

## GENERAL INFORMATION

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5-1.000

### A. Major Issues Addressed in Transportation Analysis

The TIMA document will address such issues as:

1. The current transportation system and operational characteristics in the site vicinity,
2. The interface between the on-site circulation system and the adjacent circulation system,
3. The intensity and character of the development,
4. Trip generation,
5. Distribution and assignment estimates, and
6. Impacts of the development on the existing and planned transportation systems.

### B. Study Timing

A Transportation Impact and Mitigation Analysis (TIMA) may be required for general plan amendment, rezoning, and use permit applications. The need for, and extent of, the study shall be based on the criteria described in this guide and any analysis provided in previous applications. Whatever level of analysis is required, studies shall be submitted in final form prior to scheduling a development proposal for public hearing.

### C. Study Preparation Process

The study preparation process should include open discussions between the applicant, the study consultant, and city of Scottsdale staff. Therefore, project discussion should begin when the application for the development is initiated, not after a development plan is finalized and a traffic study completed. This will ensure that the objectives of both the land owner/developer and the city can be met.

After a pre-application meeting, issues and process will be determined and discussed at a joint meeting with staff members from the city's Planning and Transportation Departments. Members from these departments, representing a "Development Review Team" will determine if any at-large issues are affected by the proposal. The Transportation Department Staff and the Project Coordination Manager will establish a timetable and oversee the TIMA document preparation process. A meeting will be arranged to review the scope of the work and the proposed timetable for completion.

Once the TIMA document is completed it will be submitted to the city for review. The document will be reviewed for completeness and compliance with TIMA Guidelines within five working days. This completeness review will only determine if all required information and analysis has been provided. It will not assess the quality of the submitted report or its findings. If the document is determined to be complete, a meeting will be scheduled to review the report and findings with the applicant. Transportation staff will conduct a thorough review of the document and prepare a summary report of the findings. This summary and a copy of the TIMA document will be included in the staff report for the case. Minor revisions may be required before the project will be scheduled for the requested hearing.

## 5-1.100

**INITIATING IMPACT & MITIGATION ANALYSIS****A. Pre-application Meeting**

The procedures outlined herein present the minimum information required to determine what level of traffic analysis is required. The purpose of the pre-application conference is to provide guidance and direction to the applicant concerning the nature and extent of the analysis. Failure by the applicant to provide these items may result in delay in initiating the TIMA process. At a minimum, the following items must be provided for review:

1. Vicinity map
2. Current aerial map
3. Summary of existing building or development on the site – examples: existing building area and land use, current zoning, approved site plan, previous zoning history, etc.
4. Preliminary summary of proposed development by land use – examples: building area, number of employees, leasable tenant space, acreage, etc.
5. Proposed site plan

**B. Warrants for Studies**

Proposed projects will fall into one of three categories for purposes of transportation impact and mitigation analysis. The first category is proposed projects that are deemed to have insignificant traffic impacts. The second category is projects that have localized impacts to the city's transportation system. The third category is proposed developments that have significant impacts to the transportation system that may extend beyond the vicinity of the site. For those situations where it is questionable as to which category is appropriate, the Traffic Engineering Director will make the final determination. The Traffic Engineering Director also has the authority to waive the requirement for a traffic impact analysis for unusual situations that fall outside of the following guidelines or where the analysis is deemed to be unnecessary based on previous studies or current traffic conditions.

"Existing, allowed land use" will be interpreted as development that is allowed under the city's current zoning and General Plan designation. Development may be restricted to previously approved site plans and development programs, where prescribed by zoning stipulations. For those situations where it is questionable as to what level of development is allowed on the site, the Zoning Administrator will make the final determination.

## 5-1.101

**CATEGORY 1**

If a proposed development is anticipated to generate less daily trips than it would under the existing, allowed land use, and generates less than 100 vehicle trips per hour in the "peak period on the adjacent street system," then a transportation impact and mitigation analysis is not necessary. The following sizes of different land use classifications are deemed to generate less than 100 trips in the peak hour, and therefore do not require any analysis.

- < 100 residential dwelling units,
- < 6,000 gross square feet retail,
- < 25,000 gross square feet office,
- < 100,000 gross square feet industrial/employment
- < 160 hotel / motel / resort rooms,
- < 30,000 gross square feet medical office

For a development application that falls under this category, the applicant will be required to submit the following:

1. Site plan
2. Adjacent street volumes
3. Accident history
4. Trip generation comparison to the existing land use

**CATEGORY 2**

If a proposed development is anticipated to generate more daily trips than it would under the existing, allowed land use, and generates less than 100 vehicle trips per hour in the "peak period on the adjacent street system," then a Category 2 study is required to determine the extent of the transportation impacts of the proposed development.

For a development application that falls under this category, the traffic analysis will include the following:

1. Site plan
2. Adjacent street volumes
3. Accident history
4. Trip generation comparison to the existing land use
5. Level of service analysis of roadway segments and intersections adjacent to the site

The following considerations are some of the development and transportation system characteristics that will be evaluated in determining the extent of the study area and the need for additional or expanded analysis such as a traffic signal warrant analysis.

- Current traffic volumes and level of service on the adjacent streets
- Driveway location and volume
- Collision data on adjacent street segments and at nearby intersections
- Special conditions and circumstances particular to the development or the transportation system

**CATEGORY 3**

If a proposed development is anticipated to generate more daily trips than it would under the existing, allowed land use, and generates more than 100 vehicle trips per hour in the "peak period on the adjacent street system, then a Category 3 study is required to determine the extent of the transportation impacts of the proposed development.

For a development application that falls under this category, the traffic analysis will include the following:

1. Site plan
2. Adjacent street volumes
3. Accident history
4. Trip generation comparison to the existing land use
5. Level of service analysis of roadway segments and intersections adjacent to the site
6. Level of service analysis of major roadway segments and intersections in the vicinity of the site

The following considerations are some of the development and transportation system characteristics that will be evaluated in determining the extent of the study area and the need for additional analysis such as neighborhood traffic mitigation.

