POLICIES AND GUIDELINES FOR TRAFFIC IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT IN THE CITY OF ANNAPOLIS

INTRODUCTION

The purpose of this document is to establish uniform guidelines for evaluating traffic impacts as part of the development review process for proposed new or an expansion of an existing development requesting access, directly or indirectly or modification of access to the road system in the City. The two main objectives of the Traffic Impact Analysis guidelines are:

- to provide information to potential developers in the City on specific requirements of a traffic impact analysis, and
- to ensure consistency in the preparation and review of such an analysis.

It is believed that such guidelines will help preserve the character and integrity of the road system that are used by vehicles, bicyclists and pedestrians; improve public safety; and maintain the quality of life enjoyed by City residents.

The guidelines outlined in this document are the minimum requirements when a traffic impact analysis is conducted for any proposed development in the City.

Prior to beginning a traffic study, the applicant or designee may submit a Scoping Letter and request the concurrence of the Department of Planning & Zoning. The Scoping Letter specifies the study area, methodology, waiver(s), level of details required for a particular project and other relevant assumptions. Should a scoping meeting be requested, the developer or his/her representative(s) shall submit in writing all issues/concerns to be discussed at the meeting to the Department of Planning & Zoning at least two (2) weeks before the meeting.

There are a number of reasons why traffic impact studies are needed. Traffic impact studies help to:

- to forecast the traffic impacts created by a new development based on accepted practices, not perception.
- to determine improvements needed to accommodate new development
- relate land use decisions with traffic conditions
- identify traffic problems which could affect a developer’s decision on pursuing a proposed project

DEFINITIONS

Average day: A Tuesday, Wednesday or Thursday for most uses. The average day may be a Saturday for uses that have higher peak hour traffic volumes on Saturday rather than mid-week.

Average Daily Traffic: The total traffic volume passing a point or segment of a roadway in both directions during an average 24-hour period.

Capacity: On a roadway link, the maximum number of vehicles which can pass a given point during one hour under prevailing roadway and traffic conditions.

Existing Traffic: In a traffic analysis, current traffic in accordance with recent traffic counts on the current road network.

Gap (critical gap): The median time headway (in seconds) between vehicles in a major traffic stream which will permit side-street vehicles at STOP or YIELD controlled approach to cross through or merge with major traffic stream under prevailing traffic and roadway conditions

Level of service: A qualitative measure describing operational conditions within a traffic stream: generally described in terms of such factors as speed and travel time, delay, freedom to maneuver, traffic interruptions, comfort and convenience, and safety

Mode choice: Estimation of the number of trips made by each possible mode such as auto, transit, walking, etc. to make a trip.

Peak hour: The one-hour period of greatest utilization of a transportation facility; weekdays normally have two peaks, one in the morning and one in the afternoon. It represents the most critical period of operation and the highest typical capacity requirements.

Peak Period: A three-hour or more period during which the transportation facility has significantly increase levels of use, includes the peak hour

Peak Hour of Generator: The single hour of highest volume of traffic entering and exiting a site.

Traffic mitigation: Reduction of traffic impacts on intersections and/or roadways to an acceptable level of service through the modification of the site plan, roadway construction improvements or improvements in the existing traffic control devices.

Traffic Impact: The effect of site traffic on the operations and safety of the road network

Traffic Impact Analysis: A traffic engineering study which determines the potential traffic impacts of a proposed traffic generator. A complete traffic impact analysis will include an estimation of future traffic with and without the proposed generator, analysis of traffic impacts and recommended roadway improvements which may be necessary to accommodate the expected traffic.

Traffic generator: a designated land use (commercial, industrial, residential, office, etc.) or a change in land use that generates pedestrian and/or vehicular traffic to and from the site.

Trip: A one-way movement by a person or a vehicle having an origin and a destination

Trip assignment: Determination of site and non-site traffic that will use each access point and route

Trip distribution: Allocation of the site generated trips to all possible routes to and from the site.

