SANTEC / ITE
GUIDELINES FOR TRAFFIC IMPACT STUDIES [TIS] IN THE SAN DIEGO REGION

MARCH 2, 2000 FINAL DRAFT

PREFACE

These guidelines are subject to continual update, as future technology and documentation become available. Always check with local jurisdictions for their preferred or applicable procedures.

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SANTEC / ITE GUIDELINES FOR TRAFFIC IMPACT STUDIES [TIS] IN THE SAN DIEGO REGION

SANTEC / ITE GUIDELINES FOR TRAFFIC IMPACT STUDIES [TIS] IN THE SAN DIEGO REGION

I. BACKGROUND

In September 1998, the San Diego Regional Traffic Standards Task Force gathered for the first time to promote "cooperation among the Cities, Caltrans, and the County of San Diego to create a region-wide standard for determining traffic impacts in environmental reports." Ultimately the San Diego Traffic Engineers' Council (SANTEC) and the Institute of Transportation Engineers (ITE – California Border Section) were requested to prepare guidelines for traffic impact studies [TIS] that could be reviewed by the Task Force and other appropriate groups. The primary documents used to help prepare these guidelines were SANDAG's Congestion Management Program and Traffic Generators manual, City of San Diego's Traffic Impact Study Manual and Trip Generation Manual, and Caltrans' Draft Guide for the Preparation of Traffic Impact Studies.

II. PURPOSE OF TRAFFIC IMPACT STUDIES [TIS]

Traffic impact studies forecast, describe, and analyze the traffic and transit effects a development will have on the existing and future circulation infrastructure. The purpose of the TIS is to assist engineers in both the development community and public agencies when making land use and other development decisions. A TIS quantifies the changes in traffic levels and translates these changes into transportation system impacts in the vicinity of a project.

TIS requirements are usually outlined as part of any environmental (CEQA) project review process; and, in order to monitor effects by these requirements, Notices of Preparation must be submitted to all affected agencies.

III. OBJECTIVES OF TIS GUIDELINES

The following guidelines were prepared to assist local agencies throughout the San Diego Region in promoting consistency and uniformity in traffic impact studies. All Circulation/Community Element roadways, all State routes and freeways (including metered and unmetered ramps), and all transit facilities that are impacted should be included in each study.

In general, the region-wide goal for an acceptable level-of-service (LOS) on all freeways, roadway segments, and intersections is "D." For undeveloped or not densely developed locations, as determined by any local jurisdiction, the goal may be to achieve a level-of-service of "C." Individual local jurisdictions, as well as Caltrans, have slightly different

LOS objectives. For example, the Regional Growth Management Strategy for San Diego has a level-of-service objective of "D;" while the Congestion Management Program has established a minimum level-of-service of "E", or "F" if that is the existing 1990 base year LOS. In other words, if the existing LOS is "D" or worse, preservation of the existing LOS must be maintained or acceptable mitigation must be identified.

These guidelines do not establish a legal standard for these functions, but are intended to supplement any individual TIS manuals or level-of-service objectives for the various jurisdictions. These guidelines attempt to consolidate regional efforts to identify when a TIS is needed, what professional procedures should be followed, and what constitutes a significant traffic impact.

The instructions outlined in these guidelines are subject to update as future conditions and experience become available. Special situations may call for variation from these guidelines. Caltrans and lead agencies should agree on the specific methods used in traffic impact studies involving any State Route facilities, including metered and un-metered freeway ramps.

IV. NEED FOR A STUDY

A TIS should be prepared for all projects which generate traffic greater than 1,000 total average daily trips (ADT) or 100 peak-hour trips. If a proposed project is not in conformance with the land use and/or transportation element of the general or community plan, use threshold rates of 500 ADT or 50 peak-hour trips. Early consultation with any affected jurisdictions is strongly encouraged since a "focused" or "abbreviated" TIS may still be required – even if the above threshold rates are not met.

Currently, a Congestion Management Program (CMP) analysis is required for all large projects, which are defined as generating 2,400 or more average daily trips or 200 or more peak-hour trips. This size of study would usually include computerized long-range forecasts and select zone assignments. Please refer to the following flow chart (Figure 1) for TIS requirements.