- Current traffic volumes and level of service on the adjacent streets
- Driveway location and volume
- Proximity to and potential impact upon nearby residential areas
- Collision data on adjacent street segments and at nearby intersections
- Special conditions and circumstances particular to the development or the transportation system

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**5-1.200****EXTENT OF STUDIES**

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**5-1.201****CATEGORY 2 STUDY**

This study will include the following type of development:

1. A site plan with proposed access points;
2. An area map showing the surrounding transportation system, including the locations of the signalized intersections within two miles of the nearest signalized intersection on adjacent streets in all directions;
3. A market study, if applicable;
4. Most recent accident rates and rankings on adjacent roadway segments and intersections within the study area;
5. Current traffic volumes on the street system within the study area; trip generation;
6. Trip distribution;
7. Traffic assignment;
8. Existing levels of service on adjacent roadways, including signalized intersections within the study area; and
9. Horizon year levels of service with and without the proposed development.

The Category 2 study need not be a detailed analysis of the present and future conditions. No elaborate data collection effort or extensive computer modeling is usually necessary for such a study. Its purpose is to provide an analysis of existing and anticipated traffic conditions on the adjacent transportation system and identify potential concerns that may need additional analysis.

**5-1.202****CATEGORY 3 STUDY**

A complete TIMA analysis will be required for any proposed development that is anticipated to generate more than 100 trips in the peak hour of the adjacent street. The type and extent of analysis required for a complete TIMA analysis will depend on the development under consideration and its potential impact on the study area transportation network. Large developments with regional impacts will require extensive analysis and sophisticated computer modeling applications; smaller developments might only require manual trip distribution and assignment techniques. The city will determine the extent of the Category 3 study.

**5-1.300****STUDY AREA**

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The study area for a Category 2 study will be the roadway segments and intersections located adjacent to the site. Major intersections within one mile of the site may be included in the study area based upon the guidelines noted above.

The study area for a Category 3 study will be the intersections, and connecting roadway segments, within two miles of the site or the nearest signalized intersection that satisfy either of the following traffic conditions:

- Intersections with entering volumes that currently exceed 40,000 vehicles per day, or
- Intersections with approach volumes in the design year that are increased by 5% or more as a result of the traffic generated from the proposed development.

**CONTEXT & FRAMEWORK**

**5-1.400**

**EXISTING CONDITIONS**

**5-1.401**

The reports for either a Category 2 or Category 3 study will provide current approach volumes for twenty-four hours of a typical weekday, and turning movement volumes in fifteen minute intervals for the time periods of 7:00 to 9:00 a.m. and 4:00 to 6:00 p.m., for all intersections of streets that are classified as major collector, minor arterial, major arterial, couplet, parkway, expressway, or freeway in the study area. The results of a level-of-service analysis, for the peak, fifteen-minute periods in the morning and in the evening for the existing conditions, will be included in the report. The report will also list the accident rate, frequency, and severity for all intersections and roadway segments in the study area for the most recent available year.

**HORIZON YEAR(S)**

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For a Category 2 study, the traffic analysis will be based on traffic conditions for the build-out or completion year of the development. In some cases staff may require an additional horizon year if there are significant changes anticipated to the surrounding infrastructure or traffic volumes.

For a Category 3 study, the traffic analysis will be based on traffic conditions for the build-out or completion year of the development, and a minimum five year projection from the anticipated build-out date, which may be rounded up to the closest five-year increment (2010, 2015, 2020, etc.) If the project is a large, multi-phased development, the initial horizon year will be the date that corresponds to the opening of the first major phase of development. In some cases staff may require an additional horizon year for multi-phase projects or projects with significant changes anticipated to the surrounding infrastructure or traffic volumes.

The study will provide morning and evening peak hour approach and turning movement volumes for each intersection in the study area for the required horizon years. Level-of-service analyses for these peak hour conditions, without the site traffic and with the site traffic, will be included in the report.

**PEAK TRAFFIC HOUR(S)**

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The report will analyze the peak traffic periods on the adjacent street system during the morning and evening, peak, fifteen-minute periods. The report will also analyze the peak traffic periods for the development, should these periods occur at different times or on different days from the peak periods of the adjacent street system.

**BACKGROUND STUDY AREA DATA**

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The city of Scottsdale Traffic Engineering Division prepares a traffic volume and accident data report for every even-numbered year. This information will be available to the traffic-engineering consultant. The consultant will use the most recently available data, at a minimum. If data from earlier years is deemed pertinent, the consultant may utilize it to supplement the most recent data.

The city of Scottsdale Traffic Engineering Division periodically obtains traffic volume information at various locations. This information will be available to the consultant. The consultant may not use traffic volume data older than fifteen months as current information. However, it may be utilized for supplemental purposes. If traffic volume data more recent than fifteen months is not available, then the developer is responsible for obtaining the information directly.

The city of Scottsdale Transportation Planning Division prepares traffic volume projections for five-year increments. This information will be available to the consultant. However, the

information will need to be reviewed by the consultant for applicability to the TIMA. Adjustment and recalculation may be necessary. In the event that the proposed development is very large in terms of anticipated traffic generation or in terms of deviation from the Scottsdale General Plan, comprehensive traffic projection modeling may be necessary.

**5-1.405****REVIEW OF ANTICIPATED OFF-SITE CHANGES**

The Transportation Department will provide copies of TIMAs prepared for previous proposed developments that may be pertinent to a current analysis. The city will also provide other transportation related reports that may be of assistance. The consultant will be responsible for reviewing these reports and incorporating their data, conclusions, and recommendations where appropriate.

The consultant will be responsible for obtaining copies of the current Circulation Element of the General Plan for the city of Scottsdale, and adhering to the policies and guidelines it contains.