Trip generation: The process of estimating the number of vehicle trips originating from or destined for the uses on a land parcel

Volume-to-Capacity Ration (V/C): A performance measure computed using the ratio of an actual roadway volume to the capacity of a roadway link.

WARRANT FOR A TRAFFIC IMPACT STUDY

A key trigger for conducting a traffic impact study is "trip generation." The trip generation of a proposed development is the number of inbound and outbound vehicle trips expected to be generated by the proposed development during an average day or during a peak period. Per Annapolis City Code Section 22.21.010, a project must have a traffic impact study if:

- The proposed development and/or additions to existing structure is expected to generate four hundred daily trips or more based upon trip generation rates published in the latest edition of the *Trip Generation Manual*, published by the Institute of Transportation Engineers (ITE); or
- There are current traffic problems or issues in the project area, e.g. high traffic accident frequency; or
- The proposed entrances and exits from the site are too close to an intersection

At the discretion of the Director of the Department of Planning & Zoning, a traffic impact analysis may also be required for any other reason, including:

- The presence of any current traffic problems or issues in the project area, e.g. high traffic accident frequency.
- Potential negative impacts on the neighborhood or perceived public safety

The report shall be prepared under the supervision of a registered professional civil engineer (PE) or Professional Transportation Planner (PTP). The report shall be sealed and signed (if applicable). Each section of the guidelines describes how that section in the traffic impact report shall be prepared.

STUDY AND REPORT FORMAT

1) Introduction and Summary
    a) Purpose of report and study objectives

b) Executive summary—site location and study area, description of the proposed development, major findings, conclusions and recommendations

2) Proposed Development
   a) Site Location
   b) Land use and intensity
   c) Site plan of appropriate scale (readable version with access geometries)
   d) Development phasing and timing (if applicable)

3) Study Area
   a) Size of the geographic area of the study
   b) Site accessibility
   c) Land use—existing, approved and anticipated future development

4) Existing Conditions Analysis
   a) Physical characteristics—roadway characteristics, traffic control devices, transit services, pedestrian and bicycle facilities,
   b) Traffic Volume—daily, morning and afternoon peak periods and others as required (including bicycle and pedestrian volume)
   c) Existing Level of service—daily, morning and afternoon peak periods and others as required for each movement
      i) Base roadway and intersection conditions with existing traffic
      ii) Base roadway and intersection conditions with existing and background traffic
   d) Critical Gap in Traffic Flow
   e) Safety

5) Site Generated Traffic
   a) Site Trip Generation
   b) Mode Choice (if applicable)
   c) Trip Distribution
   d) Site Traffic Assignment

6) Total Traffic Analysis
   a) Site access driveways
   b) Future Level of Service Analysis and other Measures of Effectiveness
      i) roadway and intersections with total traffic (existing, background, growth and site generated traffic)
      ii) there should be tables showing existing traffic, future traffic without the proposed development, and future traffic with the proposed development.
      iii) roadway and intersections with total traffic and all programmed improvements and/or proposed improvements, if any
   c) Queue analysis
   d) Traffic control needs, if any

7) Roadway and Intersection Improvements
   a) Site plan/land use techniques

b) Roadway improvements
c) Operational improvements
d) Access management techniques
e) Transportation demand management actions

8) Conclusions

9) Recommendations

10) Appendices
a) Traffic counts
b) Capacity analyses worksheets
c) Traffic signal warrant studies, if applicable

TRAFFIC IMPACT ANALYSIS PROCEDURAL GUIDELINES

1. EXECUTIVE SUMMARY AND INTRODUCTION

An executive summary shall be provided at the front of the report. The purpose of the executive summary is to provide a short synopsis of the important findings and conclusions, The executive summary shall be understandable as a stand-alone document and shall include the following information:

- a description of the site location of the proposed development with regard to the area road network
- a description of the proposed development with respect to the types and sizes of all proposed land uses, construction phasing (where applicable) and proposed access points and their relationship to the areas roadway system
- a discussion of all major findings including existing traffic conditions, programmed roadway/transportation improvements (where applicable), site generated traffic volume, background traffic volume and total traffic volume (site and background)
- Levels of service with and without the proposed development
- any roadway and/or intersection improvements that may be proposed to mitigate any potential negative impacts of the proposed development

The traffic impact analysis report shall begin with a brief introduction and an executive summary. The introductory section shall include:

- state the purpose of the report (who conducted the report and why).
- a discussion of the study objectives.

