Trip Generation Handbook, 3rd Edition
Advisory Supplement

The primary content included in the 3rd Edition of Trip Generation Handbook (TGH) was completed and approved prior to the development of Trip Generation Manual (TGM) 10th Edition. As a result, users should be aware of some editorial inconsistencies between the TGH guidance and the contents of TGM 10th Edition. The following is a summary of the notable inconsistencies.

The TGH presents several alternate approaches for adjusting TGM 9th Edition suburban vehicle trip generation data for application in urban, mixed-use, or transit-oriented settings. TGM 10th Edition expands the alternate approaches by presenting separate data plots for center city core, dense multi-use urban, general urban/suburban, and rural settings where data are available. It is recommended that the TGH plots be used in place of the alternate TGH approaches when available. For land uses with data plots for only general urban/suburban settings, the current TGH approach remains applicable and is recommended for modifying general TGH for a particular local application.

The data plots in TGH 9th Edition included miscalculated values for weighted standard deviation. The TGH 3rd Edition (Proposed Recommended Practice) included a separate appendix with corrected values. Since the TGH 10th Edition now includes the correct values, the appendix containing this information has been removed.

TGH 3rd Edition text and sample problems reference specific TGH 9th Edition tables and data plots. The text references are sufficiently clear for the analyst to properly apply the data in TGH 10th Edition and therefore were not updated with this release.

The TGM 10th Edition contains numerous new land uses, independent variables, area types, and time periods. For each, new definitions have been added to the TGM 10th Edition Desk Reference. Subsequent editions of TGH will include a similar comprehensive list of all current definitions.

Much of the data presented in tables in TGH Appendices C through E is now included in the TGM 10th Edition database. These appendices could be removed in a subsequent edition of TGH.

All inconsistencies noted will be corrected in subsequent editions of the TGH.

Certain individual volunteer members of ITE's recommended practice development bodies are employed by federal agencies, other governmental offices, private enterprise, or other organizations. Their participation in ITE recommended practice development activities does not constitute endorsement by these government agencies or other organization endorsement of any of ITE recommended practice development bodies or any ITE recommended practices that are developed by such bodies.

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Acknowledgments

This handbook is the result of many months of concerted effort by dedicated volunteers, both ITE members and non-members, and the ITE headquarters staff.

ITE staff convened an expert panel in May 2012 comprised of individuals with an active interest, knowledge, and balance of opinions and perspectives on trip generation issues and practices from the public and private sectors. The meeting attendees, listed below, developed the scope of work and approach for development of this recommended practice document.

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ITE Headquarters retained an editor, Kevin G. Hooper (F), to coordinate the development of the recommended practice. He was responsible for organizing, synthesizing and expanding upon material developed by the volunteer chapter authors. He was also responsible for addressing all of the feedback provided through several reviewed and balloted versions of the document. ITE is most appreciative of the tireless efforts and excellent work performed by Mr. Hooper.

(Letters in parentheses indicate ITE member grade: H – Honorary, F – Fellow, M – Member.)
1 INTRODUCTION

1.1 Purpose of Trip Generation Handbook

1.2 Recommended Practice

1.3 Use of Trip Generation Handbook

1.4 Professional Judgment

1.5 Changes since 2nd Edition of Handbook

1.6 Update Procedure

2 TRIP GENERATION BASICS

2.1 Concept of Site Trip Generation

2.2 Person Trips and Vehicle Trips

2.3 Study Sites and Proxy Sites

2.4 Uses of Trip Generation Data

2.5 Trip Generation Database

2.6 Evolution of Trip Generation Estimation

2.7 Communicating the Basis for Site Trip Generation Estimates

3 PROCESS FOR ESTIMATING TRIPS GENERATED BY A STUDY SITE

3.1 Overview of Process

3.2 Define Study Site

3.3 Define Site Context

3.4 Define Objectives for Trip Generation Analysis

3.5 Trip Generation for a Multimodal Site

4 TRIP GENERATION MANUAL DATA

4.1 Background

4.2 Trip Generation Data Plots

4.3 Basis for Recommended Process

4.4 Process for Selecting Average Rate or Equation in Trip Generation Manual Data

4.5 Examples of Recommended Process

5 PERSON TRIPS

5.1 Background

5.2 Assumptions

5.3 General Approach for Estimating Multimodal Site Person Trips

5.4 Conversion between Vehicle Trips and Person Trips

5.5 Study Site and Baseline Mode Shares and Vehicle Occupancy

6 TRIP GENERATION FOR MIXED-USE DEVELOPMENT

6.1 Background

6.2 Definition of Mixed-Use Development

6.3 Mixed-Use Development Classified as a Single Land Use

6.4 Underlying Assumptions about Internal Capture at a Mixed-Use Site

6.5 Process for Estimating Mixed-Use Trip Generation

6.6 Cautionary Notes

6.7 Data Collection at a Mixed-Use Development

7 TRIP GENERATION FOR URBAN INFILL/REDEVELOPMENT

7.1 Background

7.2 Definition of Infill Development

7.3 Underlying Assumptions for Infill Site Trip Generation

7.4 Process for Estimating Infill Trip Generation

7.5 Examples of Recommended Process

8 TRIP GENERATION FOR A TRANSIT-FRIENDLY DEVELOPMENT

8.1 Background

8.2 Definition of Transit-Friendly Development

8.3 Factors Affecting Transit Use at a TFD

8.4 Process for Estimating Transit Trips at a TFD Site
1 Introduction

1.1 Purpose of Trip Generation Handbook

The principal objectives of Trip Generation Handbook (or the Handbook) are:

- to provide guidance in the proper techniques for estimating trip generation, both person and vehicle, for potential development sites in urban, suburban, and rural settings;
  - The techniques use data presented in Trip Generation Manual (or the Manual) and in appendices of this Handbook. The Manual presents the data; the Handbook recommends how to use and interpret the data.
- to encourage the standardization of trip generation data collection efforts;
  - This Handbook is intended to facilitate the submission of data to enable further refinements of the recommended approaches as well as a more robust database.
- to encourage, support, and facilitate analyst ethics and objectivity in the use of Trip Generation Manual data.
  - Although study preparers and reviewers may have different objectives and perspectives, all parties involved in the development of trip generation estimates should conduct analyses and reviews objectively, accurately, and professionally, and adhere to established professional ethics similar to the Institute of Transportation Engineers (ITE) Canons of Engineering Ethics.

1.2 Recommended Practice

The instruction and guidance contained in the Handbook represent an ITE recommended practice. The guidance provided in this Handbook is structured to meet the following fundamental criteria:1

- The recommended methods are compatible with existing traffic and multimodal impact analysis methods. They enable the analyst to estimate vehicle or person trip generation of individual land use types by direction, inbound and outbound, and estimate peak hour vehicle or person trip generation using commonly available independent variables.
- The recommended methods can be used now for all land uses and contexts utilizing current typical levels of effort for transportation impact analyses for projects needing custom trip generation data.
- All computations are intuitive to users (both analysts and reviewers) and transparent by way of documentation.
- The estimation methods can be applied wherever Trip Generation Manual data are used.
- Input data needed to apply recommended methods are readily available or the ease and cost of collecting and applying the data are reasonable.2

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2 Spreadsheet tools should be publicly available at no cost for methods that require multiple input variables and more than simple computations.
The guidelines presented in this Handbook represent preferred best practices under most conditions. These guidelines recognize professional judgment may be needed throughout the process of estimating trip generation for a study site.

- The recommended methods are sensitive to surrounding contextual differences that influence site trip generation.
- The estimation methods use person trips as the common denominator when converting between baseline ITE data and multimodal site data.

An ITE recommended practice presents suggested methods for performing stated technical activities and should not be considered a standard or requirement.

To that end, this Handbook does not contain or recommend policy for use by agencies. Rather, it recommends analytical methods. Conclusions reached or policies associated with using trip generation analyses as a tool are not part of this Handbook.

1.3 Use of Trip Generation Handbook

The Handbook guidance is based on the state-of-the-practice expertise of ITE members and other professionals who developed or reviewed its content. Nevertheless, the guidance is presented in a form intended to be understandable by all professional practitioners.

This Handbook is organized to enable the analyst to refer to individual chapters that address specific and immediate needs. However, it is important for the analyst to be familiar with the contents of the entire Handbook in order to identify the appropriate chapter or chapters. The analyst should not expect to simply refer to this Handbook’s table of contents or index, find a term or concept, and then use it properly without investing the time to understand the concept fully and its applicability. When referring to a topic or using information from within a single chapter, the analyst needs to understand the entire chapter.

The analyst must understand the logic and general recommended approach for all estimation of trips generated by a study site as presented in Chapter 3. The remaining chapters (4 through 12) and the information provided in the appendices should be referred to and used as needed.

The data collection and analysis approaches presented in this Handbook move toward collection and application of person trip-level data (from previously vehicle-centric data collection and consideration). While the future direction of this Handbook is moving toward more multimodal and detailed person-level data collection and application, it is well understood that this new approach and methodology must include some ability to transition from the exclusive use of vehicle-based data to information that is more inclusive of planning for all modes.

ITE trip generation data are intended for uses associated with site trip generation; that is, trip generation associated with buildings and related facilities of individual developments. These data are not intended for regional planning activities beyond facilities adjacent to and near the study site. Corridor scale transportation requirements and improvements are better determined with the aid of a regional travel demand model, metropolitan transportation surveys, census data, and related data sources.
1.4 Professional Judgment

Many elements of the procedures presented in *Trip Generation Handbook* require the use of professional judgment to make a proper and informed selection or estimation. The range of decisions an analyst may make include

- Proper land use code (LUC);
- Preferred independent variable;
- Acceptable sites for data collection;
- Daily or peaking characteristics;
- Land use information such as employment density or building occupancy;
- Internal capture at mixed-use development;
- Site-generated trips that are by walk, bike, or transit mode;
- Pass-by and diverted trips;
- Truck trips;
- Points of access for site data collection; and
- Intercept survey locations.

Professional judgment is the use of scientific knowledge, empirical data, known mathematical relationships, and past experience to select an appropriate solution for a specific problem. Calculation of a vehicle trip generation estimate using an average rate or equation only requires simple math skills. Complex problem-solving requires the analyst to supplement scientific knowledge and empirical data with analogies from previous studies or projects, identifying similarities and differences, and appropriately incorporating all considerations into conclusions. Practical experience is critical—it not only provides information but also contributes to the “analogy base” from which the analyst can draw. These analogies can be simple and direct but in many cases are quite complex with many nuances.

In order to exercise professional judgment properly, the analyst must understand the assumptions and simplifications in past data sets, the cause-and-effect relationships between counted vehicle trips and tested independent variables, and the relative precision and variability of trip generation data. An example of poor professional judgment is to rely on rules of thumb without understanding or considering their derivation or initial context. When professional judgment is used, the analyst should describe and document any assumptions and their application.

1.5 Changes Since 2nd Edition of *Handbook*

The 3rd Edition of *Trip Generation Handbook* has undergone several significant changes in content. The guidance provided in this *Handbook* now enables an analyst to estimate person and vehicle trips generated by single-use and mixed-use development in various urban, suburban, and rural contexts.

The introductory chapters and appendices of this *Handbook* consolidate all the information presented previously in the *Trip Generation Manual* Users Guide and in the introductory chapters of the 2nd Edition of *Trip Generation Handbook*. The consolidated chapters serve as a single source of information describing the contents of the *Trip Generation Manual* data volumes.

The recommended practice material from the 2nd Edition of *Trip Generation Handbook* has undergone a comprehensive review, resulting in an update and refinement to each component of the recommended practice.
● Improved guidance is provided
  ○ for the evaluation of mixed-use developments,
  ○ for the establishment of local trip generation rates,
  ○ for the interpretation of the *Trip Generation Manual* data plots,
  ○ for the estimation of truck trips generated by a development site, and
  ○ for the collection of data to support trip generation analyses;
● New guidance is provided for the estimation of trips generated by sites in urban settings or
  served by significant levels of transit service;
● Additional data are provided in the pass-by trip data tables.

1.6 Update Procedure

ITE has established a standard procedure for reviewing and updating the data summarized in this
report. The data analyses displayed in this *Handbook* and in the *Manual* were performed using
commercial software. All trip generation rates, equations, and plots are subject to update upon the
receipt of new data.

ITE invites all interested parties to collect data from one or more sites and submit the data to
ITE Headquarters. Suggested data collection forms and can be found on the ITE website at
www.ite.org/tripgeneration/Trip_Generation_Data_Form.pdf. Completed forms should be submitted
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2 Trip Generation Basics

2.1 Concept of Site Trip Generation

Trip generation is one measure of travel behavior. It is based on the notion that people regularly travel to or from a particular land use and location and that the amount and type of activity at the location—whether retail, office, residential, or service-oriented—uniquely determines the amount, type, and mode of that travel. The calculation of the number of trips entering or exiting different kinds of activity and land uses forms the foundation of trip generation estimation.

As an illustration of trip generation, consider that people leave their homes every day to travel to work, go shopping, go to school, visit friends, or attend appointments. Each departure from the home is considered a trip. Each return to the home is likewise considered a trip. If a cordon is placed around the residence to record the comings and goings over a 24-hour period, the number of trips the dwelling unit generates per day can be determined. If four trips leave the home—for instance, one to work, one to school, one to shop, and one to the dentist—and these same four trips return to the home on the same day, the dwelling unit has a trip generation rate, for that particular day, of eight trips per day (four outbound and four inbound). If additional trips are made to or from that dwelling unit by visitors, by delivery vehicles, or other service personnel, these trips would also be considered trips generated by the residence.

Similarly, travel to and from any type of location can be counted. Each specific type of establishment—a factory, a store, an office building, or an entire shopping center—is considered a trip generator.

As noted above, the fundamental measurement for trip generation is trips. In technical terms, a trip has an origin and a destination at its two ends (known as trip ends). Each trip end is a part of a trip. For site trip generation, the analyst is usually interested in trips entering (inbound) and exiting (outbound) a site. An entering trip end is a destination trip end; an exiting trip end is an origin trip end. Common usage throughout this Handbook is to refer to the inbound and outbound trip ends as “trips” because they are the site’s portion of those trips.

2.2 Person Trips and Vehicle Trips

Trips may be made via various modes of travel: as a pedestrian, bicyclist, transit patron, personal passenger vehicle driver, personal passenger vehicle passenger, truck driver, or truck passenger. The guidance in this Handbook enables the analyst to record and subsequently analyze trips in units of either person trips or vehicle trips.

The term “person trips” refers to trips made to or from a site by each individual person using any mode (personal passenger vehicle, truck, pedestrian, transit, bicycle). Two people in a personal passenger vehicle counts as two person trips. “Vehicle trip” generation refers to the number of vehicles traveling to or from a site. If a vehicle has two people in it, it still counts as one vehicle trip.
2.3 Study Sites and Proxy Sites

The basic premise upon which all trip generation estimates are based is that the number of trips entering and exiting two development sites with the same land use, size, and dimension, and setting will be comparable. The general procedures presented in this Handbook provide guidance on how to find and use trip generation data from development sites that are comparable to the development site being analyzed. Throughout this Handbook, the development site for which a trip generation is being estimated is called the study site. The comparable sites with relevant trip generation data are called proxy sites.

Nearly all data presented in the current Trip Generation Manual data volumes have been collected at low-density, single-use, homogeneous, general urban or suburban developments with little or no public transit service and little or no convenient pedestrian access. These proxy sites are called baseline sites in this Handbook because they are the starting points for most vehicle trip generation estimation recommended in the following chapters.

2.4 Uses of Trip Generation Data

The basic product of the procedures in this Handbook, to the limits possible with available or readily collectible data, is an estimate of the inbound and outbound trips by mode (personal passenger vehicle, truck, transit, bicycle, pedestrian) for a study site. These trip generation estimates are used for a variety of functions, such as

- Determining site access and circulation requirements for a study site;
- Estimating future traffic volumes upon which off-site transportation improvements are based;
- Determining fees for use in addressing potential impacts to the transportation systems; or
- Evaluating the implications of requests for potential zoning or land use changes.

In some cases, the modal trip generation estimates can be used for purposes beyond trip generation such as to assess parking demand, forecast regional travel for special generators, or estimate vehicular emissions or other environmental measures. Appendix L discusses potential connections between site trip generation estimates and travel demand models, especially as they relate to special generators.

2.5 Trip Generation Database

2.5.1 Source of Trip Generation Manual Data

The data presented in Volumes 2 and 3 of the Trip Generation Manual (known as the data volumes) are from studies conducted throughout the United States and Canada. The data were contributed on a voluntary basis by various state and local governmental agencies; consulting firms; individual transportation professionals; universities and colleges; developers; associations; and local sections, districts, and student chapters of ITE. In many cases, the data were originally contained in published reports or unpublished analyses conducted by such groups. The sources of these reports or analyses are listed in Appendix N. The source numbers for studies contained in each land use are listed on the land use description pages in Volumes 2 and 3 of the Manual.
2.5.2 Data Collection

Some of the data reported in the *Manual* were collected using automatic counters configured to count vehicular traffic entering and exiting a site. These counts were taken on driveways of sufficient length to avoid the double counting of turning vehicles. In some cases, counts were non-directional and therefore did not distinguish between entering and exiting vehicles.

Manual counts often supplemented the automatic counts to
- Obtain vehicle occupancy and classification;
- Check the reliability of the automatic counters; or
- Obtain directional counts during peak periods when a non-directional automatic count was being conducted.

In other cases, only manual counts (or video counts interpreted manually) were conducted during peak periods.

Additional information regarding site characteristics was obtained through personal interviews, field measurements, telephone conversations, or mail-back questionnaires.

2.5.3 Data Storage

The *Trip Generation Manual* data are stored in a trip generation database maintained at ITE Headquarters. The amount of data submitted for an individual site varies from one peak-hour volume to seven days of directional hourly volumes. All data received are initially examined by ITE staff for validity and reasonableness before being entered into the database. Each data record is referenced in the database by a source number, the month and year of the measurement, the metropolitan area (when known), and a three-digit land use code. Data for more than 170 land uses are organized within 10 major land use categories. Additional land uses are added to the database as data become available.

2.5.4 Data Age

The database compiled to produce the *Manual* contains data from the years 1960 through 2013. The data were obtained primarily from volunteer sources. The data are carefully reviewed by ITE professionals with specific expertise and responsibility for trip generation calculations and analyses. This review includes consideration of several factors including
- Completeness of both land use independent variable and traffic counts;
- Relationship and consistency to prior data within database;
- Variations from typical land use in the stated category; and
- Other characteristics (such as employment density, seasonal or time-of-day issues, area type, mixed use issues, and extensive use of non-automobile modes).

In addition to reviewing data when initially submitted, ITE professionals review each land use code data set prior to a new edition. This review is primarily focused on codes with new data and considers the age of the data and whether conditions or trends indicate that substantial land use or cultural changes have affected trip generation patterns. Statistical tests (including combinations of variations from averages, standard deviation expansion, clustering of recent data, $R^2$, T-tests, and F-ratios) are used to determine if differences are significant between older data and newer data.
Prior to publication of the 8th Edition, ITE investigated whether changes in banking industry technology (in particular, automated teller machines and, more recently, electronic banking) and customer practices during the 1990s could have resulted in travel pattern changes. The ITE analysis concluded that pre- and post-2000 bank trip generation data were significantly different. As a result, all data prior to year 2000 were removed from the database for the two banking land uses—Walk-in Bank Land Use Code (LUC 911) and Drive-in Bank (LUC 912).

The primary advantage of using only current data is they may more accurately reflect current trip characteristics associated with a given land use. The disadvantage is the potential decreased data sample and the consequent increased effects of sites with atypically high or low trip generation to have an undue influence on overall trip generation estimates for the land use.

2.6 Evolution of Trip Generation Estimation

The *Trip Generation Manual* has been the primary source of vehicle trip generation data for transportation impact analyses in the United States and Canada. The majority of the data in the *Manual* were collected at general urban and suburban single-land-use sites with their access isolated from other land uses consistent with traditional zoning, such as office parks, shopping centers, and residential subdivisions. When early editions of the *Manual* were published, new development was occurring mostly on greenfield sites in suburban and exurban communities or on large vacant tracts of land within the belts of partially developed land surrounding large cities. The combination of land use segregation and development located distant from city centers resulted in trips to and from those sites being made predominantly by personal passenger vehicle. As a result, for the analyst conducting impact analyses of a single-use development in a suburban or exurban site, the *Trip Generation Manual* vehicle trip generation data are relevant and accurate.

Development patterns and building types in recent years have shifted to include increasingly denser, mixed-use and infill development and redevelopment in urban locations with significant transit service. Studies have concluded that the vehicle trip generation data contained in the *Manual* overestimates vehicle trips generated by development and redevelopment in compact, urbanized areas where walking, bicycling, and transit are viable modes of transportation—termed “multimodal sites” in this *Handbook*. This edition of the *Handbook* addresses the issue and provides guidance for the estimation of person and vehicle trips at multimodal sites.

The application of suburban data in dense or multimodal urban settings can in some cases overestimate motor vehicle demand. The result has been past decisions where:

- modes such as bicycle, pedestrian, transit, and rideshare (carpooling and shared mobility) may have been largely ignored, resulting in inadequate support or capital
- mitigation of vehicle impacts may have exceeded needs
- potential imbalance of transportation fees, exactions and public improvements may have occurred
- parking may have been overbuilt
- the consequences of urban development on greenhouse gases may have not been properly understood

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3 As a result of consumer preferences, developer trends, zoning, availability of financing, and public infrastructure spending.
2.7 Communicating the Basis for Site Trip Generation Estimates

The process of describing trip generation concepts can result in confusion on the part of other professionals, elected and appointed officials, and the general public. Policy discussions can unintentionally misinterpret aspects of trip generation estimation techniques. The following sample statement is intended to help the analyst explain the basis for trip generation estimates derived with the aid of *Trip Generation Handbook*.

“Trip generation estimates developed for this study are based on the 9th Edition of the *Trip Generation Manual* published by the Institute of Transportation Engineers (ITE). The *Manual* is the most widely used industry resource for this type of data. The trip generation data are organized by land use types, with more than 170 different categories of land uses. For each category the *Manual* provides a data set for use in estimating the number of vehicle and person trips generated by a site based on its characteristics such as physical size or intensity. Trips may be estimated by direction (entering or exiting the site) and for time periods typically pertaining to a full day (weekday or weekend), peak hours of the adjacent roadway, and peak hours of the particular land use. Used properly, the *Trip Generation Manual* provides an objective basis for estimating trips generated by a proposed development.”

Appendix K contains sample presentation slides to help the analyst communicate the same message in a public forum.
3.1 Overview of Process

This chapter presents a general process that can and should be used for the estimation of site-generated trips. The process is illustrated in Figure 3.1.

The first three boxes in the flow chart represent information the analyst must obtain and consider as the first step in the trip generation estimation process for a study site. In these boxes, the analyst defines the study site characteristics, including its site context within the surrounding area, and establishes specific analysis objectives in terms of trip types and time period. Guidance for all three boxes is provided in the following sections of this chapter (3.2, 3.3, and 3.4).

Box 4 is a pivotal decision point in which an appropriate analysis approach is selected. A study site and its setting are considered multimodal if current or future conditions indicate there is the potential for non-vehicle trips being made to, from, and within the site because it:

- Is surrounded by compact urban development with nearby complementary land uses (infill site);
- Consists of a mix of complementary land uses in any part of an urban region (mixed-use development);
- Is served by public transit, in particular if designed specifically to capitalize on transit access to the site (transit-friendly development);
- Is served by corporate transit or corporate-sponsored ridesharing programs designed to improve employee commute options and reduce site-generated parking demand and peak hour traffic; or
- Is in an area that has a noticeable amount of walking and bicycling activity or an area planned for promotion of non-motorized travel (as examples, sites in urban core areas or sites near schools and senior centers).

This selection of the appropriate analysis approach is described in more detail in section 3.5 of this chapter.

If the study site is multimodal, the analyst should follow the process outlined in Boxes 5 through 8 in Figure 3.1. This process should be considered the standard approach for estimating site-generated trips.

If the study site is comparable to the baseline sites presented in the Trip Generation Manual data volumes (that is, typically stand-alone and single-use in a suburban, rural, or small urban setting), a simplified approach is acceptable. The analyst should follow the guidance outlined in Box 9.

The process outlined in Boxes 5 through 8 should also be followed if the objective is to estimate person trips (including pedestrian, bike, and transit trips) generated by a study site, regardless of its setting.
Figure 3.1 Analysis Approach for Estimating Site Trip Generation

1. **DEFINE STUDY SITE**
   Land Use Type & Site Characteristics (Section 3.2)

2. **DEFINE SITE CONTEXT**
   (Section 3.3)

3. **DEFINE ANALYSIS OBJECTIVES**
   Types of Trips & Time Period (Section 3.4)

4. **IS STUDY SITE MULTIMODAL?**
   (Section 3.5)

5. **ESTIMATE BASELINE VEHICLE TRIPS**
   (Chapters 4 or 9)

6. **CONVERT BASELINE VEHICLE TRIPS TO PERSON TRIPS**
   (Chapter 5)

7. **ESTIMATE**
   - Internal Person Trips
   - External Walk/Bike Trips
   - External Transit Person Trips
   - External Person Trips in Vehicles
   (Chapters 6 through 8)

8. **CONVERT PERSON TRIPS TO FINAL VEHICLE TRIPS**
   (Chapter 5)

9. **ESTIMATE VEHICLE TRIPS**
   (Chapters 4 or 9)

10. **ESTIMATE VEHICLE TRIP SUBSETS**
    - Pass-By/Diverted Trips (Chapter 10)
    - Truck Trips (Chapter 11)
If the objective is to establish a local trip generation rate for a particular land use or study site, the simplified approach (Box 9) may be acceptable but the Box 5 through 8 approach is required if the study site is located in an infill setting, contains a mix of uses on-site, or is near significant transit service.

If the objective includes the need to estimate pass-by trips or truck trips at a study site, the recommended procedures in Chapters 10 and 11, respectively, should be used. The procedures should be applied after site-generated vehicle trips are estimated with the procedures outlined in Boxes 5 through 8 or in Box 9, as appropriate.

3.2 Define Study Site

The initial step in the process (Box 1 in Figure 3.1) is to define the characteristics of the study site. These characteristics include its land use type and its size.

3.2.1 Based on a Site Plan

The analyst should select a land use code in the Trip Generation Manual data volumes that corresponds to the study site. The “Description” should be read carefully to confirm that the land use and its corresponding trip data are appropriate for the study site development. Other land uses with similar descriptions should be reviewed to confirm that the selected land use code is the appropriate choice.

If the development site includes more than one land use, each individual component should be identified and classified. It should be noted that there are several “individual” land use codes that include more than one land use. As examples,

- A shopping center (Land Use Code 820) may contain retail, restaurant, and office components but is classified as a single land use because the Manual data were collected for entire shopping centers, not for individual land uses;
- A complex containing general office buildings and support services such as banks, restaurants and service stations arranged in a park- or campus-like atmosphere is considered an office park (Land Use Code 750);
- An office building with support retail or restaurant facilities contained inside the building is treated as a general office building (Land Use Code 710); and
- A hotel with an on-site restaurant and small retail shops is considered the hotel category (Land Use Code 310).

3.2.2 Based on Generalized Land Use

In the early stages of land development, there may be a need to develop an approximate estimate of site trip generation, even though specific site characteristics are not yet known. In that case, the analyst may know nothing more than the proposed or anticipated zoning classification of the land in question. Without a specific site plan, the precise quantity and type of development is not known.

The analyst must understand the basic regulatory structure of uses in the zoning and should consider the array of permitted uses the zoning district ordinance. The analyst should also consider any requirement or protocol of the agency that will review the transportation impact study.
The trip generation estimate should reflect, to the extent possible, the specific uses within the known or assumed generalized (usually zoning) classification. These land uses can best be surmised through knowledge of the specific ITE Land Use Codes permissible and prevailing locally within the (zoning) classification, preferably in similar locales and with similar site size and access characteristics. If there is no zoning (existing or proposed) at the time of analysis, the prevailing use(s) in the area should be considered.

Typical development densities (like gross square feet of building floor area per site acre, dwelling units per site acre, or an appropriate similar ratio) should be estimated for the selected land uses. Listings of values for typical development densities can be obtained, preferably from local agency planning and development departments or, if unavailable, found in national publications. No typical values are provided in this Handbook because “typical national” data are unlikely to match “typical local” conditions. In fact, “typical” development densities may vary in different parts of a region. Because of the inherent imprecision of the land use definition process presented here, it is critical that locally sensitive land use mix and density be evaluated.

Typical floor-to-area ratio (FAR) values vary substantially as a function of land value, structured parking, open space requirements, building setbacks, and other code requirements. Prevailing and appropriate development practices in similar circumstances should be investigated.

The above procedure should be considered preliminary until more definitive information is available. Sensitivity analyses with alternative land use mixes or densities could be appropriate.

3.2.3 Independent Variable

In trip generation, an independent variable is a physical, measurable, and predictable characteristic which describes the study site or trip generator (for example, gross floor area) and which has a direct relationship to the variation in the number of trips generated by a land use. Another term often used is “explanatory variable.”

The analyst should carefully read the definitions for independent variables in the Glossary in Appendix A.

It is critical that the analyst understand the availability and definition of each potential independent variable for a particular land use. The size and intensity of use at the study site should be quantified using one or more of the typical characteristics used as independent variables in the land use code data pages. Examples include rooms (for hotel), beds (for hospital), seats (for quality restaurant), students (for day care center), and vehicle fueling positions (for gasoline/service station with convenience market).

3.3 Define Site Context

Site context (Box 2 in Figure 3.1) includes the characteristics of the area and transportation system that may influence travel to and from the study site. At this initial stage of the trip generation estimation process, the site context assessment is simply to determine whether the study site is in a multimodal setting. A study site that could have persons accessing the site by walking, bicycling, or riding transit is considered multimodal.
This assessment can be qualitative. The following are examples of context that should be considered in this initial stage:

- General area type—regional central business district (CBD), outlying CBD, urban core, activity center, general urban, suburban business district, suburban strip commercial, general suburban, special district, rural business district, and rural (definitions of the individual area types are provided in the Glossary in Appendix A);
- Economic characteristics—apparent vitality of the area (with current and projected vacancy rates as indicators);
- Travel mode choices—general assessment of transit, pedestrian, and bicycle access;
- Walkability—assessment of pedestrian environment; and
- Demand management—areawide or local conditions or policies that affect time of day peaking and travel modes.

3.4 Define Objectives for Trip Generation Analysis

The analyst must define the objectives of the analysis of study site trip generation (Box 3 in Figure 3.1). The analysis objectives should include the trip types to be estimated and the time period for the estimated trips.

3.4.1 Types of Trips

The analyst should define the types of trips for which trip generation estimates are desired by considering the following questions.

- Are vehicle trips sufficient or are person trips (such as walk trips, bike trips, or transit trips) also needed?
- If person trips are needed, do they need to be separated by mode (auto, walk, bike, transit) or as a sum of walk, bike, and transit as non-vehicle trips?
- Are total vehicle trips sufficient or do truck trips need to be estimated separately?
- Do vehicle trips need to be divided into primary, diverted, and pass-by trips?
- If the site is a mixed-use development, are only trips external to the site needed or is an estimate of internal trips also needed?

3.4.2 Time Period

The analyst should define the desired time period for the trip generation estimate. The definition must include

- Time of year (such as average, Christmas season, or summer);
- Day of the week (such as average weekday, Friday, Saturday, or Sunday); and
- Time of day (such as 24-hour, AM or PM peak hour of site-generated traffic, or AM or PM peak hour of adjacent street traffic).
For each land use code, _Trip Generation Manual_ provides data pages and data plots for all time periods for which data have been submitted. These typically include daily and AM and PM peak hour data. For many land uses, separate data are provided for weekday, Saturday, and Sunday. For some land uses with a particular weekday travel peak on Fridays (for example, Multiplex Movie Theater, Land Use Code 445), Friday trips are presented.

Seasonal variations are also important for some land uses. As a prime example, U.S. shopping centers traditionally are busiest during the period between Thanksgiving (fourth Thursday in November) and Christmas. For shopping centers (Land Use Code 820), data for both non-Christmas and Christmas season trips are provided. Recreational and hotel land uses are often seasonal. Offices, resort hotels, and tourist attractions are subject to vacation period impacts. Other types of developments also vary by season.

The trip generation data are intended to represent typical conditions for the particular land use during the defined time period. For example, it is reasonable to assume that data were collected for schools while school is in session or for snow ski areas and golf courses when weather is conducive to their use. In situations with special circumstances, supplemental data are provided.

_Trip Generation Manual_ contains data pertaining to reported time period distributions of traffic for 12 land uses. As shown in Table 3.1, time of day distributions are available for 11 land uses. Day of the week and month of the year distributions are available for three land uses. These distribution data can be used to identify when significant peaks or valleys in trip generation may occur at a development site.

### Table 3.1 Land Uses in _Trip Generation Manual_ with Time Period Distribution Data

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Time Period with Available Distribution Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time of Day</td>
</tr>
<tr>
<td>152—High-Cube Warehouse/Distribution Center</td>
<td>Yes</td>
</tr>
<tr>
<td>430—Golf Course</td>
<td>Yes</td>
</tr>
<tr>
<td>444—Movie Theater with Matinee</td>
<td>—</td>
</tr>
<tr>
<td>565—Day Care Center</td>
<td>Yes</td>
</tr>
<tr>
<td>813—Free-Standing Discount Superstore</td>
<td>Yes</td>
</tr>
<tr>
<td>815—Free-Standing Discount Store</td>
<td>Yes</td>
</tr>
<tr>
<td>820—Shopping Center</td>
<td>Yes</td>
</tr>
<tr>
<td>854—Discount Supermarket</td>
<td>Yes</td>
</tr>
<tr>
<td>857—Discount Club</td>
<td>Yes</td>
</tr>
<tr>
<td>875—Department Store</td>
<td>Yes</td>
</tr>
<tr>
<td>932—High-Turnover (Sit-Down) Restaurant</td>
<td>Yes</td>
</tr>
<tr>
<td>934—Fast-Food Restaurant with Drive-Through Window</td>
<td>Yes</td>
</tr>
</tbody>
</table>

3.5 Trip Generation for a Multimodal Study Site

3.5.1 Step-by-Step Approach

The order of the boxes in the Figure 3.1 flow chart is critical to an accurate estimation of site-generated person trips by mode.

In Box 5, the analyst estimates vehicle trips generated by all the land uses in the study site using procedures presented in Chapters 4 or 9. For a multimodal site, this estimate represents the baseline vehicle trips generated by the study site. This is the same process described in Box 9 to estimate vehicle trips at a study site (using Chapters 4 or 9).

In Box 6, the analyst converts the initial gross estimate of vehicle trips generated by the site land uses to person trips using the procedures presented in Chapter 5. Baseline vehicle occupancy and mode shares are used.

In Box 7, the analyst estimates non-vehicle person trips for any type of multimodal site. Depending on the type and setting of the study site, the analyst can make use of any or all of the following procedures.

- If the site is a mixed-use development, the procedures presented in Chapter 6 are recommended. The number of internally captured person trips in the mixed-use development are calculated, then subtracted from the total site-generated person trips to determine the external person trips.
- If the site is located in an infill setting, the procedures presented in Chapter 7 are recommended. The external trips that are made by pedestrian or bicycle modes to and from a nearby complementary development are estimated separately, then subtracted from the total external person trips to determine the external, non-walk and non-bike person trips generated by the study site. These non-walk and non-bike person trips are called motorized trips in the Chapter 8 text.
- If the site is served by significant levels of transit, the procedures presented in Chapter 8 are recommended. The transit trips generated by the site are estimated, then subtracted from the motorized person trips to calculate person trips in personal passenger vehicles or trucks. If the study site is served by fixed-route bus transit only, the Chapter 7 urban infill procedure can be applied to estimate transit trips.

The product of the Box 7 calculations is an estimate for person trips generated by the study site, external to the site and by mode.

In Box 8, the analyst determines net site-generated vehicle trips by converting person trips back to vehicle trips using mode share and vehicle occupancy estimates for the study site (as described in Chapter 5). The analyst can further stratify the site-generated trips by trip type (pass-by, primary, diverted) and vehicle type (auto, truck) using the procedures presented in Chapters 10 and 11, respectively.