**5-1.406****FIELD RECONNAISSANCE AND DATA COLLECTION**

If current traffic volume data is not available, the consultant will be responsible for obtaining traffic volume data in accordance with the requirements of the study, as stated previously. The consultant must also obtain speed limit information and analyze sight distance availability and requirements. The Transportation Planning Division will provide information regarding bicycle and transit facilities in the vicinity of the site of the proposed development. The consultant will be responsible for incorporating the needs of these facilities into the analysis and report.

**5-1.500****NON-SITE TRAFFIC FORECASTS****A. Components of Non-Site Traffic**

Estimates of non-site traffic are required for a complete analysis of horizon-year conditions. These estimates represent the "base" conditions, that is, without the site development.

**B. Methodology**

There are two principle methods of projecting off-site traffic that are acceptable: use of area-wide modeled data and trends or growth rates. Each method has its appropriate use depending on the availability of data and the size of the proposed development.

In most cases, modeled data will be available from the city of Scottsdale Transportation Department. In those cases where this data is not available, the city will determine if the data needs to be produced for an adequate analysis, or if a trends analysis will suffice.

**C. Analysis of Future Conditions**

Future traffic demand estimates are developed by adding the estimated site generated traffic, all approved (or potential) development in the area, and current traffic volumes adjusted for general growth in the area. The consultant will determine the levels of service in the study area based on the non-site traffic for the horizon year.

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## SITE TRAFFIC GENERATION

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### GENERAL PROCEDURE

The potential traffic impacts of a planned development are forecast for the projected conditions in the horizon year(s) of the project. The first step in the process is trip generation.

The trip generation process provides an estimate of the number of trips that will be generated due to the new development. Generally, the trip generation process consists of applying trip rates or equations for different types and sizes of land use development to the proposed land uses in the development to determine the total number of new trips added to the system. Trip generation will be calculated for the a.m. and p.m. peak hours and the daily period.

### SOURCES

The sources from which trip generation rates are taken are extremely important in assuring an accurate estimate of the impacts of a proposed development. In general, whatever the source, it is important to establish that the trip rate for a given land use is representative of the proposed development land use. Such items as size, location, services, and number of studies should be considered before using any data source.

#### A. State And Local Data Sources

In most cases, assuming a similar number of studies, local trip generation rates will be more accurate for predicting the trip generation of the development proposal. If such data is available, it should be reviewed with city staff to determine its applicability to the site.

#### B. National Data Sources

Several national data sources are available. The most widely used is Trip Generation, published by the Institute of Transportation Engineers (ITE). Other sources include: NCHRP Report 187, Transportation Research Board, 1978 and Development and Application of Trip Generation Rates, Federal Highway Administration, 1985.

National sources can be used as starting points in estimating the amount of traffic that may be generated by a specific building or land use. Whenever possible, or when the number of studies on which the rate is based is limited, these national rates should be adjusted to reflect local conditions. National sources should not be used without the application of sound judgment.

#### C. Collection of Additional Data

If it is determined that a local rate is most appropriate, but existing local data samples are limited, the consultant will be required to collect additional local data to provide a credible sample size on which to base the trip generation estimate. Local trip generation data should be collected at sites that exhibit similar characteristics to the development being studied and that are self-contained, with adequate parking not shared by other activities. The consultant should follow the guidelines contained in Trip Generation Handbook: An ITE Recommended Practice, ITE, 2000.

### SELECTION OF TRIP GENERATION RATES OR EQUATIONS

As described in Trip Generation Handbook, the following step-by-step procedure must be used for determining whether the equation or the rate should be used:

1. Calculate and compare the forecasted trips using both the regression equation and the trip rate. Generally, if the forecasted trips calculated from the two methods are within 5% of each other, use the method that most closely represents the data points in the

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5-1.603

range of the independent variable being used. If the difference is greater than 5%, go to step 2.

2. Use the equation when there are at least 20 data points that are distributed over the range of values typically found for the independent variable, when there are few erratic data points, and when the y-intercept for the equation is zero or near zero. If these conditions are not met, go to step 3.
3. Compare the lines representing the equation and the rate to determine which best fits the data points at the size of the independent variable in question. Use the equation or the rate whose line best fits the data points at the size of the independent variable in question. If neither line fits the data points, or if both fit equally well, go to step 4.
4. Review the standard deviation of the rate and the  $R^2$  value of the equation. These measures provide information about how well the lines, in general, fit the data points. A low standard deviation (less than 110% of the average rate) is good. A high  $R^2$  value (more than 0.75 for the equation) is good. Use the equation or the rate, depending on how well its measure satisfies these standards. If a decision still cannot be made, go to step 5.
5. Since at this point, there is no logical and valid basis for choosing between the rate and the equation, the user must choose the method to use based only on their best judgment, or collect an acceptable set of local data from which a local rate or equation can be derived.

#### **A. Use of Average, Minimum, and Maximum Rates**

Most trip generation data sources report the average rate based on a group of studies for land use. Sometimes maximum and minimum observed rates and some statistical measure of the spread of data between the extremes are also provided. When comparing average rates from different data sources, be sure to check the consistencies and differences in how the averages were computed.

When using average trip rates, all applicable adjustments must be made for variations in the independent variable. In addition, trips should be estimated for the average rate plus one standard deviation to determine how the results of the analysis would be affected.

#### **B. Use of Equations**

As described above, careful consideration must be given to the use of rates versus equations. In most instances, equations provide a better correlation with actual data than do average rates. In any event, the selection and reasons for using either equations or rates should be documented in the report.

#### **C. Choosing the independent variable**

The choice of the independent variable can be one of the most important decisions in estimating trip generation. The selected variable should be easily projected with reasonable accuracy. When information is available for more than one independent variable, the predictive accuracy of both the independent variable and the trip generation rate or equation must be considered. However, it is also important to check the sample size for each given independent variable. In the case of two variables with a similar correlation, the variable with the larger sample should be used. Trip rates or equations based on small sample sizes should be used with caution.