2. DESCRIPTION OF THE PROPOSED DEVELOPMENT

The description of the proposed development/project must include the following:

- site location
- land use
- site plan

- phasing (where applicable) and timing

SITE LOCATION (VICINITY MAP)
A map showing the project location and the study area in relation to all surrounding roads shall be provided. The map shall show the size of the site (in acres) and the amount of frontage available on all adjacent streets.

LAND USE
All land uses being proposed for the site shall be described in details. All known tenants and types of uses (e.g. medical offices, banks, fast food restaurants, etc) that will be attracted by the development shall be detailed out. The size or intensity of each specific land use must be stated in the appropriate units, for example dwelling units for residential development, square feet of gross building area for commercial uses, etc.

SITE PLAN
The proposed development drawn to an appropriate scale with the following shall be provided:

- site boundary
- location and size of all land uses within the development, if applicable
- adjacent streets
- existing rights-of-way
- pavement cross sections on all adjacent streets
- location and design of all nearby driveways/street intersections
- location and design of all proposed driveways
- parking layout and internal circulation
- building configurations

PHASING AND TIMING
The developer shall provide the expected opening date of the proposed development. If a project is to be built over a period of 5 years or more, a phasing schedule shall also be provided. The phasing schedule shall detail the specific land use; type and size; and expected date of completion of each phase.

3. THE STUDY AREA
This section provides some guidelines regarding the determination of the geographic area (size) of the study. The following shall be described in detail in the report: the existing and future land uses in the study area and the transportation system to the site of the proposed development.

SIZE OF THE GEOGRAPHIC AREA OF THE STUDY
Table 1 defines the general geographic area of the traffic impact for proposed development of various scales. The final size and shape of the study area is dependent on the size and type of the proposed development, the existing and planned roadway system, adjacent and proposed land uses and the presence of natural and/or man-made barriers.

At the request of the developer (with written justification submitted by the developer), the Department of Planning & Zoning may recommend reduction or elimination of roadway(s) or intersection(s) from the study based on minimal impact and/or excessive distance. Distance is considered relative to the impact (size) of the proposed development.

SITE ACCESSIBILITY

The traffic impact report shall contain a description of existing roadway/transportation system in the vicinity of the study area. A special consideration shall be given to all major roads/streets to and from the site. The description must include the following:

- existing traffic volume
- existing operations
- roadway cross sections
- any travel restrictions such as one-way streets, left turn prohibitions
- programmed or planned changes to existing transportation system (new traffic signals, roadway widening and/or extension, bicycle and pedestrian facilities)

LAND USE IN THE STUDY AREA

All current land uses and anticipated future development in the vicinity of the proposed development area shall be described in detail in the report. Any planned project that, due to its location and/or size, will significantly impact future traffic conditions shall be noted. Information on current land uses and future development may be obtained from the Planning & Zoning Office and other City departments.

Table 1. Criteria for Determining the Minimum Study Area

Size of development and phase	Average Daily Trips Generated	Years of Completion (build-out)	Minimum Study Area Size
Small, single Phase	less than 200*	1 year	Site access driveways, adjacent signalized intersections and/or major unsignalized intersections within 1,000 ft
Moderate, single Phase	200-399*	1 year	Site access driveways, adjacent signalized and/or major unsignalized intersections within one-quarter (1/4) miles (minimum)
Large, single phase	400 and greater	1 year	Site access driveways, adjacent signalized and/or major unsignalized intersections within one-quarter (1/4) mile (minimum)
Moderate or large, multi-phase	400 and greater	open year of each phase	Site access driveways, adjacent signalized and/or major unsignalized intersections within one-half (1/2) mile (minimum)

*If a traffic impact study is required by the Director of Planning and Zoning

4. EXISTING CONDITIONS ANALYSIS

The existing conditions provide the basis for comparing traffic impacts of the proposed development. The following must be covered in the analysis of existing conditions: physical characteristics of the existing transportation system, traffic volume counts, level of service, safety, etc.

