, join national routes	Exclusively	> 50 km	2 - 4% Classes 1 and 2	1000 – 100 000+
			2	Major arterial*	Cities and large towns, transport nodes (harbours and international airports), smaller border posts, join major routes	Exclusively	>25 km		500 – 25 000+
			3	Minor arterial*	Towns, villages and rural settlements, tourist destinations, transport nodes (railway sidings, seaports, landing strips), small border posts, other routes	Predominant	> 10 km	6 - 12% Classes 1, 2 and 3	100 – 2 000+
Access / Activity	Access, mixed pedestrian and vehicle traffic, short distance, low order, lower speed, community / farm, road or street.	Access, turning and crossing movements are allowed, the majority of traffic has an origin or destination in the district, the function of the road is to provide a safe environment for vehicles and pedestrians using access points	4	Collector road	Connect farming districts, rural settlements, tourist areas, national and private parks and mines to mobility routes	Minimal	< 10 km	20 - 25%	< 1 000
			5	Local road	Farm or property access, connection to other routes	Nil Discontinuous	< 5 km	65 - 75%	< 500
			6	Walkway (path or track)	Settlements, farms, transport nodes, water points	n/a			

** In rural areas, the term distributor may be preferred to arterial*

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Road Classification

Table C: Urban Functional Road Classification

Function			Description		Mobility				Traffic	
Basic Function	Alternate functional descriptions	Determining function	Class No (U_)	Class name	Through traffic component	Distance between parallel roads (km)	% of built km	Reach of Connectivity	Expected range of ADT (average daily traffic)	% of travel veh-km
Mobility	vehicle priority, vehicle only, long distance, through, high order, high speed, numbered, commercial, economic, strategic; route, arterial road or highway.	Movement is dominant, through traffic is dominant, the majority of traffic does not originate or terminate in the immediate vicinity, the function of the road is to carry high volumes of traffic between urban districts	1	Principal arterial (freeway)	Exclusively	5 - 10 km	5 - 10% Classes U1 and U2	> 20 km	40 000 - 120 000+	40 – 65% Classes U1 and U2
			2	Major arterial	Predominant	1.5 - 5.0 km		> 10 km	20 000 - 60 000	
			3	Minor arterial	Major	0.8 - 2.0 km	15 - 25% Classes U1, U2 and U3	> 2 km	10 000 - 40 000	65 – 80% Classes U1, U2 and U3
Access / Activity	Access, mixed pedestrian and vehicle traffic, short distance, low order, low speed, community, street.	Access, turning and crossing movements are allowed, the majority of traffic has an origin or destination in the immediate area, the function of the road is to provide a safe environment for vehicles and pedestrians using access points	4a	Collector street, commercial	Discourage		5 – 10%	< 2 to 3 km	< 25 000	5 – 10%
			4b	Collector street, residential	Discourage			< 2 km	< 10 000	
			5a	Local street, commercial	Prevent		65 – 80%	< 1 km	< 5 000	10 – 30%
			5b	Local street, residential	Prevent			< 0.5 km (1 km Max)	< 1 000	
			6a	Walkway, pedestrian priority	Ban					
			6b	Walkway, pedestrian only	Ban					

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Road Classification

TRH 26 : It has been shown that a six lane roadway with uncontrolled access would be required to provide the same capacity as an access managed four lane highway (Stover and Koepke, 2002)

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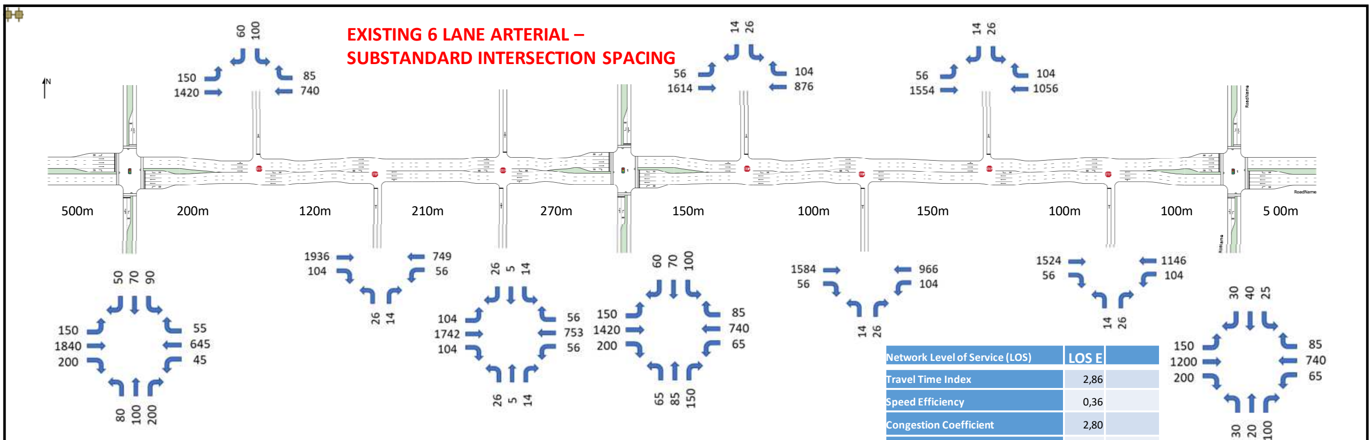

Performance Measure (E-W)		
Travel Speed (Average)	46,4	km/h
Travel Distance (Average)	2511,1	m
Travel Time (Average)	194,8	sec
Route Delay (Average)	42,7	sec
Route Stop Rate	2,05	
Desired Speed	60,0	km/h
Route Level of Service (LOS)	LOS B	
Travel Time Index	7,48	
Speed Efficiency	0,77	
Congestion Coefficient	1,29	

Performance Measure (W-E)		
Travel Speed (Average)	42,9	km/h
Travel Distance (Average)	2510,5	m
Travel Time (Average)	210,7	sec
Route Delay (Average)	59,2	sec
Route Stop Rate	2,59	
Desired Speed	60,0	km/h
Route Level of Service (LOS)	LOS B	
Travel Time Index	6,83	
Speed Efficiency	0,71	
Congestion Coefficient	1,40	

Network Level of Service (LOS)	LOS E	
Travel Time Index	2,86	
Speed Efficiency	0,36	
Congestion Coefficient	2,80	
Travel Speed (Average)	21,4	km/h
Travel Distance (Total)	7929,7	veh-km/h
Travel Time (Total)	370,0	veh-h/h
Desired Speed	60,0	km/h
Demand Flows (Total for all Sites)	31237	veh/h
Arrival Flows (Total for all Sites)	30444	veh/h
Demand Flows (Entry Total)	5458	veh/h
Midblock Inflows (Total)	0	veh/h
Midblock Outflows (Total)	0	veh/h
Degree of Saturation	5,585	
Control Delay (Total)	217,33	veh-h/h
Control Delay (Average)	25,7	sec
Control Delay (Worst Lane)	2269,5	sec
Control Delay (Worst Movement)	2308,3	sec
Geometric Delay (Average)	0,8	sec
Stop-Line Delay (Average)	24,9	sec
Queue Storage Ratio (Worst Lane)	0,67	
Total Effective Stops	9475	veh/h

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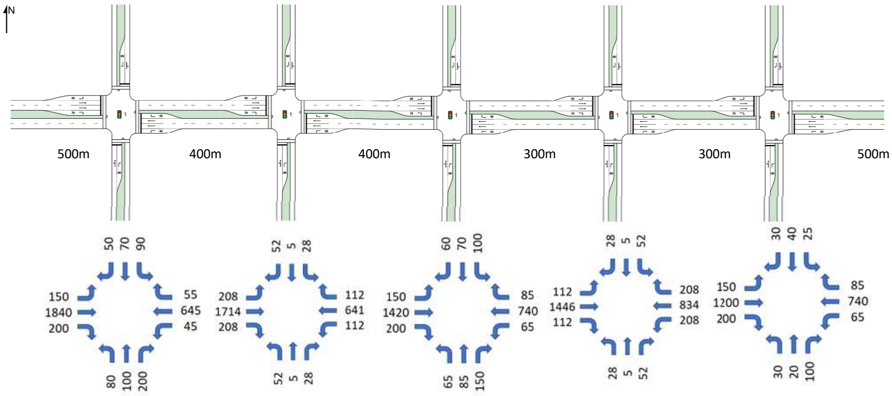
4 LANE ARTERIAL – WITH MANAGED SIGNALISED INTERSECTION SPACING



Network Level of Service (LOS)	LOS D	
Travel Time Index	5,26	
Speed Efficiency	0,57	
Congestion Coefficient	1,74	
Travel Speed (Average)	34,4	km/h
Travel Distance (Total)	8117,1	veh-km/h
Travel Time (Total)	235,8	veh-h/h
Desired Speed	60,0	km/h
Demand Flows (Total for all Sites)	16900	veh/h
Arrival Flows (Total for all Sites)	16732	veh/h
Demand Flows (Entry Total)	5458	veh/h
Midblock Inflows (Total)	0	veh/h
Midblock Outflows (Total)	0	veh/h
Degree of Saturation	1,400	
Control Delay (Total)	97,56	veh-h/h
Control Delay (Average)	21,0	sec
Control Delay (Worst Lane)	243,1	sec
Control Delay (Worst Movement)	243,1	sec
Geometric Delay (Average)	1,4	sec
Stop-Line Delay (Average)	19,6	sec
Queue Storage Ratio (Worst Lane)	0,35	
Total Effective Stops	8737	veh/h

Performance Measure (E-W)		
Travel Speed (Average)	49,7	km/h
Travel Distance (Average)	2466,0	m
Travel Time (Average)	178,7	sec
Route Delay (Average)	30,7	sec
Route Stop Rate	1,57	
Desired Speed	60,0	km/h
Route Level of Service (LOS)	LOS A	
Travel Time Index	8,09	
Speed Efficiency	0,83	
Congestion Coefficient	1,21	

Performance Measure (W-E)		
Travel Speed (Average)	46,5	km/h
Travel Distance (Average)	2466,0	m
Travel Time (Average)	190,9	sec
Route Delay (Average)	43,0	sec
Route Stop Rate	2,21	
Desired Speed	60,0	km/h
Route Level of Service (LOS)	LOS B	
Travel Time Index	7,50	
Speed Efficiency	0,77	
Congestion Coefficient	1,29	

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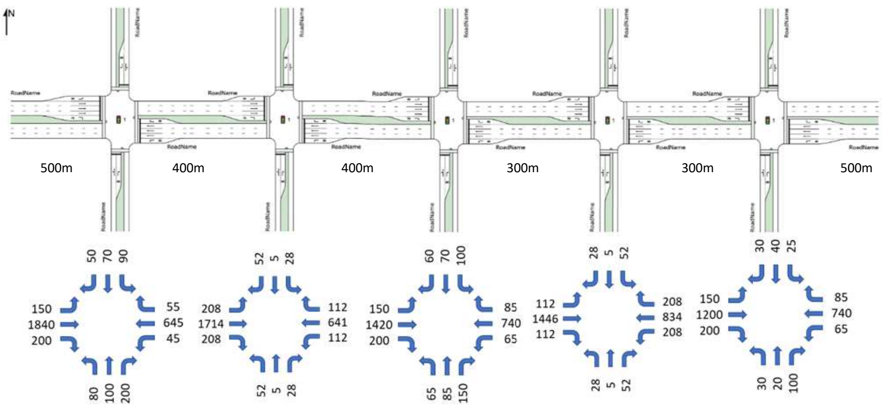
6 LANE ARTERIAL – WITH MANAGED SIGNALISED INTERSECTION SPACING



Network Level of Service (LOS)	LOS C	
Travel Time Index	5,89	
Speed Efficiency	0,63	
Congestion Coefficient	1,59	
Travel Speed (Average)	37,8	km/h
Travel Distance (Total)	8164,6	veh-km/h
Travel Time (Total)	216,0	veh-h/h
Desired Speed	60,0	km/h
Demand Flows (Total for all Sites)	16900	veh/h
Arrival Flows (Total for all Sites)	16810	veh/h
Demand Flows (Entry Total)	5458	veh/h
Midblock Inflows (Total)	0	veh/h
Midblock Outflows (Total)	0	veh/h
Degree of Saturation	1,218	
Control Delay (Total)	77,90	veh-h/h
Control Delay (Average)	16,7	sec
Control Delay (Worst Lane)	164,3	sec
Control Delay (Worst Movement)	164,3	sec
Geometric Delay (Average)	1,4	sec
Stop-Line Delay (Average)	15,3	sec
Queue Storage Ratio (Worst Lane)	0,21	
Total Effective Stops	7661	veh/h

Performance Measure (E-W)		
Travel Speed (Average)	49,7	km/h
Travel Distance (Average)	2466,0	m
Travel Time (Average)	178,5	sec
Route Delay (Average)	30,6	sec
Route Stop Rate	1,45	
Desired Speed	60,0	km/h
Route Level of Service (LOS)	LOS A	
Travel Time Index	8,10	
Speed Efficiency	0,83	
Congestion Coefficient	1,21	

Performance Measure (W-E)		
Travel Speed (Average)	48,5	km/h
Travel Distance (Average)	2466,0	m
Travel Time (Average)	183,1	sec
Route Delay (Average)	35,1	sec
Route Stop Rate	1,72	
Desired Speed	60,0	km/h
Route Level of Service (LOS)	LOS B	
Travel Time Index	7,87	
Speed Efficiency	0,81	
Congestion Coefficient	1,24	

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STEP 4

Preliminary assessment

- A preliminary assessment must always be undertaken – why ?
- Screen for fatal flaws and provide the client with an indication of key requirements such as major infrastructure constraints and requirements
- This stage is commonly overlooked, and many engineers do not carry out a preliminary assessment.

CARRY OUT PRELIMINARY ASSESSMENT

CHECK IF THRESHOLDS OF TRAFFIC STUDY ARE MET

VISIT THE SITE - OBSERVATIONS - CAPACITY CONSTRIANTS, FATAL FLAWS

1. **Trip generation calculations**
2. **Peak hour site visit**
3. **Desktop assignment**
4. **Prepare preliminary assessment report**

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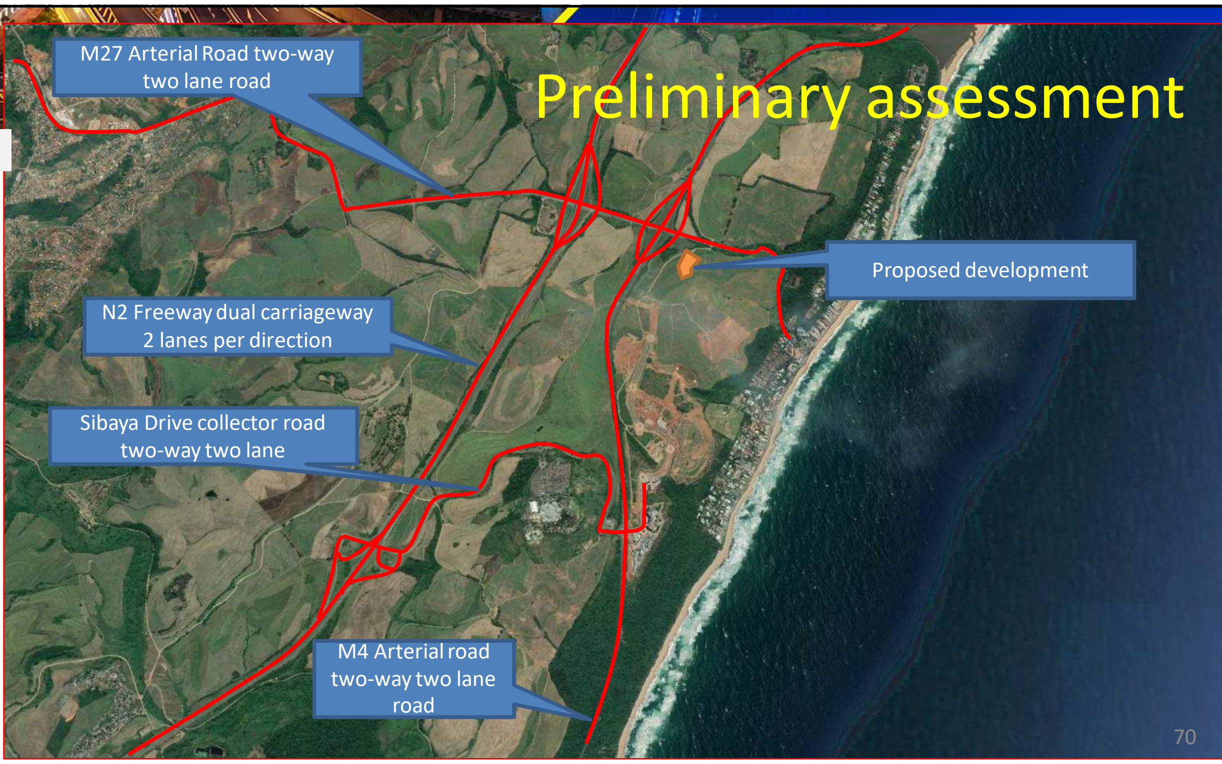
STEP 4

Preliminary assessment



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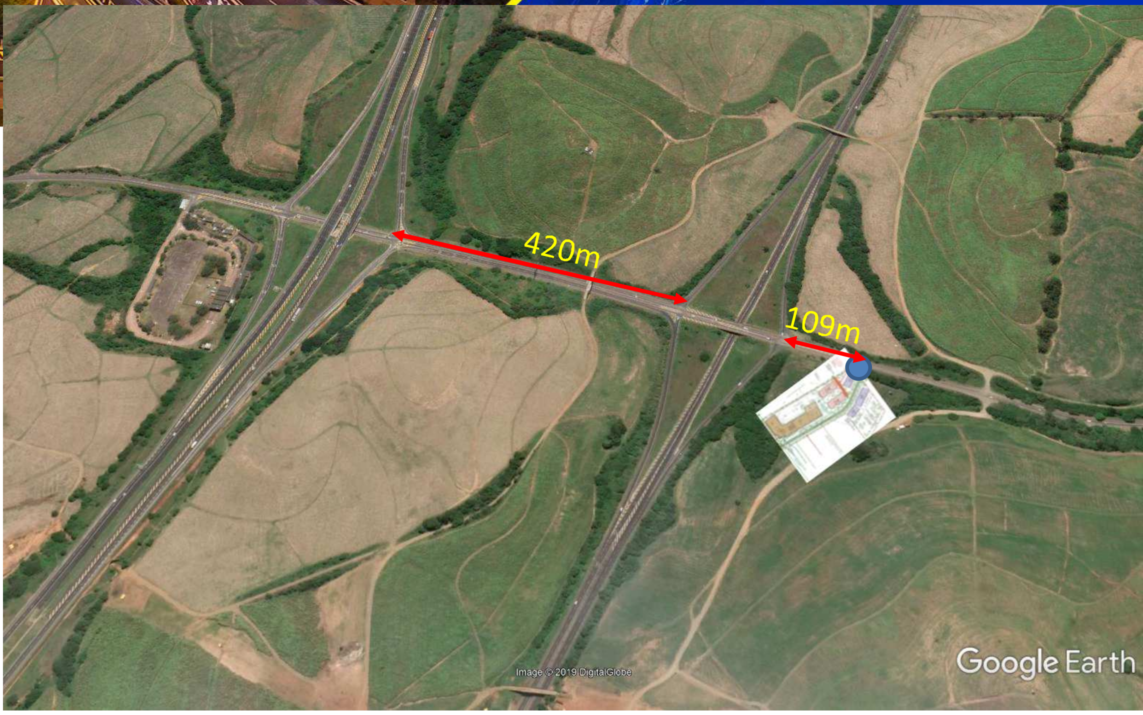
STEP 4



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TRAFFIC SOLUTIONS CONSULTING

PRELIMINARY TRAFFIC ASSESSMENT

Proposed Sibaya Coastal Resort

127 Umhloti Road, Sibaya, Durban

22 April 2019

1. **DEVELOPMENT LAND USE**

   Land use rezoning from agricultural to local business zone 2

   280 residential units

   400 m2 of office

2. **TRIP GENERATION**

   Trip generation based on COTO THM 17 manual (unadjusted traffic demand estimation)

Land use	Extent	Trip rate	Week day AM / PM peak hour
Residential	280 units	1.3 vehicle trips / unit	364
Office	400 m2	2.1 vehicle trips / 100m2	9
			374

   The development is likely to generate 374 peak hour vehicle trips and which is more than the threshold of 50 peak hour trips and therefore a traffic impact study is required

3. **SITE OBSERVATATION**

   A peak hour site observation was undertaken on 4 April 2019 and indicated that there are capacity constraints on the adjacent road of the M27 and it is likely that an additional through lane along the M27 including dedicated turn lanes at the access are required for this development.

   Public transport vehicles where observed in the vicinity of the site. The majority of the traffic travelled westbound along the M27.

4. **ACCESS**

   The current access location shown on the preliminary development plan does not comply with the access spacing for this class of road. Access spacing of 120m is required

5. **SITE PLAN**

   The site plan shows gated/boom access control which does not meet the required distance spacing from the public road

6. **TRAFFIC CONTROL**

   The access intersection is likely to be signalised given the class of road and high through traffic volumes on the M27 passing the access

7. **Disclaimer**

   This is an informational preliminary assessment and is not an engineering report. It is based on the site plan/concept plan provided and may not be relevant to future development proposals

Preliminary assessment

STEP 4

- Include the development details
- Carry out preliminary trip generation calculations
- Determine the need for TIA based on trip generation and thresholds
- Site observations – critical to understand constraints and possible requirements for infrastructure
- Access locations and compliance
- High level look at the site plan if available

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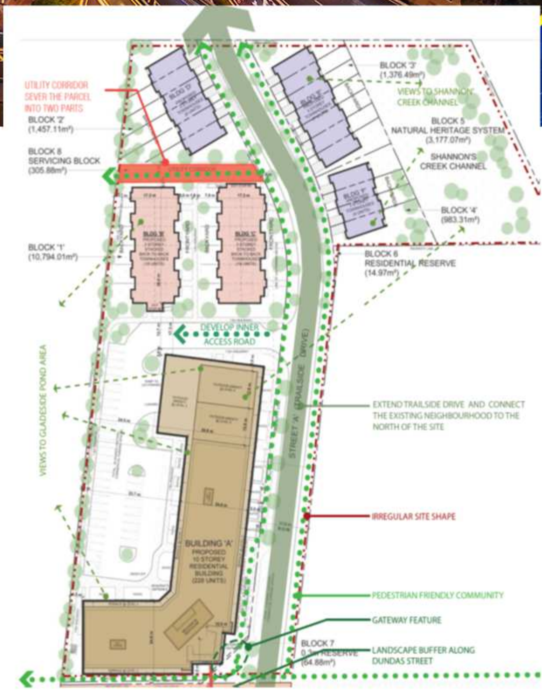
Preliminary assessment

STEP 4



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Arrange meeting with the client

STEP 5

- After completing the preliminary assessment – meet with the client
- Advise on go / no go decisions
- Early warnings are critical to avoid major issues
- Client is dependent on you – you are the specialist to advise – be thorough in this aspect

ARRANGE MEETING WITH CLIENT

BRIEF ON EXTENT OF ASSESSMENT

POSSIBILITY OF INFRASTRUCTURE REQUIREMENTS

→

1. **Discuss the extent of development from a traffic point of view with the client**
2. **Indicate the requirements for possibility of transport infrastructure**
3. **Discuss key local authority compliance requirements**

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Arrange meeting with authorities

STEP 5

- Important meeting where critical aspects for preparing the TIA are discussed

ARRANGE MEETING WITH RELEVANT AUTHORITIES - DISCUSS THE DEVELOPMENT PROPOSAL

AGREEMENT ON ASSUMPTIONS

1. **Introduce yourself, who you represent and appointment from your client**
2. **Introduce the project**
3. **Discuss the polices and standards applicable to the development**
4. **Development plan, preliminary traffic assessment**
5. **Collaborative process**
6. **Discuss key parameterS ; traffic generation, study area, access, background traffic transport plans,**
7. **To send follow up meeting notes to confirm discussion**

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Arrange meeting with authorities

STEP 6

- Introduce yourself and mention your meeting.
- Provide a brief description of your development, including:
  - Location map
  - Concept plan highlighting the proposed access points
  - Anticipated opening year
  - Phasing plan if your development has two or more phases
  - Size of your development, such as square area, dwelling units, etc
- Provide a map with the intersections and roads you propose to study
- Discuss the trip generation rates, modal split, trip reduction factor
- Use of available models
- Request the traffic signal timing plans

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Arrange meeting with authorities

STEP 6

- Enquire about or confirm other proposed developments and transport projects planned within your study area to include for background traffic growth.
- List the study periods you plan to study (such as daily, a.m. peak hour, school p.m. peak hour, p.m. peak hour, Saturday midday peak hour, etc.).
- List your proposed analysis years.
- List the methodology/software you'll use for your analyses.
- Provide your schedule and ask about their typical review process and its associated timeline (for instance, how much time will they need to review your traffic study).
- Request the authority to confirm these details or provide comments on potential changes by a specific date – or based on their agreed time

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Prepare Traffic Impact Assessment

STEP 7

- Once the client and local authority engagement have occurred and the necessary information has been obtained and agreed – its time to prepare the TIA
- In general 18 sections form part of the TIA

PREPARE TRAFFIC IMPACT ASSESSMENT

1. Development proposal and town planning information
2. Study area
3. Background Information
4. Site investigation
5. Other planning authorities
6. Traffic assessment horizon years
7. Assessment time periods
8. Traffic information / data collection
9. Traffic growth rates and other developments
10. Existing development land use rights
11. Trip generation
12. Modal split
13. Total traffic demand
14. Mitigation
15. Traffic assessment scenarios
16. Site traffic assessment
17. Transport requirements
18. Recommendation

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Prepare Traffic Impact Assessment Development particulars

- The following information must be provided for the development:
  - Trade name of the development (where available).
  - Erf details, street address of development, including suburb.
  - Reference to the town planning application including an extract from the town planning report relating to the extent of development and relevant details.
  - A location plan must be provided showing the location of the development.
  - Where applicable, references to any previously submitted and approved traffic assessments for the property must be provided.
  - Whether the proposed land use is within existing land use rights and town planning regulations stating any deviations if any.
- The following information must be provided for the existing land-use rights (exercised and not exercised) as well as the land-use rights applied for:
  - Total site area in m^2.
  - Floor Area Ratio (FAR) and Gross Leasable Area (GLA).
  - Size of development per land use type and in the units e.g. area - m^2, dwelling units, etc.
  - Town planning land use controls including the zoning certificates

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Prepare Traffic Impact Assessment Development particulars

- The TIA shall be undertaken for the exact and actual land-use rights for which the application is made **as contained in the town planning application document**. No assessment shall be submitted or accepted if the assessment is made for different land-use rights varying from the town planning application document. In situations where the application is made for a range of land-use rights, the assessment shall be undertaken for the land-use with the worst impact or alternatively granted conditional approval based on the total number of trips that has been assessed.

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STEP 7

Prepare Traffic Impact Assessment Study area

- The study area for the TIA is the extent to which the development impacts on the transport system
- Identification of the study area requires some preliminary assessment based on
  - Extent of the development i.e. traffic generation
  - Development location
  - The existing operations of the transport system (e.g. road network)
  - Indication of the development land use and its distribution
- The selection of the study can often be a two stage process where the initial selection is carried out and the during the preparation of the TIA it may need to be extended
- This is often not understood by both clients and engineers
- Many authorities provide guidance on this aspect which varies from authority to authority
- The following slides will provide an overview of the guidance provided by both local and international authorities

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STEP 7

Prepare Traffic Impact Assessment Study area

London city in Southwestern Ontario, Canada, **TRANSPORTATION IMPACT ASSESSMENT GUIDELINES** 2012

3.2 Description of Study Area

3.2.1 DEFINITION OF THE STUDY AREA

Generally, the size of the study area will be a function of the size and nature of the development proposal and the existing and future operations of the surrounding road network.

The study area shall encompass all City, County and Provincial roads, intersections, interchange ramp terminals and transit facilities, which will be noticeably affected by the travel generated by the proposed development. Typically, this will include area that may be impacted by one or more of the following:

- Increase by 5% or more of traffic volumes or transit usage on adjacent facilities;
- Volume/capacity (V/C) ratios for overall intersection operations, through movements, shared through/turning movements increased to 0.9 or above;
- V/C ratios for exclusive movements increased to 0.9 or above.

Since the definition of a TIA study area cannot be based on definitive criteria, it is important that the Proponent contact City Transportation Staff to establish mutually acceptable study area limits and scope of assessment.

Example for selection of study area

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Prepare Traffic Impact Assessment Study area

STEP 7

NEW YORK CITY The CEQR Technical Manual (the Manual) assists city agencies, project sponsors, and the public in conducting environmental reviews subject to City Environmental Quality Review (CEQR)- 2014

Determining the Study Area and selection of analysis locations, including, but not limited to, **streets, intersections, highway ramps, pedestrian and bicycle facilities, truck loading/unloading and parking facilities**. The identification of locations and facilities to be studied and the extent of the coverage (e.g., one block, one-half mile, or one mile from the site) **is a function of the proposed project, its geographical setting, its size and its scale. It could very well range from one block to an entire neighborhood or sub-area of the City. Defining the study area calls for considerable judgment**. For certain projects, there may be a need to define a primary study area and a secondary study area, with the primary area being the focus of intense analysis and the secondary area being the focus of a more targeted and less intense analysis. Specific guidance for determining the study area and analysis locations for each transportation element is discussed below in that area's assessment section.

Example for selection of study area

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Prepare Traffic Impact Assessment Study area

STEP 7

341. Traffic Study Area Definition of an appropriate traffic study area is probably the single most critical decision to be made, and the one in which hard guidelines are most difficult to formulate. In this work element, it is important to cover key potential impact locations with the understanding that the study area should be appropriately sized to include potential impact locations. The traffic impact analysis should consider several primary factors in defining the study area:

- How many new vehicle trips would be generated or diverted by the proposed project in its peak hours? Since the magnitude of the projected trip generation is one guide to be considered in defining the extensiveness of the study area, this information is derived from the Travel Demand Factors memorandum prepared as part of the Level 1 Screening Assessment.
- What are the most logical traffic routes for access to and from the site (i.e., its "traffic assignment")? These are traced on a map and used to identify potential analysis locations along them. This information is derived from the Level 2 Screening Assessment.
- What are the existing and/or potential problem locations (i.e., congestions, excessive delays, high vehicular and/or pedestrian accident history, complex intersections, etc.) along these routes or next to these routes that could be affected by traffic generated by the proposed project? It is useful to review information available from previous reports and databases regarding problem locations, and it is very important to drive or walk the area during peak travel hours to make an informed determination.

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Example for selection of study area

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STEP 7

Prepare Traffic Impact Assessment Study area

The traffic study area may be either contiguous or a set of non-contiguous intersections combined into a study "area." The traffic study area could extend from a minimum of one to two blocks from the site to as much as one-half mile or more from the site. It is defined by the logical direct routes along which traffic proceeds to and from the site, and typically includes major arterials and streets along the most direct routes to the project site as well as significant alternate routes. Multi-legged intersections and other problem locations along these routes should generally be incorporated into the traffic study area. Consequently, the study area need not have a particular shape--it could be rectangular, a long and narrow area extending along a major route to the project site, etc. **Although it is difficult to outline the number of analysis locations encompassed within the study area for a detailed traffic analysis, in most cases it would range from a low of six to eight intersections or analysis locations to a high of about 30 or more such locations. The six to eight analysis location guideline reflects analyses at the four corners of a typical square block site plus additional analysis location(s) along approach route(s) to the site. The 30 or more analysis location guideline reflects the potential to cover two or three avenues or streets on each side of the site, as well**. It should be noted that each project is different, and the appropriate number of intersections to be selected for study should be based on the Level 2 Screening Assessment trip assignments.

Example for selection of study area

STEP 7

Prepare Traffic Impact Assessment Study area

A small-scale project that would generate a modest volume of peak hour trips in a congestion-free area could require even fewer than the **six to eight analysis location guideline. Similarly, a major development project in a congested section of the City could require significantly more than 30 analysis locations; "megaprojects" could encompass traffic study areas with 100 or more intersections**. However, in the event that the study area appears to be very large and encompass significantly more than 30 analysis locations, care should be exercised so that some of the intermediate locations within the area—but not on a direct route to the site—are not included unnecessarily. It is advisable to use a knowledgeable traffic expert to ensure that the traffic study area is appropriately defined.

Example for selection of study area

STEP 7

Prepare Traffic Impact Assessment Study area

The completion of the Travel Demand Factors (TDF) memorandum (Level 1 Screening Assessment) and the Project Generated Trip Assignment (Level 2 Screening Assessment) provides a sound basis for defining the traffic study area. It is also possible to "screen out" several analysis locations at this stage of the work effort, provided that the preliminary trip generation estimates and the preliminary traffic assignments are close to their final versions. **Generally, intersections with fewer than 50 vehicle trips in a peak hour may be screened out. However, the analysis should include those intersections identified as problematic (in terms of operation and/or safety) or congested, even though the assigned trips are less than the established threshold**. It is also possible that once the preliminary trip assignments have been completed, the initially defined traffic study area may need to be enlarged to encompass other intersections. This is typically the case when several intersections at the outer edges of the study area are likely to be significantly impacted. However, the study area should only be expanded in consultation with the lead agency and DOT. In addition to the above operation-based guidelines, the traffic study area should also consider intersections or locations that may be problematic from the safety viewpoint. High-crash locations, if any, should be identified in consultation with DOT and the traffic study area should include these intersections. A high crash location is one where there were 48 or more total crashes (reportable and non-reportable) or five or more pedestrian/bicycles injury crashes in any consecutive 12 months of the most recent 3-year period for which data is available.

Example for selection of study area

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STEP 7

Prepare Traffic Impact Assessment Study area

Department for Transport, UK, Guidance on Transport Assessment, 2007

A detailed TA will be required where a proposed development is likely to have significant transport and related environmental impacts. **The study area for a proposed development should be determined in discussion between the developer and appropriate authorities**.
It will generally depend on the type and scale of the development, and early consultations with the appropriate authorities will assist in defining its extent. A description of the study area should include reference to the site location, the local transport network and relevant transport features.

