

# Site Impact Traffic Analysis

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## INTRODUCTION

The purpose of this paper is to explain the requirements of the public agencies in the City of Indianapolis and the State of Indiana with regard to trip generation, assignment of traffic to the public street system and distribution of the generated traffic. Further this paper will describe the procedures used in the City of Indianapolis and State of Indiana to:

- Determine trip generation rates.
- Describe how individual land use trip generation rates are combined in multi-use developments to estimate total traffic to and from the development.
- Describe procedures used to estimate the volume of new traffic that will be generated on the public street system by a proposed development.
- Present data on how effective several of these procedures have been.
- Describe how land use trip generation rates are used to estimate the approximate time that a traffic signal may be warranted.

## HISTORY

In the City of Indianapolis a traffic impact study is not a prerequisite for the filing of a rezoning petition for an undeveloped tract of land.

Zoning officials do not use a traffic generation and distribution analysis for the evaluation of a rezoning petition.

A traffic generation and distribution analyses may be used by the issuers of permits for the review and approval of an access plan, the general geometrics and traffic control of the driveways and improvements to the abutting street. This type of analysis becomes important for multi-use development of large tracts of undeveloped land.

The Institute of Transportation Engineers, through its *Trip Generation Report*, has provided a sound basis for estimating trip generation for individual land uses. However, as written by Carl Buttker in *Using the ITE Trip Generation Report*: "All rates presented in Trip Generation were developed from measurements at isolated single use developments." He further wrote that: "Very little data are available to recommend a method for estimating reduced driveway volumes because of combined uses."

The City of Indianapolis also recognized this deficiency and initiated procedures to try to overcome the problem as early as 1978.

The Indianapolis Department of Transportation (DOT) established a scope or procedure to be followed in performing a traffic analysis and a procedure to be followed in summarizing the analysis in a formal report. The scope of the traffic analysis includes the estimated trips to be generated for each type of land use, the estimated traffic to enter and exit from the street and the estimated distribution of traffic on the public street system. These procedures are consistent with the Institute's *Trip Generation Report*.

However, the Indianapolis Department of Transportation determined that trip generation data would be required on an hourly basis instead of 24-hour total traffic. From this a peak hour for the proposed development can be established for an evaluation of the traffic flow characteristics of the abutting street. This requirement has therefore resulted in the need for additional data collection to calibrate the Institute's *Trip Generation Report*, and improve its usefulness as a design criteria in the real world of fast changing concepts in land development.

#### TRIP GENERATION RATES

To accomplish the procedures as outlined by DOT, A & F Engineering Co., Inc. started to develop its own trip generation data for the local area. This local area data is always compared to the data of the Institute's *Trip Generation Report*. This cross referencing assures all that the local data is compatible with other communities throughout the country.

A standard format has been established to document the data for each individual use. This format, which is shown in Table 1, includes the following:

**Size:** The size of the project is identified in living units, rooms, square feet, etc.

**Trips:** The trip generation rate is shown for the individual land use. This rate has been determined from local traffic volume counts. The rate is identified as per living unit, per room, per 1000 sq ft, etc. When using the per 1000 sq ft unit, gross floor area is always used since this is generally more easily calculated than gross leasable area.

**Total Hours:** The total hours for which the data apply are shown. In general, 24 hour data are not used since the local agencies have determined that data outside the normal work day and/or peak hour of abutting street are not needed.

**Time Period:** The time period for the data is identified.

**Entering:** The percentage distribution of the entering traffic for the

previously identified time period is shown. These data are based on the local traffic volume counts.

**% Exiting:** The percentage distribution of exiting traffic.

**Hourly  
Distribution**

**of Traffic:** This is the hour-by-hour distribution of traffic for both entering traffic and exiting traffic. These data are based on actual traffic volume counts, in the local area.

**TABLE 1. Generated Traffic**

Land Use:	Condominiums
Size (Living Units):	100
Trips:	6.4/Living Unit
Total Hours:	13
Time Period:	7:00 AM to 8:00 PM
% Entering	48.8
% Exiting	51.2

**Hourly Distribution of Traffic**

Period	Entering Trips	Exiting Trips
7:00 AM	6	30
8:00 AM	13	32
9:00 AM	14	26
10:00 AM	24	30
11:00 AM	25	32
12:00 N	32	30
1:00 PM	27	21
2:00 PM	29	22
3:00 PM	24	19
4:00 PM	33	22
5:00 PM	32	21
6:00 PM	31	21
7:00 PM	<u>22</u>	<u>23</u>
Totals	312	328

In collecting the local data some interesting facts have been discovered with regard to several types of land use, facts that are not mentioned in the Institute's *Trip Generation Report*. In collecting data for office buildings it has been found that there is a significant difference in generation rates for a multitenant building versus a single tenant building. It has also been found that the hourly percentage distribution of entering and exiting traffic varies for each of these two types of land uses. Table 2 shows the comparison between the multi-tenant building and the single tenant building.