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4 The step-by-step approach directs the analyst to estimate vehicle trips generated by a study site, then convert the estimate to person trips. This approach is necessary because of the current limited availability of person trip data at development sites. As a comprehensive person trip database is developed, the recommended approach will evolve to follow a direct person trip estimation process that bypasses the vehicle trip estimation step.
### 3.5.2 Application of Approach for All Types of Study Sites

The process flow chart works regardless of the number or mix of land uses and available travel modes. Table 3.2 presents a list of the various generic types of study sites and the corresponding *Handbook* chapters with relevant guidance.

#### Table 3.2 Source *Handbook* Chapters for Estimating Trips Generated by Study Site

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed-use development in urban infill setting with significant transit service</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mixed-use development in urban infill setting</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Mixed-use development with significant transit and few external walk trips</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Mixed-use development with limited transit and few external walk trips</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-use development in urban infill setting with significant transit</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Single-use development in urban infill setting</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-use development with significant transit and few external walk trips</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-use development with limited transit and few external walk trips</td>
<td>X</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### 3.5.3 Disaggregate versus Aggregate Approach

One of the advantages of a step-by-step disaggregate approach (in other words, separating the effects of mixed-use development, urban infill setting, and proximity to transit service) is it enables the analyst to isolate and consider the reasonableness of each individual component of the
reductions (transit, walk, and bike trips). The results should make sense, for example, in terms of the number of people boarding/alighting per peak period bus or per peak hour heavy or light rail transit vehicle, of the number of people walking to off-site destinations, or of internal trips between on-site uses in a mixed-use development.

The relevance of a disaggregated approach can be demonstrated by considering the characteristics of walk trips and transit trips.

Walk trips are made by persons to travel to or from nearby land uses. They are often short trips. The quantity of walk trips tends to be largely a function of the quantity and density of complementary development near the study site. When the quantity and density of nearby development is held constant, the quality and proximity of transit service has only a minor effect on the number of walk trips to or from the study site. This is why external walk trips are calculated using procedures presented in Chapter 7 for infill development.

Transit trips are made by persons whose primary other mode choice (if one exists) is a personal passenger vehicle, either as a driver or passenger. These are not walk-trip length trips (but could be bicycle-trip length trips). Their quantity is a function of the quality and proximity of transit service to the study site. When the transit service descriptors are held constant, the density of nearby development has only a minor effect on trips made to or from the study site by transit.

Alternative approaches that combine the vehicle trip reduction impacts of a mix of on-site land uses, of an urban infill setting, and of transit service are described in Appendix G. As future refinements are made to the aggregate methods, they should merit further consideration.

3.5.4 Transportation Demand Management

Appendix H provides an overview of the potential impacts of individual transportation demand management (TDM) measures and comprehensive programs on site vehicle trip generation. However, this Handbook does not provide specific guidance on how an analyst might adjust vehicle occupancy, transit mode share, walk mode share, or bike mode share due to the presence of a study site TDM program.

Chapter 8 provides an approach for estimating transit trips generated by a study site. Chapter 7 provides an approach for estimating walk trips generated by a study site. The use of appropriate proxy sites can enable the analyst to account for areawide or site-specific TDM program effects on mode shares and vehicle occupancy. With the inclusion of person trips in the trip estimation process, the analyst is able to investigate and demonstrate the effects of changes in, for example, vehicle occupancy on net vehicle trips generated by a study site.
4  Trip Generation Manual Data

4.1 Background

Trip Generation Manual provides an abundance of data on the relationships between vehicle trip generation and site characteristics for various land uses. Trip Generation Manual, 10th Edition is expected to contain data for both person trips and vehicle trips. The guidance presented in this chapter can be adapted to also apply to the estimation of person trips. Each data page in Volumes 2 and 3 presents the results of data analyses that can include

- A plot of site-generated trips versus the value of the independent variable for each study;
- The weighted average trip generation rate (number of trips per unit of independent variable); and
- A fitted curve equation that relates trips to the value of the independent variable.

The purpose of this chapter is to provide guidance so that the analyst can make a reasonable and responsible estimate of vehicle trips generated for a study site using this data. Selection of an appropriate method for estimating trips requires the analyst to exercise professional judgment. To do this, the analyst must have a thorough understanding of the data pages and the displayed statistics. If available, the analyst should also consider using properly collected and validated local data in addition to the national database.

In some cases, selection and use of the trip generation rate or equation may be dictated by local ordinance or agency policy. As examples, the analyst may be instructed to always use the fitted curve equation, if it is given, or to always use the higher of the average rate and fitted curve values. The approach described here is recommended over an arbitrary policy because it is sensitive to data quality and thus is likely to be more accurate.

4.2 Trip Generation Data Plots

4.2.1 Content and Format

Figure 4.1 is a sample data plot displaying statistical and descriptive information for a single land use for a specified independent variable and for a specified time period. This sample data page provides explanatory notes describing each element of the figure. The majority of land uses contained in Volumes 2 and 3 of Trip Generation Manual include data plots.

Each data point within a data plot represents the observed number of vehicle trips that enter or exit a single site, plotted against the value of the independent variable for the site.

Data plots are not provided for a land use that contains only one study for an independent variable and time-of-day combination. In that case, the data are presented in tabular form immediately following the land use description.
Figure 4.1 Sample Data Page in *Trip Generation Manual*

4.2.2 Reported Statistics

Table 4.1 summarizes the types of mathematical and statistical information provided in *Trip Generation Manual* data plots as a function of the number of available data points. The table also indicates that, for data sets with five or fewer data points, the statement “Caution—Use Carefully—Small Sample Size” is provided.

### Table 4.1 Information Provided in *Trip Generation Manual* Data Pages

<table>
<thead>
<tr>
<th>Number of Data Points</th>
<th>Weighted Average Rate &amp; Range of Rates</th>
<th>Data Plot</th>
<th>Standard Deviation</th>
<th>Fitted Curve Equation*</th>
<th>Caution Regarding Small Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No</td>
<td>No</td>
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</tr>
<tr>
<td>2</td>
<td>Yes</td>
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<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>6 or more</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

* Fitted curve equation is provided if $R^2$ value is at least 0.5.


4.2.2.1 (Weighted) Average Trip Rate

The weighted average trip generation rate (simplified to “average trip rate” in the data plots and in the *Handbook* text) is defined as the number of weighted trips per unit of the independent variable. The rate assumes a simple linear relationship between trips and the independent variable, having a slope equal to the rate and with the straight line passing through the origin (that is, with a value of zero for the independent variable, the number of trips generated is zero). Therefore, the number of trips can be estimated by multiplying the number of trips per unit of independent variable by the number of units of the independent variable associated with the study site.

The weighted average trip rate is used rather than the average of the individual rates for all development sites with data because of the variance found within each data set. Sites with a large variance from the mean can over-influence the average rate if it is not weighted. Calculation of weighted average rate is demonstrated in Appendix J.

Every data plot contains a line corresponding to the weighted average rate. The line extends between the calculated numbers of trips corresponding to the study sites with the lowest and highest values for the independent variable.

In a data plot for which all of the points correspond to a single value for the independent variable, no line is drawn. As an example, for Land Use 853 (Convenience Market with Gasoline Pumps) with
vehicle fueling positions as the independent variable and weekday as the time period, all the data points have four fueling positions. A line corresponding to an average rate cannot be drawn. The weighted average rate is still listed on the data page.

4.2.2.2 Standard Deviation for the Average Trip Rate

Standard deviation is a measure of data dispersion relative to the calculated average. A low standard deviation represents less dispersion. Standard deviation is provided when there are three or more data points.

Calculation of weighted standard deviation is demonstrated in Appendix J.

4.2.2.3 Regression Analysis

Regression analysis provides a tool for developing an equation that defines the line that “best fits” the data. This specific mathematical relationship between trips and the related independent variable is defined as the “fitted curve equation.”

For each data set with at least four data points, a fitted curve equation and a corresponding coefficient of determination ($R^2$) is calculated. The coefficient of determination is defined as the percent of the variance in the number of the trips associated with the variance in the independent variable value. For example, if the $R^2$ value is 0.75, then 75 percent of the variance in the number of trips is accounted for by the variance in the independent variable value. As the $R^2$ value increases toward 1.0, the better the fit; as the $R^2$ value decreases toward 0, the worse the fit.

A best-fit curve and its associated equation are presented in the data plot if the $R^2$ value is at least 0.5. The fitted curve equation appears on the graph as a solid line to show how well it represents the actual data points.

Two general forms of fitted curve equations are considered in Trip Generation Manual data plots:

- Linear: $T = aX + b$
- Logarithmic: $Ln(T) = aLn(X) + b$

Where $X$ is the independent variable and $T$ (the number of trips) is the dependent variable. The regression analysis determines the values of $a$ and $b$ that minimize the expected error in estimating the dependent variable.

The fitted curve equation with the highest $R^2$ value is presented. Unlike the weighted average rate, the plotted fitted curve equation does not necessarily pass through the origin nor is the relationship necessarily linear.
4.2.3 Cautionary Notes

Variations in trip generation characteristics for specific land uses produce what often appear to be scatter diagrams in the *Trip Generation Manual* data plots. These variations may be due to a small sample size of data sites; differences in overall economic conditions at the times of data collection; differences in the settings of sites studied; other unique characteristics of the specific sites; and daily, seasonal, and geographic variations. Accordingly, professional judgment must be exercised in the use of the reported data and statistics.

The plots presented in *Trip Generation Manual* cover only the range of independent variables for which data are available. Caution should be used if extrapolating the data beyond the ranges provided because no information has been supplied to document trip generation characteristics beyond the given ranges.

There are several data plots where the fitted curve equation has a significantly large or negative y-intercept. For an independent variable with a low value, the fitted curve equation might produce a generated trips estimate that is unreasonable (such as fewer than zero). This usually happens when the variable is outside the range of the data points for this data plot. In such a case, the analyst should use the cluster of data points around the size of the study site independent variable to estimate trips. The analyst should never use the data for study sites outside the data extremes.

It should also be noted that in some cases, because of the limited sample size and variation in data received, the projected trip generation estimate for the peak hour of the adjacent street traffic exceeds the trip generation estimate for the peak hour of the generator. By definition, this is impossible. In these isolated cases, knowledge of the project site and professional judgment should be used in the selection of an appropriate trip generation estimate.

4.2.4 Selection of an Appropriate Independent Variable

For many land uses, *Trip Generation Manual* includes data analysis and plots for more than one independent variable. Selection of the appropriate variable for a study site is a critical decision. Usually, it is best to use the one that (1) is most directly causal for the variation in trips generated by a land use and (2) is accurately projectable for a development site.

If the analyst has reason to believe that an independent variable (and how it was measured for sites reported in the *Manual*) does not match the characteristics of a study site, that land use data analysis and plots should not be used. Other independent variables should be explored and a local trip generation study could also be considered (see Chapter 9).

The analyst should exercise caution before trying to quantify the trip generation effects of isolated and minor changes in characteristics of a particular land use. *Manual* data are compiled from a wide range of sources with a potentially high variability in site characteristics within the bounds of each individual land use code definition. Moreover, the *Manual* does not provide information on the secondary characteristics of the surveyed sites (for example, their setting) and therefore any analysis of the effects of changes in site characteristics is purely hypothetical and not verifiable with the current edition data.
Ideally, the independent variable that has the strongest logical relationship with trip-making, and that can be measured or estimated to sufficient accuracy, should be selected. For example, for an office building, gross square feet is typically a better independent variable than is overall site acreage. However, it is also important to evaluate the sample size for each independent variable. In the case of two variables with similar measures of “best fit,” the analyst should usually favor the most accurately projected variable. If there appears to be little difference, then the variable with the larger sample size should be selected.

The chosen independent variable should be stable for a particular land use type and not a direct function of actual site tenants. The values and measurements attributable to an independent variable should not change dramatically with changes in building tenants. Physical site characteristics (such as square feet of floor area or number of dwelling units) are preferable to tenant characteristics (such as employees or residents).

Finally, a selected independent variable should be obtained through a primary measurement, not derived from secondary data. For example, many estimates of the number of employees working in a commercial building are derived as a function of the floor area (in square footage) of the office building and an assumed employment density. An estimate of trips based on an independent variable derived using this approach is not likely to be as accurate as one based on primary data. Nevertheless, if the selected independent variable must be derived rather than measured, the analyst should apply a realistic and credible factor based on verifiable or valid relationships applicable to the site being considered.

<table>
<thead>
<tr>
<th>Use Fitted Curve Equation when:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● A fitted curve equation is provided and the data plot has at least 20 data points</td>
</tr>
</tbody>
</table>

OR

● A fitted curve equation is provided, the curve has an $R^2$ of at least 0.75, the fitted curve falls within data cluster, and the weighted standard deviation is more than 55 percent of the weighted average rate.

<table>
<thead>
<tr>
<th>Use Weighted Average Rate when:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● The data plot has at least three data points (and preferably, six or more);</td>
</tr>
<tr>
<td>● The $R^2$ value for the fitted curve is less than 0.75 or no fitted curve equation is provided;</td>
</tr>
<tr>
<td>● The weighted standard deviation for the average rate is less than 55 percent of the weighted average rate; and</td>
</tr>
<tr>
<td>● The weighted average rate is within data cluster in plot.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Collect Local Data when:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Study site is not compatible with ITE Land Use Code definition;</td>
</tr>
<tr>
<td>● Data plot has only one or two data points (and preferably, when five or fewer);</td>
</tr>
<tr>
<td>● The weighted standard deviation for the average rate is greater than 55 percent of the weighted average rate;</td>
</tr>
<tr>
<td>● Independent variable value is not within range of data; or</td>
</tr>
<tr>
<td>● Neither weighted average rate line nor fitted curve is within data cluster at size of study site.</td>
</tr>
</tbody>
</table>
4.3 Basis for Recommended Process

The recommended approach for using information from *Trip Generation Manual* data pages to estimate trip generation for a study site is based on the following statements:

- The value of the independent variable for the study site must be within the range of data included to use the data plot;
- When the data plot has at least 20 data points and a fitted curve equation are provided, the fitted curve equation should be used;
- A fitted curve equation with an \( R^2 \) of at least 0.75 is appropriate to use because it indicates the recommended acceptable level of correlation between trips generated by a site and the value measured for an independent variable;
- A weighted average rate is appropriate to use when the weighted standard deviation is less than or equal to 55 percent of the weighted average rate;
- The use of supplemental local data is suggested when the data plot has fewer than six data points; and
- The number of trips determined by either the rate or the equation should be within the cluster of data points (that is, the range of trip values) found at the study site’s independent variable value. Otherwise, collecting and using additional local data is suggested.

A detailed step-by-step approach for using *Trip Generation Manual* data is presented in Section 4.4 of this chapter.

4.4 Process for Selecting Average Rate or Equation in *Trip Generation Manual* Data

A step-by-step procedure is described below for determining how best to estimate trip generation using data contained in *Trip Generation Manual*. These guidelines are merely tools to help the analyst estimate trip generation. These tools are by design straightforward and uncomplicated. They do not include all considerations that could be relevant to a particular situation. Thus, professional judgment must be applied at all stages in this analysis process. The procedure is also outlined with simplified text in the flow chart in Figure 4.2.

4.4.1—Step 1: Determine if the study site is consistent with the description of a land use code in *Trip Generation Manual* and with the described or presumed characteristics of development sites for which data points are provided.

- If the answer is yes, proceed to Step 2.
- If the answer is no, collect local data for the land use being analyzed and establish a local or consolidated rate. Refer to Chapter 9 for guidance.

4.4.2—Step 2: Determine if the size of the study site (in terms of the unit of measurement of the independent variable) is within the range of the data shown in the data plot.

- If the answer is yes, proceed to Step 3.
- If the answer is no, either (1) consider the use of a different independent variable and its associated data pages, or (2) collect local data and establish a local or consolidated rate. Refer to Chapter 9 for guidance.
Figure 4.2 Process for Selecting Average Rate or Equation in *Trip Generation Manual* Data

1. Compatible with ITE Land Use Code?
   - Yes
   - No

2. Size within Data Extremes?
   - Yes
   - No

3. Number of Data Points
   - 1 or 2
   - 3–5
   - 6+

4. Fitted Curve Equation?
   - Yes
   - No

5. Standard Deviation ≤55%?
   - Yes
   - No

6. Data Cluster Okay?
   - Yes
   - No

7. 20 or more Data Points?
   - Yes
   - No

8A. $R^2 ≥ 0.75$? Within Cluster?
   - Yes
   - No

8B. Std. Dev ≤55%? Within Cluster?
   - Yes
   - No

- If 8A is yes & 8B is yes
- If 8A is yes & 8B is no
- If 8A is no & 8B is yes
- If 8A is no & 8B is no

Choose Line at Cluster

Use Fitted Curve Equation

Use Weighted Average Rate

Collect Local Data

Collect Local Data (Refer to Chapter 9)
4.4.3—Step 3: Determine how many data points compose the sample reported in *Trip Generation Manual*.

- If the number of data points is **one or two**, either (1) consider the use of a different independent variable and its associated data pages, or (2) collect local data and establish a local or consolidated rate. Refer to Chapter 9 for guidance.
- If the number of data points is **three, four, or five**, the analyst is encouraged to collect local data and establish a local or consolidated rate (see Chapter 9), but can otherwise proceed to Step 4.
- If the number of data points is **six or more**, proceed to Step 4.

4.4.4—Step 4: Determine if a fitted curve equation is provided.

- If the answer is **yes**, proceed to Step 7.
- If the answer is **no**, proceed to Step 5.

4.4.5—Step 5: Determine if the weighted standard deviation is less than or equal to 55 percent of the weighted average rate (calculation: the weighted standard deviation divided by weighted average rate is less than or equal to 0.55).

- If the answer is **yes**, proceed to Step 6.
- If the answer is **no**, either (1) consider the use of a different independent variable and its associated data pages or (2) collect local data and establish a local or consolidated rate. Refer to Chapter 9 for guidance.

4.4.6—Step 6: Determine if the line that corresponds to the weighted average rate is within a cluster of data points near the size of the study site.

- If the answer is **yes**, **USE THE WEIGHTED AVERAGE RATE**.
- If the answer is **no**, either (1) consider the use of a different independent variable and its associated data pages, or (2) collect local data and establish a local or consolidated rate. Refer to Chapter 9 for guidance.
- If there are no data points near the site size, but there are good matches at somewhat smaller and larger sizes, assume the answer is **yes**.

4.4.7—Step 7: Determine if there are at least 20 data points distributed over the range of values typically found for the independent variable. Determine if the line corresponding to the fitted curve equation is within the cluster of data points near the size of the study site.

- If both answers are **yes**, **USE THE FITTED CURVE EQUATION**.
- If at least one answer is **no**, proceed to Step 8.

4.4.8—Step 8: Determine the answers to Questions 8A and 8B.

**Question 8A:** Is the $R^2$ for the fitted curve equation greater than or equal to 0.75? And, is the line corresponding to the fitted curve equation within the cluster of data points at the size of the study site? Note: If there are no data points near the site size, but there are good matches at somewhat smaller and larger sizes, the analyst may assume the answer is **yes**.
**Question 8B:** Is the weighted standard deviation for the weighted average rate less than or equal to 55 percent of the weighted average rate? And, is the line corresponding to the weighted average rate within the cluster of data points at the size of the study site? Note: If there are no data points near the site size, but there are good matches at somewhat smaller and larger sizes, the analyst may assume the answer is **yes**.

If Questions 8A and 8B are both answered **yes**, then choose whichever line (representing either the fitted curve equation or the weighted average rate) best fits the data points at the value of the independent variable for the study site. This decision could be different for different points in the chart.

If the answer to Question 8A is **yes** and to Question 8B is **no**, then **USE THE FITTED CURVE EQUATION**.

If the answer to Question 8A is **no** and to Question 8B is **yes**, then **USE THE WEIGHTED AVERAGE RATE**.

If the answers to Questions 8A and 8B are both **no**, then **COLLECT LOCAL DATA**. Refer to Chapter 9 for guidance.

An acceptable **exception** to the “collect local data” recommendation occurs if the rate or equation line passes through the cluster of data at the value of the independent variable for the study site. If such is the case, the analyst may use either the weighted average rate or the fitted curve equation (whichever line is appropriate).

**4.5 Examples of Recommended Process**

The recommended step-by-step procedure for selecting between a weighted average rate and a fitted curve equation when estimating trip generation is illustrated by the following examples. Reference is made to data presented in *Trip Generation Manual, 9th Edition*.

**Example 1:** Estimate trip generation for Land Use Code 140 (Manufacturing) on a weekday during the PM peak hour of adjacent street traffic as a function of gross floor area (GFA). Assume the site will have 800,000 sq. ft. of GFA. Refer to page 175 of *Trip Generation Manual, 9th Edition* for data.

**Step 2:** size of site is within the range of data

**Step 3:** sufficient number of data points (56)

**Step 4:** fitted curve equation provided

**Step 7:** more than 20 data points (56)

**Use Fitted Curve Equation**
Example 2: Estimate trip generation for Land Use Code 310 (Hotel) on a weekday during the PM peak hour of the adjacent street traffic as a function of employees. For this example, assume the hotel will have 100 employees. Refer to page 624 of *Trip Generation Manual, 9th Edition* for data.

**Step 2:** size of site is within the range of data  
**Step 3:** sufficient number of data points (13)  
**Step 4:** fitted curve equation provided  
**Step 7:** fewer than 20 data points (13)  
**Step 8A:** $R^2$ of 0.57 is less than 0.75  
**Step 8B:** standard deviation (0.42 percent) is less than or equal to 55 percent of the weighted average rate (0.80)  
**Step 8:** answers to Question 8A is no and to Question 8B is yes  
**Use Weighted Average Rate**

Example 3: Estimate the daily trip generation for Land Use Code 520 (Elementary School) on a weekday during the PM peak hour for adjacent street traffic as a function of employees. For this example, assume 70 employees. Refer to page 985 of *Trip Generation Manual, 9th Edition* for data.

**Step 2:** size of site is within the range of data  
**Step 3:** sufficient number of data points (14)  
**Step 4:** no fitted curve equation provided  
**Step 5:** standard deviation (1.05) is greater than 55 percent of the weighted average rate (1.76)  
**Collect Local Data** (or consider the use of a different independent variable and its associated data pages)

Example 4: Estimate trip generation for Land Use Code 813 (Free-Standing Discount Superstore) on a weekday during the AM peak hour of adjacent street traffic as a function of gross floor area. For this example, assume the store size will be 180,000 sq. ft. of GFA. Refer to page 1441 of *Trip Generation Manual, 9th Edition* for data.

**Step 2:** size of site is within the range of data  
**Step 3:** sufficient number of data points (67)  
**Step 4:** no fitted curve equation provided  
**Step 5:** standard deviation (0.75) is less than or equal to 55 percent of the weighted average rate (1.85)  
**Step 6:** weighted average line is within a cluster of data points near the development size  
**Use Weighted Average Rate**
5  Person Trips

5.1 Background

Most data presented in the Trip Generation Manual data volumes are vehicle-based and have been collected at low-density, single-use, suburban developments with little or no transit service, limited bicycle access, and little or no convenient pedestrian access. These sites are called baseline sites because they are the starting points for vehicle trip generation estimation.

As described earlier in Chapter 3, the analyst needs to adjust baseline vehicle trip generation estimates to correctly estimate trip generation for a site:

- Surrounded by compact urban development (an infill site);
- Consisting of a mix of complementary land uses (mixed-use development);
- Served by public or corporate transit, in particular if designed specifically to capitalize on transit access to the site (transit-friendly development);
- That attracts walking and bicycling trips with the quality and connectivity of supporting networks (a site in an urban core area; a site near school or senior center);
- That prices on-site parking or that requires patrons to use off-site priced parking; and
- In an area with high vehicle occupancy as a result of an areawide transportation demand management program or preferential treatment for ridesharing.

Adjustments are necessary because trips to sites with these characteristics (termed multimodal sites in this Handbook) often have different mode shares and vehicle occupancy than the baseline sites. Applying baseline vehicle trip generation to a multimodal site without adjustment may result in an overestimate of vehicle trips for that site. To adjust for differences in vehicle occupancy and use of pedestrian, bicycle, and transit modes, a trip generation estimate needs to account for each person traveling to and from a site rather than just the number of vehicles entering and exiting the site.

This chapter demonstrates how to estimate person trips for both baseline and study sites. This chapter is compatible and complementary with guidance presented in Chapters 6 through 8 for multimodal sites.

Trip Generation Manual, 10th Edition is expected to contain data for both person trips and vehicle trips. The guidance presented in this chapter can be adapted to also apply to the estimation of person trips.

5.2 Assumptions

The following three assumptions form the basis for the use of person trips (and their relationship to vehicle trips) in the development of trip generation estimates. These assumptions are by necessity simplistic and, therefore, are not expected to produce numerically exact results. Nevertheless, these assumptions are both necessary for the trip estimation approaches recommended in Chapters 6 through 8 and appropriate given the limited extent of a national person trip database.
First, the quantity of person trips generated by a particular land use and unit of development is assumed to be the same regardless of its context. This means that, on average, the amount of activity for a given quantity of a particular land use is consistent. For example, for a 60,000 square ft. office building, the number of person trips generated during the weekday AM street peak hour does not substantially vary because of its location. This assumption is already basic to the estimation of site trip generation since it supports the use of average rates from baseline sites.

Second, mode shares and vehicle occupancy are assumed to be the same at all sites with a specific land use code (LUC) in the same land use and transportation system context and in the same (localized) area. This assumption is based on the idea that, on average, people respond in the same way to similar conditions. It means, for example, that two adjacent general office buildings with the same mix of tenants, same transit service, same pedestrian and bicycle accessibility, same parking pricing, and same employee and visitor residence and service areas will have the same mode shares and vehicle occupancy for trips generated.

Third, ITE baseline vehicle trip generation data are assumed to reflect inherent mode share percentages and vehicle occupancy. Therefore, for typical baseline development (that generally has no or infrequent transit service, free parking, no rideshare program, and no special pedestrian and bicycle facilities or amenities), the mode shares and vehicle occupancy are relatively consistent across the baseline database.

5.3 General Approach for Estimating Multimodal Site Person Trips

The basic approach presented in this Handbook for estimating mode shares and vehicle occupancy for a study site is to adapt baseline vehicle trip generation data using appropriate mode share and vehicle occupancy data. This approach enables the analyst to make use of the entire Trip Generation Manual database as a source for baseline vehicle trip generation characteristics. As the national and local databases begin to include person trip data based on actual site counts, a more direct calculation (rather than an adjustment to baseline data) may eventually be possible.

The general approach takes the following steps:

1. Estimate baseline vehicle trips generated for the study site using data from Trip Generation Manual or other acceptable source with data representing baseline conditions. Use the procedures presented in Chapters 3 and 4 to guide development of the estimate.

2. Convert baseline vehicle trips to baseline person trips using baseline mode shares and vehicle occupancy. The conversion process is covered in sections 5.4 and 5.5 of this chapter.

3. Determine applicable mode shares and vehicle occupancy representing conditions associated with the characteristics of the study site and its surrounding context. Section 5.5 of this chapter presents a general overview of available methods for determining study site mode shares and vehicle occupancy. Chapters 6, 7, and 8 provide detailed and specific tools for making these adjustments.

4. Calculate the estimated person trips by mode for the study site using the applicable study site mode shares and vehicle occupancy.
5. Convert the adjusted person trips to **adjusted vehicle trips** (using the equations in section 5.4 of this chapter).

As is described in section 5.5, the availability of potential sources of baseline and proxy site data can affect the final approach taken to estimate study site person trips and vehicle trips.

### 5.4 Conversion Between Vehicle Trips and Person Trips

The general approach for estimating multimodal site person trips and vehicle trips (presented in section 5.3 of this chapter) requires the conversion between vehicle trips and person trips. The formula for conversion from **vehicle trips to person trips** is

\[
person\ trips = (vehicle\ occupancy) \ast (vehicle\ trips) + transit\ trips + walk\ trips + bike\ trips
\]

\[
T_P = (T_V \ast VO) + T_T + T_W + T_B
\]

where

- \(T_P\) = person trips
- \(T_V\) = vehicle trips
- \(VO\) = vehicle occupancy
- \(T_T\) = transit trips
- \(T_W\) = walk trips
- \(T_B\) = bicycle trips

The conversion of **study site person trips to study site vehicle trips** (after the analyst makes changes to mode share and vehicle occupancy using the recommended procedures presented in Chapters 6 through 8) uses the following equation:

\[
vehicle\ trips = \frac{[(person\ trips) \ast (percent\ person\ trips\ in\ vehicles)]}{vehicle\ occupancy}
\]

\[
T_V = \frac{[T_P - (T_T + T_W + T_B)]}{VO}
\]

where

- \(T_V\) = vehicle trips
- \(T_P\) = person trips
- \(T_T\) = transit trips
- \(T_W\) = walk trips
- \(T_B\) = bicycle trips
- \(VO\) = vehicle occupancy
If the percentage of all person trips that are in a vehicle (or 100 percent minus the combined percentage of non-vehicle trips) is known,

\[
\text{vehicle trips} = \frac{[(\text{person trips}) \times (\text{percent person trips in vehicles})]}{\text{vehicle occupancy}}
\]

\[
T_v = \frac{(T_p \times PCT_v)}{VO}
\]

where

\[
T_v = \text{vehicle trips}
\]

\[
T_p = \text{person trips}
\]

\[
PCT_v = \text{percent person trips in vehicles}
\]

\[
VO = \text{vehicle occupancy}
\]

The following formula combines proxy site mode shares and vehicle occupancy data with estimated baseline person trips in the above formula to produce study site vehicle trips:

\[
\text{study site vehicle trips} = \frac{[(\text{baseline person trips}) \times (\% \text{ person trips in vehicles at proxy site})]}{\text{proxy site vehicle occupancy}}
\]

\[
T_{v,SS} = \frac{(T_p \times PCT_{v,PS})}{VO_{PS}}
\]

where

\[
T_{v,SS} = \text{study site vehicle trips}
\]

\[
T_p = \text{person trips}
\]

\[
PCT_{v,PS} = \text{percent person trips in vehicles at proxy site}
\]

\[
VO_{PS} = \text{vehicle occupancy at proxy site}
\]

5.5 Study Site and Baseline Mode Shares and Vehicle Occupancy

5.5.1 Selection of Method Based on Data Sufficiency

Table 5.1 lists the available methods for estimating study site and baseline mode shares and vehicle occupancy. Some methods may not be available for a study site due to a lack of sufficient data. The methods are presented in the table in descending order of preference based on their assumed reliability and ease of application.

“Data sufficiency” is used as a qualifying factor in the assessment of the methods in the table. The overall recommendation is to use data from an established trip generation resource (such as the Trip Generation Manual data volumes or tables in the Handbook chapters or appendices) if the data are sufficient to represent the study site characteristics. Sufficient data have three qualities:
• The same land use code and size as the study site—As much as site size is important, the site market areas should also be comparable in size. For example, a small neighborhood market and a small specialty food market may have the same GFA but draw from significantly different market areas and therefore the mode shares for generated trips could be very different.

• A setting similar to that of the study site—Section 3.3 of Chapter 3 provides a general description of site context criteria that could be relevant. Chapters 7 and 8 identify the criteria that are most relevant when establishing the sufficiency of proxy sites in infill locations and served by significant transit, respectively.

• Adequate quantity of sites—The proxy site data should include at least three data points (five or more are preferable).

The first two factors are intentionally not quantitatively definitive. The analyst must use professional judgment to assess the sufficiency of the database sites to correlate to the study site characteristics.

If any of the sufficiency criteria are not met with a national database, the next acceptable method is to collect and use local proxy data. Likewise, if the analyst has reason to suspect study site trip-making will be different from the national database, the local proxy data approach should be used.

### Table 5.1 Available Methods for Estimating Study Site Mode Shares and Vehicle Occupancy

<table>
<thead>
<tr>
<th>Source of Study Site Vehicle &amp; Person Trips</th>
<th>Source of Study Site Mode Shares &amp; Vehicle Occupancy</th>
<th>Method Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITE Baseline or Local Proxy Sites</td>
<td>National Research and Sources or Trip Generation Manual</td>
<td>Convert baseline vehicle trips to baseline person trips using <em>Trip Generation Manual and Handbook</em> baseline or local proxy site data. Use methods described in Chapters 6 through 8 to estimate adjustments in baseline person trips for a mixed-use, infill, or transit-friendly study site. Method described in Section 5.5.3.</td>
</tr>
<tr>
<td>ITE Baseline or Local Proxy Sites</td>
<td>Local Proxy Sites</td>
<td>Convert baseline vehicle trips to baseline person trips using <em>Trip Generation Manual and Handbook</em> baseline or local proxy site data. Convert baseline person trips to study site person trips using mode share and vehicle occupancy data collected at three or more proxy sites in same area and setting as study site. Method described in Section 5.5.4.</td>
</tr>
<tr>
<td>Local Proxy Site</td>
<td>Local Proxy Site</td>
<td>Use person trip generation by mode and with vehicle occupancy at existing development at study site (applicable only if site is occupied with land use similar or relevant to that being proposed). Method described in Section 5.5.5.</td>
</tr>
</tbody>
</table>
5.5.2 Baseline Site Mode Shares and Vehicle Occupancy

Baseline person trips are calculated by

- First, converting ITE baseline vehicle trip generation estimates to vehicle person trips using the baseline vehicle occupancy for the specific land use code (or the same general land use category), and
- Second, converting vehicle person trips to person trips by mode through the use of applicable baseline mode shares.

Baseline vehicle trip generation can be estimated from data provided in Trip Generation Manual. Procedures for making those estimates are described in Chapters 3 and 4. Little information is provided regarding baseline vehicle occupancy or mode shares.

For this Handbook, a limited amount of weekday commuter peak period (7:00–9:00 a.m., 4:00–6:00 p.m.) mode share and vehicle occupancy data were collected for baseline sites to provide a general starting point for some of the more common land use types. Baseline data were collected at apartments, motels, offices, shopping centers, restaurants, a bank, and a bowling alley. These baseline mode share and vehicle occupancy data are presented in Appendix B.

There are not enough samples in the Appendix B data to derive precise percentages by mode for the land use types for which data were collected. However, in almost all cases, the percentage of total person trips in vehicles exceeds 95 percent. In some cases the averages by land use are 100 percent motor vehicle. Based on the limited data shown, the analyst can reasonably conclude the following with regard to baseline mode shares:

- The percentage mode share of person trips made by vehicle (personal passenger vehicle plus truck) for most baseline sites is 95 percent or more.
- The majority of non-vehicle trips are by walking.
- From the limited number of samples with more than 100 observations, it appears there may be only very small directional differences in total vehicle share percentages for some land uses. Smaller samples contain slightly larger variations. Those could be real or could be just statistical data noise from smaller samples.
- Percentages of person trips in vehicles are only available in this data set for a few land uses. The findings may or may not be transferrable to other land uses. It is not suggested at this time to assume the same results for other land uses. However, it may be reasonable to assume similar results for land uses within the same land use category (such as residential, lodging, or general retail).

If the analyst assumes a mode share of 95 percent of person trips are in vehicles, then the ITE vehicle trip generation rates/equations (when converted to person trips) represent 95 percent of the total person trips (both drivers and passengers). The other 5 percent are walk, bicycle, and transit trips.

5 The land use types were selected so the data would be transferrable to similar land uses. For example, residential apartment mode shares should be applicable to all suburban baseline apartment classifications.
Regarding baseline vehicle occupancy, the analyst can reasonably conclude the following:

- For land uses with larger sample sizes (more than 100 observations), vehicle occupancy is fairly consistent for a given land use type. However, there are differences in vehicle occupancy among land uses.
- For some land uses, inbound and outbound vehicle occupancy is similar. There could be some land uses for which directional peak period vehicle occupancy might logically differ, such as office, with commuters dominant in one direction and visitors in the opposite. That remains to be determined through more data collection.

If the analyst has reason to suspect the local baseline mode shares or vehicle occupancy are different than what the national database produces, local baseline data can also be collected and used. Note however that these local baseline data are NOT intended to be mode shares and vehicle occupancy in the vicinity of the study site; rather, they should be mode shares and vehicle occupancy at suburban, stand-alone, single-use sites (that is, at baseline sites).

Additional baseline data are needed to expand coverage to more land uses and to increase the level of confidence in the findings to date. Baseline sites are easy enough to find that these data should be collectible solely through observational counts if done carefully. Interviews should not be needed for baseline trip generation data collection.