Example for selection of study area

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STEP 7

Prepare Traffic Impact Assessment Study area

Department of Transport and main Roads, Queensland, Australia Guideline Guide to Traffic Impact Assessment December 2018

Impact assessment area:

The extent of the impacts of development traffic on other users and on infrastructure can range from being localised to quite dispersed, depending on the size of the development and its catchment relative to the base traffic conditions. For practical reasons, a boundary needs to be defined within which to assess a reasonable level of impact of this additional development traffic. This boundary is the impact assessment area. The impact assessment area does not necessarily define where impacts will be but defines the extent of the intersections and links in the network surrounding the development that need to be assessed. The impact assessment area varies for each impact type, and has been defined as outlined in the following slide.

Example for selection of study area 89

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Table 6.4 – Impact assessment area by impact type

Impact type	Impact assessment area
Road safety	All intersections where the development traffic exceeds 5% of the base traffic for any movement in the design peak periods[3] in the year of opening of each stage All road links where the development traffic exceeds 5% of the base traffic in either direction on the link in the design peak periods[3] in the year of opening of each stage
Access and frontage	The SCR corridor for the extent of the geometric frontage of the site, includes works on both the frontage side and potentially on the opposite side of the road
Intersection delay	All intersections where the development traffic exceeds 5% of the base traffic for any movement in the design peak periods[3] in the year of opening of each stage
Road link capacity	All road links where the development traffic exceeds 5% of the base traffic in either direction on the link's annual average daily traffic (AADT) in the year of opening of each stage
Pavement	All road links where the development standard axle repetitions (SARs) exceeds 5% of the base traffic in either direction on the link's SARs in the year of opening of each stage; the method for calculation of SARs is outlined in Section 13.3
Transport infrastructure	All road links where the development traffic exceeds 5% of the base traffic in either direction on the link's AADT in the year of opening of each stage, or where Transport and Main Roads identifies prevailing structural integrity issues of transport infrastructure (for example, bridges or culverts)

In addition, it is noted that, owing to the existing state of the network, there may be exceptional circumstances where an intersection or road link with development traffic less than 5% of base traffic would warrant inclusion within the impact assessment area. Examples of where an exception may be appropriate include:

- an existing or potential safety or traffic issue that will be exacerbated
- where generated traffic applies to one turning movement
- developments that will generate a different type of traffic that may require geometric improvements (for example, heavy vehicles, road trains).

Prepare Traffic Impact Assessment Study area

STEP 7

Example for selection of study area 90

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Prepare Traffic Impact Assessment Study area

STEP 7

TMH 16, Volume 1, South African Traffic Impact and Site Traffic Assessment Manual, Version 1.0, August 2012

2.5.2 The study area is an area from which transportation elements are selected for the Traffic Impact Assessment. Differentiation is made between primary and secondary study areas. The transportation elements to be included in the primary study area are defined in this section while the elements to be included in the secondary study area are defined in the following section.

Example for selection of study area

Prepare Traffic Impact Assessment Study area

STEP 7

2.5.3 The elements to be included in the primary study area shall be selected as follows:

a) Accesses to the site. All accesses (vehicle, pedestrian and cyclist) to the site. Such accesses are also included in the study area of Site Traffic Assessments.

b) External roads. Elements from roads classified as external according to the Engineering Service Contribution Policy on which the development is likely to have an impact or which may not meet the requirements of the Traffic Assessment Standards and Requirements Manual. These elements shall be restricted to Class 4 and 5 roads in the vicinity of the development up to the first Class 1 to 3 roads that can be reached by the Class 4 and 5 road network from the development, up to and including the first connection(s) on the Class 1 to 3 roads. The elements shall be restricted to those within a maximum distance of 1.5 km from the accesses to the site, measured along the shortest routes to the accesses, provided that there is at least one intersection within this distance. Where there is no such intersection, the distance will be extended to include at least one intersection. Judgment may be exercised by the Assessor in selection the elements that must be included in the study area (including the first intersection on Class 1 to 3 roads).

Prepare Traffic Impact Assessment Study area

STEP 7

c) New or improved external roads. Where new external roads or improvements to existing external roads are proposed (irrespective or the class of road), such roads shall be included in the study area irrespective of the above requirements.
d) Public transportation, pedestrian and cyclist facilities that fall within the study area as defined above.
e) Sensitive areas. All roads in residential and other sensitive areas on which the proposed development is likely to have a significant impact. Judgment may be exercised in the identification of such elements.

Prepare Traffic Impact Assessment Study area

STEP 7

Secondary study area
2.6.1 The primary study area defined in the previous section is adequate for most land uses except those that require the transport of heavy goods. For land uses that require transportation of such goods, the primary study area must be extended to include a secondary study area as defined in this section.

2.6.2 Examples of land uses that normally require heavy goods transportation include heavy industrial/manufacturing and mining. Examples of heavy goods include quarried or mined materials, heavy machinery and heavy products. Mined materials include sand, clay, kaolin, ores and minerals while heavy machinery include machinery used for mining, power generation and the production of goods. Heavy products include bricks, concrete products and refined metals.

2.6.3 The secondary study area must include all roads that will be used for the transport of the heavy goods to or from a development over the full length of the trips (from origins up to destinations). The assessment to be undertaken in this secondary area, however, will be limited to an evaluation of the impact of the heavy goods transport as required by the Traffic Assessment Standards and Requirements Manual.

STEP 7

Prepare Traffic Impact Assessment Study area

2.6.4 In order to establish the roads to be included in the secondary study area, an assessment must be made of the origins or destinations of the heavy goods transport. The routes that will be followed must be determined and included in the impact assessment.

2.6.5 It is a requirement of this manual that approved routes together with proposed mitigating measures must be defined in the Environmental Management Plans for construction, operation, demobilisation and rehabilitation of the development.

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STEP 7

Prepare Traffic Impact Assessment Study area

ETHEKWINI TRANSPORT AUTHORITY MANUAL FOR TRAFFIC IMPACT ASSESSMENTS AND SITE TRAFFIC ASSESSMENTS, JULY 2015

4.3.5 Study area

The study area is an area from which transportation elements are selected for the TIA. The elements shall be selected as follows in the case where TIA's are undertaken in the Site Development Plan context:

- Site Development Plan:
  - Accesses to the site. All accesses (vehicle, pedestrian and cyclist) to roads must be included in the study area
  - These elements shall be restricted to :
  - Minimum of two intersections on the road where access is proposed, on either side of the access (or one intersection where the access is taken from a cul-desac) plus all intersections where 75 additional peak hour passenger car trips are added to the sum of critical lanes".
  - Sensitive areas. All roads in sensitive areas on which the proposed development is likely to have an impact. Judgment may be exercised in the identification of such elements and is subject to approval by the ETA.

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STEP 7

Prepare Traffic Impact Assessment Study area

- Where TIA's are undertaken for Framework, Spatial, Functional and Local area plans, confirmation of the study area is subject to agreement with the ETA.
- The extent of the study area is determined irrespective of the responsible authority or municipal boundaries. The study area may thus extend over more than one municipal area and include roads under the jurisdiction of other authorities.
- The following information must be supplied in all cases:
  - Information must be provided in the report on the extent of the study area as well as the elements of the transportation system that have been selected for assessment. Where appropriate, a schematic plan of the study area must be provided showing the study area and the selected elements.

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STEP 7

Prepare Traffic Impact Assessment Background information

- Transportation facilities for which information must be provided includes:
  - Existing roads, streets, interchanges, intersections and accesses, together with number of lanes and type of intersection control e.g. stop, yield, roundabout or traffic signal, geometric conditions and safety
  - Public transport, pedestrian and cycling networks and facilities.
  - Planned changes to transportation facilities that are likely to be implemented in the area during the time horizon for which the traffic assessment is undertaken.
- The report must also include any relevant information that is made available by the eThekwini Municipality. Such information may include the following:
  - Spatial development framework
  - Traffic management plan
  - Road network master plan
  - Functional road hierarchy plan
  - Public transport plan
  - Modelled traffic demand

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STEP 7

Prepare Traffic Impact Assessment Background information

- Begin with an Online Research
- Most authorities use the internet to post relevant data for your traffic study. You can use this information to prepare the TIA. Here's what to look for:
  - Transportation plans
  - Traffic study policies / guidelines
  - Land use plans – Local area plans, precinct plans development plans, land use schemes
  - Transport capital improvement projects and plans
- The first place to start your online research is the local government (city) website.
- You're trying to find their transportation plan (integrated transport plan, local area transport plans) if they have one. The transportation plan is usually a section of the local authorities overall comprehensive plan and describes the vision for their transportation network.

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STEP 7

Prepare Traffic Impact Assessment Background information

- Also gather land use planning information for your development. Some relevant questions to ask include:
  - What is the current land use of the site?
  - Is the land use proposed to change in the plan?
  - What is the current and proposed zoning of the site?
  - What is the land use and zoning of the adjacent site? Some clients/authorities like to have this background information in their traffic studies – should be mandatory.
- The developer may have provided answers to some or all of these questions, but double check to verify the information.
- More often TIA's are prepared without understanding the land use information / land use context
- What about precedence ?

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Prepare Traffic Impact Assessment Background information

STEP 7

- As you are looking at the local authorities website, search for policies related to traffic impact assessment .
- Some cities do have explicit policies providing the exact detail of the study needs and process. They may be detailed enough to give you a full outline for the study along with what to include in each section and what format is required.
- Sometimes, the local authorities policies are part of their ordinances (by-laws), and almost all have their ordinances posted. You should scan through them to see if there is anything relevant to accesses and design standards.
- Most local authorities also list the projects scheduled for the next five years, often labelled the Capital Improvement Plan / Roads Master Plan. See if any projects are affecting your study area.
- It's also wise to let your client know if the road in front of their development will be under major reconstruction the year after their project opens.

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Prepare Traffic Impact Assessment Background information

STEP 7

- In summary the following information should be obtained
- Traffic study policies
  - Traffic study standards
  - Design standards
- Transportation plans
  - Capital improvement plans
  - Traffic volume data
  - Historical daily traffic volumes
  - Peak hour turning movement volumes
  - Crash data
  - Traffic signal data
  - Land use / town planning information

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Prepare Traffic Impact Assessment Background information

STEP 7

- Through the town planning section of the local authority, you can typically find site information, including public right-of-way widths. This right-of-way information may be useful if you end up recommending road or intersection widening as part of your traffic study.
- Lastly, if your study area is served by bus or rail transport service go to the transport operator's to get routes and schedules. You may need to account for public transport operations in your capacity analyses.
- Existing Conditions from Aerials or the local authority GIS website – often provides aerial, cadastral , engineering services, land use zoning, etc.
- As part of the online research, you could start with the popular aerial online site or software, such as Google EarthTM, or Google Street View.

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Prepare Traffic Impact Assessment Background information

STEP 7

- Obtain the onsite transport information such as roads, traffic control, infrastructure, etc
- Start by drawing a quick sketch of each study intersection based on the aerial with the following details:
  - Exclusive left or right turn lanes – measure their storage lengths on the aerial and include them on the sketch
  - Through lanes and/or shared lanes if turn lanes aren't provided
  - Traffic control – stop signs, traffic signals or roundabouts
  - Medians
  - Shoulders
  - Sidewalks
  - On-street bike lanes
  - Nearby parking lots
  - On-street parking
  - Street names
  - Public transport facilities and locations

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Prepare Traffic Impact Assessment
Background information

STEP 7

- Also, print out a street map of the study area. It is easier to capture field notes on maps. Ensure the map is zoomed in enough so you can make notes of information between study intersections.
- It is easier to correct sketches in the field than trying to create originals while we're on the side of the road. Something usually gets missed if you skip this first task in the office.
- It is a requirement that the site be visited to undertake the investigations required for the assessment and relevant information on the site investigation must be provided in the assessment
- A photographic record of existing transportation facilities and land development in the area must be included in the assessment report.

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Prepare Traffic Impact Assessment
Site investigations

STEP 7

- You may be asking yourself why you even need to go out in the field when everything is right there on the online aerial.
- Aerials aren't always right. Imagine preparing a traffic study based on the obsolete road network.
- The study would have had zero credibility - authority, public and client
- There are frequently many important details you can't always see on an aerial.
- Ideally, the field visit should occur before your traffic counts are undertaken - details from an aerial can be wrong. The field visit will help you figure out if the data collection plan needs to change
- In general field visit is usually combined with the data collection part of the project.
- To be thorough two visits are needed
  - One is to collect existing transport facilities information and to verify locations for data collection (e.g. traffic counts)
  - Second visit is during the data collection so that traffic analysis is representative of onsite conditions

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Prepare Traffic Impact Assessment Site investigations

STEP 7

- Here's an approach to the fieldwork and ensuring the existing study characteristics are verified:
- The engineer views the study intersections and roadways online, printing a close-up of each one.
- The engineer lists the items to verify in the field, such as parking restrictions, etc., and the initial location for the field equipment.
- The field technician, as part of the data collection work, verifies the study intersection and roadway information per the engineer's information.
- By printing a one-page sheet for each intersection, notes can be added for reminders about things to look for as well as having space for other notes once in the field - a standard list of items to examine in the field, :

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Prepare Traffic Impact Assessment Site investigations

STEP 7

- Traffic operations
- Lane utilisation
- Public stop locations
- Traffic signal operations (phasing)
- Parking restrictions
- Posted speed limits
- Excessive grades or slopes (that either affect traffic operations, or making widening a road difficult)
- Vegetation, objects, or buildings on the intersection corners that block sight lines

Once the field technician is out at the site, take pictures. Smartphones are a convenient and amazing tool for this task because they produce really good photos. Get one photograph of each approach at each study intersection. Be certain to keep a log of the photos so you can identify them back in the office. Taking pictures saves additional field visits.

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STEP 7

Prepare Traffic Impact Assessment Site investigations

- Another on-site option is a dash-mounted or another type of video camera recording both the study site and your dictation simultaneously (smartphones could also be used)
- While you're verifying the accuracy of the hand sketches, be aware of other things that could affect traffic in your study area, such as:
  - Large parking lots that could affect the balance of traffic between study intersections
  - Large pedestrian generators, such as schools
  - Road construction
  - Developments under construction
  - Public transport vehicles and stopping

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STEP 7

Prepare Traffic Impact Assessment Site investigations

- During a peak hour data collection, make some general observations of traffic flow. This provides a feel of operations to compare against when using computer analysis and allows them to confidently state they have observed operations. Some key observations include:
  - Do shoulders get used by cars as separate left turn lanes or bypass lanes?
  - Do the traffic signals along a corridor seem to be coordinated, so through traffic moves down the corridor smoothly?
  - What are the signal cycle lengths? Bring a stopwatch or use your phone to spot check the time it takes for the signal timing to rotate all the way through its cycle. Be sure to measure several cycles as they can vary – can also be obtained from local authority.
  - Are there any queues backing up from turn lanes into the through lane or do queues extend back from one intersection blocking the upstream intersection?
  - Is it difficult to turn onto a major street from a side street with a stop sign?

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Prepare Traffic Impact Assessment Site investigations

STEP 7

- Do your expected travel pattern and routes to and from the proposed site correspond to the major traffic flow you're watching?
- These first-hand observations could save your reputation in a public / appeal hearing. Public regularly question about how traffic currently operates at a specific location or intersection. If a site visit has been carried out to specifically watch operations during peak hour, you can honestly respond with the knowledge of volumes and traffic patterns. In addition you can explain how this is incorporated in the analysis.
- Documenting existing conditions is necessary to provide the base information in computer models and other aspects of a typical traffic impact study. More importantly, this step should be viewed as an opportunity to fully understand how traffic operates today.

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Prepare Traffic Impact Assessment Other Authorities

STEP 7

- Approval from other planning authorities is required and confirmed in writing and must be included in the TIA where the application is:
  - Dependent on access to transport infrastructure under the jurisdiction of other authorities
  - Impacts on transport infrastructure under the jurisdiction of other authorities
  - Located within the area of influence of other authorities

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Prepare Traffic Impact Assessment
Assessment years

STEP 7

B2.1 Assessment years

2.1.1 Traffic assessments must be undertaken for the following horizon years:

a) Design horizon year.
b) Planning horizon year.

2.1.2 The design horizon year is the year selected for determining transportation improvements that are required to accommodate the proposed development.

Transportation improvements must be designed for a horizon year of 5 years. This horizon year is measured from the date of the application, provided that all required documentation has been submitted by this date. Otherwise, the horizon year is measured from the date of submission of all required documentation.

In situations where the development is implemented in phases over a period longer than 5 years, the assessment must also be undertaken for the years in which each phase will be completed.

For Site Traffic Assessments, the design horizon year must account for the development that will be implemented in accordance to the application and the above design horizon year on the external road network.

2.1.3 The planning horizon year is the year selected for determining whether it is physically possible to accommodate the development together with future traffic growth. This analysis is not used for determining the transportation improvements required to accommodate the proposed development.

The planning horizon year must be selected as one in which all developments in the study area are expected to be fully completed and developments in the area have stabilised. Planning horizon years of 20 years are typically used in municipal planning but longer periods may be required.

For Site Traffic Assessments, the planning horizon year must account for the total land-use rights of the development together with the above planning horizon year on the external road network.

TMH 16
Volume 1
South African Traffic Impact and Site Traffic Assessment Manual
Version 1.0
August 2012

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Prepare Traffic Impact Assessment
Assessment years

STEP 7

4.3.9 Traffic demand estimation

(a) Assessment years

Traffic assessments must be undertaken for the following horizon years:

- Design horizon year.
- Planning horizon year.

The design horizon year is the year selected for determining transportation improvements that are required to accommodate the proposed development.

Transportation improvements must be designed for a horizon year of:

- 5 years where the traffic demand is less than 1000 peak hour passenger car trips
- 10 years where the traffic demand is 1000 and less than 2000 peak hour passenger car
- Planning horizon year where the traffic demand is greater than 2000 peak hour passenger cars
- In situations where the development is implemented in phases over time, the assessment must also be undertaken for the years in which each phase will be completed.

Where the demand exceeds 2000 peak hour passenger car trips, a planning horizon year assessment must be undertaken. Agreement with the ETA is necessary relating to the extent of the planning horizon year (e.g. 10, 15, 20 year assessment) and relevant details. It is mandatory that such assessments are carried out using traffic simulation modelling.

The planning horizon year must be selected as one in which all developments in the study area are expected to be fully completed and developments in the area have stabilised.

ETHEKWINI TRANSPORT AUTHORITY MANUAL FOR TRAFFIC IMPACT ASSESSMENTS AND SITE TRAFFIC ASSESSMENTS, JULY 2015

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Prepare Traffic Impact Assessment
Assessment years

STEP 7

NEW YORK CITY The CEQR Technical Manual (the Manual) assists city agencies, project sponsors, and the public in conducting environmental reviews subject to City Environmental Quality Review (CEQR)- 2014

- Build year / or build out year – year that the development is operational

Department of Transport and main Roads, Queensland, Australia
Guideline , Guide to Traffic Impact Assessment December 2018

- Impact assessment year
- The impact assessment year is the year at which the impacts of the development are assessed. The impact assessment year (as outlined in Table 6.5) varies by impact type because the effects of development can be quite different on infrastructure than they are on other users. Furthermore, some

Example for assessment years 115

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Prepare Traffic Impact Assessment
Assessment years

STEP 7

Table 6.5 – Impact assessment year by impact

Impact type	Impact assessment year(s)
Road safety	Year of opening of each stage including the final stage
Access and frontage	Year of opening of each stage including the final stage and 10 years after the year of opening of the final stage for access intersections (includes both new and amended accesses)
Intersection delay	Year of opening of each stage including the final stage
Road link capacity	Year of opening of each stage including the final stage
Pavement	Year of opening of each stage including the final stage Note that mitigation of pavement impacts occurs for a period of 20 years after the opening of the final stage
Transport infrastructure	Year of opening of each stage including the final stage.

Example for assessment years 116

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Prepare Traffic Impact Assessment
Assessment years

Department for Transport, UK, Guidance on Transport Assessment, 2007

ASSESSMENT YEARS

- The assessment year(s) in respect of capacity analysis for the transport network should be consistent with the size, scale and completion schedule of the proposed development, and that of other major developments in the vicinity of the site, as well as planned improvements to the transport system.

- The appropriate horizon assessment year should be agreed with the relevant authorities during pre-application consultations.

- In addition to the opening year, one or two further assessment years should be considered.

Example for assessment years 117

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STEP 7

Prepare Traffic Impact Assessment
Assessment years

- For the local transport network, a development should be assessed with regard to the Local Development Framework (LDF), and for a period of no less than five years after the date of registration of a planning application.

- Should the development take place over a longer period, it would be appropriate to extend the length of the assessment period. The development proposal should be supported by an acceptable TA, carried out in accordance with the (Guidance on Transport Assessment) GTA.

- This will help to ensure that the transport impacts of the development are more accurately applied to a situation where all committed local transportation infrastructure improvements are in place.

Example for assessment years 118

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STEP 7

Prepare Traffic Impact Assessment
Assessment years

- For the Strategic Road Network (SRN), the future assessment year should normally be ten years after the date of registration of a planning application for the development, in line with the forward horizon of the Regional transport strategy (RTS). Should the development take place over a longer period than the horizon of the wider planning framework, a longer period of assessment will need to be agreed with the (Highway Agency) HA. The development proposal should be supported by an acceptable TA, carried out in accordance with the GTA, or on a basis otherwise agreed with the Agency.

- This timescale broadly reflects the Department for Transport's current funding regimes, particularly for major improvement schemes such as the Targeted Programme of Improvements (TPI). The length of this assessment period, at the discretion of the Secretary of State for Transport, can be amended for individual cases, where there is a wider political and economic imperative or, for example, where proposals will take a long time to develop fully. For further details please refer to DfT Circular 02/2007, Planning and the Strategic Road Network.

- The appropriate horizon assessment year should be agreed with the relevant authorities during pre-application consultations.

Example for assessment years

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STEP 7

Prepare Traffic Impact Assessment
Assessment days and hours

- Assessment days
  - Assessment day is the day or day/s selected for assessing the traffic impacts of the proposed development.
  - Dependent of the land use of the development
  - Some instances, the proposed development consist of a mix of land uses hence can be more than one day of assessment
  - Also dependent on background traffic in the study area
  - The starting point is the trip generation rates. This gives a good indication of land use trips on applicable days

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Prepare Traffic Impact Assessment Assessment days and hours

STEP 7

Assessment hours

The assessment hours must be selected from normal or abnormal days of the year or both, as follows:

- In urban areas, the assessment hours must be selected from normal days, except when land uses are specifically focussed on abnormal days (e.g. holiday resorts).
- In rural areas, the assessment hours must be selected from both the normal and abnormal days.
- The identification of rural areas will be guided by the authority
- For abnormal days, the assessment hours will be selected from the abnormal days specified and provided by the authority.

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Prepare Traffic Impact Assessment Assessment days and hours

STEP 7

Assessment days and hours

- The day and time period used in determining the appropriate design requirements / traffic impacts for a proposed development is directly related to:
    - Type of land use
    - Traffic characteristics of the adjacent street system
- Trip generation for different days and time periods should be examined to determine when the development being proposed experiences its peak traffic flow and to define the relationship between the site's peak generation and peaking characteristics of the adjacent street system
- In most cases the development traffic volume combined with the adjacent street traffic is at its highest during the typical commuter peak hours
- Some land uses do not peak at the same time as the adjacent street
- Combination of the development traffic and street volumes at different times need to be checked in order to determine the proposed sites maximum impact

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STEP 7

Shopping Center - Christmas Season (820)

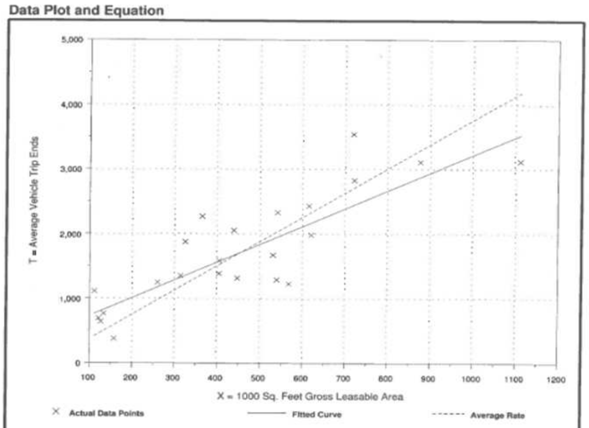
Average Vehicle Trip Ends vs: 1000 Sq. Feet Gross Leasable Area
On a: Weekday, Peak Hour of Adjacent Street Traffic, One Hour Between 4 and 6 p.m.

Number of Studies: 24
Average 1000 Sq. Feet GLA: 459
Directional Distribution: 50% entering, 50% exiting

Trip Generation per 1000 Sq. Feet Gross Leasable Area

Average Rate	Range of Rates	Standard Deviation
3.76	2.16 - 10.01	2.30

Data Plot and Equation



Fitted Curve Equation: $T = 2.76(X) + 457.28$ $R^2 = 0.68$

Shopping Center - Christmas Season (820)

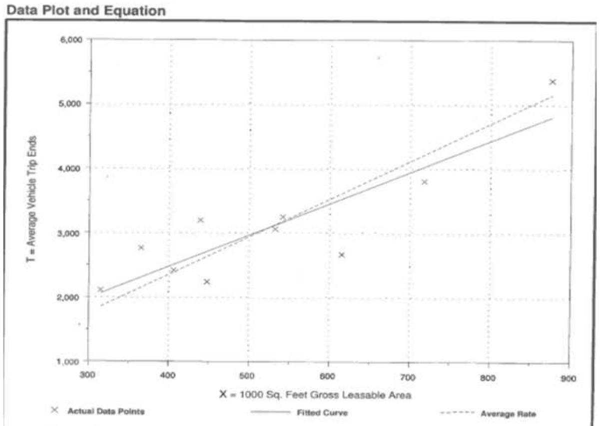
Average Vehicle Trip Ends vs: 1000 Sq. Feet Gross Leasable Area
On a: Saturday, Peak Hour of Generator

Number of Studies: 10
Average 1000 Sq. Feet GLA: 526
Directional Distribution: 51% entering, 49% exiting

Trip Generation per 1000 Sq. Feet Gross Leasable Area

Average Rate	Range of Rates	Standard Deviation
5.88	4.33 - 7.57	2.58

Data Plot and Equation



Fitted Curve Equation: $T = 4.90(X) + 515.88$ $R^2 = 0.77$

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STEP 7

816 Hardware and Paint Store — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	1.15		5.20			12.00	10.00		
% Heavy									
In/Out	65:35		45:55			50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by			27%						
% Diverted			28%						

817 Nursery (Garden Centre) — 101 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	1.40	3.00	4.10			4.00			
% Heavy									
In/Out	65:35	30:70				45:55			
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

820 Shopping Centre — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.60		3.40			4.50		6.000	3500
% Heavy									
In/Out	65:35		50:50			50:50			
PHF Dev						0.90			
PHF Street									
Veh Occupancy									
% Pass-by			13%			12%		1.950	48000
% Diverted			29%			38%			

830 Bulk Trade Centre — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	1.10		1.50	0.90		3.90			
% Heavy									
In/Out	70:30		40:60	45:55		50:50			
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

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Prepare Traffic Impact Assessment Traffic counts

STEP 7

- Existing traffic data is the base for your analysis and the foundation for forecasting future traffic volumes.
- The purpose in this task is to, therefore, gather or collect up-to-date and accurate traffic data.
- For most studies, obtaining the 12 hour daily traffic volumes with turning movement volumes is sufficient.
- Sometimes only peak 2 hour counts are carried out
- A single day traffic count is used to design for a project with a life span of 20-30 years – is this realistic
- 48 hour counts are now starting to gain popularity with average peak hour being used for assessment purposes
- There is daily variation in traffic counts, coupled with incidents that could impact on that day
- Type of traffic counts – manual versus video recording – some authorities are making it mandatory for video recording

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Prepare Traffic Impact Assessment Traffic counts

STEP 7

- Other key points to remember for data collection:
  - The goal is typical conditions, or the traffic level experienced by most people on most days unless required otherwise –typically collect data Tuesday through Thursday.
  - Avoid collecting around big holidays, large events, school examinations / closure or during extreme weather.
  - If the site is near a school – should cover the time period when that school is in session.
  - If possible, collect all intersection counts on the same day(s), which lessens the risk of discrepancies between adjacent intersections.
- The required traffic counts must be undertaken for the selected assessment hours. Traffic must be counted in 15-minute intervals during the peak period.
- On roads that carry a significant volume of heavy or public transport vehicles (more than 10% of the total traffic), a vehicle classification count must be undertaken
- Traffic counts shall be undertaken under supervision of a competent person who is responsible for the quality of the counts.
- Traffic counts up to two (2) years old may be used in the assessment, provided that no changes have occurred during this period that may have significantly affected the traffic demand.

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Prepare Traffic Impact Assessment
Future background traffic

STEP 7

- The future background traffic accounts for general background traffic growth within or through the study area, plus trip-making expected to be generated by anticipated projects (and latent land use rights) that are also likely to be in place by the proposed project's opening year and future assessment year.
- Background growth rates and the methodologies used in accounting for trips from expected development projects are presented below.
- Growth rates are usually supplied by the authority or alternatively presented by the traffic professional based on historic data and existing traffic count data

Typical growth rates (COTO, 2013, SA):

Development Area	Growth rate
Low growth areas	0 - 3%
Average growth areas	3 - 4%
Above average growth areas	4 - 6%
Fast growing areas	6 - 8%
Exceptionally high growth areas	> 8%

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Prepare Traffic Impact Assessment
Future background traffic

STEP 7

- How to develop growth rates:
  - Use the area’s blanket growth factor.
  - Use historical daily traffic volumes. Ideally, you would have five years of traffic volumes. Then you can estimate the data and pick out a growth rate to the nearest 0.5% or average the growth rates.
  - Use another recent traffic study completed and approved within the study area.
  - Use the authority’s transportation plan. Most areas have a comprehensive or individual transportation plan that may include 20-year forecasts. You can calculate a growth rate from those forecasts in your study area. Be wary of over-estimating if you have a large development. Some or all your development traffic may already be accounted for in the local authority forecasts.
  - Use the regional transportation model. This method provides the truest, or at least the most defendable, background traffic forecast condition. Using the regional model is often quite cumbersome (and expensive) and only justified on very large projects, such as a regional shopping mall or developments in excess of 1000/2000 vehicle trips.

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Prepare Traffic Impact Assessment Future background traffic

- The goal is to create a defendable growth factor that can be applied to your existing traffic volumes to calculate a future year background traffic scenario.
- It could be argued that growth rates do vary by type of road, it isn't feasible to develop peak hour turning movement counts going between intersections based on multiple growth rates because traffic would not balance. Choose one of these methods, or a combination, to develop a linear growth rate that will be reasonable for the project area.
- Also, if there is a nearby development that was recently approved but not yet built, it is necessary to account for traffic from that development in addition to the background traffic forecasts developed based on the linear growth rate. It is likely though that there could be a minor portion of double-counting, but it's certainly worth considering.
- Once the growth rate has been determined, apply this to the existing daily volumes and existing peak hour turning movement volumes to develop the future year background traffic forecasts.

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Prepare Traffic Impact Assessment Future background traffic

Key note:

- Applying a growth rates to obtain future background traffic beyond ten years is not realistic
- Beyond 10 year forecast – traffic demand modelling used e.g. use the local authorities traffic demand model.

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STEP 7

Prepare Traffic Impact Assessment
Trip generation

- Calculating Traffic Volumes Due to the Development
  - There are two elements to forecasting how much traffic will enter and exit the development:
  - Determining the quantity of the traffic, and
  - Determining the route that traffic will travel
  - The industry standard for determining how much traffic will be generated by development is the THM 17, South African Trip Data manual .
  - A trip end is one car entering OR one car leaving a development. A single car that goes to your development and subsequently leaves the site adds up to two trips.
  - USA uses, ITE, Trip Generation Manual, 9th
  - There are national datasets around the world, such as the TRICS dataset used in the UK

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STEP 7

Prepare Traffic Impact Assessment
Trip generation

- The basic procedure is to multiply the average trip generation rate for your land use and study period by the units in your development, and then apply the direction distribution (in/out) split.
- For example – single-family homes have an average trip rate for the weekday a.m. peak hour of 1.0 vehicles per dwelling unit with 25% entering and 75% exiting. A subdivision with 100 homes would therefore generate 100 vehicles in the AM peak hour – 25 entering and 75 exiting vehicles.

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STEP 7

Prepare Traffic Impact Assessment
Trip types and trip reductions

- It's relatively uncomplicated to calculate the traffic coming in and out of a single-family home subdivision in the suburbs. These are new houses and the residents will predictably be driving to work, the grocery store, and to school to drop off the kids. However, there are several scenarios where a new development doesn't actually increase the total number of cars on the road, but shifts or redirects traffic. These include shopping centres, restaurants, fast-foods, petrol service stations.
- The three basic types of deductions to apply to the raw trip generation are Pass-By, Diverted, and Transferred Trips:
  - Primary trips – these are new trips on the road network
  - Pass-by trips – Pass-by trips are trips that are made as intermediate stops on the way from an origin to a primary destination without route diversion. Pass-by trips are attracted from traffic passing the site on an adjacent street or road that provided direct access to the development
  - Diverted trips – trips that are attracted from traffic on roadways within the vicinity of the development but require a diversion from the roadway to another roadway to gain access to the development

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STEP 7

Prepare Traffic Impact Assessment
Trip types and trip reductions

- Transferred trips– Transferred trips are trips that are already present on the road network and which are visiting similar developments near to the proposed development

- Have the potential of transferring or switching their destination to the proposed development.

