JULY 2006
FINAL REPORT

PROCEDURES FOR PREPARATION OF:

TRANSPORTATION IMPACT STUDIES

Town of Marana, Arizona
Public Works Department
Traffic Engineering Division

PROCEDURES FOR PREPARATION OF
TRANSPORTATION IMPACT STUDIES

TOWN OF MARANA, ARIZONA

PUBLIC WORKS DEPARTMENT
TRAFFIC ENGINEERING DIVISION

JULY 2006

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Definitions

Access Management: The process of properly selecting and locating access points to land development from the adjoining streets so that system capacity, performance and integrity are maintained. Freeways have the highest level of access management, whereas local streets have the least.

ADOT: Arizona Department of Transportation.

ADT: Average daily traffic. The term used to describe the total number of vehicles on a roadway segment during a typical weekday.

Background Traffic: The component of total traffic, excluding site traffic.

Bike Lane: A lane devoted to non-motorized bicycles. This is different from a multi-use defined below.

Functional Classification System: The definition of the street network in a hierarchy including freeways/parkways; major and minor arterials; major and minor collector streets, local streets, and driveways. Through travel occurs on higher classification streets; lower classification streets provide direct land access. Most travel occurs on freeways and arterials; however, most roads are collectors and local streets.

Highway Capacity Manual (HCM): A publication by the Transportation Research Board establishing methods and procedures for evaluating roadway and intersection performance. The HCM defines level of service, see below.

Horizon Year(s): The future date(s) analyzed in a TIS or traffic statement, based on completion and full utilization of the development or development phases.

HOV: High Occupancy Vehicle. Any vehicle carrying two or more passengers. Most larger communities have HOV lanes on major highways that permit only HOV's (and sometimes motorcycles and alternative fuel vehicles) to use them.

ITE: Institute of Transportation Engineers the preeminent organization for professional transportation engineers. ITE publishes the Trip Generation Manual, which provides information on trip generation for land uses and building types.

Level of Service (LOS): a qualitative measure of how well an intersection or roadway performs under prevailing or forecast traffic conditions.

> **Intersection LOS**: This is a measure of the average delay experienced by each vehicle passing through an intersection. It can be measured for the vehicles making each directional turning movement, using each approach leg, or as a composite average value for all vehicles using the intersection. Similar to roadway level of service, it is reported with a letter grade designation ranging from A to F. An LOS A represents insignificant delay (less than 10 seconds per vehicle); LOS F represents significant waiting. This means more than 50 seconds per vehicle for intersections with non-existent or inadequate signals or more than 80 seconds per vehicle for intersections with signals.
>
> **Roadway LOS**: This is a measure of the amount of roadway congestion ranging from LOS A—no congestion, free flowing conditions -- to LOS F—extreme congestion. LOS is one of the most common terms used to describe how "good" or how "bad" traffic is projected to be. LOS serves as a benchmark to determine whether new development will comply with an existing LOS or if it will exceed the preferred or adopted LOS. Traffic impact studies determine how specific streets and

intersections will function currently and with increased traffic volumes either with or without roadway improvements or other mitigation techniques.

There are six levels of service letter grades typically recognized by transportation planners and engineers, as follows:

Level of Service A -LOS A describes a condition of free flow, with low volumes and high speeds.

Level of Service B -LOS B is the zone of stable flow, with operating speeds beginning to be restricted somewhat by traffic conditions. Drivers still have reasonable freedom to select their speed and lane of operation.

Level of Service C - LOS C is the zone of mostly stable flow, but speeds and maneuverability are more closely constricted by the higher volumes.

Level of Service D - LOS D is a zone that approaches unstable flow, with tolerable operating speeds, however driving speed is considerably affected by changes in operating conditions.

Level of Service E - LOS E is a zone that cannot be described by speed alone. Operating speeds are lower than in Level D, with volume at or near the capacity of the highway.

Level of Service F - LOS F is a zone in which the operating speeds are controlled by stop-and-go mechanisms, such as traffic signals. This is called forced flow operation. The stoppages disrupt the traffic flow so that the volume carried by the roadway falls below its capacity; without the stoppages, the volume of traffic on the roadway would be higher, i.e., it would reach capacity. It should be noted that LOS is a measure of a roadway segment's efficiency at moving motor vehicles.

Internal Capture: The trips associated with a mixed use development that remain internal to the site and are subtracted from the gross trip generation calculations.

Manual on Uniform Traffic Control Devices (MUTCD): A publication from the USDOT that standardizes the location, type, and use of traffic control signs, signals and markings.

Master Transportation Study: A very comprehensive transportation, circulation, and infrastructure study prepared for large scale, master planned communities. The project site is usually owned or controlled by one owner or corporation. These studies usually have transportation project costs estimates, implementation timelines, and funding commitments as well as the elements found in the more routine TIS.

MEV: Million(s) entering vehicles at an intersection during an analysis period, usually used in collision rate analysis.

Mode Split: The stratification of current and projected traffic to travel modes such as motor vehicle, transit, bike, and pedestrian.

MTP: Metropolitan Transportation Plan. The plan is created by the Pima Association of Governments, our Metropolitan Planning Organization (MPO) for eastern Pima County. The plan is required by federal law.

PAG: The Pima Association of Governments, being the certified Metropolitan Planning Organization for the Tucson region.

Pass-by Trips: Traffic accessing a site from the adjacent roadway(s) and from the current traffic stream.

Reverse Commute: The travel from the city center to suburban locations, moving counter to the primary or major volume of traffic flow.

Roadway Capacity: The maximum flow rate, in vehicles per hour, that can be reasonably expected on a particular segment of roadway during a given time period under prevailing roadway, traffic, and control conditions, as defined by the *Highway Capacity Manual*.

Roadway Improvements: Improvements to roads such as widening, adding signals to intersections, or adding turning lanes. These are often required to mitigate traffic impacts and maintain a required level of service (LOS).

RTA: The Regional Transportation Authority for Pima County.

Service Volume: The maximum flow rate, in vehicles per hour, at a given level of service.

SOV: Single Occupant Vehicle sometimes called the "drive alone mode."