It is recommended that additional data be collected—especially for the land uses most frequently analyzed in infill areas where the differences between baseline and infill trip generation rates may differ significantly (see the Chapter 7 discussion on trip generation for infill development).

For baseline mode shares and vehicle occupancy for other land use types, it is recommended that baseline sites be found and observational surveys conducted.

### 5.5.3 Preferred Option—National Proxy Site Data for Study Site

If the study site adheres to the characteristics captured in the data and procedures presented in Chapters 6, 7, and 8 (for mixed-use, infill, and transit-friendly development), those procedures should be used to estimate study site mode shares and vehicle occupancy. The analyst should confirm that the national database consists of a sufficient number of sites that are comparable in type of land use, size of land use, and setting as the study site.

If potential walk trips to and from the study site are expected to compose a significant share, then the analyst should focus on site context issues that affect walk mode shares. Examples include:

- Proximity of complementary land uses (such as density and quantity of residential near a retail study site and density and quantity of office near a retail site [and vice versa]);
- Types of pedestrian facilities;
- Quality of the walk experience; and
- Barriers created by nearby roadways (such as street width, vehicle speed, and uncontrolled crossings).

Chapter 7 provides additional guidance on relevant setting factors for infill development.
If potential bicycle trips to and from the study site are expected to compose a significant share, then the analyst should focus on site context issues that affect bicycle mode shares. Examples include

- Types of bicycle facilities (such as bicycle lanes, multi-use trails, separated bikeways, designated bicycle routes, and bicycle boulevards);
- Barriers created by nearby roadways (such as street width, vehicle speed, and uncontrolled crossings); and
- Proximity of complementary land uses (such as density and quantity of residential near an office study site [and vice versa]).

If potential transit trips to and from the study site are expected to compose a significant share, then the analyst should focus on site context issues that affect transit mode shares. Examples include

- Proximity to transit service (bus stops, transit stations);
- Type of transit service (heavy rail, light rail, commuter rail, streetcar, bus rapid transit, express bus, local bus, shuttle);
- Quality and reliability of transit service (peak period headways, hours of operation, days of operation);
- Quality of passenger amenities (such as bus shelters); and
- Connectivity between transit stop/station and study site (such as pedestrian facilities and ease of crossing major streets).

Chapter 8 provides additional guidance on relevant setting factors for development served by significant levels of transit.

If the analyst has reservations about the applicability or reliability of the national proxy data, the analyst, as an alternative, should consider collecting data at local proxy sites (see Section 5.5.4).

**5.5.4 Second Acceptable Method—Person Trip Generation Survey at Study Site**

If the study site has existing development of the type(s) being proposed to be further developed on the site, the analyst can collect person trip, mode share, and vehicle occupancy data at the same site. This may occur when an existing development is being expanded or redeveloped with the same or very similar land uses and site characteristics (such as the adequacy of parking supply). Recommended procedures for conducting these surveys are described in Chapter 12, with additional pertinent details provided in Chapters 6, 7, and 8, as appropriate.

**5.5.5 Third Acceptable Method—Local Proxy Site Data for Study Site**

The national database may not have a sufficient number of proxy sites with the same land use, size, and setting as the study site. For this method, the analyst collects person trips, mode shares, vehicle occupancy, and vehicle trips at local proxy sites that closely resemble the characteristics of the study site. Recommended procedures for conducting these surveys are described in Chapter 12, with additional pertinent details provided in Chapters 6, 7, and 8, as appropriate.

If the analyst uses only the mode share or vehicle occupancy data found at proxy sites, data should be collected at three or more sites. If the analyst plans to also use the person trip and vehicle trip data collected at proxy sites, the analyst should adhere to the procedures presented in Chapter 9 when deciding whether the local data are sufficient to establish a local trip generation rate.
The results of the proxy site data collection should be compared to any appropriate national data presented in Chapters 6 through 8 and assessed for reasonableness.

### 5.5.6 Options that Require Significant Caution

Adapting metropolitan area home or workplace travel survey data is rarely acceptable for site trip generation applications. Similarly, data from the occasional U.S. National Household Transportation Study (NHTS)\(^6\) are rarely acceptable. The reason is that most available metropolitan travel survey and NHTS data are correlated with trip purpose (not land use) and travel analysis zone or census tract (not specific site), so it is very hard to find an equivalency that can convert data from the travel or NHTS survey to site trip generation data.

U.S. Census journey-to-work survey data are also rarely acceptable for site trip generation analysis. These data are limited to home-based work trips, and virtually all land uses generate more than just commute trips.

In the absence of a site-specific survey or a large sample regional travel survey, consideration can be given to using a travel demand model as a source for information on vehicle occupancy and mode choice by trip purpose. The percent of trips by purpose vary by land use type. For a residential land use, trip purpose percentages can be derived from reviewing the percent purpose of trip productions found in predominantly residential traffic analysis zones. For non-residential zones, the percent trip purpose should reflect the dominant land use type. Once site-generated trips are allocated by trip purpose, then vehicle occupancy rates and mode shares can be applied. If a mode choice model is available and the site is served by transit, estimated mode shares and vehicle occupancies from similar zones in the model could be borrowed for site-specific assumptions. For a “highway only” model, there is generally only a single set of vehicle occupancy factors, if any at all.

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\(^6\) Cambridge Systematics, Inc. et al. NCHRP Report 716: *Travel Demand Forecasting: Parameters and Techniques*. Washington, DC: Transportation Research Board, 2012 provides transferrable parameters such as trip production and attraction rates and vehicle occupancy rates based on the 2009 NHTS. However, this report does not provide trip production or attraction rates for specific ITE land use categories such as single-family vs. multi-family dwellings, shopping centers, or restaurants.
6 Trip Generation for Mixed-Use Development

6.1 Background

Most data presented in *Trip Generation Manual* were collected at single-use, free-standing sites. However, development sites with two or more complementary land uses are now much more common and a method to accurately estimate the external trip generation effects of these types of developments is needed. At a development site consisting of two or more land uses, there is potential for interaction among those uses (referred to as “internal capture trips”), particularly where the trip can be made by walking. As a result, the total generation of external trips (that is, those entering and exiting the overall site) may be less than the simple sum of the trips generated by each discrete land use.

The recommended methodology is the same recommended procedure presented in NCHRP Report 684: *Enhancing Internal Trip Capture Estimation for Mixed-Use Developments.* The NCHRP report provides details on the development of the recommended estimation procedure, its underlying data, and validation of the estimation procedure. The report includes a summary of past research on trip generation and internal trip capture at mixed-use developments, as well as a discussion of other estimation methods that may be appropriate for the analyst to consider.

The recommended approach conforms to the Chapter 3 flow chart for estimation of site trip generation (see Figure 3.1):

- The baseline vehicle trip generation estimates are produced using the procedures presented in Chapters 4 and 9, as appropriate;
- Vehicle trip estimates are converted to person trips using methods presented in Chapter 5;
- The product of the process recommended in this chapter is an estimate of the total person trips entering or exiting the study site, after trips internal to the site (by walking, bicycle, transit, or personal passenger vehicle) are subtracted from total person trips generated by the study site;
- If the mixed-use site is located in an urban infill setting or near a rail transit station or a multi-route bus transit center with high-frequency service, the procedures presented in Chapters 7 and 8 should be applied to the product of the person trip estimates produced in this chapter; and
- Mixed-use development can attract vehicle traffic that is currently on adjacent or nearby streets. Refer to Chapter 10 for guidance on estimating pass-by and diverted trips.

6.2 Definition of Mixed-Use Development

For the purpose of this *Handbook*, a mixed-use development is typically a single real-estate development that consists of land uses corresponding to two or more ITE land use types between which trips can be made without using the off-site road system. A mixed-use development may also be referred to as a multi-use development.

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Because of the complementary nature of these land uses, some trips are made among the on-site uses. This capture of trips internal to the site has the net effect of reducing vehicle trip generation between the overall development site and the external street system (compared to the total number of trips generated by comparable land uses developed individually on stand-alone sites).

Mixed-use developments are commonly found ranging in size between 100,000 and 2 million sq. ft. of gross floor area within an overall area of up to roughly 300 acres. The data presented in this chapter correspond to mixed-use developments in this size range. The recommended procedures for estimating trip generation at mixed-use developments are likely applicable at even larger sites, but the analyst is encouraged to collect and consider additional data.

A key characteristic of a mixed-use development is that trips between the various land uses can be made on site and these internal trips do not utilize the major street system. In some mixed-use developments, these internal trips can be made either by walking or by vehicles using internal roadways without using external streets.

An internal capture rate can generally be defined as the percentage of total person trips generated by a site that are made entirely within the site. The trip origin, destination, and travel path are all within the site.

The trip reduction for internally captured trips is separate from the reduction for pass-by trips. These are two distinct components of trip-making behavior and both could be applicable for a proposed development. The internal trips, if present, should be subtracted before pass-by trip reductions are applied (refer to Chapter 10 for a complete discussion of pass-by trip estimation).

6.3 Mixed-Use Development Classified as a Single Land Use

A mixed-use development could consist of any combination of different land use types within a defined, congruous area. But that definition would encompass a wide range of potential applications, many of which are not intended to be the focus of this chapter.

A traditional downtown or central business district is not considered a mixed-use development for the purposes of this Handbook. Downtown areas typically have a mixture of diverse employment, retail, residential, commercial, recreation, and hotel uses. Extensive pedestrian interaction occurs because of the scale of the downtown area, ease of access, and proximity of the various uses. Automobile occupancy, particularly during peak commuting hours, is usually higher in the CBD than in outlying areas. Some downtowns have excellent transit service. For these reasons, trip generation characteristics in a downtown environment are different from those found in general urban or suburban areas. Most data presented throughout Trip Generation Manual from sites in suburban or outlying business district settings with limited or no transit service and free or inexpensive parking. Accordingly, trip generation characteristics in this chapter, and specifically in the case of capture rates at mixed-use developments, are directly applicable only to sites outside the traditional downtown. Chapter 7 presents a recommended approach for estimating person trips generated in any urban setting including a downtown.

A shopping center could also be considered a mixed-use development because it typically includes uses other than general retail such as restaurants, banks, and office. However, because data have
been collected directly for them as a-stand-alone developments, shopping centers are considered in \textit{Trip Generation Manual} as a single land use. The associated trip generation data presented in the Manual already reflect the effects of internal capture and the mixed-use nature of the center. **Accordingly, internal capture rates are not applicable and should not be used to estimate trips for shopping centers if using statistics and data for Land Use Code 820.** However, if the shopping center is part of a larger mixed-use development or if it is planned to have out-parcel development of a significantly different land use type, such as residential, the site could be considered a mixed-use development for the purpose of estimating site trip generation.

A subdivision or planned unit development containing general office buildings and support services such as banks, restaurants, and gasoline service stations arranged in a park- or campus-like atmosphere should be considered an \textbf{office park} (Land Use Code 750), not a mixed-use development. An office building with support retail or restaurant facilities contained inside the building should be treated as a \textbf{general office building} (Land Use Code 710) because the Manual data already reflect such support uses. A \textbf{hotel with an on-site restaurant and small retail} falls within Land Use Code 310 and should not be treated as mixed-use development.

\subsection*{6.4 Underlying Assumptions about Internal Capture at a Mixed-Use Site}

The internal trip-making characteristics of a mixed-use development site are directly related to its mix of on-site land uses (which are typically a combination of office, retail, restaurant, cinema/entertainment, residential, or hotel). When combined within a single mixed-use development, these land uses tend to interact and thus attract a portion of each other’s trip generation. As should be expected, the observed internal capture rates for mixed-use developments vary by time of day, mix of on-site land uses, and size of the development.

Four premises form the basis for the recommended methodology:

\begin{itemize}
  \item **Premise 1:** The distribution of trip purposes among persons entering or exiting a development site is relatively stable. In other words, the ratios of commute trips, work trips, and visitor trips to or from an office building is roughly the same whether the building is stand-alone or within a mixed-use development.
  \item **Premise 2:** The distribution of destination land uses (that is, at the other end of a trip from the development site) is likewise assumed to be relatively stable. For example, the destinations of trips from an office building are distributed among the many potential destinations (such as retail or residential) in roughly the same pattern whether the office is a stand-alone site or in a mixed-use development.
  \item **Premise 3:** The converse of Premise 2 is also true, that the distribution of origins for trips to a particular land use is assumed to be relatively stable.
  \item **Premise 4:** The number of trips from a land use within a mixed-use development to another land use within the same mixed-use development (that is, an internal trip) is a function of the size of the “receiving” land use and the number of trips it attracts, as well as the size of the “originating” land use and the number of trips it sends. \textit{The number of trips between a particular pair of internal land uses is limited to the smaller of these two values.}
\end{itemize}

Key to the success of this methodology in replicating internal capture patterns at mixed-use sites is its balancing step that constrains internal trip-making to realistic levels given the mix of land uses. Figure
6.1 shows an example of this balancing. Assume Land Use A is a large residential development and Land Use B is a smaller retail component of a mixed-use development. The residential development is large enough to generate 75 peak hour outbound trips that could go to an on-site retail destination, and could attract 50 inbound trips from an on-site retail origin. However, in this particular mixed-use development, the retail portion of the development is only large enough to generate 25 peak hour outbound trips to an on-site residential destination and 35 peak hour inbound trips from an on-site residential origin. Therefore with this particular combination of size and type of land uses, the mixed-use development internally captures a maximum of 35 trips from Land Use A to Land Use B and 25 trips from B to A. The remainder of the potential residential-to-retail on-site trips become external trips.

![Figure 6.1 Balanced Internal Trips in Mixed-Use Development Example](image)


### 6.5 Process for Estimating Mixed-Use Trip Generation

The recommended procedure for estimating internal trip capture and trip generation for a mixed-use development is a series of nine steps:

- Step 1: Determine whether methodology is appropriate for study site.
- Step 2: Estimate person trip generation for individual on-site land uses.
- Step 3: Estimate proximity between on-site land use pairs.
- Step 4: Estimate unconstrained internal person trip capture rates with proximity adjustment.
- Step 5: Estimate unconstrained demand between on-site land use pairs.
- Step 6: Estimate balanced demand between on-site land use pairs.
- Step 7: Estimate total internal person trips between on-site land use pairs.
- Step 8: Estimate total external person trips for each land use.
- Step 9: Calculate overall internal capture and total external vehicle trip generation.

A spreadsheet tool is available which automatically performs many of the required calculations based on input data. The spreadsheet tool can be downloaded from within the Other Resources link in the Trip and Parking Generation section of the ITE website (www.ite.org/tripgeneration/index.asp).

If using the spreadsheet tool, the analyst needs to complete Steps 1 through 3. The estimation tool automatically calculates overall internal capture and total external vehicle trips in Steps 4 through 8 and summarizes the results. The complete step-by-step procedure is provided here.
if the analyst chooses to do the calculations manually (if the analyst, for example, is using local data to supplement the national database). Appendix F contains an example application of the recommended process.

The step-by-step procedure and spreadsheet contain data that enable the analyst to evaluate internal capture at a mixed-use site with any combination of office, retail, restaurant, cinema/entertainment, residential, and hotel land uses. Because data are not currently available for other land use categories, internal capture to and from those uses is assumed to be zero in the spreadsheet tool.

The analyst is cautioned that each mixed-use development has unique characteristics that influence the extent of internal trip capture. Such characteristics include, but are not limited to, the following:

- The number and magnitudes of complementary land uses;
- The layout of the land uses relative to each other;
- Specific businesses, residence types, and other component characteristics within each land use category;
- Proximity and connectivity between each pair of land uses;
- Design characteristics of the development and its internal transportation system;
- Specific characteristics of the development’s access and parking; and
- Competing opportunities outside the development.

6.5.1 Step 1: Determine Whether Methodology Is Appropriate for Study Site

The procedure should be used for estimating internal capture only at a mixed-use development that has characteristics resembling the sites from which the internal capture rates have been derived. In determining if the recommended procedure is appropriate for a particular mixed-use development, the analyst should consider at least the following factors:

- **Development Type:** The mixed-use development should be a single, physically and functionally integrated development on a single development block or a group of contiguous blocks with two or more uses, with internal pedestrian and vehicular connectivity, and with shared parking among some or all uses. The site should have sufficient parking supply to meet demand although the most convenient parking may sometimes fill during peak demand periods.

- **Development Location:** The mixed-use development should be downtown fringe, general urban, or suburban. It should not be located either within or adjacent to a central business district. Trip generation for a study site in a CBD setting is addressed in Chapter 7.

- **Development Size:** The data that form the bases for the internal capture methodology are from mixed-use development sites that have between 100,000 and 2 million sq. ft. of building space and an overall acreage of up to roughly 300 acres. The mixed-use development should fall within those ranges. It can be a single site, a block, or a district or neighborhood (with multiple interconnected or interactive blocks within a defined boundary); however, this procedure should not be used for a development composed of different adjacent, but not directly connected, land uses. Adjacent blocks can be considered to be directly connected if there is an internal street, driveway, alley system, or pedestrianway by which person trips can be made to travel from one block to another. If the development site has multiple land uses and the blocks are configured in such a way that internal trips must exit the site and use an external street system, then the site is not a mixed-use development.
• **Land Use Mix:** The mixed-use development should consist of a combination of at least two of the following uses: retail, restaurant, office, residential, hotel, and cinema/entertainment. Internal capture for land uses beyond these six should be considered to be zero (unless comparable survey data for other land uses are provided) because there are no supporting data from which to derive an appropriate percentage. In addition, if a substantial portion of the land use at a mixed-use site is outside these six land uses, the *Handbook* internal capture rates might not be appropriate. Alternatively, the analyst can collect internal capture data at proxy sites with similar land use and setting characteristics.

• **ITE Trip Generation Manual Database:** The mixed-use development should not already be covered in the ITE trip generation database as reported in the latest edition of *Trip Generation Manual*. Current ITE Land Use types that already account for internal trip-making include shopping center, office park with retail, office building with ground floor retail or on-site cafeteria, and hotel with limited retail and restaurant space.

• **Time Period for Analysis:** The internal capture rates contained in this *Handbook* cover the weekday AM and PM peak periods for adjacent street traffic. Internal capture rates for weekend peak periods, for weekday midday peak periods, or for a daily period should not be assumed to be the same as or even a simple, direct function of the weekday AM and PM peak period rates. The analyst should collect additional data. Refer to section 6.7 of this chapter for guidance.

If the mixed-use development type, location, or size is not compatible with the sites in the internal capture database or if an estimate of internal capture during the midday or on a weekend is desired.

### 6.5.2 Step 2: Estimate Person Trip Generation for Individual On-Site Land Uses

The purpose of the second step is to estimate the person trips generated for each on-site land use. Person trips can be estimated from

- Directional (in, out) vehicle trip generation estimates for each land use;
- Mode share (percent of external person trips in personal passenger vehicle, truck, transit, and non-motorized) for each land use; and
- Vehicle occupancy for each land use.

These are baseline assumptions. They are used to factor baseline vehicle trip estimates to baseline person trip estimates which are assumed to be the same as study site person trip estimates. These should not reflect anticipated or potential changes in study site external mode shares (for example, walk trips to/from a mixed-use development in an infill setting or transit trips to/from a mixed-use development near a transit station). Those external mode share calculations are addressed in Chapters 7 and 8.

The following paragraphs describe the data requirements for each set of inputs, including references to the appropriate location on the spreadsheet tool where each data item should be entered. Figure 6.2 presents the PM peak hour input and output pages in the spreadsheet model. The spreadsheet also includes AM peak hour input and output pages and internal capture rate look-up tables for both AM and PM.

**Vehicle Trip Generation by Land Use.** The analyst should estimate vehicle trip generation for each component land use using the procedures presented in Chapters 3 and 4 of this *Handbook*. 
The recommended procedure can estimate internal trip capture for the following generic land use categories: office, retail, restaurant, residential, hotel, and cinema/entertainment.

Therefore, for the purpose of estimating internal capture, the analyst must consolidate individual appropriate land uses into the above land use categories. As an example, for a mixed-use development containing apartments and townhouses, compute vehicle trips generated for each and total them to estimate the total residential vehicle trips. The vehicle trip generation estimates should be entered in Table 1 of the spreadsheet tool shown in Figure 6.2 as entering or exiting vehicle trips.

The recommended procedure estimates internal capture only for trips to/from land uses that fall into one of the above six categories. Also included in Table 1 of the estimator spreadsheet is a row for the analyst to input the inbound and outbound vehicle trip generation data for all other land uses that are not subject to internal trip capture computations. If there are multiple on-site land uses that are not subject to internal trip capture, the individual land use estimates should be combined before entering into the “All Other Land Uses” row. These trips are automatically assumed to be external trips (that is, with no internal capture) in subsequent computations.

The spreadsheet calculates the total of the entering and exiting vehicle trips for the individual land uses.
Figure 6.2 Spreadsheet Tool for Estimation of Trip Generation and Internal Trip Capture at a Mixed-Use Development (PM Peak)

### NCHRP 684 Internal Trip Capture Estimation Tool

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Organization:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Location:</td>
<td></td>
</tr>
<tr>
<td>Scenario Description:</td>
<td></td>
</tr>
<tr>
<td>Analysis Year:</td>
<td>PM Street Peak Hour</td>
</tr>
<tr>
<td>Analysis Period:</td>
<td></td>
</tr>
</tbody>
</table>

#### Table 1-PM: Base Vehicle Trip Generation Estimates (Single-Use Site Estimate)

<table>
<thead>
<tr>
<th>Land Use</th>
<th>ITE LUCs</th>
<th>Quantity</th>
<th>Units</th>
<th>Total</th>
<th>Entering</th>
<th>Exiting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restaurant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Other Land Uses²</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Table 2-PM: Baseline Mode Split and Vehicle Occupancy Estimates

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Entering Person Trips</th>
<th>Exiting Person Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Veh. Occ.</td>
<td>% Transit</td>
</tr>
<tr>
<td>Office</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restaurant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Other Land Uses²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Table 3-PM: Average Land Use Interchange Distances (Walking Distance in Feet)

<table>
<thead>
<tr>
<th>Origin (From)</th>
<th>Destination (To)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Retail</td>
</tr>
<tr>
<td>Retail</td>
<td>Office</td>
</tr>
<tr>
<td>Restaurant</td>
<td>Office</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>Office</td>
</tr>
<tr>
<td>Residential</td>
<td>Office</td>
</tr>
<tr>
<td>Hotel</td>
<td>Office</td>
</tr>
</tbody>
</table>

#### Table 4-PM: Internal Person-Trip Origin-Destination Matrix*

<table>
<thead>
<tr>
<th>Origin (From)</th>
<th>Destination (To)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Retail</td>
</tr>
<tr>
<td>Retail</td>
<td>Office</td>
</tr>
<tr>
<td>Restaurant</td>
<td>Office</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>Office</td>
</tr>
<tr>
<td>Residential</td>
<td>Office</td>
</tr>
<tr>
<td>Hotel</td>
<td>Office</td>
</tr>
</tbody>
</table>

#### Table 5-PM: Computations Summary

<table>
<thead>
<tr>
<th>All Person Trips</th>
<th>Total</th>
<th>Entering</th>
<th>Exiting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Capture Percentage</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>External Vehicle Trips¹</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>External Transit Trips²</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>External Non-Motorized Trips³</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

#### Table 6-PM: Internal Trip Capture Percentages by Land Use

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Entering Trips</th>
<th>Exiting Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Retail</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Restaurant</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Residential</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Hotel</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

1. Land Use Codes (LUCs) from Trip Generation Manual, published by Institute of Transportation Engineers.
2. Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator.
3. Vehicle trips computed using the mode split and vehicle occupancy values provided in Table 2-PM.
4. *Indicates computation that has been rounded to the nearest whole number.

Estimation Tool Developed by Texas A&M Transportation Institute
Figure 6.2 (Continued) Spreadsheet Tool for Estimation of Trip Generation and Internal Trip Capture at a Mixed-Use Development (PM Peak)

Table 7-PM (O): Conversion of Vehicle Trip Ends to Person Trip Ends

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Vehicle Trips</th>
<th>Person Trips*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>Retail</td>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>Restaurant</td>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>Residential</td>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>Hotel</td>
<td>1.00</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 8-PM (O): Internal Person Trip Origin-Destination Matrix (Computed at Origin)

<table>
<thead>
<tr>
<th>Origin (From)</th>
<th>Destination (To)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Office</td>
</tr>
<tr>
<td>Retail</td>
<td>0</td>
</tr>
<tr>
<td>Restaurant</td>
<td>0</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>0</td>
</tr>
<tr>
<td>Residential</td>
<td>0</td>
</tr>
<tr>
<td>Hotel</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 8-PM (O): Internal Person Trip Origin-Destination Matrix (Computed at Destination)

<table>
<thead>
<tr>
<th>Origin (From)</th>
<th>Destination (To)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Office</td>
</tr>
<tr>
<td>Retail</td>
<td>0</td>
</tr>
<tr>
<td>Restaurant</td>
<td>0</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>0</td>
</tr>
<tr>
<td>Residential</td>
<td>0</td>
</tr>
<tr>
<td>Hotel</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 9-PM (D): Internal and External Trips Summary (Entering Trips)

<table>
<thead>
<tr>
<th>Destination Land Use</th>
<th>Person Trip Estimates</th>
<th>External Trips by Mode*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>Office</td>
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<td>0</td>
</tr>
<tr>
<td>Retail</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Restaurant</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Residential</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hotel</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>All Other Land Uses ³</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 9-PM (O): Internal and External Trips Summary (Exiting Trips)

<table>
<thead>
<tr>
<th>Origin Land Use</th>
<th>Person Trip Estimates</th>
<th>External Trips by Mode*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>Office</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Retail</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Restaurant</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Residential</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hotel</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>All Other Land Uses ³</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

¹Vehicle trips computed using the mode split and vehicle occupancy values provided in Table 2-PM.

²Person trips.

³Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator.

Vehicle Occupancy. The procedure requires vehicle occupancy rates in order to convert baseline trip generation estimates from vehicle trips to person trips. The analyst should use the common values reported in Chapter 5 (and Appendix B) if that set of data is sufficient for the study site analysis. The baseline vehicle occupancy data should be for the same land use type, represent the same general setting, and be composed of at least three data points in order to be considered sufficient. If not, the analyst should collect vehicle occupancy data at a sufficient number of nearby proxy sites.

Enter the vehicle occupancy for each land use category in Table 2 of the spreadsheet. Note that the analyst may enter separate expected vehicle occupancy levels for each land use by direction. If no vehicle occupancy data are entered, a vehicle occupancy of 1.0 persons per vehicle is assumed in the spreadsheet.

Mode Share. The procedure requires the analyst to determine the baseline mode shares for external person trips generated by individual land uses within the mixed-use development. Mode shares should be divided into at least total vehicles (personal passenger vehicles plus trucks), transit, and non-motorized modes such as bicycle or walking. The analyst should use the common mode share values reported in Chapter 5 (and Appendix B) if that set of data is sufficient for the study site analysis. The baseline mode share data should be for the same land use type, represent the same general setting, and be composed of at least three data points in order to be considered sufficient. If not, the analyst should collect mode share data at a sufficient number of nearby proxy sites.

Enter the mode shares associated with each land use category in spreadsheet Table 2. Note that the vehicle occupancy and mode share data are also entered for land uses not subject to internal trip capture computations for the purposes of mode assignment for these trips (all external trips) and is provided solely for convenience. If no mode share values are entered by the analyst, 100 percent of the person trips generated by a land use within the mixed-use development are assumed to be in vehicles.

It is preferable for the analyst to use a reasonable estimate for the baseline mode shares and vehicle occupancy. However, if the analyst is only going to calculate and use vehicle trips (and not person trips or trips by travel mode) AND if the mixed-use development is in a suburban setting with an expectation for very few external walk, bike, or transit trips, it is acceptable to assume that
- 100 percent of person trips are in vehicles; and
- Vehicle occupancy is 1.0 person per vehicle.

If the mixed-use development is located in an infill setting or close to significant transit service, the calculation of external mode shares and vehicle occupancy for the study site requires the use of a reasonable estimate for baseline mode shares and vehicle occupancy. As stated later in the Urban Infill chapter (in section 7.4.1), for such a development, it is incorrect to simply assume baseline values of 100 percent person trips by vehicle and a 1.00 vehicle occupancy.

---

8 Because the baseline and study site mode shares and vehicle occupancy are not expected to be different for a suburban, stand-alone mixed-use development.

9 Because it will result in an over-estimate of vehicle trip reductions that result from the infill setting or proximity to significant transit.
6.5.3 Step 3: Estimate Proximity between On-Site Land Use Pairs

Unconstrained internal trip capture rates between certain land use pairs can vary as a function of distance between the uses. In order to account for that distance, the recommended procedure uses the average distance between pairs of interacting land uses within the mixed-use development. Determine the average distances between individual on-site land use pairs that are present in the study site development.

The only land use pairs for which proximity adjustment factors are available (and therefore are the only land use pairs for which distances are used in the analysis) are the following:

- Office-to-retail;
- Office-to-restaurant;
- Office-to-residential;
- Retail-to-residential;
- Restaurant-to-residential;
- Cinema/entertainment-to-residential;
- Residential-to-retail;
- Residential-to-restaurant; and
- Hotel-to-residential.

The only time period for which sufficient data are available to derive a reliable proximity relationship is the weekday PM peak period. In this procedure, AM peak period internal capture rates are not adjusted to reflect distance between land uses.

The recommended procedure for measuring the distance between two on-site land uses is as follows. If there is only one building of each land use category (for example, one apartment building and one office building), enter the walking distance between the entrances to each building. If there is a group of buildings or businesses of one land use category in an area, separate that land use into blocks, with a block being the building faces along both sides of a street (see Figure 6.3 for an example). Locate the centroid of the entrances of each specific land use for each block. Measure the distance between each block centroid of that land use and the other, interacting land use. If there are multiple blocks, the analyst should measure between all pairs of blocks and use the weighted average distance, using square feet of land use involved in each exchange as the weighting factor.
In the Figure 6.3 example, the dots represent the centroids of the entrances for Land Use A in blocks 1 and 2 and for Land Use B in block 3. The distances $D_1$ and $D_2$ are the respective distances from Land Use A in blocks 1 and 2 to Land Use B in block 3. The weighted average distance between Land Use A and Land Use B is

$$D_{WTD} = \frac{((D_1 \times A_{LU-1}) + (D_2 \times A_{LU-2}))}{(A_{LU-1} + A_{LU-2})}$$

where

- $D_{WTD}$ = weighted average distance between Land Uses A and B
- $D_1$ = distance between block 1 and block 3
- $D_2$ = distance between block 2 and block 3
- $A_{LU-1}$ = Land Use A square feet in block 1
- $A_{LU-2}$ = Land Use A square feet in block 2

For each pair of interacting land uses, enter a distance (in feet) by the prevailing travel mode into Table 3 in the estimator spreadsheet tool.
6.5.4 Step 4: Estimate Unconstrained Internal Person Trip Capture Rates with Proximity Adjustment

In this step, unconstrained internal trip capture rates that are appropriate for the subject mixed-use development site are determined. The spreadsheet tool automatically determines the rates. The following description is provided to enable the analyst to understand the derivation of the data.

Base internal trip capture rates are identified in Step 4A. These initial rates are modified to account for specific proximity characteristics of the study site mixed-use development in Step 4B. The final proximity-adjusted internal trip capture rates are calculated using simple multiplication as described in Step 4C.

**Step 4A: Estimate Base Unconstrained Internal Trip Capture Rates**

Internal trip capture rates have been developed for land use pairs with the following generic land use categories: office, retail, restaurant, residential, hotel, and cinema/entertainment.

Table 6.1 presents estimated unconstrained internal trip capture rates for trip origins within a mixed-use development. For example, during the weekday AM peak hour, of all the person trips exiting an on-site retail land use, as many as 29 percent of the trips could be destined for an on-site office and as many as 14 percent could be destined to an on-site residential use.

Table 6.2 presents estimated unconstrained internal trip capture rates for trip destinations within a mixed-use development. For example, during the AM peak hour, of all the person trips entering an on-site retail land use, as many as 32 percent of the trips could originate at an on-site office and as many as 17 percent could originate at an on-site residential use.

It should be noted that no internal trip capture rates are provided between a land use and itself. This is because an internal trip between two components of similar land use type is implicitly accounted for when estimating trip generation for that particular land use.

The internal trip capture rates presented in Tables 6.1 and 6.2 are considered “unconstrained” because they represent the maximum potential trip interaction between two land uses, by direction. Subsequent steps of the recommended estimation procedure adjust the unconstrained person trips to account for site-specific constraints that limit the internal trip capture achieved for a given land use pair.

Tables 6.1 and 6.2 report unconstrained internal trip capture rates for an AM street peak hour (typically between 7:00 and 9:00 a.m.) and a PM street peak hour (typically between 4:00 and 6:00 p.m.). The internal trip capture rates presented are only valid for trip generation studies during those time periods. Data for other periods, such as weekday daily, weekday mid-day, or weekends are not available.

If the analyst finds a table value of zero for a particular land use pair (or a value well below a logical value), the analyst has the option to collect internal capture information at a proxy mixed-use development site with the same pair of land uses. Section 6.7 of this chapter provides guidance on how to collect appropriate internal capture data. In this circumstance, the analyst does not need to survey an entire mixed-use development, just the two land uses that are the target pair.

If the mixed-use development study site contains a land use for which unconstrained internal capture rates are not provided in Tables 6.1 and 6.2, the analyst should either (1) assume no internal capture for trips to and from that land use or (2) establish an internal capture rate through the conduct of
intercept surveys at a proxy mixed-use development site with the same land use Codes. Section 6.7 of this chapter provides specific guidance on the types of information to gather in the data collection process. Although an assumption of no internal trip capture may be unrealistic, the recommended procedures do not account for land uses not listed in the table. In the absence of any supporting data, it would, of course, be more conservative to potentially over-estimate external trip generation. If the land use is truly unique and one for which no proxy sites exist, a reasonable assumption supported by documentation should be appropriate.
### Table 6.1 Unconstrained Internal Person Trip Capture Rates for Trip Origins within a Mixed-Use Development

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>AM Peak Hour</th>
<th>PM Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFFICE</td>
<td>Retail</td>
<td>28%</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Restaurant</td>
<td>63%</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>Cinema/Entertainment</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Residential</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Hotel</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>RETAIL</td>
<td>Office</td>
<td>29%</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Restaurant</td>
<td>13%</td>
<td>29%</td>
</tr>
<tr>
<td></td>
<td>Cinema/Entertainment</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>Residential</td>
<td>14%</td>
<td>26%</td>
</tr>
<tr>
<td></td>
<td>Hotel</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>RESTAURANT</td>
<td>Office</td>
<td>31%</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>Retail</td>
<td>14%</td>
<td>41%</td>
</tr>
<tr>
<td></td>
<td>Cinema/Entertainment</td>
<td>0%</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>Residential</td>
<td>4%</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>Hotel</td>
<td>3%</td>
<td>7%</td>
</tr>
<tr>
<td>CINEMA/ENTERTAINMENT</td>
<td>Office</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Retail</td>
<td>0%</td>
<td>21%</td>
</tr>
<tr>
<td></td>
<td>Restaurant</td>
<td>0%</td>
<td>31%</td>
</tr>
<tr>
<td></td>
<td>Residential</td>
<td>0%</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>Hotel</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>RESIDENTIAL</td>
<td>Office</td>
<td>2%</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>Retail</td>
<td>1%</td>
<td>42%</td>
</tr>
<tr>
<td></td>
<td>Restaurant</td>
<td>20%</td>
<td>21%</td>
</tr>
<tr>
<td></td>
<td>Cinema/Entertainment</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Hotel</td>
<td>0%</td>
<td>3%</td>
</tr>
<tr>
<td>HOTEL</td>
<td>Office</td>
<td>75%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Retail</td>
<td>14%</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td>Restaurant</td>
<td>9%</td>
<td>68%</td>
</tr>
<tr>
<td></td>
<td>Cinema/Entertainment</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Residential</td>
<td>0%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Table 6.2 Unconstrained Internal Person Trip Capture Rates for Trip Destinations within a Mixed-Use Development

<table>
<thead>
<tr>
<th>Destination</th>
<th>Weekday AM Peak Hour</th>
<th>Weekday PM Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>To OFFICE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From Retail</td>
<td>4%</td>
<td>31%</td>
</tr>
<tr>
<td>From Restaurant</td>
<td>14%</td>
<td>30%</td>
</tr>
<tr>
<td>From Cinema/Entertainment</td>
<td>0%</td>
<td>6%</td>
</tr>
<tr>
<td>From Residential</td>
<td>3%</td>
<td>57%</td>
</tr>
<tr>
<td>From Hotel</td>
<td>3%</td>
<td>0%</td>
</tr>
<tr>
<td>To RETAIL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From Office</td>
<td>32%</td>
<td>8%</td>
</tr>
<tr>
<td>From Retail</td>
<td>8%</td>
<td>50%</td>
</tr>
<tr>
<td>From Cinema/Entertainment</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>From Residential</td>
<td>17%</td>
<td>10%</td>
</tr>
<tr>
<td>From Hotel</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>To RESTAURANT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From Office</td>
<td>23%</td>
<td>2%</td>
</tr>
<tr>
<td>From Retail</td>
<td>50%</td>
<td>29%</td>
</tr>
<tr>
<td>From Cinema/Entertainment</td>
<td>0%</td>
<td>3%</td>
</tr>
<tr>
<td>From Residential</td>
<td>20%</td>
<td>14%</td>
</tr>
<tr>
<td>From Hotel</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td>To CINEMA/ENTERTAINMENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From Office</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>From Retail</td>
<td>0%</td>
<td>26%</td>
</tr>
<tr>
<td>From Restaurant</td>
<td>0%</td>
<td>32%</td>
</tr>
<tr>
<td>From Residential</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>From Hotel</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>To RESIDENTIAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From Office</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>From Retail</td>
<td>2%</td>
<td>46%</td>
</tr>
<tr>
<td>From Restaurant</td>
<td>5%</td>
<td>16%</td>
</tr>
<tr>
<td>From Cinema/Entertainment</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>From Hotel</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>To HOTEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From Office</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>From Retail</td>
<td>0%</td>
<td>17%</td>
</tr>
<tr>
<td>From Restaurant</td>
<td>4%</td>
<td>71%</td>
</tr>
<tr>
<td>From Cinema/Entertainment</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>From Residential</td>
<td>0%</td>
<td>12%</td>
</tr>
</tbody>
</table>

Step 4B: Apply Proximity Adjustment Factors (PM Peak Hour Only)

The unconstrained internal capture values presented in Tables 6.1 and 6.2 represent rates to be expected between land use pairs that are not affected by proximity. As some land use pairs are located farther apart, the unconstrained internal capture rates may decline. Step 4B of the estimation procedure accounts for the specific proximity characteristics of the mixed-use development. Proximity adjustment factors are included for only the land use pairs for which the available data clearly demonstrates a direct relationship between proximity and internal capture rate. These are composed of only PM peak period trips from

- All land uses to residential and applicable only to the trip origin end;
- Office to retail or restaurant, applicable at both the origin and destination ends of a trip; and
- Residential to retail or restaurant, applicable at both origin and destination ends of a trip.