In the planning stage, some variables, such as employment and parking, are estimated on the basis of other variables, such as gross square feet of building space. When little is known about the size of the generator except the proposed use of the land to be developed, common development densities can be used to obtain a preliminary estimate of the independent variable. The city of Scottsdale Zoning Ordinance should be checked to determine the appropriate density parameters ([www.scottsdaleaz.gov/codes](http://www.scottsdaleaz.gov/codes)).



Floor area is one of the most commonly used independent variables. There are, however, different ways to compute floor area, and there are different definitions. These must be consistent when determining a trip generation rate, and they should correspond to accepted floor area definitions. For office buildings, these include gross floor area, gross leasable area, and net leasable area. Care should be taken to exclude areas such as large atriums, which do not by themselves generate trips. Gross leasable area is commonly used for shopping centers.

### **CHOOSING THE APPROPRIATE TIME PERIOD(S)**

The range of average rates for different time periods will be examined to determine when the generator peaks in traffic flow and to define the relationship between the peak generation and the peaking characteristics of the adjacent street system.

When the peak hour of the generator does not correspond to either the a.m. or p.m. peak hours of the adjacent street system, that additional time period must be analyzed to determine site-specific design requirements (such as auxiliary lane storage lengths).

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### **DAILY AND SEASONAL VARIATIONS**

Trip generation estimates for the average weekday are appropriate analyses for most, but not all, land uses. For some land uses, more trips are generated on Friday or Saturday than on the average weekday. Those days, rather than the average weekday, may be the most appropriate design or analysis period for those uses.

Seasonal variations are also important for some land uses. As a prime example, shopping centers should be analyzed for the period between Thanksgiving and Christmas, which is traditionally the busiest shopping season. For recreational and hotel land uses the consultant must provide an analysis that adjusts the background traffic to replicate the appropriate peak season of the generator. Seasonal adjustment factors are available from the Transportation Department.

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### **DRIVEWAY TRAFFIC VS. TRAFFIC ADDED TO ADJACENT STREETS**

It is usually assumed that all trips entering and exiting a new development are new trips that were not made to or through the area prior to the development being completed. However, for some non-residential developments, a portion of these trips may be "captured" from trips already being made to other existing developments on the adjacent street system, or they may be merely passing by on the way from one place to another. The driveway volume for a new development may, therefore, be significantly different from the amount of traffic added to the adjacent street system. For example, retail establishments, restaurants, banks, service stations, and convenience markets attract people from the passing stream of traffic; these are known as pass-by trips.

ITEs Trip Generation Handbook contains discussions and references on the issue of pass-by trips. Because of the limited data available, adjustments for pass-by trips should be applied carefully. If pass-by trips are a major consideration, studies and interviews at similar land uses must be conducted or referenced.

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### **MULTI-USE PROJECTS**

Most trip generation rates and equations have been gathered at and apply to isolated single-use developments. When multiple uses are combined into one development, simply adding the single-use estimates together can result in a total trip generation estimate that is too high.

While trip rates and equations are available for shopping centers, little data exists for other multi-use projects such as downtowns, suburban mixed-use centers, or planned unit

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developments. Some national publications, such as NCHRP Reports, may provide data that can be useful in some cases.

Multi-use projects are another case in which any adjustments should be applied carefully because of the limited amount of data available. If this is a major consideration for the proposed development, an analysis should be performed to determine the amount of trips that would be external for single uses, but which would be internal in a proposed mixed-use development. Trip Generation Handbook provides some information on this subject.

**5-1.608****SPECIAL OR UNUSUAL GENERATORS**

Occasionally, a development proposal will consist of special or unusual land uses for which typical trip generation rates or equations are not available, or simply do not apply.

Judgment must be applied to identify a land use or combination of land uses that best represent the trip-making characteristics of the site. The reasoning and data used by the consultant in developing a trip generation estimate for a special or unusual generator must be justified and explained in the report.

**5-1.700****SITE TRAFFIC DISTRIBUTION & ASSIGNMENT****5-1.701****DISTRIBUTION METHODS**

The directions from which traffic will access the site can vary depending on many factors, including:

1. The type of proposed development and the area from which it will attract traffic,
2. The presence or absence of competing developments within the same market area,
3. The size of the proposed development, and
4. The conditions on the surrounding street system.

The influence area of the development needs to be identified for the site. Ideally, the influence area should contain approximately 80% of the trip ends that will be attracted to the site. If a market study is available, it should be used in establishing the influence area. Otherwise, an influence area should be established based on a reasonable documented estimate.

The three most common methods for estimating trip distribution are by analogy, by model, and by surrogate data. In most cases, a surrogate data method can be utilized for developing the trip distribution. Utilizing this procedure involves using socioeconomic and demographic data to establish population or employment land use distributions around the site. In most cases, population can be used as the basis for estimating distribution of office, retail, and entertainment trips; employment is a reasonable surrogate for residential trips, and other trips can be similarly distributed using logical surrogates. For horizon years, land use estimates based on the city's General Plan should be utilized.

For some very large-scale developments, a trip distribution model should be utilized to estimate site trip distribution. The gravity model portion of the city's traffic forecasting model is available for this purpose.

**5-1.702****TRIP ASSIGNMENT AND PASS-BY TRIPS**

Once trip distribution is completed, trip assignment is used to determine the amount of traffic that will use certain roadway links within the influence area. The product of the trip assignment process is the total project-generated trips, by direction and turning movement.

Trip assignment should be made considering logical routings, available roadway capacities, left turns at critical intersections, and travel times. The assignment should also reflect the horizon year(s) and the roadway and land use conditions at that time.