Stacking: The process of vehicles forming a line or queue. If the stacking extends into the through-lanes, delays and unsafe conditions become prevalent.

Street Cross-Section: A term used to describe the total number of lanes on a street, along with other elements such as sidewalks and utility locations. For instance, a street that has two lanes of northbound traffic, two lanes of southbound traffic, and a continuous center left turn lane is commonly referred to as a five-lane cross-section.

Subregional Transportation Study: A detailed study of a large part of the community not under one ownership, but otherwise similar to a Master Transportation Plan.

TAZ: Transportation Analysis Zone. A geographic area that identifies land uses and associated trips. TAZs are used for making land use projections and performing traffic modeling.

Traffic Assignment: The specific allocation of trips generated by a site to the current and future roadway network.

Traffic Calming: The process of designing streets or adding design elements to tame fast moving traffic and to address unsafe traffic conditions. Design elements include, for example, speed humps, narrowed streets, or adding a traffic circle. Good initial design and street layout can negate the need to install traffic calming measures after the street is built.

Traffic Letter: A brief letter report or memorandum confirming that a proposed development within an approved block plat or development plan conforms to the data and assumptions found in a more comprehensive TIS or master transportation study for that parcel. If the site does not conform, a more detailed report or an update to the original report may be required.

Traffic Statement: A brief report describing existing and future conditions associated with a project that may not require the scale of a full TIS, based on its projected trip generation. Statements are usually for projects with fewer than 100 peak hour trips generated and may be in letter format.

Transportation Impact Study (TIS): A study conducted by a transportation professional using analytical methods and computer simulation to predict the volumes and associated impacts from traffic generated by a proposed land use or development project. The study analyzes the impacts to roads and intersections and includes recommendations for roadway improvements and other mitigation that may be needed to mitigate congestion and unsafe situations, and to comply with the regulations of the reviewing jurisdictions.

Trip: A one-way journey having an origin and a destination. Trips may be further categorized as person-trips or vehicle-trips.

Trip Distribution: The general allocation of site traffic to the offsite roadway network.

Trip End: The term used to describe trips in terms of their common origins or destination.

Trip Generation: The amount of traffic created by a land use. Trip generation rates for over 300 land uses are published by ITE, and are widely used in traffic engineering reports and planning studies.

Turn Lane: A lane devoted to vehicles making a turning movement to go in a different direction. Turn lanes are necessary to ensure the free-flow of traffic in the through lanes by providing a separate area/lane for turning traffic to slow down and complete the turning maneuver without impeding the movement of through traffic.

VMT: Vehicle Miles Traveled. Increases in VMT from existing residents are occurring every year, contributing to added congestion on roadways.

VPH: Vehicle per peak hour. This relates to Link Volumes (see above).

Volume-to-Capacity Ratio: Expressed as v/c, this is a measure of traffic demand on a facility (expressed as volume) compared to its traffic-carrying capacity. A v/c ratio of 0.7, for example, indicates that a traffic facility is operating at 70 percent of its capacity. In evaluating the performance of a roadway, v/c ratios should be considered together with the letter grade system, which is more of a qualitative assessment based heavily on speeds and travel time. With traffic moving at an acceptable rate of speed, roadways will perform at favorable Level of Service grades. However, even with an acceptable LOS grade, a v/c ratio may indicate that the same facility is operating at or near full capacity (e.g., 0.95 to 0.99). Conversely, road segments operating at deficient levels of service (e.g., peak-hour LOS E and F) may have an acceptable v/c ratio in cases where the adjoining intersections are not operating efficiently (e.g., cycle lengths on the traffic signals are long or the signal progressions are poor). Consequently, a high v/c ratio does not always imply that a facility has more volume than it can handle nor does a deficient LOS grade necessarily indicate that there is insufficient roadway capacity available.

Weaving: The process of crossing multiple traffic lanes to change routes or direction of travel.

These definitions using everyday language were adapted for the Town of Marana from American Planning Association's "The Language of Traffic" 2002 and other sources.

1. INTRODUCTION TO MARANA TRANSPORTATION IMPACT STUDIES PROCEDURES

One of Marana's major responsibilities is to plan, build, operate and maintain a safe and efficient transportation system for Town residents, businesses, and visitors. The Transportation Impact Study (TIS) procedures contained in this document are established to help meet this goal. The procedures explain the process and content of the studies, and provide some technical requirements specific to the Town. The procedures outline the general analysis approach and methods. Many of the terms and concepts used herein are explained in the definitions section. However, the procedures are not intended to supplant the technical expertise in transportation systems analysis and traffic engineering needed to prepare a TIS.

A TIS evaluates the impact of a proposed land development, zoning change, or special land use approval on the transportation system. The purposes are to (1) ensure that proposed development does not overburden the transportation network, (2) identify any traffic problems associated with access to the site from the existing transportation network, (3) delineate solutions to potential problems for all modes, and (4) identify improvements to be included with or funded by the proposed development. The studies emphasize vehicular travel, but they also address transit, bikes, and pedestrians. They fit into an overall framework of approved plans and programs, technical studies, transportation improvement programs.

The TIS is a useful tool for early identification and mitigation of potential traffic problems. They often play an important role in the success or failure of a development project. When insufficient attention is given to traffic impacts, the following problems could result:

- On-site traffic congestion, circulation, and access problems
- Unacceptable congestion on adjacent roadways
- Inadequate access for various modes and vehicle types
- Increased accident experience

The preparation of a TIS provides an opportunity for the Town and the developer to share information and jointly address traffic related problems. It provides a means of balancing development needs with the functional integrity of the roadways that serve both the development and the region. Almost all land development projects will need some level of TIS. The level of detail and extent of the study area depends on the type and size of the land development, how much traffic it will create, and its location within the Town. For small projects in uncongested rural areas, the report will be quite brief. Conversely, larger projects in congested urban areas may be very extensive because they need to resolve how traffic problems are mitigated. These procedures, along with

the judgment of Town staff, will define if a study is required and how extensive it needs to be.

Chapter 2 of this report explains the simple steps in the process and emphasizes early coordination between the applicant and the transportation analyst, as well as ongoing coordination with Town staff. Chapter 3 explains what the Town expects the reports to contain and some of the technical methods we expect to be used. The appendix contains a checklist, meeting agenda, and other important supporting materials.