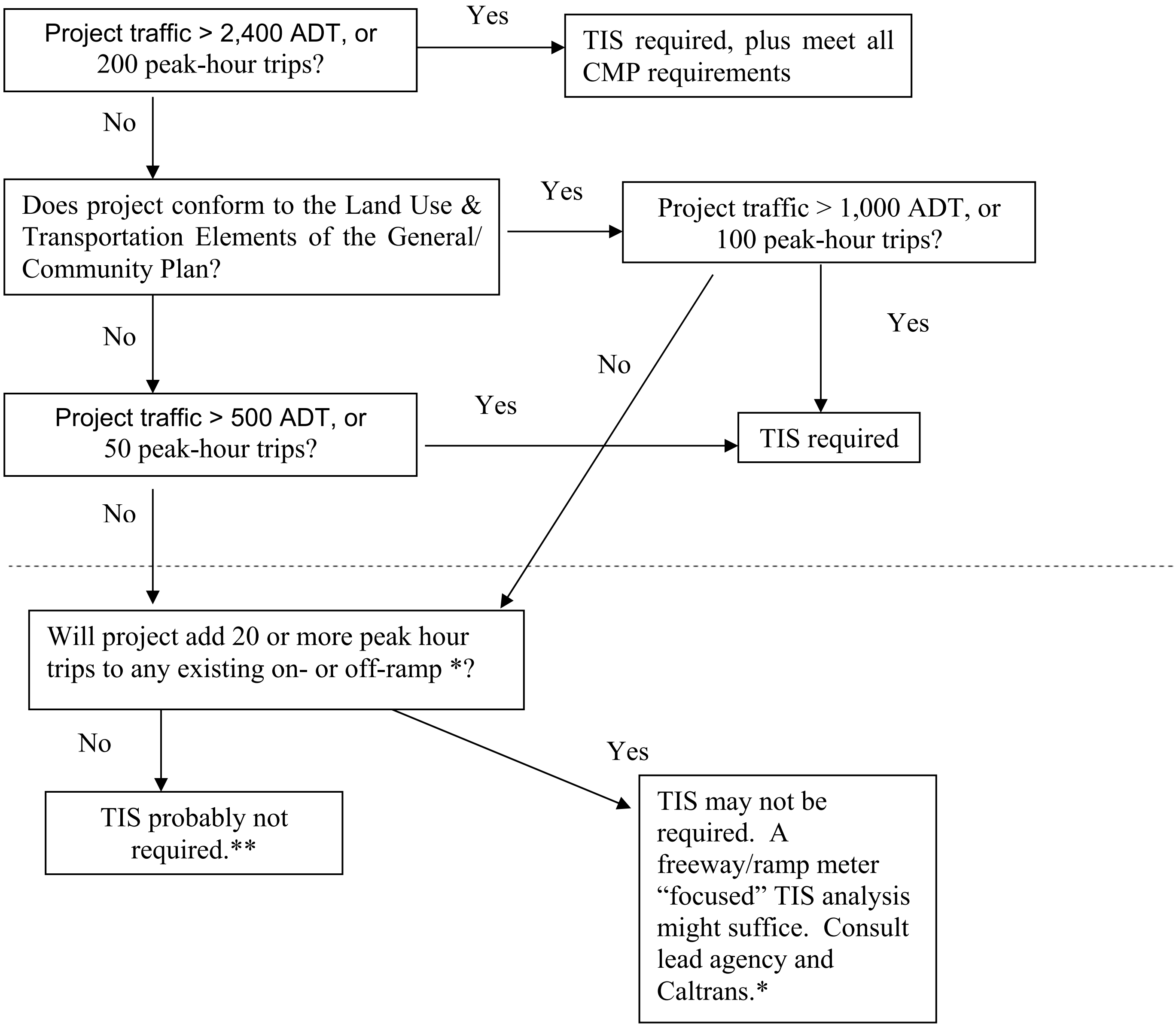
The geographic area examined in the TIS must include the following:

- All local roadway segments (including all State surface routes), intersections, and mainline freeway locations where the proposed project will add 50 or more peak-hour trips in either direction to the existing roadway traffic.

- All freeway entrance and exit ramps where the proposed project will add a significant number of peak-hour trips to cause any traffic queues to exceed ramp storage capacities (see Figure 1). (NOTE: Care must be taken to include <u>other</u> ramps and intersections that may receive project traffic <u>diverted</u> as a result of already existing, or project causing congestion at freeway entrances and exits.)