No proximity adjustments are available for the AM peak period.

If a land use pair is not included in the above list, the Table 6.1 and Table 6.2 unconstrained internal capture values are used without adjustment. Figure 6.4 shows the two curves that establish the relationship between proximity and internal trip capture rate. The proximity adjustment is equal to 1.0 for land uses in close proximity, and declines as distances between land uses increases. The lowest possible value for the proximity adjustment factor is 0.10, thereby allowing for a minimal amount of internal trips between two on-site land uses at a mixed-use development regardless of the distance between the two uses.

The estimation tool calculates the proximity adjustment factor automatically based on the land use proximity measurements calculated in Step 3 and entered by the analyst in Table 3.

Step 4C: Calculate Proximity-Adjusted Internal Trip Capture Rates

For each applicable land use pair and direction, the appropriate unconstrained internal trip capture rate from Table 6.1 or 6.2 (Step 4A) is multiplied by the proximity adjustment factor calculated in Step 4B to obtain the proximity-adjusted internal trip capture rates to be utilized in subsequent steps of the estimation procedure. The results appear in Table 7 of the spreadsheet.
6.5.5 Step 5: Estimate Unconstrained Demand between On-Site Land Use Pairs

In this step, unconstrained demand between on-site land use pairs is estimated. The proximity-adjusted internal trip capture rates (from Step 4) are multiplied by the appropriate directional person trip generation value in the estimation spreadsheet tool (calculated earlier in Step 2). For each pair of land uses, four values for unconstrained demand will be estimated, two for each direction of travel (as demonstrated earlier in Figure 6.1). The origin-destination matrix for unconstrained internal trips between on-site land uses computed at the origin is reported in Table 8(O) in the computational details worksheet of the spreadsheet estimator tool. The origin-destination matrix for unconstrained internal trips between on-site land uses computed at the destination is reported in Table 8(D).

6.5.6 Step 6: Estimate Balanced Demand between On-Site Land Use Pairs

In this step, internal demand volume is balanced by direction by comparing the values in the corresponding cells of Table 8(O) and Table 8(D) for each land use pair and selecting the lower value. The purpose of this step is to balance the estimates of directionally internally captured trips.
between land uses. Figure 6.5 illustrates the concept on internal trip balancing between land uses within a mixed-use development.

**Figure 6.5 Estimator Balancing Concept**

This step is performed for two reasons:

1. Estimates for each individual land use are based on the quantity of that land use and its capacity to send or receive internal trips. Without balancing, there is no assurance there is enough capacity on the receiving end to accept as many trips as are being sent.

2. The total trips sent internally (that is, internally captured trips) from one use to another must equal the number received at the other end of the trip. Both numbers must be the same.

The balanced demand for each land use pair is calculated by the spreadsheet tool with the results posted in Table 4 on the main estimator tool worksheet.

**6.5.7 Step 7: Estimate Total Internal Person Trips between On-Site Land Use Pairs**

In this step, total internal person trips are estimated by adding the internal trips to each other land use, then totaling the internal trips from each other land use. These totals are calculated and posted in the computational details worksheet in the “Internal” column of Table 9(D) for entering trips and Table 9(O) for exiting trips.

The analyst should review these values and verify that they appear reasonable.

**6.5.8 Step 8: Estimate Total External Person Trips for Each Land Use**

In this step, total external person trips are estimated by subtracting the estimated internal trips from the total trips for each individual land use. For entering trips, the spreadsheet tool subtracts the total internal trips for each land use as calculated in Step 7 from the total person trips from Table 7(D). The total external trips by land use are produced by the worksheet in the “External” column of Table 9(D) for entering trips and Table 9(O) for exiting trips.
6.5.9 Step 9: Calculate Overall Internal Capture and Total External Vehicle Trip Generation

The final step is calculation of the total net external vehicle trip generation for the mixed-use development site. The total external trips by land use reported in the “External” column of Table 9(D) for entering trips and Table 9(O) for exiting trips represent the total external person trips expected at the mixed-use development site. The total external person trips generated is multiplied (within the spreadsheet tool) by the expected mode shares of external person trips by land use (Table 2) to compute the total external person trips by mode for each land use. The total external person trips by transit and non-motorized modes are reported in the two far right columns of Table 9(D) for entering trips and Table 9(O) for exiting trips. The balance of person trips for each land use and direction are assumed to be vehicle trips. The estimated external person trips by vehicle are divided by the expected vehicle occupancy for each land use and direction (Table 2) to obtain the total external vehicle trip generation expected at the site.

The total person trips, external vehicle trips, external person trips by transit, and external person trips by non-motorized modes by direction are reported in Table 5 of the spreadsheet. The site internal trip capture rate is estimated by taking the sum of the all values in the internal person trip origin-destination matrix (Table 4) and dividing this value by the total person trips by direction (Table 7). The internal trip capture rate for each individual land use and direction of travel is calculated in a similar manner, and the results are reported in Table 6.

All of the data and calculations used in the spreadsheet tool should represent baseline conditions. The calculations do not reflect anticipated or potential changes in study site external mode shares (for example, walk trips to/from a mixed-use development in an infill setting or transit trips to/from a mixed-use development near a transit station). Those external mode share calculations are addressed in Chapters 7 and 8.

6.6 Cautionary Notes

The internal trip capture data and estimation procedure presented in Section 6.5 quantifies the influence of several key factors on internal trip capture rates. Numerous other factors have a direct influence on travel at a mixed-use development, factors for which the current data and estimation procedure do not account. Additional data and analysis are desirable to better quantify the relationships between these factors and mixed-use development trip generation and internal trip capture rates. A summary of the pertinent information contained in several existing documents is included in NCHRP Report 684.

Limited Sample Size—The estimated typical internal trip capture rates presented in Section 6.5 in Tables 6.1 and 6.2 rely directly on data collected at a limited number of mixed-use developments in Florida, Georgia, and Texas. While this Handbook recognizes the limitations of these data, they represent the only known credible site-level data on mixed-use internal trip capture rates and are provided as illustrative of typical rates. If local data on internal trip capture rates by land use pair can be obtained, the local data should be used and the data submitted to ITE for possible inclusion in future publications (refer to section 6.7 of this chapter for guidance).
Pass-By Trips—The application of pass-by trip reductions presented in Chapter 10 should likewise be applicable to mixed-use sites. However, none of the internal trips can be of a pass-by nature because they do not travel on the adjacent (external) street system. **Pass-by trip percentages are applicable only to trips that enter or exit the adjacent street system.** Apply the pass-by trip estimation procedure in Chapter 10 of this *Handbook* only to the mixed-use development external vehicle trips.

Atypical Tenant Mix—The specific tenants at the mixed-use development sites from which the internal capture relationships in the recommended procedure are derived are relatively complementary. For example, the restaurants located near or adjacent to office buildings are often coffee shops or are geared to serve a lunchtime clientele and an after-work crowd. A family sit-down restaurant would likely generate a different level of internal capture with the on-site office. The analyst is cautioned to review the particular characteristics of the mixed-use development study site and its tenants before using the internal trip capture rates presented in Tables 6.1 and 6.2. The analyst should assess whether each set of internal trip capture rates makes sense considering the particular individual land uses within the specific, mixed-use development site.

Competing Markets—Proximity to competing markets is expected to influence internal trip capture rates. The greater the distance to external competing uses, the greater the likelihood of capturing trips internally within a mixed-use development site. However, at this time, there is no trip generation data available on which to base adjustment factors of this type. It is important to note that the modes of external trip-making to and from competing markets are addressed in Chapter 7, Trip Generation for Urban Infill/Redevelopment.

Other Site-Specific Issues—Many other issues potentially affect trip-making at mixed-use sites. For examples, can those who work on-site afford to live on-site? How long will it take for the office uses to attract work trips from on-site residences? Is there an internal pedestrian, bicycle, or transit circulation system or roadway network that enhances or discourages internal trips?

Shared Parking—Shared parking and mixed-use trip generation estimation methodologies, though similar, are not interchangeable. Shared parking factors cannot be applied directly to estimate trip generation at a mixed-use development.

6.7 Data Collection at a Mixed-Use Development

Chapter 12 provides guidance on a proper approach for collecting appropriate person and vehicle trip information at a mixed-use development. The procedures in the chapter focus on the conduct of a comprehensive data collection program to cover an entire mixed-use development.

If the analyst desires to focus on trip interactions between individual land use pairs at an existing mixed-use development, the procedures can be adapted. The data collection program will likely require intercept surveys similar to Chapter 12 survey instruments.

The modified data collection program must include
- Measurement of total person trips (directionally) between the specified land uses, and
- The proportions of all trips to/from the individual land uses that these trips between the specified land uses comprise.
If, for example, the analyst wants to determine internal capture between two land uses (A and B), the product of the data collection effort must produce at a minimum:

- There are an estimated $X$ person trips from Land Use A to Land Use B during the time period;
- There are an estimated $Y$ person trips from Land Use B to Land Use A during the time period;
- Of all person trips from Land Use A during the time period (both internal and external to the mixed-use development site), $P$ percent go to Land Use B;
- Of all person trips to Land Use B during the time period (both internal and external to the mixed-use development site), $Q$ percent come from Land Use A;
- Of all person trips from Land Use B during the time period (both internal and external to the mixed-use development site), $R$ percent go to Land Use A; and
- Of all person trips to Land Use A during the time period (both internal and external to the mixed-use development site), $S$ percent come from Land Use B.

Suggested procedures, survey instruments, sample sizes, and other pertinent information are presented in Chapter 12.
7 | Trip Generation for Urban Infill/Redevelopment

7.1 Background

This chapter presents a recommended approach for estimating person and vehicle trip generation for development and redevelopment in compact, urbanized, mostly developed areas where walking, bicycling, and transit are viable modes of transportation. Development in this type of area is also known as “infill” development.

The current *Trip Generation Manual* data volumes do not reflect trip generation at urban infill sites. Redevelopment in built out areas and new development in areas that are almost fully built out often results in fewer vehicle trips generated than would result in suburban and outlying locations. These effects may be the result of modal shifts:

- More walking (because of closer proximity of complementary uses);
- More transit ridership (because of convenient, frequent transit service);
- More bicycling (because of bicycle facilities that improve safety or reduce travel time); or
- Higher vehicle occupancy (because of more carpooling that results from overall traffic congestion, preferential treatments along roadway network, or parking pricing).

In recent years, several research efforts have collected trip generation data at various types of infill sites and devised methods and tools for estimating vehicle trip generation for infill and related types of development sites. The approach recommended in this chapter draws from the research findings and was selected for its ease of application and likelihood of widespread acceptance. The approach relies on data that are typically available for proposed developments at the time of their applications for zoning, land use revisions, and development review.

The recommended approach conforms to the Chapter 3 flow chart for estimation of site trip generation (see Figure 3.1):

- The baseline vehicle trip generation estimates used in the infill trip estimation method are produced using the procedures presented in Chapters 4 and 9, as appropriate.
- Vehicle trip estimates are converted to person trips using methods presented in Chapter 5.
- If the infill development is a mixed-use development, the internal capture trips should be estimated (using the Chapter 6 procedures) prior to applying the external trip adjustments presented in this chapter.
- The product of the process recommended in this chapter is an estimate of the total person trips entering or exiting the study site by pedestrian, bicycle, or transit mode.
- If the infill site is located near a rail or rapid transit station or a multi-route bus transit center with high-frequency service, the procedures presented in Chapter 8 should also be applied to the product of the person trip estimates produced in this chapter.
- Infill development can attract vehicle traffic that is currently on adjacent or nearby streets. Refer to Chapter 10 for guidance on estimating pass-by and diverted trips.
7.2 Definition of Infill Development

For the purpose of this Handbook, an infill site is a site for which the surrounding area within a one-half mile radius is mostly developed (perhaps, more than 80 percent). An infill site can be in or around a central business district, urban core, suburban business district or any other area that is substantially developed.

The following are suggested approximate thresholds for typical infill sites. A particular site does not need to satisfy all four criteria to be considered infill. However, most infill sites will exhibit most of the characteristics; few will exhibit none or only one.

- **Walkable area**—A study site or proxy site is likely infill if it is located within a built urban or suburban district composed of traditional central city blocks (typically 200 to 500 ft. long [approximately 61 to 152 m long]) with sidewalks on all block faces, crosswalks at all intersections, and pedestrian phases on all traffic signals. The analyst may define other metrics for walkability.11
- **Convenient/frequent transit service**—A study site or proxy site is likely infill if there is a light or heavy rail station within one-half mile, or a bus rapid transit station or bus stop on the same or the adjacent block, providing peak headways of typically 20 minutes or less for 4 to 6 hours each weekday.
- **Bicycle accessible**—A study site or proxy site is likely infill if it has a pedestrian entry, parking lot/garage, and/or location of bicycle parking within one block of a designated bicycle facility such as a marked bicycle lane, a signed bicycle route, a bicycle boulevard, or an off-street path.
- **Mix of interacting land uses**—A study site or proxy site is likely infill if it is located in a district composed of a mix of commercial, residential, retail, dining, civic, cultural, or other interacting land uses so that a worker, resident, or visitor of the district need not travel long distances for everyday needs and services.

These thresholds are not intended to limit applications to just highly urban sites. The threshold size, density, and intensity of the context in which the study site and proxy site are located are not as important as the similarity in their contextual characteristics. Criteria may be adjusted, for example, by a local agency to represent a small town business district or nearly fully developed suburban sites exhibiting the stated characteristics. Similarly, a small-to-medium municipality may be well-served by peak transit service of 30-minute headways, for peak periods shorter than two hours, with a result of significant transit use in corridors served during those periods.

7.3 Underlying Assumptions for Infill Site Trip Generation

The recommended method relies on an underlying premise that a particular land use will generate the same number of person trips regardless of context (whether general suburban, suburban business district, or general urban), with the only differences being the mode of travel and vehicle occupancy for person trips that enter or exit the land use.

---

10 For this calculation, surface and structured parking is considered “developed” and rural land and open space are considered “undeveloped.” Public streets are excluded from the computation.

11 Other less measurable characteristics of a walkable network include buffers that separate pedestrians from moving traffic, landscaping (especially street trees that provide shade), pedestrian scaled lighting, buildings that front the back of sidewalk, direct entries onto sidewalks, and architectural interest at the scale of the pedestrian.
Vehicle trips are the portion of person trips that use a vehicle (personal passenger vehicle or truck), adjusted for vehicle occupancy. The formula is

\[
v_{\text{vehicle}} = \frac{\text{person trips} \times \text{vehicle mode share}}{\text{average vehicle occupancy}}
\]

\[
VT = \frac{PT \times MS}{VO}
\]

where

- \( VT \) = vehicle trips
- \( PT \) = person trips
- \( MS \) = person trip mode share in vehicles
- \( VO \) = average vehicle occupancy

The equation can be reordered to calculate person trips as the dependent variable. For a baseline site:

\[
\text{baseline person trips} = \frac{\text{baseline vehicle trips} \times \text{baseline vehicle occupancy}}{\text{baseline person trip mode share in vehicles}}
\]

\[
PT_{\text{BL}} = \frac{VT_{\text{BL}} \times VO_{\text{BL}}}{MS_{\text{BL}}}
\]

where

- \( PT_{\text{BL}} \) = baseline person trips
- \( VT_{\text{BL}} \) = baseline vehicle trips
- \( VO_{\text{BL}} \) = baseline vehicle occupancy
- \( MS_{\text{BL}} \) = baseline person trip mode share in vehicles

For an infill site (substituting for study site in the equation above):

\[
\text{infill site vehicle trips} = \frac{\text{infill site vehicle trips} \times \text{infill site vehicle occupancy}}{\text{infill site person trip mode share in vehicles}}
\]

\[
PT_{\text{SS}} = \frac{VT_{\text{SS}} \times VO_{\text{SS}}}{MS_{\text{SS}}}
\]

where

- \( PT_{\text{SS}} \) = infill site person trips
- \( VT_{\text{SS}} \) = infill site vehicle trips
- \( VO_{\text{SS}} \) = infill site vehicle occupancy
- \( MS_{\text{SS}} \) = infill site person trip mode share in vehicles
Given the assumption that baseline site person trips and infill site person trips are the same, the two equations are equal. The result is the following formula for calculating vehicle trips for an infill site, using the mode shares of person trips in vehicles and vehicle occupancy for baseline and infill conditions:

\[
infill\ site\ vehicle\ trips = baseline\ vehicle\ trips \times \frac{infill\ site\ vehicle\ mode\ share}{baseline\ vehicle\ mode\ share} \times \frac{baseline\ veh.\ occ.}{infill\ site\ veh.\ occ.}\]

\[
VT_{SS} = VT_{BL} \times (MS_{SS} / MS_{BL}) \times (VO_{BL} / VO_{SS})
\]

where

- \(VT_{SS}\) = infill site vehicle trips
- \(VT_{BL}\) = baseline vehicle trips
- \(MS_{SS}\) = infill site person trip mode share in motor vehicles
- \(MS_{BL}\) = baseline person trip mode share in motor vehicles
- \(VO_{BL}\) = baseline vehicle occupancy
- \(VO_{SS}\) = infill site vehicle occupancy

If the infill study site and baseline vehicle occupancy values are the same (as is typically the case), the equation simplifies to

\[
infill\ site\ vehicle\ trips = baseline\ vehicle\ trips \times \frac{infill\ site\ vehicle\ mode\ share}{baseline\ vehicle\ mode\ share}\]

\[
VT_{SS} = VT_{BL} \times (MS_{SS} / MS_{BL})
\]

where

- \(VT_{SS}\) = infill site vehicle trips
- \(VT_{BL}\) = baseline vehicle trips
- \(MS_{SS}\) = infill site person trip mode share in vehicles
- \(MS_{BL}\) = baseline person trip mode share in vehicles
Given:

Study site is estimated to generate 300 PM peak hour vehicle trips.

Baseline person trips mode share in vehicles is 95 percent.

Study site person trip mode share in vehicles is 80 percent (based on survey of three proxy sites).

Baseline site and study site vehicle occupancy is assumed to be the same.

Infill vehicle trips are calculated as follows:

\[
\text{infill site vehicle trips} = 300 \times \frac{0.80}{0.95} = 253
\]

The recommended approach described below requires the analyst to determine four values:

- Mode shares for baseline sites and for the infill site; and
- Vehicle occupancy for baseline sites and the infill site.

The simplicity or complexity of the method lies within the way these values are determined. If the baseline and study site vehicle occupancy are assumed to be identical, neither value is required for the calculation of infill site vehicle trips.

7.4 Process for Estimating Infill Trip Generation

The recommended process for estimating infill site trip generation follows three steps:

- Step 1—Determine baseline mode shares and vehicle occupancy
- Step 2—Estimate study site mode shares and vehicle occupancy
- Step 3—Estimate vehicle trips for study site

The method is both simple and transparent, using person trips as the common unit of travel. The method can be readily applied across all land uses and contexts without further model development.

7.4.1 Step 1—Determine Baseline Mode Shares and Vehicle Occupancy

Baseline site mode shares and vehicle occupancy are discussed and presented in Chapter 5. The analyst should use values listed in Tables B.1 through B.3 in Appendix B for baseline site mode shares and vehicle occupancy. If baseline data are not available in the tables, either

- Use a default value of 95 percent vehicle mode share and assume no change in vehicle occupancy between the baseline and study sites;
- Use the average of mode share and vehicle occupancy data collected at three or more comparable developments in baseline locations. A procedure for collecting baseline data is provided in Chapter 12.

It is incorrect to simply assume baseline values of 100 percent person trips by vehicle and a 1.00 vehicle occupancy.
7.4.2 Step 2—Estimate Study Site Mode Shares and Vehicle Occupancy

The following section presents three alternative methods for deriving the study site mode share and vehicle occupancy factors. The analyst should consider all three methods in order to select a preferred method for a particular study site application. Method A is recommended if there are sufficient data in the national database for the land use type and site context.

7.4.2.1 Method A—Use Data from National Database

Tables C.1 through C.10 in Appendix C provide infill trip generation mode share (and limited vehicle occupancy) data summaries that can be used directly to estimate the same for a study site. If the tables include data for at least three sites of an applicable land use type in a similar context, the analyst should compute an average mode share and vehicle occupancy (if the latter are likely to be different for the study site than for baseline sites in the same area) and use for the study site (described below in Step 3).

This method is easy and convenient to apply and does not require the expense of significant new data collection. It is consistent with the recommended use of Trip Generation Manual data (described in Chapter 4) to estimate vehicle trips. However, the shortage of existing infill data makes the utility of the method quite limited and the method has not been formally validated.

The method uses qualitative context descriptors in lieu of quantifiable metrics describing varying levels of context. This is done to simplify the estimation process and reduce the quantity of data required to both develop and apply the estimation method. The flexibility afforded in this method of qualifying infill areas relies on the professional judgment of the analyst to account for any variations in similar contexts found in different locales.

The data in Tables C.1 through C.10 in Appendix C represent a start on an infill trip generation database, but are still very limited. There are too few sites in each context type to be able to conclude much other than that the more “urban” the site, the lower the motor vehicle mode shares. Data are needed from more sites, more land uses, and more contexts to permit the development of a set of adjustment factors or models that are applicable across the most commonly analyzed land uses, let alone all land use codes. Nevertheless, the limited data do provide significant findings and conclusions, as follows.

- The total vehicle mode shares of person trips at infill sites are consistently and significantly below baseline levels for most land uses for which data are available from multiple sites. Correspondingly, vehicle trips at infill sites are below those at baseline sites.
- The variance in the percentage of trips made by motor vehicle appears to be related to the site context (that is, the more urban settings have lower motor vehicle mode shares) and proximity to rail transit.
Walk mode makes up most of the non-motor vehicle mode shares. Even at infill sites where rail stations are nearby, the walk mode share appears in large sample results to exceed transit mode share at most sites surveyed. Bicycle trips, where counted separately, make up a small percentage of person trips.

7.4.2.2 Method B—Use Data from Local Proxy Sites

This method uses trip generation surveys at local proxy sites to estimate mode share and vehicle occupancy for the study site. This method has the potential to provide accurate results because characteristics of the study site and the proxy site(s) can be very similar. If properly selected, use of proxy sites as a basis for infill mode share and vehicle occupancy could yield more accurate data than small sample national data summaries.

The analyst should select at least three comparable infill (proxy) sites at which to collect data. Proxy sites should have developments of similar character (with the same land use type, general size, and types of activity) and context. If three sites are not available, two may be sufficient if they are very similar to the study site in development and context characteristics. Proxy sites near the study site are preferred.

Context characteristics to consider include, but are not limited to, the following:
- Area type;
- Density;
- Compactness (as measured by land coverage);
- Development mix within one-quarter to one-half mile;
- Parking availability, convenience, and pricing;
- Pedestrian environment;
- Transit service levels (defined as number of routes, headways, and proximity of stops/stations to site); and
- Apparent vitality (visible level of activity).

It is important that the analyst focuses on characteristics that make the mode shares and vehicle occupancy of the potential proxy sites similar to those of the study site.

Chapter 12 provides guidance on how to develop and execute a data collection plan to collect person trips by mode and vehicle occupancy at an infill site. The analyst should submit any new infill data to ITE for inclusion in the national infill trip generation database.

7.4.2.3 Method C—Use Relationships Developed for Local Application

Several research projects (described in Appendix G) have compiled infill trip generation data and have developed multivariate approaches to account for the influence of urban context characteristics on trip generation. These research results are limited to a small number of land uses and site contexts at this time. However, they may provide sufficient information for adjusting baseline trip generation estimates for these land uses in the regions where they were developed.
7.4.3 Step 3—Estimate Vehicle Trips for Study Site

The analyst should use the equations in section 7.3 of this chapter to calculate vehicle trips for the study site:

\[
VT_{SS} = VT_{BL} \times \left( \frac{MS_{SS}}{MS_{BL}} \right) \times \left( \frac{VO_{BL}}{VO_{SS}} \right)
\]

where

- \( VT_{SS} \) = infill site vehicle trips
- \( VT_{BL} \) = baseline vehicle trips (developed using procedures presented in Chapters 4 and 9)
- \( MS_{SS} \) = infill site person trip mode share in motor vehicles (from step 2 above)
- \( MS_{BL} \) = baseline person trip mode share in motor vehicles (from step 1 above)
- \( VO_{BL} \) = baseline vehicle occupancy (from step 1 above)
- \( VO_{SS} \) = infill site vehicle occupancy (from step 2 above)

7.5 Examples of Recommended Process

7.5.1 Method A—Use Data from National Database

Objective: Estimate weekday AM and PM street peak hour vehicle trips for a proposed 320,000 square foot, free-standing, mixed tenant, general office building to be located on a redevelopment site in a mid-sized regional CBD well-served by transit. There is a light rail station three blocks away that is served by two lines. Parking supply more than meets demand but most employees must pay to park. The area is very walkable and attracts some bicycle commuting and visitors. The regional CBD has the same land use and activity mix as most healthy mid-size downtowns.

Step 1—Determine Baseline Mode Shares and Vehicle Occupancy: In the professional judgment of the analyst, the baseline mode share and vehicle occupancy data in Appendix B are sufficient for this application.
- AM motor vehicle mode share—99 percent inbound and 100 percent outbound
- PM motor vehicle mode share—100 percent inbound and 99 percent outbound
- AM vehicle occupancy—1.06 (both inbound and outbound)
- PM vehicle occupancy—1.11 inbound and 1.07 outbound

Step 2—Estimate Study Site Mode Shares and Vehicle Occupancy: Tables C.3 and C.4 in Appendix C shows data for several downtown general office buildings with rail transit stations within one-quarter mile (area type “0Ta”). The average mode shares and vehicle occupancy for those buildings are as follows:
Vehicle occupancy data are not provided. Even though vehicle occupancy for an office building in this regional CBD could be a little higher than for typical suburban sites due to parking fees, in the professional judgment of the analyst the study site vehicle occupancy is assumed to be the same as the baseline level.

**Step 3—Estimate Vehicle Trips for Study Site:** The data requirements for the equation in section 7.4.3 are

- Proxy site vehicle mode share—from step 2
- Baseline vehicle mode share—from step 1
- Baseline vehicle trips—from Chapter 4 of this *Handbook*

Calculations of the AM and PM baseline vehicle trips are shown in the first set of rows in the following worksheets. Calculations of infill vehicle trips are shown in the second set of rows.

<table>
<thead>
<tr>
<th>Proxy Office Buildings</th>
<th>Range of Floor Areas (1,000 GSF)</th>
<th>AM Mode Share Percent</th>
<th>PM Mode Share Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Motor Vehicle</td>
<td>Transit Walk Bike</td>
</tr>
<tr>
<td>Average</td>
<td>64–416</td>
<td>46</td>
<td>30  18  6</td>
</tr>
</tbody>
</table>

Compute baseline vehicle trips for 320,000 sq. ft. GFA office building (Land Use Code 710 in *Trip Generation Manual*). Use fitted curve equations because the AM Peak Hour and PM Peak Hour data pages contain 218 and 236 data points, respectively.

<table>
<thead>
<tr>
<th>AM Peak Hour</th>
<th>PM Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \ln (T) = 0.80 \ln (x) + 1.57 ) (</td>
<td>x = 320, T = 485 )</td>
</tr>
<tr>
<td>Inbound trips = 0.88 \times 485 = 427</td>
<td>Inbound trips = 0.17 \times 437 = 74</td>
</tr>
<tr>
<td>Outbound trips = 0.12 \times 485 = 58</td>
<td>Outbound trips = 0.83 \times 437 = 363</td>
</tr>
</tbody>
</table>

Compute infill vehicle trips adjusting for mode share and vehicle occupancy:

\[ \text{infill site vehicle trips} = \frac{\text{baseline vehicle trips}}{\frac{\text{infill site vehicle mode share}}{\text{baseline average mode share}}} \]

<table>
<thead>
<tr>
<th>AM Peak Hour</th>
<th>PM Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infill Site Vehicle Trips</td>
<td>Infill Site Vehicle Trips</td>
</tr>
<tr>
<td>Inbound Trips = 427 \times 46%/99% = 198</td>
<td>Inbound Trips = 74 \times 42%/100% = 31</td>
</tr>
<tr>
<td>Outbound Trips = 58 \times 46%/100% = 27</td>
<td>Outbound Trips = 363 \times 42%/99% = 154</td>
</tr>
</tbody>
</table>
7.5.2 Method B—Use Data from Local Proxy Sites

Because the study site is located near a rail transit station, an alternative approach for estimating vehicle trip generation is to use (1) the Appendix C infill data for estimating walk and bike trips only and (2) Chapter 8, Transit-Friendly Development guidance for estimating transit trips.

**Objective:** Estimate weekday AM and PM street peak hour vehicle trips for a proposed 150-room motel with no meeting space or other supporting facilities. The site is located in an almost fully developed outlying business district about three blocks by four blocks in size.

The business district consists of low- to mid-rise office buildings totaling about 800,000 sq. ft., six high turnover sit-down and quality restaurants, 800,000 sq. ft. of retail, 800 apartments in low- to mid-rise buildings, and small amounts of supporting and complementary commercial. Blocks average about 400 ft. by 500 ft (122 m by 152 m). There are three bus routes with 12–20 minute headways connecting this area to downtown (three miles east) and a medical center (two miles south). Parking is adequate in every block with some in pay garages (two-hour free parking with validation), some in free lots, and 30-minute and two-hour meters on street. Informal observations indicate there are significant walking and transit use in the business district. Based on this description, the motel study site qualifies as an urban infill setting.

**Step 1—Determine Baseline Mode Shares and Vehicle Occupancy:** Appendix B provides the following baseline values for surveyed motels:
- AM motor vehicle mode share—93.3 percent inbound and 99.0 percent outbound
- PM motor vehicle mode share—98.7 percent inbound and 98.0 percent outbound
- AM vehicle occupancy—1.26 (inbound and outbound)
- PM vehicle occupancy—1.31 inbound and 1.30 outbound

**Step 2: Estimate Study Site Mode Shares and Vehicle Occupancy:** The available infill trip generation data in Appendix C do not include any information for motels. The analyst needs to use the Method B approach in order to estimate study site mode shares and vehicle occupancy.

There are no hotels or motels in the business district. The anticipated market for the proposed motel is for business travel to places in the business district, downtown, and the medical center. There are potential proxy motels in another business district five miles south of downtown. The proxy site business district is four blocks by seven blocks averaging about 400 ft. on a side. It includes 1,200,000 sq. ft. of office, 14 various restaurants, 600,000 sq. ft. of retail, 1,200 apartments, one movie theater, and similar parking, transit service, and walkability. The proxy business district is determined to be similar to the study site business district.

Person trip mode shares and vehicle occupancy are collected at three motels within the proxy site business district. The data are presented in the following worksheet. The average proxy site values for directional mode shares and vehicle occupancy for both the AM and PM peak periods are determined to be reasonable and appropriate to use for the study site.
Chapter 7: Trip Generation for Urban Infill/Redevelopment

Step 3—Estimate Vehicle Trips for Study Site: The data requirements for the equation in section 7.4.3 are

- Proxy site person trips in motor vehicle mode share—from step 2
- Baseline person trips in motor vehicle mode share—from step 1
- Proxy site vehicle occupancy—from step 2
- Baseline vehicle occupancy—from step 1
- Baseline vehicle trips—from Chapter 4 in this Handbook

Calculations of the AM and PM baseline vehicle trips are shown in the first set of rows in the following worksheet. Calculations of infill vehicle trips are shown in the second set of rows.

### Step 3—Estimate Vehicle Trips for Study Site

<table>
<thead>
<tr>
<th>Proxy Motels</th>
<th>Occupied Rooms</th>
<th>AM</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Motor Vehicle</td>
<td>Transit</td>
</tr>
<tr>
<td>1</td>
<td>78</td>
<td>85</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>143</td>
<td>89</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>189</td>
<td>90</td>
<td>3</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>88</td>
<td>5</td>
</tr>
</tbody>
</table>

### AM Peak Hour

- Ln (T) = 0.92 Ln (x) – 0.46
  - for x = 150, T = 63
  - Inbound Trips = 0.36 * 63 = 23
  - Outbound Trips = 0.64 * 63 = 40

### PM Peak Hour

- Ln (T) = 0.94 Ln (x) – 0.51
  - for x = 150, T = 67
  - Inbound Trips = 0.54 * 67 = 36
  - Outbound Trips = 0.46 * 67 = 31

### Compute infill vehicle trips adjusting for mode share and vehicle occupancy using baseline data and proxy site data and formula (1) in chapter, which is:

\[
\text{infill site vehicle trips} = \frac{\text{baseline vehicle trips}}{\text{baseline vehicle mode share}} \times \frac{\text{infill site vehicle mode share}}{\text{baseline veh. occ.}}
\]

<table>
<thead>
<tr>
<th>AM Peak Hour</th>
<th>PM Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infill Site Vehicle Trips</td>
<td>Infill Site Vehicle Trips</td>
</tr>
<tr>
<td>Inbound Trips = 23 * 88%/93.3% * 1.26/1.31 = 21</td>
<td>Inbound Trips = 36 * 85%/98.7% * 1.31/1.26 = 32</td>
</tr>
<tr>
<td>Outbound Trips = 40 * 88%/99.0% * 1.26/1.31 = 34</td>
<td>Outbound Trips = 31 * 85%/98% * 1.30/1.26 = 28</td>
</tr>
</tbody>
</table>
8 Trip Generation for Transit-Friendly Development

8.1 Background

This chapter presents a recommended approach for forecasting the number of transit trips generated by a proposed development site. The current Trip Generation Manual data volumes do not provide any transit trip generation data.