- These trips are different from pass-by and diverted trips in that trips are wholly or partly transferred from one development to another

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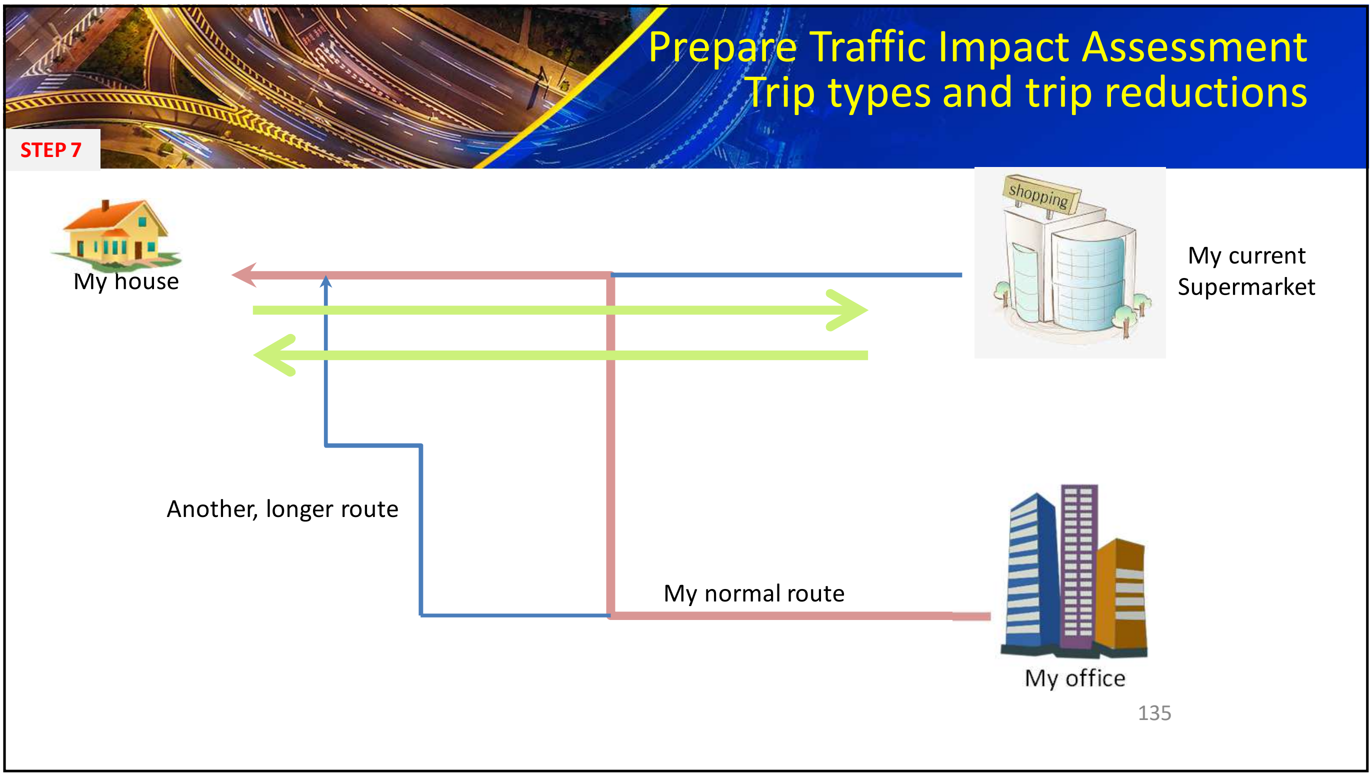
Prepare Traffic Impact Assessment
Trip types and trip reductions
STEP 7
My house
My current Supermarket
Another, longer route
My normal route
My office
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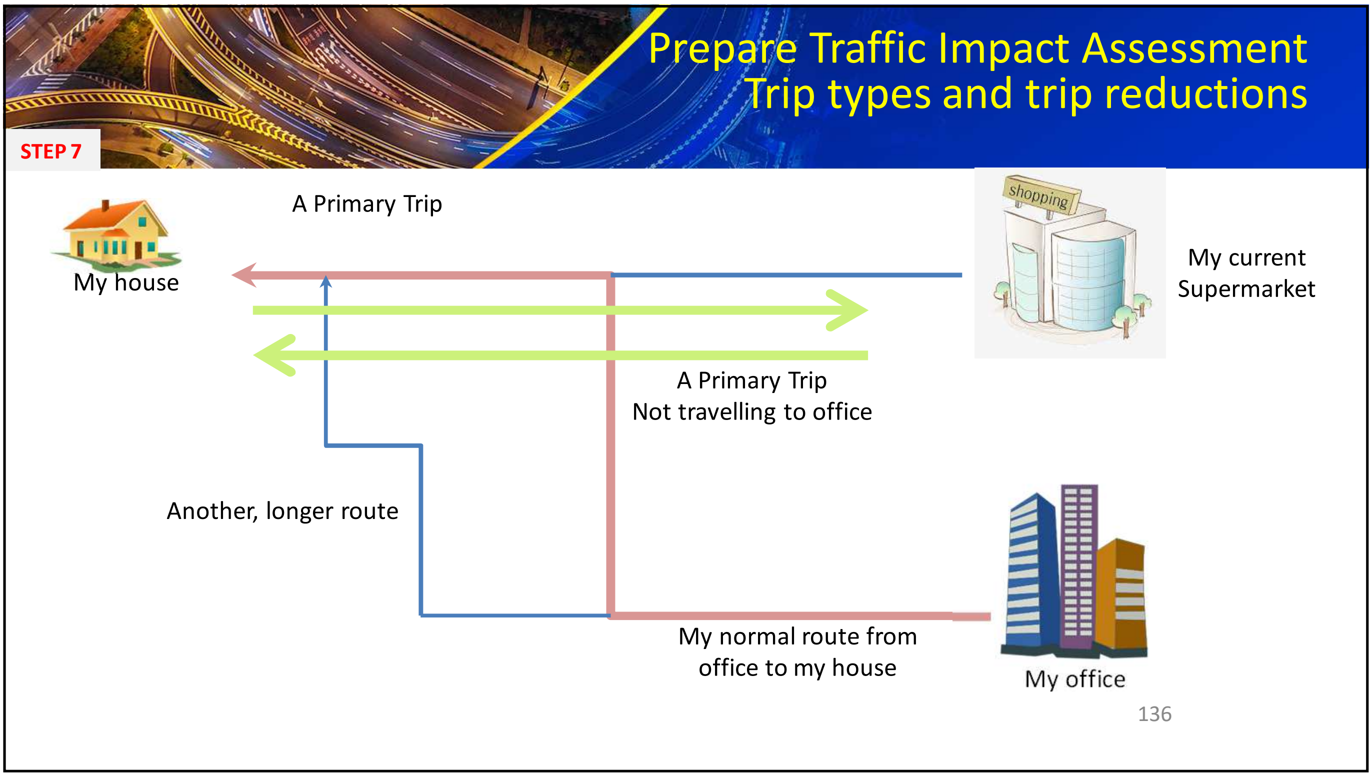
Prepare Traffic Impact Assessment
Trip types and trip reductions
STEP 7
My house
A Primary Trip
My current Supermarket
A Primary Trip
Not travelling to office
Another, longer route
My normal route from office to my house
My office
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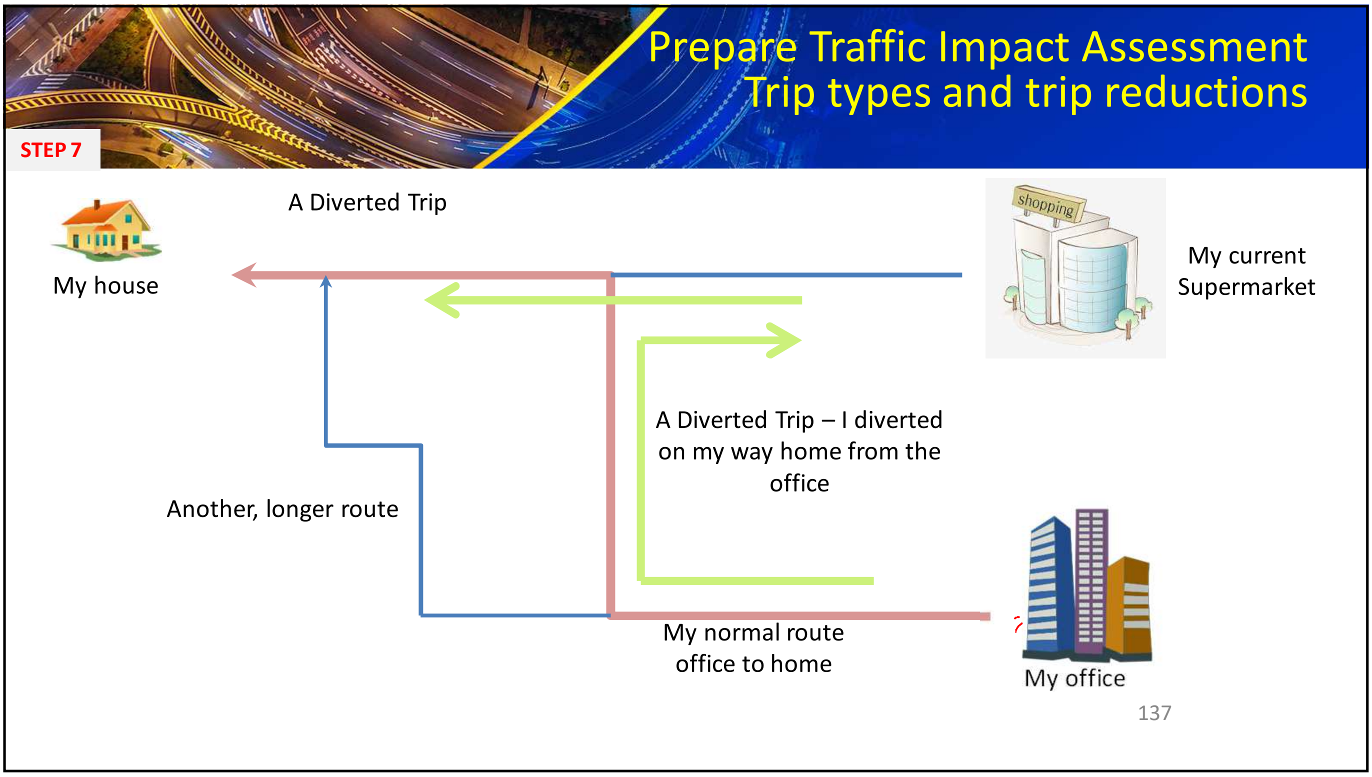
Prepare Traffic Impact Assessment
Trip types and trip reductions
STEP 7
A Diverted Trip
My house
My current
Supermarket
A Diverted Trip – I diverted
on my way home from the
office
Another, longer route
My normal route
office to home
My office
137

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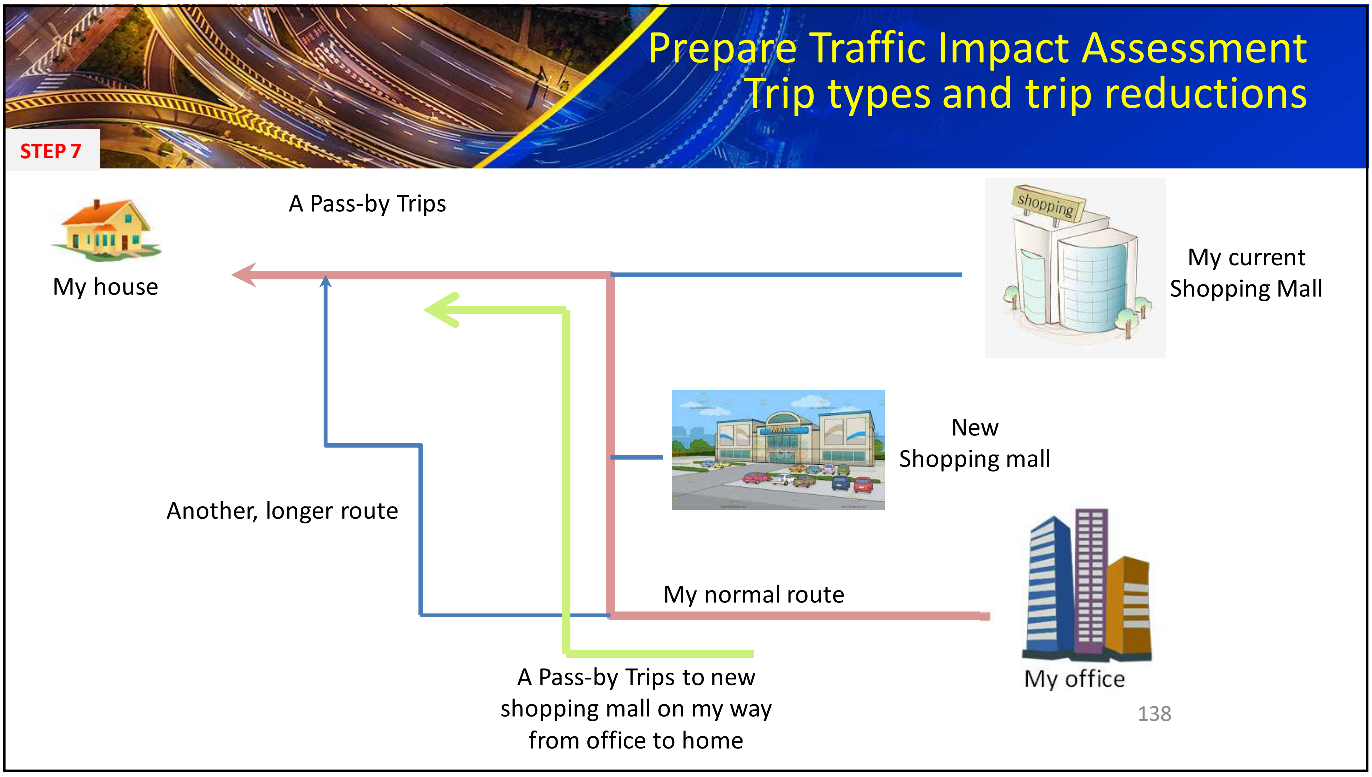
Prepare Traffic Impact Assessment
Trip types and trip reductions
STEP 7
A Pass-by Trips
My house
My current
Shopping Mall
New
Shopping mall
Another, longer route
My normal route
A Pass-by Trips to new
shopping mall on my way
from office to home
My office
138

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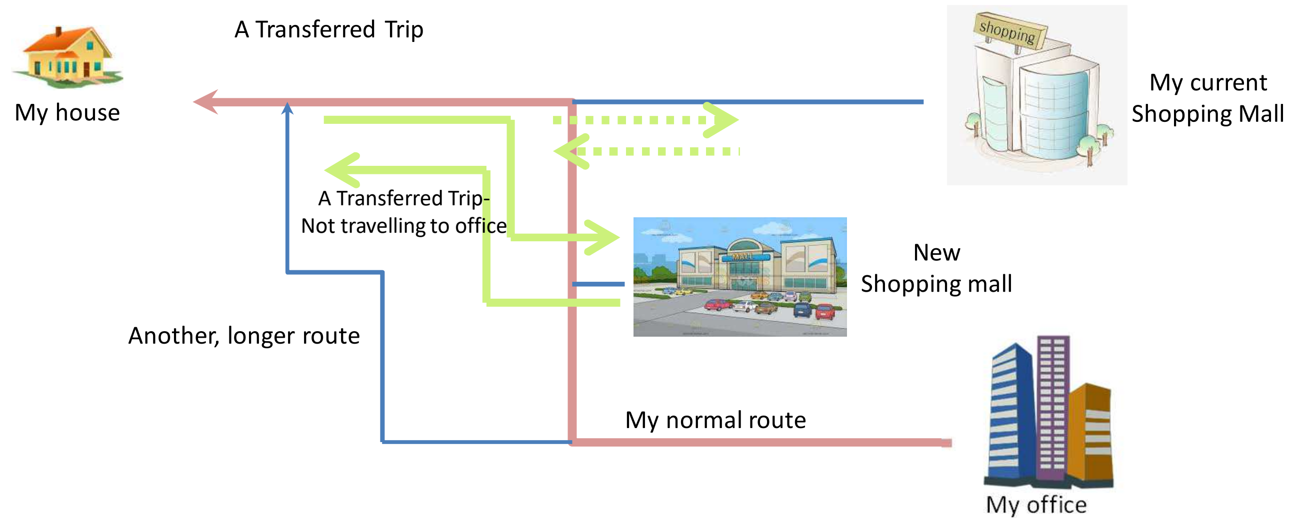
STEP 7

Prepare Traffic Impact Assessment
Trip types and trip reductions



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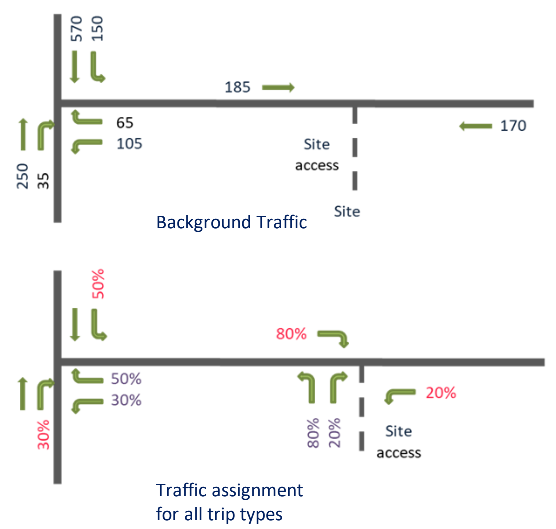
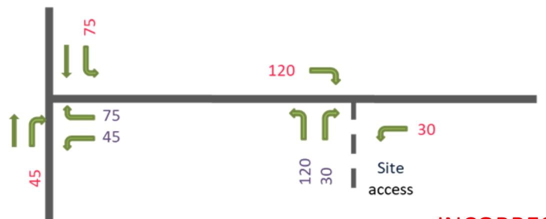
STEP 7

Prepare Traffic Impact Assessment
Trip types and trip reductions



Site traffic generation – NEW DEVELOPMENT

1. 300 total trips (50/50 IN/OUT SPLIT)
2. 150 vph enter
3. 150 vph exit
4. Pass-by trips = 20% = 60 (30 vph enter 30 vhp exit)
5. Diverted trips = 10% = 30 (15 vph enter 15 vph exit)



INCORRECT

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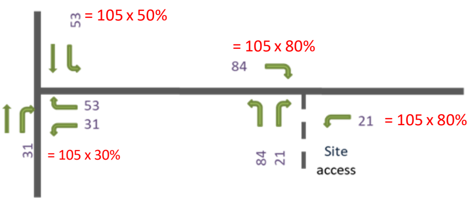
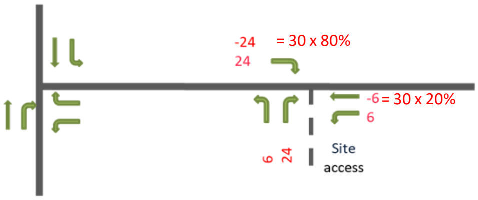
STEP 7

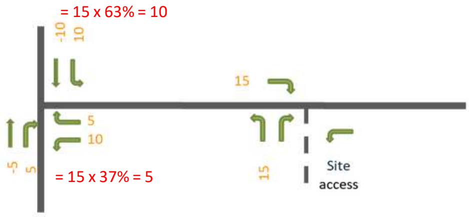
Prepare Traffic Impact Assessment
Trip types and trip reductions



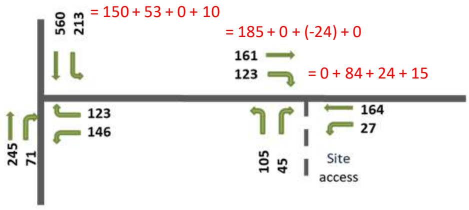
Primary trips



Pass-by trips



Diverted trips



Background + primary + pass-by + diverted trips

Site traffic generation

1. 300 total trips
2. 150 vph enter
3. 150 vph exit
4. Pass-by trips = 20% = 60 (30 vph enter 30 vhp exit
5. Diverted trips = 10% = 30 (15 vph enter 15 vph exist)

Site traffic generation

1. Primary Trips = 210 i.e. 105 enter and 105 exit

(300-60-30 = 210)

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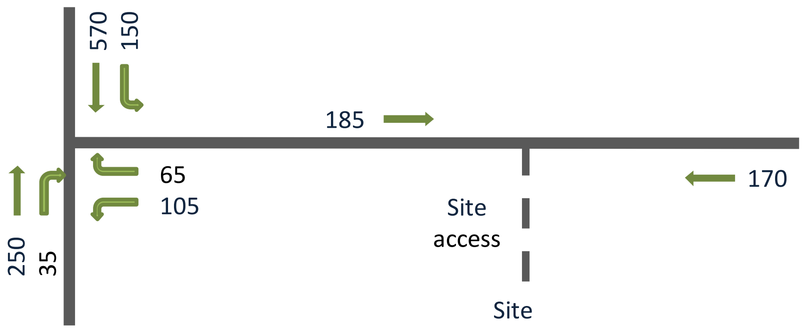
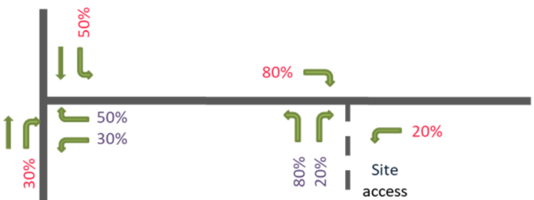
STEP 7

Prepare Traffic Impact Assessment
Trip types and trip reductions





Traffic assignment for all trip types

Proposed local shopping of 850m^2
Friday peak hour volumes shown for existing traffic (background traffic)

Calculate trip generation and show :

- Primary trips,
- pass-by trips,
- Diverted trips and;
- Existing background plus primary, pass-by and diverted trips

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Prepare Traffic Impact Assessment
Trip types and trip reductions

STEP 7

Trip generation

820 Shopping Centre — **100 sqm GLA**

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.60		3.40			4.50		6.000	3500
% Heavy									
In/Out	65:35		50:50			50:50			
PHF Dev						0.90			
PHF Street									
Veh Occupancy									
% Pass-by			13%			12%		1.950	48000
% Diverted			29%			38%			

$$\text{Size adjustment factor} = 1 + \frac{A}{1 + \frac{\text{sqm Size}}{B}}$$

In which A and B are parameters provided in the table and *sqm Size* is the size (GLA) of the development measured in units of m^2.

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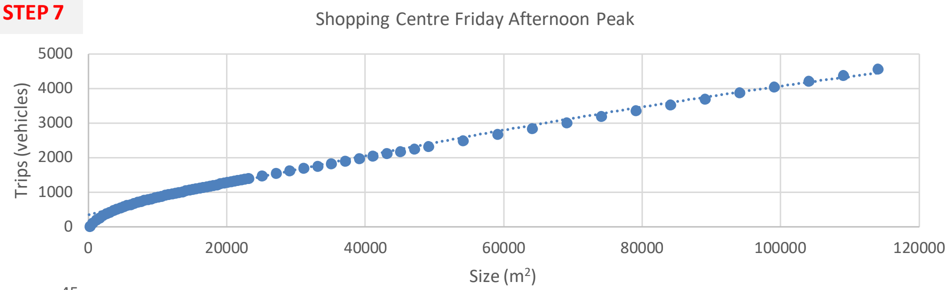
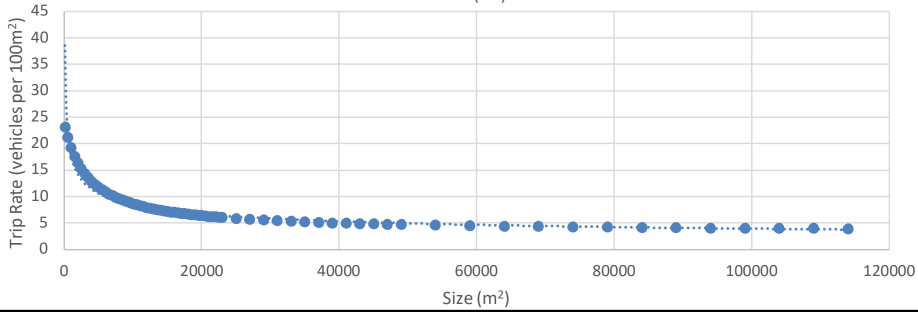
Prepare Traffic Impact Assessment
Trip types and trip reductions

STEP 7





Shopping center traffic demand and trip rates

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Prepare Traffic Impact Assessment
Trip types and trip reductions

STEP 7

Other trip reduction factors can be applied to trip generation rates to reduce the total vehicle trips:

- Internal trip reduction – mixed use factor – land use development mix that reduces the need to travel – walking trips or internal vehicle trips
- Vehicle ownership - reduction in trip generation in areas with a low level of vehicle ownership
- Public transport - reduction in trip generation due to location and usage of public transport corridors and facilities
- The reduction in the trip generation rate will reduce the need to implement road improvements, but additional facilities to accommodate the other modes of transport (public transport or walking) may or will be required. This impact must be addressed as part of the traffic assessment.

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Table 3.2: Trip Generation Adjustment Factors

	Land Use	Size Units	Percentage reduction for developments in areas with: Mixed-use Development	Low vehicle Ownership	Very Low Ownership	Transit nodes or Corridors
100	**Industrial**					
110	Service Industry	100 sqm GLA	5%	20%	30%	15%
120	Heavy industry/manufacturing	100 sqm GLA	5%	20%	30%	15%
121	Mining	1 Employees	5%	20%	30%	15%
130	Industrial Area (Park)	100 sqm GLA	5%	20%	30%	15%
140	Manufacturing	100 sqm GLA	5%	20%	30%	15%
150	Warehousing and Distribution	100 sqm GLA	5%	20%	30%	15%
151	Mini-Warehousing	100 sqm GLA	5%	20%	30%	15%
200	**Residential**					
210	Single Dwelling Units	1 D/Unit	10%	40%	70%	15%
220	Apartments and Flats	1 D/Unit	15%	30%	50%	15%
225	Student Apartments and Flats	1 D/Unit	25%	50%	80%	15%
231	Townhouses (Simplexes and Duplexes)	1 D/Unit	15%	30%	50%	15%
232	Multi-Level Townhouses	1 D/Unit	15%	30%	50%	15%
251	Retirement Village	1 D/Unit	5%	50%	80%	15%
254	Old-Age Home	1 D/Unit	5%	50%	80%	15%
260	Recreational Homes	1 D/Unit	10%	20%	30%	15%
300	**Lodging**					
310	Hotel, Residential	1 Room	20%	20%	30%	15%
330	Hotel, Resort	1 Room	20%	20%	30%	15%
350	Guest House	1 Room	20%	30%	50%	15%
400	**Recreational and Sport**					
430	Golf Course	1 Course	5%	0%	0%	0%
473	Casino	100 sqm GLA	5%	20%	30%	15%
480	Amusement Park	1 ha	5%	30%	50%	15%
488	Sport Stadium	1000 Seat	5%	30%	50%	15%
492	Health and Fitness Centre	100 sqm GLA	15%	20%	30%	15%
500	**Institutional**					
520	Public Primary School	1 Student	30%	50%	80%	15%
530	Public Secondary School	1 Student	30%	50%	80%	15%
536	Private School	1 Student	30%	50%	80%	15%
550	University / College	1 Student	20%	40%	60%	15%
560	Places of Public Worship (Weekend)	1 Seat	10%	50%	80%	15%
561	Places of Public Worship (Weekday)	1 Seat	10%	50%	80%	15%
565	Pre-School (Day Care Centre)	1 Student	5%	50%	80%	15%
566	Cemetery	1 Ha	0%	30%	50%	15%
600	**Medical**					
611	Public Hospital	1 Bed	0%	50%	80%	15%
612	Private Hospital	100 sqm GLA	0%	20%	30%	15%
620	Nursing Home	1 Bed	0%	50%	80%	15%
630	Medical Clinic	100 sqm GLA	0%	50%	80%	15%
700	**Office**					
710	Offices	100 sqm GLA	20%	20%	30%	15%
713	Home offices and undertakings	1 House	10%	20%	30%	15%
720	Medical consulting rooms	100 sqm GLA	10%	30%	50%	15%
770	Business Centre (Park)	100 sqm GLA	15%	20%	30%	15%
780	Conference Centre	1 Seat	10%	20%	30%	10%

Prepare Traffic Impact Assessment
Trip types and trip reductions

STEP 7

Table 3.2: Trip Generation Adjustment Factors

	Land Use	Size Units	Percentage reduction for developments in areas with: Mixed-use Development	Low vehicle Ownership	Very Low Ownership	Transit nodes or Corridors
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121	Mining	1 Employees	5%	20%	30%	15%
130	Industrial Area (Park)	100 sqm GLA	5%	20%	30%	15%
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151	Mini-Warehousing	100 sqm GLA	5%	20%	30%	15%
200	**Residential**					
210	Single Dwelling Units	1 D/Unit	10%	40%	70%	15%
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231	Townhouses (Simplexes and Duplexes)	1 D/Unit	15%	30%	50%	15%
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Prepare Traffic Impact Assessment
Trip types and trip reductions

Calculate trip generation for the proposed development

Code	Land use	Size	units	Measure	Reduction factors	
					Mixed use	PT
780	Convention centre	8000	100	Seats	0	15%
492	Health studio	2000	20	Per 100m²	10%	6%
310	Hotel	10000	150	Rooms		
933	Fast Food	250	2,5	Per 100m²	12%	13%
820	Shopping center	4500	45	Per 100m²		

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Prepare Traffic Impact Assessment
Trip types and trip reductions

Calculations
Using spreadsheet

				Reduction Factors			AM Peak Hour							PM Peak Hour						
Code	Land use	Size (m)	Units	Mixed Use	PT	Factor	Trip Rate	Adjusted Trip Rate	In	Out	In	Out	Total	Trip Rate	Adjus Trip	In	Out	In	Out	Total
780	Convestion centre	8000	100	0	15%	85%	0,5	0,566667	0,9	0,1	51	5,67	56,67	0,5	0,566667	0,1	0,9	5,666667	51	56,66667
492	Health studio	2000	20	10%	6%	85%	5	4,976471	0,5	0,5	49,76471	49,76	99,53	9,5	9,455294	0,6	0,4	113,4635	75,64235	189,1059
310	Hotel	10000	150			100%	0,5	0,5	0,6	0,4	45	30,00	75,00	0,5	0,5	0,55	0,45	41,25	33,75	75
933	Fast Food	250	2,5	12%	13%	77%	45	34,452	0,55	0,45	47,3715	38,76	86,13	50	18,3744	0,55	0,45	25,2648	20,6712	45,936
820	Shop/Retail	4500	45	15%	16%	71%	0,6	1,55295	0,65	0,35	45,42379	24,46	69,88	3,4	5,616443	0,5	0,5	126,37	126,37	252,74
	Total	24750											387							620

Example Calculations for Shop / Retail

Trip Ajustment Factor due to reduction in trips = (1-15%)x(1-16%) = 71,4%

Size Adjustment factor, A = 6 and B = 3500

$$\text{Size Adjustment} = 1 + \frac{6}{1+\frac{4500}{3500}} = 3.625$$

Adjusted Trip Rate for AM = 0.6 x .714 x 3.625 = 1.55295

AM Trips = 1.55295 x (4500/100) = 69.88 (say 70 trips) i.e.≅ 45 trips in and 25 trips out

$$\text{Size adjustment factor} = 1 + \frac{A}{1+\frac{\text{sqm Size}}{B}}$$

In which A and B are parameters provided in the table and *sqm Size* is the size (GLA) of the development measured in units of m^2.

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Prepare Traffic Impact Assessment
Trip distribution and traffic assignment

STEP 7

- The trip distribution of primary trips may be determined by one of the following methods:
  - Gravity model. According to the gravity model, trip distribution is proportional to the relative magnitude of origin and destination zones, and inversely proportional to the travel time between the zones.
  - Analogy method. Uses the directional distribution observed at another similar development in the vicinity of the site.
  - Surrogate method. Uses available socio-economic data to determine trip origins and destinations.
- Trip distribution may not be based on traffic counts in the vicinity of the development, unless it can be shown that such counts are indicative of the likely trip distribution for the development.

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Prepare Traffic Impact Assessment
Trip distribution and traffic assignment

STEP 7

- For smaller study areas, it is recommended that trip distribution should be estimated manually, using one of the above methods based on knowledge of local conditions.
- For large study areas, however, a detailed analysis should be undertaken based on the gravity model. In such an analysis, an origin-destination matrix should be developed showing the trip distribution between origins and destinations. Constraint must be enforced on the matrix to ensure that the total trip productions and attractions do not exceed those calculated by means of trip generation rates. An iterative process is normally required for this purpose. The calculations are normally undertaken by means of software but can also be undertaken manually.
- The primary trips must be estimated as a percentage of the total trip generation of the development and these percentages are then distributed and assigned to specific routes on the road network.

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Prepare Traffic Impact Assessment
Trip distribution and traffic assignment

STEP 7

- Traffic assignment involves determining the percentage of traffic that will use specific routes in the network. The traffic assignment is made with consideration to logical routings, available roadway capacity, right-turn movements, travel times and other relevant factors.
- The traffic assignment must be undertaken in terms of percentages of the trip generation of a development. The percentages must be shown on a schematic diagram of the study area. Where traffic is deducted from particular routes or turning movements, the percentages must be shown as negative quantities, but otherwise as positive quantities.
- Separate diagrams are required for each of the following trip types:
  - a) Pass-by trip distribution
  - b) Diverted trip distribution
  - c) Transferred trip distribution
  - d) Primary trip distribution
- In all cases, the percentages must be shown for the in- and outbound
- traffic movements.
- The assigned traffic volumes are determined by multiplying the trip generation rate of the development with the assigned percentages.

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Prepare Traffic Impact Assessment
Trip distribution and traffic assignment

STEP 7

- Once you have the base trip generation calculated (and sub-divided into new, pass-by, diverted, and internal if needed), distribute those trips on your study roads and through your study intersections for peak hour analyses.
- The assignment pattern means determining which road(s) each trip will use to and from the proposed development. This process is usually the least scientific part of the traffic forecasting process.
- The basic (manual) methods to determine the trip assignment for your site include :

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Prepare Traffic Impact Assessment
Trip distribution and traffic assignment

STEP 7

- Using the daily volumes and available capacity on the study roads access points to and from your site. Sum the volumes and divide each daily volume by that total to determine a percentage for that road. For example, if the three ways into your study area have daily traffic volumes of 32,000, 16,000and 45,000 vehicles per day; round the to/from distribution pattern to 35%, 15%and 50%, respectively.
- Consulting area maps to review access to regional roads (interchanges), population centres, and nearest competing land uses are. For instance, if your study is for a new Shopping centre, figure out where the other area Shopping centres and target stores are. If there are stores to the west and south, your distribution pattern should probably focus toward the north and east.
- Use the existing assignment around the site based on turning movement counts. This is especially true if your development is an addition to an existing If you're adding a wing to a hospital, base your distribution pattern on the existing driveway turning movement counts.