PHYSICAL CHARACTERISTICS

The analysis of the physical characteristics of the existing transportation system shall include the following:

- location of nearby driveways
- roadway geometric—horizontal and vertical alignments sight distances
- lane configurations at each intersection to be analyzed
- traffic control devices, their locations, types, phasing and time (where applicable)—traffic signals, stop signs etc.
- posted speed limit
- bicycle and pedestrian facilities—bike paths/lanes, sidewalks, transit services—passenger shelters, bus stops, etc.

TRAFFIC VOLUME COUNTS

Existing traffic volume should be based on current count information. Average three- to seven-day machine counts should be used to determine daily and peak volumes along roadway segments and peak hour turning movement counts should be used to determine peak intersection volumes. Counts that are one to three years old must be increased by 4% per year. Counts that are older than three years should not be used. When traffic counts are conducted when schools are not in session (e.g. during the summer months), the AM and PM peak period traffic volume must be increased by 4% and 5% respectively.

Three-day counts should be taken on Tuesdays, Wednesdays and Thursdays. Peak hour turning movement counts should be based on the highest four 15-minute intervals for AM and PM from a 72-hour period of counts. Where the AM and PM peak periods are well-established for a particular intersection(s) as a result of regular traffic volume counts, a. 72-hour period of traffic counts may not be required.

Other peak periods may be specified in addition to, or in place of, the morning/evening peak periods under the following conditions:

- peak period traffic in the study area occurs at different time of the day (noon time, weekdays)
- unusual peaking characteristics of the proposed development (e.g. theater).

Where appropriate, seasonal factors may be used to adjust actual traffic counts with the approval of the Department of Planning & Zoning.

CRITICAL GAP IN TRAFFIC FLOW

The median time headway (in seconds) between vehicles in a traffic stream that determines how difficult or easy side-street vehicles cross through or merge with the main traffic stream must be analyzed for all unsignalized intersections in the study area.

TRANSIT
If vehicle trip reductions are being assumed because of transit services, the following shall be documented: location of bus routes, accessibility to bus stops, frequency of service and hours of operation.

BIKEWAY AND PEDESTRIAN FACILITIES
If vehicle trip reductions are being assumed because of these facilities, the following must be provided: pedestrian/bikeway facilities that connect or are proposed to connect the proposed development to adjacent trip-generation uses. Proximity to these adjacent uses should be within a 10-minute walk or bike ride.

BACKGROUND TRAFFIC
Also called non-site traffic, background traffic volume refers to the amount of traffic that will be on the roadway network in the project area without the proposed development. Graphic illustrations of background traffic shall be provided. Sources of background traffic include:

- a 4% annual growth in traffic to build year, if applicable
- traffic generated by other approved developments
- traffic generated from subdivisions with approved final plats
- traffic generated from subdivisions with approved sketch plans
- existing traffic

EXISTING LEVEL OF SERVICE ANALYSIS
Level of service or capacity analysis shall be done for signalized and unsignalized intersections. The techniques outlined in the latest edition of *Highway Capacity Manual* shall be used.

If a traffic signal is recommended by the study, a warrant study based on the procedures outlined in the latest edition of the *Manual on Uniform Traffic Control Devices* (MUTCD) shall be used.

Computer software that is based on the computational procedures in the HCM may be used. There are two methods of analysis for signalized intersections in HCM: (a) Operational Analysis Method and (b) Planning Analysis Method. Operational Analysis method provides for a full analysis of capacity and the LOS for each lane as well as the intersection as a whole. The Operational Analysis Method shall be used for horizon years up to and including five (5) years. The Planning Analysis Method addresses the status of the intersection with respect to its capacity and it is useful for longer horizon years, six (6) or more years.