As discussed in [Section 5-1.600](#) above, many land uses do not generate only vehicle trips that are entirely new to the roadway network. A portion of their trips may simply be diverted from trips already on adjacent or nearby streets. Because of limited data and research in the area of pass-by trips, a thorough analysis is required if pass-by trips are to be accounted for in the study. The following procedure will be used:

1. For the peak hour being analyzed, determine the percentage of pass-by trips as part of the total trip generation. The basis for this estimate should be documented. Split the total trip generation number into a new trip amount and a pass-by trip amount.
2. In addition to estimating a normal trip distribution (for new trips), also estimate a trip distribution for pass-by trips (giving strong consideration to the commuting work trip).
3. Perform two separate trip assignments, based on the two distributions. One assignment applies to pass-by trips; the other assignment applies to new trips. Care must be taken, as the pass-by trip assignment is more complicated. Pass-by assignment percentages should not automatically be applied to two-way traffic, since an outbound pass-by trip may use a different route than an inbound pass-by trip. Also, due to the diversion concept, pass-by trip assignment involves subtracting trips from some existing traffic movements and assigning the trips to other movements.
4. Combine the numerical pass-by and new trip assignments. Remember the subtraction required on some vehicle movements because of diversion. Proceed to the analysis process.
5. Check the results for reasonableness. If pass-by trips diverted from a thoroughfare represent more than 15% of the traffic volume on the street, they should be re-evaluated.

## **REDEVELOPMENT PROJECTS**

Since the purpose of the impact study is to evaluate a development proposal's impact on the transportation system, redevelopment projects require some special analysis. In the case of redevelopment projects, existing site-generated trips should be subtracted from existing and horizon year off-site traffic. The traffic generated by the proposed development is then added to the adjusted off-site traffic according to the above procedures to determine the impacts on the transportation system.

The consultant will establish the existing site generated trips through the collection of driveway counts. If the redevelopment area is substantial, or for some other reason does not lend itself to the collection of driveway counts for this purpose, trip generation rates may be applied to establish the existing site generated trips.

## **ANALYSIS**

This section describes the analytical techniques used to derive the study findings, conclusion, and recommendations. As new methodologies are developed and validated, they may be considered by the city or the consultant for applicability to the study requirements.

Capacity analysis must be performed at each of the major street and site access intersection locations (signalized and unsignalized), as well as transportation links, located within the study area. In some cases, there may be a need to analyze additional critical intersections or segments located outside the basic study area.

In addition to capacity analysis, several other transportation service-related factors shall be considered, including:

- Safety
- Circulation patterns
- Traffic control needs

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- Transit needs or impacts
- Transportation system management
- Neighborhood impacts
- On-site parking adequacy and off-site parking facilities, if any are to be used for site generated parking
- Pedestrian and bicycle circulation
- Service and delivery vehicle access and circulation

**5-1.801****TOTAL TRAFFIC ESTIMATE**

For each analysis period being studied, a projected total traffic volume must be estimated for each segment of the roadway system being analyzed. These projected total traffic volumes (consisting of site and non-site traffic) will be used in the capacity analyses. The traffic impact report must clearly depict the total traffic estimate and its components. Projected daily traffic volumes must be determined for all major streets within the study area as well.

**5-1.802****GUIDELINES**

Once the total traffic volume estimate has been established, capacity analyses will be performed. In some cases, the projected demand may be unrealistically higher than the capacity available on the existing or proposed transportation system components. In those cases where improvements are not feasible, an adjustment may be necessary in the site and/or background traffic to reflect realistic traffic diversion caused by capacity restraint. In such cases, the traffic components on all adjusted segments must be added again to obtain a more realistic total traffic projection. The original traffic estimates and specific reference to trip diversion shall be included in the report.

**5-1.803****IDENTIFICATION OF IMPACTS, NEEDS, & COMMON DEFICIENCIES**

The analysis is intended to show the relationship between operations and geometry and to assess deficiencies, as well as to identify alternatives for further consideration. This requires the identification of impacts, needs, and deficiencies.

The analysis of internal circulation, parking, off-site circulation, and capacity analyses will provide the basis for identifying transportation deficiencies and needs related to the proposed development. The analyses shall be conducted for conditions both with and without the proposed project in order to establish the incremental impacts of the project and the incremental needs it generates.

**5-1.804****LEVEL OF SERVICE AND CAPACITY ANALYSIS**

The evaluation of traffic operating conditions is referred to as level of service (LOS). The assessment of LOS is based on the quantitative effect of factors such as speed and volume of traffic, geometric features of the roadway or intersection, traffic interruptions and delay, and freedom to maneuver.

**A. Signalized Intersections**

Signalized intersection level of service will be determined utilizing the methods contained in the Highway Capacity Manual (HCM), 2000 or most recent edition. Two methods (operational and planning) are provided for the analysis of signalized.

The operational analysis requires detailed information on all prevailing traffic, roadway, and signalization characteristics. It provides for a full analysis of capacity and level of service and can be used to evaluate alternative traffic demands, geometric designs, signal plans, or all three. Because of the detailed data requirements, the operational analysis should be used only for the evaluation of existing conditions or for the analysis of projects with a horizon year of less than 5 years in the future. When critical variables are missing, it may

be necessary to conduct a planning analysis. However, default values may be used for some of the variables without seriously compromising computations. Caution should nonetheless be used when applying such values and it must be used. The input data needs, with values that have been determined to be most appropriate for Scottsdale, are listed in [Figure 5.1-1](#).