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Prepare Traffic Impact Assessment
Trip distribution and traffic assignment

STEP 7

- If your project is retail-oriented, you may be able to get a trade area/demographic study from the developer that provides a distribution pattern. However, these studies are tightly guarded and not shared with traffic engineers very often, but it's worth asking.
- If your project involves a school or club, you may be able to get areas for all their students or members. This is a great way to develop the distribution patterns for those types of uses and these types of developers are much more willing to share this information than the retail developers.
- If you can get into the regional model, you may be able to extract distribution pattern percentages for your study site, but this is rarely done – this should however become the norm where such models are available.

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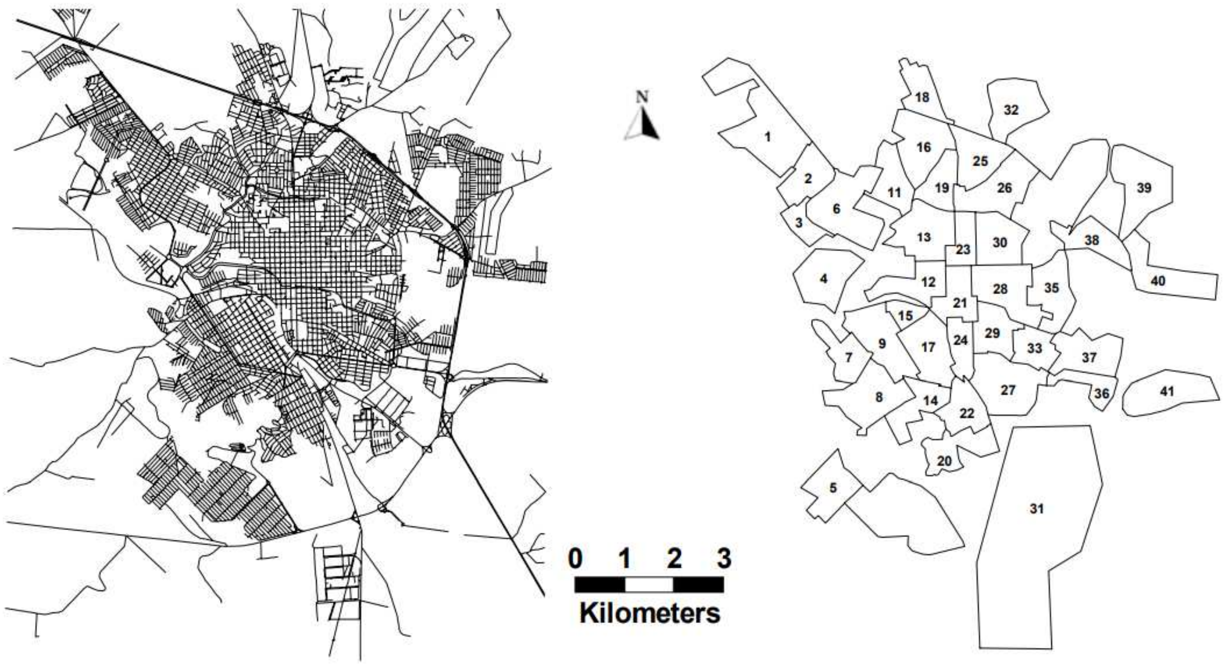

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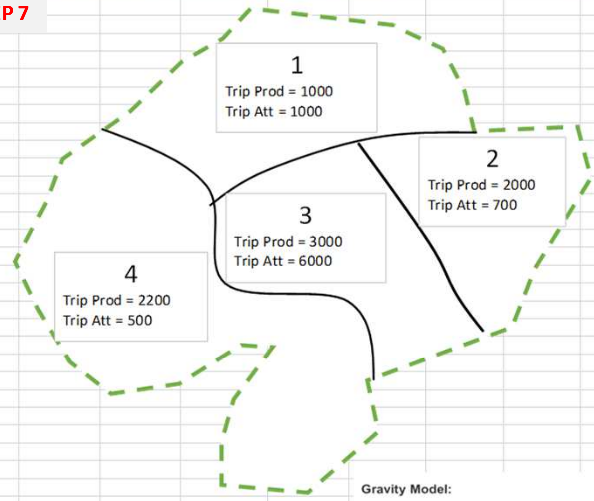
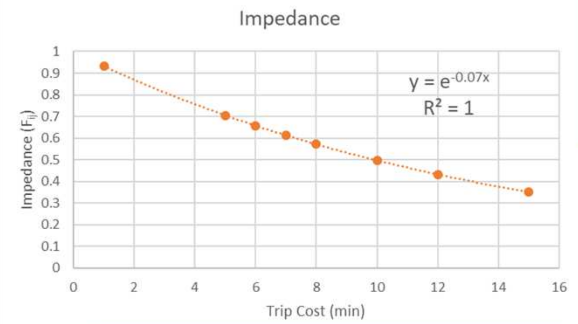
STEP 7





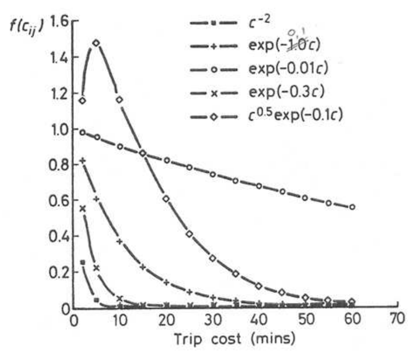
Gravity Model:

$$V_{ij} = P_i \frac{(A_j F_{ij})}{\sum_j A_j F_{ij}}$$

Where;
P_i = Number of productions from zone "i"
A_j = Number of attractions to zone "j"
F_{ij} = Friction factor, a measure of impedance from "i" to "j"

Traffic Zone	Travel Time (min)			
	1	2	3	4
1	5	8	12	15
2	8	5	10	8
3	12	10	5	7
4	15	8	7	5

Travel Time	1	5	6	7	8	10	12	15
Fij	0.93	0.70	0.66	0.61	0.57	0.50	0.43	0.35



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STEP 7

STEP ONE
Friction Matrix

Traffic Zone	Fij 1	2	3	4
1	~~0.70~~	0.57	0.43	0.35
2	0.57	~~0.70~~	0.50	0.57
3	0.43	0.50	~~0.70~~	0.61
4	0.35	0.57	0.61	~~0.70~~

STEP TWO
Use Gravity Model to calculate trips between each zone

INTERATION 0

Traffic Zone	Trips 1	2	3	4	Pi	
1	182	103	669	45	1000	1000
2	264	228	1376	132	2000	2000
3	244	196	2387	173	3000	3000
4	161	184	1692	162	2200	2200
Aj	1000	700	6000	500		
	851	712	6125	512		

STEP 3
Column/row factoring

INTERATION 1

	1	2	3	4
Aj	851	712	6125	512
Expected	1000	700	6000	500
fatcor	1.175168291	0.983800125	0.979555686	0.975980418

INTERATION 1

Traffic Zone	Trips 1	2	3	4	Pi	Expected
1	214	102	656	44	1015	1000
2	310	224	1348	129	2011	2000
3	287	193	2338	169	2987	3000
4	189	181	1658	158	2187	2200
Aj	1000	700	6000	500		
Expected	1000	700	6000	500		

STEP 3
Column/row factoring

Pi	Expected	Factor
1015	1000	0.984797241
2011	2000	0.994422883
2987	3000	1.004492484
2187	2200	1.00605327

INTERATION 2

Traffic Zone	Trips 1	2	3	4	Pi	Expected
1	211	100	646	43	1000	1000
2	308	223	1341	128	2000	2000
3	288	194	2349	170	3000	3000
4	191	182	1668	159	2200	2200
Aj	997	699	6003	500		
Expected	1000	700	6000	500		

	% Difference			
	-0.25%	-0.12%	0.05%	0.07%

STOP

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STEP 7

- volume delay function
- $TT_x = TT_{FF} + \left(1 + a\left(\frac{v}{c}\right)^4\right)$
- *TT_x= travel time on route x (hr)*
- *TT_{FF} = free flow travel time (hr)*
- *a = constant*
- *v = volume (veh/hr)*
- *c = capacity (veh/hr)*
- $TT_1 = 0{,}1 + \left(1 + 1\left(\frac{v}{1800}\right)^4\right)$
- $TT_2 = 0{,}09 + \left(1 + 1\left(\frac{v}{700}\right)^4\right)$
- $TT_3 = 0{,}1 + \left(1 + 1\left(\frac{v}{300}\right)^4\right)$
- Require to assign 700 vehicles from origin to destination

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STEP 7

- Free flow travel times on each route:
- Route 1 = 0,1 hr = 6min
- Route 2 = 0,09 hr = 5,4min
- Route 3 = 0,15 hr = 9min
- Start with incremental capacity constraint assignment
- Solution:
- 459 veh on Route 1 (65%)
- 241 veh on Route 2 (35%)
- 0 veh on route 3

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STEP 7

Prepare Traffic Impact Assessment Total traffic demand

- Total horizon year traffic demand must be estimated for the design as well as planning horizon years.
- The total traffic demand is determined by first estimating the background traffic and then adding the trip generation of the development to this background traffic.
- The background (“without” development) traffic demand is estimated as follows:
  - Traffic counts are used to estimate current demand.
  - From the traffic counts, subtract the trip generation of the existing exercised rights of the development.
  - The resultant traffic is then grown using an appropriate growth rate (where required).
  - Traffic from other developments and future development is added to the grown traffic to determine future background traffic (where appropriate).
- The total “with” development traffic demand is then estimated as follows:
  - Where necessary, the future background traffic is first redistributed to accommodate proposed changes to the transportation system.
  - The total trip generation of development, including existing and new rights, is then added to determine the “with” development traffic.

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Prepare Traffic Impact Assessment Total traffic demand

- For all scenarios, it's OK to round forecasts to represent an approximate level of accuracy. During the peak periods, round each turning movement volume to the nearest five or ten, unless it's a low-volume movement that has a couple of vehicles, then round them to the nearest five.

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Prepare Traffic Impact Assessment Total traffic demand

- Remember to do a quality control check on all your forecasts. Ensure the numbers add up correctly. Double check that background combined with the development volume does indeed equal the with development scenario. Make certain development traffic volumes add up appropriately between your study intersections; cars generally don't disappear. Volumes may not match between intersections if there's a reasonable explanation, like on-street parking or driveways, but be certain that any discrepancies are reasonable – e.g. 200 cars parking on a street during your peak hour isn't reasonable. Finally, check to see if your graphics of the vehicles entering and exiting your development match the numbers on your trip generation table.

- Although that seems like a lot of extra checks and balances, keep in mind that on controversial projects opponents of the project will be doing the "sums" and will happily point out those discrepancies in an attempt to discredit the study.

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STEP 7

Prepare Traffic Impact Assessment
Total traffic demand

Background traffic ("without" development traffic)

- Existing peak hour traffic (counts).
- Adjustments of traffic counts for congestion.
- Trip generation of development with existing exercised rights.
- Peak hour traffic less trip generation with exercised rights.
- Future traffic growth.
- Traffic from other developments.
- Total future background traffic

"With" development traffic

- Redistribution of future background traffic due to development.
- Total trip generation of development, including new rights.
- Total "with" development traffic for each horizon year.

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STEP 7

Prepare Traffic Impact Assessment
Total traffic demand

- Traffic demand for public transport, walking and bicycle modes of transport must be estimated where transportation elements involving these modes have been identified that may be affected by such traffic demand.
- The multimodal traffic demand estimation will mostly be required in areas with low vehicle ownership or where a development is located near to public transport facilities. In other areas, this demand estimation may be required for land uses that attract large volumes of pedestrians or public transport (such as educational developments, sports stadiums or central business districts).
- In situations where the multi-modal demand is relatively low, the assessment of the impacts may be made qualitatively without estimating the actual traffic demand. A quantitative assessment, however, will be required when the demand for the other modes already approaches or exceeds system capacity or where the development itself is expected to generate high levels of travel.

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Prepare Traffic Impact Assessment
Total traffic demand

STEP 7

Demand estimation

- The quantitative multimodal traffic demand must be estimated using information provided in the Trip Data Manual on the expected trip generation rates (including pass-by trips) of such modes. Where such information is not available, there will be no obligation on the Assessor to undertake a quantitative multimodal analysis.
- A qualitative analysis, however, will still be required.
- The estimation of pedestrian or cycling traffic demand may be undertaken using the methods described in the previous chapters. This implies that pedestrian and bicycle traffic must be counted, future background traffic estimated, trips generated and assigned and the total future development traffic determined.

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Prepare Traffic Impact Assessment
Total traffic demand

STEP 7

- For public transport, however, the demand estimation will be restricted to the estimation of the additional traffic that will be generated by the development. This implies that no counts need to be undertaken and future background public transport demand will not be estimated.
- The Municipality is responsible for making information available on the spare capacity of the public transport system to accommodate developments.
- The information may also be shown in schematic diagrams.

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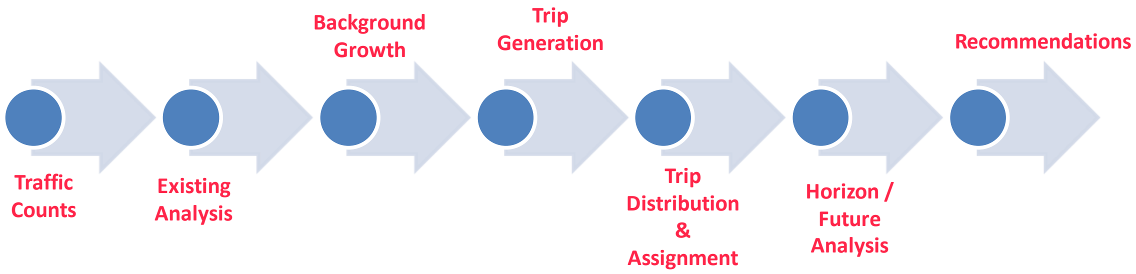
Prepare Traffic Impact Assessment

STEP 7

- What is the impact on a TIA for various scenarios and assumptions:



Existing process

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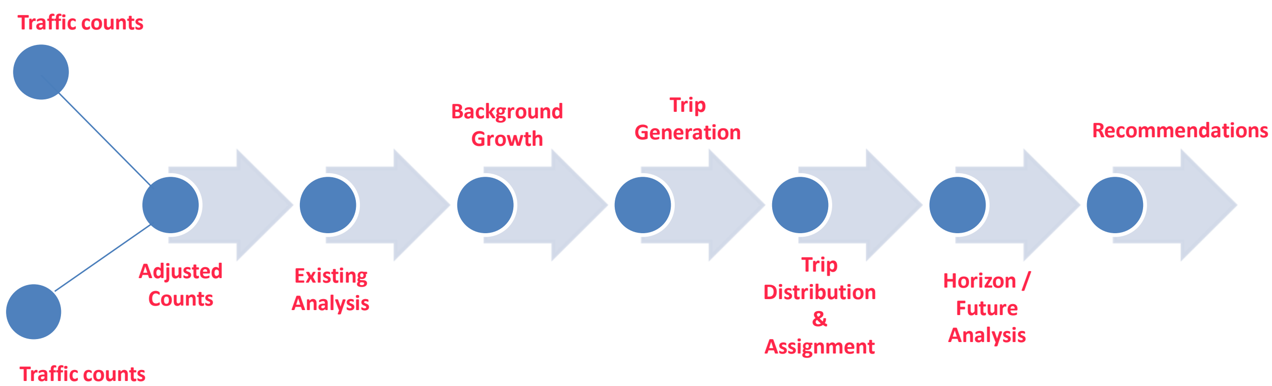
Prepare Traffic Impact Assessment

STEP 7

- What is the impact on a TIA for various scenarios and assumptions:
- The trend is to move towards 48 hour data collection – for obvious reasons



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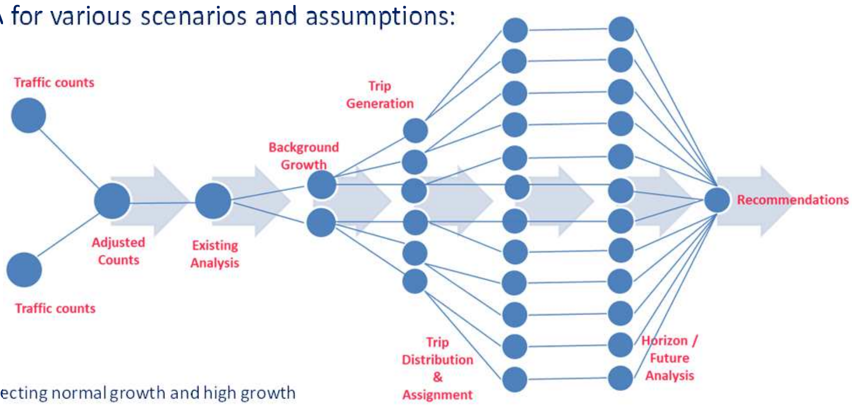
Prepare Traffic Impact Assessment

STEP 7

- What is the impact on a TIA for various scenarios and assumptions:



- Two different background growths reflecting normal growth and high growth
- Three trip generation results reflective of different levels of new traffic based on different public transport, internal and walk trips
- Two different trip assignment patterns based on actual counts and market research
- 12 different scenarios for future analysis

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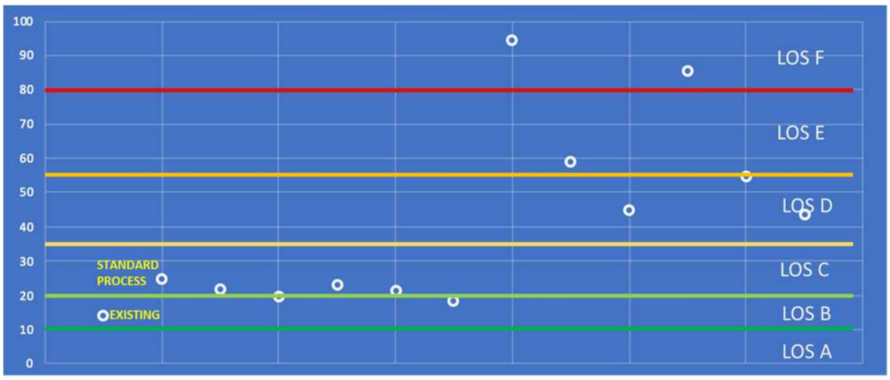
Prepare Traffic Impact Assessment

STEP 7



10,000m^2 office
2% and 5% growth rates
Trip generation scenario 1:
No reduction for PT, NMT, Internal
Trip generation scenario 2:
15% PT, 10% NMT, 0% Internal
Trip generation scenario 3:
30% PT, 15% NMT, 10% Internal

Evaluated one intersection assuming a scenario with a office development. Two sets of background growths were determined as well as three sets of trip generation and two sets of trip assignments. The signalised intersection was analysed 12 times with varying levels of future traffic. The graph shows the future analysis results in terms of overall intersection average delay (and Level of Service), with the existing results for comparison. The future analysis result that would have been determined using the "standard" approach is also highlighted.

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Prepare Traffic Impact Assessment
Traffic assessment scenarios - Analysis

STEP 7

- Capacity Analysis represents a key piece of the Traffic Impact Study – determining whether the roadways or intersections and other transport facilities can handle the traffic.
- Generally traffic analysis is undertaken using the Transportation Research Board of the National Academies' Highway Capacity Manual (HCM), 2010 or 6th Edition. Always worthwhile to check local authority specific requirements. HCM 7th Edition released – this year 2022
- Level of Service
- The HCM uses a concept called Level of Service (LOS) to quantify traffic delay and congestion. This measuring tool is just like grade school, ranking traffic from LOS A to LOS F. LOS A is the best with little to no delay and the ideal traffic operations and free-flow conditions. LOS F is the worst, with poor traffic operations and bumper-to-bumper conditions.
- Using a LOS letter grade is intended to be an easy way to convey traffic operations to the general public and has been adopted across the United States and other countries.

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Prepare Traffic Impact Assessment
Traffic assessment scenarios - Analysis

STEP 7

- LOS criteria have been developed for urban corridors, freeways, weaving and merge/diverge movements, intersections as a whole, and individual turning movement through an intersection. Although based on different analyses, the general meaning of the LOS grades remains the same for each element. Therefore, the public is presented a common result no matter the type of traffic analysis.
- LOS represents a complication as most people would assume that the we would be providing LOS A. The HCM, however, deems LOS E to be at-capacity, meaning the number of cars is right at the number the road or intersection can accommodate (supply equals the demand). Most authorities then designate LOS D as satisfactory and the lowest acceptable. In other words, no mitigation is necessary to improve operations if the facility is at LOS D or better.

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Prepare Traffic Impact Assessment
Traffic assessment scenarios - Analysis

- Most HCM methods analyse conditions during the peak 15 minutes of the peak hour.
- The worst peak 15 minutes within the peak hour converted to an hourly design volumes or alternatively the peak hour is adjusted by applying the peak hour factor (PHF) to arrive at the design volume .
- Many think that this is excessive however it should be kept in mind that the effects of roadway operations breaking down at a single location can last for much longer periods of time (potentially hours in larger metropolitan areas) and that the ripple effects of a breakdown can extend to other roadway segments and intersections.
- Therefore, the HCM analyses the peak 15 minutes, to evaluate the worst 15-minute period within the analysis hour that can lead to facility breakdowns.

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Prepare Traffic Impact Assessment
Traffic assessment scenarios - Analysis

- The capacity analysis must be undertaken using the methodologies and parameters specified by the local authority – in most cases this of the Highway Capacity Manual (TRB, 2010, or 6th edition)
- The capacity analysis may also be undertaken using microscopic or macroscopic simulation software, provided that such software has been calibrated and validated for South African conditions. Where such software is used, the level-of-service criteria of the Highway Capacity Manual shall apply.
- Traffic Simulation Modelling Software
  - Use of traffic simulation modelling software is permitted provided that:
  - Model development criteria and methodology is agreed with the authority
  - All modelling techniques, parameters, calibration, validation are provided including the traffic modelling software files.
  - Some authorities all accept specific software programmes (other software programmes will not be considered)
  - Common software include : SIDRA, AIMSUN, TRANSYT, VISSIM

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Prepare Traffic Impact Assessment
Traffic assessment scenarios - Analysis

STEP 7

- The level of service provided by a transportation facility is deemed acceptable when the requirements provided are met for each individual traffic stream or movement at all critical locations in the transportation system during the worst 15-minute time period. The assessment shall NOT be based on the average level of service of the facility.
- In general, the traffic operations are acceptable when, during the peak 15-minute period:
- The volume/capacity ratio does not exceed a maximum of 1.0 (volume does not exceed the capacity of the facility) and;
- The Level of Service (LOS), as defined by the Highway Capacity Manual, is not worse than the levels :

Acceptable Level of Service

Area/Road Class	Normal Days	Abnormal Days
Urban	LOS D	LOS E
Rural Class 3 - 5	LOS C	LOS D
Rural Class 1 - 2	LOS B	LOS C

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Prepare Traffic Impact Assessment
Traffic assessment scenarios - Analysis

STEP 7

- Road link (segment) capacity versus intersection capacity
  - Urban streets needs to be assessed both from link capacity and intersection capacity point of view and both assessments must be acceptable
  - Capacity can be specifically measured using HCM methodology for freeway (Class 1), multilane highways (Class 2) and two-lane highways
  - For commercial collector (Class 4a) and commercial local (Class 5a) roads can use HCM Urban Street methodology where applicable
  - Residential collector and local roads (i.e class 4b and 5b) – discretion of the local authority – current trend is that capacity is measured as “environmental capacity” – COTO, 2014
  - Traffic volumes on residential roads must be limited or restricted to prevent intrusion and ensure safety

Environmental capacity of roads

Road class	Preferred (veh/hr)	Maximum (veh/hr)
Urban Class 4b	500	1 000
Urban Class 5b	200	500

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Prepare Traffic Impact Assessment Analysis

Uninterrupted Facility Analysis

- Freeways – merge and diverge segments, weaving segments, basic freeway segment
- Multilane highways – segments to influenced intersection traffic control
- Two-lane highways – segments to influenced intersection traffic control

Interrupted Facility Analysis

- Urban street facilities and segments
- Signalised intersections
- Two-way and all-way stop control intersections
- Roundabouts
- Interchange ramp terminals
- Off street pedestrian and bicycle facilities

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Prepare Traffic Impact Assessment Mitigation measures

- Mitigations measures – that which is necessary to ensure that traffic operations meet the local authority requirements:
- You end up with a transport facility operating unacceptably in one of your study scenarios, it's up to you to figure out how to make all that traffic work efficiently.
- In simple terms:
  - Start with the earliest scenario that has an identifiable problem (e.g. existing background traffic scenario).
  - Select a potential improvement (consider a high level feasibility screening to ensure that the potential improvement is possible and has no fatal flaws – e.g. testing an additional lane that solves the problem only solves the problem if this can be achieved – if this additional lane requires expropriation, construction of bridge structures etc., this is not feasible).
  - Run the capacity analyses with this improvement.
  - Keep testing improvement options until you solve the problem. Then once you've reanalysed all your scenarios with acceptable results, document the improvements suggested and the timeline, or scenario, for when they're needed.

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Prepare Traffic Impact Assessment Mitigation measures

STEP 7

- Identify Areas of Concern:
  - Quantify when expected issues arise and the extents of the problems.
  - There is a significant difference between a “failing” (i.e. LOS F) left turn lane in the 10-year development scenario and issues with the through lanes starting in the existing scenario.
  - The easiest way to review everything is to list each transport facility e.g. road segments, intersections and movements where the results show unacceptable traffic operations.
  - Another item to add to the list would be the volume-to-capacity or v/c ratio.
  - A v/c ratio of 1.0 suggests “at capacity.” Above 1.0 indicates a facility is over-capacity, while below 1.0 suggests an under capacity facility. The v/c ratio will also help you determine the magnitude of any issues.

Transport facility	Existing scenario		Future background traffic scenario		Future development scenario	
	v/c	LOS	v/c	LOS	v/c	LOS
Road segment between intersection 2 and 3	0,8	LOS D	0,95	LOS E	1,1	LOS F
Intersection 1 – NB Through movement	1,1	LOS F	1,25	LOS F	1,34	LOS F

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Prepare Traffic Impact Assessment Mitigation measures

STEP 7

- Determine Initial Mitigation
  - Determining solutions to the issues you identified, also known as mitigation. We usually examine supply-side mitigation first. Supply-side mitigation looks at changes to the roadway system to either accommodate more traffic or to make the traffic move more efficiently. You can use multiple supply-side improvements, including:
    - Signal timing adjustments, Traffic signal phasing changes, such as adding left turn arrows
    - Improved signing and pavement markings
    - Peak hour turning restrictions
    - Traffic control change, such as adding stop signs
    - Addition of an exclusive turn and/or through lane
    - Addition of a through lane
    - Alternative intersection traffic control
    - Access management options
    - Other roadway operational changes (change to one-way?)
    - Intelligent Transportation Systems (ITS) options

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Prepare Traffic Impact Assessment Mitigation measures

STEP 7

- Demand side mitigation measures:
  - Measures are often overlooked or not considered
  - While the supply-side focuses on the roadway system and increasing capacity, the demand side focuses on reducing the impact of traffic volumes:
- Demand-side mitigation suggests methods to reduce a development's expected traffic generation, such as:
  - Public transport
  - Pay for parking
  - Peak hour parking restrictions
  - Truck/delivery peak hour restrictions
  - Staggered work hours or days
  - Smaller development size

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Prepare Traffic Impact Assessment Mitigation measures

STEP 7

- Other considerations for mitigation measures :
  - Consider the transportation plan for the city. The plan may have already explored and suggested improvements that can be used to support the development (subject to timing of implementation).
  - Similarly, other recent traffic and transportation impact studies in the area may have identified future improvements.
  - As you think about the possible improvements for your situation, you'll want to keep several key factors in mind – safety, availability of transport reserve (e.g. road reserve), and feasibility
  - Proposed mitigations must comply with safety and design standards – special circumstances may warrant design / safety expectations – rare
  - Availability of the transport reserve is critical – in most cases upgrading of the transport facility by means of land acquisition renders the project not feasible
  - It is therefore required that the transport proposals are tested from a feasibility point of view

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Prepare Traffic Impact Assessment Mitigation measures

STEP 7

- Feasibility of mitigation measures:
  - Where new roads, intersections and other transportation facilities, or improvements to existing facilities are proposed, Traffic Layout (TL) or Traffic Road Layout (TRL) plans must be prepared. The TRL is intended to evaluate the feasibility of the proposals.
  - Requirements for TRL's:
  - Horizontal alignment design to be produced to scale on aerial photography backdrop (or Topographical survey if available)
  - Existing cadastral and servitudes to be shown – available from local authority
  - Dimensions for all new elements to be provided
  - Vehicle swept path to be shown for required design vehicle
  - Vertical alignment of centre line for new roads / sections of roads – existing contour information available from Corporate GIS department can be used (or Topographical survey if available)

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Prepare Traffic Impact Assessment Mitigation measures

STEP 7

- Future transport proposals
- Relevant design standards to be used
  The TRL must be accompanied with a screening checklist to indicate the feasibility of such
- improvements;
  - Land availability – show extent of land acquisition required
  - Environmental sensitivity – based on existing available information
  - Impact on engineering and telecommunications services - based on existing available
  - information
  - Impact on public transport
  - Impact on non-motorised transport (NMT)
  - Impact on future transport proposals
- Where land acquisition is required, the TIA must include an undertaking from the land owner confirming consent for the land acquisition.
- The need for economic appraisal of the development is growing. If the local authority or the developer is going to invest in bulk infrastructure to support developments – what is the "return" on this investment, versus other opportunities / competing priorities.