A table showing the results of capacity analyses should be included in the report. For signalized intersections, levels of service should be shown with their corresponding control delays for each of the turning movements as well as the weighted average for the intersection as a whole. In the case of unsignalized intersections, the table shall contain levels of service and corresponding control delays in seconds.

A LOS analysis shall be conducted for the following conditions:

- base roadway and intersection conditions with existing traffic
- base roadway and intersection conditions with existing and background traffic

Base roadway and intersections means the existing roadway and intersections conditions and any programmed improvements that will be completed by the end of the horizon year of the proposed development. LOS worksheets shall be provided for the two (2) conditions described above.

5 SITE GENERATED TRAFFIC

Site generated traffic analysis involves the estimation of the general characteristics of the additional traffic that will be generated by the proposed development. In addition to trip generation analysis, other analyses that shall be performed are mode choice, trip distribution and trip assignments.

SITE TRIP GENERATION

Where available, local trip generation rates shall be used. If local trip rates cannot be obtained, the recommended source for site trip generation is the Institute of Traffic Engineers (ITE) Trip Generation. The latest ITE trip generation rates shall be used.

Note that for some land uses, ITE Trip Generation does not have any information, or ITE trip rate is based on limited sample size. In such a situation, other sources may be used. These sources must be justified and documented. The preferred sources include:

- state or county data from comparable development
- other published references
- other trip generation studies for similar developments on similar site

ITE Trip Generation provides data in two forms: the average trip rate, a regression equation. The following steps are recommended for identifying the most correct trip generation estimation:

- Calculate trips based upon both the average rate and equation. If results are close, the question of which to use is irrelevant. If not, go to 2.
- Use equation if there are at least 20 well-distributed data points and the “Y” intercept is near zero. If not, go to 3
- If the correlation coefficient (TV) is 0.75 or higher, use the equation. If not, use the average rate.

Irrespective of the source of trip generation rate, the traffic report shall indicate the sources of trip generation data, including the page number(s), tables, rates/equations used, etc. Any trip generation data used must be reasonable and defensible.

Trip Reduction Factors

Pass-by Trips

The City will allow the assumption of pass-by trips for certain retail and service uses. The recommended allowable percentages outlined in Table 2 are based on data summarized

in ITE publications and other sources. It is important to note that pass-by trips do not affect driveway volumes derived from trip generation rates; it affects only the adjacent street traffic volume. Any other pass-by percentage(s) used and/or any assumption regarding pass-by trips shall be justified and documented.

Table 2. Examples of Recommended Pass-by Percentages

Land Use	**Maximum Pass-by %**
Service Station	60
Convenience Store	60
Fast Food Restaurant with Drive-through	50
Shopping Center	
Smaller than 100,000 Sq. Ft. GFA	50
Larger than 100,000 Sq. Ft. GFA	25

Diverted Trips

Trips that will be diverted from other roadways because of the proposed development shall be considered as new trips.

Multi-use Development

Total trip generation in a multi-use development may be reduced according to the procedures set forth in the latest ITE Trip Generation Handbook. Multi-use development that may qualify for trip generation reduction must have the following characteristics:

a. Must have been planned as a single project
b. Must be at least 100,000 square feet of gross floor area in size
c. Must contain two or more land uses
d. Some trips are between on-site land uses
e. These trips must travel on internal street system to the development
f. A central business district, a shopping center, an office park with retail, and office building with retail, or a hotel with limited retail and restaurant space are not considered multi-use development.

MODE CHOICE

In the ITE Trip Generation, almost all trips are auto-trips since the trip generation data were primarily collected at developments where auto was the primary mode choice. In some cases such as high population density areas, some percentage of trips to and from the proposed development may be made by modes other than auto—on foot, by bicycle or transit. If the assumption is made regarding other mode choices, the report shall indicate the reasonableness of the assumption regarding non-auto trips. Additionally, the report shall document the current travel behavior, availability of transit service and any other relevant data.