**TABLE 2. Comparison of Generation Rates for Multi-tenant Office Versus Single Tenant Office**

	Multi-Tenant	Single Tenant
Trips	16.1/1000 Sq Ft	11.2/1000 Sq Ft

**Hourly Distribution of Traffic**

Period	Entering Trips	Exiting Trips	Entering Trips	Exiting Trips
Beginning				
7:00 AM	113	17	371	13
8:00 AM	228	30	174	18
9:00 AM	77	41	48	32
10:00 AM	52	56	28	33
11:00 AM	72	122	23	140
12:00 N	101	138	139	155
1:00 PM	129	61	115	54
2:00 PM	67	79	32	40
3:00 PM	65	72	33	59
4:00 PM	58	114	27	230
5:00 PM	38	272	10	226
Totals	1000	1000	1000	1000

Another type of use that shows a significant difference are apartments. There is a variance in rates for apartments where there are children and for apartments that are for adults only. However, for these two types of uses the arrival and departure time are more nearly similar.

Still another type of use that shows a wide variance are office/-warehouse uses. Because of the wide difference in the percentage make up of office space to warehouse space it is almost necessary to collect new data for each development. However, it has been possible to identify about six or seven variations, including multi-tenant and single tenant, for use in the Indianapolis area so that it is no longer necessary to continually collect new data for this type of land use.

**MULTIPLE LAND USE DEVELOPMENTS**

Trip generation data for individual land uses are generally straightforward and easily collected. The data can be verified by comparing it to our national averages as shown in the Institute's *Trip Generation Report*. However, the development of data for multiple land use developments can be considerably more difficult.

Today's multiple land use development can include a wide variety of uses. One combination may include quality restaurants, fast food restaurants, and office buildings which may be both single tenant or multi-tenant buildings. A second type of combination may include a strip center with several outlots where the outlots are either fast food restaurants and/or high turnover restaurants.

Since it would be next to impossible to find and collect data for each possible combination of uses, a procedure has been developed to estimate the total volume of generate traffic for the development. The procedure used in the Indianapolis area is as follows:

- Estimate the traffic for each land use in the development. The estimate is based on the local generation rates and includes the previously mentioned hour-by-hour data.
- Sum all of the traffic volumes for the individual land uses.
- Estimate the percentage of trips that will result from internal circulation and second stops.

The first part of this procedure is very simple. The procedure is to simply use the data already on file for an individual land use or, in some cases, it may require additional data collection.

The second part is also fairly simple, especially if your data is summarized hourly as has been suggested. In a multiple use development all land uses do not generate traffic beginning and ending during the same time period of the day. For example, office buldings generally generate their peak traffic between 6 a.m. or 7 a.m. and 6 p.m. whereas quality restaurants generate peak traffic between 10 a.m. and 8 p.m. It should also be pointed out that this difference in time periods when traffic is generated, was a major reason for the adoption of the policy to collect trip generation data on an hourly basis in the Indianapolis area.

Table 3 is an example of combining generated traffic for a multi-use project. The example shown is for entering traffic only. Exiting traffic would be shown in a similar manner.

**TABLE 3. Summary of Generated Traffic Multiple Use Development**  
Entering Traffic

Period	Office	Quality Restaurant	Hotel	Total
7:00 AM	264		83	348
8:00 AM	534		110	644
9:00 AM	181		57	238
10:00 AM	122	20	60	202
11:00 AM	169	57	91	317
12:00 N	237	74	74	385
1:00 PM	302	34	57	393
2:00 PM	157	14	66	237
3:00 PM	152	28	115	295
4:00 PM	136	58	143	337
5:00 PM	89	31	140	260
6:00 PM		44	145	189
7:00 PM		49	134	183
Totals	2344	409	1275	4028

The third part of the procedure is the difficult part. Just how does one estimate how often one person will use more than one facility within a development? During the early years when data were being collected it was necessary to sit down with the public officials and try to develop a reasonable estimate of how much second stop traffic there would be. Most often those estimates were based on one's own personal knowledge and experience.

From these early discussions, it was generally agreed by all parties, public officials and developers, that a reduction of twenty percent would be used. It was further accepted that this figure, right or wrong, did not place an undue hardship on either the public or the developer.

It has been possible to check our early estimates for determining the percentage of internal circulating traffic as a result of continued data collection for additional developments. One of the developments that have been checked included a strip center of 178,000 square feet, and two outlots, one of which was a fast food restaurant and the other a high turnover restaurant. The actual reduction for internal circulation was found to be 22.8%. This is based on the sum of the individual uses as a percentage of the differences in the actual traffic volume count and estimated traffic volume count. Table 4 is a summary of the individual data and the resulting percentage reduction.