Figure 1

FLOW CHART FOR TRAFFIC IMPACT STUDY REQUIREMENTS



* Check with Caltrans for current ramp metering rates and ramp storage capacities. (See Attachment B – Ramp Metering Analysis)

** However, for health and safety reasons, and/or local and residential street issues, an “abbreviated” or “focused” TIS may still be requested by a local agency. (For example, this may include traffic backed up beyond an off-ramp’s storage capacity, or may include diverted traffic through an existing neighborhood.)

The data used in the TIS should generally not be more than 2 years old, and should not reflect a temporary interruption (special events, construction detour, etc.) in the normal traffic patterns unless that is the nature of the project itself. If recent traffic data is not available, current counts must be made by the project applicant/consultant.

V. PROJECT COORDINATION VIA STAFF CONSULTATION

Early consultation between the development community, local and lead agencies, and Caltrans is strongly recommended to establish the base input parameters, assumptions, and analysis methodologies for the TIS.

It is critical that the TIS preparer discuss the project with the lead reviewing agency's staff engineer/planner at an early stage in the planning process. An understanding of the level of detail and the assumptions required for the analysis should be reached. While a pre-submittal conference is highly encouraged, it may not be a requirement. For straight-forward studies prepared by consultants familiar with these TIS procedures, a telephone call or e-mail, followed by a fax verifying key assumptions, may suffice. Always check with the local jurisdictions for their concerns.

VI. SCENARIOS TO BE STUDIED

After documenting existing conditions, both near-term (within approximately the next five years) and long-term (usually for a 20-year planning horizon or build-out of the area), analyses are needed.

All of the following scenarios should be addressed in the TIS (unless there is concurrence with the lead agency[ies] that one or more of these scenarios may be omitted):

- Existing {roadway infrastructure}
- Existing + Near-term Cumulative Projects {approved and pending}
- Existing + Near-term Cumulative Projects + Proposed Project {each phase when applicable}
- Horizon Year {typically Year 2020 or twenty years in the future}
- Horizon Year + Proposed Project {if different from General/Community Plan}

Scenario definitions:

<u>Existing</u> conditions – Document existing traffic volumes and peak-hour levels of service in the study area. The existing deficiencies and potential mitigation should be identified.

<u>Existing + Near-term</u> – Analyze the cumulative condition impacts from "other" approved and "reasonably foreseeable" pending projects (application on file or definitely in the pipeline) that are expected to influence the study area. This is the baseline against which project impacts are assessed. The lead agency should provide copies of the traffic studies for the "other" projects. If data is not available for near-term cumulative projects, an ambient growth factor should be used.

Existing + Near-term + Proposed Project – Analyze the impacts of the proposed project on top of existing conditions and near-term projects (along with their committed or funded mitigation measures, if any).

Horizon Year – Identify Year 2020 traffic forecasts or 20-year future conditions through the output of a SANDAG model forecast (currently TRANPLAN) or other computer model approved by the local agency. If the proposed project is consistent with the land uses represented in the model, the TIS may only need to use this condition.

Horizon Year + Proposed Project – If the project land uses are more traffic intense than what was assumed in the horizon year model forecasts, analyze the additional project traffic impacts to the horizon year condition. When justified, and particularly in the case of very large developments or new general/community plans, a transportation model should be run with, and without, the additional development to show the net impacts on all parts of the area's transportation system.

In order to use LOS criteria to measure traffic impact significance (see Table 1), proposed model or manual forecast adjustments must be made to address scenarios both with and without the project. Model data should be carefully verified to ensure accurate project and "other" cumulative project representation. In these cases, regional or sub-regional models conducted by SANDAG need to be reviewed for appropriateness.

Note: Project trips can be assigned and distributed either manually or by the computer model based upon review and approval of the local agency Traffic Engineer. The magnitude of the proposed project will usually determine which method is employed.

If the manual method is used, the trip distribution percentages should be derived from a computer generated "select zone assignment" or optionally (local agency approval) by professional judgement.

If the computer model is used, the centroid connectors should accurately represent project access to the street network. Preferably the project would be represented by its own traffic zone. Some adjustments to the output volumes may be needed (especially at intersections) to smooth out volumes, quantify peak volumes, adjust for pass-by and diverted trips, and correct illogical output.