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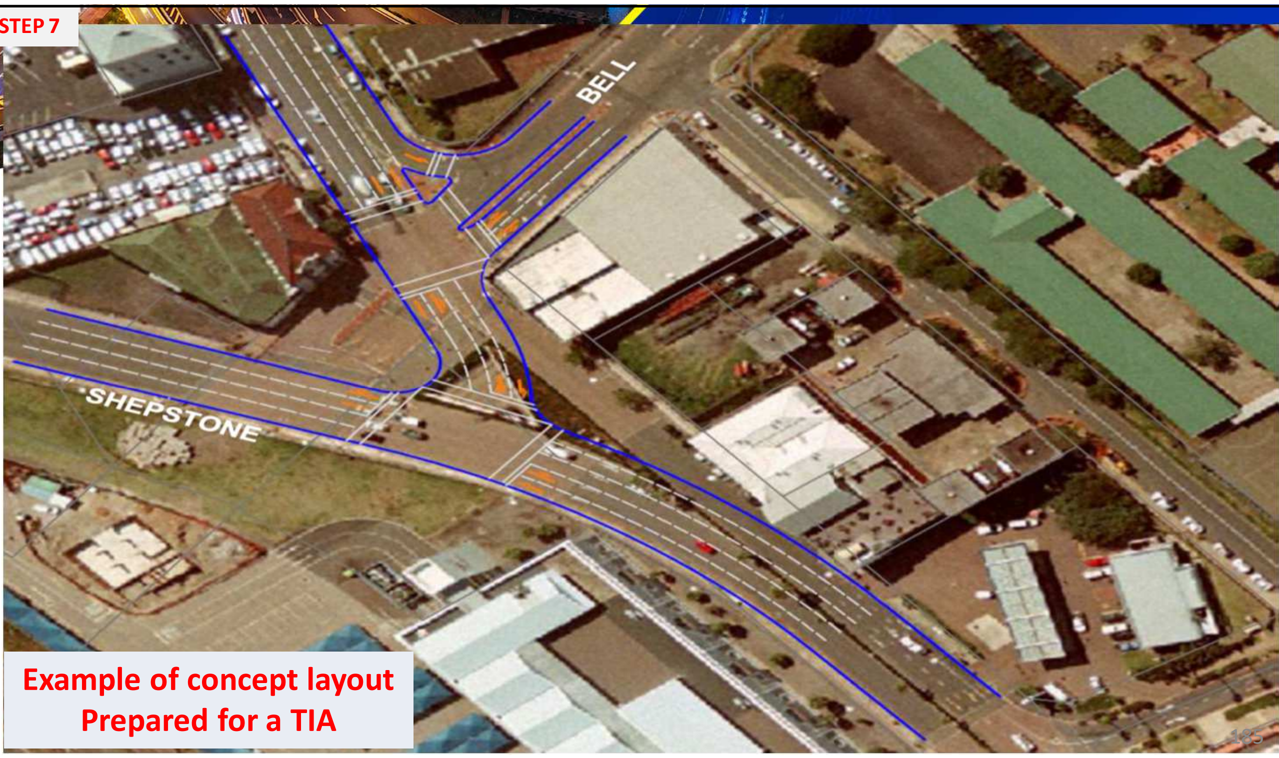
STEP 7



Example of concept layout
Prepared for a TIA

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STEP 7

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STEP 7

Example of concept layout Prepared for a TIA

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STEP 7

Prepare Traffic Impact Assessment Mitigation measures

- The other demand side mitigation measure of reducing the development size is generally seen to be less popular by the developer and also sometimes the authority
- However if there are sound economic justification then this would be an appropriate solution.
- Be sure to test and retest the mitigation measures to ensure that the proposal results in acceptable traffic operations for all scenarios
- Once the mitigations have been selected and tested, ensure you meet with your client and local authority to discuss the proposals
- Also it is preferable to collaborate with the local authority in developing mitigation measures. The staff at the local authority generally have a good understanding of traffic constraints in the area under their jurisdiction and often have ideas / or concepts that could resolve the problem.
- Always be prepared to defend the proposed mitigation measures and demonstrate why this is preferred versus other options that you have considered (i.e. you must consider options)

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Prepare Traffic Impact Assessment
Site traffic assessment

STEP 7

- The purpose of a Site Traffic Assessment (STA) is to assess whether transportation facilities proposed in a Site Development Plan or for a township during Township Establishment meet the standards and requirements of the authority.
- Site Development Plans are plans that the local authority require of a landowner intending to erect or alter any buildings or other structures on a development site.
- The STA will include all the similar requirements of the TIA but will be limited to the site including the access points to the public road network.
- The requirements for the STA is also specific to the requirements of the local authority which can vary from authority to authority – e.g. the onsite parking and loading design requirements in terms of aisle widths, gradients, etc varies across authority – similarly access layout requirements
- An example of the onsite traffic requirements (building plan stage) are as follows:

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Site traffic assessment required (refer to STA checklist)	
Engineering Drawings, Cost estimate, Financial guarantees, and Undertakings for new or existing road improvements	
Light vehicle access/driveway	
Access location dimension from property beacon to center line of access Access location from intersection: Min. 150m from class 1 / 2 roads Min. 60m from class 3 roads Min. 20m class 4 / 5 roads	
Access width at road edge	
Access scoop shown/access hardening shown (refer to Access Detail)	
Access / driveway long section to be shown (refer to Access Detail)	
Access width at boundary to be max. 9m	
Min. access width / driveway widths (refer to Table 1)	
Two-way driveway/ramp width min. 3m may be allowed if serving ≤ 6 parking bays (no pedestrians)	
Max. gradient 1:8 if access/driveway used by pedestrians	
Max. gradient 1:7 if access/driveway used by light vehicles only	
Heavy vehicle access/driveway	
Access location dimension from property beacon to center line of access Access location from intersection: Min. 150m from class 1 / 2 roads Min. 60m from class 3 roads Min. 20m class 4 / 5 roads	
Access width at road edge based on heavy vehicle tracking and tracking shown Access width at boundary max. 9m	
Access scoop / access hardening shown (refer to Access Detail)	
Access / driveway long section to be shown (refer to Access Detail)	
Min. access width / driveway widths (refer to Table 1)	
Max. gradient for access/driveway 1:10	
Ramps	
Light vehicle ramps grade max.1:7	
Heavy vehicle ramp grade max. 1:10	
Max. gradient for parking ramps 1:15	
Min. ramp widths (refer to Table 1)	
Parking and loading	
Max. gradient across parking area 1:15	
Light vehicle parking area min. height clearance 2.5m	
Loading vehicle parking area min. height clearance 4.5m	
Parking / loading bay dimensions – refer to Town Planning : *Minimum Standards for Parking and Loading Facilities to be Provided Within Any Site*	

STEP 7

Aisle width adequate for two-way/one-way – refer to Town Planning : *Minimum Standards for Parking and Loading Facilities to be Provided Within Any Site*
Vehicle tracking for loading areas
No. of loading bays – refer to Town Planning : *Minimum Standards for Parking and Loading Facilities to be Provided Within Any Site*
No. of light vehicle parking bays relaxed from 4.9m depth to 4.6m only if less than 10% of the total parking
Parking bay width for light vehicles relaxed to max. 0.1m if isolated parking areas
Min. one access (ingress and egress) for max. 400 parking bays
Full frontal access to parking from road not permitted
Tandem parking bays permitted only if surplus to parking requirements
Additional/General
Boundary wall / fence to be shown for all developments (excluding single dwelling house – single unit per site)
Petrol service station (PSS) frontage min. 36m
Pump island for PSS min. 5m from site boundary
PSS clear visibility of min. 120m in both directions at height of 1.37m from point of egress
PSS not to be sited on a road having gradient at any point within 120m of any point of access to the PSS > 1:7
Heavy vehicle access control (gate/boom/security control) to be setback based on requirements of ETA Manual for Site Traffic and Traffic Impact Assessments– or waivered if building plan endorsed that 'access to remain open during business operating hours'
Light vehicle access control (gate/boom/security control) to be setback based on requirements of ETA Manual for Site Traffic and Traffic Impact Assessments - or waivered if building plan endorsed that 'access to remain open during business operating hours'
Left-in-left out access designed and endorsed on plan
Accesses to be clearly annotated for type of vehicle use (light/heavy veh. or both)

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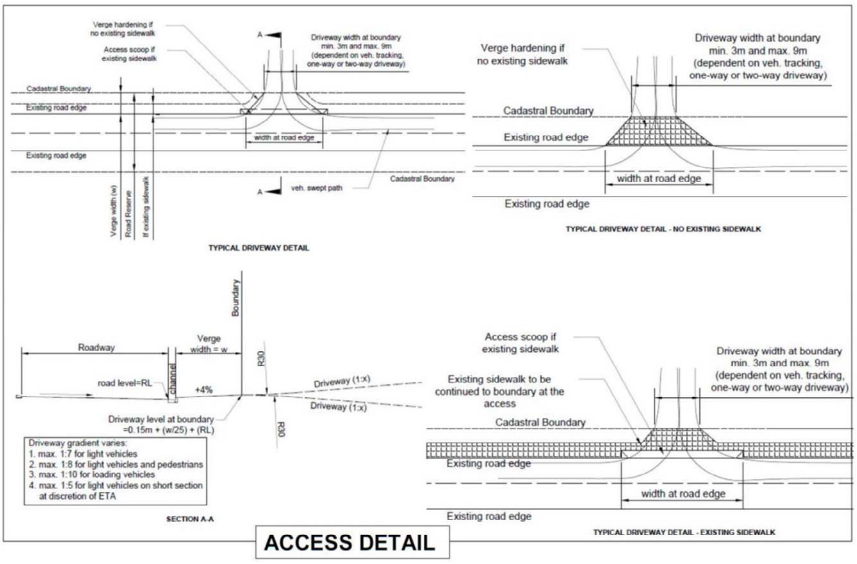
STEP 7



ACCESS DETAIL

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STEP 8 and 9

- Submit to client for approval
- Submit to relevant authority / authorities for approval
- May require changes to the traffic impact assessment

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Prepare Traffic Impact Assessment
Traffic analysis basics

- The following slides presents some of the key traffic facility assessment that can be carried out using manual calculations based on HCM, 2016.
- Most often this task is automated using software, it is however useful to understand the HCM simplified manual calculations that can also be used.
- HCM 6th edition – 2016 : simplified method: *Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual* 2016 (TRB, 2016)
- The procedures designed to support the following planning and preliminary engineering analyses:
  - Feasibility studies of Intersection improvements, and Signal timing improvements, and
  - Land development traffic impact studies.
- Intersection sufficiency is determined quickly by estimating its volume-to-capacity (v/c) ratio. These ratios can also be used to quickly compare different capacity improvement alternatives and select the more cost-effective alternatives for further analysis.
- A critical movement analysis is used to predict the critical v/c ratio of the intersection and make an assessment of the sufficiency of the intersection to accommodate the forecasted peak hour traffic volumes.

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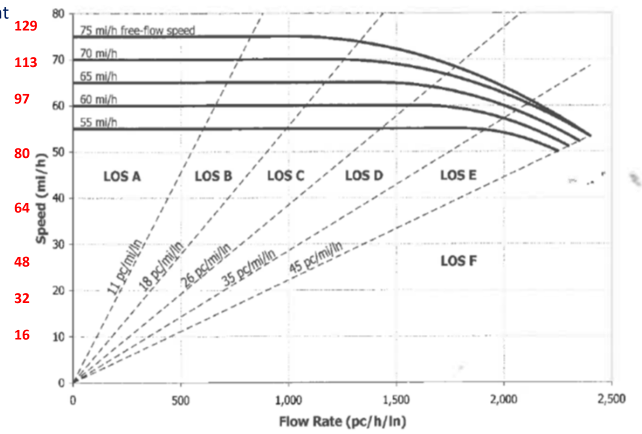
Prepare Traffic Impact Assessment
Traffic analysis basics; HCM 2016

Basic Freeway Segment

Outside the influence of merging and diverging or weaving manoeuvres
On Ramp influence 1500ft (457,2m) downstream of the merge point
Off ramp influence 1500ft (457,2m) upstream of diverge point
Weaving segment influence 500ft (152,4m) up and down stream of the segment

LOS	Density (pc/km/ln)	Density (pc/mi/ln)
A	≤7	≤11
B	>7-11	>11-18
C	>11-16	>18-26
D	>16-22	>26-35
E	>22-28	>35-45
F	>28	>45



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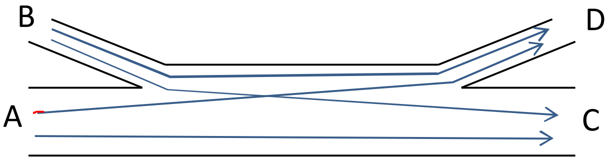
Prepare Traffic Impact Assessment
Traffic analysis basics; HCM 2016

Weaving Segment

Flows A-D and B-C are weaving flows
Requires intense lane changing
Traffic in weaving segments subject to turbulence in excess of that experienced at basic freeway segments



LOS	Freeway Weaving Segment Density (pc/km/ln)	Weaving Segments on multilane highways or C-D roads Density (pc/km/ln)
A	0-6	0-12
B	>6-12	>12-24
C	>12-17	>24-32
D	>17-22	>32-36
E	>22	>36
F	Demand exceeds capacity	

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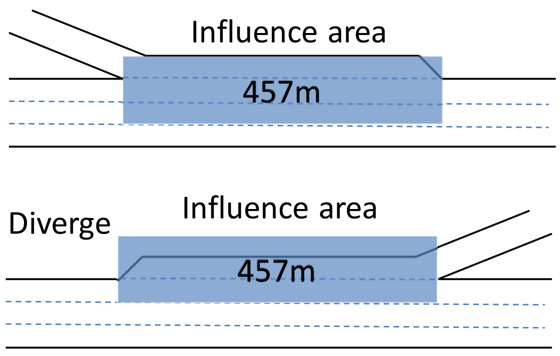
Prepare Traffic Impact Assessment
Traffic analysis basics; HCM 2016

Merge



LOS	Freeway Weaving Segment Density (pc/km/ln)	Comments
A	0-6	Unrestricted operations
B	>6-12	Merging and diverging manoeuvres noticeable to drivers
C	>12-17	Influence area speeds begin to decline
D	>17-22	Influence area turbulence becomes noticeable
E	>22	Turbulence felt by virtually all drives
F	Demand exceeds capacity	

N.B Freely available software online to carry out all HCM freeway facilities analysis

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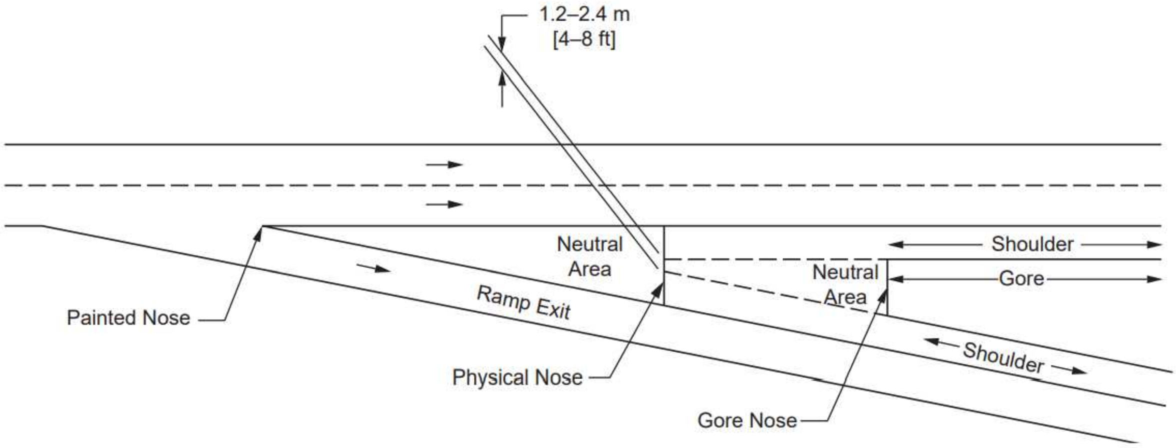

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Prepare Traffic Impact Assessment Signalised intersections, HCM 2016

1. Determine need for protected right turning phasing
2. Assign volumes to lane groups
3. Convert turning movements to pcu's / pce's
4. Calculate critical lane group volumes
5. Determine intersection sufficiency
6. Calculate cycle time / phasing
7. Calculate lane group capacity
8. Estimate delay
9. Determine LOS
10. Estimate queues

HCM 2016 simplified Method

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Prepare Traffic Impact Assessment Signalised intersections, HCM 2016

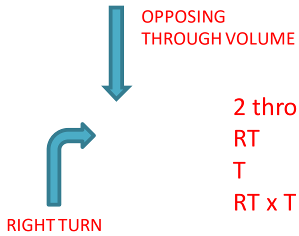
Step 1: Determine Right-Turn Phasing (only if phasing is unknown)
A protected right turn phase is selected if any of these conditions are met:

- Right-turn volume exceeds 240 veh/h;
- The product of the right-turn volume and the opposing through volume exceeds a given threshold (50,000 if there is one opposing through lane, 90,000 if there are two opposing through lanes, and 110,000 if there are three or more opposing through lanes); or
- The number of right-turn lanes exceeds one.
- If both opposing approaches have an exclusive right-turn lane, and its opposing approach meets at least one condition for protected right-turn phasing, then it will also be assumed to have protected right-turn phasing.

IF YOU HAVE THE PHASING – USE IT

NB. Four types of phasing:

1. Permitted
2. Protected
3. Protected + Permitted
4. Split Phasing



2 through lanes

RT	= 200 vph
T	= 1500 vph
RT x T	= 300 000

Prepare Traffic Impact Assessment Signalised intersections, HCM 2016

Step 2: Identify Lane Groups

- A lane group is a lane or set of lanes designated for separate analysis. All traffic movements for a given approach (i.e., left, through, and right) must be assigned to a lane group. A lane group can consist of one or more lanes. There are two guidelines for assigning traffic movements to
- lane groups:
  - When a traffic movement uses only an exclusive lane(s), it is analysed as an exclusive lane group.
  - When two or more traffic movements share a lane, all lanes which convey those traffic movements are analysed as a mixed lane group.

- When a Left-turn movement is shared with a through movement, it is considered to be a part of the through movement lane group. When a left-turn movement is shared with a right-turn movement (such as at a T-intersection), it is considered to be a part of the right-turn movement lane group.

Prepare Traffic Impact Assessment
Signalised intersections

- Lane groups to be assessed to determine if a de facto turn lane exists.
- A de facto turn lane occurs on approaches - where either a left- or right-turn movement is shared with a through movement, but that lane is only used by turning vehicles.
- This occurs in situations where the turning movements are high, there are significant impedances for the turning movements, or both.
- De facto turn lanes should be analysed as exclusive turn lanes and all through movements should be assumed to occur from the through-only lane(s).
- In cases where there are multiple turn lanes and one lane is shared with a through movement, that combination of lanes should be treated as a single-lane group and all the lanes should be associated with the through lane group.

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Prepare Traffic Impact Assessment
Signalised intersections

Approach lanes to intersection	Movements by Lane	Lane Group
1		One lane group LG 1
2		Two lane groups LG 1 LG 2
2		LG 1 LG 2
3		Two lane groups or three lane groups LG 1 LG 2 LG 1 LG 2 LG 3

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Prepare Traffic Impact Assessment Signalised intersections, HCM 2016

Step 3: Convert Turning Movements to Through Passenger Car Equivalents
Step 3a: Heavy Vehicle Adjustment
The adjustment for heavy vehicles E_{HVadj}

$$E_{HVadj} = 1 + PHV(E_{HV} - 1)$$

E_{HVadj} = heavy vehicle adjustment factor (unitless),
P_{HV} = proportion of heavy vehicles in the movement (decimal), and
E_{HV} = passenger car equivalent for heavy vehicles in the movement (default = 2.0)

Step 3b: Peak Hour Factor Adjustment
The adjustment for variation in flow during the peak hour is calculated using Equation:

$$E_{PHF} = \frac{1}{PHF}$$

where
E_{PHF} = flow variation adjustment factor (unitless), and
PHF = peak hour factor (unitless, ranges from 0.25 to 1.00, default = 0.92).

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Step 3c: Turn Impedance Adjustment

- The turn impedance adjustment factors E_{LT} and E_{RT} adjust for impedances experienced by left- and righty-turning vehicles, respectively.
- The methods used to determine E_{LT} and E_{RT} depend on the signal phasing used for the turns. Through vehicles do not experience the impedances that turning vehicles do, so the flows for these movements are not adjusted.
- Permitted Right-Turn Phasing. The values for E_{RT} for permitted right turns are given :

Opposing Through and Left-Turn Volumes (veh/h)	E_{RT}
<200	1.10
200–599	2.00
600–799	3.00
800–999	4.00
≥1,000	5.00

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- Protected and Split Right-Turn Phasing. If the right turn is protected, or uses split phasing, then E_{RT} = 1.05 regardless of volume.
- Protected-Permitted Right-Turn Phasing. Equation is used to calculate E_{RT} when protected-permitted phasing is used. Signal timing must be known or estimated.
- The effective green time for the first portion of the protected-permitted phase includes the yellow interval between the two portions.

- $$E_{RT} = \frac{(E_{RT,prot} g_{RT,prot})(E_{RT,perm} g_{RT,perm})}{g_{RT,prot} + g_{RT,perm}}$$

where

E_{RT} = right-turn impedance adjustment factor (unitless),
$E_{RT,prot}$ = right-turn impedance adjustment factor for the protected portion of the right-turn phase (unitless) = 1.05,
$E_{RT,perm}$ = right-turn impedance adjustment factor for the permitted portion of the right-turn phase (unitless),
$g_{RT,prot}$ = effective green time for the protected portion of the right-turn phase (s), and
$g_{RT,perm}$ = effective green time for the permitted portion of the right-turn phase (s).

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- Permitted Left-Turn Phasing. Left-turning vehicles are sometimes impeded by pedestrians.
- The values for E_{LT} for permitted left turns are :

Pedestrian Activity	E_{LT}
None or low	1.20
Medium	1.30
High	1.50
Very high	2.10

Pedestrian activity is characterised as follows:
None (default)
Low – 50 pedestrians per hour
Medium – 200 pedestrians per hour
High – 400 pedestrians per hour
Very High – 800 pedestrians per hour

- Protected and Split left-Turn Phasing - the E_{LT} value for “none or low” pedestrian activity should be used.

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Step 3d: Parking Adjustment Factor

The parking adjustment factor E_p is a function of the presence of on-street parking and applies to through and left-turn volumes.

Parking Activity	Number of Lanes in Lane Group	*Ep*
No parking lane	All	1.00
Adjacent parking	1	1.20
	2	1.10
	3	1.05

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Step 3e: Lane Utilisation Factor

- Lane utilisation factor E_{LU} adjustment for the volume imbalance between lanes when there are two or more lanes on an approach.

Lane Group Movements	No. of Lanes in Lane Group	E_{LU}
Through or shared	1	1.00
	2	1.05
	≥3	1.10
Exclusive RT	1	1.00
	≥2	1.03
Exclusive LT	1	1.00
	≥2	1.13

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Step 3f: Adjustment Factor for Other Effects

- Incorporate the saturation flow rate effects of work zones (if any), mid-segment lane blockage, and sustained spillback from downstream segment in a comprehensive volume adjustment factor for other effects E_{other}.

Step 3g: Through Passenger Car Equivalent Flow Rate

$$v_{adj} = V E_{Hvadj} E_{PHF} E_{RT} E_{LT} E_p E_{LU} E_{other}$$

where
v_{adj} = through passenger car equivalent flow rate (through passenger cars per hour, tpc/h),
V = turning-movement volume (veh/h),
E_{HVadj} = heavy vehicle adjustment factor (unitless),
E_{PHF} = flow variation adjustment factor (unitless),
E_{LT} = left-turn impedance adjustment factor (unitless),
E_{RT} = right-turn impedance adjustment factor (unitless),
E_p = parking adjustment factor (unitless),
E_{LU} = lane utilization adjustment factor (unitless), and
E_{other} = adjustment factor to account for other conditions determined by the analyst (unitless).

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Step 3h: Equivalent Per-Lane Flow Rate

- The equivalent per-lane flow rate v_i for a given lane group i is calculated as follows:

$$v_i = \frac{v_{adj,i}}{N_i}$$

where
v_i = equivalent per-lane flow rate for lane group i (tpc/h/ln),
$v_{adj,i}$ = through passenger car equivalent flow rate for lane group i (tpc/h), and
N_i = number of lanes within lane group i, accounting for de facto lanes.

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Step 4: Calculate Critical Lane Group Volumes

- Critical lane groups represent the combination of conflicting lane groups from opposing approaches that have the highest total demand.
- Critical lanes groups dictate the amount of green time required during each phase as well as the total cycle length required for the intersection.
- The movements and phasing for the north–south and east–west approaches are assessed independently. The combination of movements that make up the critical movements are different for protected and permitted right-turn phasing, and for split phasing.

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Step 4a: Identify Critical Movements

Protected Right-Turn Phasing. When opposing approaches use protected right-turn phasing, the critical lane group volumes will be the maximum of the two sums of the right-turn lane volume and the opposing through (or shared through) lane volume, or left-turn lane volume if that is greater. For the east–west approaches, the critical lane group volume $v_{c,EW}$ is calculated

$$v_{c,EW} = max\begin{cases} v_{EBRT} + \max(v_{WBTH}, v_{WBLT}) \\ v_{WBRT} + \max(v_{EBTH}, v_{EBLT}) \end{cases}$$

where
$v_{c,EW}$ = critical east–west lane group volume (tpc/h/ln),
v_{EBRT} = equivalent flow rate for the eastbound right-turn lane group (tpc/h/ln),
v_{EBTH} = equivalent flow rate for the eastbound through lane group (tpc/h/ln),
v_{EBLT} = equivalent flow rate for the eastbound left-turn lane group (tpc/h/ln),
v_{WBRT} = equivalent flow rate for the westbound right-turn lane group (tpc/h/ln),
v_{WBTH} = equivalent flow rate for the westbound through lane group (tpc/h/ln), and
v_{WBLT} = equivalent flow rate for the westbound left-turn lane group (tpc/h/ln).

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Step 4a: Identify Critical Movements

Similarly for the north–south approaches, the critical volume $V_{c,NS}$

$$v_{c,NS} = max \begin{cases} v_{NBRT} + \max(v_{SBTH}, v_{SBLT}) \\ v_{SBRT} + \max(v_{NBTH}, v_{NBLT}) \end{cases}$$

where

$V_{c,NS}$ = critical north–south lane group volume (tpc/h/ln),
v_{NBRT} = equivalent flow rate for the northbound right-turn lane group (tpc/h/ln),
v_{NBTH} = equivalent flow rate for the northbound through lane group (tpc/h/ln),
v_{NBLT} = equivalent flow rate for the northbound left-turn lane group (tpc/h/ln),
v_{SBRT} = equivalent flow rate for the southbound right-turn lane group (tpc/h/ln),
v_{SBTH} = equivalent flow rate for the southbound through lane group (tpc/h/ln), and
v_{SBLT} = equivalent flow rate for the southbound left-turn lane group (tpc/h/ln).

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Permitted Right-Turn Phasing. When opposing approaches use permitted phasing, the critical lane group volume will be the highest lane group volume of all lane groups for a pair of approaches. For the east–west and north–south approaches, the critical volume $v_{c,EW}$ and $v_{c,NS}$ is calculated using the following Equations:

$$v_{c,EW} = \max(v_{EBRT}, v_{EBTH}, v_{EBLT}, v_{WBRT}, v_{WBTH}, v_{WBLT})$$
$$v_{c,NS} = \max(v_{NBRT}, v_{NBTH}, v_{NBLT}, v_{SBRT}, v_{SBTH}, v_{SBLT})$$

Split Phasing. When opposing approaches use split phasing (where only one approach is served during the phase), the critical lane group volume will be the highest lane group volume of all lane groups for that approach. The critical volume $v_{c,EW}$ and $v_{c,NS}$ is calculated using the following Equations:

$$v_{c,EW} = \max(v_{EBRT}, v_{EBTH}, v_{EBLT}) + \max(v_{WBRT}, v_{WBTH}, v_{WBLT})$$
$$v_{c,NS} = \max(v_{NBRT}, v_{NBTH}, v_{NBLT}) + \max(v_{SBRT}, v_{SBTH}, v_{SBLT})$$

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Protected-Permitted Right-Turn Phasing. The signal timing must be known or estimated by the analyst, which would have been done as part of Step 3c. To find the critical lane group volumes, the equivalent through-car volume in the right lane during the protected portion of the phase is found by splitting the total demand in proportion to the length of the protected portion of the phase to the overall protected-permitted phase.

$$V_{RT,prot} = V_{RT}\left(\frac{g_{RT,prot}}{g_{RT,prot} + g_{RT,perm}}\right)$$

where
$V_{RT,prot}$ = right-turn demand during the protected portion of the phase (tpc/h/ln),
V_{RT} = overall right-turn demand during the right-turn phase (tpc/h/ln),
$g_{RT,prot}$ = effective green time for the protected portion of the right-turn phase (s), and
$g_{RT,perm}$ = effective green time for the permitted portion of the right-turn phase (s).

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- The critical lane volumes are then found using only the protected portion of the compound phase. The critical lane group volume is the highest total of a through lane volume and its opposing protected right-turn volume. The remainder of the methodology does not change. In the delay module (optional Step 7), the overall right-turn demand V_{RT} is used to find delay.

Step 4b: Calculate the Sum of the Critical Lane Volumes

- The sum of the critical lane volumes V_c is calculated as follows:

$$V_c = V_{c,EW} + V_{c,NS}$$

where
V_c = critical intersection volume (tpc/h/ln),
$V_{c,EW}$ = critical east–west volume (tpc/h/ln), and
$V_{c,NS}$ = critical north–south volume (tpc/h/ln).

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Step 5: Determine Intersection Sufficiency
Step 5a: Calculate the Critical Volume-to-Capacity Ratio

- The critical volume-to-capacity ratio X_c is calculated using Equation:

$$X_c = \frac{V_c}{c_i}$$

where

X_c = critical volume-to-capacity ratio (unitless),
V_c = critical intersection volume (tpc/h/ln), and
c_i = intersection capacity (tpc/h/ln).

Intersection sufficiency

Xc	Description	Capacity Assessment
<0.85	All demand is able to be accommodated; delays are low to moderate.	Under
0.85–0.98	Demand for critical lane groups near capacity and some movements require more than one cycle to clear the intersection; all demand is able to be processed at the end of the analysis period; delays are moderate to high.	Near
>0.98	Demand for critical movements is just able to be accommodated within a cycle but more oftentimes requires multiple cycles to clear the intersection; delays are high and queues are long.	Over

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- Intersection capacity is the maximum per-lane through movement flow rate that can be accommodated by the intersection, accounting for lost time.
- A value of 1,650 tpc/h/ln can be used as a default if local data are not known. This value reflects a saturation flow rate of 1,900 tpc/h/ln, a lost time of 4 seconds per critical phase, and a cycle length of 30 seconds per critical phase.
- A value of 1,500 tpc/h/ln may be used for signalised intersection capacity in smaller urban areas (under
- 250,000 population). Higher values may be appropriate for suburban or rural signals with high speed approaches (≥72 kmph).

Step 5b: Assess the Intersection Sufficiency

- The final step of the *v/c* analysis is to assess the sufficiency of the intersection to accommodate a given demand level.

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Simplified Method, Part 2: Delay, LOS, and Queue Calculation

STEP 7: Calculate Capacity
STEP 7a: Calculate Cycle Length
The traffic signal cycle length C is assumed to be 30 seconds per critical phase.
The analyst can use another value based on local practice or conditions.

$C = 30n$

where
C = traffic signal cycle length (s), and
n = number of critical phases.

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STEP 7b: Calculate the Total Effective Green Time
The total effective green time g_{TOT} available during the cycle is calculated using Equation;

$$g_{TOT} = C - L$$

where
gtot = total effective green time (s),
C = traffic signal cycle length (s), and
L = lost time per cycle (s) (default = 4 seconds per critical phase).

The total effective green time is then allocated to each critical phase in proportion to the critical lane group volume for that movement using Equation :

$$g_i = g_{TOT} \frac{V_{ci}}{V_c}$$

where
g_i = effective green time for phase i (s),
g_{tot} = total effective green time (s),
V_{ci} = critical lane group volume for phase i (tpc/h/ln), and
V_c = critical intersection volume (tpc/h/ln).

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For the non-critical phase (and the movements served by these phases), the effective green time is set equal to the green time for the phase on the opposing approach that serves the same directional movement. The green time for each phase should be reviewed against minimum pedestrian requirements, safety, etc

STEP 7c: Calculate Capacity and Volume-to-Capacity Ratio
The capacity c_i and volume-to-capacity ratio X_i for each lane group i are calculated using Equations;

$$c_i = BaseSat\left(\frac{g_i}{C}\right)$$

$$x_i = \frac{v_i}{c_i}$$

where
c_i = capacity of lane group i (tpc/h/ln),
v_i = volume for lane group i (tpc/h/ln),
BaseSat = 1,900 for large urban areas (over 250,000 population) and 1,750 otherwise (pc/h/ln),
g_i = effective green time for lane group i (s), and
C = traffic signal cycle length (s).

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For the intersection as a whole, the critical degree of saturation X_c is calculated using following Equations:

$$X_c = \frac{\sum_{i=1}^{n} v_{ci}}{c_{SUM}}$$

$$c_{SUM} = 1{,}900\left(\frac{\sum_{i=1}^{n} g_{ci}}{C}\right)$$

where
X_c = critical degree of saturation (unitless),
v_{ci} = volume for critical phase i (tpc/h/ln),
c_{SUM} = intersection capacity (tpc/h/ln),
g_{ci} = effective green time for critical phase i (s), and
C = traffic signal cycle length (s).

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Step 7: Estimate Delay

The control delay for each lane group d_i is calculated using:

$$d_i = d_1 PF + d_2 + d_{unsig}$$

where

d_i = control delay for lane group i (s/veh),
d_1 = uniform delay (s/veh),
PF = progression adjustment factor (unitless),
d_2 = incremental delay (s/veh), and
d_{unsig} = analyst-provided estimate of unsignalized movement delay, if any (s/veh).

Progression Quality	Progression Factor *PF*
Good (some degree of coordination between the two signalised intersections)	0.7
Average (random arrivals)	1.00
Poor (poor coordination between the intersections)	1.25

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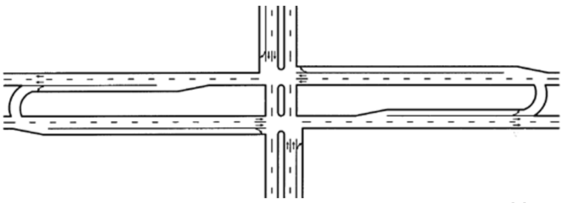
The unsignalised movement delay d_{unsig} is the average delay (if any) for turns at the intersection that are not controlled by a signal head. This delay is usually zero but may be non-zero for situations such as a stop/yield-controlled channelized left-turn lane. It may also be non-zero for alternative intersection concepts, such as Michigan U-turns and others.

The uniform delay d_1 is calculated using the following Equation:

$$d_1 = \frac{0.5C(1 - g/C)^2}{1 - [\min(1, X)\left(\frac{g}{C}\right)]}$$

where

d_1 = lane group uniform delay (s/veh),
C = traffic signal cycle length (s),
g/C = lane group effective green ratio (unitless), and
X = lane group volume-to-capacity ratio (unitless).



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The incremental delay d_2 is calculated as follows:

$$d_2 = 225\left[(X-1)+\sqrt{(X-1)^2+\frac{16X}{c}}\right]$$

where
d_2 = lane group incremental delay (s/veh),
X = lane group volume-to-capacity ratio (unitless), and
c = lane group capacity (tpc/h/ln).

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Step 8: Determine LOS
The LOS for each lane group or for the intersection as a whole is given below on the basis of average control delay. Note that if the volume-to-capacity ratio exceeds 1.0, then the LOS will be F regardless of the control delay.

Control Delay (s/veh)	LOS
≤10	A
>10–20	B
>20–35	C
>35–55	D
>55–80	E
>80 or X > 1.00	F

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Step 9: Estimate Queues

The deterministic average queue for each lane group (i.e., the average queue at the end of red) is determined by dividing the average uniform delay for that lane group by the capacity for that lane group.

$$Q = \frac{d_1 \times c}{3{,}600}$$

where
Q = deterministic average queue for the lane group (tpc/ln),
d_1 = uniform delay for the lane group (s), and
c = per-lane capacity of the lane group (tpc/h/ln).

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- The deterministic average queue for the lane group does not take into account random bunching of traffic arrivals within the analysis period.
- Deterministic average queue multiplied by 2.0 (approximately the ratio of the 95th percentile to the mean for a Poisson process) to obtain an approximation of the 95th percentile longest queue likely to be observed during a traffic signal cycle.
- Equation only applies when the lane group operates under capacity, and, on average, the queue is able to fully dissipate each cycle.
- When a lane group operates over capacity, the difference between the lane group demand and the lane group capacity, divided by the number of lanes in the lane group, provides the number of vehicles per lane not served (i.e., in queue) at the end of the analysis hour.