The recommended approach conforms to the Chapter 3 flow chart for estimation of site trip generation (see Figure 3.1):

- The baseline vehicle trip generation estimates are produced using the procedures presented in Chapters 4 and 9, as appropriate;
- Vehicle trip estimates are converted to person trips using methods presented in Chapter 5;
- If the development is also a mixed-use development, the internal capture trips should be estimated (using the Chapter 6 procedures) prior to applying the external trip adjustments presented in this chapter;
- If the development is also in an urban infill setting, external walk and bicycle trips should be estimated (using the Chapter 7 procedures) prior to applying the mode share adjustments presented in this chapter; and
- Even with significant nearby transit service, a development can attract vehicle traffic that is currently on adjacent or nearby streets. Refer to Chapter 10 for guidance on estimating pass-by and diverted trips.

8.2 Definition of Transit-Friendly Development

For the purpose of this Handbook, a transit-friendly development (TFD) is any development that is directly connected, immediately adjacent to, or directly oriented toward a rail or rapid transit station or stop (including heavy rail, light rail, streetcar, commuter rail, and bus rapid transit) or a multi-route bus transit center with high-frequency service.

If the TFD is near rail transit or near a multi-route bus transit center, use Chapter 7 to estimate external walk trips and Chapter 8 to estimate transit trips. If the TFD is near bus transit only, use Chapter 7 to estimate both walk and transit trips.

Transit-oriented development (TOD) is the more common term used to describe TFD in research reports and local ordinances. However, the precise definition of TOD can (and does) vary among its many applications. Therefore, this Handbook is using a term with a specific definition applicable to its included guidance.

The analyst should feel free to substitute the term TOD for TFD throughout this chapter as long as it is understood that the definition of TFD (and therefore the guidance in this chapter) may not apply to all types of development considered TOD. The term TOD has been retained in the text describing research reports referenced in this chapter and Appendix D.
A TFD site can be a single-use or a mixed-use development. It can be located in an urban or suburban setting. A TFD site is typically compact at a moderate-to-high density and includes pedestrian-friendly features. For the TFD sites identified and evaluated in the research literature, residential densities are typically at least four dwelling units per acre and commercial floor area ratios are typically at least 0.4. Significantly higher densities are found adjacent to or near rail transit stations.

8.3 Factors Affecting Transit Use at a TFD

8.3.1 Transit Service

TCRP Report 128\(^{12}\) reports that “proximity to rail stations is a stronger determinant of transit usage for work trips than land-use mix or quality of walking environment. Thus, concentrating growth around rail stops will often yield high ridership dividends almost regardless of the urban design attributes of the immediate area. Still, all transit trips involve walking to some degree; thus the provision of safe, efficient, and comfortable-feeling walking corridors to/from a transit station is an essential attribute of a successful TOD.” TCRP 128 also found that research data “suggest the presence of an ‘indifference zone’ for longer-distance work trips. That is, once work commuters are within one-quarter mile of a rail station, factors like mixed land uses, traffic calming, pedestrian amenities, and even density seem to matter little [to transit mode shares].” TCRP 128 also reports that “strong determinants of whether those working in TODs take transit or not are the availability, price, and convenience of [TOD] parking [at the employment end of the trip].”

The research data also indicate that the type of transit system serving a TFD (such as heavy rail, light rail, or bus) has an effect on the transit trip-making characteristics of TFD residents, workers, and visitors. Integral to the quality of the transit service is its frequency, reliability, and ease for patrons to reach destinations in terms of travel time and transfers required.

8.3.2 Site Design and Land Use

The exact quantifiable impact of good (or poor) urban design on TFD transit mode shares has not been empirically measured adequately as a stand-alone factor in reducing site-generated vehicle trips. Therefore, TFD site design is not an explicit consideration in the recommended approach (presented in section 8.4) for estimating mode share in this Handbook. However, this does not condone the lack of logical site design characteristics or accommodations oriented to pedestrian connectivity and travel. In fact, pedestrian and bicycle travel can have an effect on external trip-making at a TFD site that is also a mixed-use development (Chapter 6) or infill site (Chapter 7).

The recommended approach for estimating person and vehicle trip generation at a TFD focuses on the type of transit service and proximity of transit as the only independent variables.

---

household size, or auto availability) have been found to be critical factors in research that has evaluated them on a macro-scale for their relationship to TFD mode shares. The difficulty with these and some other variables is the likely limited availability of this information at the time of need—that is, when the analyst is estimating potential vehicle trip generation at a proposed development site.

8.4 Process For Estimating Transit Trips at a TFD Site

8.4.1 Transit Mode Share of Motorized Trips

Transit users are estimated after walk/bike trips to/from the site are “removed” from the pool of person trips generated by the site (based on guidance in Chapter 7). The remainder are the person trips that arrive/depart the site via transit or via a vehicle (personal passenger vehicle or truck) as a driver or passenger. For the purposes of this Handbook, these non-walk/non-bike person trips are called motorized trips. It is essential that the analyst understand the concept of motorized trips in order to apply the recommended approach properly.

To demonstrate the concept of motorized trips, assume the following mode share data have been compiled for two proxy sites:

- Site A is a suburban TFD located near a rail station. Peak period mode shares are determined to be
  - 80 percent by vehicle (67 percent as driver and 13 percent as passenger for an average vehicle occupancy of 1.2)
  - 0 percent walk/bike
  - 20 percent by transit

- Site B is a TFD located in an urban infill setting. Peak period mode shares are determined to be
  - 48 percent by vehicle (40 percent as driver and 8 percent as passenger for an average vehicle occupancy of 1.2)
  - 40 percent walk/bike
  - 12 percent by transit

A quick glance would indicate that Site A has the higher transit mode share (20 percent versus 12 percent for Site B). But for both sites, the transit mode share of motorized trips is 20 percent. For Site B, of the site trips that are motorized, 20 percent (12 divided by 60 [48 + 12]) are by transit. All of the transit mode shares presented in the tables and charts presented in Appendix D are expressed as percentages of the site motorized trips (unless stated otherwise). Analysis of research results has found a much better relationship with this measure than with total transit mode share.

8.4.2 Preferred Method—Use Proxy Site Data

The national database of person trips by mode for TFD sites is limited. Therefore, the preferred method for estimating transit mode share for external trips at a TFD is to conduct surveys at three or more proxy sites with land use and site characteristics comparable to the study site (or to locate appropriate data from previously conducted surveys). For a nearby site to be a suitable proxy site, it should have

- The same land uses;
- Similar proximity to a transit station;
• The same type (heavy rail, light rail, streetcar, bus rapid transit, express bus) and similar frequency of transit service;
• A comparable size range in terms of development units (such as office square footage or residential dwelling units); and
• A similar site context.

It is important the analyst focus on characteristics that make the mode shares of the potential proxy sites similar to those of the study site. Proxy sites near the study site are preferred.

Chapter 12 provides guidance on how to develop and execute a data collection plan to collect person trips by mode at a proxy site. The analyst should submit any new mode share data to ITE for inclusion in the national trip generation database.

From the mode share information gathered at the proxy site, the analyst can calculate the transit proportion of the motorized trips external to the proxy site. This proportion can be applied to the external motorized trips generated by the study site.

If the proxy site has characteristics that differ from the study site, manual adjustments should be made to the assumed transit mode share proportion. For example, data presented in Appendix D demonstrate that transit mode shares at an office site decrease with increasing distance from a transit station. If the proxy site is closer or farther than the actual distance for the study site, the analyst should adjust the proxy site mode share using the same curve relationship.13

8.4.3 Acceptable Method—Adapt Research Results

If proxy site data are not available or cannot be collected, it is acceptable to consider data from research conducted in other metropolitan areas. Appendix D summarizes mode share data collected for several studies of TFD sites. For each TFD study, information is provided on the specific land uses surveyed, the site size (such as number of dwelling units), its location within the urban area (CBD or non-CBD), and its proximity to transit (rail or bus). These data, though limited, could provide the analyst a starting point from which to derive an estimate of transit mode shares for site-generated person trips.

The research results and data presented in Appendix D provide clear indications that the proximity of transit service to a development site can result in some of the site-generated person trips being made by means of transit.

However, most of the research results reported in Appendix D are based on data that do not exactly match the travel characteristics that are needed for the recommended approach. For example,

• Some of the research collected or reported vehicle trip generation rather than mode share information (thereby mixing the potential effects of both proximity to transit and proximity to complementary land uses in an infill setting);
• Some of the research results are based on sample surveys of workers or residents that are self-administered rather than on a universal count and a sampled survey of all trips to or from a site;

13 Adjust the proxy site mode share as follows. First, identify the points on the curve in Appendix D (showing the mode shares at various distances from a transit station) that correspond to the proxy site and study site distances. Second, apply the percentage difference represented by the points on the curve to adjust the proxy site results to the study site.
Some of the research results are based on daily data rather than peak hour or peak period data;
- Some of the research data represent only incomplete subsets of the complete peak period travel population (for example, commuter trips rather than total trips at a residential or office site);
- Some of the research results are based on surveys that obtained information on “typical” or “regular” travel patterns which can be different from the “actual” travel patterns on the survey date; and
- Some of the estimates of transit mode shares for trips to or from the TFD sites are based on field observations rather than intercept surveys; it is unclear how the field observations would have been able to distinguish between walk trips and transit trips to or from a rail station not located at or adjacent to the TFD site.

The limitations of specific data sets are described in the individual research report summaries in Appendix D. The above are intended to be observations about, not critiques of, the cited research and its applicability to data needs prescribed in this *Handbook*.

An imperfect match between specific data needs and actual available data can sometimes be overcome through thoughtful refinement of the data. As an example, a data source for an office site could provide pertinent transit mode share information, but the data only cover commuters. For the AM peak period, the commuter transit mode share may be an adequate representation for all site-generated person trips because the non-commuter trips are such a small percentage during that time period. However, the use of only commuter trip mode shares to estimate the PM peak period is likely to be inaccurate; visitor trip mode shares are also needed. If both commuter and visitor mode share information is available, the analyst needs to find a credible estimate for the mix of commuter and visitor trips from a local or national source in order to weight and merge the data. Finally, the mode share calculations should be done directionally.

Table 8.1 summarizes the types of TFD sites for which data are reported in Appendix D. Data are provided for five different land use categories located both within and outside the metropolitan area CBD and located close to heavy rail, light rail, and significant bus service. The last column in the table lists the section in Appendix D that provides the pertinent data and describes its source.
Table 8.1 Types of TFD Sites for which Data are Reported in Appendix D.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location within Urban Area&lt;sup&gt;14&lt;/sup&gt;</th>
<th>Transit Service&lt;sup&gt;15&lt;/sup&gt;</th>
<th>Location of Relevant Data in Appendix D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Outside CBD</td>
<td>Heavy Rail</td>
<td>D.1.2; D.2.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light Rail</td>
<td>D.2.1</td>
</tr>
<tr>
<td></td>
<td>CBD</td>
<td>Heavy Rail</td>
<td>D.2.1; D.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light Rail</td>
<td>nonD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multi-Route Bus Transit Center</td>
<td>D.3</td>
</tr>
<tr>
<td>Residential</td>
<td>Outside CBD</td>
<td>Heavy Rail</td>
<td>D.1.1; D.2.2; D.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light Rail</td>
<td>D.1.1; D.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multi-Route Bus Transit Center</td>
<td>D.3; D.4</td>
</tr>
<tr>
<td></td>
<td>CBD</td>
<td>Heavy Rail</td>
<td>D.2.2; D.3; D.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light Rail</td>
<td>D.3; D.5</td>
</tr>
<tr>
<td>Retail</td>
<td>Outside CBD</td>
<td>Heavy Rail</td>
<td>D.1.3; D.2.3; D.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light Rail</td>
<td>D.1.3</td>
</tr>
<tr>
<td></td>
<td>CBD</td>
<td>Heavy Rail</td>
<td>D.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light Rail</td>
<td>D.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multi-Route Bus Transit Center</td>
<td>D.3</td>
</tr>
<tr>
<td>Hotel</td>
<td>Outside CBD</td>
<td>Heavy Rail</td>
<td>D.1.4; D.2.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light Rail</td>
<td>D.1.4</td>
</tr>
<tr>
<td>Cinema</td>
<td>Outside CBD</td>
<td>Heavy Rail</td>
<td>D.2.5</td>
</tr>
</tbody>
</table>

For a TFD located in a CBD (whether served by heavy rail, light rail, or bus), it is recommended the analyst collect and use local data. The limited number and unique characteristics of the sites

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<sup>14</sup> The “outside the CBD” locations include suburban business districts, activity centers, and dense commercial corridors, as well as stand-alone development sites.

<sup>15</sup> A site identified in Table 8.1 as near a heavy or light rail transit station is likely to also be served by bus transit. A site identified as near bus service has at least a nearby multi-route bus transit center with high-frequency service that could include express bus. The exact nature of the bus transit service can be determined through examination of the individual research documents.
documented in Appendix D make it impractical (with the current database) to derive information that could be pertinent universally at CBD sites.

For a TFD site served by bus only, it is recommended that the analyst use the data and approach presented in Chapter 7 for infill development to estimate the combination of walk and transit trips generated by the study site. The analyst can consider the TFD research data for non-CBD residential sites after confirmation that the site setting and transit service characteristics are compatible with those of the study site.
9 Use of Local Data to Estimate Trip Generation

9.1 Background

Chapter 4 presents a recommended process for assessing the appropriateness of Trip Generation Manual data for estimating trip generation at a particular study site. The procedure states that local data should be collected and used to estimate trip generation under the following circumstances:

- If the characteristics or setting of a study site are not covered by a land use description and the individual data points presented in the Trip Generation Manual data volumes; OR
- If the size of a study site is not within the range of data points presented in the Manual data volumes; OR
- If the Manual database has an insufficient number of data points; OR
- If the Manual database produces weighted average rates or fitted curves for which standard deviation or regression coefficients are not appropriate for use; OR
- If local circumstances (such as the site setting or context, age of residents, worker shifts, area type, parking conditions, or business activity) indicate a study site may have different trip-making characteristics than the baseline sites for which data were collected and reported in the Manual.

This chapter presents a recommended procedure for estimating trip generation using local trip generation data.

If the study site is located in a downtown or infill setting, is served by significant public transportation, or is a mixed-use development, other chapters in this Handbook provide specific guidance for estimating vehicle and person trip generation. Chapter 6 addresses mixed-use development, Chapter 7 addresses infill development, and Chapter 8 addresses development in close proximity to significant transit service.

9.2 Cautionary Notes

While many analysts and local officials feel their area is somehow unique, this can lead to a conclusion that this uniqueness means vehicle trip generation characteristics in their area are different from those in the national database. However, it is the experience of the professionals who prepared the guidance contained in this Handbook that differences in trip generation between sites have more to do with the site context and setting than exclusively with geography.

A development site in one metropolitan area will generally have trip generation characteristics comparable to those of a development site in another metropolitan area if the site settings are similar. In contrast, two development sites in the same state or same local jurisdiction may have different trip generation characteristics because of significant differences in their settings. For example, the analyst should expect vehicle trip generation characteristics to be different between sites located in a downtown setting versus sites located in a suburban setting. Likewise, a site located near and with accessibility to major transit service can exhibit a lower vehicle trip generation rate than a similarly located site with no transit service. Guidelines for estimating the effects of setting and proximity to transit on study site vehicle trip generation are presented in Chapters 7 and 8.
It is recommended that the geography of data points not be the primary focus of concern with the national database when deciding whether to collect or use local trip generation data. Rather, the analyst should understand that site context is the overriding factor influencing trip generation, not the state or local jurisdiction.

### 9.3 Collection of Local Trip Generation Data

The decision to establish a stand-alone local trip generation rate or equation should start with the development of a hypothesis for why the national *Trip Generation Manual* data might not be appropriate for local application. For example, the rationale could involve the age of residents, or the supply and price of parking, or market area characteristics for a retail site. It is critical that the analyst document a common-sense rationale for the local trip generation characteristics to be significantly different from that presented in the *Manual*. Clearly, the absence of any data covering a particular land use or a data deficiency in the existing database (for example, in the range of site sizes) is a sufficient rationale.

The analyst should collect trip generation data at a minimum of three local sites. Collecting data at five or more sites is preferable. Where there are only one or two potential data collection sites in a comparable setting, the analyst should use that data, coupled with other local or national data, to derive the estimate. The analyst is cautioned that this recommendation should not be used as an excuse for collecting and using data from only one or two sites when more sites are reasonably available.

Chapter 12 presents guidance on the selection of appropriate data collection sites, on the appropriate procedures for collecting data, and on the analysis and summary of data. The following are reminders of specific issues that need to be considered when the analyst designs and conducts a program to establish a local trip generation rate or equation.

- Each data collection site should be located in a setting comparable to that of the study site. For a jurisdiction that wishes to establish a local trip generation rate based on specific characteristics, the local trip generation sites should match the setting or size characteristics set out in the initial hypothesis.
- The data collection sites should reflect the size range of the study site and the anticipated general intensity of activity. Each independent variable presented in the *Manual* for the particular land use (such as GFA or employees) should be included, if available, in the identification of potential comparable sites.
- The data collection time period should reflect the time of day, day of the week, and month of the year corresponding to the analysis period needed for the study site or for the local trip generation database.

In accordance with guidance presented in Chapter 12, the analyst should collect person trip information, tabulated by travel mode, as well as vehicle trips.

### 9.4 Calculation of a Stand-Alone Local Trip Generation Rate or Equation

The weighted average rate and standard deviation can be calculated as described in Appendix J of this *Handbook*. The weighted average rate is appropriate for use as a stand-alone local estimator for
trip generation if the weighted average rate for the local counted sites is at least 15 percent\(^\text{16}\) higher or lower than the comparative *Manual* rate and if the local trip generation data provide results that satisfy the Chapter 4 criteria that demonstrate the validity of the data in a statistical sense.\(^\text{17}\)

If the *Manual* database is composed of two or fewer data points AND if the local trip generation data provide results that satisfy the Chapter 4 criteria, then the weighted average rate (or, if applicable, the fitted curve equation) is appropriate for use as a stand-alone local estimator for trip generation.

On the other hand, if either of the two criteria for establishing a stand-alone local trip generation rate or equation is not met (because the local data either (1) are not sufficiently different from the national data to warrant consideration as being distinct or (2) do not demonstrate sufficient consistency to warrant consideration as a stand-alone local trip generation rate), then the analyst should consider consolidating the local and national databases, as described in the following section 9.5.

### 9.5 Calculation of a Consolidated Local Trip Generation Rate

The following text presents formulas that should be used for merging local and national databases. They can be used for any land use, time period, and independent variable for which a weighted average trip rate is provided in the *Manual*. Derivation of a consolidated fitted curve equation is not possible with the data that are available.

As shown in the equation below, the consolidated weighted average trip generation rate equals the sum of all trips in the combination of the ITE database and the local database divided by the sum of all the independent variable units in the combination of the ITE database and the local database.

\[
\text{Consolidated Weighted Average Rate} = \frac{\sum \text{Trips (ITE)} + \sum \text{Trips (local)}}{\sum \text{IV Units (ITE)} + \sum \text{IV Units (local)}}
\]

where

\[
\sum \text{Trips (ITE)} = \text{“weighted average trip rate” (from ITE data page statistics) multiplied by “average value of independent variable values” (from data page) multiplied by number of studies (from data page)}
\]

\[
\sum \text{IV Units (ITE)} = \text{“average value of independent variable values” (from data page) multiplied by number of studies (from data page)}
\]

\[
\sum \text{Trips (local)} = \text{the sum of trips recorded for all of the local data collection sites}
\]

\[
\sum \text{IV Units (local)} = \text{the sum of independent variable values for all of the local data collection sites}
\]

\(^{16}\) The “15 percent difference” threshold is considered to be a reasonable, though arbitrary, guideline. If the analyst, based on professional judgment, is confident of the validity and applicability of the data for local application, then the analyst should use the local data rather than the national data. But the analyst is reminded that the simple randomness of numbers will produce some variation and the 15 percent threshold tries to limit the possibility of reaching unfounded conclusions that local conditions are indeed different from the national database.

\(^{17}\) As described in that chapter, an acceptable weighted average trip generation rate requires at least three data points with a computed standard deviation that is no more than 55 percent of the weighted average rate. An acceptable fitted curve equation requires at least four data points with a computed \(R^2\) of at least 0.75.
9.6 Documentation

The stand-alone or consolidated local trip generation documentation should clearly state the following:

- The local rates or equations;
- The circumstances in which they are applicable; and
- What to do in situations where they are not applicable (for examples, use national data or collect more local data).

The documentation should also include the site-specific information for the local data, such as:

- Land use;
- Value(s) of the independent variable(s);
- Survey date and day of the week;
- Survey time period and its relation to site peak hour and peak hour of adjacent street; and
- Site context.

All trip generation data should be submitted to ITE for inclusion in future editions of Trip Generation Manual. In cases where a local rate or equation is developed, consideration should be given to submitting the results of the local trip generation analysis to ITE. Sources will be cited but the identity of specific sites will be kept confidential. Data and analyses should be transmitted to:

Institute of Transportation Engineers
Trip Generation Data
1627 Eye St., NW, Suite 600
Washington, DC 20006
Tel: +1 202-785-0060
Fax: +1 202-785-0609
www.ite.org

9.7 Examples of Recommended Process

The following examples demonstrate the steps for determining whether a stand-alone, local trip generation rate/equation, or a consolidated local trip generation rate is appropriate. The calculations referenced below are presented in detail in the Appendix J examples for how to calculate weighted average, variance, and standard deviation.

Example 1—Local Data Weighted Average more than 15 Percent Different from Manual Weighted Average Rate but Inadequate Local Data Statistics

In the professional judgment of the analyst, Trip Generation Manual data for Land Use Code 492 (Health/Fitness Club) is not appropriate for estimating the weekday morning peak hour of the generator as a function of site GFA for a local study site. Trip generation data are collected at three local proxy sites:

- Site A is 43,000 sq. ft. GFA and has 11 vehicle trips in AM site peak hour
- Site B is 49,000 sq. ft. GFA and has 83 vehicle trips in AM site peak hour
- Site C is 15,000 sq. ft. GFA and has 34 vehicle trips in AM site peak hour
The three sites have a total GFA of 107,000 sq. ft. and 128 total AM peak hour trips for a weighted average of 1.20 (calculated as 128/107).

For Land Use 492, the data pages in *Trip Generation Manual, 9th Edition* present the following:
- Weighted average weekday trip rate (per 1,000 sq. ft. GFA) = 1.43
- Average value for the independent variable unit (1,000 sq. ft. GFA) = 39
- Number of studies = 4

The weighted average trip rate for the three local proxy sites (1.20) is 16 percent lower than the *Manual* rate (1.43). However, the weighted standard deviation for the local data is 0.97 (81 percent of the weighted average rate) and is too high to be acceptable (that is, greater than 55 percent). Therefore, the recommended use of the local data is to consolidate it with the national data to produce a consolidated local rate.

\[
\text{consolidated weighted average rate} = \frac{\sum \text{trips (ITE)} + \sum \text{trips (local)}}{\sum \text{IV units (ITE)} + \sum \text{IV units (local)}}
\]

where

\[
\sum \text{trips (ITE)} = 1.43 \times 39 \times 4 = 223
\]

“weighted average trip rate” multiplied by “average value of independent variable values” multiplied by number of studies

\[
\sum \text{IV units (ITE)} = 39 \times 4 = 156
\]

“average value of independent variable values” multiplied by number of studies

\[
\sum \text{trips (local)} = 128
\]

\[
\sum \text{IV units (local)} = 107
\]

\[
\text{consolidated weighted average rate} = 1.33 = \frac{223 + 128}{156 + 107}
\]

The consolidated weighted average rate (1.33) is less than the *Manual* weighted average rate of 1.43, but higher than the weighted average rate of 1.20 for the three local data points.
Example 2—Local Data Weighted Average less than 15 Percent Different from Manual Weighted Average Rate

Trip generation data are collected at a fourth local proxy site to add to the three sites described above:

- Site A is 43,000 sq. ft. GFA and has 11 vehicle trips in AM site peak hour
- Site B is 49,000 sq. ft. GFA and has 83 vehicle trips in AM site peak hour
- Site C is 15,000 sq. ft. GFA and has 34 vehicle trips in AM site peak hour
- Site D is 48,000 sq. ft. GFA and has 65 vehicle trips in AM site peak hour

The four sites have a total GFA of 155,000 sq. ft. and 193 total AM peak hour trips for a weighted average rate of 1.25 (calculated as 193/155).

The weighted average trip rate for the four local proxy sites (1.25) is 13 percent lower than the Manual rate (1.43). Because the weighted trip generation rate for the local data is within 15 percent of the Manual data trip generation rate, the recommended use of the local data is to consolidate it with the national data to produce a consolidated local rate.

\[
\text{consolidated weighted average rate} = \frac{\Sigma \text{trips (ITE)} + \Sigma \text{trips (local)}}{\Sigma \text{IV units (ITE)} + \Sigma \text{IV units (local)}}
\]

where

\[
\Sigma \text{trips (ITE)} = 1.43 \times 39 \times 4 = 223 \text{ (from Example 1)}
\]
\[
\Sigma \text{IV units (ITE)} = 39 \times 4 = 156 \text{ (from Example 1)}
\]
\[
\Sigma \text{trips (local)} = 193
\]
\[
\Sigma \text{IV units (local)} = 155
\]

\[
\text{consolidated weighted average rate} = 1.34 = \frac{223 + 193}{156 + 155}
\]

The consolidated weighted average rate (1.34) is less than the Manual weighted average rate (1.43), but higher than the weighted average rate (1.25) for the four local data points.

Example 3—Local Data Weighted Average more than 15 Percent Different from Manual Weighted Average Rate and Adequate Local Data Statistics

Trip generation data are collected at a fifth local proxy site to add to the four sites described above:

- Site A is 43,000 sq. ft. GFA and has 11 vehicle trips in AM site peak hour
- Site B is 49,000 sq. ft. GFA and has 83 vehicle trips in AM site peak hour
- Site C is 15,000 sq. ft. GFA and has 34 vehicle trips in AM site peak hour
- Site D is 48,000 sq. ft. GFA and has 65 vehicle trips in AM site peak hour
- Site E is 38,000 sq. ft. GFA and has 40 vehicle trips in AM site peak hour

The five sites have a total GFA of 193,000 sq. ft. and 233 total AM peak hour trips for a weighted average of 1.21 (calculated as 233/193).

The calculated average trip rate for the five local proxy sites (1.21) is 16 percent lower than the Manual rate (1.43). The weighted standard deviation is 0.67 (55 percent of the weighted average rate). The local rate is acceptable for use for estimating trips generated by the study site.
10 Primary, Pass-By, and Diverted Trips

10.1 Background

The guidance presented in Chapters 3 through 9 enables the analyst to estimate vehicle trips or person trips, by mode, which enter and exit a study site. These volumes are appropriate for determining the total traffic to be accommodated by site driveways.

However, not all traffic entering or exiting a site driveway is necessarily new traffic added to the street system. The actual amount of new traffic is dependent upon the purpose of the trip and the route used from its origin to its destination. For example, retail-oriented developments such as shopping centers, discount stores, restaurants, banks, service stations, and convenience markets are often located adjacent to busy streets in order to attract motorists already on the street system for a different purpose. These sites attract a portion of their trips from traffic passing the site on the way from an origin to an ultimate destination. Thus, these “pass-by” trips do not add new traffic to the adjacent street system and may be reduced from the total external trips generated by a study site.

Vehicle trips generated by a site can be separated into two major categories: pass-by trips and non-pass-by trips. In some traffic impact study applications, it is necessary to further subdivide non-pass-by trips into primary trips and diverted trips. These trip types are defined below and are illustrated in Figure 10.1.

If the study site is a mixed-use development, internal capture reductions should be estimated prior to splitting site-generated trips into pass-by and non-pass-by trips. If the study site is an infill setting or is served by significant transit, reductions in site-generated vehicle trips to reflect walk, bicycle, and transit trips should be estimated prior to splitting trips into pass-by and non-pass-by trips. The above reductions are computed as person trips. Pass-by trips are computed in terms of vehicle trips.
Figure 10.1 Primary, Pass-By, and Diverted Trips
10.2 Definitions

A pass-by trip is made as an intermediate stop on the way from an origin to a primary trip destination without a route diversion. Pass-by trips are attracted from traffic passing the site on an adjacent street or roadway that offers direct access to the generator. **Pass-by trips are not diverted from another roadway not adjacent to the site.** In the Figure 10.1 example, the shopping center-generated trips that are the result of a motorist driving from the shown office to the shown home are pass-by trips.

A non-pass-by trip is simply any trip generated by a site that is not a pass-by trip. This term is sometimes used when diverted trips are not tabulated separately from primary trips in the data collection process or are not evaluated separately in the analysis process.

A primary trip is made for the specific purpose of visiting the generator. The stop at the generator is the primary reason for the trip. The trip typically goes from an origin to a destination and then returns to the origin. Home-to-work-to-home, work-to-restaurant (for lunch)-to-work, and home-to-shopping-to-home are all examples of pairs of primary trips. If an intermediate stop is made along the way, the primary trip becomes either a pass-by trip (described above) or a diverted trip (described below).

A diverted trip is attracted from the traffic volume on roadways within the vicinity of the generator but without direct access to the site. A diverted trip requires a diversion from a roadway not adjacent to the site to another roadway to gain direct access to the site. A **diverted trip adds traffic to streets adjacent to a site and could remove a trip on streets from which it diverted.** Figure 10.1 shows an example of what was a primary trip from an office to a home that has diverted to a gas station. Both pass-by and diverted trips may be part of a multiple-stop chain of trips.

10.3 Process for Estimating Pass-By Trip-Making

The analyst has two basic options for developing an estimate for pass-by trip-making at a study site:

1. Derive a pass-by estimate from national database presented in Appendix E, or
2. Collect and use pertinent local data on pass-by trip-making at proxy sites.

10.3.1 National Database

Listed in Table E.1 in Appendix E are the 25 land uses for which ITE has received and compiled pass-by and diverted trip data. The table denotes whether the data are presented in this Handbook in a table or a figure (in a data plot similar to those presented in Trip Generation Manual for trip generation data). Table E.1 also identifies the time periods for which the data have been reported. The data are presented in Tables E.2 through E.38 and Figures E.1 through E.19.

A fitted curve is provided if the plot has at least four data points and the coefficient of determination \(R^2\) for the linear fitted curve equation is at least 0.50. Prior editions of Trip Generation Handbook
The guidance provided in this section deals directly with pass-by trip estimation. A similar procedure can be used for estimating diverted trips and primary trips. Included fitted curves for some data plots with $R^2$ values of less than 0.5.

If provided, the fitted curve equation should be used as a starting point for pass-by trip estimation. Consideration should then be given to the data scatter at the size of the independent variable for the study site. The analyst should also recognize that the pass-by survey results are presented in the tables and the figures regardless of the survey sample size and its effect on potential errors in estimating the pass-by trips for the surveyed site.

If a fitted curve equation is not provided, the average rate should be considered as a starting point if the following criteria are met.

- Sample consists of three or more data points; and
- Size of the study site (in terms of the independent variable unit of measurement) is within the range of the data points provided in the table or figure.

Primarily due to less available data, the level of accuracy in estimating pass-by percentages is typically lower than that available for estimating overall trip generation.

The analyst should start with the average rate listed in the pertinent table and make appropriate refinements, if circumstances dictate. For example, a review of the data or of the data plot might indicate the study site could be expected to have a slightly higher or lower pass-by rate due to its size, location, or proximity to through-traffic.

10.3.2 Local Data

If national data are not available or if any of the above criteria are not met, surveys should be conducted at three or more existing developments (proxy sites) that are similar to the study site. Surveys conducted on the same major roadways would, for example, be preferred. Chapter 12 presents recommended pass-by data collection procedures. This data should be submitted to ITE to supplement the existing database.

10.4 Cautionary Notes

10.4.1 Pass-By Trips

Statistical analysis and correlation of pass-by data collected by the profession continue to evolve. However, due to the limited amount of pass-by data available and the inherent variability in surveyed site characteristics, it has proven difficult to obtain high correlation indices.

Traditional pass-by trip analyses have attempted to correlate pass-by trip percentages (the percentage of the total number of external trips generated by a site) with units of occupied site development (such as gross leasable area, gross floor area, seats in a restaurant, or fueling positions at a gas/service station). For some land uses, pass-by trip percentages are also thought to be correlated with the magnitude of the traffic passing the site on the adjacent roadway(s).
Pass-by trips are drawn from the passing traffic stream, but are always included in site driveway movements. In traffic analyses, summation of driveway volumes must equal the total external site generation (that is, the sum of primary, pass-by, and diverted trips).

Pass-by trips are not included in (and thus, are subtracted from) the through-volumes passing a given site access point on an adjacent road. If application of a pass-by percentage results in an unrealistic reduction in the calculated through volume on the adjacent road, the pass-by percentage should be re-evaluated for reasonableness. For example, it is unlikely for a site’s pass-by traffic to represent the majority of adjacent street traffic.

In a mixed-use development, it is likely there will be trips internal to the site (refer to Chapter 6 for guidance). Before applying the pass-by reduction, the analyst should remove internal trips from the total number of external trips generated by the mixed-use site. Pass-by trips are only applicable to external trips (that is, those that enter or exit the site), not internal trips.

If the study site is located in an infill setting or is a transit-friendly development, the mode share shifts presented in Chapters 7 and 8, respectively, should be applied in the calculation of site-generated vehicle trips prior to calculating pass-by trips.

**10.4.2 Diverted Trips**

Diverted trips are clearly different from pass-by trips. Diverted trips add trips to the adjacent roads at a proposed or expanded site. However, it is common for a traffic impact assessment of site development to treat diverted trips as additional trips within the study area of the traffic impact study.

Diverted trips are often difficult to identify. Consequently, diverted trips should be estimated in a traffic impact study only if

- Reliable data reporting the percentage distribution of the three types of trips (primary, pass-by, and diverted trips) are available for the land use(s) being considered; and
- The travel routes for diverted trips can be clearly established.

If these conditions cannot be met, the analyst should treat all non-pass-by trips as primary trips.

In establishing travel routes for diverted trips, the analyst should consider the location and relative volume of traffic on major roadways within the study area for the traffic impact analysis. Locally established data or data from the site developer may also be helpful in identifying the travel routes for diverted trips.

Overall, diverted trips represent a change in local area travel patterns but constitute no new increase on a macroscopic scale. Within the immediate study area, diverted trips represent additional traffic on individual streets adjacent to a proposed development and could decrease traffic on the streets from which they divert, and should be analyzed that way (if diverted trips are considered in the study and if the streets from which traffic is diverted are within the study area).

**10.5 Example of Recommended Process**

This section describes an example of the assignment process for primary, pass-by, and diverted trips. The objectives in this example are to
1. Estimate the number of new trips added to the adjacent street traffic volume with the development of a shopping center with 707,000 sq. ft. of gross leasable area (GLA), and

2. Determine the turning movement volumes at the shopping center driveway.

The background two-way PM peak hour traffic on a street adjacent to the proposed shopping center is 1,200 vehicles, as shown in Figure 10.2(A)—1,000 traveling west and 200 traveling east. Also shown in Figure 10.2(A) is a major highway in close proximity to the east of the proposed shopping center.

The shopping center is estimated to generate 2,220 PM peak hour trips (based on the fitted curve equation given for Land Use Code 820 in Trip Generation Manual, 9th Edition). An assessment of the shopping center parking configuration and access points indicates an estimated 18 percent of the site-generated traffic will use the driveway being analyzed in this example. Thus, the driveway volume is estimated to be 400 PM peak hour trips (calculated as 18 percent of 2,220 trips). For this example, 48 percent of trips enter (192 trips) and 52 percent exit (208 trips) the proposed shopping center.

Data on pass-by and diverted trips collected at other shopping centers during the weekday PM peak period are compiled in Table E.9 and plotted graphically in Figure E.7, both in Appendix E. These exhibits are used to identify the appropriate pass-by and diverted trip percentages to be used in this example.

- From the fitted curve equation accompanying the data in Figure E.7, it is estimated that the pass-by trip percentage for a 600,000 square foot shopping center is 23 percent.
- Neither a data plot nor fitted curve equation is available to estimate the diverted trip percentage. A review of the data in Table E.9 indicates there are ten studies from shopping centers between 600,000 and 800,000 sq. ft. in size which also contain data on diverted trip percentages. The average diverted trip percentage from these ten studies is 29 percent.