VII. TRAFFIC GENERATION

Use of SANDAG [Traffic Generators manual and (Not So) Brief Guide….]or City of San Diego [both of the City's Traffic Impact Study Manual and Trip Generation Manual] rates should first be considered. Next, consider rates from ITE's latest Trip Generation manual or ITE Journal articles. If local and sufficient national data do not exist, conduct trip generation studies at sites with characteristics similar to those of the proposed project. If this is not feasible due to the uniqueness of the land use, it may be acceptable to estimate defensible trip rates – only if appropriate documentation is provided.

Reasonable reductions to trip rates may also be considered: (a) with proper analysis of pass-by and diverted traffic on adjacent roadways, (b) for developments near transit stations, and (c) for mixed-use developments. (Note: Caltrans and local agencies may use different trip reduction rates. Early consultation with the reviewing agencies is strongly recommended.)

Site traffic distribution, assignment, necessary model adjustments, and Congestion Management Program (CMP) concerns should all follow current SANDAG and City of San Diego procedures.

VIII. TIS ANALYSIS

The TIS analysis shall determine the effect that a project will have for each of the previously outlined study scenarios. Peak-hour capacity analyses for freeways, roadway segments (ADTs may be used here to estimate V/C ratios), intersections, and freeway ramps must be conducted for both the near-term and long-term conditions. The methodologies used in determining the traffic impact are not only critical to the validity of the analysis, they are pertinent to the credibility and confidence the decision-makers have in the resulting findings, conclusions, and recommendations.

The following methodologies for TIS analysis should be used (unless early consultation with the lead agency and Caltrans has established other methods), along with some suggested software packages and options:

1. Arterials, Multi-lane and Two-lane Highways, and all other Local Streets - current Highway Capacity Manual [HCM]: w/Highway Capacity Software [HCS]
2. Signalized Intersections – HCM: w/HCS, TRAFFIX, SigCinema, and SYNCHRO acceptable to Caltrans; and, HCS, TRAFFIX, SIGNAL 94, and NCAP acceptable to local jurisdictions
3. Unsignalized Intersections – HCM
4. Freeway Segments – HCM or Caltrans District 11 freeway LOS definitions (see Attachment C): w/HCS
5. Freeway Weaving Areas – Caltrans Highway Design Manual (Chapter 500)
6. Freeway Ramps – Caltrans District 11 Ramp Metering Analysis (Attachment B), and Caltrans Ramp Meter Design Guidelines (August 1995), HCS (for ramp design only)
7. Freeway Interchanges – HCM: for diamond interchanges where the timing and phasing of the two signals must be coordinated to ensure queue clearances, consider Passer III-90
8. Transit, Pedestrians, and Bicycles – HCM
9. Warrants for Traffic Signals, Stop Signs, School Crossings, Freeway Lighting, etc. – Caltrans' Traffic Manual

10. Channelization and Intersection Geometry - Caltrans' Traffic Manual and Guidelines for Reconstruction of Intersections, City of San Diego's Traffic Impact Study Manual -Appendix 4

Note: Neither local jurisdictions nor Caltrans officially advocate the use of any special software packages, especially since new ones are being developed all the time. However, consistency with the Highway Capacity Manual (HCM) is advocated in most cases. The above-mentioned software packages have been utilized locally. Because it is so important to have consistent end results, always consult with all affected jurisdictions, including Caltrans, regarding the analytical techniques and software being considered (especially if they differ from above) for the TIS.

IX. SIGNIFICANCE OF TRAFFIC IMPACTS TO CONSIDER MITIGATION

The following Table 1 indicates when a project's impact is significant – and mitigation measures are to be identified. That is, if a project's traffic impact causes the values in this table to be exceeded, it is determined to be a significant project impact. (Mitigation for all identified significant impacts should be provided for any project requiring CEQA analysis.)

Note: It is the responsibility of Caltrans, on Caltrans initiated projects, to mitigate the effect of ramp metering, for initial as well as future operational impacts, on local streets that intersect and feed entrance ramps to the freeway. Developers and/or local agencies, however, should be required to mitigate any impact to existing ramp meter facilities, future ramp meter installations, or local streets, when those impacts are attributable to new development and/or local agency roadway improvement projects.