TRIP DISTRIBUTION

Trip distribution analysis is concerned with the flow of traffic between trip origins and destinations within the influence area of the proposed development. Trip distribution analysis provides the spatial dimension to trip generation estimates and thereby permits policy analysis with respect to the planning of the transportation networks.

Any one of the following methods may be used for trip distributions of new trips. The method used and the data source(s) must be documented in the report.

- based on the proximity of trip generators and attractions and on existing travel patterns.
- Any trip distribution model of travel behavior—the gravity models, growth factor models, etc.

In cases where the proposed development has several components, the trip distribution analysis shall be completed for each land use. Site trip distribution shall be expressed in percentage for each direction of travel. Graphic representations showing the directional distribution and the percent of turning vehicles shall be provided.

SITE TRAFFIC ASSIGNMENT

This involves the assignment of the projected site traffic onto the area roadway network using the estimated directional distributions estimated. This could be done by multiplying the projected site traffic volume by the percent directional distributions on a particular route. Where less than 100 percent auto usage and/or pass-by trips are assumed, these must be deducted before assigning the estimated traffic onto the road network. A diagram illustrating the site traffic assignments shall be provided.

6. TOTAL TRAFFIC ANALYSIS

Total traffic consists of existing traffic, growth in existing traffic, background traffic, and site generated traffic. Total traffic analysis involves the analysis of the future roadway and intersection traffic conditions, and any roadway improvements and/or traffic management. Total traffic shall be analyzed with respect to the following:

- site access driveway(s)
- level of service and other measures of effectiveness
- traffic safety
- bicycle/pedestrian considerations
- traffic control needs
- roadway improvements/traffic management

Graphical representations showing the assignment of total traffic volume shall be provided.

SITE ACCESS DRIVEWAY(S)

Site access driveway(s) to City, County and/or State road is an intersection and therefore shall be analyzed with respect to traffic operations, capacity and safety. Site access driveway analysis shall be based on total traffic volume including pass-by trips.

The location and design of the site access driveway shall be in accordance to the following guidelines (consult Public Works)

- joint access of adjacent properties shall be considered where adjacent frontages are short (150 ft or less)
- adequate spacing from adjacent street and driveway intersections two-way driveways shall intersect the adjacent roadway at a minimum of 75 to a preferred 90 degree angles
- adequate sight distance, safe, etc.

FUTURE LEVEL OF SERVICE (LOS) ANALYSIS

The future LOS analysis shall be done for signalized and unsignalized intersections. If state and/or county roads are to be impacted by the proposed development, the developer shall satisfy the requirements by the state and/or the county.

A table showing the results of capacity analyses should be included in the report. Within this table, levels of service should be shown with their corresponding delays and reserved capacities for each of the turning movements as well as the weighted average for the intersection as a whole. There should be tables showing existing traffic, future traffic without the proposed development, and future traffic with the proposed development. An additional table is needed if road improvements are required to show the effect of proposed improvements.

The purpose of the future LOS analysis is to relate the roadway geometrics to traffic operations, identify needs and identify alternatives improvements (if necessary) as a result of the proposed development.

Levels of service and capacity analyses shall be done using the procedures described in Section 4.

QUEUE ANALYSIS

Queue analysis is required for all turn lanes for the purpose of estimating queue lengths that need to be accommodated at intersections. Various methods for queue analysis may be used.

TRAFFIC SAFETY

Various elements of the site plan and any recommended improvements must be reviewed in relation to pedestrian, bicycle and vehicular safety. Attention must be given to elements such as sight distance; length of turning lanes; and the location, alignment, width and radii of access driveways.

PEDESTRIAN SAFETY

The design of access driveways and/or intersections must ensure that pedestrian traffic can be accommodated safely and efficiently, especially in developed areas and/or locations near schools. Pedestrian considerations may include crosswalks if warranted, raised median island and pedestrian display and actuation at signalized intersections.