### 10.5.1 Pass-By Trips

Based on the discussion above, 23 percent (92 trips) of the driveway volume (400 trips) is pass-by trips. The directional distribution of trips entering/exiting among pass-by trips is similar to the driveway as a whole (48 percent entering, 52 percent exiting). As a result, there are 44 pass-by trips entering the site and 48 pass-by trips exiting the site. The assumed distribution for pass-by trips is shown in Figure 10.2(B). Because 83 percent of the traffic passing by the site comes from the east (calculated as 1,000 of the 1,200 shown previously in Figure 10.2 (A)), it is expected 83 percent of the pass-by trips will likewise arrive from the east and depart toward the west.

The assignment of the pass-by trips generated by the proposed shopping center is shown in Figure 10.2(C). Based on the directional distribution in Figure 10.2(B), 37 pass-by trips are expected to arrive from the east and 7 are expected to arrive from the west; 40 pass-by trips are expected to depart to the west and 8 are expected to depart to the east. Note that the calculation also shows the expected through-trip reductions as the pass-by trips turn into the new driveway.
For example, the new westbound right-turn volume of 37 causes a corresponding reduction in the westbound through movement.

### 10.5.2 Diverted Trips

It is estimated that 29 percent of the total driveway volume will be diverted from the major highway in close proximity to the east of the proposed shopping center. Therefore, a total of 116 trips (29

**Figure 10.2 Example Application of Pass-By, Diverted, and Primary Trips**
percent of 400 trips) are diverted trips. Assuming the diverted trips have a similar enter/exit split as the overall driveway volume, it is estimated that 56 diverted trips will be entering and 60 diverted trips will be exiting the site. Because these trips are diverted from the major highway east of the proposed shopping center, 100 percent of the diverted trips will arrive from and depart to the east (see Figure 10.2(D)).

The assignment of the diverted trips generated by the proposed shopping center is shown in Figure 10.2(E). Because the major highway from which trips are diverted is located to the east of the study site, all diverted trips (56 entering and 60 exiting) travel to/from the east as shown in Figure 10.2(E).

### 10.5.3 Primary Trips

The remaining driveway volume is primary trips. The total number of primary trips at the driveway is calculated by subtracting the estimated pass-by and diverted trip volumes from the total estimated trip volumes for each direction. For example, the primary trip volume for entering trips is calculated by subtracting 44 pass-by and 56 diverted trips from the estimated total entering volume (192 trips), resulting in a total of 92 primary trips entering the site.

The assumed trip distribution for the primary trips is shown in Figure 10.2(F). These values are based on local knowledge of expected trip patterns for primary trips to and from the shopping center (based on existing travel patterns or surrounding land uses). For this example, 60 percent of primary trips are expected to arrive from the east and return to the east after the trip to the shopping center.

The assignment of the primary trips generated by the site is shown in Figure 10.2(G). The total number of primary trips entering and exiting the site is 92 and 100 trips, respectively. Sixty percent of primary trips are expected to arrive from the east and return to the east, resulting in 55 primary trips arriving from the east and 60 primary trips departing to the east. A total of 37 primary trips arrive from the west and 40 primary trips depart to the west.

### 10.5.4 All Trips

The final assignment of all trips entering and leaving the shopping center driveway, as well as passing the driveway, is shown in Figure 10.2(H). These values are simply the algebraic sum of the base volumes (from Figure 10.2(A)), the pass-by trips generated by the site (from Figure 10.2(C)), the diverted trips generated by the site (from Figure 10.2(E)), and the primary trips generated by the site (from Figure 10.2(G)). Note that the through-traffic volumes at the site driveway in both directions on the major street are reduced from the base volumes as a result of the pass-by trips.
11 \hspace{0.5em} \textbf{Truck Trip Generation}

The ability to accurately predict truck trips generated by a development site has grown in importance as truck activity patterns and practices have changed. “Just-in-time” truck delivery practices have evolved to become “Just-about-all-the-time” deliveries. Further changes in patterns are the result of reductions in on-site inventories, requests for fast deliveries of prepared goods, continuous flows of information to and from vehicles, and a variety of changes in the supply chain for the movement of goods. These changes have direct impacts on site-specific truck trip generation. This chapter presents a recommended process for developing truck trip generation estimates.

National Cooperative Freight Research Program (NCFRP) Report 26: Guidebook for Developing Subnational Commodity Flow Data\textsuperscript{18} suggests the use of a “playbook” to facilitate the selection of the “right” approach to collect and analyze truck trip generation data. The following recommended process borrows directly from the playbook structure and terminology.

\textbf{Step 1 Determine Intended Use of Estimate and Formulate Objective(s)}

The analyst should identify the specific objectives for developing truck trip estimates. Questions to answer include

- What truck definition is appropriate for the site and subsequent analysis?
- Are hourly or daily truck volumes desired? If hourly, what specific period(s)?
- What level of precision is desired or required for the truck volume estimate?

\textbf{Step 2 Identify Stakeholders}

Stakeholders include both public sector and private sector entities that are involved or have an interest in the truck trip generation issue. Stakeholders should include potential users or reviewers of the truck trip data. Stakeholders should also include potential sources of freight and truck movement information.

\textbf{Step 3 Understand Nature of Freight Movement at Site}

The analyst should disaggregate truck trips that deliver cargo to the site and truck trips that leave the site with cargo. In many cases, the numbers and types of trucks that deliver cargo to a site are not the same as, nor do they operate on the same schedule as, the numbers and types of trucks that pick-up cargo from the site. It may also be appropriate to separate service trucks from trucks that deliver or pick-up cargo.

The analyst should determine the factors that influence site truck trip generation. These factors can be used as independent variables. Typical factors include truck equivalent units shipped,

site employees, and site loading bays. But the preferred independent variable could be unique to the particular site. The stakeholders identified in Step 2 are critical sources for this information. Compilation and analysis of this data may lead to the identification of additional stakeholders.

The analyst should quantify (to the degree applicable for the intended analyses, and practical) the monthly, weekly, daily, and hourly fluctuations in the movement of freight to or from the site.

**Step 4 Choose Between Primary Data Collection and Use of Secondary Data Sources**

The use of data and relationships reported in secondary sources might be adequate and appropriate in some cases. Appendix I contains a summary of findings from NCHRP Report 739/NCFRP Report 19 (Freight Trip Generation and Land Use), a summary of truck trip data in the Trip Generation Manual data volumes, information about a web-based clearinghouse with truck trip generation data, and a list of additional suggested resources. However, before using any of this secondary data, the analyst is encouraged to review and understand the limitations of existing data sources as explained in the NCHRP Report 739/NCFRP Report 19 findings. As an example, many of the Trip Generation Manual truck data are presented as percentages of overall vehicle trips generated by a site; the NCHRP/NCFRP report clearly demonstrates that these percentages are not expected to have any statistical reliability.

If the analyst has any doubt that the secondary data will provide a sufficient level of accuracy to satisfy the analysis objectives, primary data should be collected. The gathering of accurate establishment level data on truck activities will provide direct assurance of reliable truck trip generation rates. Chapter 12 includes a recommended approach and a prototype survey instrument that can be easily adapted for a specific application.

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12 Data Collection

12.1 Background

In order for the methods presented throughout this Handbook to produce accurate trip generation estimates, they must be based on consistent, correctly collected, and applicable data. This chapter presents a recommended framework for the collection of data pertinent to trip generation estimates. The framework is structured to be straightforward, easily replicated, and adaptable to any potential land use and development type.

The analyst should first identify the information needed from the data collection effort. Once that is established, the analyst should identify specific data to be collected, general criteria for the type and setting of sites at which to collect it, and the time period(s) to be covered.

The chapter includes specific guidance for data collection for:
- Person trips
- Vehicle trips
- Pass-by trips
- Truck trips
- Internal trips

12.1.1 Transportation Data to Collect

The potential site-generated trip generation data that could be collected are person trips by mode; vehicle trips; pass-by, diverted, and primary trips (may supplement one of the other data collection efforts or be collected independently); truck trips; and internal capture trips within a mixed-use development (normally includes person trips).

If person trips by mode are to be collected, the objective of the data collection effort is to determine the primary travel mode of the trip entering or exiting the site.

- If a person crosses the site cordon line in a personal passenger vehicle or truck, as driver or passenger, vehicle is considered the travel mode.
- If a person crosses the site cordon line in a transit vehicle, transit is considered the travel mode.
- If a person crosses the site cordon line as a pedestrian or on a bicycle, the travel mode (for trip generation purposes) depends on whether other modes are used on the trip:
  - If a person uses transit on any part of the trip, transit is considered the primary trip mode. A person may walk or bicycle to or from transit, but transit typically covers the longest distance.
  - If a person uses a personal passenger vehicle or truck on any part of the trip (and does not use transit), vehicle is considered the primary trip mode.
  - If a person uses a bicycle on any part of the trip (and does not use transit or a motor vehicle), bicycle is considered the primary trip mode.
  - If a person walks the entire length of the trip, walking is the primary mode.
A person trip by vehicle (both personal passenger vehicle and truck, either separately or combined) can include:

- A trip in a vehicle parked on-site;
- A trip in a vehicle parked off-site (there should be few or none of these at a baseline or isolated site); and
- A trip by a passenger picked up or dropped off at or near the site.

ITE recognizes that an analyst may choose (or may only be able) to collect simple vehicle trips or an aggregation of person trips (in which all non-vehicle trips are treated as single travel mode). The greater the level of detail for the trip generation data the better for the overall ITE trip generation database. However, all data are acceptable and can be useful.

12.1.2 Context or Setting for Data Collection Site

If data are being collected at a proxy site for a study site, the context or setting for the data collection site should match that of the study site.

If the data are being collected to supplement the national vehicle trip database, the context or setting should be a stand-alone, single-use, suburban site with limited or no transit service and limited opportunity or demand for walk trips between the site and its surrounding area.

If the data are being collected for the person trip database, the context should be selected to represent either baseline conditions as described for the vehicle trip database, or infill conditions.

If the data are being collected for a mixed-use site, the site selection should consider criteria described in Chapter 6 of this Handbook.

If the data are being collected to establish a “local” trip generation database, the context or setting should match that of potential study site applications.

Table 12.1 lists the descriptive information that should be compiled for the data collection site.
<table>
<thead>
<tr>
<th>Information</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall Characteristics of Site</strong></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Common name for the overall site.</td>
</tr>
<tr>
<td>Site Maturity</td>
<td>The site should be fully occupied (or nearly so), mature (occupied for at least two years), and considered successful locally. As examples, an occupancy of 85 percent is recommended as a reasonable lower limit for an office building; occupancy for a retail site or an apartment is likely to be higher (perhaps 90 percent); a successful hotel could have a lower room occupancy (perhaps 75 percent).</td>
</tr>
<tr>
<td>Mix of Tenants</td>
<td>Primary tenant (that is, the tenant(s) that serves as the primary driving force behind the overall site); whether the site has a truly unique tenant.</td>
</tr>
<tr>
<td><strong>Physical Characteristics of Site</strong></td>
<td></td>
</tr>
<tr>
<td>Site Plan with Locations and Types of Access</td>
<td>Site diagram, sketch, plan, or aerial photo of the site that shows</td>
</tr>
<tr>
<td></td>
<td>- Overall site layout with building footprints;</td>
</tr>
<tr>
<td></td>
<td>- Building entrances and pedestrian pathways;</td>
</tr>
<tr>
<td></td>
<td>- Site access points for motorists (including delivery and service vehicles), pedestrians (including transit patrons), and bicyclists; and</td>
</tr>
<tr>
<td></td>
<td>- Type of traffic control at or serving each access point (signalized or unsignalized).</td>
</tr>
<tr>
<td>Land Use(s)</td>
<td>Primary land use (or land uses at a mixed-use site) within the site in accordance with <em>Trip Generation Manual</em> land use codes.</td>
</tr>
<tr>
<td>Building Size(s)</td>
<td>Building size(s) in development units such as office building square footage (GSF), amount of leased retail space (GLA), number of restaurant or theater seats, or number of residential units. Also obtain the number of stories.</td>
</tr>
<tr>
<td>Building Occupancy</td>
<td>Building occupancy (actual occupied space or units, not just leased). In a multi-tenant building, contact the property manager, leasing agent, or owner to obtain occupied space data.</td>
</tr>
<tr>
<td>Site Density</td>
<td>Total development units per site acreage.</td>
</tr>
<tr>
<td>On-Site Parking</td>
<td>Quantity of on-site spaces; type of parking facility (either surface or garage); and nominal daily/hourly cost and time restrictions.</td>
</tr>
<tr>
<td><strong>Setting/Context of Site within Surrounding Region</strong></td>
<td></td>
</tr>
<tr>
<td>Location within Urban Area (General Setting)</td>
<td>Regional CBD, outlying CBD, urban core, activity center, general urban, suburban business district, suburban strip commercial, general suburban, special district, rural business district, or rural (refer to Glossary in Appendix A for definitions).</td>
</tr>
<tr>
<td>Adjacent Land Use Description</td>
<td>Degree to which off-site land uses compete with or complement with those on-site.</td>
</tr>
<tr>
<td>Proximity to Transit</td>
<td>Walk distance to rail or rapid transit station or nearest bus stop with significant service; peak period transit headways.</td>
</tr>
<tr>
<td>Off-Site Parking</td>
<td>Proximity of off-site parking available for site (including pricing).</td>
</tr>
</tbody>
</table>
12.1.3 Time Period

The final component of the definition of the data collection purpose is to establish the timeframe for which data are desired or required. The analyst needs to identify

- The season or month of the year (such as typical month, holiday shopping season, summer, or when school is in session);
- The day of the week (such as weekday [typically, Tuesday through Thursday], Friday, Saturday, or Sunday); and
- The time-of-day (such as 24-hour, morning peak hour for the site, morning peak hour for the adjacent street, afternoon peak hour for the site, afternoon peak hour for the adjacent street, or other peak hour of generator if it may be subject to traffic impact analysis).

Refer to the Time Periods section of the Glossary in Appendix A for definitions of these time periods.

12.2 Data Collection Basics

12.2.1 Observation Counts and Interview Surveys

There are two principal techniques available to the analyst to collect vehicle trips, person trips, pass-by trips, or internal capture trips at a development site:

- Observation count—a count of persons (in some cases, by mode) or vehicles (in some cases, by vehicle class); includes both manual (in-person or a person viewing a video recording) and automated (tube counters); and
- Interview survey—an interview of persons to obtain mode of travel; pass-by, diverted, or primary trip purpose; or internal capture characteristics.

Both the purpose of the data collection effort and the characteristics of the data collection site dictate whether an observation count will suffice or if a combination of interviews and counts is necessary. If it is possible and practical to conduct the necessary data collection by observation counts alone, it is preferable to do so. A count requires fewer resources because planning a count and the training and supervising of a field crew is easier.

Table 12.2 presents the typical components of a data collection effort for four common purposes (vehicle trips, person trips, pass-by trips, and internal capture trips) and for two types of data collection sites (isolated and non-isolated). An isolated site is one at which a data collector can determine accurately, through observation only, the primary mode of travel for each person arriving or departing the site. The table indicates that

- Observation counts can suffice for collecting person trip or vehicle trip information for an isolated site;
- Interviews with counts are typically required for the collection of pass-by or internal capture information; and
- A non-isolated site (such as a mixed-use development, a development served by off-site transit routes and stations/stops, an infill development located in a highly walkable area, or a site that uses off-site parking) requires interviews and counts.
### Table 12.2 Typical Components of a Data Collection Effort

<table>
<thead>
<tr>
<th>Data Collection Purpose</th>
<th>Characteristics of Data Collection Site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Isolated Site</td>
</tr>
<tr>
<td>Vehicle Trips</td>
<td>Observation Count</td>
</tr>
<tr>
<td>Person Trips</td>
<td>Observation Count (typically)</td>
</tr>
<tr>
<td>Pass-By Trips</td>
<td>Count and Interview</td>
</tr>
<tr>
<td>Internal Capture Trips</td>
<td>Count and Interview</td>
</tr>
</tbody>
</table>

For a site with on-site parking and access directly between the building and parking facility, vehicle occupants can be counted with certainty if they are entering or leaving as vehicle drivers or passengers. Interviews are not needed to determine mode or vehicle occupancy. For such trips, observation counts are sufficient unless other information (such as pass-by trips) is needed.

If interviews are needed, it may not be necessary to use interviews around the entire site. As an example, for a non-isolated site with on-site parking and one or more pedestrian entrances (for persons who walk, ride transit, bicycle, or use off-site parking), it is likely that interviews will be needed at the pedestrian entrances to determine primary mode of travel for each person trip. However, an observation count at the on-site parking entrance should be able to determine vehicle occupancy and, therefore, person trips by vehicle. If other travel information is needed (such as pass-by trips), interviews may be needed at that entrance.

### 12.2.2 Person Trips versus Vehicle Trips

All data collection procedures in this section refer to the collection of person trip information (such as persons by mode and vehicle occupancy). If the analysis objectives require only vehicle trip generation data, the procedures and forms can be easily simplified to fit this specific need. As a reminder, however, ITE prefers that all trip generation data submittals include person trip as well as vehicle trip information.

For most isolated sites, person trip data can be compiled as easily and with the same level of resources as a vehicle trip generation count.

In general, vehicle trip data are acceptable for the following three situations:

1. If data are being collected at a proxy site for a single-use, suburban study site;
2. If data are being collected to establish a “local” trip generation database and the study sites are expected to be single-use, suburban sites; and
3. If data are being collected to compile supplementary data for the national ITE vehicle trip database (but person trip data are preferred) and the data collection sites are single-use, suburban sites.
12.2.3 Data Collection that Requires Interviews

Interviews are needed at a site that cannot be fully isolated because the mode of travel for persons entering or leaving the site cannot be positively observed from the site cordon line. Among the conditions that may contribute to the need for interviews are:

- Inability to determine a person’s primary mode of travel (for example, transit stop out of sight);
- Inability to see where people park (for example, off-site parking for personal passenger vehicles, delivery trucks, and bicycles);
- On-site parking shared with another building; and
- Some trips cross cordon lines but go to another location.

Interviews are also necessary in order to determine pass-by trips or internal capture trips. Suggested survey instruments for interviews are presented later in this chapter for determining travel mode (in section 12.6), pass-by trips (section 12.7), and internal capture at a mixed-use site (section 12.8).

Interviewers can typically interview only a sample of all people entering or exiting a building or site entrance. Therefore, it is necessary to also conduct a count of all people entering and exiting each interview location so that the interview data can be factored to represent the universe of all person trips at that entrance. In addition, the factoring will account for different sampling rates at a site with multiple interview points.

If interviews are to be conducted at only a representative sample of building access locations, door counts of all entering and exiting people will also be needed at each entrance where no interviews are to be conducted so the interview data can be factored to represent all trips.

The characteristics of a specific development site may occasionally (but rarely) necessitate use of other types of interviews or respondent surveys. Appendix M summarizes key components of a range of survey types that could have applicability for a particular data collection effort. As long as the surveys are properly designed and implemented to obtain an adequate and representative sample to ascertain the proper data, such alternatives can be acceptable.

12.3 Generic Guidance for all Data Collection

12.3.1 Site-Specific Data Collection Plan

A transportation professional experienced in trip generation data collection should visit the candidate site and determine the site access components, assess how site access works, and supervise the formulation of a data collection plan. Professional judgment is often needed for this step.

The analyst should develop a site-specific data collection plan that demonstrates how all trips to and from the site (whether vehicle trips or person trips) can be counted and how the appropriate subsets (such as person trips by mode, pass-by trips, or internal capture trips) can be isolated and tabulated.

It is essential that the site configuration enable the data collection program to be able to isolate and efficiently count (and interview if needed) the trips to, from, and within the development. Ideally, there should be no through traffic.
At a data collection site where tube traffic counters are expected to be used, the design of vehicle access points should be such that mechanical counting techniques will produce accurate vehicle counts (for example, a short driveway throat makes it difficult to place a tube counter to work properly), or if not, manual or video counts should be employed.

A data collection plan for a multimodal site (that is, a site where walking, bicycling, and transit are viable modes of transportation) should also meet the criteria described in sections of this Handbook that are related to those types of sites:

- Chapter 6 for mixed-use development;
- Chapter 7 for infill development; and
- Chapter 8 for transit-friendly development.

As an example, for a mixed-use development, the analyst should identify the specific buildings or building entrances at which to collect internal capture data. This could be a subset of all site entrances and should include only entrances with potential to have trips internal to the site, whether by foot, bike, or vehicle.

### 12.3.2 Permission and Cooperation

On-site interviews and observations can be conducted only with the permission and cooperation of the site owner or property manager. Off-site observations will benefit from this cooperation as well but it may not be necessary.

The analyst or data collection supervisor should contact (and meet, if necessary) property management to discuss the purpose and procedures of the data collection effort and how to keep it from interfering with normal site activities. The analyst or data collection supervisor should convey an understanding of the needs (1) to not impede patrons and (2) to not divulge proprietary or sensitive information. An incentive for property management to cooperate can be an offer to include a site-specific question during the interview process (and to offer the opportunity to receive the survey results or a copy of the study report). If a good working relationship can be developed, property management can often help tailor the intercept sampling procedure for the site and to interpret the survey results.

In most cases, the owner or manager will communicate directly with site tenants, businesses, or landlords. In some cases, the data collection supervisor may need to initiate these contacts.

### 12.3.3 Data Collection Duration

Observation counts (and interviews, if applicable) should be conducted for at least two hours, starting at least one-half hour before and ending at least one-half hour after the known or presumed peak hour in order to make sure the peak hour is actually covered.

### 12.3.4 Field Crew Staffing and Training

Some data collection personnel will need to count vehicles or people entering and exiting the data collection site. For some data collection efforts, personnel will need to conduct interviews. Generally,
outgoing and assertive staff make the best interviewers. A person with a retiring personality should not be deployed as an interviewer but may make a good counter.

When determining staffing requirements for a person or vehicle count, the data collection supervisor must be sure to not overload the counter with too many tasks based on the person or vehicle flow that must be counted. A brief pilot test of the responsibilities for each counter and interviewer can confirm their reasonableness or identify necessary refinements.

The data collection supervisor should conduct a training exercise so that both interviewers and counters can become familiar with the survey instruments through practice.

All data collection personnel should be provided with a map showing each location where counts and/or interviews are to be performed. The data collection supervisor should include on each map the overall data collection site with names of buildings, tenants, and areas to which interviewees might refer as well as the specific location and movements the counter or interviewer is to handle.

### 12.3.5 Field Crew Supervision

The data collection supervisor should perform a check of each staff person’s work during the first hour to make sure work is being done correctly and information recorded accurately. Misunderstandings and deficiencies should be corrected so they do not recur.

Observation counts should be completely checked by the data collection supervisor immediately after each data collection period. For each individual count location and for the sum of the site cordon counts, ensure that

- The count covers full period;
- Inbound and outbound balances are reasonable;
- Variations by 15-minute period are reasonable and logical;
- Modal shares are within expected ranges; and
- Vehicle occupancy is within expected ranges.

If discrepancies are found, the data collection supervisor should determine if corrections can be made, and if not, schedule a recount as needed.

Interview forms should be completely checked immediately after each data collection period. For each interview location, ensure that

- Times of interviews are recorded;
- Responses are within range of permitted choices (that is, codes are consistent with choices available);
- Write-in responses are complete and understandable;
- Trip origin or destination and travel mode are logical; and
- Modes of access at the site are logical for each particular trip.

Where discrepancies or errors appear to exist, the data collection supervisor should review forms with the interviewer (contact as soon as possible while their memory is clearest) to determine if corrections can be made or if interviews must be discarded. Small percentages of unusable interviews should be deleted. Large numbers may require that part of the survey be repeated.
12.3.6 Interview Logistics

It is important to successfully interview a representative cross-section of trips. The data collection supervisor should train the interviewers to resist the tendency to pre-select what appears to be an “easier” target, perhaps of a similar age, sex, or background as the interviewer, thereby introducing undesirable bias into the sample.

An interview should be designed to take no more than 60 seconds to complete. After a survey is completed, the interviewer should check the survey entry to confirm its completeness. A competent interviewer (who actively approaches people to get interviews and who records responses completely and accurately) located at a moderately active entrance should be able to complete interviews with at least 10 people per hour. However, activity levels will vary and typically result in a range of five to 20 completed interviews per hour. For a pass-by survey, the number of completed interviews could be higher because the interviews are much briefer. An average interviewer should be able to obtain completed interviews from one out of every three to four persons approached when walking.

The interviewer should expect some people will simply decline the interview or will act as if or say they are rushed. If they are willing to share information quickly as they walk by, the interviewer can conduct an abbreviated version of the survey. In anticipation of this event, the analyst should prioritize the information to be gathered. For example, for a survey intended to determine person trip mode share, the interviewer should make sure the person is leaving the site and obtain the off-site travel mode. For a survey intended to determine internal capture at a mixed-use development, the two essential questions are “Where are you going?” and “How are you getting there?”—an option that can be completed within 15 seconds.

There is no simple answer or unified standard on the sufficiency of a sample for calculating trip rates. However, it is important to document the sample size of any survey used for site-specific analysis, as well as sub-strata information appropriate to the population being sampled.

12.3.7 Interview Factoring

The interview data need to be expanded or factored to represent the total number of people who enter and exit the building or cross the cordon line. The factoring needs to be done separately for inbound and outbound directions (if interviews are conducted in both directions) because the interviews will represent different percentages of the total person trips entering or exiting. Normally, factoring is done for each building entrance but sometimes it may be acceptable to combine data for multiple entrances if the characteristics of the trips and tripmakers are likely to be the same.

In order to expand the directional interview data to represent all people passing the intercept interview location, the analyst should multiply the directional interview data for that entrance by the ratio of people counted to usable interviews, or

\[
\text{directional expansion factor} = \frac{\text{directional door count}}{\text{directional usable interviews}}
\]
The analyst can choose to use additional respondent stratifications if collected, such as gender or age range, in order to remove any potential bias from the interviews. The objective of any factoring is to properly represent responses for the universe of people entering or exiting the data collection site.

12.4 Observation Count—Vehicle Trips and Vehicle Occupancy

Observation counts are typically recorded on a form (or computer tablet) with separate data entry fields for each direction for each entrance being counted. Counts should be made both directionally and by 15-minute period to

- Permit determination of peak hour or peak period profiles as appropriate; and
- Provide directional vehicle occupancy (which can differ for some LUCs during some periods of the day).

A suggested count form is shown in Figure 12.1. The form includes non-motor vehicle travel modes which can be ignored if the data collection objective is simply for vehicle trips and vehicle occupancy. This form can be automated or modified as needed for specific site conditions.

The form covers a single location. Other formats may be employed (for example, to include two locations observed by a single counter), but should contain at least the same choices and be readily tabulated and summarized.

A counter using this form enters one mark for each vehicle crossing the cordon line. That mark should be placed in the column that corresponds to the number of persons in that vehicle. Separate rows are provided for inbound and outbound movements for each 15-minute period.

The form in Figure 12.1 shows a maximum recordable occupancy of four persons per vehicle. This will normally be sufficient. However for a site with vanpooling or some other cause for vehicle occupancy in excess of four people, additional columns are suggested to cover the higher values.

For the purposes of determining vehicle occupancy, persons to be counted as occupants include anyone visible from outside a vehicle who is not riding in a child’s seat. Vehicle occupancy is sometimes difficult to determine in a vehicle with heavily tinted windows, above average height, passenger seating areas without windows, or child restraint seating.

---

20 A counter may be able to count multiple access points.
Figure 12.1 Vehicle Trip and Person Trip Count Form

<table>
<thead>
<tr>
<th>Count Location:</th>
<th>Counter:</th>
<th>Date:</th>
<th>Hour Starting:</th>
<th>:00 a.m. p.m. Area Typea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minutes after hour</td>
<td>Direction</td>
<td>Personal Passenger Vehicle Occupants</td>
<td>Delivery/Service Truck Occupants</td>
<td>Walk</td>
</tr>
<tr>
<td>:00 to :15</td>
<td>Enter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>:15 to :30</td>
<td>Enter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>:30 to :45</td>
<td>Enter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>:45 to :00</td>
<td>Enter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exit</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a Area Types: (0a) regional CBD, (0b) outlying CBD, (1) urban core, (2) activity center, (3) general urban, (4) suburban business district, (5) suburban strip commercial, (6) general suburban, (7) special district, (8) rural town business district, (9) rural, (C) adjacent to university campus, (T) rail transit station within one-quarter mile, (To) rail station adjacent or connected.
12.5 Observation Count—Person Trips by Mode

Person trip counts can be for several purposes:
- To tabulate total person trips;
- To tabulate person trips by mode (by observation only); or
- To tabulate total person trips for the factoring of interview responses.

The count form in Figure 12.1 can serve as a means for tabulating person trips by mode. Each person entering or exiting the data collection site is counted as an individual. The counter marks the count form in the appropriate trip mode for each individual.

The analyst needs to decide beforehand and the data collection supervisor must instruct counters how to treat atypical person trips. As examples,
- A child entering or exiting a school bus is considered a transit trip, in general;
- A child walking to or from school is considered a walk trip, in general; and
- A person on a tour trip (such as walking a dog or on a run) is considered a walk trip if the trip takes the person beyond the sidewalk adjacent to the site.

For subsequent analysis purposes, these data can be aggregated after the data collection is complete.

Figure 12.2 shows a manual count form that can be used to count people exiting or entering each door of each establishment where interviews are to be conducted or that the interviews are to represent. This form or an automated equivalent can be modified to meet specific data collection site needs.

12.6 Interview Survey—Travel Mode

Figure 12.3 shows a sample form for use in intercept interviews to determine travel mode. Figure 12.4 shows an alternative survey instrument where the respondent is asked directly for the primary mode of travel. The latter form provides a more accurate accounting of travel mode but does require more interviewer training to elicit the proper responses. It is organized to ask the inbound trip information first, but could easily be reversed if desired to ask the outbound trip information first.

The Figure 12.4 form is intended to also determine internal capture at a mixed-use site (see section 12.8 of this chapter) and therefore includes several queries that could be removed if determined unnecessary for the overall data collection objective. The form includes a “refusal” column that can be filled out by the interviewer based on observation.

---

21 If a transit route enters the data collection site, the preferred way to count inbound and outbound person trips by transit is to count boardings and alightings at the on-site transit stop. Within a large mixed-use development, it is possible that a transit trip could begin and end within the data collection site. If that is a possibility, the data collection supervisor needs to determine how to count people entering and leaving the site by transit (for example, it may be necessary to conduct on-board interviews).
Figure 12.2 Sample Door Count Form

Location: __________________ Counter: ___________________ Date: ____________ Hour Starting: ___:00 a.m. p.m.

<table>
<thead>
<tr>
<th>Minutes after Hour</th>
<th>Direction</th>
<th>Business / Place / Count Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>:00 to :15</td>
<td>Enter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exit</td>
<td></td>
</tr>
<tr>
<td>:15 to :30</td>
<td>Enter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exit</td>
<td></td>
</tr>
<tr>
<td>:30 to :45</td>
<td>Enter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exit</td>
<td></td>
</tr>
<tr>
<td>:45 to :00</td>
<td>Enter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exit</td>
<td></td>
</tr>
</tbody>
</table>

Figure 12.3 Survey Instrument for Determining Travel Mode

<table>
<thead>
<tr>
<th>Q 1</th>
<th>Main Travel Mode</th>
<th>Departure for next survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q 2</td>
<td>Group Size</td>
<td></td>
</tr>
<tr>
<td>Q 3</td>
<td>Interview Time</td>
<td></td>
</tr>
<tr>
<td>Q 4</td>
<td>Time</td>
<td></td>
</tr>
<tr>
<td>Q 5</td>
<td>Level 1</td>
<td></td>
</tr>
<tr>
<td>Q 6</td>
<td>103 Carlton Gore Road ph 531 5006</td>
<td></td>
</tr>
<tr>
<td>Q 7</td>
<td>Interview Site</td>
<td></td>
</tr>
<tr>
<td>Q 8</td>
<td>Site</td>
<td></td>
</tr>
<tr>
<td>Q 9</td>
<td>Source: Traffic Design Group Inc.</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Interview Site, Site, and Source: 103 Carlton Gore Road, ph 531 5006.
12.7 Interview Survey—Pass-By Trips

A sample form for conducting the pass-by and diverted trip survey is presented in Figure 12.5. A response of “yes” to Question 2 should be counted as a primary trip. A survey response of “yes” to Question 3 should be counted as a pass-by trip. The remainder of the trips should be considered diverted trips. Question 4 should be reported to ITE in terms of miles. However, it may be easier for motorists to provide geographic information (for example, the nearest intersection to the motorist’s usual route). If such responses are provided, the analyst should develop a reasonable estimate of the number of miles traveled between the motorist’s usual route and the site. The pass-by and diverted trip survey results (as well as the site trip generation data) should be summarized in a format similar to that presented in Figure 12.6.

The number of pass-by and diverted trip interviews should meet the minimum sample size requirements listed in Table 12.3. The analyst should make an initial estimate of the expected percentage of pass-by trips. Figures E.1 through E.14 and Tables E.2 through E.30 in Appendix E can be used to derive this initial estimate. For example, using Table 12.3 for a 95 percent level of confidence and maximum error of 10 percent, a shopping center would require a minimum of 97 usable interviews if the expected pass-by trip percentage is 50 percent. If the expected pass-by percentage is 20 percent, the minimum sample size is 62 usable interviews. If an initial estimate of the expected pass-by percentage is not able to be made from the data presented in Appendix E, the analyst should use the minimum sample size requirement listed under the “Unknown” column. As demonstrated in the table, a larger sample is required for a 95 percent level of confidence than for a 90 percent level of confidence; a larger sample size is also required as the maximum tolerable error in mean decreases. It should be noted that the minimum sample sizes suggested in the table

represent the numbers of vehicles, not persons. During the interview process, no more than one occupant per vehicle should be interviewed.

When developing the data collection plan for a pass-by and diverted trip survey, the analyst should consider the relative volume and characteristics of traffic that is expected to use each access point for a site which has multiple access driveways. Pass-by and diverted trip interviews should be conducted on all sides of the site with access in order to not favor one roadway or one area of the site over another. If different driveways are anticipated to exhibit significantly different pass-by or diverted percentages, the minimum sample size should be met for each.

**Table 12.3 Minimum Sample Size for Pass-By/Diverted Trip Surveys**

<table>
<thead>
<tr>
<th>Maximum Error in Mean</th>
<th>Expected Percent Pass-By Trips</th>
<th>90% Level of Confidence</th>
<th>95% Level of Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>5%</td>
<td>174</td>
<td>228</td>
<td>260</td>
</tr>
<tr>
<td>10%</td>
<td>44</td>
<td>57</td>
<td>65</td>
</tr>
<tr>
<td>15%</td>
<td>20</td>
<td>26</td>
<td>29</td>
</tr>
</tbody>
</table>
### Figure 12.5 Sample Questionnaire for Pass-By/Diverted Trip Interview

Name of Development ____________________________________________________________

Location of Surveyor ____________________________________________________________

Date of Survey _________________________________________________________________

#### Sample Survey Instrument

<table>
<thead>
<tr>
<th>TIME</th>
<th>Q1. Where did your trip begin immediately prior to arriving at this site?</th>
<th>Q2. Will you go directly back to your origin from here?</th>
<th>Q3. Would you have driven by this site if you had not stopped here now?</th>
<th>Q4. If No to Q3, how many miles out of your way did you travel to get here?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A. Home</td>
<td>Y. Yes [end survey]</td>
<td>Y. Yes [end survey]</td>
<td>(Description of route is acceptable if miles are not known.)</td>
</tr>
<tr>
<td></td>
<td>B. Work</td>
<td>N. No</td>
<td>N. No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. Other Retail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D. Other (describe)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Figure 12.6 Pass-By and Diverted Trip Survey Summary

Name and Address of Development (Note: ITE will keep identifying information confidential)

Metropolitan Area __________________________

Description of Land Use (shopping center, bank, fast-food restaurant, etc.) __________________________

Land Use Code: __________________________

Survey Date _______________ Day of Week __________

Number of Interviews __________

**Independent Variables:** use same variables as specified in *Trip Generation Manual* for surveyed land use; include other independent variables that can be collected and forecast and that might correlate to pass-by or diverted trip-making.