Not all mitigation measures can feasibly be "hard" (new lanes or new capacity) improvements. A sample mitigation measure might include financing toward a regional ITS [Intelligent Transportation System] project, such as improved or "dynamic" ramp metering with real-time delay information available to motorists. The information can be accessed on either home or in-vehicle computers, or even by telephone (each ramp could have its own phone number with delay information) so the motorist can make a driving decision long before she or he arrives at a congested on-ramp. This sample mitigation would allow a project applicant (especially with a relatively small project) to meet mitigation by paying into a regional ramp meter fee, providing the fee can be established in the near future.

Other mitigation measures may include Transportation Demand Management recommendations – transit facilities, bike facilities, walkability, telecommuting, traffic rideshare programs, flex-time, carpool incentives, parking cash-out, etc. Additional mitigation measures may become acceptable as future technologies and policies evolve.

Table 1

MEASURE OF SIGNIFICANT PROJECT TRAFFIC IMPACTS

Level of Service with Project*	Allowable Change due to Project Impact**					
	Freeways		Roadway Segments		Intersections	Ramp*** Metering
	V/C	Speed (mph)	V/C	Speed (mph)	Delay (sec.)	Delay(min.)
D, E, & F (or ramp meter delays above 15 min.)	0.01	1	0.02	1	2	2

NOTES:

* All level of service measurements are based upon HCM procedures for peak-hour conditions. However, V/C ratios for Roadway Segments may be estimated on an ADT/24-hour traffic volume basis (using Table 2 or a similar LOS chart for each jurisdiction). The acceptable LOS for freeways, roadways, and intersections is generally "D" ("C" for undeveloped or not densely developed locations per jurisdiction definitions). For metered freeway ramps, LOS does not apply. However, ramp meter delays above 15 minutes are considered excessive.

** If a proposed project's traffic causes the values shown in the table to be exceeded, the impacts are determined to be significant. These impact changes may be measured from appropriate computer programs or expanded manual spreadsheets. The project applicant shall then identify feasible mitigation (within the Traffic Impact Study [TIS] report) that will maintain the traffic facility at an acceptable LOS. If the LOS with the proposed project becomes unacceptable (see above * note), or if the project adds a significant amount of peak-hour trips to cause any traffic queues to exceed on- or off-ramp storage capacities, the project applicant shall be responsible for mitigating significant impact changes.

*** See Attachment B for ramp metering analysis.

KEY:
- V/C = Volume to Capacity ratio
- Speed = Speed measured in miles per hour
- Delay = Average stopped delay per vehicle measured in seconds for intersections, or minutes for ramp meters
- LOS = Level of Service

Table 2

ROADWAY CLASSIFICATIONS, LEVELS OF SERVICE (LOS) AND AVERAGE DAILY TRAFFIC (ADT)

STREET CLASSIFICATION	LANES	CROSS SECTIONS* (APPROX.)	LEVEL OF SERVICE W/ADT** A	B	C	D	E
Expressway	6 lanes	102-160/122-200	30,000	42,000	60,000	70,000	80,000
Prime Arterial	6 lanes	102-108/122-128	25,000	35,000	50,000	55,000	60,000
Major Arterial	6 lanes	102/122	20,000	28,000	40,000	45,000	50,000
Major Arterial	4 lanes	78-82/98-102	15,000	21,000	30,000	35,000	40,000
Secondary Arterial/ Collector	4 lanes	64-72/84-92	10,000	14,000	20,000	25,000	30,000
Collector (no center lane) (continuous left-turn lane)	4 lanes 2 lanes	64/84 50/70	5,000	7,000	10,000	13,000	15,000
Collector (no fronting property)	2 lanes	40/60	4,000	5,500	7,500	9,000	10,000
Collector (commercial-industrial fronting)	2 lanes	50/70	2,500	3,500	5,000	6,500	8,000
Collector (multi-family)	2 lanes	40/60	2,500	3,500	5,000	6,500	8,000
Sub-Collector (single-family)	2 lanes	36/56	---	---	2,200	---	---

LEGEND:

* Curb to curb width (feet)/right of way width (feet): based upon the City of San Diego Street Design Manual and other jurisdictions within the San Diego region.

** Approximate recommended ADT based upon the City of San Diego Street Design Manual.

NOTES:

1. The volumes and the average daily level of service listed above are only intended as a general planning guideline.

2. Levels of service are not applied to residential streets since their primary purpose is to serve abutting lots, not carry through traffic. Levels of service normally apply to roads carrying through traffic between major trip generators and attractors.