TRAFFIC CONTROL NEEDS

If there is a need for traffic control(s) such as signal or other traffic controls, the appropriate type and location of the needed traffic control(s) shall be described in the report. Any proposed stop-controlled intersection must operate at a satisfactory level of service and be designed to operate in a safe manner. If a new traffic control signal is proposed, the location must meet the signal warrants as described in the latest edition of the *Manual on Uniform Traffic Control Devices* (MUTCD).

7. ROADWAY AND INTERSECTION MITIGATION OR IMPROVEMENTS

Mitigation means the construction and/or funding of roadway and/or improvements to off-site road facilities by the developer. Any mitigation plans shall be developed in consultation with the Director of Planning & Zoning and shall be reviewed by the Planning Commission.

Improvements are required if the roadway, the intersection and/or a particular movement will operate below LOS D or worse with the proposed development. Under this condition, the roadway and/or intersection improvements shall bring the level-of-service to at least LOS D.

Improvements will be required if the roadway and/or intersection will operate at LOS E or F for the horizon year(s) without the proposed development, and will be even worse with the proposed development. In this case, the proposed mitigation shall aim to maintain the same level of delay and ensure safety.

In circumstances where mitigation would have a negative impact on the characteristics (historical, environmental or unique urban) which served as the basis for declaring an intersection (s) constrained, mitigation needed to pass the test for adequate road facilities on a constrained road facility shall increase the capacity on the constrained facility to the fullest extent possible without negatively impacting the characteristic(s) which caused the road facility to be constrained.

If the roadway and/or intersection being considered for mitigation is owned by another jurisdiction such as State Highway Administration or Anne Arundel County, the operating agency will be the deciding agent in this procedure. The City of Annapolis will offer a finding that the operating agency concurs with the mitigating improvement(s) being proposed by the applicant.

Mitigation measures may include any roadway and/or intersection capacity improvements except grade separation of the roadways and ramps within the intersection or improvements to through lanes of intermediate arterials and higher classified roads. Under certain circumstances, mitigation measures may include Transportation Demand Management (TDM) strategies to reduce vehicle trips.

Mitigation techniques may include, but are not limited to the following:

1) Transportation Demand Management (TDM) strategies

- carpools
- vanpools
- transit services
- shuttle system
- pedestrian/bicycle systems within mixed use developments
- modified work schedules
- employee transportation coordinator

2) Site Plan/Land Use Techniques
   - reduce project size
   - modify project phasing, if any
   - increase driveway queuing
   - revise internal circulation
   - pedestrian and /or bicycle circulation
   - revise vehicle/truck access or circulation

3) Roadway Improvements
   - construct a by-pass lane
   - pave roadway
   - realign street
   - improve sight distance
   - intersection improvements
   - add deceleration/acceleration lanes
   - add a traffic signal if warrants/spacing criteria are met
   - add a median crossover

4) Operational Improvements
   - change signal timing or phasing
   - improve signal progression
   - reduce peak hour trips through use of transit
   - off-peak shift changes (demand management)
   - time of day lane changes

5) Access Management Techniques
   - increase driveway spacing from intersections relocate driveway(s) or intersection(s)
   - reduce number of driveways
   - install a median
   - develop a service road system
   - share access with adjacent land

8. CONCLUSIONS

The report shall include conclusions for the analysis of existing and future conditions and road improvements to mitigate any negative impacts of the proposed development.

9. APPENDICES, TABLES

The following materials in the appendices must be included in the report:

- traffic counts
- unsignalized and signalized intersection analysis
- traffic signal warrant studies (if applicable)

All tables and figures must be legible. The following figures and table may be included in the report.