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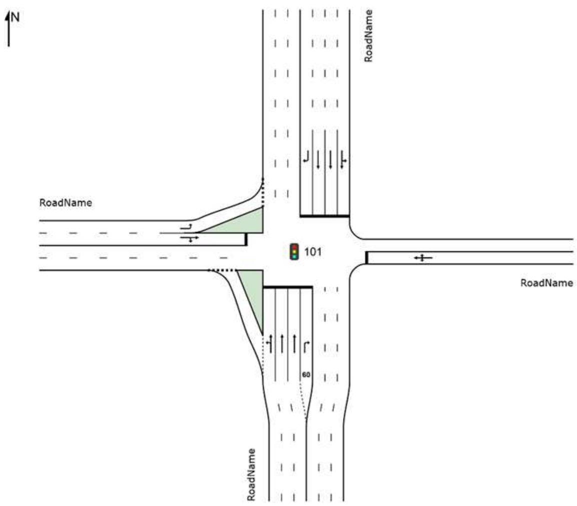
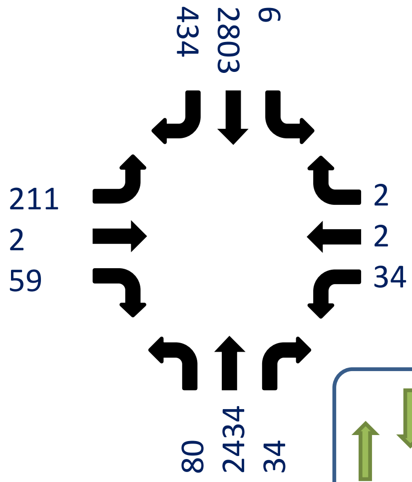
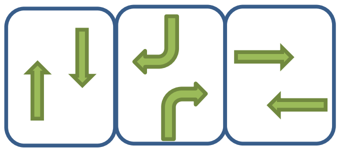




Protected right turn for NB / SB
Permitted right turns for EB WB
Volumes are in pcu's



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Signalised Intersection Planning Method (Part 1), Inputs												
	NB			SB			EB			WB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	80	2434	34	6	2803	434	0	2	59	39	2	2
Lanes			1			1						
	3			3			1			1		
PHF	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
% HV	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Parking Activity												
Ped Activity												
RT Phasing												

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Signalised Intersection Planning Method (Part 1), Inputs												
	NB			SB			EB			WB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
	Step 1: Determine the Right-Turn Phasing											
Check #1			NO			YES			NO			NO
Check #2			YES			YES			NO			NO
Opposing volume			2803			2434			2			2
			95302			1056356			118			4
# Opp Lanes			3			3			1			1
Check #3			YES			YES			NO			NO
			1			1			1			1
Exclusive lane			YES			YES			NO			NO
Opp. Appr			YES			YES			NO			NO
RT phasing												

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ntersections

Signalised Intersection Planning Method (Part 1), Inputs												
	NB			SB			EB			WB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
	Step 1: Determine the Right-Turn Phasing											
Check #1			NO			YES			NO			NO
Check #2			YES			YES			NO			NO
Opposing volume			2803			2434			2			2
			95302			1056356			118			4
# Opp Lanes			3			3			1			1
Check #3			YES			YES			NO			NO
			1			1			1			1
Exclusive lane			YES			YES			NO			NO
Opp. Appr			YES			YES			NO			NO
RT phasing												
	Step 2: Assign Volumes to Lane Groups											
	NB			SB			EB			WB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
	Step 3: Convert Turning Movements to Passenger Car Equivalents											
E_{HVadj}	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
E_{PHF}	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
E_{RT}	1,00	1,00	1,05	1,00	1,00	1,05	1,00	1,00	1,10	1,00	1,00	1,10
E_{LT}	1,20	1,00	1,00	1,20	1,00	1,00	1,20	1,00	1,00	1,20	1,00	1,00
E_{P}	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
E_{LU}	1,10	1,10	1,00	1,10	1,10	1,00	1,03	1,05	1	1,00	1,00	1,00
other	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Flow per lane group												
v_{adj}	106	2677	36	8	3083	456	0	2	65	47	2	2
Lane group flow rate (tpc/h)	2783		36	3091		456		67			51	
Flow per lane group	928		36	1030		456		67			51	
Capacity per lane group	950		428	950		428		333			333	
v/c	0,98		0,08	1,08		1,07		0,202			0,15	
g/C	0,50		0,23	0,50		0,23		0,175			0,18	
Delay d1	29,3		36,7	32,8		47,4		42,3			42,0	
Dealy d2	24,0		0,4	54,9		62,2		1,4			1,0	
Tot delay (sec)	**53,4**		**37,1**	**87,7**		**109,6**		**44**			**43**	
Q (veh)	**28**		**9**	**73**		**26**		**8**			**8**	
LOS	**D**		**D**	**F**		**F**		**D**			**D**	
	Step 4: Calulate Critical Lane Groups											
vc_{EW}	67											
vc_{NS}	1383											
	1450											
	Step 5: Determine Intersection Sufficiency											
v_c/c_i	0,88											
Intersection Sufficiency	Demand for critical movements is just able to be accommodated within a cycle but more oftentimes requires											

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g_{TOT} = 120 – 12 = 108
g_{EW} = 108X(70/1454) = 5,2s (not safe for peds)
g_{NS} = 108X(1384/1454) = 102s

Phasing not practical – manual adjustment and phasing as follows:

Phase a : 63s
Phase b: 29s
Phase c: 16s *(not safe for peds) min say 21s hence phase a and b changes to 60s and 27s but poor LOS*

Capacity for NB,$SB_{TH\,/\,LT}$ = 1029 pcu/hr/ln
Capacity for NB,SB_{RT} = 459 pcu/hr/ln
Capacity for EB,$WB_{TH\,/\,RT/LT}$ = 222 pcu/hr/ln

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Data Category	Input data element
Traffic characteristics	Demand flow rate
	Percent heavy vehicles
	Intersection peak hour factor
	Platoon ratio
	Upstream filtering adjustment factor
	Base saturation flow rate
	Lane utilisation adjustment factor
	Pedestrian flow rate
	On street parking manoeuvres
	Local bus stopping rate
Geometric design	Number of lanes
	Average lane width
	Number of receiving lanes
	Turn bay length
	Presence of on street parking
	Approach grade
Signal control	Type of signal control
	Phase sequence
	Green time
	Yellow time
	Red time
other	Analysis period
	Speed limit
	Stop line detector length and detector mode
	Area type

Data Category	Input data element
Traffic characteristics	Demand flow rate of motorised vehicles
	Pedestrian flow rate
	Bicycle flow rate
Geometric design	Street width
	Number of lanes
	Width of bicycle lane
	Pedestrian crossing width and length
	Corner radius
	Approach grade
Signal control	Pedestrian phase
	Cycle length
	Yellow time
	Red time
Other	Analysis period

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Simplified HCM Method for Two-Way Stop-controlled Intersections

1. Determine and Label Movements and Priorities
2. Convert Movement Demand to Flow Rates
3. Determine Conflicting Flows
4. Determine Critical and Follow-up Headways
5. Calculate Potential Capacities
6. Calculate Movement Capacities
7. Calculate Shared Lane Capacities
8. Calculate Delay Estimation

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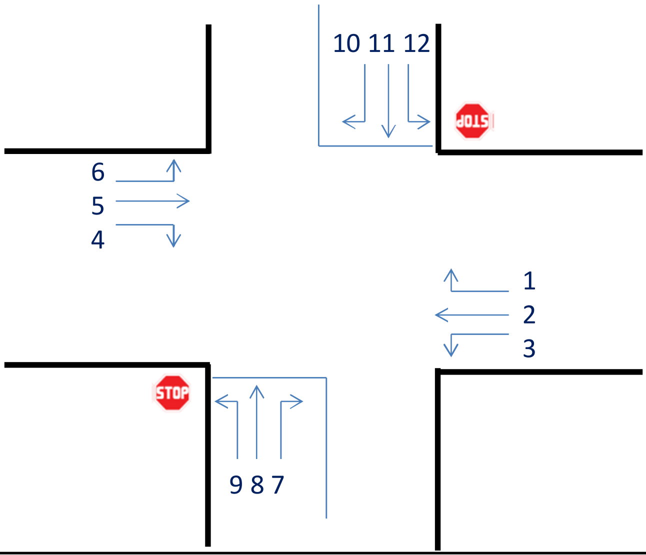
Step 1: Determine and Label Movements and Priorities



Movement priorities

Rank 1 movements – major street through and left turn (2,5,3,6)

Rank 2 movements – major street right turns (1,4)

Rank 3 movements – minor street through movements (8,11)

Rank 4 movements – minor street right turns (7,10)

Control Delay (s/veh)	LOS by Volume-to-Capacity Ratio $v/c \le 1.0$	$v/c > 1.0$
0–10	A	F
>10–15	B	F
>15–25	C	F
>25–35	D	F
>35–50	E	F
>50	F	F

Note: The LOS criteria apply to each lane on a given approach and to each approach on the minor street. LOS is not calculated for major-street approaches or for the intersection as a whole.

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Step 2: Convert Movement Demand to Flow Rates

Movement demand volumes are converted to flow rates

$$v_i = \frac{V_i}{PHF}$$

where

v_i = demand flow rate for movement i (veh/h)
V_i = demand volume for movement i (veh/h), and
PHF = peak hour factor

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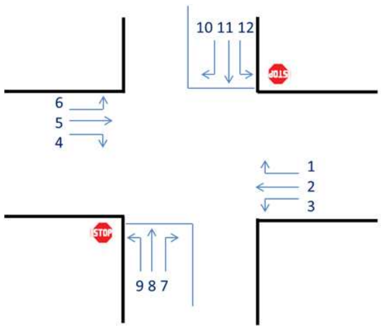
Step 3: Determine Conflicting Flows

Conflicting flows for the major street rights turns (movements 1 and 4) are calculated using Equation :

$$v_{c,1} = v_5 + v_6$$
$$v_{c,4} = v_2 + v_3$$



where

$v_{c,1}$, $v_{c,4}$ = conflicting flow rates for movements 1 and 4, respectively (veh/h), and
v_2, v_3, v_5, v_6 = demand flow rates for movements 2, 3, 5, and 6, respectively (veh/h).

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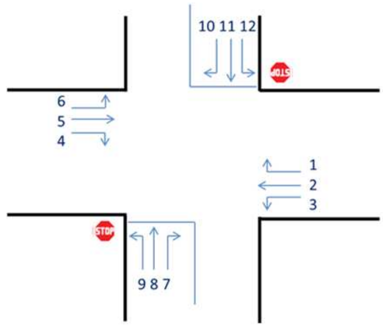
Conflicting flows for the minor street left turns (movements 9 and 12) are calculated using depending on the number of lanes on the major street:



Two-lane major streets:

$v_{c,9} = v_2 + 0.5v_3$

$v_{c,12} = v_5 + 0.5v_6$

Four- and six-lane major streets:

$v_{c,9} = 0.5v_2 + 0.5v_3$

$v_{c,12} = 0.5v_5 + 0.5v_6$

where
vc,9, vc,12 = conflicting flow rates for movements 9 and 12, respectively (veh/h), and
v2, v3, v5, v6 = demand flow rates for movements 2, 3, 5, and 6, respectively (veh/h).

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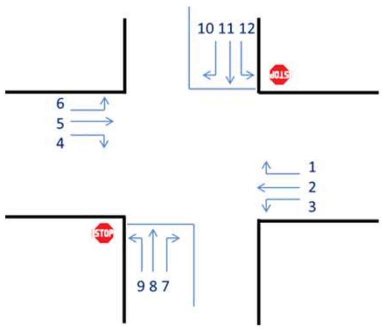
Conflicting flows for the minor street through movements (8 and 11) are calculated using :



$v_{c,8} = 2v_1 + v_2 + 0.5v_3 + 2v_4 + v_5 + v_6$

$v_{c,11} = 2v_4 + v_5 + 0.5v_6 + 2v_1 + v_2 + v_3$

where

$v_{c,8}$, $v_{c,11}$ = conflicting flow rates for movements 8 and 11, respectively (veh/h); and

v_1, v_2, v_3, v_4, v_5, v_6 = demand flow rates for movements 1, 2, 3, 4, 5, and 6, respectively (veh/h).

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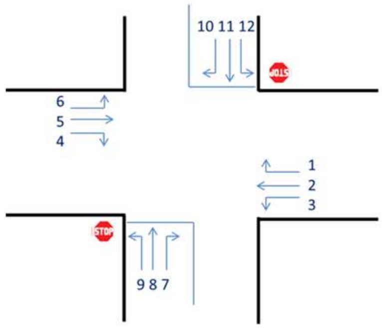
Conflicting flows for the minor street right turns (movements 7 and 10) are calculated depending on the number of lanes on the major street:



Two-lane major streets:

$v_{c,7} = 2v_1 + v_2 + 0.5v_3 + 2v_4 + v_5 + 0.5v_6 + 0.5v_{12} + 0.5v_{11}$

$v_{c,10} = 2v_4 + v_5 + 0.5v_6 + 2v_1 + v_2 + 0.5v_3 + 0.5v_9 + 0.5v_8$

Four-lane major streets:

$v_{c,7} = 2v_1 + v_2 + 0.5v_3 + 2v_4 + 0.5v_5 + 0.5v_{11}$

$v_{c,10} = 2v_4 + v_5 + 0.5v_6 + 2v_1 + 0.5v_2 + 0.5v_8$

Six-lane major streets:

$v_{c,7} = 2v_1 + v_2 + 0.5v_3 + 2v_4 + 0.4v_5 + 0.5v_{11}$

$v_{c,10} = 2v_4 + v_5 + 0.5v_6 + 2v_1 + 0.4v_2 + 0.5v_8$

where

$v_{c,7}$, $v_{c,10}$ = conflicting flow rates for movements 7 and 10, respectively (veh/h); and

v_1, v_2, v_3, v_4, v_5, v_6, v_8, v_9, v_{11}, v_{12} = demand flow rates for movements 1, 2, 3, 4, 5, 6, 8, 9, 11, and 12, respectively (veh/h).

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Step 4: Determine Critical and Follow-up Headways

The critical headway $t_{c,x}$ is calculated for each movement x as follows:

$t_{c,x} = t_{c,base} + t_{c,HV} P_{HV} (+t_{c,G}G - t_{3,RT})$

where

$t_{c,x}$ = critical headway for movement x (s),

$t_{c,base}$ = base critical headway from

$t_{c,HV}$ = heavy vehicle adjustment factor (s) = 1.0 for major streets with one lane in each direction and 2.0 for major streets with two or three lanes in each direction, and

P_{HV} = proportion of heavy vehicles for movement (decimal).

$t_{c,G}$ = adjustment factor for grade (0.1 for movements 9 and 12; 0.2 for movements 7,8,10, and 11) (s)

G = percent grade expressed as an integer e.g. G= -2 for 2% downhill grade

$t_{3,RT}$ = adjustment factor for intersection geometry (0.7 for minor-street right turn at three leg intersection; 0.0 otherwise)

Vehicle movement	Base Critical Headway (s) Number of Lanes on Major Street		
	2	4	6
Major street right turn (1,4)	4,1	4,1	5,3
Minor street left turn (9, 12)	6,2	6,9	7,1
Minor street through movement (8, 11)	6,5	6,5	6,5
Minor street right turn (7, 10)	7,1	7,5	6,4

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The follow-up headway $t_{f,x}$ is calculated for each movement x as follows:

$t_{f,x} = t_{f,base} + t_{f,HV} P_{HV}$

where
$tf_{,x}$ = critical headway for movement x (s),
$t_{f,base}$ = base critical headway from table
$t_{f,HV}$ = heavy vehicle adjustment factor (s) = 0.9 for major streets with one lane in each direction and 1.0 for major streets with two or three lanes in each direction, and
P_{HV} = proportion of heavy vehicles for movement (decimal).

Vehicle movement	Base Follow-Up Headway (s) Number of Lanes on Major Street		
	2	4	6
Major street right turn (1,4)	2,2	2,2	3,1
Minor street left turn (9, 12)	3,3	3,3	3,9
Minor street through movement (8, 11)	4,0	4,0	4,0
Minor street right turn (7, 10)	3,5	3,5	3,8

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Step 5: Calculate Potential Capacities

The potential capacity $c_{p,x}$ for movement x is calculated using Equation

$$c_{p,x} = v_{c,x} \frac{e^{-v_{c,x} t_{c,x}/3600}}{1 - e^{-v_{c,x} t_{f,x}/3600}}$$

where
$c_{p,x}$ = potential capacity for movement x (veh/h),
$v_{c,x}$ = conflicting flow rate for movement x (veh/h),
$t_{c,x}$ = critical headway for movement x (s), and
$t_{f,x}$ = follow-up headway for movement x (s).

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STEP 7: Calculate Movement Capacities

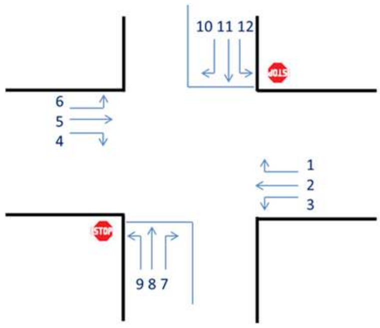
The movement capacities $c_{m,j}$ for the Rank 2 movements j (major street rights turns, movements 1 and 4, and minor street left turns, movements 9 and 12) are calculated using Equation :

$$c_{m,\,j} = c_{p,\,j}$$

where

$c_{m,j}$ = movement capacity for Rank 2 movements j (j = 1, 4, 9, or 12), and

$c_{p,j}$ = potential capacity for Rank 2 movements j.



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The movement capacity for shared major street right turn and through lane

Probability of no queue in the major street shared lane

$$p^{*}_{0,j} = 1 - \frac{1 - p_{0,j}}{1 - x_{i,1+2}}$$

Probability of no queue in major street right turn traffic (j for movements 1, 4)

$$p_{0,j} = 1 - \frac{v_j}{c_{m,j}}$$

Probability of no queue in major street right and through shared lane (j for movements 1, 4)

$$x_{i,1+2} = \frac{v_{i1}}{s_{i1}} + \frac{v_{i2}}{s_{i2}}$$

Combined degree of saturation in major street through and shared right turn lane

s_{i1}, s_{i2} ; major street saturation flow rate of 1800 veh/h and 1500 veh/h for through and right turn movements respectively

v_{i1},v_{i2}: major street through and right turn flow rates respectively

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The movement capacities $c_{m,k}$ for the Rank 3 movements k (minor street though movements 8 and 11) are calculated using Equation:

$$c_{m,i} = c_{p,i}\left(1 - \frac{v_1}{c_{m,1}}\right)\left(1 - \frac{v_4}{c_{m,4}}\right)$$

where
$c_{m,1}$, $c_{m,4}$, $c_{m,8}$ (for i =8), $c_{m,11}$ (for i = 11) = movement capacity for movements 1, 4, 8, and 11, respectively (veh/h),
$c_{p,8}$, $c_{p,11}$ (for i =8 or 11) = potential capacity for movements 8 and 11, respectively (veh/h), and
v_1, v_4 = demand flow rates for movements 1 and 4, respectively (veh/h).

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The movement capacities $c_{m,l}$ for the Rank 4 movements 7 and 10 (minor street right turns) are calculated using Equations:

$$c_{m,7} = (c_{p,7})(p')(p_{0,12})$$
$$c_{m,10} = (c_{p,10})(p')(p_{0,9})$$
$$p_{0,i} = 1 - \frac{i}{c_{m,i}}$$
$$p' = 0.65p'' - \frac{p''}{p''+3} + 0.6\sqrt{p''}$$
$$p'' = \begin{cases} p_{0,1}p_{0,4}p_{0,11}(movement\ 7) \\ p_{0,1}p_{0,4}p_{0,8}(movement\ 10) \end{cases}$$

where
$c_{m,i}$ = movement capacity for movement i (veh/h),
$c_{p,7}$, $c_{p,10}$ = potential capacity for movements 7 and 10, respectively (veh/h),
$p_{0,i}$ = probability of a queue-free state for movement i (decimal),
v_i = demand flow rate for movement i (veh/h), and
p', p'' = adjustments to the impedance created by higher-ranked movements (decimal).

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Step 7: Calculate Shared Lane Capacities

The shared lane capacities c_{SH} *(veh/h)* of the two minor street approaches are calculated as follows:

$$c_{SH} = \frac{\sum_y v_y}{\sum_y \frac{v_y}{c_{m,y}}}$$

where

c_{SH} = shared lane capacity of a minor street approach (veh/h),

v_y = demand flow rate of movement y in the subject shared lane (veh/h), and

$c_{m,y}$ = movement capacity of movement y in the subject shared lane (veh/h).

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Step 8: Calculate Delay Estimation

The average control delay d for a movement is calculated using Equation (for movements ranks 1 to 4

$$d = \frac{3{,}600}{c_{m,x}} + 900T\left[\frac{v_x}{c_{m,x}} - 1 + \sqrt{\left(\frac{v_x}{c_{m,x}} - 1\right)^2 + \frac{\left(\frac{3{,}600}{c_{m,x}}\right)\left(\frac{v_x}{c_{m,x}}\right)}{450T}}\right] + 5$$

where

d = average control delay (s/veh),

v_x = demand flow rate for movement x (veh/h),

$c_{m,x}$ = movement capacity of movement x (veh/h), and

T = analysis time period (h), default = 0.25.

The deterministic average queue for each stop-controlled approach at an intersection is determined by dividing the approaches' average delay by its capacity: $Q_A = 3{,}600\,\frac{d_A}{c_{SH}}$

Q_A = deterministic average queue on approach (veh),

d_A = average approach delay (s/veh), and

c_{SH} = shared lane capacity of a minor street approach (veh/h).

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Compute Control Delay to Rank 1 Movements

The effect of a shared lane on the major-street approach where right-turning vehicles may block Rank 1 through (or possibly left-turning vehicles) can be significant. If no exclusive right-turn lane is provided on the major street, a delayed right turning vehicle may block the Rank 1 vehicles behind it.

$$d_{Rank1} = \begin{cases} \dfrac{(1 - p^*_{0,j}) d_{M,RT} \left(\frac{v_{i,1}}{N}\right)}{v_{i,1} + v_{i,2}} & N > 1 \\ (1 - p^*_{0,j}) d_{M,RT} & N = 1 \end{cases}$$

where
d_{Rank1} = delay to Rank 1 vehicles (s/veh),
N = number of through lanes per direction on the major street,
$p^*_{0,j}$ = proportion of Rank 1 vehicles not blocked
$d_{M,RT}$ = delay to major-street left-turning vehicles (s/veh),
$v_{i,1}$ = major-street through vehicles in shared lane (veh/h), and
$v_{i,2}$ = major-street turning vehicles in shared lane (veh/h).

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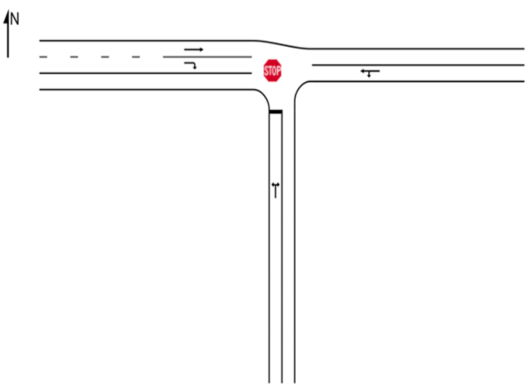

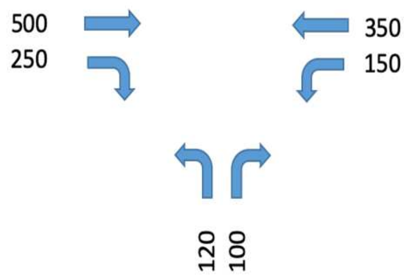

Peak 15 minute volumes as hourly flow rate, 10% heavy vehicles

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Two-Way Stop Control (TWSC) Intersection Planning Method, Input data Worksheet												
	WB			EB			NB			SB		
	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
Movements	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Volume	0	350	150	250	500		100		120	0	0	0
Lanes												
		1		1	1			1				
PHF	1	1	1	1	1	1	1	1	1	1	1	1
Flow rate v_i	0	350	150	250	500	0	100	0	120	0	0	0
Proportion of Heavy vehicles, P_{HV}	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Gradient	0	0	0	0	0	0	0	0	0	0	0	0
$t_{c,G}$	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,2	0,1	0,2	0,2	0,1
$t_{3,RT}$							0,7					
T	*0,25*											

Two-Way Stop Control (TWSC) Intersection Planning Method												
	WB			EB			NB			SB		
	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
Movements	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Flow rate, v_i		350	150	250	500		100		120			
Conflicting flows, v_c				500			1425		425			
Base critical headway, $t_{c,base}$				4,1			7,1		6,2			
$t_{c,HV}$				1			1		1			
Critical headway, $t_{c,x}$				4,2			6,5		6,3			
Base follow-up headway, $t_{f,base}$				2,2			3,5		3,3			
$t_{f,HV}$				0,9			0,9		0,9			
Follow-up headway, $t_{c,x}$				2,29			3,59		3,39			
Potential capacity, $c_{p,x}$				1024			143		612			
$p_{0,i}$				0,756			0,302		0,804			
p''							0,756					
p'				0,000			0,812					
Movement capacity, $c_{m,i}$				1024			116		612			
Shared lane capacity c_{SH}				1024				208				
$v_x/c_{m,x}$				0,24			1,06		1,06			
Control delay, *d (s/veh)*				***9,6***			***126,1***		***126,1***			
LOS				***A***			***F***		***F***			
Queue *(veh)* *Q95*				***1,0***			***9,8***					
Approach control delay, d_A				***3,2***			***126,1***					

$$Q_{95} \approx 900T\left[\frac{v_x}{c_{m,x}} - 1 + \sqrt{\left(\frac{v_x}{c_{m,x}} - 1\right)^2 + \frac{\left(\frac{3{,}600}{c_{m,x}}\right)\left(\frac{v_x}{c_{m,x}}\right)}{150T}}\right]\left(\frac{c_{m,x}}{3600}\right)$$

Q_{95} = 95th percentile queue (veh),
v_x = flow rate for movement x (veh/h),
$c_{m,x}$ = capacity of movement x(veh/h),and
T = analysis time period (0.25 h for a 15-min period) (h).

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1. Covert Demands to Flow Rates
2. Adjust flow rates for Heavy Vehicles
3. Determine Circulating flow
4. Determine Entry Flows
5. Determine capacity of Entry Lane
6. Convert flow rates and capacities to vehicles per hour
7. Calculate v/c Ratios
8. Calculate delay and LOS

Prepare Traffic Impact Assessment Roundabouts, HCM 2016

Step 1: Estimate Flow Rates from Demands
Movement demand volumes are converted to flow rates using the following Equation:

$$v_i = \frac{V_i}{PHF}$$

where
v_i = demand flow rate for movement i (veh/h),
V_i = demand volume for movement i (veh/h), and
PHF = peak hour factor (decimal), default = 0.92.

Control Delay (s/veh)	LOS by Volume-to-Capacity Ratio $v/c \le 1.0$	$v/c > 1.0$
0–10	A	F
>10–15	B	F
>15–25	C	F
>25–35	D	F
>35–50	E	F
>50	F	F

Note: The LOS criteria apply to each lane on a given approach and to each approach on the minor street. LOS is not calculated for major-street approaches or for the intersection as a whole.

Step 2: Heavy Vehicle Adjustment
Demand flow rates in vehicles per hour are adjusted for the presence of heavy vehicles - adjusted flow rates in passenger cars per hour (pc/h).

$$v_{i,pce} = \frac{v_i}{f_{HV}} \qquad f_{HV} = \frac{1}{1+P_T(E_T-1)}$$

where
$v_{i,pce}$ = adjusted flow rate for movement i (pc/h), vi = demand flow rate for movement i (veh/h),
f_{HV} = heavy vehicle adjustment factor (decimal), and
P_T = proportion of heavy vehicles for movement i (decimal); E_T = passenger car equivalent for heavy vehicles

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Step 3: Determine Circulating Flow Rates

$$v_{c,NB,pce} = v_{WBU,pce} + v_{SBR,pce} + v_{SBU,pce} + v_{EBT,pce} + v_{EBL,pce} + v_{EBU,pce}$$
$$v_{c,SB,pce} = v_{EBU,pce} + v_{NBL,pce} + v_{NBU,pce} + v_{WBT,pce} + v_{WBL,pce} + v_{WBU,pce}$$
$$v_{c,EB,pce} = v_{NBU,pce} + v_{WBL,pce} + v_{WBU,pce} + v_{SBT,pce} + v_{SBL,pce} + v_{SBU,pce}$$
$$v_{c,WB,pce} = v_{SBU,pce} + v_{EBL,pce} + v_{EBU,pce} + v_{NBT,pce} + v_{NBL,pce} + v_{NBU,pce}$$

Driving on Right side of road

where
$v_{c,xx,pce}$ = circulating flow rate opposing approach direction xx (pc/h), where xx = NB (north- bound), SB (southbound), EB (eastbound), or WB (westbound), and
$v_{xxy,pce}$ = adjusted flow rate for turning-movement y from approach direction xx (pc/h), where y = U (U-turn), L (left turn), or T (through movement).

$$v_{c,NB,pce} = v_{EBU,pce} + v_{SBR,pce} + v_{SBU,pce} + v_{WBT,pce} + v_{WBR,pce} + v_{WBU,pce}$$
$$v_{c,SB,pce} = v_{WBU,pce} + v_{NBR,pce} + v_{NBU,pce} + v_{EBT,pce} + v_{EBR,pce} + v_{WBU,pce}$$
$$v_{c,EB,pce} = v_{SBU,pce} + v_{WBR,pce} + v_{WBU,pce} + v_{NBT,pce} + v_{NBR,pce} + v_{NBU,pce}$$
$$v_{c,WB,pce} = v_{NBU,pce} + v_{EBR,pce} + v_{EBU,pce} + v_{SBT,pce} + v_{SBR,pce} + v_{SBU,pce}$$

Driving on Left side of road

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Step 4: Determine Entry Flow Rates by Lane

For single-lane entries, the entry flow rate is the sum of all movement flow rates using that entry. For two-lane entries, the following procedure may be used to assign flows to each lane:

- If only one lane is available for a given movement, the flow for that movement is assigned only to that lane.
- The remaining flows are assumed to be distributed across the two lanes, subject to the constraints imposed by any designated or de facto lane assignments and any observed or estimated lane utilization imbalances.
- Five generalised multilane cases may be analysed with this procedure. For cases in which a movement may use more than one lane, a check should first be made to determine what the assumed lane configuration may be. This may differ from the designated lane assignment based on the specific turning-movement patterns being analysed.
- For intersections with a different number of lanes on each approach, the analyst should exercise reasonable judgment in assigning volumes to each lane. On the basis of the assumed lane assignment for the entry and the lane utilisation effect described above, flow rates can be assigned to each lane by using the formulas given in the following slides.

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Assumed (de facto) lane assignments

Designated Lane Assignment	Assumed Lane Assignment
RT, TL	If $v_u + v_R > v_T + v_{L,e}$: R, TL (de facto right-turn lane) If $v_{L,e} > v_U + v_R + v_T$ RT, L (de facto left-turn lane) Else RT, TL
R, RTL	If $v_T + v_{L,e} > v_U + v_R$: R, TL (de facto through - right-turn lane) Else R, RTL
RTL, L	If $v_u + v_R > v_T + v_{L,e}$: RT, L (de facto right-through lane) Else R, RTL

Flow rate assignments for two-lane entries

Case	Assumed Lane Assignment	Right Lane	Left
1	Right, through-left	v_u+v_R	$v_T+v_{L,e}$
2	Right-through, left	$v_U+v_R+v_T$	$v_{L,e}$
3	Right-through, through-left	$(\%RL)v_e$	$(\%LL)v_e$
4	Right, right-through-left	$(\%RL)v_e$	$(\%LL)v_e$
5	Right-through-left, left	$(\%RL)v_e$	$(\%LL)v_e$

$v_U, v_R, v_T, v_{L,e}$ are U-turn, right-turn, through, and no bypass left-turn flow rates using a given entry, respectively
L = left, TL = through-left-, RT = right-through; RTL = right-through-left; R = Right
%RL = % of entry traffic using right lane; %LL = % of entry traffic using left lane; %LL+%RL = 1

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Step 5: Determine Capacity of Entry Lane

The entry lane capacity $c_{e,pce}$ is determined on the basis of the number of entry and conflicting lanes, using the appropriate equation given below.

Entry Lane	Conflicting Lanes	Capacity Equation
1	1	$c_{e,pce} = 1{,}380e^{-(1{,}02\times10^{-3})v_{c,pce}}$
2	1	Both lanes: $c_{e,pce} = 1{,}420e^{-(0{,}91\times10^{-3})v_{c,pce}}$
1	2	$c_{e,pce} = 1{,}420e^{-(0{,}851\times10^{-3})v_{c,pce}}$
2	2	Left lane: $c_{e,pce} = 1{,}420e^{-(0{,}85\times10^{-3})v_{c,pce}}$ Right lane: $c_{e,pce} = 1{,}350e^{-(0{,}92\times10^{-3})v_{c,pce}}$

Note: $c_{e,pce}$ = entry lane capacity (pc/h) and $v_{c,pce}$ = conflicting flow rate for the entry (pc/h).

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STEP 7: Convert Lane Flow Rates and Capacities to Vehicles per Hour

The flow rates and capacities by lane, in passenger cars per hour, are converted back into vehicles per hour using the following Equations:

$$v_j = v_{j,pce} f_{HV}$$
$$c_j = c_{j,pce} f_{HV}$$

where

v_j = demand flow rate for lane j (veh/h), $v_{j,pce}$ = adjusted flow rate for lane j (pc/h),
f_{HV} = heavy vehicle adjustment factor (decimal),
cj = capacity of lane j (veh/h), and
$c_{j,pce}$ = capacity of lane j (pc/h).

Step 7: Calculate Volume-to-Capacity Ratios

The volume-to-capacity ratio x_j for each lane j is calculating using Equation:

$$x_j = \frac{v_j}{c_j}$$

where

v_j = demand flow rate of the subject lane j (veh/h), and
c_j = capacity of the subject lane j (veh/h).

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Step 8: Calculate Delay Estimation

If average control delay is desired to be computed, the volume-to-capacity ratio results from Step 7 are carried forward into

Step 8a: Calculate Average Control Delay per Entry Lane.
each entry lane is calculated using Equation 143.
The average control delay d for each entry lane

$$d = \frac{3,600}{c_{m,x}} + 900T\left[x - 1 + \sqrt{(x-1)^2 + \frac{\left(\frac{3,600}{c_{m,x}}\right)x}{450T}}\right] + 5(\min([x, 1])$$

where

d = average control delay of the subject lane (s/veh), c = capacity of the subject lane (veh/h),
T = analysis period duration (h) (default = 0.25 h),
x = volume-to-capacity ratio of the subject lane, and
$c_{m,x}$ = movement capacity of movement x in the subject lane

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Queuing Analysis

The deterministic average queue Q for each approach at an intersection is determined by dividing the average delay for that approach by the capacity for that approach.

$$Q_A = 3,600\frac{d}{c}$$

where
Q_A = deterministic average queue on approach (veh),
d = average control delay on approach (s/veh), and
c = capacity of approach (veh/h).
The deterministic average queue does not take into account the bunching of vehicle arrivals within the analysis period. An approximate estimate of the stochastic 95th percentile queue can be obtained by multiplying the deterministic average queue by 2.0 (the approximate ratio of the 95th percentile to the mean for a Poisson process).