X. SCREEN CHECK

As part of the first draft of a TIS, the preparer must ensure that all required elements have been included. This screen check procedure will help reduce the number of submittals, and will encourage early dialog between the reviewer and the preparer. The local agency reviewer will check the study for completeness, and strive to return all incomplete submittals within seven working days. A presubmittal conference is encouraged to determine which elements are not required for the TIS.

Attachment A contains the TIS Screen Check.

ATTACHMENT A

To be completed by Staff:
Date Received __________________
Reviewer ______________________
Date Screen Check ______________

TRAFFIC IMPACT STUDY
SCREEN CHECK

To be completed by consultant (including page #):
Name of Traffic Study ____
Consultant ____
Date Submitted ____

Indicate Page # in report:				Satisfactory YES	Satisfactory NO	NOT REQUIRED
pg. ____	1.		Table of contents, list of figures and list of tables.	☐	☐	
pg. ____	2.		Executive summary.	☐	☐	
pg. ____	3.		Map of the proposed project location.	☐	☐	
	4.		General project description and background information:			
pg. ____		a.	Proposed project description (acres, dwelling units….)	☐	☐	
pg. ____		b.	Total trip generation of proposed project.	☐	☐	
pg. ____		c.	Community plan assumption for the proposed site.	☐	☐	
pg. ____		d.	Discuss how project affects the Congestion Management Program, if applicable	☐	☐	
pg. ____	5.		Parking, transit and on-site circulation discussions are included.	☐	☐	
pg. ____	6.		Map of the Transportation Impact Study Area and specific intersections studied in the traffic report.	☐	☐	
pg. ____	7.		Existing Transportation Conditions:			
		a.	Figure identifying roadway conditions including raised medians, median openings, separate left and right turn lanes, roadway and intersection dimensions, bike lanes, parking, number of travel lanes, posted speed, intersection controls, turn restrictions and intersection lane configurations.	☐	☐	
		b.	Figure indicating the daily (ADT) and peak-hour volumes.	☐	☐	
		c.	Figure or table showing level of service (LOS) for intersections during peak hours and roadway sections within the study area (include analysis sheets in an appendix).	☐	☐	
	8.		Project Trip Generation:			
pg. ____			Table showing the calculated project generated daily (ADT) and peak hour volumes.	☐	☐	
pg. ____	9.		Project Trip Distribution using the current TRANPLAN Computer Traffic Model (provide a computer plot) or manual assignment if previously approved. (Identify which method was used.)	☐	☐	
	10.		Project Traffic Assignment:			
pg. ____		a.	Figure indicating the daily (ADT) and peak-hour volumes.	☐	☐	
pg. ____		b.	Figure showing pass-by-trip adjustments, and, if cumulative trip rates are used.	☐	☐	☐
	11.		Existing Near-term Cumulative Conditions:			
pg. ____		a.	Figure indicating the daily (ADT) and peak-hour volumes.	☐	☐	
pg. ____		b.	Figure or table showing the projected LOS for intersections during peak hours and roadway sections within the study area (analysis sheets included in the appendix).	☐	☐	
pg. ____		c.	Traffic signal warrant analysis (Caltrans Traffic Manual) for appropriate locations.	☐	☐	
	12.		Existing Near-term Cumulative Conditions + Proposed Project (each phase			