TYPE OF CONDITION	PARAMETER	SYMBOL	DEFAULT
<b>Geometric conditions</b>	<b>Area Type</b>	<b>CBD, Other</b>	<b>No default</b>
	Number of Lanes	N	No default
	Average Lane Width, ft.	W	No default
	Grade, %	%G	0%
	Existence of Exclusive LT or RT lanes	None	No default
	Length of Storage Bay, LT or RT Lane	L <sub>s</sub>	No default
	Parking Conditions	Yes, No	No parking
<b>Traffic conditions</b>	Volumes by Movement, vph	V	No default
	Ideal Saturation Flow Rate by Mov't, pcphgpl	S <sub>o</sub>	2,000 pcphgpl (through lanes) 1,800 pcphgpl (turn lanes)
	Peak Hour Factor	PHF	0.9
	Percent Heavy Vehicles	%HV	2%
	Conflicting Pedestrian Flow Rate, peds/hr	PEDS	None: 0 peds/hr Low: 50 peds/hr Mod: 200 peds/hr High: 400 peds/hr
	Local Buses Stopping in Intersection	NB	0/hr
	Parking Activity, pkg maneuvers/hr	N <sub>m</sub>	20/hr (pkg exists)
	Arrival Type (1-6)	AT	3 if isolated 4 if coordinated
	Proportion of Vehicles Arriving on Green	P	
	<b>Signalization conditions</b>	Cycle length, sec	C
Green Time, sec		G	No default
Yellow Change Interval		Y	3.0 seconds
All-Red Clearance Interval		AR	1.0 second
Actuated or Pre-timed Operation		A or P	Pre-timed
Pedestrian Push-Button?		Yes, No	Yes
Minimum Pedestrian Green		G <sub>p</sub>	No default
Phase Plan		None	No default

**FIGURE 5.1-1. LEVEL OF SERVICE DEFAULT DATA**

One of the most critical traffic characteristics that must be quantified to complete an operational analysis is the quality of the progression. The arrival type is best observed in the field but could be approximated by examining time-space diagrams for the street in question. The arrival type should be determined as accurately as possible because it will have a significant impact on delay estimates and LOS determination.

The planning analysis only addresses capacity because it is not necessary or practical to perform detailed calculations of delay, given the accuracy of the data that are generally available for planning purposes. The planning method generates two important products: (a) a projection of the status of the intersection with respect to its capacity, and (b) an approximation of a signal timing plan. Combining this approximation with appropriate values for other parameters used in the operational analysis, it is possible to extend the planning analysis into the level of the operational analysis.

The data requirements for the planning method are much less rigorous. Still, it is necessary to answer the following three questions in order to perform the analysis:

1. Will parking be allowed?
2. Will the signal be coordinated with the upstream signal on this approach?
3. How will left turns be accommodated?

If the answers are not known to any of these questions, then the analysis should be completed and compared for each alternate condition, and a recommendation made as to the most desirable design conditions.

### **B. Unsignalized Intersections**

Unsignalized intersection level of service will be determined utilizing the methods contained in the Highway Capacity Manual (HCM), Third Edition. Procedures have been developed to analyze both two-way, stop controlled intersections and all-way, stop controlled intersections. Each of these analysis methods is further divided into analysis of four-way intersections and T-intersections.

### **C. Arterials**

In most cases, the capacity of an arterial street is dictated by the signalized intersections operating along its length. The analysis procedures described in the HCM, therefore, rely on the results of the analysis methods above as a part of the input. Planning applications may use the entire arterial methodology, in a straightforward but somewhat simplified way, by computing stopped delay using certain default values as outlined in the signalized intersection analysis section. A reasonable estimation of the intended signal timing and quality of progression is vital to this process.

### **D. Capacity Analysis Software**

Software that accurately replicates the HCM computations may be used in lieu of manual computations. Assumptions should be verified, as well as checking default values. The consultant must verify that the city has access to the software that is intended to be used, so that city staff may properly verify inputs and results.

## **5-1.805**

## **SAFETY**

### **A. Vehicles**

The initial review of existing data within the study area shall include the accident experience for the past three years. This review should identify locations where roadways serving the site must be analyzed, and measures to alleviate accident hazards must be considered. Accident rates vary, but any intersection with more than one accident per million entering vehicles is worthy of additional analysis. Accident records can be obtained from the Transportation Department.

**B. Pedestrians and Bicycles**

The site plan should be reviewed to ensure that the internal circulation system and external access points are designed for pedestrian safety and to minimize vehicle/pedestrian conflicts. Locations for transit stops and their associated pedestrian flows to building access points require thorough assessment to ensure safety. Similarly, pedestrian flows to and from parking facilities need careful consideration during site planning, which often requires detailed information on the project's use and layout.

These considerations should also be addressed for projects expected to generate significant bicycle traffic.

**FORMULATION OF MITIGATION ALTERNATIVES**

When the analyses indicate that a particular location is projected to operate at an acceptable level of service, no improvements are required. If, however, deficiencies are recognized, then improvements in access, geometry, or operations must be investigated. When reasonable improvements cannot sufficiently accommodate projected traffic, more detailed assessments of project size, land use, or development phasing may be required.

Many major projects necessitate improvements to the area's roadway infrastructure, both internally and externally. The nature of these improvements and their timing must be related to the anticipated phasing of the development, as well as the changes within the study area as a whole.

For redevelopment projects, mitigation alternatives will include transportation demand management measures, including, but not limited to transit, bicycle, and pedestrian improvements.

**5-1.806**

**SITE ACCESS & OFF-SITE IMPROVEMENTS**

To develop recommendations for site access and off-site roadway improvements requires that judgments be applied to a number of alternative solutions or recommendations.

**ESTABLISHMENT OF GOALS**

Study recommendations and conclusions are intended to provide safe and efficient movement of traffic to and from, within and past, the proposed development, while minimizing the impact to non-site trips.

The following levels of service are required to be provided after the completion of each phase of the development, as well as completion of the entire project:

1. All intersections and arterials must operate at LOS D (or better) during the peak traffic hour of the roadway system. All intersection approaches, and intersection turning movements should operate at LOS D (or better) and must operate at LOS E (or better) during the peak traffic hour of the roadway system. When the planning analysis is performed, the requirement will be that all intersections operate at "near capacity" or "under capacity."
2. In areas where current levels of service, or future levels of service without the development, are E or worse, the delay or v/c ratio may not be significantly increased by the development traffic.