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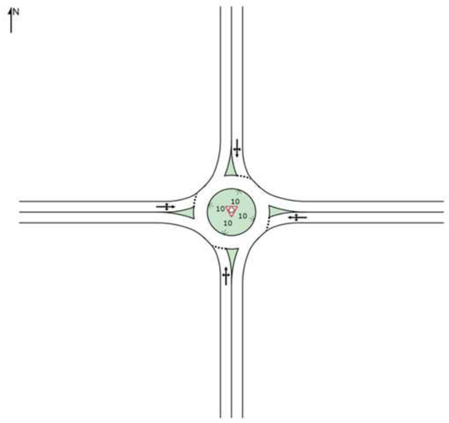

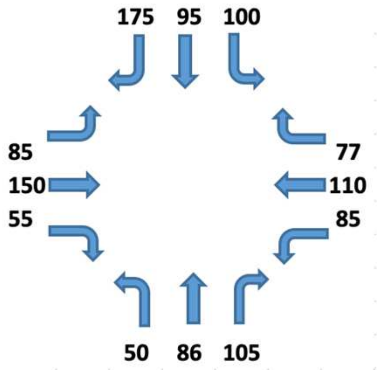

Peak 15 minute volumes as hourly flow rate
2% Heavy Vehicles
PCE Factor 2

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T	0.25											
PCU	2											
Roundabout Planning Method, Input data Worksheet												
	NB			SB			EB			WB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	50	86	105	100	95	175	85	150	55	85	110	77
Lanes	1			1			1			1		
PHF	1	1	1	1	1	1	1	1	1	1	1	1
Proportion of Heavy vehicles, P_T	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
v_i	50.00	86.00	105.00	100.00	95.00	175.00	85.00	150.00	55.00	85.00	110.00	77.00
E_T	2.00	2.00	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
f_{HV}	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
T	0.25											
Roundabout Planning Method												
	NB			SB			EB			WB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Movements	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Flow rate, v_i,pce	51	88	107	102	97	179	87	153	56	87	112	79
Circulating flows, v_c	369			316			273			332		
Entry flows	246			377			296			277		
Entry capacity $c_{e,pce}$	947			1000			1044			984		
Capacity c_j	928			980			1024			965		
Volume-to Capacity Ratio	0.260			0.378			0.283			0.282		
Delay d (s/veh)	**6.5**			**7.8**			**6.3**			**6.6**		
LOS	**A**			**A**			**A**			**A**		
95^{th} Percentile Queue (veh) Q_{95}	**1**			**2**			**1**			**1**		

$$Q_{95} \approx 900T\left[x - 1 + \sqrt{(1-x)^2 + \frac{\left(\frac{3{,}600}{c_j}\right)(x)}{150T}}\right]\left(\frac{c_j}{3600}\right)$$

Q_{95} = 95th percentile queue (veh),
x = volume-to-capacity ratio of the subject lane,
c_j = capacity of the subject lane(veh/h), and
T = time period(h) (T=1 for a 1-h analysis; T=0.25 for a 15-min analysis).

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Prepare Traffic Impact Assessment
Pedestrians - segment, HCM 2016

Pedestrian facilities: Sidewalks – use Urban street methodology

(adapted from the HCM segment method) can be used to quickly evaluate the pedestrian LOS for stretches of urban streets between signalized intersections.
For high pedestrian volume locations (over 1,000 pedestrians per hour), the HCM procedure for evaluating pedestrian space should be used.

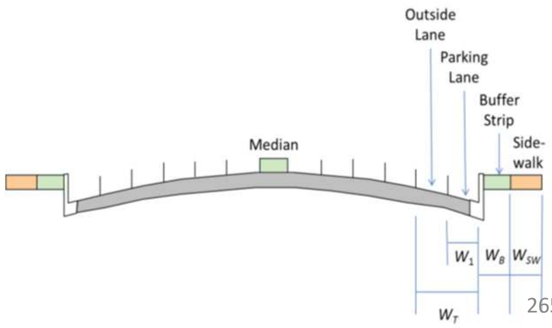
PLOS Score	LOS
≤1.50	A
>1.50–2.50	B
>2.50–3.50	C
>3.50–4.50	D
>4.50–5.50	E
>5.50	F

Source: Adapted from HCM (2016), Exhibit 18-2.

$$PLOS = -1.2276 \ln([f_{LV} W_T] + [0.5 W_1] + [0.5\% OSP] + [f_B W_B] + [f_{SW} W_s]) + \frac{0.0091V}{4N} + (0.0004 SPD^2) + 6.0468$$

where

PLOS = pedestrian level of service score for a segment (unitless),
ln = natural logarithm,
f_{LV} = low volume factor (unitless) = 1.00 if $V > 160$ veh/h and (2.00 – 0.005V) otherwise,
W_T = distance from the inner edge of the outside lane to the kerb (ft)
W_1 = distance from the outer edge of the outside lane to the kerb (ft)
%OSP = percent of segment with occupied on-street parking (percent),
f_B = buffer area coefficient (unitless) = 5.37 if a barrier is provided and 1.00 otherwise,
W_B = buffer width (ft), the distance between the kerb and sidewalk
f_{SW} = sidewalk presence coefficient (unitless) = 6 – 0.3W_S,
W_{SW} = sidewalk width (ft), with a maximum allowed value of 10 ft,
V = directional volume of vehicles in the direction closest to pedestrians (veh/h),
N = number of through lanes of traffic in the direction closest to pedestrians, and
SPD = average vehicle speed between intersections (excluding stops) (mph).



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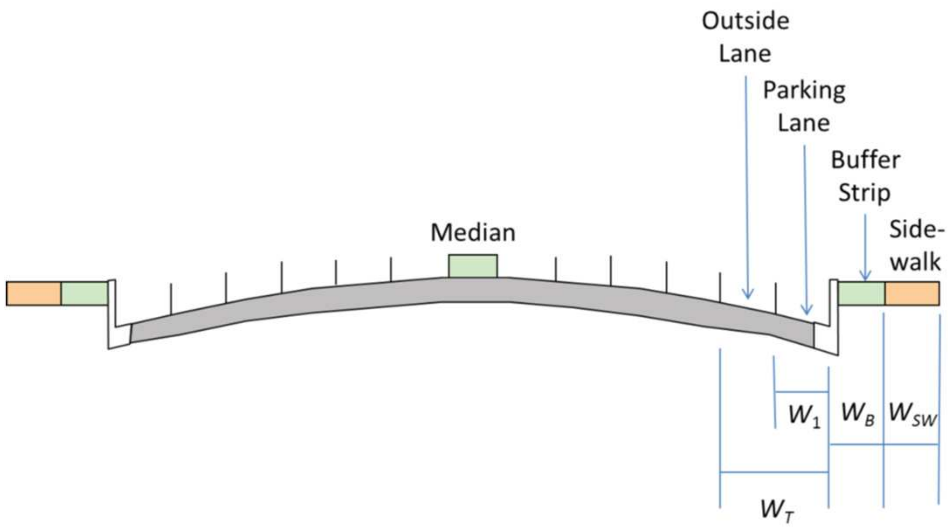
Prepare Traffic Impact Assessment
Pedestrians - segment, HCM 2016



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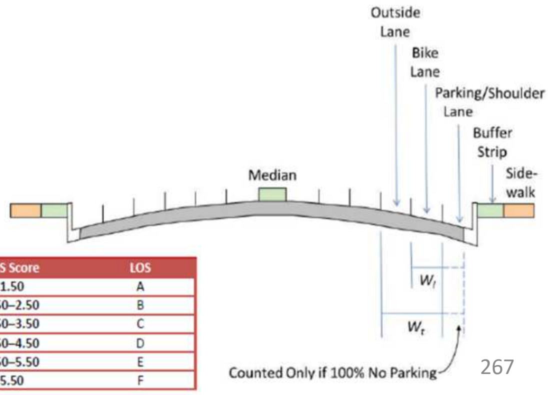
Prepare Traffic Impact Assessment
Bicycle lanes, HCM 2016

Bicycle lanes on Urban streets

$$BLOS = 0.507 \ln\left(\frac{V}{4N}\right) + (0.199 f_s [1 + 0.1038 HV]^2) + \left(7.066 \left[\frac{1}{PC}\right]^2\right) - (0.005 W_e^2) + 0.760$$

BLOS = bicycle level of service score for a segment (unitless),
ln = natural logarithm,
V = directional volume of vehicles in the direction closest to bicyclists (veh/h),
N = number of through lanes of traffic in the direction closest to bicyclists,
f_s = effective speed factor (unitless) = (1.1199 × ln[S – 20] + 0.8103),
HV = proportion of heavy vehicles in the motorized vehicle volume (%),
PC = pavement condition rating, using FHWA's five-point scale (1 = poor, 5 = excellent),
We = average effective width of the outside through lane (ft) = *Wv* – (0.1 × %OSP) if W_l < 4 and *Wv* + W_l – (0.2 × %OSP) otherwise, with a minimum value of 0,
Wv = effective width of the outside through lane as a function of traffic volume (ft) = W_T if *V* > 160 veh/h or the street is divided, and W_T × (2 – 0.005*V*) otherwise,
%OSP = percent of segment with occupied on-street parking (percent),
W_l = width of the bicycle lane and paved shoulder (ft); a parking lane can only be counted as shoulder if 0% occupied and the channel width is not included, and
W_T = width of the outside through lane, bicycle lane if present, and paved shoulder if present (ft); a parking lane can only be counted as shoulder if 0% occupied and the channel width is not included.

BLOS Score	LOS
≤1.50	A
>1.50–2.50	B
>2.50–3.50	C
>3.50–4.50	D
>4.50–5.50	E
>5.50	F



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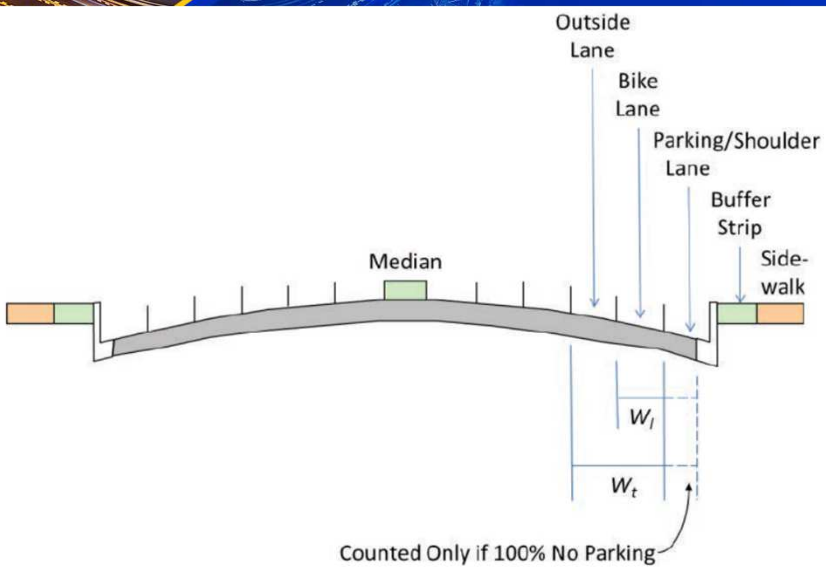
Bicycle lanes, HCM 2016



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Prepare Traffic Impact Assessment
Bicycle lanes, HCM 2016

PC = pavement condition rating, using FHWA's five-point scale (1 = poor, 5 = excellent),

Rating	Description
4.0-5.0	New or nearly new superior pavement. Free of cracks and patches.
3.0-4.0	Flexible pavements may begin to show evidence of rutting and fine cracks. Rigid pavements may begin to show evidence of minor cracking.
2.0-3.0	Flexible pavements may show rutting and extensive patching. Rigid pavements may have a few joint fractures, faulting, or cracking.
1.0-2.0	Distress occurs over 50% or more of the surface. Flexible pavement may have large potholes and deep cracks. Rigid pavement distress includes joint spalling, patching, and cracking
0.0-1.0	Distress occurs over 75% or more of the surface. Large potholes and deep cracks exist.
Notes	
1	If pavement is of uneven quality, these ratings apply to portion of street where most bikes would be (right most lane, bike lane, shoulder).
2	Rigid pavements are portland cement concrete pavements. Flexible pavements are asphalt pavements.

Prepare Traffic Impact Assessment
Pedestrians – exclusive off street walkway, HCM 2016

Pedestrians on exclusive off-street facilities

Not considered part of urban street, excludes facilities located directly alongside urban streets (bicycle lanes, sidewalks)
Pedestrian LOS on an exclusive facility is based on the average space available to pedestrians.
It is calculated using the following three equations:

$$v_{15} = \frac{v_h}{4PHF} \qquad v_p = \frac{v_{15}}{15W_E} \qquad A_p = \frac{S_p}{v_p}$$

where
v_{15} = pedestrian flow rate during peak 15 min (p/h),
v_h = pedestrian demand during analysis hour (p/h),
PHF = peak hour factor,
v_p = pedestrian flow per unit width (p/m/min),
WE = effective facility width (m),
A_p = average pedestrian space (m^2/p), and
S_p = average pedestrian speed (m/min).

Prepare Traffic Impact Assessment
Pedestrians – exclusive off street walkway, HCM 2016

LOS	Average Space (m^2/p)	Related Measures			Comments
		Flow (p/min/m)	Average Speed (m/s)	*v/c* Ratio	
A	>5,6	≤16	>1,30	≤0.21	Ability to move in desired path, no need to alter movements
B	>3,7-5,6	>16-23	>1,27-1,30	>0.21-0.31	Occasional need to adjust path to avoid conflicts
C	>2,2-3,7	>23-33	>1,22-1,27	>0.31-0.44	Frequent need to adjust path to avoid conflicts
D	>1,4-2,2	>33-49	>1,14-1,22	>0.44-0.65	Speed and ability to pass slower pedestrians restricted
E	>0,7-1,4	>49-75	>0,76-1,14	>0.65-1.00	Speed restricted, very limited ability to pass slower pedestrians
F	≤0,7	variable	≤0,76	Variable	Speeds severely restricted, frequent contact with others

Random Flow
Walkways with grades <5%
In cross flow situations, the LOS E-F threshold is 1,2m^2/p

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Prepare Traffic Impact Assessment
Pedestrians – exclusive off street walkway, HCM 2016

LOS	Average Space (m^2/p)	Related Measures	Comments
		Flow Rate (p/min/m)	
A	>49	≤0,15	Ability to move in desired path, no need to alter movements
B	>8-49	>0,15-0,9	Occasional need to adjust path to avoid conflicts
C	>6-8	>0,9-1,8	Frequent need to adjust path to avoid conflicts
D	>2-6	>1,8-3,4	Speed and ability to pass slower pedestrians restricted
E	>1-2	>3,4-5,5	Speed restricted, very limited ability to pass slower pedestrians
F	≤1	>5,5	Speeds severely restricted, frequent contact with others

Platoon adjusted
Walkways with grades <5%
In cross flow situations, the LOS E-F threshold is 1,2m^2/p

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Prepare Traffic Impact Assessment
Pedestrians – exclusive off street walkway, HCM 2016

LOS	Average Space (m²/p)	Related Measures			Comments
		Flow (p/min/m)	Average Speed (m/s)	*v/c* Ratio	
A	>1,9	≤1,5	>1,30	≤0.33	Ability to move in desired path, no need to alter movements
B	>1,6-1,9	>1,5-1,8	>1,27-1,30	>0.33-0.40	Occasional need to adjust path to avoid conflicts
C	>1,1-1,6	>1,8-2,4	>1,22-1,27	>0.40-0.53	Frequent need to adjust path to avoid conflicts
D	>0,7-1,1	>2,4-3,4	>1,14-1,22	>0.53-0.73	Speed and ability to pass slower pedestrians restricted
E	>0,5-0,7	>3,4-4,6	>0,76-1,14	>0.73-1.00	Speed restricted, very limited ability to pass slower pedestrians
F	≤0,5	variable	≤0,76	Variable	Speeds severely restricted, frequent contact with others

Stairways

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Prepare Traffic Impact Assessment
Pedestrians – shared off street walkway, HCM 2016

Pedestrians on a Shared Off-Street Facility

Pedestrian LOS on a shared off-street facility is based on the number of times per hour an average pedestrian meets or is passed by bicyclists using the path. The weighted number of meeting and passing events is calculated as follows:

$$F_q = \frac{Q_{sb}}{PHF}\left(1-\frac{S_p}{S_b}\right) \quad ; F_m = \frac{Q_{ob}}{PHF}\left(1-\frac{S_p}{S_b}\right) \quad ; \quad F = \left(F_p + 0.5F_m\right)$$

where
F_p = number of passing events (events/h), Fm = number of meeting events (events/h),
Q_{sb} = bicycle demand in same direction (bicycles/h),
Q_{ob} = bicycle demand in opposing direction (bicycles/h), PHF = peak hour factor,
S_p = mean pedestrian speed on path (mph), S_b = mean bicycle speed on path (mph), and
F = weighted total events on path (events/h).

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Prepare Traffic Impact Assessment
Pedestrians – shared off street walkway, HCM 2016

LOS	Weighted Event Rate/h	Related Measures	Comments
		Bicycle service flow rate per direction (bicycles/h)	
A	≤38	≤28	Optimum conditions, conflicts with bicycles rare
B	>38-60	>28-44	Conditions good, few conflicts with bicycles rare
C	>60-103	>44-75	Difficult to walk two abreast
D	>103-144	>75-105	Frequent conflicts with cyclist
E	>144-180	>105-131	Conflicts with cyclist frequent and disruptive
F	>180	>131	Significant user conflicts, diminished experience

An "event" is a bicycle meeting or passing a pedestrian

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Prepare Traffic Impact Assessment
Vehicle on urban street segment, HCM 2016

- Urban street segments and facilities
  - Portions of roadways that have traffic signals, stop controlled intersections spaces less than 3.2km (2mi) apart on average
  - Serves multiple travel modes – car, pedestrians, bicycle, public transport
  - Points and links – intersections and roadway between intersections
  - Typically classified as an urban arterial or collector distributor road – typical lengths of 1.6km to 3.2km
  - Through vehicle travel speed used to determine LOS

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Prepare Traffic Impact Assessment
Vehicle on urban street segment, HCM 2016

Urban streets – vehicle level of service

- Any street or roadway with signalised intersections, stop controlled intersections, or roundabouts that are spaced no farther than 2 miles (3,2km) apart can be evaluated using the HCM methodology for urban streets and the procedures described in this section.

1. Calculate running time
2. Calculate downstream intersection capacity
3. Calculate volume-to-capacity ratio
4. Calculate control delay
5. Calculate Travel speeds and LOS

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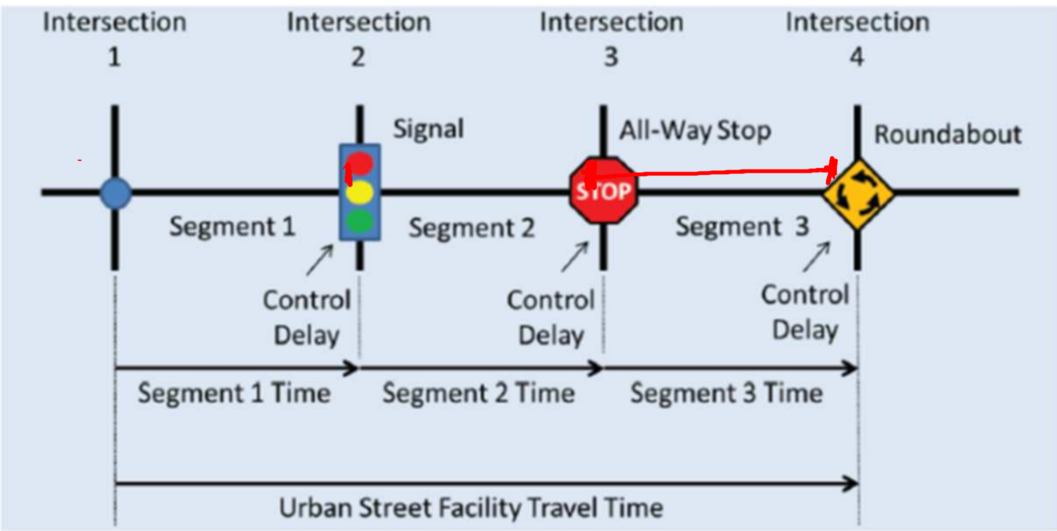
Prepare Traffic Impact Assessment
Vehicle on urban street segment, HCM 2016



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Prepare Traffic Impact Assessment
Vehicle on urban street segment, HCM 2016

Input Requirements

The method requires data for four input parameters:
1. The through movement volume along the segment v_m (veh/h),
2. The number of through lanes on the segment NTH,
3. The segment length L (m), and
4. The posted speed limit Spl (kmph).

Default values are assumed for five other input parameters:
- Through movement saturation flow rate s = 1,900 veh/h/ln,
- Effective green ratio $^g/_c$ = 0.45,
- Traffic signal cycle length C = 120 s,
- Progression quality along the segment = average, and
- Analysais period duration T = 0.25 h.

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Prepare Traffic Impact Assessment
Vehicle on urban street segment, HCM 2016

As a default, the cycle length is assumed to be 120 seconds and the g/C ratio is assumed to be 0.45.
The latter value assumes that the green time is evenly divided between the north–south and east–west intersection approaches and that lost time accounts for ten percent of the cycle length.
The analyst can and should override these defaults based on local knowledge (such as coordination plans).

Step 1: Calculate Running Time
The running time t_R is calculated as follows:

$$t_R = \frac{3{,}600L}{1000.214\left(S_{pl} + UserAdj\right)}$$

where
t_R = running time excluding intersection delays (s),
S_{pl} = posted speed limit (kmph),
UserAdj = user-selected adjustment (kph) to reflect the difference between the facility's posted speed limit and the (base) free-flow speed (default = 8 kmph), and
L = segment length (m).

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Prepare Traffic Impact Assessment
Vehicle on urban street segment, HCM 2016

Step 2: Calculate the Capacity of the Downstream Intersection
The capacity of the downstream intersection is calculated as follows:

$$c = g/C \times N_{TH} \times s$$

where
c = capacity of the downstream intersection (veh/h),
g/C = effective green ratio for the through movement (default = 0.45) (unitless),
N_{TH} = number of through lanes, and
s = saturation flow rate for the through movement (veh/h/ln).

Step 3: Calculate the Volume-to-Capacity Ratio
The volume-to-capacity ratio for the through movement X is calculated as follows:

$$X = \frac{v_m}{c}$$

where
X = volume-to-capacity ratio for the through movement (unitless),
vm = through movement volume along the segment (veh/h), and
c = capacity of the downstream intersection (veh/h).

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Vehicle on urban street segment, HCM 2016

Step 4: Calculate the Control Delay
The control delay d in seconds per vehicle is determined either from the signalized intersection planning method or calculated as described herein.
The uniform delay d_1 is calculated using Equation:

$$d_1 = \frac{0.5C(1 - g/C)^2}{1 - [min(1, X)(g/C)]}$$

where
$d1$ = uniform delay for through vehicles (s/veh),
C = traffic signal cycle length (s),
g/C = effective green ratio for the through movement (unitless), and
X = volume-to-capacity ratio for the through movement (unitless).

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Prepare Traffic Impact Assessment
Vehicle on urban street segment, HCM 2016

The incremental delay d_2 is calculated as follows:

$$d_2 = 225\left[(X-1) + \sqrt{(X-1)^2 + \frac{16X}{c}}\right]$$

where
d_2 = incremental delay for through vehicles (s/veh),
X = volume-to-capacity ratio for the through movement (unitless),
c = capacity of the downstream intersection (veh/h), and
NTH = number of through lanes.

The average control delay d for through vehicles is calculated using Equation :

$$d = d_1 PF + d_2$$

where
d = average control delay for through vehicles (s/veh),
d_1 = uniform delay for through vehicles (s/veh),
PF = progression factor reflecting the quality of signal progression (unitless) from Exhibit 50, and
d_2 = incremental delay for through vehicles (s/veh).

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Prepare Traffic Impact Assessment
Vehicle on urban street segment, HCM 2016

Progression Quality	Progression Factor (*PF*)
Good (some degree of coordination between the two signalized intersections)	0.70
Average (random arrivals)	1.00
Poor (poor coordination between the intersections)	1.25

Step 5: Calculate the Average Travel Speed and Determine Level of Service

The average travel time on the segment TT is calculated using Equation:

$$T_T = t_R + d$$

where
T_T = average though movement travel time (s),
t_R = running time (s), and
d = average control delay for through vehicles (s/veh).

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Prepare Traffic Impact Assessment
Vehicle on urban street segment, HCM 2016

The average travel speed on the segment $S_{T,seg}$ is calculated using Equation

$$S_{T,seg} = \frac{3600 \times L}{1000.214 \times T_T}$$

where
$S_{T,Seg}$ = average travel speed for the through movement (kmph),
L = segment length (m), and
TT = average though movement travel time (s).

LOS	Base Flow-Free Speed (kmp)							
	88,5	**80,5**	**72,4**	**64,4**	**60**	**56,3**	**48,3**	**40,2**
A	>70,8	>64,4	>57,9	>51,5	**>48**	>45,1	>38,6	>32,2
B	>59,5	>54,7	>48,3	>43,4	**>40**	>37,0	>32,2	>27,4
C	>45,1	>40,2	>37,0	>32,2	**>31**	>29,0	>24,1	>20,9
D	>35,4	>32,2	>29,0	>25,7	**>24**	>22,5	>19,3	>16,1
E	>27,4	>24,1	>22,5	>19,3	**>19**	>17,7	>14,5	>12,9
F	≤27,4	≤24,1	≤22,5	≤19,3	**≤18,5**	≤17,7	≤14,5	≤12,9

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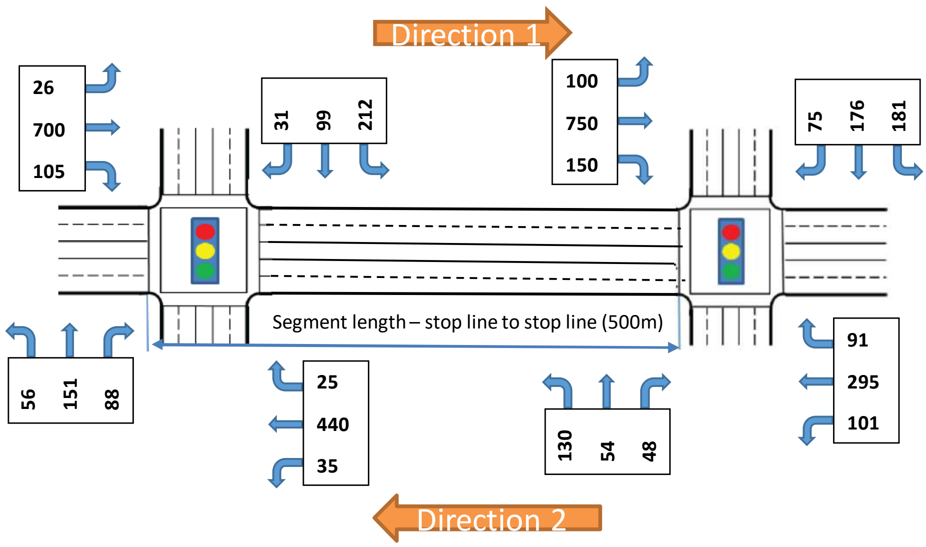
Prepare Traffic Impact Assessment
Example calculation for urban streets



- Cycle Time = 90s
- $^g/_C$ = 0,45
- 5% Heavy vehicles
- On street parking occupancy in direction 1 = 30%
- On street parking occupancy in direction 2 = 5%
- 15-minute analysis period converted to hourly volumes
- Average progression

- **Calculate LOS for the segment for:**
  - **Pedestrians**
  - **Bicycles**
  - **Vehicles**

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Prepare Traffic Impact Assessment
Example calculation for urban streets

- Cross section for the urban street example – applicable to both directions

Sidewalk 3m	Buffer 2m	Shoulder Parking 2.8m Incl 0.3m channel	Bicycle 2m	Travel lane 3.5m	Travel lane 3.5m	median

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Prepare Traffic Impact Assessment
Example calculation for urban streets

Pedestrian LOS calculations

PLOS - Direction 1				
	US Customary		SI Units	
Buffer	6,56	ft	2	m
Channel	0,98	ft	0,3	m
Shoulder Parking	8,20	ft	2,5	m
Travel lane width	11,48	ft	3,5	m
Sidewalk width	9,84		3	m
No. of through lanes	2	no.		
%OSP percent of segment with occupied on-street parking	30%			
Vehicle speed limit	37,3	mph	60	kmph
f_{LV}	1,00			
W_T	20,67		6,3	m
W_1	9,19		2,8	
%OSP	30%			
f_B	1,00			
W_B	6,56		2	
f_{SW}	3,05			
W_S	9,84			
V	1000,00			
N	2,00			
SPD	37,29		60	kmph
PLOS	2,67			
	LOS C			

PLOS - Direction 2				
	US Customary		SI Units	
Buffer	6,56	ft	2	m
Channel	0,98	ft	0,3	m
Shoulder Parking	8,20	ft	2,5	m
Travel lane width	11,48	ft	3,5	m
Sidewalk width	9,84		3	m
No. of through lanes	2,00	no.		
%OSP percent of segment with occupied on-street parking	5%			
Vehicle speed limit	37,3	mph	60	kmph
f_{LV}	1,00			
W_T	20,67		6,3	m
W_1	9,19		2,8	
%OSP	0,05			
f_B	1,00			
W_B	6,56		2	
f_{SW}	3,05			
W_S	9,84			
V	500			
N	2,00			
SPD	37,29		60	kmph
PLOS	2,11			
	LOS B			

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Prepare Traffic Impact Assessment
Example calculation for urban streets

Bicycle LOS calculations

BLOS - Direction 1						BLOS - Direction 2				
	US Customary		SI Units				US Customary		SI Units	
V	1000	veh/h				V	500	veh/h		
N	2					N	2			
Median	Yes					Median	Yes			
Vehicle speed	37,29024	mph	60	kmph		Vehicle speed	37,29024	mph	60	kmph
f_s	4,002174					f_s	4,002174			
HV	5%					HV	5%			
PC	4					PC	4			
Lane width	11,48		3,5	m		Lane width	11,48		3,5	m
On street parking bay width	8,2021	ft	2,5	m		On street parking bay width	8,2021	ft	2,5	m
%OSP	30%					%OSP	5%			
Bicycle lane width	6,56	ft	2	m		Bicycle lane width	6,56	ft	2	m
W_T	11,48	ft	3,50	m		W_T	11,48	ft	3,50	m
W_V	11,48	ft	3,50	m		W_V	11,48	ft	3,50	m
W_l	6,56168	ft	2	m		W_l	6,56168	ft	2	m
$W_v+W_l-(0{,}2x\%OSP)$	17,98462	ft	5,481712	m		$W_v+W_l-(0{,}2x\%OSP)$	18,03462	ft	5,496952	m
W_e	17,98462	ft	5,481712	m		W_e	18,03462	ft	5,496952	m
BLOS	2,837					BLOS	2,477			
	LOS C						**LOS B**			

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Prepare Traffic Impact Assessment
Example calculation for urban streets

Vehicle LOS calculations

Input data	Direction 1	Direction 2
User-selected spped adjustment	8	8
Through movment volume v_m (veh/h)	1000	500
Number of through lanes NTH	2	2
Segment length (m)	500	500
Posted speed limit Spl (kmph)	60	60
Through movement saturation flow rate s (veh/h)	1800	1800
Effective green ratio g/C	0,45	0,45
Cycle length C (s)	90	90
Progression qaulity	1	1
Analysis period T (h)	0,25	0,25
Step 1: Running Time		
Running time (s) $= \frac{3{,}600L}{1000.214(S_{pl}+UserAdj)}$	26,5	27,9
Step 2: Capacity		
$c = g/C \times N_{TH} \times s$	1620	1620
step 3: Volume-to-capacity ratio		
$X = \frac{v_m}{c}$	0,62	0,31
Step 4: Control delay		
$d_1 = \frac{0.5C(1-g/C)^2}{1-[min(1,X)(g/C)]}$	18,8	15,8
$d_2 = 225\left[(X-1)+\sqrt{(X-1)^2+\frac{16X}{c}}\right]$	1,77	0,50
Progression factor PF: 0,70 (good), 1.00(average), 1,25 (poor)		
control delay (s) $d = d_1 PF + d_2$	20,6	16,3
Step 5: Average Travel Speed		
Travel time (s) $T_T = t_R + d$	47,1	44,2
Travel Speed (kmph) $S_{T,seg} = \frac{3600 \times L}{1000.214 \times T_T}$	38,2	40,7
	LOS C	LOS C

Base free flow speed = 68km/h
Interpolate LOS

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Prepare Traffic Impact Assessment Delegates to draft a TIA

Development details:

Address: 117 Flanders Drive, Mount Edgecombe, Durban
Client: Purchased the site and requires a change in land use via special consent application for the purposes of a place of public worship
Existing zoning : Activity zone and the site was developed for use as a gymnasium
Place of worship is included in the special consent land use

Development proposal:
The existing building will be converted into a place of worship for 800 worshipers.