Frequently Asked Questions

Here are a few frequently asked questions that help put the rest of this document into context.

When is a TIS Required and what is the scope?

Transportation studies are required for all projects in the Town except for a single home on an individual residential lot. In some cases, a brief traffic statement or letter report is all that's needed. In most cases a more detailed report complying with these procedures will be required. And in a few cases where a large development is proposed, a very extensive study may be needed. Depending on the extent of the project, these guidelines can be used for the preparation of reports for a small-scale project requiring only a brief letter report or "traffic statement", a more traditional transportation impact analysis for typical residential and commercial projects, a master transportation study for master planned communities, or a subregional transportation study emphasizing a large section of the community. The scope of the study should reflect the nuances of the development's intensity, access modes, and the current and planned transportation system(s) serving the site.

Who prepares the report?

The reports ***must*** be professionally prepared and sealed by a registered civil engineer with proper training and experience, in accordance with Title 32, Arizona Revised Statutes and the Arizona State Board of Technical Registration. In rare instances, an architect, geologist, engineer or landscape architect registered in Arizona may prepare the study, as provided by ARS §32-143, if the traffic study is incidental to the overall project and the registrant has the knowledge and skills to prepare the report. ***The role of the transportation specialist should primarily be as an analyst, not as an advocate of the development.*** A knowledgeable professional will already be familiar with the analytical methods and procedures discussed later in these guidelines.

When are the studies prepared and when are they submitted?

The studies should be prepared as an integral part of the site planning and design process. They should not be prepared as an afterthought, i.e., after a site plan, block plat, or subdivision plat has already been designed, simply because the findings of the TIS may cause a major revision to the project's design. Different types of studies are prepared and submitted at different phases of development, including zoning and design. The type and extent of the study will be defined by the Traffic Engineering

Division Manager (or designee). The reports should be submitted to the Town with an overall development submittal package so they can be logged in and tracked.

How do the studies relate to other plans and programs?

A TIS is often built upon other plans and studies in the project area, and they should be appropriately referenced. Related studies and plans may include any of the following:

- Marana Transportation Plan
- Marana General Plan and Circulation Element
- Northwest Area Plan
- Roadway Corridor Studies and traffic reports
- TIS for nearby development
- Rezoning reports and traffic studies
- PAG's Metropolitan or Regional Transportation Plan
- PAG Transportation Improvement Program
- Statewide Transportation Plan and STIP
- Development Agreements and Pre-annexation Agreements

How much do the studies cost and is there a review fee?

The Town does not prepare the reports; we only help establish the scope of study, provide some data, review and accept[1] reports. A professional retained by the applicant must prepare the TIS. Fees can vary widely, from as little as a couple hundred dollars for a "traffic statement" to many thousands of dollars for a more detailed report. The Town charges a non-refundable review fee per the development fee schedule.

[1] Marana does not "approve" technical reports, *per se*. Instead the Town "accepts" reports as being complete and meeting Town standards for format and analytical content.

2. PREPARATION OF A TIS

This section describes the contents of a TIS, how it should be prepared, and submitted to the Town. The key to a successful study is coordination with Town staff. Most reports can be accepted on the first or second submittal if there is adequate communication with staff about the report's scope and any special concerns or problems areas that need to be emphasized. The general flow is described in the following steps and in Exhibit 1. The TIS checklist, contained in the appendix, is integral to report preparation, review, and approval.

Step 1 - Pre-Submittal Conference

At the request of the applicant, a meeting between Public Works staff and applicant is held to discuss the project and to agree on the general scope of the study and the preliminary information needed in Step 2. This meeting is optional, but strongly encouraged since it is used to clarify issues surrounding the project or to explain the review process. In some cases, meetings can take place over the phone or electronically via e-mail. The meeting can take place before preliminary information is submitted or after the Public Works Department has reviewed it. These discussions should occur very early in the project planning and design process. The appendix contains a suggested agenda for the pre-application meeting.

Step 2 - Applicant Prepares and Submits TIS Checklist

Some preliminary information is needed for staff to base a determination on the scope of the study, influence area, and to provide related studies near the new project. The preliminary information will be used in the TIS, and the checklist must be submitted with the report.

Preliminary information includes the following for review by staff:

- A brief narrative description of the project
- Location of the project , size and type of land use(s)
- Horizon year(s)
- Proposed access and driveway location(s)
- Vicinity Map showing the site location
- Anticipated build-out year
- Daily, AM and PM peak hour trip generation, based on ITE *Trip Generation* rates
- Trip distribution and traffic assignment
- Passer-by, internal capture, and linked-trip assumptions
- Consideration of alternate modes including bikes, pedestrians, and transit
- Mode split, if transit or alternative modes are viable for the project
- Analysis horizon years
- Data currently available to be used in the study, and new data to be obtained
- Intersection and roadway segment performance goals (LOS)
- Initial concepts for traffic mitigation, if any
- Special information requested from the Town
- A completed TIS checklist

Step 3 - Preliminary Information Reviewed by the Public Works Department

The Town's Public Works Department will review the preliminary information and the checklist. Usually the information will be complete and acceptable to the Town with only minor changes. The Public Works Department and the applicant will resolve any special items to be included in the TIS. In some cases it may be necessary to expand the typical scope of the study. Public Works staff will make recommendations regarding the appropriate project horizon year and intermediate analysis periods, if any. The Town staff will review and accept the checklist and preliminary information submitted by the applicant. The applicant provides the Town with a summary of the pre-application meeting, the accepted preliminary information and checklist for review and approval. The applicant then goes on to Step 4.

Step 4 - Applicant Prepares and Submits Report

The report is prepared according to the guidelines in Chapter 3 and any special instructions received from staff. The report should include references and mathematical calculations, as well as printouts from any computer-generated analysis. Four bound copies of the report are submitted, each containing a copy of the preliminary information and checklist. The analysis must be conducted according to contemporary standard practice in the fields of transportation planning and traffic engineering. The applicant may make an informal presentation at submittal, although this is not required.