**5-1.900**

**5-1.901**

**RECOMMENDATIONS**

During the final phase of the study, all analyses are reviewed and reassessed to best respond to the actual transportation needs of the project and the adjacent area. Results must be placed in logical perspective and sequence.

**5-1.902**

In high-growth areas, particularly when large developments are being analyzed, it is important to determine the impact of individual phases of the development. This procedure becomes necessary in situations requiring assessments to fund improvements. In such cases, the following analyses should be completed:

1. Levels of service under existing conditions.
2. Levels of service for future horizon dates, with anticipated non-site generated traffic growth. Committed improvements should be included for each horizon year in the analyses. Additional improvements necessary to attain LOS D for base conditions should be identified.
3. Levels of service including site generated traffic for horizon years, both with and without proposed additional improvements to local and regional roadways beyond those identified in step 2.

#### **A. Network Improvements**

Network improvements recognize that individual developments and increasing traffic volumes are part of the long-term growth of an area. Roadway improvements associated strictly with any given development may not necessarily address the long-term needs of the rest of the region on a systematic basis, and thus not address overall transportation system needs. Therefore, a section of the traffic impact study will address compatibility with the existing and planned infrastructure.

#### **B. Localized Improvements**

Localized improvements consist of modification, expansion, and in some cases addition of roadway facilities in the immediate vicinity of the proposed development. The scope of these improvements will be consistent with the LOS criteria established above. They will address specific site and through traffic needs, and will be compatible with the city's long-term improvement plans.

#### **C. Program Improvements**

If adequate transportation improvements cannot be reasonably recommended, consideration should be given to reducing trip generation during problem periods by reducing the project magnitude or altering the land use mix.

### **5-1.903**

#### **IMPLEMENTATION SCHEDULE**

It is important to view recommendations for improvements within appropriate time perspectives. Recommendations should be sensitive to the following issues:

1. Timing of short-term and long-term network improvements that are already planned, scheduled, and/or funded.
2. Time schedules of adjacent developments.
3. Size and timing of individual phases of development.
4. Right-of-way needs and availability of additional rights-of-way within appropriate time frames.
5. City priorities for transportation improvements and funding.
6. Cost-effectiveness of implementing improvements at a given stage of development.
7. Necessary lead-time for additional design and construction.

### **5-1.1000**

#### **ON-SITE CIRCULATION**

An integral part of an overall traffic impact study relates to basic site planning principles. It is extremely important that off-site roadway improvements be fully integrated with on-site recommendations.



**1001 APPROACH TO SITE PLANNING**

Internal design will have a direct affect on the adequacy of site access points. The identification of access points between the site and the external roadway system, and subsequent recommendations concerning the design of those access points, is directly related to both the directional distribution of site traffic and the internal circulation system configuration. It is clear that driveway traffic volumes of varying sizes need to be accommodated on the site in terms of both providing sufficient capacity and queuing space, and of distributing automobiles to and from parking spaces, pick-up/drop-off points, and drive-through lanes. An integrated system should deliver vehicles from the external roadway system in a manner that is easily understood by drivers, that maximizes efficiency, accommodates anticipated traffic patterns, and ensures public safety. Pedestrian linkages should conveniently and safely connect transit stops and parking facilities with building entrances. Similar linkages should be provided between buildings.

It must be understood that simply providing access to a site by means of curb cuts does not necessarily mean that access to the development has been adequately addressed. The quality of access as it relates to the internal site circulation and design will have a direct relationship on the quality of traffic flow in and around the site development, as well as a direct impact on public safety.

**ON-SITE PLANNING PRINCIPLES**

**A. Access Points**

Requirements for access to the public street system are detailed in Section 2-1.500 and Section 5-3.200. The guidelines should be followed as closely as possible. Exceptions will only be granted where there are demonstrable extenuating circumstances.

Joint access (the sharing of a driveway by two or more properties) is desirable, particularly where property frontages are short and driveway volumes will be low. Such driveways should be located on joint property lines or be accessible via cross-access easements on the private property being served by the joint driveway.

**B. Vehicular Queuing Storage**

Adequate internal and external vehicle queuing storage is essential to providing safe and efficient access and circulation. Queuing analyses must be included to demonstrate the adequacy of the proposed storage lanes.

Drive-in and drive-through establishments should be provided with adequate queue storage capacity to accommodate normal peak queues. Since many of these businesses have major daily or seasonal variations in activity, peaking characteristics should be carefully evaluated.

**C. Internal Vehicular Circulation**

Internal circulation is the means by which vehicular traffic is delivered between entry points and parking areas, pick-up/drop-off points, and service areas. Internal circulation roadways should permit access between all areas. These roads should be designed to safely and efficiently deliver vehicles and pedestrians to their respective destinations.

**D. Service and Delivery Vehicles**

Service and delivery vehicles require separate criteria for movement to and from the site. Of particular interest is that adequate turning paths are provided for large service vehicles to allow entry and exit without encroaching upon opposing lanes or curbed areas. In addition, sufficient storage areas must be provided so that service vehicles do not hinder the use of parking and circulation routes for other visitors to the site.

**5-1.1002**

**E. Pedestrian, Transit, Bicycles, and Handicapped Facilities**

The overall site plans should also consider public transportation, pedestrians, bicyclists and those with disabilities. Adequate facilities for parking bicycles should be included. Transit facilities, car pool parking, and shuttle bus staging areas should be provided as appropriate for the development. Where provided, these facilities should be located adjacent to service drive and entrance locations, at key locations along circulation drives, or at major pedestrian focal points along the external roadway system.

Pedestrian connections between these facilities and the site's buildings must be integrated into the overall project design, and provide maximum accessibility through the use of sidewalk ramps, etc. These connections must also be provided to the public sidewalk and path or trail systems surrounding the site. See Sections 5-6 Transit, 5-7 Bikeways, 5-8 Pedestrian Facilities, and 5-9 Neighborhood Traffic Management.