**TABLE 4. Comparison of Estimated Traffic Volumes Versus Actual Traffic Volumes**

Use	Estimated Traffic
Strip Center	13522
Fast Food Restaurant	1250
High Turnover Restaurant	<u>855</u>
Total Estimated Traffic Volume	15627
Actual Traffic Volume	12068
Percent Internal Circulation	22.8%

### ESTIMATING NEW TRAFFIC ADDED TO THE PUBLIC STREET SYSTEM

To estimate the amount of *new* traffic that will be added to the public street system requires an additional set of information and data. For the purposes of this paper the definition of new traffic is defined as "traffic that is not on the street system prior to the existence of the development, but will use the system because of the development."

If the development should include an office building or if the development is an office complex, it can be generally assumed that almost all of the traffic to and from the development will be new traffic.

If there are fast food restaurants included in the development, there

are studies available that will provide a good basis for estimating how much of the generated traffic will be new traffic and how much will be captured traffic. However, for most land uses there is still a lack of good data that can be used to estimate the new traffic and captured traffic.

#### ASSIGNMENT OF TRAFFIC TO THE PUBLIC STREET SYSTEM

The assignment of the traffic to the public street system is the process of deciding the percentage of traffic that will ingress and egress each of the access points to the development.

In the Indianapolis area the assignment of traffic to the public street system has generally been a coordinated effort between the developers and the public officials sitting down together and reaching a reasonable solution. In general the procedure used is to first review the existing street traffic volumes and the existing traffic patterns in the vicinity of the development. Secondly, the location of the various land uses are reviewed with respect to their location to the access points of the development. From this information a reasonable estimate of the percentage of traffic that will be using each of the access points can be made.

#### DISTRIBUTION OF THE GENERATED TRAFFIC TO THE STREET SYSTEM

The directional distribution of the generated traffic to the abutting street system and to the individual access drives serving the development is another very difficult part of any analysis and requires judgement and experience.

To assist in estimating the directional distribution of traffic to the abutting public street system a considerable number of license plate studies and post card origin and destination studies have been made to determine the origin and direction of incoming traffic. To further assist in the improvement of estimating the directional distribution of traffic, traffic volume data is always recorded by direction when collecting trip generation data. This information has been useful in later analyses when it was necessary to distribute traffic to the abutting street system for the new development.

In order to simplify this process in the Indianapolis area, it has been an acceptable criterion that the percentage of arriving traffic will equal the percentage of exiting traffic in the opposite direction from the arriving traffic.

#### VALIDATION OF TRIP DISTRIBUTION

The procedures identified in the above section have been extremely helpful in increasing the accuracy of estimating the directional distribution of the generated traffic to the abutting street system. The accuracy provides a comfort zone to both the developer and the governmental agencies.

Table 5 is a summary of the comparison of estimated trip distribution in 1979 versus the actual distribution of traffic volumes at a multi-use development five years later. The after study data has shown the actual difference to be 0.6%.

**TABLE 5. Estimated Trip Distribution Versus Actual Trip Distribution**

	Estimated in 1979	Actual in 1984	Difference
Percent Entering Point A	23.1%	22.5%	-0.6%
Percent Entering Point B	76.5%	77.1%	+0.6%

### TRIP GENERATION AND TRAFFIC SIGNAL WARRANTS

Utilizing the trip generation data and the procedures outlined in the various sections of this paper: multiple land use developments, assignment of generated traffic and distribution of generated traffic, it is possible to estimate traffic volumes on an incremental basis as individual elements of a development are scheduled to be completed.

Applying these individual sets of data one can do a traffic signal warrant analysis for each increment of the construction. With this information one can then predict the approximate time a traffic signal may be warranted. By using the individual increment method, it is possible to adjust the data should the land use of the development change or the progress of the construction be either accelerated or be delayed.

### SUMMARY

The Institute of Transportation Engineers has developed an excellent source document in its *Trip Generation Report*. In view of the requirements established by the City of Indianapolis the *Trip Generation Report* has been calibrated for use in the local area and, as a result, has been made to work in the real world.

- The calibrations have included an expansion of basic trip data to include an hour-by-hour assignment of traffic for both entering and exiting traffic.
- The calibration has included a procedure for expanding the data for use in multi-land use developments. The calibration of the data has included a limited review of an actual test development where the results have shown the procedure works.
- The calibration has developed procedures to assign and distribute generated traffic to the abutting public street system. The calibration has included a limited review of a before and after study where the results have proven satisfactory.

- The calibration has developed a procedure for using trip generation data and traffic assignments to investigate traffic signal warrants and estimate possible installation dates.
- The calibration has shown that trip generation can be made to effectively work in the real world.