Step 5 - Town Provides Review Comments

Prior to reviewing the report, staff will insure that the preliminary information and checklist are included. If not, the report will be returned without review. Town staff will then review the report and provide written comments, typically within three weeks of submittal. If staff has any questions or needs clarification, they may call or e-mail the applicant or firm preparing the report.

Step 6 - Applicant Revises and Resubmits Report in Response to Comments

After receiving written staff comments, the applicant will have the report revised and resubmitted. Please also submit a brief memo describing how the comments were addressed. Call staff to discuss any of the comments if they need clarification. Staff will then review the revised document and accept the report if all the requested changes and corrections have been made. Staff will send out an approval letter or make additional comments, as appropriate. If additional submittals are needed, steps 5 and 6 are repeated until approval.

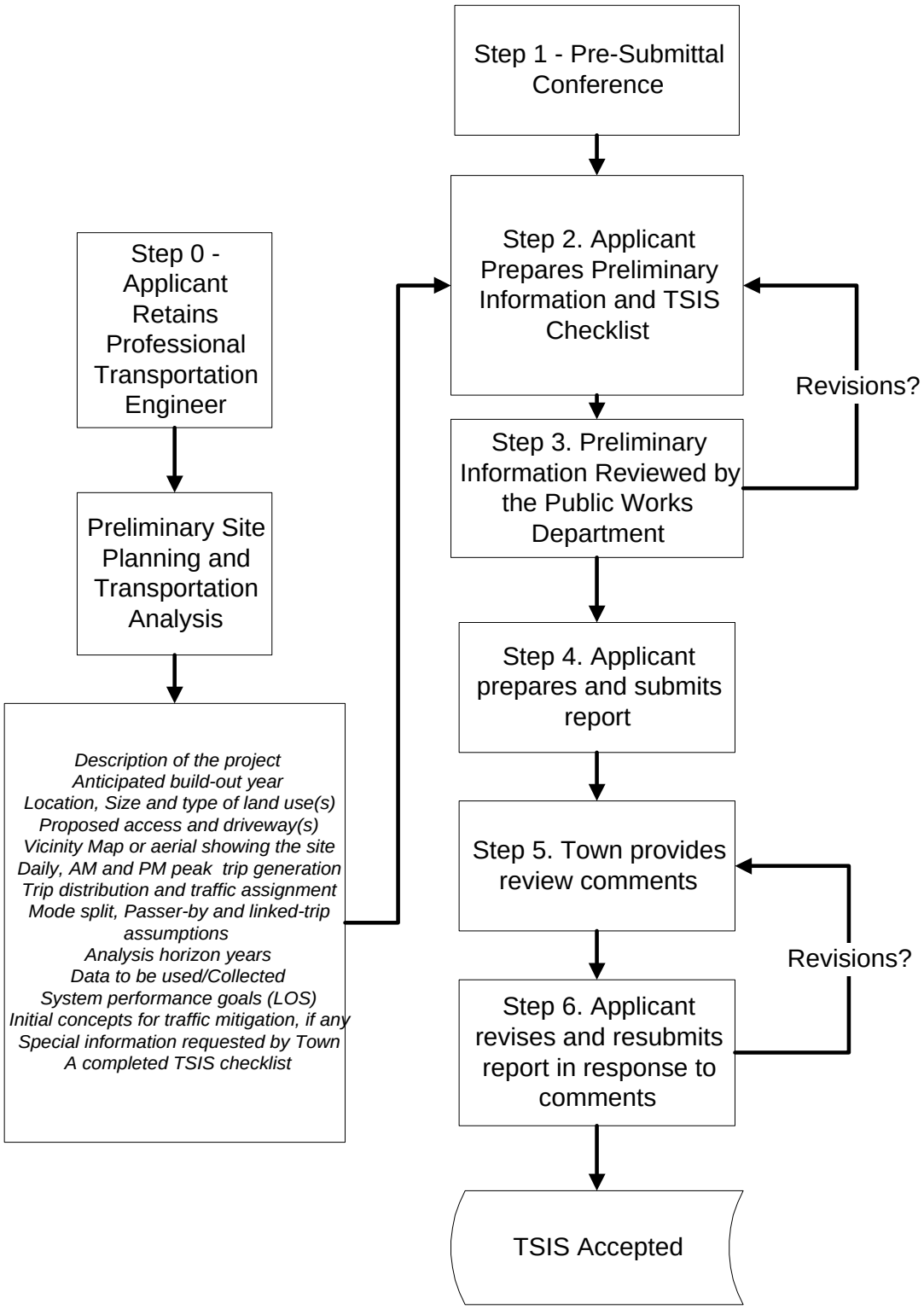

Exhibit 1 TIS Flowchart

3. REPORT CONTENT AND METHODS

This chapter describes what is included in the studies and some of the tools and resources used to analyze current and future impacts. A list of exhibits is also provided. As mentioned above, it is very important to include the checklist and preliminary information in front of each report copy, preferably after the cover page, because they establish the scope of the report.

Reports may be marked as copyright; however a limited release to the Town of Marana is required as a condition of submittal so the Town can coordinate studies with nearby development and comply with requests for information under the Freedom of Information Act. This release can be included in a copyright or disclaimer notice in the frontispiece.

Format and Style

The report's format and style should provide legible text and graphics. The report should be 8-1/2 x 11, bound, with 11 x 17" fold out illustrations and plan pockets if needed. The reports may be printed on both sides. Remember that the reports need to fit into file drawers and document archive boxes. Oversize reports should **not** be submitted unless approved in advance.

Frontispiece

This is all of the formatted information at the beginning of the report, including the following:

- Report Cover, showing project name, applicant/owner, consultant, date
- Checklist and preliminary information (accepted by Town)
- Title Page, identifying project name, applicant/owner, consultant, project and reference numbers, date, disclaimers, and copyright notice, if any
- Table of Contents/List of Exhibits
- Seal of registrant, per Title 32, Arizona Revised Statutes

Introduction and Project Summary

This section is essentially an executive summary of the report containing a brief background and description of the project and the major findings and recommendations. The following should be included:

- Brief overview of location, access, land use and intensity
- Location and description of proposed development
- Any special conditions or attributes of the project
- Land uses – current and proposed
- Zoning – current and proposed
- Table of proposed land uses by category, size, area and number of units
- Project Site Plan – consistent with the plan submitted for development review (may also be in map pocket)

- Anticipated development phasing and timing
- Summary of major findings and recommendations of report

Study Area Conditions

This section will provide a detailed description and inventory of the study area, current roadways, traffic safety concerns, and related factors. Information can be gathered from field inspection and public records, including the Internet. The following elements are to be included.