<table>
<thead>
<tr>
<th>IndependentVariable</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>____________________</td>
<td></td>
</tr>
<tr>
<td>____________________</td>
<td></td>
</tr>
<tr>
<td>____________________</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Survey Period (______ TO ______)</th>
<th>Peak Hour (______ TO ______)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Site Volume - Inbound</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Outbound</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pass-by Trip Percentage</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Diverted Trip Percentage</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Usable Interviews</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Adjacent Street Traffic</strong>a</td>
<td></td>
</tr>
</tbody>
</table>

*aAdjacent street traffic includes all traffic with direct access to the site. If site access is via service roadways, the adjacent streets are those that lead to the service roadways and thus may not be physically contiguous to the site.*
12.8 Interview Survey—Internal Capture

In order to collect sufficient internal capture information at a mixed-use site, the data collection effort should include interviews at as many establishments as possible while obtaining the desired number of interviews per land use during each survey period. Under the best scenario, interviews are conducted at each establishment within the site. If that is not possible, conduct interviews at a representative cross-section within each land use. When using the sampling approach, deploy interviewers to the busiest locations in each land use.

Generally, for a single time period, it is desirable to have at least 50 usable interviews\(^{22}\) per land use (30 minimum). This may not be possible for land uses that are small or are relatively inactive during the survey time period (such as weekday morning retail). One way an interview sample can be expanded is by conducting interviews during the same time periods over multiple days.

Interviews of persons are typically conducted as they leave a single land use or building within the site. Each interview can obtain information on both the trips to and from the surveyed building and to and from the overall mixed-use site. NCHRP 684 provides sample forms that can be used. The interview forms presented earlier in Figures 12.3 and 12.4 could be used. Table 12.4 lists the types of trip type information that should be gathered.

\(^{22}\) Sample sizes of less than 30 are usually avoided to ensure the sample results benefit from the central limit theorem that says the sampling distribution of the means will approach that of a normal distribution even if the population being sampled is not normally distributed.
Table 12.4 Information to Gather in Internal Capture Survey

<table>
<thead>
<tr>
<th>Destination (or Origin) of Trip</th>
<th>Within the mixed-use site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Outside the mixed-use site</td>
</tr>
<tr>
<td>Land use at destination (or at origin)</td>
<td>Office</td>
</tr>
<tr>
<td></td>
<td>Retail</td>
</tr>
<tr>
<td></td>
<td>Restaurant</td>
</tr>
<tr>
<td></td>
<td>Residential</td>
</tr>
<tr>
<td></td>
<td>Medical office</td>
</tr>
<tr>
<td></td>
<td>Cinema/entertainment</td>
</tr>
<tr>
<td></td>
<td>Hotel/motel</td>
</tr>
<tr>
<td></td>
<td>Other (specify)</td>
</tr>
<tr>
<td>Travel mode to destination (or from origin)</td>
<td>Vehicle driver</td>
</tr>
<tr>
<td></td>
<td>Vehicle passenger</td>
</tr>
<tr>
<td></td>
<td>Walk</td>
</tr>
<tr>
<td></td>
<td>Transit</td>
</tr>
<tr>
<td></td>
<td>Bicycle</td>
</tr>
</tbody>
</table>

If the survey will be conducted at the cordon driveway or other type of location, the analyst may need to revise the questions to capture the last (for exit interviews) or first (for inbound interviews) on-site stop. Other modifications may be needed for special locations or applications. The analyst should make sure the questionnaires to be used fit the conditions as well as collect the desired data. In general, use of a survey instrument such as that shown in Figure 12.4 is adaptable to nearly any survey condition and can be automated if desired. Each item is needed for a complete analysis or for checking responses. In addition, some data collection sites may need supplemental questions to firmly and clearly establish the characteristics of the trips being reported.

12.9 Person Trip Data Processing Examples

12.9.1 Isolated Site

The following example demonstrates the data collected, the data processing step, and a typical data summary for an isolated site for which person trip data are collected using observation counts. The example represents a specific survey condition; not all isolated sites can be surveyed as described. The site is an isolated commercial site with a single on-street pedestrian entrance (A) and on-site
parking (P), with a single entrance (see Figure 12.7). Two bus stops (T) serve the site and are located at the intersection next to the building. All parking is on-site. The raw count data are shown in the top half of Table 12.5. The table shows calculation of person trips by mode and direction as well as directional vehicle occupancy.

Figure 12.7 Data Collection Results for Isolated Site Example

![Example A Access Diagram]

Table 12.5 Raw Data and Computations for Isolated Site Example

<table>
<thead>
<tr>
<th>Raw Data from Counton Counts – Survey Period</th>
<th>Driveway Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persons</td>
<td>Dropper</td>
</tr>
<tr>
<td>Column A</td>
<td>B</td>
</tr>
<tr>
<td>Door A</td>
<td>1</td>
</tr>
<tr>
<td>Parking</td>
<td>-</td>
</tr>
</tbody>
</table>

Computation of Person Trips by Mode and Vehicle Occupancy

Columns B through J: direct from columns B through D and F through H

Column V:
Vehicle Driver Enter = Vehicles in (col A × Drop-off (col E) + Pick-up (col F))
Vehicle Driver Exit = Vehicles Out (K × J × Drop-off (col E) + Pick-up (col F))

Column W:
Vehicle Passenger Enter = Total Passengers in Driveway Vehicles × Drop-off (col A)
Vehicle Passenger Exit = Total Passengers in Driveway Vehicles + Pick-up (col E)

where,
Total Passengers Entering in Driveway Vehicles = (1 × col J) + (2 × col K) + (3 × col L)
Total Passengers Entering in Driveway Vehicles - (1 × col J) + (2 × col K) + (3 × col L)
Vehicle Occupancy (col V) = (Drivers (col V) + Passengers (col W)) / (Drivers (col V))

Note: Person trip calculation assumes pick-up/drop-off involves one passenger riding with one driver.

Table 5. Example A Person Trips by Mode

<table>
<thead>
<tr>
<th>Person Trips</th>
<th>Direction</th>
<th>Transit</th>
<th>Bike</th>
<th>Walk</th>
<th>Vehicle Driver</th>
<th>Vehicle Passenger</th>
<th>Total</th>
<th>Vehicle Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column S</td>
<td>T</td>
<td>U</td>
<td>V</td>
<td>W</td>
<td>X</td>
<td>Y</td>
<td>Enter</td>
<td>0</td>
</tr>
<tr>
<td>Exit</td>
<td>6</td>
<td>2</td>
<td>67</td>
<td>498</td>
<td>81</td>
<td>654</td>
<td>1.16</td>
<td></td>
</tr>
</tbody>
</table>
12.9.2 Non-Isolated Site

The following example demonstrates the data collected, the data processing step, and a typical data summary for a non-isolated site that needs interviews but for which some access points can be covered with observation counts.

The objective of the data collection effort is to determine person trip mode shares at a non-isolated commercial site. As illustrated in Figure 12.8, the site has three pedestrian entrances (A, B, C) along two frontages and an underground garage (P) with an entrance in the front. Two bus stops (T) serve the site and are located a block away, out of sight of the data collection site cordon. On-site parking is supplemented by off-site parking with access out of sight of the site.

In order to meet the data collection objectives, the analyst decides to conduct (1) door counts and exit interviews at pedestrian entrances, and (2) vehicle occupancy counts at the on-site garage entrance. The data collection supervisor observes there is very little activity at entrance B and that the directional distribution of users seems to resemble that for entrance A. The data collection supervisor decides to not conduct interviews at entrance B and to assume the entrance A interview results will match those for entrance B.

The raw count and interview results are shown in Table 12.6 along with an explanation for all calculations. The table also shows person trips by mode and vehicle occupancy by direction for the data collection site.

**Figure 12.8 Data Collection Results for Non-Isolated Site Example**
### Table 12.6 Raw Data and Computations for Non-Isolated Site Example

<table>
<thead>
<tr>
<th>Access</th>
<th>In</th>
<th>Out</th>
<th>Auto</th>
<th>Bus</th>
<th>Walk</th>
<th>Total</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk</td>
<td>49</td>
<td>0</td>
<td>12</td>
<td>4</td>
<td>29</td>
<td>49</td>
<td>A</td>
</tr>
<tr>
<td>Bike</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Auto</td>
<td>31</td>
<td>0</td>
<td>12</td>
<td>12</td>
<td>92</td>
<td>114</td>
<td>B</td>
</tr>
<tr>
<td>Auto</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>4</td>
<td>24</td>
<td>31</td>
<td>167</td>
<td>225</td>
<td>A+B</td>
</tr>
<tr>
<td>Factor</td>
<td>1.83</td>
<td>4.51</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.88</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Entrance</th>
<th>In</th>
<th>Out</th>
<th>Auto</th>
<th>Bus</th>
<th>Walk</th>
<th>Total</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk</td>
<td>39</td>
<td>0</td>
<td>12</td>
<td>4</td>
<td>92</td>
<td>123</td>
<td>C</td>
</tr>
<tr>
<td>Bike</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Auto</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>4</td>
<td>24</td>
<td>31</td>
<td>167</td>
<td>216</td>
<td>C</td>
</tr>
<tr>
<td>Factor</td>
<td>4.88</td>
<td>1.60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6.48</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary Mode</th>
<th>Auto</th>
<th>Bus</th>
<th>Walk</th>
<th>Total</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver</td>
<td>31</td>
<td>12</td>
<td>92</td>
<td>105</td>
<td>A</td>
</tr>
<tr>
<td>Driver</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Total Driver</td>
<td>31</td>
<td>12</td>
<td>92</td>
<td>105</td>
<td>4.88</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Person Trips</th>
<th>Auto</th>
<th>Bus</th>
<th>Walk</th>
<th>Total</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access</td>
<td>570</td>
<td>418</td>
<td>73</td>
<td>621</td>
<td>4.88</td>
</tr>
<tr>
<td>Entrance</td>
<td>271</td>
<td>281</td>
<td>57</td>
<td>519</td>
<td>4.88</td>
</tr>
</tbody>
</table>

*Includes all trips by auto, see text.*
<table>
<thead>
<tr>
<th>Computations and Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rows for access points A, B, C, and P show summarized raw data from counts and interviews. Computations will be needed to accomplish the following:</td>
</tr>
<tr>
<td>1. Combine door counts and interviews for Entrances A and B per supervisor’s plan.</td>
</tr>
<tr>
<td>2. Compute interview expansion factors using ratios of door counts to completed interviews for both inbound and outbound directions so interview data will cover all persons who entered or exited the site on foot. Expand the interview data for each entrance to represent the total volumes in and out.</td>
</tr>
<tr>
<td>3. Total interview data.</td>
</tr>
<tr>
<td>4. Since the questionnaire did not ask people traveling by auto and using off-site parking or being picked up or dropped off if they were a driver or a passenger (survey oversight), the supervisor decided to assume that visitors using the off-site garage have the same vehicle occupancy as users of the on-site garage. Auto users needs to be split into drivers and passengers.</td>
</tr>
<tr>
<td>5. Total person trips by mode and direction from the on-site garage cordon count and the pedestrian entrance interviews.</td>
</tr>
<tr>
<td>6. Compute the directional vehicle occupancies (combined).</td>
</tr>
</tbody>
</table>
Computation descriptions:

1. Combine door counts and interviews for Entrances A and B per supervisor’s plan. Add door counts in rows A and B to get 153 in and 167 out. Corresponding exit interviews for door A are 29 in and 37 out.

2. Compute interview expansion factors using ratios of door counts to completed interviews for both inbound and outbound directions so interview data will cover all persons who entered or exited the site on foot. Inbound and outbound interview expansion factors are ratio of door counts to completed interviews, or

   Expansion Factor in = Door Count in/Completed Interviews in = 153/29 = 1.83

   Similarly, Expansion Factor out = 167/37 = 4.51

   Multiply the inbound interview data in row A by 1.83 to get expanded data for doors A and B combined.

   Multiply the outbound interview data in row A by 4.52 to get expanded data for doors A and B combined.

   The results are shown in the row labeled A+B Factored.

   Repeat the factoring process for door C. The expansion factors are shown in row C and factored interview results are shown in the row labeled C Factored.

3. Total interview data. Add the two newly created factored rows. The results are in the row labeled Sum of Entrances Factored.

4. Since the questionnaire did not ask people traveling by auto and using off-site parking or being picked up or dropped off if they were a driver or a passenger (survey oversight), the supervisor decided to assume that visitors using the off-site garage have the same vehicle occupancy as users of the on-site garage. Auto user needs to be split between drivers and passengers. Divide inbound and outbound auto users in the row labeled Sum of Entrances Factored by the respective inbound and outbound vehicle occupancies for the on-site garage (see Example A) to get auto drivers. For example,

   Auto Drivers in = Auto (total) in/Vehicle Occupancy in = 49/1.52 = 32

   Corresponding Auto Passengers = Auto (total)—Auto Drivers.

5. Total person trips by mode and direction from the on-site garage cordon count and the pedestrian entrance interviews. This combines the factored data with the on-site garage cordon count data in row P. The row P data is processed the same way as it was in Example A. Auto drivers and auto passengers from row P are added to the factored data. The result is shown in the row labeled Total Person Trips.

6. Compute the directional vehicle occupancies (combined).

   Vehicle Occupancy In = [Veh Drivers In (col 3) + Veh Passgrs In (col 4)]/Veh Drivers In = (156+82)/156 = 1.53

   Outbound vehicle occupancy is calculated using data in rows 9 and 10. Veh Occ out = (588+92)/588 = 1.16
12.10 Truck Trip Data Collection

If an objective is to determine truck trips generated at a data collection site, the analyst should attempt to separate truck trips into trip purposes. Trip generation relationships to site-specific independent variables are different for (1) a truck that comes to the site to deliver cargo, (2) a truck that leaves the site after picking up cargo, and (3) a truck that visits the site (such as a service truck). In some cases, the truck trip delivers cargo as part of a chain of intermediate trips (for example, to deliver produce to a series of grocery stores). In some cases, the truck trip for a specific trip purpose also produces a “backhaul” (in other words, the truck delivering cargo to a site leaves the site empty). If it is not possible to determine truck trip purpose through simple observation, the use of a survey is likely needed.

Table 12.7 presents a sample list of information that could be useful in (1) the estimation of site-generated truck trips by trip purpose, and (2) the identification of potential independent variables with direct relationship to truck trip volumes. Questions should be asked and answers recorded with a level of rigor that allows for more probing at any point in the interview (taken as notes on the survey instrument).
### Table 12.7 Questionnaire Elements for Truck Data Collection Survey

<table>
<thead>
<tr>
<th>Topic</th>
<th>Interviewer Instructions/Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Description</td>
<td>Primary business activity(ies)—to be converted into single industry sector designation for commodities using the 43 categories available in the Standard Classification of Transported Goods. Note other activities that generate freight.</td>
</tr>
<tr>
<td>Number of Employees</td>
<td>Current number of full-time and part-time employees at the site. If response is only available for multiple locations in the region, note this aggregation and record other data elements as aggregates.</td>
</tr>
<tr>
<td>Shipments by Mode</td>
<td>How the site receives and ships most of its goods—clearly indicating if the goods are being received (inbound) or being shipped (outbound).</td>
</tr>
<tr>
<td>Deliveries Received by Mode</td>
<td>Average number of deliveries received weekly. If interviewee can only provide monthly or annual numbers, convert these figures to weekly data in post-processing procedures.</td>
</tr>
<tr>
<td>Shipments Generated by Mode</td>
<td>Average number of shipments generated weekly. If interviewee can only provide monthly or annual numbers, convert these figures to weekly data in post-processing procedures.</td>
</tr>
<tr>
<td>Size of Shipment</td>
<td>For each mode used for inbound and outbound activities and whether most of these shipments are “less than full load” or “full load.” For containers, indicate size of container (such as 20 ft. or 40 ft.).</td>
</tr>
<tr>
<td>Weight of Shipment</td>
<td>Normal weight of a full shipment (not including vehicle weight) inbound and/or outbound by all modes. Containers assumed as truck trip, but indicated separately as container on truck.</td>
</tr>
<tr>
<td>Size of Facility</td>
<td>Size in square feet under roof. Indicate outdoor space used as separate information.</td>
</tr>
<tr>
<td>Annual Volume of Shipments</td>
<td>Total number of shipments inbound/outbound for most recent year.</td>
</tr>
</tbody>
</table>


NCFRP Report 11, *Truck Drayage Productivity Guide*, provides a variety of methods for collecting data related to truck activities at a port, including the use of webcam data collection. With proper placement and viewing angle of the camera, it is possible to capture a number of important variables for understanding the operating conditions at a port (for example, the gate processing time of each truck). In addition, the data can provide high quality data on the number of trucks moving through a site. Future consideration should be given to “harvesting” webcam truck count data from specific sites, either in conjunction with establishment surveys, or in some cases where it is easy to understand the truck trip purposes (for example, all the trucks are entering the site with containers of distribution center cargo and leaving empty).
12.11 Data Submittal to ITE

A brief report that presents the site-specific information and the data collection results should be submitted to ITE. At a minimum, include the following information:

- Name, address, and location (city, state/province, metropolitan area) of development (note: ITE will keep the identity of the site confidential);
- Land use type (such as shopping center, bank, or fast-food restaurant), especially if it varies from the existing ITE land use code description;
- ITE Land Use Code;
- Survey date and day of the week;
- Time period during which the data collection took place;
- Number of complete and usable interviews conducted (if interviews conducted);
- Volume of traffic on adjacent streets that have full or partial access to the site (hourly volume during data collection period);
- Size of the development measured in the same independent variable units presented in Trip Generation Manual; and
- Size of the development in terms of other independent variables that could be collected and forecast and that might correlate to trip-making.

Data will be accepted and sources cited in subsequent editions of Trip Generation Manual. The identity of specific sites will be kept confidential. Data should be transmitted to

Institute of Transportation Engineers
Trip Generation Data
1627 Eye Street, NW, Suite 600
Washington, DC 20006 USA
Telephone: +1 202-785-0060
Fax: +1 202-785-0609
Appendix A. Glossary

The definitions presented in this glossary are intended specifically for use in *Trip Generation Handbook*. The glossary terms are grouped as follows:
- Trip Types and Trip Modes;
- Area Types;
- Time Periods;
- Independent Variables;
- Data Page Terms; and
- Other Terms.

Trip Types and Trip Modes

**Baseline Vehicle Trips**—vehicle trips estimated with the aid of *Trip Generation Handbook* methodologies to represent the estimated vehicle trips at baseline sites. These baseline trips are converted to baseline person trips and then adjusted using study site vehicle occupancy and mode share assumptions in order to estimate vehicle trip generation at a multimodal study site.

**Bicycle Trip**—an inbound or outbound person trip where the greatest distance between the trip origin and trip destination is traveled by a bicycle. Bicyclists include all people traveling on pedal-powered vehicles.

**Diverted Trip**—a vehicle trip made as an intermediate stop while traveling from an origin to a primary destination with a route diversion from a primary route to another roadway to gain access to the site. A diverted trip is attracted from the traffic volume on roadways within the vicinity of the generator but without direct access to the site. A diverted trip requires a diversion from a roadway not adjacent to the site to another roadway to gain direct access to the site. A diverted trip adds traffic to streets adjacent to a site and could remove a trip on streets from which it diverted. For an illustration of a diverted trip, refer to Figure 10.1 in Chapter 10.

**Inbound Trip**—a trip that enters a site.

**Internal Capture Trip**—a person trip made between two distinct on-site land-uses at a mixed-use site without using an off-site road system. Internal trips can be made by personal passenger vehicle, truck, walking, bicycling, or transit.

**Motorized Trip**—a person trip that is part of either a vehicle trip or transit trip. A **non-motorized** trip is a person trip that is part of either a walk trip or bicycle trip.

**Non-Motorized Trip** ([see Motorized Trip](#))

**Non-Pass-By Trip** ([see Pass-By Trip](#))

**Outbound Trip**—a trip that exits a site.
Pass-By Trip—a vehicle trip made as an intermediate stop on the way from an origin to a primary trip destination without a route diversion. Pass-by trips are attracted from traffic passing the site on an adjacent street or roadway that offers direct access to the generator. Pass-by trips are not diverted from another roadway not adjacent to the site. For an illustration of a pass-by trip, refer to Figure 10.1 in Chapter 10. A non-pass-by trip is simply any vehicle trip generated by a site that is not a pass-by trip. This term is sometimes used when diverted trips are not tabulated separately from primary trips in the data collection process or are not evaluated separately in the analysis process.

Person Trip—a trip made by any mode of travel by an individual person from an origin to a destination. Every trip made anywhere by a person is a person trip. If three people leave a development site in a single vehicle, this is counted as three person trips.

Primary Trip—for the purposes of trip generation, a vehicle trip made for the specific purpose of visiting the generator. The stop at the generator is the main reason for the trip; it is not a stop on the way to another destination. For an illustration of a primary trip, refer to Figure 10.1 in Chapter 10. Home-to-work-to-home, work-to-restaurant (for lunch)-to-work, and home-to-shopping-to-home are all examples of pairs of primary trips. If an intermediate stop is made along the way, the trip is instead a pass-by trip or a diverted trip.

Transit Trip—an inbound or outbound person trip that crosses the site cordon line in a transit vehicle or where the greatest distance between the trip origin and trip destination is traveled by transit vehicle. Transit includes the following modes: bus, heavy rail (metro, subway, rapid transit), light rail (streetcar, tramway, trolley), commuter rail (regional rail), monorail, ferry boat, trolleybus, cable car, automated guideway transit (personal rapid transit), aerial tramway, and inclined plane. For the purposes of this Handbook, the following modes are classified as personal passenger vehicle and not transit: taxi, paratransit, and vanpool (including airport shuttles).

Trip or Trip End—a single or one-direction person or vehicle movement with either the origin or the destination (exiting or entering) inside a study site. In technical terms, a trip has an origin and a destination at its respective ends (known as trip ends). Each trip end is a part of a trip. For site trip generation, the analyst is usually interested in trips entering (inbound) and exiting (outbound) a single site. An entering trip end is a destination trip end; an exiting trip end is an origin trip end. Common usage throughout this Handbook is to refer to the inbound and outbound trip ends as trips because they are the site’s portion of those trips.

Vehicle Trip—an inbound or outbound person trip that crosses the site cordon line in a personal passenger vehicle or truck, or that crosses the site cordon line as a pedestrian to or from a personal passenger vehicle or truck. If, for example, a person drives a personal passenger vehicle from home, parks off-site, and walks from the parking facility to an office building, the trip (at both ends) is considered a vehicle trip.

Walk Trip—an inbound or outbound person trip where the greatest distance between the trip origin and trip destination is traveled on foot or on any type of assistive device (including wheelchair, walker, skates, or skateboard). For the purpose of trip generation, due to its speed of travel, a Segway person trip is also considered a walk trip for the mode share definition.
Area Types

**Activity Center**—large multi-use center within a major metropolitan area (greater than 500,000 population) surrounded by lower density (usually suburban) development. Contains a mix of uses including major amounts of office and retail, along with hotel, residential, and, often, entertainment and other commercial uses. Activity centers typically have more jobs than residents. An activity center within a highly commercial or multi-use area should be considered part of an urban core.

**Central Business District (CBD)**—the *regional CBD* is the downtown area for the core city of the metropolitan region. It is the largest CBD within its region and typically includes shared and priced parking both on-street and in structured garages or surface lots, an extensive pedestrian sidewalk network, multi-storied buildings, and a wide range of land uses including a government center. The regional CBD also is typically the focal point of a regional transit system. An *outlying CBD* is any community CBD that is not the largest in its region. It typically includes a government center but may or may not have a transit hub.

**General Suburban**—low density and almost fully residential except for commercial that usually occurs at major intersections, schools, and other occasional isolated uses.

**General Urban**—fully developed (or nearly so) at low-medium density with a mix of residential and commercial uses within most quarter-mile squares. May also include major non-residential uses such as industrial, institutional, or educational.

**Rural**—agricultural or undeveloped except for scattered parcels and at very low densities.

**Rural (Town) Business District**—business district of a town or small city not part of a metropolitan area of 50,000 population or more.

**Special District**—major concentration of development other than residential, commercial, or schools (K–12). These include office and industrial parks, government centers, colleges and universities, medical centers, stadium/arena complexes, recreation/entertainment districts, and other special purpose concentrations of development.

**Suburban Business District**—commercial district (not just strip commercial, or general suburban) larger than intersection commercial concentrations in a low-density, almost entirely residential area. Should include at least six complete commercial blocks. Most buildings are located behind or surrounded by parking. May have been the business district of a formerly rural but now urbanized and surrounded community.

**Suburban Strip Commercial**—segment of a street continuously lined for at least three contiguous block faces with commercial development intended to be accessed directly by motor vehicle. Buildings generally located behind or surrounded by parking.

**Urban Core**—area just outside CBD or other medium-high density multi-use area; could also be called “midtown.” Buildings normally have little or no setback from sidewalk. A city with no defined CBD may have an urban core; if it has a CBD, to also have an urban core for trip generation purposes, the metropolitan area should have a population greater than 100,000.
Time Periods

Saturday, Peak Hour of the Generator—the hour with the highest volume of traffic entering and exiting a site on a Saturday. It may occur in either the AM or PM.

Saturday, Midday Peak Hour of Adjacent Street Traffic—the one hour between 11:00 a.m. and 1:00 p.m. when the combination of site-generated traffic and the traffic on the adjacent street is the highest on a Saturday.

Sunday, Peak Hour of the Generator—the hour with the highest volume of traffic entering and exiting a site on a Sunday. It may occur in either the AM or PM.

Weekday—a continuous 24-hour period during Monday through Thursday. The period can bridge two days.

Weekday, Peak Hour of Adjacent Street Traffic—the one hour within the morning and evening commuter peak periods when the combination of site-generated traffic and the traffic on the adjacent street is the highest on a weekday (typically from data collected Monday through Thursday). If the adjacent street traffic volumes are unknown, the peak hour of the adjacent street is assumed to be the one hour when the highest hourly vehicle trips are generated by the site during the commuting peak periods between 7:00 and 9:00 a.m. or 4:00 and 6:00 p.m. Recent studies have indicated that these peak periods have expanded in some heavily populated areas.

Weekday, Peak Hour of the Generator—the hour of highest volume of traffic entering and exiting the site during the AM or PM on a weekday (typically from data collected Monday through Thursday. It may or may not coincide with the peak hour of the adjacent street traffic.

Independent Variables

Acre—a unit of measurement equal to 43,560 sq. ft. and for the purpose of Trip Generation Manual used to quantify the total gross area of a development site (including land dedicated to public agencies). The distinction between total acres and total developed acres is not always clearly defined in the site acreage reported to ITE. Therefore, caution should be used with this variable. When submitting data, the analyst should indicate the percentage of developed acreage to the total acreage of the property.

AM/PM Peak Hour Traffic on Adjacent Street—the highest hourly volumes of traffic on the adjacent streets during the AM and PM commuter peak periods, respectively (see Peak Hour of Adjacent Street Traffic under Time Periods). The value includes all traffic on streets abutting the site that have direct access to the development site. Where the site is serviced by some form of service roadway, the adjacent street definition includes any street that leads to the service road and thus may not actually be contiguous to the site. Traffic on travel lanes where road features physically restrict direct access to the development site is excluded.

Attendee—a person who is present on a given occasion, during a given event or at a given place. The variable is currently used for three recreation land uses (452, 453, and 454) but could apply to more land use codes.
Average Flights per Day—the sum of all arriving and departing flights (counted separately) normally and repeatedly on a typical day at an airport.

Based Aircraft—an aircraft registered to the particular airport.

Batting Cage—a designated location available for the purpose of a single person hitting baseballs within a contained area.

Bed—a designated place to sleep for a group quarters resident. Occupied beds are the beds for which there is an assigned person on the data collection date. In Trip Generation Manual, the terms are used for Land Use Codes (LUCs) 254 (Assisted Living), 571 (Prison), 610 (Hospital), and 620 (Nursing Home). The terms could also be used for other types of group quarters facilities.

Berth—a designated place where a boat can anchor at a marina or wharf. Truck Berth is a similar term with a different definition.

Bowling Lanes—the total number of lanes within one facility available for the purposes of bowling.

Commercial Flights per Day—the typical total number of arriving and departing commercial airline flights (primarily passenger) occurring at an airport. This measure does not normally include commercial air freight flights.

Court—an indoor or outdoor facility specifically designed for playing a racquet sport such as squash, tennis, or racquetball. The term “court” could apply to additional sports (such as basketball); however, the only current use of the variable is in Land Use Code 491 (Racquet/Tennis Club) in which courts are used solely for racquet sports. Tennis Court is a similar term.

Drive-In Lane—each individual lane at a banking facility used for financial transactions. Automated Teller Machine (ATM)-only lanes are included.

Drive-Through Lane—each individual lane at a fast-food, dry cleaning, pharmacy, or other establishment where the customers are served in their vehicles from a window or door in the building. Customers order and receive product at one or more points in the lane. An establishment may have one or more lanes and one or more pick-up points in each lane.

Dwelling Unit—a residential location such as a house, apartment, condominium, townhouse, mobile home, or manufactured home in which people may live. An occupied dwelling unit is one in which people are currently living and is, therefore, not vacant.

Employee—a full-time, part-time, or per diem/contract worker. The number of employees refers to the total number of persons employed at a facility, not just those in attendance at the particular hour or day the data are collected.

Family Members—the total number of family members who are considered members of a specific worship facility. The only land use with trip generation data currently using this independent variable is 561 (Synagogue). Member is a similar term.

Fields—any area constructed, equipped, and/or marked for outdoor activities and sports.
Full-Time Doctors—the total number of doctors who work full time at a particular facility. The term is currently used for Land Use Code 630 (Clinic).

Gross Floor Area (GFA)\(^1\)—the sum of the area of each floor level of a building (expressed in square feet), including cellars, basements, mezzanines, penthouses, corridors, lobbies, stores, and offices, that are within the principal outside faces of exterior walls, not including architectural setbacks or projections. Included are all areas that have floor surfaces with clear standing head room (6 ft. 6 in. minimum) regardless of their use. With the exception of buildings containing enclosed malls or atriums, GFA is equal to gross leasable area and gross rentable area. Occupied gross floor area refers to GFA within the facility which is currently being utilized. If a ground-level area, or part thereof, within the principal outside faces of the exterior walls is not enclosed, this floor area is considered part of the overall GFA of the building. However, unroofed areas and unenclosed roofed-over spaces, except those contained within the principal outside faces of exterior walls, should be excluded from the area calculations. For the purpose of trip generation calculation, the floor area of all parking garages within the building should not be included in the GFA of the entire building. The majority of land uses in Trip Generation Manual use GFA as an independent variable.

Gross Leasable Area (GLA)\(^2\)—the total floor area designed for tenant occupancy and exclusive use, including any basements, mezzanines, or upper floors, expressed in square feet and measured from the centerline of joint partitions and from outside wall faces. For the purpose of trip generation calculation, the floor area of all parking garages within the building should not be included within the GLA of the entire building. GLA is the area for which tenants pay rent; it is the area that produces income for the property owner. Occupied gross leasable area refers to GLA within the facility which is currently in use. Leased space that is not in productive use is not considered occupied. In the retail business, GLA lends itself readily to measurement and comparison and it has been adopted by the shopping center industry as its standard for statistical comparison. Accordingly, GLA is used in Trip Generation Manual for shopping centers. For specialty retail centers, strip centers, discount stores and freestanding retail facilities, GLA usually equals GFA.

Lift—any automated device with chairs or seats used to gain access to the top of ski run in a skiing area.

Loading Bay—a door or location along the side of a commercial facility where a large truck can be backed with a trailer for loading or unloading.

Member—an individual who belongs to a group or organization. The term is currently used as an independent variable for Land Use Codes 493 (Athletic Club), 495 (Recreational Community Center), and 591 (Lodge/Fraternal Organization). Family Members is a similar term.

Net Rentable Area—the sum of floor square footage for all storage units in a self-storage facility. The term is currently used only for Land Use Code 151 (Mini-Warehouse).

Occupied Beds (see Bed)

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\(^1\) Adapted from Institute of Real Estate Management of the National Association of Realtors. *Income/Expert Analysis, Office Buildings, Downtown and Suburban*, 2013.

Occupied Dwelling Unit (see Dwelling Unit)

Occupied Gross Floor Area (see Gross Floor Area)

Occupied Gross Leasable Area (see Gross Leasable Area)

Occupied Room (see Room)

Occupied Space (see Parking Space)

Occupied Storage Unit (see Storage Unit)

Occupied Unit (see Unit)

Parking Space—an individual stall within a parking lot or garage designated for the use of a parked private motor vehicle. An occupied space is a parking space in which a vehicle is parked.

PM Peak Hour Traffic on Adjacent Street (see AM/PM Peak Hour Traffic on Adjacent Street)

Room—as used in the Lodging Land Use Codes (300 through 399), the partitioned part of the inside of a building used for lodging such as a hotel or motel. An occupied room is a room that is rented by a lodging guest.

Service Bay and Service Stall—the location within an automobile servicing facility, building, or care center where a vehicle can be parked to be inspected and/or repaired.

Servicing Position—a location within a quick-lubrication vehicle shop or other vehicle repair shop at which a vehicle can be serviced. For example, if a quick-lubrication vehicle shop has one service bay that can service two vehicles at the same time, the number of servicing positions is two.

Storage Unit—a vault rented for the storage of goods in what is typically referred to as a self-storage facility. An occupied storage unit is one that is rented. Unit is a similar term with a different definition.

Student—a person enrolled in an institution such as a school, college, or day care center on either a full-time or part-time basis. The number of students refers to the total number of persons enrolled at a facility, not full-time equivalent (FTE) and not just those present at the time the study is conducted.

Tee, Driving Position—a designated position from which a golf ball is struck for practice.

Tennis Court—an indoor or outdoor facility specifically designed for an individual tennis match (see Court).

Truck Berth—a space for a truck at rest (for loading or unloading). The term is currently used for only Land Use Code 030 (Intermodal Truck Terminal) but could have application for additional Port and Terminal or Industrial Land Use Codes. Berth is a similar term with a different definition.

Unit—a group of rooms intended for dwelling within Land Use Code 255 (Continuing Care Retirement Community). An occupied unit is a unit for which a person is assigned. Storage Unit is a similar term with a different definition.
Vehicle—as used as an independent variable for residential Land Use Codes 210 through 240, any automobile, van, SUV, motorcycle, or light truck parked overnight within a residential area. For Land Use Code 501 (Military Base), the definition of vehicle is any vehicle authorized to enter the facility. See vehicle in Other Terms.

Vehicle Fueling Positions—the number of vehicles that can be fueled simultaneously at a service station. For example, if a service station has two fuel dispensing pumps with hoses on each side of each pump, where only one vehicle can be fueled at a time on each side, the number of vehicle fueling positions is four.

Wash Stall—a location within either a self-service or automated car wash where a vehicle can be parked to be washed.

Data Page Terms

Actual Data Point—a data point plotted on the graph based on a study performed for the specific land use code.

Average Number of [Independent Variable]—the average value of the Independent Variable for data presented on the specific data page.

Average Rate (or Weighted Average Rate or Average Trip Rate)—the weighted average number of trips entering or exiting a development site per one unit of the independent variable. It is calculated by dividing the sum of all trips for all contributing data point sites by the sum of all independent variable units for all contributing data point sites. Calculation of weighted average rate is demonstrated in Appendix J. The weighted average rate is used rather than the average of the individual rates because of the variance within each data set or generating unit. Data sets with a large variance will over-influence the average rate if they are not weighted. The data plot includes a dashed line corresponding to the weighted average rate, extending between the lowest and highest independent variable values for data points.

Average Vehicle Trip Ends, T—vehicle trips, the dependent variable in the data plot; shown on the y-axis.

Coefficient of Determination ($R^2$)—the percent of the variance in the number of trips associated with the variance in the independent variable value. If the $R^2$ value is 0.75, then 75 percent of the variance in the number of trips is accounted for by the variance in the size of the independent variable. As the $R^2$ value approaches 1.0 the better the fit; as the $R^2$ value approaches zero, the worse the fit.

Directional Distribution—the percent of total trips entering and exiting a site during the indicated time period.

Fitted Curve and Fitted Curve Equation—the single-variable regression analysis of the independent and dependent variable expressed in an optimal mathematical relationship. If the variables are related linearly the equation has the following format: $T = aX + b$. In a logarithmic relationship, the equation has the following format: $\ln(T) = a \ln(X) + b$. The data plot includes a
solid line corresponding to the equation, extending between the lowest and highest independent variable values for data points.