Indicate Page # in report:				Satisfactory YES	NO	NOT REQUIRED
			when applicable)			
pg. ____		a.	Figure or table showing the projected LOS for intersections during peak hours and roadway sections with the project (analysis sheets included in the appendix).	☐	☐	
pg. ____		b.	Figure showing other projects that were included in the study, and the assignment of their site traffic.	☐	☐	
pg. ____		c.	Traffic signal warrant analysis for appropriate locations.	☐	☐	
	13.		Horizon Year Transportation Conditions (if project conforms to the General/ Community Plan):			
pg. ____		a.	Horizon Year ADT and street classification that reflect the Community Plan.	☐	☐	☐
pg. ____		b.	Figure or table showing the horizon LOS for intersections during peak hours and roadway sections with and without the project (analysis sheets included in the appendix).	☐	☐	☐
pg. ____		c.	Traffic signal warrant analysis at appropriate locations.	☐	☐	☐
	14.		Horizon Year Transportation Conditions + Proposed Project (if project does not conform to the General/Community Plan):			
pg. ____		a.	Horizon Year ADT and street classification as shown in the Community Plan.	☐	☐	☐
pg. ____		b.	Horizon Year ADT and street classification for two scenarios: with the proposed project and with the land use assumed in the Community Plan.	☐	☐	☐
pg. ____		c.	Figure or table showing the horizon LOS for intersections during peak hours and roadway sections for two scenarios: with and without the proposed project and with the land use assumed in the Community Plan (analysis sheets included in the appendix).	☐	☐	☐
pg. ____		d.	Traffic signal warrant analysis at appropriate locations with the land use assumed in the General/Community Plan.	☐	☐	☐
pg. ____	15.		A summary table showing the comparison of Existing, Existing + Near-term Cumulative, Existing + Near-term Cumulative + Proposed Project, Horizon Year, and Horizon Year + Proposed Project (if different from General/Community Plan), LOS on roadway sections and intersections during peak hours.	☐	☐	
pg. ____	16.		A summary table showing the project's "significant traffic impacts."	☐	☐	
	17.		Transportation Mitigation Measures:			
pg. ____		a.	Table identifying the mitigations required that are the responsibility of the developer and others. A phasing plan is required if mitigations are proposed in phases.	☐	☐	
pg. ____		b.	Figure showing all proposed mitigations that include: intersection lane configurations, lane widths, raised medians, median openings, roadway and intersection dimensions, right-of-way, offset, etc.	☐	☐	
pg. ____	18.		The Highway Capacity Manual Operation Method or other approved method is used at appropriate locations within the study area.	☐	☐	
pg. ____	19.		Analysis complies with Congestion Management Program requirements.	☐	☐	☐
pg. ____	20.		Appropriate freeway analysis is included.	☐	☐	☐
pg. ____	21.		Appropriate freeway ramp metering analysis is included.	☐	☐	☐
pg. ____	22.		The traffic study is signed by a California Registered Traffic Engineer.	☐	☐	

THE TRAFFIC STUDY SCREEN CHECK FOR THE SUBJECT PROJECT IS:

____________ Approved

____________ Not approved because the following items are missing:

____

____

____

ATTACHMENT B

RAMP METERING ANALYSIS

Ramp metering analysis should be performed for each horizon year scenario in which ramp metering is expected. The following table shows relevant information that should be included in the ramp meter analysis "Summary of Freeway Ramp Metering Impacts."

LOCATION	DEMAND (veh/hr)[1]	METER RATE (veh/hr)[2]	EXCESS DEMAND (veh/hr)[3]	DELAY (min)[4]	QUEUE (feet)[5]

NOTES:

[1] DEMAND is the peak hour demand expected to use the on-ramp.

[2] METER RATE is the peak hour capacity expected to be processed through the ramp meter. This value should be obtained from Caltrans. Contact Carolyn Rumsey at (619) 467-3029.

[3] EXCESS DEMAND = (DEMAND) – (METER RATE) or zero, whichever is greater.

[4] DELAY =
$$\frac{\text{EXCESS DEMAND}}{\text{METER RATE}} \text{ X 60 MINUTES/HOUR}$$

[5] QUEUE = (EXCESS DEMAND) X 29 feet/vehicle

NOTE: Delay will be less at the beginning of metering. However, since peaks will almost always be more than one hour, delay will be greater after the first hour of metering. (See discussion on next page.)

SUMMARY OF FREEWAY RAMP METERING IMPACTS
(Lengthen as necessary to include all impacted meter locations)

LOCATION(S)	PEAK HOUR	PEAK HOUR DEMAND D	FLOW (METER RATE) F	EXCESS DEMAND E	DELAY (MINUTES)	QUEUE Q (feet)
	AM PM					
	AM PM					
	AM PM					

DISCUSSION OF RAMP METER ANALYSIS

A. CAUTION: The ramp metering analysis shown in Attachment B may lead to grossly understated results for delay and queue length, since important aspects of queue growth are ignored. Also, the draft guidelines method derives average values instead of maximum values for delay and queue length. Utilizing average values instead of maximum values can lead to obscuring important effects, particularly in regard to queue length.