- Study Area, or Area of Significant Traffic Impact according to Exhibit 2 or staff requirements;
- Influence Area, the geographic area surrounding the development from which it is expected to draw the majority of its trips;
- Land Uses adjoining the project and within the study area;
- Access to existing and proposed uses near the project site by motor vehicles and alternate modes;
- Inventory of physical characteristics of roadways, including number of lanes and typical cross section, speed limits, traffic control devices, traffic noise (roadway and rail/air if needed), transit service and bus stop locations, sidewalks, school crossings/ pedestrian crossings, roadway lighting, bike paths and bike routes, alternate modes, sight distances at proposed and existing intersections within the study area and other (trails, etc);
- Programmed roadway improvements list, including all roadway improvements within the study area currently programmed on the Town's CIP, PAG's or RTA's TIP, ADOT's transportation plan or TIP, or to be provided by developers of other sites in the study area.
- Traffic Volumes and specified intersection turning movements, obtaining new segment, approach, and turning movement counts as needed;
- System Performance and Level of Service analyses for segments and intersections (signalized and major unsignalized), using Highway Capacity Manual methods or other methods approved by the Town during Steps 1 and 2;
- Accident rates/safety for the most recent three-year period available, expressed in millions of vehicle miles (MVM) for roadway segments and millions of entering vehicles (MEV) for intersections, and identifying any obvious changes in rates. Emphasize fatal accidents and severity types. Utilize Pima County's collision rating system or similar. Provide collision diagrams if requested by the Town; and,
- Data Sources – list or footnote all data sources and provide new count data in the appendix.

Exhibit 2 provides general guidelines on the analysis area requirements and horizon years according to the size of the proposed project.

Current roadway performance is determined using Exhibit 3, which provides maximum traffic service volumes for various roadway types at LOS C, D, and E. For the purposes of preparing TIS's, LOS D shall be considered the performance standard for most areas, with LOS C considered the standard for selected rural areas, and LOS E (for peak periods only) for some congested urbanized areas. The Town's Traffic Engineering Division Manager will determine the performance standard to be used for the area under study.

Marana Analysis Category	**Development Characteristics**	**Study Horizons** (At Full Occupancy and Buildout)	**Minimum Study Area** (May be modified by Traffic Engineering Division Manager)
A	Small Development < 500 peak hour trips generated	1. Opening Year	A. Site access driveways and intersections B. Adjacent signalized and unsignalized major intersections
B	Moderate Development; single phase with 500- 1000 peak hour trips generated	1. Opening Year; 2. Five years after opening	A. Site access driveways and intersections B. All arterial routes, signalized and unsignalized major intersections within one-half mile of the site.
C	Large scale, single phase development with more than 1000 peak hour trips generated	1. Opening Year; 2. Five years after opening 3. Ten years after opening	A. Site access driveways and intersections B. All arterial routes, signalized and unsignalized major intersections within one mile of the site.
D	Moderate or Large scale, multi-phased projects with more than 500 peak hour trips generated	1. Opening Year; 2. Five years after opening 3. Fifteen years after opening	A. Site access driveways and intersections B. All arterial routes, signalized and unsignalized major intersections within one mile of the site.

Exhibit 2 Study Area Requirements

	Maximum Daily Service Volumes		
Through Lanes (Total)	**LOS C**	**LOS D**	**LOS E**
2	9,100	14,600	15,600
4	21,400	31,100	32,900
6	33,400	46,800	49,300

Adapted from Florida DOT Methods

Exhibit 3 Town of Marana Roadway LOS Thresholds

Projected Traffic

This section of the TIS provides a forecast of anticipated traffic from the project, assigns the traffic to the access routes and roadways, and identifies changes in background traffic during the analysis period. The forecasts for build-out conditions are required for all projects, and intermediate years will be required for large-scale or phased projects. For some projects, the analyst must integrate the findings of traffic studies for nearby developments that have already been accepted by the Town or other jurisdictions, but have not yet been constructed. Town staff will provide information on related developments during Steps 1 and 2.

- Site traffic generation, based on ITE Trip rates, special studies, travel demand modeling or other methods approved by the Town during steps 1 and 2
- Passerby rates and new trip calculations
- Driveway trips and New trips; AM, PM, Daily, and weekend peak (if required by Town at pre-conference)
- Mode split by Transit, Carpool, Bike, and Pedestrian, as appropriate
- Trip Distribution, generalized discussion, and Traffic Assignment to roadway network (manually or by modeling, if approved by Town)
- Background Traffic, by phase using trend line, annual growth rates, or modeling; also, traffic from other planned developments in the area, differentiated by project phase if applicable.
- Total Traffic, which includes existing traffic, site traffic and background traffic.
- Separate site traffic from background and other nearby development, as required

Transportation Improvement Analysis

This section uses the information and forecasts from the previous section to determine the impacts of the project on the transportation system. This information is subsequently used to identify mitigation strategies.