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Prepare Traffic Impact Assessment Delegates to draft a TIA

Development details and information provided:

- Locality plan
- Local area zoning plan
- Zoning development table from land use scheme
- Trip generation rates
- Road classification
- Traffic study area
- Existing intersection layouts
- Traffic counts
- Existing building plans

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Proposed place of worship
Cornubia Mall
Umhlanga Rocks Town Centre
Gateway Mall
Locality plan

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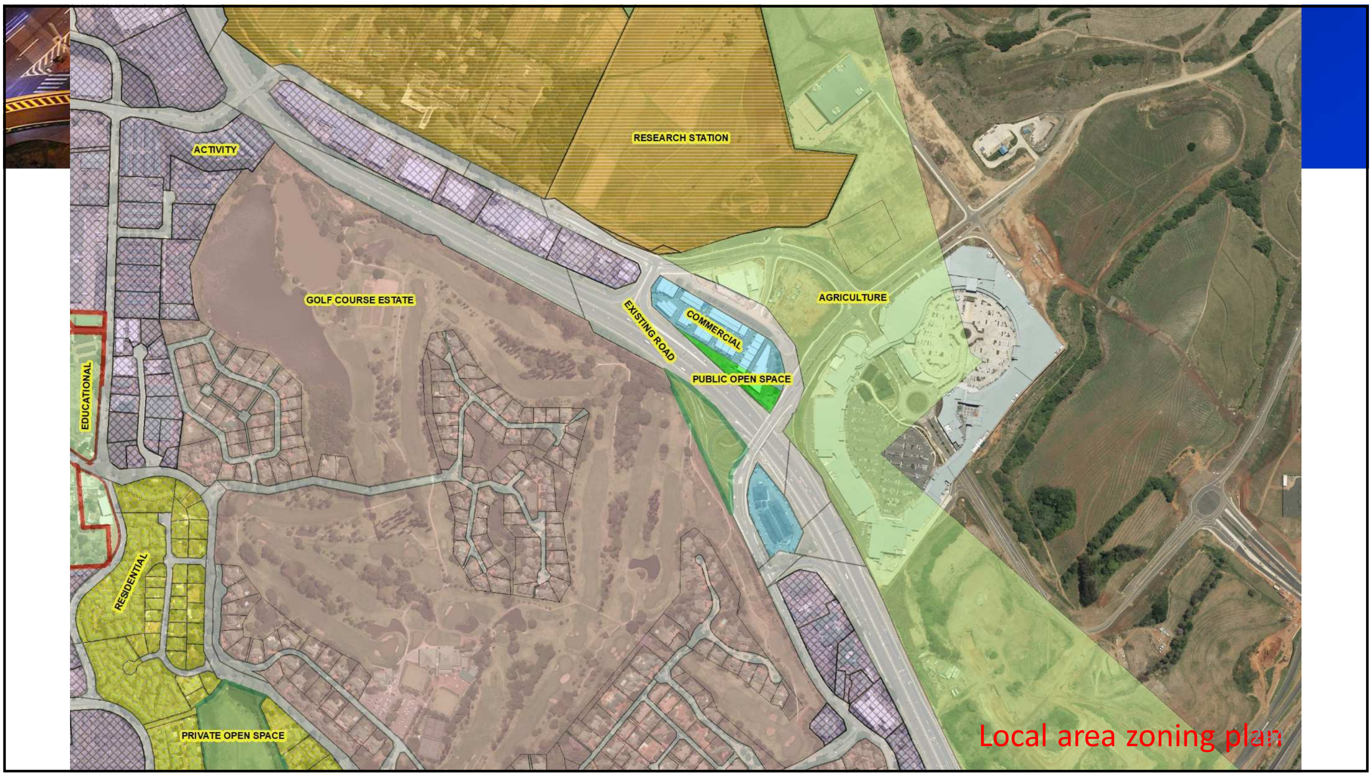
RESEARCH STATION
ACTIVITY
GOLF COURSE ESTATE
AGRICULTURE
EXISTING ROAD
COMMERCIAL
PUBLIC OPEN SPACE
EDUCATIONAL
RESIDENTIAL
PRIVATE OPEN SPACE
Local area zoning plan

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Delegates to draft a TIA

ZONE: ACTIVITY

SCHEME INTENTION: To provide, preserve, use land or buildings that accommodate a wide range of office, warehouse and service activities, including storage and distribution, in such way that the uses contribute towards the creation of a harmonious, well balanced environment of the highest aesthetic, landscaping and urban design quality.

MAP REFERENCE: NS / 05 / 2012 **COLOUR NOTATION:** Light Grey

PRIMARY		SPECIAL CONSENT	PRECLUDED
• Arts & Crafts Workshop • Builders Yard • Car Wash • Convention Centre • Display Area • Dwelling House* • Flea Market • Fuelling & Service Station • Garden Nursery • Health & Beauty Clinic • Health Studio • Industry – Light • Institution • Laundry	• Laundry • Motor Display Area • Motor Vehicle Testing Centre • Motor Workshop • Museum • Office • Office - Medical • Parkade • Place of Public Entertainment • Private Open Space • Public Open Space • Restaurant / Fast Food Outlet • Shop • Warehouse	• Action Sports Bar • Adult Premises • Airport • BTTS* • Betting Depot • Chalet Development • Crèche • Direct Access Service Centre • Educational Establishment • Flat • Funeral Parlour • Government / Municipal • Hotel • Mortuary • Motor Garage • Multiple Unit Development • Nature Reserve • Night Club • Pet Grooming Parlour • Place of Public Worship • Retirement Centre • Special Building • Transport Deport • Truck Stop • Veterinary Clinic	• Agricultural Activity • Agricultural Land • Boarding House • Cemetery / Crematorium • Container Depot • Correctional Facility • Escort Agency • Industry - Extractive • Industry-General • Industry-Noxious • Landfill • Mobile Home Park & Camping Ground • Recycling Centre • Reform School • Refuse Disposal • Restricted Building • Riding Stables • Scrap Yard • Zoological Garden

ADDITIONAL CONTROLS

1. All landscaping to the satisfaction of the Municipality. Open areas not required for parking and vehicular circulation shall be landscaped.
2. A Dwelling House maybe permitted for the use of a caretaker, manager, or security personnel.
3. Increase in Height to 8 storeys where special circumstances exist by Special Consent.
4. BTTS shall mean Base Telecommunications Transmission Station.

DEVELOPMENT PARAMETERS

SPACE ABOUT BUILDINGS		DWELLING UNITS PER HECTARE	MINIMUM ERF SIZE	HEIGHT IN STOREYS	COVERAGE	FLOOR AREA RATIO
BUILDING LINE	SIDE & REAR SPACE					
7. 5 m	3.0 m	Not Applicable	Not Applicable	5*	80 %	4.0

Zoning development table from land use scheme

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Prepare Traffic Impact Assessment
Delegates to draft a TIA

560 Places of Public Worship (Weekend) — **1 Seat**

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.05	0.05					0.65		
% Heavy									
In/Out	55:45	50:50					55:45		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

561 Places of Public Worship (Weekday) — **1 Seat**

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.05	0.05							
% Heavy									
In/Out	50:50	50:50							
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

Trip generation rates

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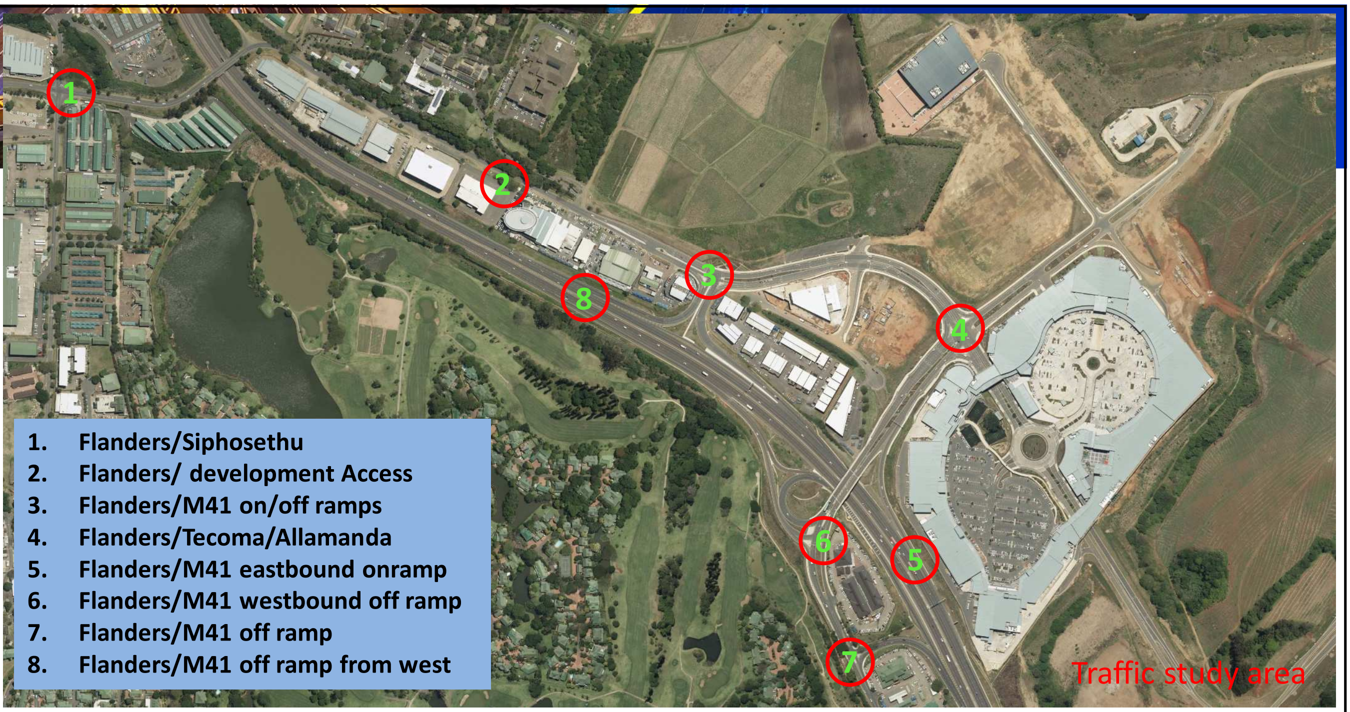

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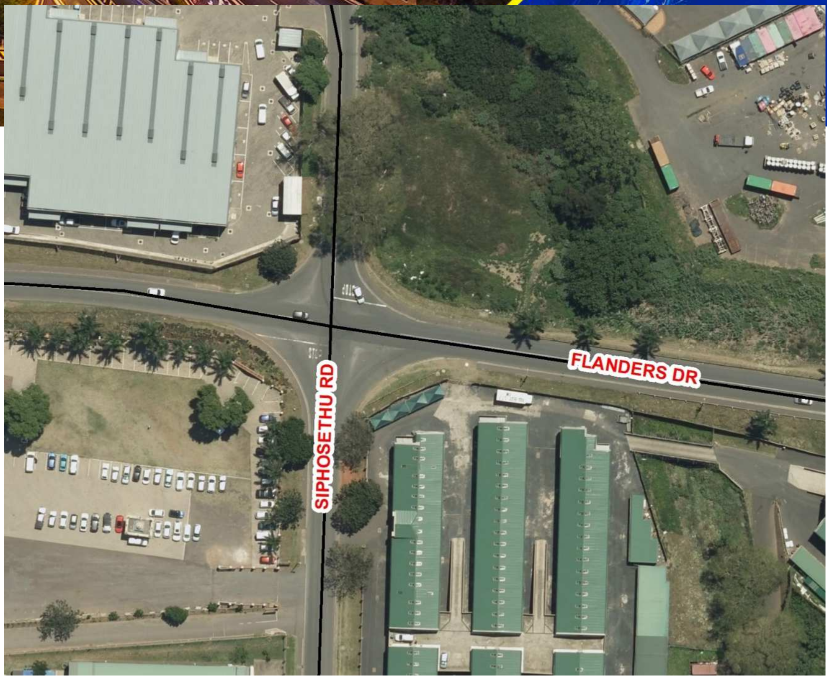

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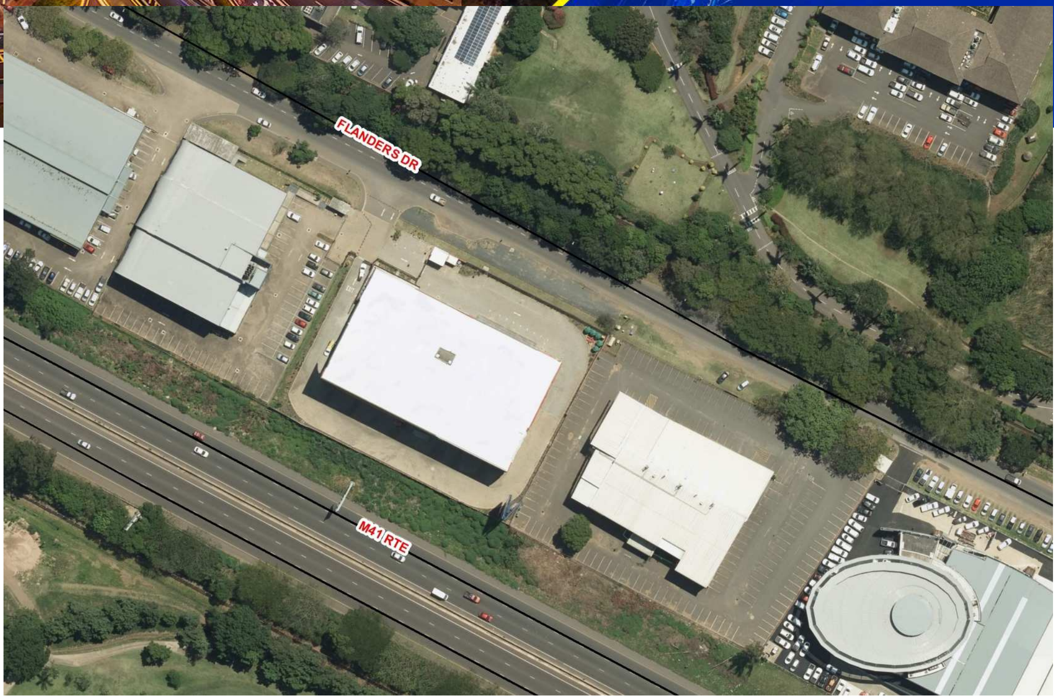

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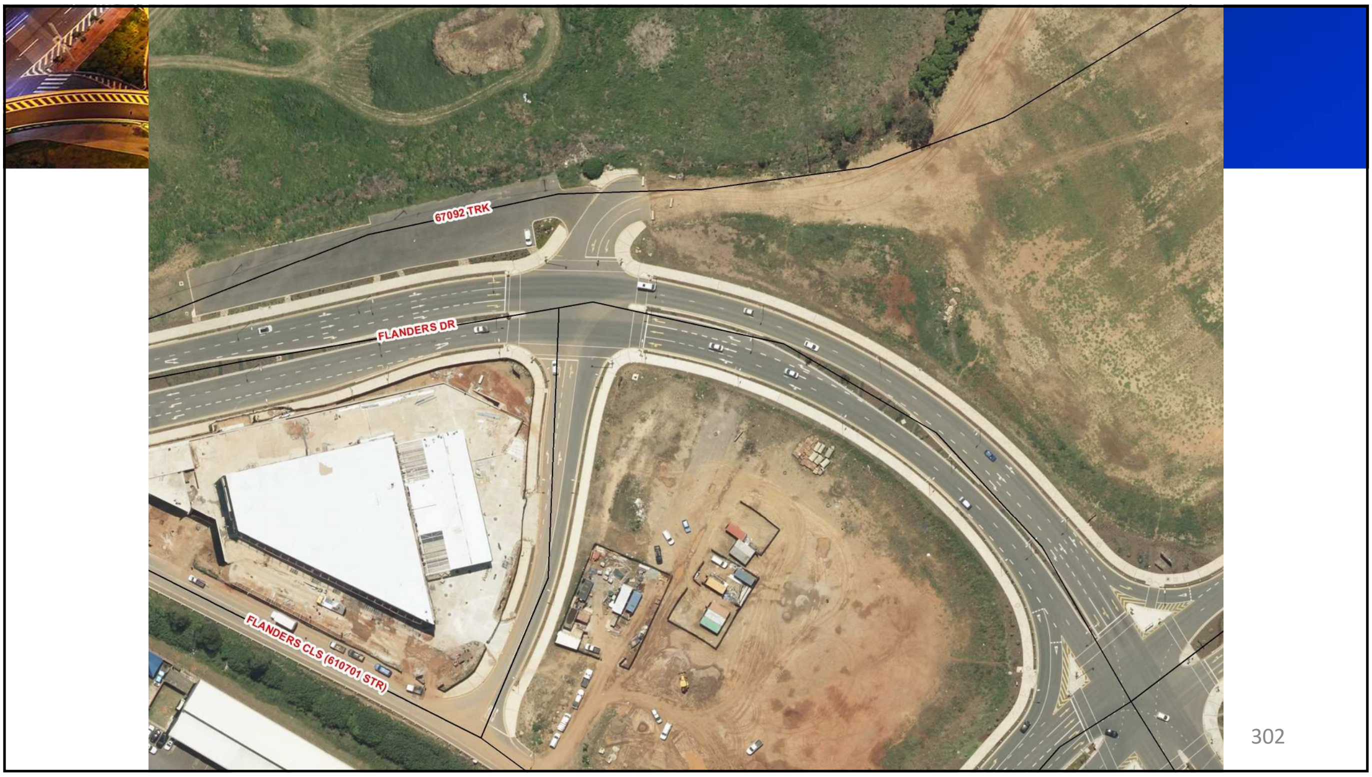
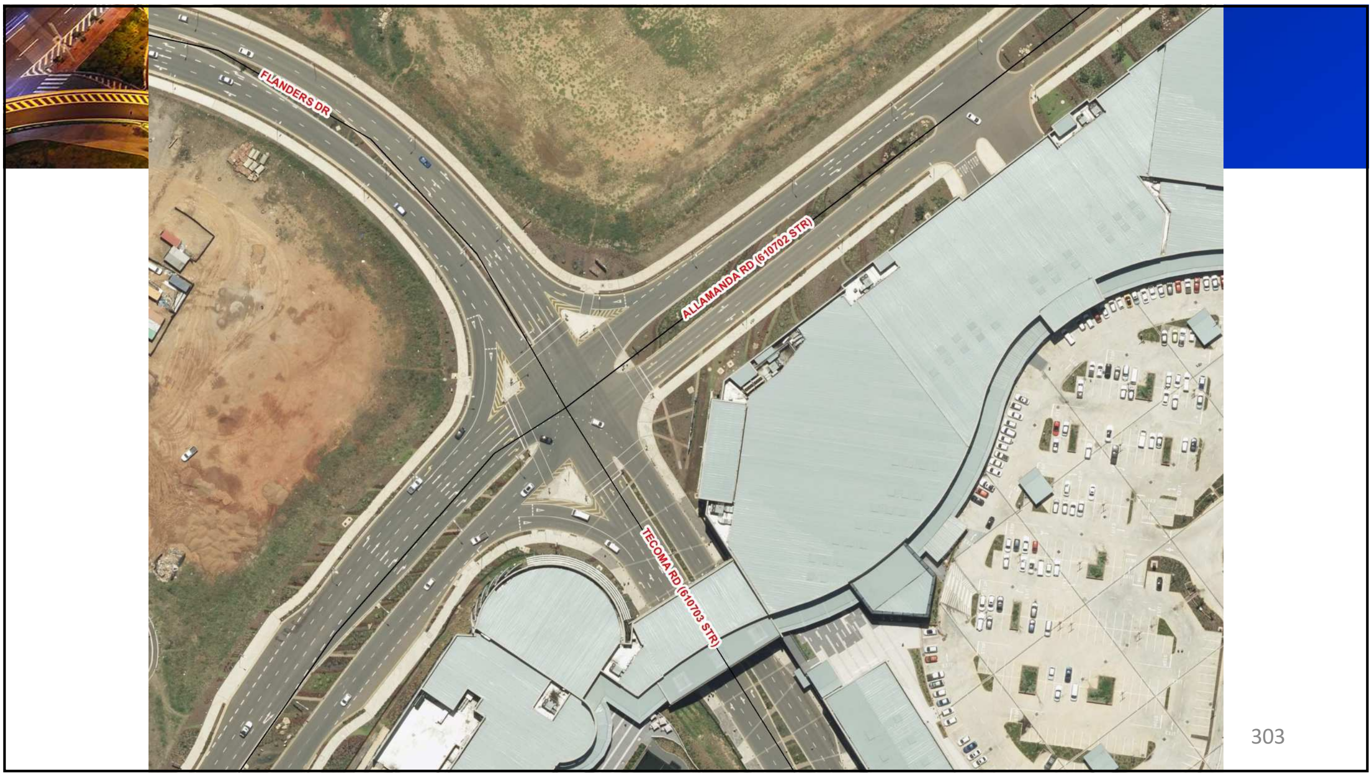
300


67092 TRK
FLANDERS DR
FLANDERS CLS (610701 STR)
M41 RTE
301

301


67092 TRK
FLANDERS DR
FLANDERS CLS (610701 STR)
302

302


FLANDERS DR
ALLAMANDA RD (610702 STR)
TECOMA RD (610703 STR)
303

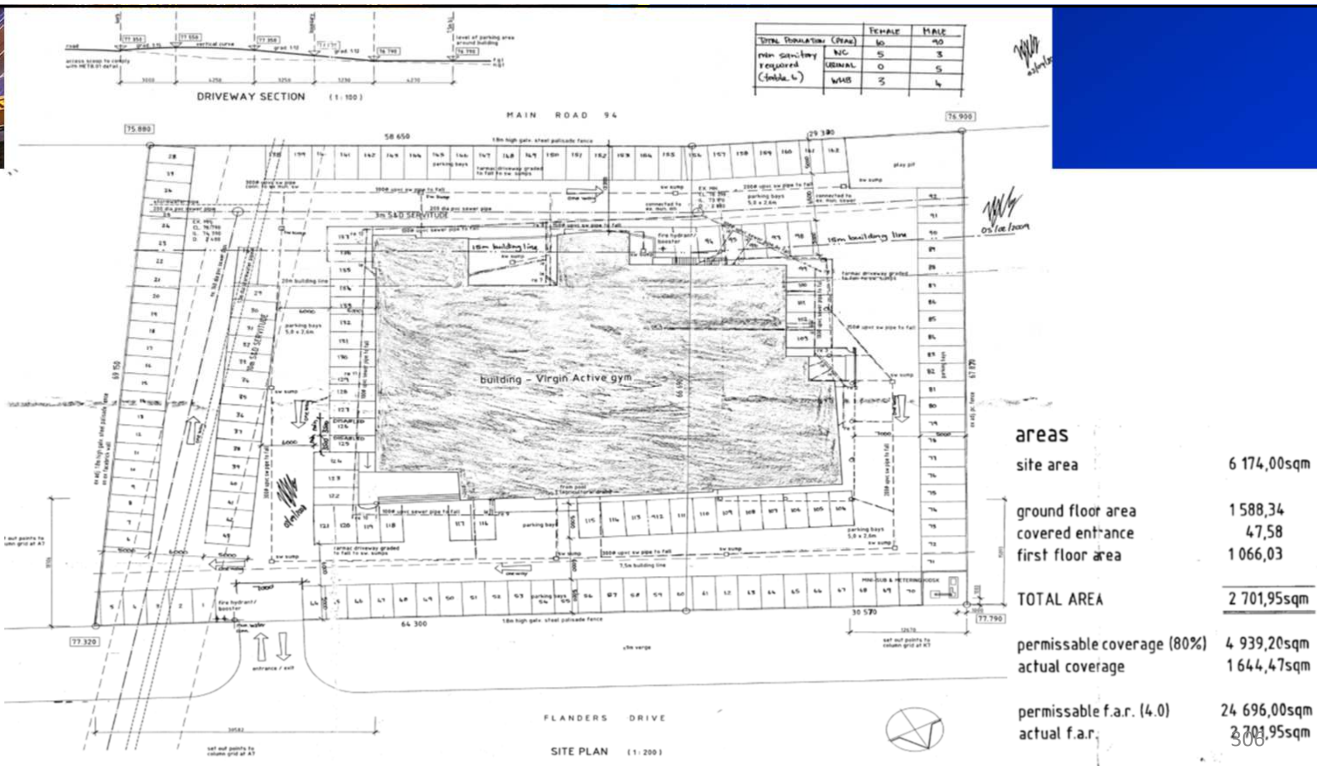
303


FLANDERS DR
67091 TRK
M41 RTE
304

304

305

305



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Size Adjustment Factor
1+A/(1+sqm Size/B)

110 Industrial Area 100sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.80	0.80				0.40			
% Heavy									
In/Out	70:30	25:75				30:70			
PHF Dev									
PHF Street									
Veh Occupancy	1.80								
% Pass-by									
% Diverted									

150 Warehousing and Distribution 100sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.50	0.50				0.15			
% Heavy									
In/Out	60:40	45:55				65:35			
PHF Dev									
PHF Street									
Veh Occupancy	1.50	1.50							
% Pass-by									
% Diverted									

210 Residential Dwelling Units 1 D/Unit

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	1.30	1.30				0.65	0.65		
% Heavy									
In/Out	25:75	70:30				50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

225 Student Apartments and Flats 1 D/Unit

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.30	0.40				0.20	0.20		
% Heavy									
In/Out	25:75	65:35				50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

251 Retirement Village 1 D/Unit

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.35	0.35		0.40		0.20	0.20		
% Heavy									
In/Out	40:60	50:50				50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

254 Old-Aged Home 1 D/Unit

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.15	0.20		0.35		0.30	0.35		
% Heavy									
In/Out	65:35	40:60		50:50		50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

310 Hotel 1 Room

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.50	0.50		0.25		0.70	0.55		
% Heavy									
In/Out	60:40	55:45		50:50		50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

350 Guest House 1 Room

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.45	0.45				0.25	0.25		
% Heavy									
In/Out	50:50	50:50				50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

430 Golf Course 1 Course

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	40.00	50.00				80.00	80.00		
% Heavy									
In/Out	80:20	45:55				50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

473 Casino 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.85	5.00		3.25	6.25	3.00			
% Heavy									
In/Out	75:25	50:50		55:45	50:50	70:30			
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

480 Amusement Park 1 ha

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.50	10.00				47.00	44.00		
% Heavy									
In/Out	85:15	60:40				60:40	45:55		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

488 Sport Stadium 1000 seats

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate		150.00			270.00	170.00			
% Heavy									
In/Out		90:10			10:90	90:10			
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

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492 Health and Fitness Centre 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	5.00	9.50				7.00			
% Heavy									
In/Out	50:50	60:40				50:50			
PHF Dev	0.85	0.85							
PHF Street									
Veh Occupancy	1.10	1.30				1.0			
% Pass-by									
% Diverted									

520 Public School 1 Student

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.80	0.30		0.35					
% Heavy									
In/Out	50:50	50:50		45:55					
PHF Dev	0.55			0.55					
PHF Street									
Veh Occupancy	1.55			1.70					
% Pass-by									
% Diverted									

536 Private School 1 Student

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.90	0.30		0.5					
% Heavy									
In/Out	50:50	50:50		45:55					
PHF Dev	0.55			0.55					
PHF Street									
Veh Occupancy	1.50			1.70					
% Pass-by									
% Diverted									

550 University 1 Student

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.50	0.50		0.50					
% Heavy									
In/Out	80:20	30:70		30:70					
PHF Dev	0.65			0.65					
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

560 Places of Public Worship (Weekend) 1 Seat

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.05	0.05					0.65		
% Heavy									
In/Out	55:45	50:50					55:45		
PHF Dev							0.65		
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

561 Places of Public Worship (Weekday) 1 Seat

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.05	0.05							
% Heavy									
In/Out	50:50	50:50							
PHF Dev		0.65							
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

565 Pre-School (Day Care Centre) 1 Student

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	1.00	0.80		0.30					
% Heavy									
In/Out	50:50	50:50		50:50					
PHF Dev		0.65		0.65					
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

566 Cemetery 1 Ha

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.20	0.20		4.00		8.00			
% Heavy									
In/Out	70:30	35:65		75:25		50:50			
PHF Dev		0.65		0.65		0.65			
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

611 Public Hospital 1 Bed

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	1.50	1.45		1.50		1.00	1.00		
% Heavy									
In/Out	80:20	40:60		40:60		50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

612 Private Hospital 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	1.65	1.50		1.60	1.70				
% Heavy									
In/Out	60:40	40:60		45:55	60:40				
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

620 Nursing Home 1 Bed

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.20	0.20		0.30		0.40	0.35		
% Heavy									
In/Out	70:30	40:60		40:60		50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

630 Medical Clinic 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	6.00	6.00		4.20		7.80			
% Heavy									
In/Out	60:40	40:60		50:50		45:55			
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

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710 Offices — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	2.10	2.10				0.45	0.15		
% Heavy									
In/Out	85:15	20:80				55:45	55:45		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

713 Home offices and undertakings — 1 House

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	6.50	6.50		7.00					
% Heavy									
In/Out	85:15	15:85		50:50					
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

720 Medical consulting rooms — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	8.00	8.00		8.00		3.90	0.45		
% Heavy									
In/Out	55:45	45:55		45:55		60:40	50:50		
PHF Dev									
PHF Street									
Veh Occupancy	1.60			1.50					
% Pass-by									
% Diverted									

770 Mixed Use Development — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	2.50	2.50							
% Heavy									
In/Out	85:15	20:80							
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

780 Conference Centre — 1 Seat

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.50	0.50							
% Heavy									
In/Out	90:10	10:90							
PHF Dev	0.75	0.75							
PHF Street									
Veh Occupancy	1.50	1.50							
% Pass-by									
% Diverted									

812 Building Hardware — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	2.80		5.50			11.00	5.00		
% Heavy									
In/Out	65:35		45:55			50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

817 Nursery (Garden Centre) — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	1.40	3.00	4.10			4.00			
% Heavy									
In/Out	65:35	30:70	50:50			45:55			
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

820 Shopping and Retail Centre — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.60	3.00	3.40			4.50		6.000	3500
% Heavy									
In/Out	65:35	50:50				50:50			
PHF Dev						0.90			
PHF Street									
Veh Occupancy									
% Pass-by			13			12		1.950	48000
% Diverted			29			38			

841 Motor Dealership — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	2.20		2.30	5.10		2.20			
% Heavy									
In/Out	65:35		50:50			45:55			
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

931 Restaurant (Sit-down) — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	0.75	11.80		9.80	9.00	11.00	9.00		
% Heavy									
In/Out	70:30	40:60		60:40	60:40	60:40	60:40		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by		39							
% Diverted		30							

933 Fast Food — 100 sqm GLA

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	45.00	50.00		30.00	55.00				
% Heavy									
In/Out	55:45	55:45		50:50	50:50				
PHF Dev									
PHF Street									
Veh Occupancy					1.65				
% Pass-by		52							
% Diverted		25							

946 Filling Station — 1 Station

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	4% of adjacent streets	4% of adjacent streets	4% of adjacent streets	4% of adjacent streets	4% of adjacent streets	4% of adjacent streets	4% of adjacent streets		
% Heavy									
In/Out	50:50	50:50	50:50	50:50	50:50	50:50	50:50		
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

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950 Vehicle Fitment Centre — 1 Station

Description	AM Peak	PM Peak	Friday PM	Midday	Evening	Saturday	Sunday	Factor A	Factor B
Trip Rate	3.00	4.30				5.20			
% Heavy									
In/Out	65:35	45:55				50:50			
PHF Dev									
PHF Street									
Veh Occupancy									
% Pass-by									
% Diverted									

			Percentage reduction for development in areas with			
	Land Use	Size Units	Mixed-use Development	Low vehicle Ownership	Very low vehicle ownership	PT nodes or Corridors
100	**Industrial**					
110	Industry Area	100 sqm GLA	5%	20%	30%	15%
150	Warehousing and Distribution	100 sqm GLA	5%	20%	30%	15%
200	**Residential**					
210	Residential Dwelling Units	1 D/Unit	10%	40%	70%	15%
225	Student Apartments and Flats	1 D/Unit	25%	50%	80%	15%
251	Retirement Village	1 D/Unit	5%	50%	80%	15%
254	Old-Age Home	1 D/Unit	5%	50%	80%	15%
300	**Lodging**					
310	Hotel	1 Room	20%	20%	30%	15%
350	Guest House	1 Room	20%	30%	50%	15%
400	**Recreational and Sport**					
430	Golf Course	1 Course	5%	0%	0%	0%
473	Casino	100 sqm GLA	5%	20%	30%	15%
480	Amusement Park	1 ha	5%	30%	50%	15%
488	Sport Stadium	1000 Seat	5%	30%	50%	15%
492	Health and Fitness Centre	100 sqm GLA	5%	20%	30%	15%
500	**Institutional**					
520	Public Primary School	1 Student	30%	50%	80%	15%
530	Public Secondary School	1 Student	30%	50%	80%	15%
536	Private School	1 Student	30%	50%	80%	15%
550	University / College	1 Student	20%	40%	60%	15%
560	Places of Public Worship (Weekend)	1 Seat	10%	50%	80%	15%
561	Places of Public Worship (Weekday)	1 Seat	10%	50%	80%	15%
565	Pre-School (Day Care Centre)	1 Student	5%	50%	80%	15%
566	Cemetery	1 Ha	0%	30%	50%	15%
600	**Medical**					
611	Public Hospital	1 Bed	0%	50%	80%	15%
612	Private Hospital	100 sqm GLA	0%	20%	30%	15%
620	Nursing Home	1 Bed	0%	50%	80%	15%
630	Medical Clinic	100 sqm GLA	0%	50%	80%	15%
700	**Office**					
710	Offices	100 sqm GLA	20%	20%	30%	15%
713	Home offices and undertakings	1 House	10%	20%	30%	15%
720	Medical consulting rooms	100 sqm GLA	10%	30%	50%	15%
770	Mixed Use Development	100 sqm GLA	0%	20%	30%	15%
780	Conference Centre	1 Seat	10%	20%	30%	10%
800	**Retail**					
812	Building Hardware	100 sqm GLA	10%	30%	50%	15%
817	Nursery (Garden Centre)	100 sqm GLA	10%	30%	50%	15%
820	Shopping and Retail Centre	100 sqm GLA	10%	30%	60%	15%
841	Motor Dealership	100 sqm GLA	5%	20%	30%	15%
900	**Services**					
931	Restaurant (Sit-down)	100 sqm GLA	10%	10%	15%	15%
933	Fast Food	100 sqm GLA	10%	40%	60%	15%
946	Filling Station	1 Station	0%	0%	0%	0%
950	Vehicle Fitment Centre	100 sqm GLA	0%	0%	0%	0%

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