**5-1.1100****TIMA REPORT****5-1.1101****PURPOSE AND END USES**

The purpose of the impact and mitigation analysis is to identify and measure the effects of a proposed development on the surrounding transportation system, and determine appropriate measures necessary to mitigate those impacts. The developer will be able to utilize the report to evaluate their development proposal and site plan. The city will also utilize the report in reviewing the attributes of proposed developments in conjunction with requests for annexation, land subdivision, zoning changes, building permits, or other development reviews.

**5-1.1102****PRESENTATION**

The study report will include at a minimum:

1. Study purpose and objectives;
2. A description of the site and study area;
3. Existing conditions in the area of the development;
4. Anticipated nearby development;
5. Trip generation;
6. Trip distribution;
7. Modal split;
8. Traffic assignment resulting from the development;
9. Projected future traffic volumes;
10. An assessment of the change in roadway operating conditions resulting from the development traffic; and
11. Recommendations for site access and transportation improvements needed to maintain traffic flow to, from, within, and past the site at an acceptable and safe level of service.

If the assumptions made in the analysis are based on published sources, then those sources should be specifically referenced. If other, less readily available sources are used, a more detailed explanation must be provided and a copy of the relevant information provided in an appendix.

Please follow the sample report outline provided below and the instructions provided by the Transportation Department staff and/or the Project Coordination Manager when completing the analysis and report. Incomplete reports will be returned to the consultant for revisions or completion prior to a full review of the analysis.

**103**

**CERTIFICATION**

A professional engineer registered in the State of Arizona must seal the report. If this certification is not provided, the report must be clearly stamped "DRAFT" or "PRELIMINARY."

**104**

**SAMPLE REPORT OUTLINE**

The outline structure shown in [Figure 5.1-2](#) provides a framework for the Transportation Impact and Mitigation Analysis report. Some studies will be easily documented using this outline; however, additional sections may be warranted because of specific issues to be addressed and/or the results of the study. Likewise, inapplicable sections listed in the outline may be omitted from the report.

**TIMA REPORT OUTLINE**

<p><b>I. Introduction to Summary</b></p> <ul style="list-style-type: none"> <li>A. Purpose of Report and Study Objectives</li> <li>B. Executive Summary <ul style="list-style-type: none"> <li>1. Site locations and study area</li> <li>2. Development description</li> <li>3. Principal findings</li> <li>4. Conclusions</li> <li>5. Recommendations</li> </ul> </li> </ul> <p><b>II. Proposed Development</b></p> <ul style="list-style-type: none"> <li>A. Off-site development</li> <li>B. Description of on-site development <ul style="list-style-type: none"> <li>1. Lane use and intensity</li> <li>2. Location</li> <li>3. Site plan</li> <li>4. Zoning</li> <li>5. Phasing and timing</li> </ul> </li> </ul> <p><b>III. Area Conditions</b></p> <ul style="list-style-type: none"> <li>A. Study Area <ul style="list-style-type: none"> <li>1. Area of influence</li> <li>2. Area of significant traffic impact</li> </ul> </li> <li>B. Study Area Land Use <ul style="list-style-type: none"> <li>1. Existing land uses</li> <li>2. Existing zoning</li> <li>3. Anticipated future development</li> </ul> </li> <li>C. Site Accessibility <ul style="list-style-type: none"> <li>1. Area roadway system <ul style="list-style-type: none"> <li>a) existing</li> <li>b) future</li> </ul> </li> <li>2. Traffic volumes and conditions</li> <li>3. Transit service</li> <li>4. Existing relevant transportation system management</li> </ul> </li> </ul> <p><b>IV. Projected Traffic</b></p> <ul style="list-style-type: none"> <li>A. Site traffic (each horizon year) <ul style="list-style-type: none"> <li>1. Trip generation</li> <li>2. Trip distribution</li> <li>3. Modal split</li> <li>4. Trip assignment</li> </ul> </li> <li>B. Through Traffic (each horizon year) <ul style="list-style-type: none"> <li>1. Method of projection</li> <li>2. Non-site traffic for anticipated development in study area <ul style="list-style-type: none"> <li>a) Method of projections</li> <li>b) Trip generation</li> <li>c) Trip distribution</li> <li>d) Modal split</li> <li>e) Trip assignment</li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>3. Through traffic</li> <li>4. Estimated volumes</li> <li>C. Total Traffic (each horizon year)</li> </ul> <p><b>V. Traffic Analysis</b></p> <ul style="list-style-type: none"> <li>A. Site Access</li> <li>B. Capacity and Level of Service</li> <li>C. Traffic Safety</li> <li>D. Traffic Signals</li> <li>E. Site Circulation and Parking</li> </ul> <p><b>VI. Improvement Analysis</b></p> <ul style="list-style-type: none"> <li>A. Improvements to accommodate base traffic</li> <li>B. Additional improvements to accommodate site traffic</li> <li>C. Alternative improvements</li> <li>D. Status of improvements already funded, programmed, or planned</li> <li>E. Evaluation</li> </ul> <p><b>VII. Findings</b></p> <ul style="list-style-type: none"> <li>A. Site accessibility</li> <li>B. Traffic impacts</li> <li>C. Need for improvements</li> <li>D. Compliance with applicable city of Scottsdale codes</li> </ul> <p><b>VIII. Recommendations</b></p> <ul style="list-style-type: none"> <li>A. Site access/circulation plan</li> <li>B. Roadway improvements <ul style="list-style-type: none"> <li>1. On-site</li> <li>2. Off-site</li> <li>3. Phasing</li> </ul> </li> <li>C. Transportation System Management Actions <ul style="list-style-type: none"> <li>1. On-site</li> <li>2. On-site operational</li> <li>3. Off-site</li> </ul> </li> <li>D. Other</li> </ul> <p><b>Conclusions</b></p>
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FIGURE 5.1-2. TIMA REPORT OUTLINE