- Site access and connectivity – show proposed roadway access points, including dimensions between driveways, median openings, adjacent and opposing street intersections, etc. Describe how vehicles and alternate modes connect to current and planned facilities.
- Intersection Performance – evaluate intersection level of service for signalized and unsignalized major intersections for background and total traffic conditions.
- Roadway Performance – evaluate weekday daily and peak periods (and weekend periods, if required) for background and total traffic conditions.
- Traffic Control Device Needs – identify the need for additional signs and/or pavement markings, per the MUTCD. Identify need for signalization for background and total traffic conditions using needs assessment using Marana/Oregon DOT method shown in the appendix. This may require a speed study to obtain the 85th percentile speed. Or, use the ADOT procedure available at http://www.dot.state.az.us/highways/Traffic/standards/PGP/TM611.pdf.
- Traffic Signal Warrant Abatement Evaluation – In cases where a new traffic signal may be warranted (such as a shopping center driveways with full access) but can not be installed due to their proximity to an existing signalized intersection, evaluate whether turn movement prohibitions (via geometric measures such as raised medians, “pork chops”, etc) would abate the warrants and still allow functional access to the site.
- Traffic Safety – describe how any high accident locations may be impacted by the development.
- Queuing Analysis – estimate queue lengths that need to be accommodated for all turn lanes at analyzed intersections under stop or signal control.
- Turn Lane Warrants – evaluate the need for turn lanes at analyzed intersections (signalized or unsignalized; warrant abatement evaluation, above) using either the warrants found in Pima County’s Subdivision Street Standards for 2-lane roadways or the warrants in NCHRP 457 for turn lanes on multi-lane roadways, as appropriate, or another procedure acceptable to the Town’s Traffic Engineering Division Manager. Notwithstanding these guidelines, the Traffic Engineering Division Manager may require the provision of turn lanes on roadways that are high-speed, high-volume, within urbanized areas, or that experience sight distance limitations.
- Assess any special considerations for the site, for example pedestrian and bike routes to schools, emergency vehicle access at hospitals, and access control for performance venues.
- Traffic Calming and neighborhood traffic mitigation – describe the potential need for and application of these strategies using Town of Marana guidelines, published separately. Consider the use of modern roundabouts in lieu of traffic signalization or traffic circles to provide traffic calming.

- Describe any intersection or stopping sight distance problems that may need mitigation or special attention during development site design or improvement plans.
- Traffic noise estimates and mitigation (if required) – using manual calculations, noise monitoring, or modeling using approved software.
- Generally describe the pavement condition and type of the study area roadways and whether the existing pavement condition can accommodate the additional project traffic without causing a significant deterioration of the roadway's pavement. The Town may require a subsequent structural analysis as part of the off-site improvement plans.

Recommended System Improvements and Traffic Mitigation

This section describes the on-site and offsite improvements and strategies necessary to mitigate traffic generated by the development. Improvements are not always roadway and access enhancements. They might also be travel reduction programs, restrictions of work hours, and similar travel demand management techniques. Improvements should address all modes of travel included in the study. The recommendations may be coordinated with Town staff prior to formal submittal of the report.

- Describe, list and/or map recommended improvements;
- Provide the recommended timeline for improvements;
- Establish "triggers" for improvements in terms of future level of service, number of new homes or jobs, traffic delay, or other parameters; and
- Describe how non-structural mitigation is implemented, i.e., travel demand management strategies and alternate modes if applicable.

Summary of Findings and Recommendations

This section summarizes the development context, development impacts, and mitigation strategies. It should be brief and can serve as an executive summary for larger studies.

- Summary of existing conditions;
- Summary of proposed project;
- Summary of traffic analyses (current and future);
- Summary of recommendations including roadway improvements, intersection improvements, access conditions, traffic control devices, and safety improvements, including enhanced geometrics and sight distances;
- Alternate modes – transit, bike, and pedestrians;
- Traffic calming and mitigation of neighborhood traffic intrusion;
- Summary of implementation triggers; and,
- Summary of other recommendations, if needed

Report Appendices

These may be submitted in one bound copy only. Digital input/output files may be requested by staff for some projects. Appendices should be organized behind a table of contents or list of materials; use dividers between data types. For HCS and other output, provide a list of each file name/run and what it assesses. Clearly mark each run

and do not include superfluous materials. Contact Town staff about submitting an electronic file only as an alternate to printed output. Appendices typically include the following items:

- Traffic data (24-hour and turning movement counts)
- Signalized and non-signalized intersections warrants analyses
- Accident data
- Planning/modeling analyses
- HCS or similar analyses, and other software output

References/Bibliography

Provide a summary of agency coordination that occurred during report preparation. This could include ADOT, Pima County, Sun Tran, and other modes such as railroad.

Report Exhibits

The reports need to be illustrated with charts, tables, graphs, and site plans to support the text. All exhibits should be referenced in the text and numbered. Maps and scale drawings should have a north arrow and scale. Scales should be consistent on similar types of exhibits, for example, all intersection line drawings would be the same scale. Illustration may be in color, but should be designed for black and white reproduction as well. Indicate the date of all aerial and ground photos, and do not use copyrighted maps and other images without written permission.

The following exhibits will be needed in most reports.

- Site location – provide a general location map
- Project Site Plan – consistent with the development plan or plat submitted for technical review; indicate project phases and access for each phase; show distances between access points and median openings. Show site plan on a recent aerial photo base (optional but desirable).
- Map of existing transportation system in the project area
- Ground photos of existing conditions (optional but desirable)
- Inventory of existing transportation system – table showing R/W, number of lanes, speed limits, ownership, pavement width, current volumes, current capacity; current level of service; current performance standard (LOS)
- Current intersection turning movements – show date of data
- Current intersection level of service by movement and period
- Current roadway segment level of service
- Collision data summary and collision diagrams (if required)
- Trip generation summary table – show calculations and ITE classifications used AM, PM, Weekday, and weekend peak (if required) by project phase
- Summary of new trips – provide table showing passerby rates and calculations by phase of development
- Trip distribution to transportation network – by phase if necessary, general percentages
- Site traffic assignment to roadway network, by peak period and project phases

- Background traffic by peak period and project phases
- Total Traffic- the sum of the existing traffic, site traffic and background traffic
- Transportation System Performance – show tables or line drawings indicating levels of service for background traffic conditions and total traffic conditions (by phase) for major intersections and roadway segments. Highlight system elements that perform worse than the approved standard by using bold type or color.
- Proposed improvements - provide a table or drawing showing the location and type of mitigating improvements. Identify when the improvements are needed.

APPENDIX

ATTACHMENT 1: **TIS CHECKLIST**

[Also available electronically online.]

7-5-2006

TOWN OF MARANA ARIZONA
TRANSPORTATION IMPACT STUDY
CHECKLIST AND SUBMITTAL FORM

Please complete this form and return to Marana Development Services, Traffic Engineering Division, for review and acceptance. Submit the completed and accepted form with your study. Studies will not be reviewed without this checklist attached. (Acceptance of this form does **not** constitute acceptance of the study.)