Predicting ramp meter delays and queues requires a storage-discharge type of analysis, where a pattern of arriving traffic at the meter is estimated by the analyst, and the discharge, or meter rate, is a somewhat fixed value set by Caltrans for each individual metered ramp.

Since a ramp meter queue continues to grow longer during all times that the arrival rate exceeds the discharge rate, the maximum queue length (and hence, the maximum delay) usually occurs after the end of the peak (or highest) one hour. This leads to the need for an analysis for the entire time period during which the arrival rate exceeds the meter rate, not just the peak hour. For a similar reason, the analysis needs to consider that a substantial queue may have already formed by the beginning of the "peak hour." Traffic arriving during the peak hour is then stacked onto an existing queue, not just starting from zero as the draft analysis suggests.

Experience shows that the theoretical queue length derived by this analysis often does not materialize. Motorists, after a brief time of adjustment, seek alternate travel paths or alternate times of arrival at the meter. The effect is to approximately minimize total trip time by seeking out the best combinations of route and departure time at the beginning of the trip. This causes at least two important changes in the pattern or arriving traffic at ramp meters. First, the peak period is spread out, with some traffic arriving earlier and some traffic arriving later than predicted. Second, a significant proportion of the predicted arriving traffic will use another ramp, use another freeway, or stay on surface streets.

It is acceptable to make reasonable estimates of these temporal and spatial (time and occupying space) diversions as long as all assumptions are stated and that the unmodified, or theoretical values are shown for comparison.

B. Additional areas for study include being able to define acceptable levels of service (LOS) and "significant" thresholds (e.g., a maximum ramp meter delay of 15 minutes) for metered freeway entrance ramps.

Currently there are no acceptable software programs for measuring project impacts on metered freeway ramps nor does the Highway Capacity Manual (HCM) adequately address this issue. Hopefully in the near future a regionwide study will be initiated to determine what metering rate (at each metered ramp) would be required in order to guarantee that traffic will flow (even at LOS "E") on the entire freeway system during peak-hour conditions. From this, the ramp delays and resultant queue lengths might then be calculated. Overall, this is a very complex issue that needs considerable research and refinement in cooperation with Caltrans.

ATTACHMENT C

LEVEL OF SERVICE (LOS) DEFINITIONS (generally used by Caltrans)

The concept of Level of Service (LOS) is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers. A Level of Service[s] definition generally describes these conditions in terms of such factors as speed, travel time, freedom to maneuver, comfort and convenience, and safety. Levels of Service definitions can generally be categorized as follows:

LOS	**D/C***	**Congestion/Delay**	**Traffic Description**
		(Used for freeways, expressways and conventional highways[A])	
"A"	<0.41	None	Free flow.
"B"	0.42-0.62	None	Free to stable flow, light to moderate volumes.
"C"	0.63-0.79	None to minimal	Stable flow, moderate volumes, freedom to maneuver noticeably restricted.
"D"	0.80-0.92	Minimal to substantial	Approaches unstable flow, heavy volumes, very limited freedom to maneuver.
"E"	0.93-1.00	Significant	Extremely unstable flow, maneuverability and psychological comfort extremely poor.
		(Used for conventional highways)	
"F"	>1.00	Considerable	Forced or breakdown. Delay measured in average flow, travel speed (MPH). Signalized segments experience delays >60.0 seconds/vehicle.
		(Used for freeways and expressways)	
"F0"	1.01-1.25	Considerable 0-1 hour delay	Forced flow, heavy congestion, long queues form behind breakdown points, stop and go.
"F1"	1.26-1.35	Severe 1-2 hour delay	Very heavy congestion, very long queues.
"F2"	1.36-1.45	Very severe 2-3 hour delay	Extremely heavy congestion, longer queues, more numerous breakdown points, longer stop periods.
"F3"	>1.46	Extremely severe 3+ hours of delay	Gridlock.

[s] Level of Service can generally be calculated using "Table 3.1. LOS Criteria for Basic Freeway Sections" from the latest Highway Capacity Manual. However, contact Caltrans for more specific information on determining existing "free-flow" freeway speeds.

* Demand/Capacity ratio used for forecasts (V/C ratio used for operational analysis, where V = volume)

[A] Arterial LOS is based upon average "free-flow" travel speeds, and should refer to definitions in Table 11.1 in the HCM.