Suggested Tables and Figures

Table or Figure	**Description**
Site Location	A map showing site location of the proposed development
Site Plan	A map of the site showing all access points
Existing transportation system	A map of the existing roadway network servicing the site. The map shall show all streets/roads adjacent to the site and site boundaries
Existing and background development	A map showing all existing and background development
Existing peak period turning volumes	A map showing current peak period turning movements
Future transportation system	A map showing anticipated transportation network
Accident collision diagram(s)	Diagram(s) showing historical patterns of accidents
Estimated site traffic generation	A table of estimated site trip generation by each land use component with inbound and outbound traffic
Directional distribution of site traffic	Map or table showing the percentage distribution of site traffic approaching and departing the area on each roadway
Site traffic	A map showing the peak period turning traffic volumes generated by the proposed development in the study.
Background traffic	A map or table showing the peak period turning traffic volumes for background traffic without the proposed development within the study area
Total traffic	A map or table showing total traffic (site and background traffic) within the study area
Levels of service analysis	Figures or tables showing levels of service with their corresponding delays and reserved capacity for intersections, roadway sections and/or individual
Recommended improvements	A map or table showing all recommended mitigation measures for roadway and/or intersection improvements.

LEVEL OF SERVICE DEFINITIONS FOR SIGNALIZED INTERSECTIONS

Level of Service (LOS) at signalized intersections are defined in terms of average control delay per vehicle, (also called signal delay). Control delay includes initial deceleration delay, queue move-up time, stopped delay and final acceleration delay. Delay is a measure of driver discomfort, frustration, fuel consumption and lost of travel time. Delay is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio (the amount of green time given to an approach) and the v/c ratio for the lane group.

LOS A: Describes operations with very low average control delay, up to 10 sec. per vehicle. This occurs when progression is very extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

LOS B: Describes operations with control delay greater than 10 seconds and up to 20 seconds per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of average delay.

LOS C: Describes operations with control delay greater than 20 seconds and up to 35 seconds per vehicle. This higher delays may result from fair progression, longer cycle lengths or both. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, though may still pass through the intersection without stopping.

LOS D: Describes operations with control delay greater than 35 and up to 55 seconds per vehicle. At level D, the influence on congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high v/c ratio. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

LOS E: Describes operations with control delay of greater than 55 and up to 80 seconds per vehicle. This level is considered by many agencies to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent occurrences.

LOS F: Describes operations with control delay in excess of 80 seconds per vehicle. This level, considered to be unacceptable to most drivers, often occurs when arrival flow rates exceed the capacity of the intersection. It may also occur at high v/c ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing factors to such delay levels.

LEVEL OF SERVICE DEFINITIONS FOR UNSIGNALIZED INTERSECTIONS

Unsignalized intersections include two-way stopped-controlled (TWSC) and all-way stopped-controlled (AWSC) intersections. The 1997 *Highway Capacity Manual* provides qualitative and quantitative descriptions of the various service levels associated with an unsignalized intersections.

LOS A: Describes operations with average control delay per vehicle of up to 10 seconds. Nearly all drivers find freedom of operation. Very seldom is there more than one vehicle in queue.

LOS B: The average control delay per vehicle on the minor street is greater than 10 seconds and up to 15 seconds. Some drivers begin to consider the delay inconvenience. Occasionally, there is more than one vehicle in queue.

LOS C: Describes operations with average control delay of greater than 15 seconds and up to 25 seconds. Many times there is more than one vehicle in queue. Most drivers feel restricted, but not objectionably so.

LOS D: Describes operations with average control delay of greater than 25 seconds and up to 35 seconds. Often there is more than one vehicle in queue and drivers feel quite restricted.

LOS E: Describes operations with average control delay of greater than 35 seconds and up to 50 seconds. This level of service represents a condition in which demand is near or equal to the probable maximum number of vehicles that can be accommodated by the movement. There is almost always more than one vehicle in queue and drivers find the delays approaching intolerable levels.

LOS F: Describes forced flow operations with average control delay of greater than 50 seconds. This represents an intersection failure condition that is caused by geometric and/or operational constraints external to the intersection.

Source: 1998 *Highway Capacity Manual, Special Report 209* by Transportation Research Board, Washington, D.C.