Project Name:

Project Location:

Applicant/Developer

Consultant:

Address **Phone**

City/Town

State **E-mail**

Arizona Civil Engineering Registrant?

Was the consultant actively involved in the site circulation, roadway layout, and selection of access locations?

Brief description of project:

Current and proposed zoning:

☐ **Pre-submittal Meeting Held on** _____

Summary of Meeting:

Nature of Transportation Study

Rezoning study?	☐ **Yes**	☐ **No**
Development Plan?	☐ **Yes**	☐ **No**
Block Plat?	☐ **Yes**	☐ **No**
Subdivision Plat?	☐ **Yes**	☐ **No**

Proposed access locations:

New Median Openings requested?	☐ **Yes**	☐ **No**
Access via Non-Town Roadways?	☐ **Yes**	☐ **No**
Coordination with Non-Town Agency(s)?	☐ **Yes**	☐ **No**

Transportation Study Parameters

Trip Generation — **Land Use Categories and Rates:**

Horizon Year(s)

Trip Distribution — **To/From** **North:** **East:** **South:** **West:** **Other:**

Passer-by Traffic & Internal Capture — **Rate(s)**

Alternate Modes Considerations — **Bike** **Pedestrian** **Transit**

Traffic Data and Preliminary Trip Generation

Analysis Elements and Methods

Roadways

Intersections

Traffic Safety and other Special Considerations

We concur that the information above is correct and that the study will include the parameters and elements described above.

Consultant Concurrence in Study Requirements **Consultant signature:**

Printed name:

Title: **Date:**

***Checklist Accepted** **Town of Marana authorized signature:**

Printed name:

Title: **Date:**

MARANA USE ONLY:

** As there may be instances when one or more study requirements are inadvertently not discussed during the pre-submittal meeting, additional study parameters or elements (other than those discussed in this Checklist) may be required following the first submittal of the study if the Town deems that they are critical to the study findings.*

ATTACHMENT 2-

RECOMMENDED ANALYTICAL METHODS, REFERENCES, AND WEB SITES

- Intersection Capacity Analyses – *Highway Capacity Manual* (most recent edition) methods as deployed in the Highway Capacity Software and similar approved software.

- Segment Capacity Analyses - *Highway Capacity Manual* (most recent edition) methods as deployed in the Highway Capacity Software and similar approved software.

- Signal Phasing and Timing – manual calculations or computer simulation with approved software.

- Corridor Analyses – any software package derived from USDOT/federally approved methods

- Traffic Forecasts – approved forecasts obtained from the Pima Association of Governments; forecasts provided by the Town of Marana; trend line or growth rate analyses approved by the Town.

- Trip Generation – ITE trip generation rates; trip generation output from an approved and operational travel demand model.

- General Requirements for Traffic Impact Analyses on state routes within Marana – Traffic Impact Analysis for Proposed Development (latest edition;

    - See ADOT's web site at http://www.dot.state.az.us/ROADS/traffic/pgp.htm

- Traffic Noise and Other analyses – confer with Town staff prior to analysis.

- NCHRP 457 - Evaluating Intersection Improvements: An Engineering Study Guide, which is available online at : http://onlinepubs.trb.org/onlinepubs/nchrp/esg/esg.pdf

ATTACHMENT 3

PROTOTYPE PRE-SUBMITTAL MEETING AGENDA

ATTENDANCE

STAFF - PUBLIC WORKS, TRAFFIC, PLANNING, OTHERS AS NEEDED

FOR APPLICANT - TRAFFIC ENGINEER(S) FOR APPLICANT (CIVIL DESIGNERS, LAND PLANNERS AND OWNERS DESIRABLE BUT NOT REQUIRED) OTHERS AS NEEDED

VISUAL AIDS - PROJECT SITE PLAN, TOWN MAP, TOWN ROADWAY MAP;
PAG OF TOWN OF MARANA TRAFFIC VOLUME MAP

RESOURCE DOCUMENTS- MARANA NORTHWEST AREA PLAN, MARANA TRANSPORTATION PLAN, MARANA CIP, PAG/RTA TIP, OTHERS AS NEEDED

AGENDA

1. **Welcome and Introductions**
   - Staff
   - Developer/Owner
   - Consultants

2. **Project Overview (By applicant)**
   - Project Location
   - Current Land Use and Zoning
   - Proposed Land Use and Zoning
   - Current Site Access
   - Describe roads and their physical condition
   - Current Alternate Modes
   - Current Congestion Issues
   - Current Safety Issues
   - Horizon Year(s)

3. **Traffic Impacts and Mitigation (By applicant)**
   - Proposed Site Access
   - New driveways, street intersections, median openings, traffic interchanges, turn bays, pedestrian crossings, bus stops, etc.
   - Trip Generation Characteristics of Development (Daily, weekend)
   - Trip Generation – estimate of new trips (Daily/ AM/PM; Saturday)
   - Passerby and “new trip” percentages
   - Anticipated Off-site Improvements/Mitigation
   - Anticipated On-site Improvements/Mitigation
   - Alternate Mode Considerations
   - Bike, pedestrian, transit
   - Traffic calming strategies
   - Neighborhood traffic intrusion mitigation

4. **Technical Analysis (All)**
   - Performance standards (level of service, delay, etc.)
   - Current and future expectations
   - Define/agree on study limits and focus areas
   - Data Collection – agree on what available traffic data to use; what data needs to be collected and by whom
   - Special Analytical methods to be used if any (micro-simulation; travel demand modeling; intersection animation; corridor simulation; alternatives analysis; signal timing; etc.)
   - Staff to provide information from related reports at this meeting (adjoining/nearby property TISs, for example) not otherwise available to the consultant.

5. **Special Transportation/Traffic Considerations (Town Staff)**
   - Staff to provide, in detail, any special concerns regarding any mode of travel to be addressed in the TIS or project design

6. Meeting Summary (By Applicant)

Expectations of the TIS
Study area
Technical emphasis
Need for on-site field review, if any
Special coordination – who is involved and how documented
Special concerns/considerations
Need for existing data/ how provided
Who obtains new data and when
Need for follow-up meeting, if any
Need for submittal presentation meeting, if any
Complete checklist to be included with TIS report submittal
When applicant's meeting summary will be required

7. Adjournment

ATTACHMENT 5

PRELIMINARY SIGNAL WARRANTS ANALYSIS METHOD

Preliminary Signal Warrants
(Adapted from Oregon Department of Transportation)

Introduction
The single most important criterion for preliminary signal warrant analysis is engineering judgment. In the following procedures only the fundamental parameters of volumes and approach lanes are provided.

Background
There are eight traffic signal warrants found in the *Manual on Uniform Traffic Control Devices* (MUTCD). The signal warrants are:

Warrant 1 Eight-Hour Vehicular Volume.
Case A – Minimum Vehicular Volume.
Case B – Interruption of Continuous
Traffic. Warrant 2 Four-Hour Vehicular Volume.
Warrant 3 Peak Hour.
Warrant 4 Pedestrian Volume.
Warrant 5 School Crossing.
Warrant 6 Coordinated Signal System
Warrant 7 Crash Experience
Warrant 8 Roadway Network.

Pursuant to the MUTCD if either of the cases in Warrant 1 is satisfied, the warrant is met. Case A deals primarily with high volumes on the intersecting minor street. Case B addresses high volumes on the major street and the delays and hazards to vehicles on the minor street trying to either access or cross the major street.

Meeting preliminary signal warrants does not always require that a signal will be installed. In some cases, before a signal can be installed a traffic signal warrant study must be conducted or reviewed by the Traffic Engineering Division Manager. Traffic signal warrants must be met and the Town Engineer's approval obtained before a traffic signal can be installed on a Town roadway.

Analysis
In MUTCD warrant 1 the eighth highest hour of an average day is used to determine whether a warrant is met. Average Daily Traffic (ADT) is used for preliminary signal warrant analysis. We apply a conversion factor of 5.65% of the major street ADT or the minor street approach volume (highest volume approach) to reach the eighth highest hour. To convert MUTCD hourly volumes to ADT volumes, divide the MUTCD volume by the factor .0565, this equals the target ADT volume to meet MUTCD warrant 1.

If the 85th percentile speed of major street traffic exceeds 40 mph (or the street is posted with a speed limit of 40 mph or more) in either an urban or rural area, or when the intersection lies within the built-up area of an isolated community having a population of less that 10,000, reduce the target volume for the warrants to 70 percent of the normal requirements. The warrant volumes, along with the number of lanes, are shown in the example preliminary traffic signal warrant analysis sheet on the following page.

MARANA, ARIZONA

Preliminary Traffic Signal Warrant Analysis

Major Street:	**Minor Street:**
Project:	**City/County:**
Year:	**Alternative:**

Preliminary Signal Warrant Volumes

Number of Approach lanes		ADT on major street approaching from both directions		Approach Volume on minor street, highest volume approach	
		Percent of standard warrants		Percent of standard warrants	
Major Street	Minor Street	100	70	100	70
Case A: Minimum Vehicular Traffic					
1	1	8,850	6,200	2,650	1,850
2 or more	1	10,600	7,400	2,650	1,850
2 or more	2 or more	10,600	7,400	3,550	2,500
1	2 or more	8,850	6,200	3,550	2,500
Case B: Interruption of Continuous Traffic					
1	1	13,300	9,300	1,350	950
2 or more	1	15,900	11,100	1,350	950
2 or more	2 or more	15,900	11,100	1,750	1,250
1	2 or more	13,300	11,100	1,500	1,250

5.65% of the above ADT volumes is equal to the MUTCD vehicles per hour (vph)

100 percent of standard warrants

70 percent of standard warrants

Preliminary Signal Warrant Calculation

	Street	Number of Lanes	Warrant Volumes	Approach Volumes	Warrant Met
Case A	Major	2+	10,600	13,000	N
	Minor	1	2,650	2,180	
Case B	Major	2+	15,900	13,000	N
	Minor	1	1,350	2,180	

Analyst and Date:	Reviewer and Date:

Determining the number of approach lanes and determining the approach volumes to use in the warrant analysis requires knowledge of the involved intersection.

1. Major Street (higher volume street)
    - Include only the through and through/turn lanes in the number of approach

lanes.

- For the ADT, count total volume approaching from both directions, **including** all turn movements.

2. Minor Street (lower volume street)
    - Include only the through, through/turn, and left turn lanes in the number of approach lanes.
    - For the ADT, count the highest approaching volume (one direction only, do not include the ADT approaching from both directions) including some or none of the right turn volume as discussed in the following scenarios:

        - ***Scenario # 1 – Shared left-through-right lane:*** Some of the right turns are included in the minor street approach ADT if the right turn demand is greater than 85% of the capacity of the shared lane. Use UNSIG10 or HCS to calculate the capacity of the shared lane. The right turn discount is 85% of the shared lane capacity (85% of the capacity is used because once the v/c exceeds 0.85, drivers suffer longer delay and begin to take unsafe gaps). Subtract the right-turn discount from the total right turn volume to determine the number of right turns in the warrant. If the remainder is less than or equal to zero, do not include any of the right turns in the approach ADT.

        - ***Scenario # 2 – Exclusive right-turn lane:*** Some of the right turns are included in the approach ADT if the right turn lane demand is greater than 85% of the capacity of the right turn lane. Use HCS to calculate the capacity of the right turn lane. The right turn discount is 85% of the right turn lane capacity. Subtract the right turn discount from the total right turning volume to determine the number of right turns that will be included in the warrant. If the remainder is less than or equal to zero, do not include any of the right turns in the approach ADT, and do not include the lanes in the number of approach lanes.

        - ***Scenario # 3 – Shared through-right lane:*** Some of the right turns are included in the approach ADT if the right turn demand is greater than 85% of the capacity of the shared through-right lane. Use UNSIG10 or HCS to calculate the capacity of the through-right shared lane. The right turn discount is 85 % of the shared lane capacity. Subtract the right turn discount from the total right turn volume to determine the number of right turns in the warrant. If the remainder is less than or equal to zero, do not include any of the right turns in the approach ADT.

If any of the above scenarios is used, show the calculations on the analysis worksheet.