**Independent Variable, X**—a physical, measurable, and predictable characteristic which describes the study site or baseline site (for example, gross floor area) and which has a direct relationship to the variation in the number of trips generated by a land use. The term “explanatory variable” is also used.

**Number of Studies**—the total number of studies reported on the specific data page.

**Range of Rates**—the minimum and maximum trip generation rates from all the studies reported.

**Standard Deviation**—a measure of data dispersion relative to the calculated average. The lower the standard deviation, the less data dispersion there is in the data and the better the data fit to the average rate. In *Trip Generation Manual*, the reported standard deviation is based on the weighted average, not the mean.

**Other Terms**

**Adjacent Street Traffic**—the sum of all traffic on streets abutting the site that has direct access to the development site. Where the site is serviced by some form of service roadway, the adjacent street definition includes any street that leads to the service road and thus may not actually be contiguous to the site. Traffic on travel lanes where road features physically restrict direct access to the development site is excluded.

**Alighting**—the act of exiting a transit vehicle. The term is used for describing the number of such actions (for example, “17 alightings at this stop”).

**Baseline Site**—a low-density, single-use development located in a suburban or other outlying area, with an auto-oriented environment with little or no transit service, bicycle activity, or pedestrian facilities beyond minimal sidewalks.

**Boarding**—the act of entering a transit vehicle. The term is used for describing the number of such actions (for example, “12 boardings at this stop”).

**Complementary Land Uses**—land uses that generate activities that interact with each other, such as residential and shopping or office and restaurant. An example of a non-complementary pair of land uses is residential and junkyard.

**Convenient Frequent Transit**—transit service to a rail station within one-half mile, and/or bus rapid transit (BRT) station or bus stop on the same or adjacent block, providing a peak headway for four to six hours each weekday typically ranging 20 minutes or less.

**Cordon Count**—the number of people or vehicles crossing a real or imaginary boundary around a designated site or specific area. For trip generation purposes for a development site, a cordon line is usually drawn to include the entire development.

**Counter, Machine**—any piece of equipment (mechanical, electronic, video) used to count people and/or vehicles entering and/or leaving a site or utilizing a traffic lane.
Counter, Manual—data collection personnel who count people or vehicles entering and exiting a development site or doing a specified movement of interest. Also called counting personnel.

Directional Count—count tallied by direction (for examples, left and right, north and south, or enter and exit). A non-directional count combines the count of vehicles or persons into a single non-directional value.

Door Count—a count of people entering and exiting a building through a specific door or access point.

Expansion Factor—a factor used to expand a sample of a whole so it will approximately and statistically represent the whole. For example, the expansion factor for a random sample of 20 cars from a total of 100 cars is 100/20, or 5.0.

Floor-to-Area Ratio (FAR)—a measure of the intensity of the use of a piece of property, determined by dividing the sum of the gross floor area of all floors of all principal buildings or structures by the total area of the parcel. Parking structures are not included in the gross floor area for the FAR calculation.

Infill Development—a development site located in a fully developed urbanized area, often with different interactive land uses and with good pedestrian and vehicular connectivity, and served by convenient/frequent transit and/or designated bicycle facilities.

Intercept Interview—an interview for which an interviewer approaches a person entering or (usually) exiting a building and requests the person to answer a limited number of questions.

Internal Capture Rate—the percentage of total trips that are made entirely within a site (in other words, the trip origin, destination and travel path are all entirely within the site); usually used in conjunction with mixed-use development. Internal capture rates are not applicable for trips within the same land use (for example, a trip made within an office building).

Isolated Site—a development site at which data collection personnel can determine accurately, through observation only, the primary mode of travel for each person arriving or departing the site. A non-isolated site relies on parking or transit that is at least partially off-site and not fully visible by data collection personnel located on the site boundary or other data collection cordon line.

Land Use Category—one of the 10 groupings of land use codes in the Trip Generation Manual data volumes: Port and Terminal (000), Industrial (100), Residential (200), Lodging (300), Recreational (400), Institutional (500), Medical (600), Office (700), Retail (800), and Services (900).

Land Use Code (LUC)—a specific land use classification number for a land use as described and numbered in Trip Generation Manual.

Metropolitan Travel Survey—a survey that samples travel by people in households, work places, high-activity unique locations, and commercial vehicles and is used, together with demographic and other metropolitan data, as a basis for describing area travel characteristics.

Mixed-Use Development—an integrated development (usually master planned) consisting of at least two complementary and interactive land uses designed to foster synergy among activities
generated by the land uses. Some trips are between on-site land uses and do not travel on off-site streets. A mixed-use development may also be referred to as a **multi-use development**.

**Mode Share**—the percentages of trips using each travel mode.

**Multimodal Site**—a development site where walking, bicycling, or transit is a viable mode of transportation. A mixed-use development, a site in an infill setting, or a site with significant transit service is considered multimodal.

**Non-Isolated Site** (see **Isolated Site**)

**Off-Site**—located outside and usually not immediately adjacent to the property where a development is located. The term is used in this *Handbook* to describe nearby land uses, parking facilities, transit service, and bicycle facilities.

**Personal Passenger Vehicle**—includes (1) any automobile, van, SUV, motorcycle, moped, or light truck driven by a private individual for personal use; (2) taxi, paratransit, or vanpool (including airport shuttle); and (3) pick-up truck not obviously being used for commercial purposes.

**Primary Mode of Travel**—the mode of travel by which the greatest distance or time of the trip is made. Chapter 12, Data Collection describes in detail how to establish the primary mode for a trip that involves more than one travel mode.

**Proxy Site**—a development site with the same land use characteristics, similar size (in terms of the independent variable), and comparable setting (area type, density, compactness or land coverage, parking availability, access to land use diversity, transit service or availability, or apparent vitality) as the study site.

**Shared Parking**—a mutually accessible supply of parking that is used by parkers from two or more buildings or land uses.

**Study Site**—the development site for which the analyst needs to estimate person or vehicle trip generation. **Analysis site** is also used.

**Transit-Friendly Development (TFD)**—any development that is directly connected, immediately adjacent to, or directly oriented toward a rail station or stop (including heavy rail, light rail, streetcar, and commuter rail) or a multi-route bus transit center with high-frequency service. **Transit-oriented development (TOD)** is a common term used to describe a TFD. However, TOD is not used in this *Handbook* because it often has a specific, local definition with legal implications. TFD is intended to correspond to a generic site with general attributes.

**Transportation Demand Management (TDM) Program**—a program of strategies that aims to reduce vehicle trips by shifting trips to modes other than driving a personal passenger vehicle, by increasing vehicle occupancy, encouraging transit use, or causing trips to be made at off-peak times or not made.

**Transportation Impact Analysis** (also called **Traffic Impact Analysis** or **Transportation** or **Traffic Impact Study**)—a study that assesses the potential effects of traffic generated by a proposed development on the transportation system in a study area.
**Vehicle**—any motorized conveyance legal for street use (includes personal passenger vehicles, trucks, and transit vehicles).

**Vehicle Occupancy**—the number of occupants in a vehicle, including the driver. When applied to a number of vehicles, it is the total occupants in those vehicles divided by the number of vehicles.
Appendix B. Person Trip Data For Baseline Sites

Baseline Mode Shares

Trip Generation Manual contains no data on mode shares for baseline site trip generation. For this Handbook, a limited amount of weekday peak period (7:00–9:00 a.m., 4:00–6:00 p.m.) site trip generation mode share data were collected for baseline sites to provide a general starting point for baseline mode shares for the most common land use types. Baseline data were collected at apartments, motels, offices, shopping centers, restaurants, a bank, and a bowling alley. The land use types were selected so the data would be transferrable to similar land uses (for example, residential apartment mode shares should be applicable to all suburban baseline apartment classifications). Tables B.1 and B.2 show the available weekday AM and PM peak period average mode shares and ranges for the baseline sites at which data were collected.

There are not enough samples to derive precise percentages by mode for the land use codes for which data were collected. However, for all but one direction during one peak period for one land use category, the motor vehicle percentage (personal passenger vehicle plus truck) of total person trips is at least 96 percent. Nearly half of the land use category averages in the tables are 100 percent motor vehicle. Based on the limited data shown, the following conclusions appear reasonable:

- The percentage mode share of person trips made by motor vehicle for baseline sites appears to be 96 percent or more. Where sample sizes exceed 100 observations, almost all the individual sites have motor vehicle shares of 96 percent or more.
- Almost all non-vehicle trips are by walking (rather than transit or bicycle).
- From the limited number of samples with more than 100 observations, it appears that there may be only very small directional differences in motor vehicle share percentages for some land uses. Smaller samples contain larger variations that could be the result of data noise from the smaller samples. More data are needed to fully understand the directional differences.
- Motor vehicle percentages are only available in this data set for a few land uses. The findings may or may not be transferrable to other land uses based on limited alternative opportunities. However, it may be reasonable to assume similar results for land uses within the same land use category (such as residential, lodging, or general retail).
- If the analyst assumes a baseline mode share of 96 percent motor vehicles, it means the ITE vehicle trip generation rates/equations represent 96 percent of the total person trips. The other 4 percent would be walk, bicycle, or transit trips.

Baseline Vehicle Occupancy

Trip Generation Manual contains limited vehicle occupancy data for some land use classifications. Table B.3 summarizes the vehicle occupancy data. All data are for baseline sites. Many of the most commonly analyzed land use codes are not included in this table.

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3 Inbound trips during the AM peak period at three motels were an average 94 percent motor vehicle.
The limited baseline site weekday peak period (7:00–9:00 a.m., 4:00–6:00 p.m.) data collection conducted for this Handbook also includes vehicle occupancy. These data were collected to provide a general starting point for baseline vehicle occupancy for the most common land use types. Tables B.1 and B.2 show the available average vehicle occupancy values for the counted baseline sites.

For land uses for which there are sample sizes of more than 100 observations, vehicle occupancy is fairly consistent for a given land use. For those few land uses, inbound and outbound vehicle occupancy is similar. However, there are differences in vehicle occupancy by land use. Likewise, there could be some land uses for which directional peak period vehicle occupancy might logically differ, such as office. That remains to be determined through more data collection.

Vehicle occupancy values shown in Tables B.1 through B.3 for similar land uses appear to be similar, considering the effect of limited samples sizes and number of sites. This Handbook recommends that additional data be collected—especially for the land uses most frequently analyzed in infill areas where the differences between baseline and infill trip generation rates may differ significantly.
### Table B.1 Baseline Weekday AM Peak Period Mode Share and Vehicle Occupancy Examples

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type</th>
<th>Development Units</th>
<th>Mode Shares</th>
<th>Vehicle Occ.</th>
<th>Sample Size</th>
<th>Mode Shares</th>
<th>Vehicle Occ.</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apartments</td>
<td>Falmouth, ME</td>
<td>5</td>
<td>173 DU</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.22</td>
<td>98</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1.10 Kevin Hooper Assoc.</td>
</tr>
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<td>Apartments</td>
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<td>6</td>
<td>240 DU</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.02</td>
<td>96</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>1.06 Iktis, Inc.</td>
</tr>
<tr>
<td>Apartments</td>
<td>Oklahoma City, OK</td>
<td>6</td>
<td>360 DU</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.03</td>
<td>99</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1.07 Traffic Ing. Consultants</td>
</tr>
<tr>
<td>Apartments</td>
<td>Tampa, FL</td>
<td>6</td>
<td>278 DU</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.14</td>
<td>95</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1.14 Parsons Brinkerhoff</td>
</tr>
<tr>
<td>Apartments</td>
<td>Tampa, FL</td>
<td>6</td>
<td>317 DU</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.23</td>
<td>97</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1.09 Parsons Brinkerhoff</td>
</tr>
<tr>
<td>Apartments</td>
<td>Tampa, FL</td>
<td>6</td>
<td>689 DU</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.12</td>
<td>96</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>1.08 Parsons Brinkerhoff</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Simple average</td>
<td>Personal Passenger Vehicle: 1.13</td>
<td>96.3</td>
<td>1.0</td>
<td>1.5</td>
<td>0</td>
<td>1.09 Parsons Brinkerhoff</td>
</tr>
<tr>
<td>Motel</td>
<td>College Station, TX</td>
<td>5</td>
<td>133 rooms</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.29</td>
<td>96</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1.32 Texas A&amp;M University</td>
</tr>
<tr>
<td>Motel</td>
<td>College Station, TX</td>
<td>5</td>
<td>88 rooms</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.21</td>
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<td>5</td>
<td>0</td>
<td>0</td>
<td>1.25 Texas A&amp;M University</td>
</tr>
<tr>
<td>Motel</td>
<td>College Station, TX</td>
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<td>79 rooms</td>
<td>Inbound</td>
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<td>0</td>
<td>0</td>
<td>1.20 Texas A&amp;M University</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Simple average</td>
<td>Personal Passenger Vehicle: 1.26</td>
<td>96.7</td>
<td>2.3</td>
<td>0.7</td>
<td>0</td>
<td>1.26 Texas A&amp;M University</td>
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<td>Bowling alley</td>
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<td>73,000</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.13</td>
<td>71</td>
<td>100</td>
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<td>0</td>
<td>1.00 Texas A&amp;M Transp. Inst.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Simple average</td>
<td>Personal Passenger Vehicle: 1.17</td>
<td>100.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.00 Texas A&amp;M Transp. Inst.</td>
</tr>
<tr>
<td>Office</td>
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<td>178,000</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.06</td>
<td>418</td>
<td>90</td>
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<td>1.06 Kevin Hooper Assoc.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Simple average</td>
<td>Personal Passenger Vehicle: 1.06</td>
<td>90.0</td>
<td>10.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.06 Kevin Hooper Assoc.</td>
</tr>
<tr>
<td>Shopping center</td>
<td>Bryan, TX</td>
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<td>110,000</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.14</td>
<td>179</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>1.19 Texas A&amp;M Transp. Inst.</td>
</tr>
<tr>
<td>Shopping center</td>
<td>College Station, TX</td>
<td>5</td>
<td>116,000</td>
<td>Inbound</td>
<td>Personal Passenger Vehicle: 1.14</td>
<td>213</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>1.13 Texas A&amp;M Transp. Inst.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Simple average</td>
<td>Personal Passenger Vehicle: 1.17</td>
<td>100.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.16 Texas A&amp;M Transp. Inst.</td>
</tr>
</tbody>
</table>

1 Area types: (0a) regional CBD, (0b) outlying CBD, (1) urban core, (2) activity center, (3) general urban, (4) suburban business district, (5) suburban strip commercial, (6) general suburban, (7) special district, (8) rural town business district, (9) rural, (C) adjacent to university campus, (M) within larger mixed use development, (Ta) rail transit station within 1/4 mile, (To) rail station immediately adjacent or connected TOD.

2 Development units in gross square feet of floor area unless otherwise indicated. Italics denote occupied development units.

3 Anchored by large grocery store.
### Table B.2 Baseline Weekday PM Peak Period Mode Share and Vehicle Occupancy Examples

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Sample Size</th>
<th>ITE LUC</th>
<th>Development Units</th>
<th>Sample Size</th>
<th>Vehicle Occ</th>
<th>Sample Size</th>
<th>ITE LUC</th>
<th>Development Units</th>
<th>Sample Size</th>
<th>Vehicle Occ</th>
<th>Sample Size</th>
<th>ITE LUC</th>
<th>Development Units</th>
<th>Sample Size</th>
<th>Vehicle Occ</th>
<th>Sample Size</th>
<th>ITE LUC</th>
<th>Development Units</th>
<th>Sample Size</th>
<th>Vehicle Occ</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apartments</td>
<td>Falmouth, ME</td>
<td>5</td>
<td>173 DU</td>
<td>220</td>
<td>96</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1.15</td>
<td>126</td>
<td>96</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.14</td>
<td>199</td>
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</table>

1. Area type: (0a) regional CBD, (0b) outlying CBD, (1) urban-core, (2) activity center, (3) general urban, (4) suburban business district, (5) suburban strip commercial, (6) general suburban, (7) special district, (8) rural town business district, (9) rural, (C) adjacent to university campus, (D) within larger mixed-use development, (Ia) rail transit station within 1/4 mile, (Ib) rail station immediately adjacent or connected TOD
2. Development units in gross square feet of floor area unless otherwise indicated. Italics denote occupied development units.
3. Anchored by grocery store comprising major portion of total floor area.
### Table B.3 Baseline Vehicle Occupancy in Trip Generation Manual Data Volumes

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<tr>
<th>Code</th>
<th>Land Use Classification</th>
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<th>Vehicle Occupancy</th>
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<td>022</td>
<td>General Aviation Airport</td>
<td>Weekday</td>
<td>1.20–1.70</td>
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<td>030</td>
<td>Intermodal Truck Terminal</td>
<td>Weekday</td>
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<td>110</td>
<td>General Light Industrial</td>
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<tr>
<td>120</td>
<td>General Heavy Industrial</td>
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</tr>
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<td>150</td>
<td>Warehousing</td>
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<td>Industrial Park</td>
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</tr>
<tr>
<td>140</td>
<td>Manufacturing</td>
<td>Weekday</td>
<td>1.37</td>
</tr>
<tr>
<td>151</td>
<td>Mini-Warehouse</td>
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</tr>
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<td>714</td>
<td>Corporate Headquarters Building</td>
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<td>Single Tenant Office Building</td>
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<td>High-Turnover (Sit-Down) Restaurant</td>
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</table>

This appendix contains a compilation of infill site modal person trip data originating in part from the sources described in Appendix G and in part from data collected at additional sites specifically for development of this Handbook. These limited data represent a start on an infill trip generation database. More data are needed for additional land uses and sites to confirm the conclusions described in Chapter 7 and to develop comprehensive mode share and vehicle occupancy for infill development across all major land use classifications and context types.

Tables C.1 through C.8 contain AM and PM peak period mode share information for residential (Tables C.1 and C.2), office (C.3 and C.4), general retail (C.5), convenience store (C.6), and restaurant (C.7 and C.8) in infill settings. Site context is represented by area type categories described in Chapter 3 of this Handbook. Many of the sites are non-isolated and required a combination of interview and count data to determine mode shares. Data were collected during one or more weekday peak periods. All data were collected directionally but were combined to report as non-directional. Vehicle occupancy was not reported for most sites.

Tables C.9 and C.10 present directional (inbound and outbound) mode share and vehicle occupancy during AM and PM peak periods, respectively, for a subset of the sites presented in Tables C.1 through C.8.

Data collected at infill sites, though limited, provides some significant findings and conclusions.

- One of the most important findings is confirmation that the motor vehicle mode share at infill development is consistently and significantly less than 100 percent. This finding is true for all of the land uses for which data are reported.
- The variance in the percentage of trips made by motor vehicle appears to depend on the site context (the more-urban settings have lower motor vehicle mode shares) and the proximity of rail transit.
- The proximity of an infill site to a university campus appears to result in a significant reduction in the motor vehicle mode share.\(^4\)
- Walking is the predominant mode of the non-motor vehicle trips at infill sites. Even at sites close to rail stations, walk trips tend to substantially outnumber transit trips.
- Bicycle trips, where counted separately, make up a small percentage of the person trips at infill sites.

Although data presented in the Tables Cemonstrates that infill development generates fewer person trips by motor vehicle, more data are needed to determine to what extent the motor vehicle mode share changes with changes in site context.

\(^4\) This finding was also observed in the California Urban Infill Trip Generation Study. Data collected at multiple mixed-use sites near the University of California at Berkeley campus showed significantly lower vehicle trips than similar mixed-use sites elsewhere. Further investigation found that nearly 50 percent of the persons surveyed were associated with the campus either as a student, faculty, or staff. Source: Kimley-Horn and Associates, Inc. Economic & Planning Systems, and Gene Bregman & Associates. Trip-Generation Rates for Urban Infill Land Uses in California Phase 2: Data Collection Final Report. California Department of Transportation (Caltrans) Headquarters Divisions of Transportation Planning and Research & Innovation, Sacramento, CA, 2009.
### Table C.1 Infill Weekday AM and PM Non-Directional Peak Period Mode Share and Vehicle Occupancy Examples—Multi-Family Residential

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<th>Land Use</th>
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<th>Occupied Dwelling Units</th>
<th>Mode Shares</th>
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Notes: Simple averages are shown only where at least three sites are available for similar combinations of area type, context, and rail transit availability. Sums of average mode shares may not add to 100% due to rounding. "na" designates not available or insufficient sample size.

1. Area types: (6a) regional CBD, (6b) outlying CBD, (1) urban core, (2) activity center, (3) galleria urban, (4) suburban business district, (5) suburban strip commercial, (6) rural town business district, (9) rural. Special context condition noted are (C) adjacent to university campus. (M) within larger mixed-use development. Rail transit availability is (Ta) rail transit station within 1/4 mile or (To) rail station immediately adjacent or connected TO.

2. Motor vehicle trips is the sum of person trips in personal passenger vehicles and trucks.

3. Number of person trips covered by usable interviews; if two values are listed, the number of vehicles counted for vehicle occupancy is shown after the value.
### Table C.2 Infill Weekday AM and PM Non-Directional

#### Peak Period Mode Share and Vehicle Occupancy Examples—Office

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</tr>
</tbody>
</table>

**Notes:**
- Simple averages are shown only where at least three sites are available for similar combinations of area type, context, and rail transit availability. Sums of average mode shares may not add to 100% due to rounding. "na" designates not available or insufficient sample size.
- Land Use Type Code Summary:
  - Type 3/3Ta/3To: Mixed-use development, (3) general urban area, (3a) high-suburban, (3Ta) medium-suburban, (3To) low-suburban.
  - Type 2: Special districts, (2) special district, (2a) special district transit center
  - Type 1/1Ta: General urban areas, (1) general urban area, (1Ta) transit center
  - Type 0a: Other, (0a) other urban area, (0aTa) not adjacent to university campus, (0aTo) within larger mixed-use development, (0bTo) rail transit availability is (Ta) rail transit station within 1/4 mile of TOD or (To) rail station immediately adjacent or connected-TOD.

*Motor vehicle trips is the sum of person and passenger vehicles.*
### Table C.3 Infill Weekday AM and PM Non-Directional Peak Period Mode Share and Vehicle Occupancy Examples—General Retail

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type</th>
<th>Occupied Development Units</th>
<th>ITE LUC</th>
<th>AM Mode Shares</th>
<th>Vehicle Occupancy</th>
<th>Sample Size</th>
<th>Source</th>
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<tbody>
<tr>
<td>Office</td>
<td>Concord, CA</td>
<td>2Ta</td>
<td>316,300 sf</td>
<td>710</td>
<td>83 12 5 0</td>
<td>1.18</td>
<td>262</td>
<td>Caltrans/TTI</td>
</tr>
<tr>
<td>Office</td>
<td>Fremont, CA</td>
<td>4Ta</td>
<td>190,000 sf</td>
<td>710</td>
<td>85 10 4 1</td>
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<td>245</td>
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</tr>
<tr>
<td>Office</td>
<td>Los Angeles, CA</td>
<td>4Ta</td>
<td>171,000 sf</td>
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<td>75 11 14 0</td>
<td>1.12</td>
<td>60-251</td>
<td>Caltrans/TTI</td>
</tr>
<tr>
<td>Office</td>
<td>Los Angeles, CA</td>
<td>4Ta</td>
<td>170,000 sf</td>
<td>710</td>
<td>76 13 11 0</td>
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</tr>
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<td>Office</td>
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<td>4Ta</td>
<td>270,600 sf</td>
<td>710</td>
<td>72 16 12 0</td>
<td>1.12</td>
<td>138-333</td>
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</tr>
<tr>
<td>Office</td>
<td>Pasadena, CA</td>
<td>4Ta</td>
<td>183,300 sf</td>
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</tr>
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<td>N. Hollywood, CA</td>
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</tr>
<tr>
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<td>86 8 5 1</td>
<td>1.28</td>
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<tr>
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<td>Caltrans/TTI</td>
</tr>
<tr>
<td>Office</td>
<td>San Diego, CA</td>
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<td>710</td>
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<td>24-627</td>
<td>Caltrans/TTI</td>
</tr>
<tr>
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<td>San Diego, CA</td>
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</tr>
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<td>1</td>
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<td>710</td>
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<tr>
<td>Office</td>
<td>Sacramento, CA</td>
<td>1Ta</td>
<td>416,000 sf</td>
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<td>62 9 27 2</td>
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<td>193</td>
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</tr>
<tr>
<td>Office</td>
<td>Sacramento, CA</td>
<td>1Ta</td>
<td>64,000 sf</td>
<td>710</td>
<td>68 8 11 13</td>
<td>na</td>
<td>25</td>
<td>Caltrans/UC Davis</td>
</tr>
<tr>
<td>Office</td>
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<td>710</td>
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<td>Caltrans/UC Davis</td>
</tr>
<tr>
<td>Office</td>
<td>San Francisco, CA</td>
<td>1</td>
<td>321,000 sf</td>
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<td>Office</td>
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<td>Office</td>
<td>Emeryville, CA</td>
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<td>235,000 sf</td>
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<td>51 22 13 14</td>
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<td>Caltrans/UC Davis</td>
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<td>Office</td>
<td>San Mateo, CA</td>
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<td>50,000 sf</td>
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<td>Office</td>
<td>Pasadena, CA</td>
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<td>98,600 sf</td>
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<tr>
<td>Office</td>
<td>Culver City, CA</td>
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<td>180,000 sf</td>
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<td>233</td>
<td>Gibson Transp. Consult.</td>
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<tr>
<td>Office</td>
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<td>710</td>
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<td>427</td>
<td>Gibson Transp. Consult.</td>
</tr>
</tbody>
</table>

**Notes:** Simple averages are shown only where at least three sites are available for similar combinations of area type, context, and rail transit availability. Sums of average mode shares may not add to 100% due to rounding. "na" designates not available or insufficient sample size.

Area types: (0a) regional CBD, (0b) outlying CBD, (1) urban core, (2) activity center, (3) general urban, (4) suburban business district, (5) suburban strip commercial, (6) general suburban, (7) special district, (8) rural town business district, (9) rural. Special context conditions noted are (C) adjacent to university campus, (M) within larger mixed-use development. Rail transit availability is (Ta) rail transit station within 1/4 mile or (To) rail station immediately adjacent or connected-TOD.

Motor vehicle trips is the sum of person trips in personal passenger vehicles and trucks.

Number of person trips covered by usable interviews; if two values are listed, the number of vehicles counted for vehicle occupancy is shown after the dash.
### Table C.4 Infill Weekday AM and PM Non-Directional Peak Period Mode Share and Vehicle Occupancy Examples—Convenience Store

<table>
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<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Occupied Development Units</th>
<th>ITE LUC</th>
<th>Mode Shares</th>
<th>PM</th>
<th>Vehicle Occupancy</th>
<th>Sample Size&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Concord, CA</td>
<td>2Ta</td>
<td>316,300 sf</td>
<td>710</td>
<td>87</td>
<td>1.04</td>
<td>206</td>
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<td>Caltrans/TTI</td>
</tr>
<tr>
<td>Office</td>
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<td>4Ta</td>
<td>190,000 sf</td>
<td>710</td>
<td>79</td>
<td>1.18</td>
<td>182</td>
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<td>Caltrans/TTI</td>
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<tr>
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<td>171,000 sf</td>
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<td>1.15</td>
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<td>Caltrans/TTI</td>
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<td>710</td>
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<td>1.10</td>
<td>41-180</td>
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<td>Caltrans/TTI</td>
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<td>Office</td>
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<td>4Ta</td>
<td>183,300 sf</td>
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<td>Caltrans/TTI</td>
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<tr>
<td>Office</td>
<td>N. Hollywood, CA</td>
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<td>153,900 sf</td>
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<td>102</td>
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<td>Caltrans/TTI</td>
</tr>
<tr>
<td>Office</td>
<td>N. Hollywood, CA</td>
<td>4Ta</td>
<td>179,500 sf</td>
<td>710</td>
<td>75</td>
<td>1.19</td>
<td>200</td>
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<td>7Ta</td>
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<td>710</td>
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<td>112-1072</td>
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<td>Caltrans/TTI</td>
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<tr>
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<td>1.05</td>
<td>33-661</td>
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<td>222,500 sf</td>
<td>710</td>
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<td>1.08</td>
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<tr>
<td>Office</td>
<td>Sacramento, CA</td>
<td>1Ta</td>
<td>416,000 sf</td>
<td>710</td>
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<td>na</td>
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<td>Caltrans/KC Davis</td>
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<tr>
<td>Office</td>
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<td>1Ta</td>
<td>64,000 sf</td>
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<td>68</td>
<td>na</td>
<td>na</td>
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</tr>
<tr>
<td>Office</td>
<td>Oakland, CA</td>
<td>0BMT&lt;sup&gt;0&lt;/sup&gt;</td>
<td>192,000 sf</td>
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<td>na</td>
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<td>Caltrans/KC Davis</td>
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<td>310,000 sf</td>
<td>710</td>
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<td>na</td>
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<td>Caltrans/KC Davis</td>
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<tr>
<td>Office</td>
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<td>321,000 sf</td>
<td>710</td>
<td>19</td>
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<td>Caltrans/KC Davis</td>
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<td>Caltrans/KC Davis</td>
</tr>
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<td>0BMT&lt;sup&gt;0&lt;/sup&gt;</td>
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<td>Caltrans/KC Davis</td>
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<td>4</td>
<td>235,000 sf</td>
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<td>50,000 sf</td>
<td>710</td>
<td>82</td>
<td>na</td>
<td>68</td>
<td></td>
<td>Caltrans/KC Davis</td>
</tr>
<tr>
<td>Office</td>
<td>Pasadena, CA</td>
<td>4</td>
<td>98,600 sf</td>
<td>710</td>
<td>69</td>
<td>1.08</td>
<td>263</td>
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<tr>
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<td>5</td>
<td>347,000 sf</td>
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<td>1.04</td>
<td>681</td>
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<td>1.07</td>
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<td>710</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td></td>
<td>Gibson Transp.</td>
</tr>
</tbody>
</table>

Notes: Simple averages are shown only where at least three sites are available for similar combinations of area type, context, and rail transit availability. Sums of average mode shares may not add to 100% due to rounding. "na" designates not available or insufficient sample size.

* Area types: (0a) regional CBD, (0b) outlying CBD, (1) urban core, (2) activity center, (3) general urban, (4) suburban business district, (5) suburban strip commercial, (6) general suburban, (7) special district, (8) rural town business district, (9) rural. Special context conditions noted are (C) adjacent to university campus, (M) within larger mixed-use development. Rail transit availability is (Ta) rail transit station within 1/4 mile or (To) rail station immediately adjacent or connected-TOD.

* Motor vehicle trips is the sum of person trips in personal passenger vehicles and trucks.

* Number of person trips covered by usable interviews; if two values are listed, the number of vehicles counted for vehicle occupancy is shown after the dash.
### Table C.5 Infill Weekday AM and PM Non-Directional Peak Period Mode Share and Vehicle Occupancy Examples—Restaurant

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type</th>
<th>Occupied Development Units</th>
<th>ITE LUC</th>
<th>AM</th>
<th>PM</th>
<th>Vehicle Occupancy</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shopping center</td>
<td>Los Angeles, CA</td>
<td>3</td>
<td>54,900 sf</td>
<td>820</td>
<td>86</td>
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<td>1.44</td>
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<tr>
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<td>11,000 sf</td>
<td>820</td>
<td>68</td>
<td>24</td>
<td>8</td>
<td>1.39</td>
<td>348 Gibson Transp. Consult.</td>
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<td>Supermarket</td>
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<td>0a</td>
<td>43,300 sf</td>
<td>850</td>
<td>50</td>
<td>10</td>
<td>40</td>
<td>na</td>
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<td>44,800 sf</td>
<td>876</td>
<td>95</td>
<td>5</td>
<td>0</td>
<td>1.12</td>
<td>53 Gibson Transp. Consult.</td>
</tr>
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<td>Flower shop</td>
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<td>0</td>
<td>0</td>
<td>na</td>
<td>na Caltrans/Kimley-Horn</td>
</tr>
</tbody>
</table>

**Notes:**

- Simple averages are shown only where at least three sites are available for similar combinations of area type, context, and rail transit availability. Sums of average mode shares may not add to 100% due to rounding. “na” designates not available or insufficient sample size.
- Area types: (0a) regional CBD; (0b) outlying CBD; (1) urban core; (2) activity center; (3) general urban; (4) suburban business district; (5) suburban strip commercial; (6) general suburban; (7) special district; (8) rural town business district; (9) rural. Special context conditions noted are (C) adjacent to university campus; (M) within larger mixed-use development. Rail transit availability is (Ta) rail transit station within 1/4 mile or (To) rail station immediately adjacent or connected-TOD.
- Motor vehicle trips is the sum of person trips in personal passenger vehicles and trucks.
- Number of person trips covered by usable interviews; if two values are listed, the number of vehicles counted for vehicle occupancy is
- Section surveyed.
Table C.6 Infill Development Weekday Directional AM Peak Period Mode Share and Vehicle Occupancy Examples

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type</th>
<th>Occupied Development Units</th>
<th>ITE LUC</th>
<th>Mode Shares</th>
<th>Vehicle Occupancy</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>1Ta</td>
<td>2,100 sf</td>
<td>851</td>
<td>Motor</td>
<td>Transit</td>
<td>Walk</td>
<td>Bike</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>1Ta</td>
<td>2,400 sf</td>
<td>851</td>
<td>19</td>
<td>13</td>
<td>61</td>
<td>7</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>1Ta</td>
<td>3,318 sf</td>
<td>851</td>
<td>29</td>
<td>6</td>
<td>56</td>
<td>9</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>3</td>
<td>2,600 sf</td>
<td>851</td>
<td>42</td>
<td>13</td>
<td>39</td>
<td>6</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>3</td>
<td>2,400 sf</td>
<td>851</td>
<td>66</td>
<td>4</td>
<td>26</td>
<td>4</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>3</td>
<td>2,400 sf</td>
<td>851</td>
<td>39</td>
<td>8</td>
<td>51</td>
<td>2</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>3</td>
<td>2,400 sf</td>
<td>851</td>
<td>62</td>
<td>8</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>3</td>
<td>2,400 sf</td>
<td>851</td>
<td>88</td>
<td>2</td>
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<td>0</td>
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<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
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<td>2,400 sf</td>
<td>851</td>
<td>45</td>
<td>10</td>
<td>31</td>
<td>14</td>
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<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>3</td>
<td>2,400 sf</td>
<td>851</td>
<td>25</td>
<td>8</td>
<td>55</td>
<td>12</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>3</td>
<td>2,400 sf</td>
<td>851</td>
<td>74</td>
<td>0</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>3</td>
<td>2,400 sf</td>
<td>851</td>
<td>63</td>
<td>3</td>
<td>27</td>
<td>7</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>3</td>
<td>2,400 sf</td>
<td>851</td>
<td>56</td>
<td>0</td>
<td>37</td>
<td>7</td>
</tr>
<tr>
<td>Convenience store</td>
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<td>2,464 sf</td>
<td>851</td>
<td>77</td>
<td>3</td>
<td>13</td>
<td>7</td>
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<td>Clackamas, OR</td>
<td>3Ta</td>
<td>2,400 sf</td>
<td>851</td>
<td>67</td>
<td>15</td>
<td>15</td>
<td>3</td>
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<tr>
<td>Convenience store</td>
<td>Gresham, OR</td>
<td>5</td>
<td>2,475 sf</td>
<td>851</td>
<td>90</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Portland, OR</td>
<td>5</td>
<td>2,500 sf</td>
<td>851</td>
<td>74</td>
<td>0</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Wilsonville, OR</td>
<td>6</td>
<td>2,500 sf</td>
<td>851</td>
<td>76</td>
<td>3</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Forest Grove, OR</td>
<td>6</td>
<td>2,400 sf</td>
<td>851</td>
<td>70</td>
<td>0</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Wilsonville, OR</td>
<td>6</td>
<td>2,500 sf</td>
<td>851</td>
<td>94</td>
<td>0</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Aloha, OR</td>
<td>6</td>
<td>3,000 sf</td>
<td>851</td>
<td>56</td>
<td>11</td>
<td>24</td>
<td>9</td>
</tr>
</tbody>
</table>

Simple average - all LUC 851
<table>
<thead>
<tr>
<th>Motor Vehicle</th>
<th>Transit</th>
<th>Walk</th>
<th>Bike</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>59</td>
<td>6</td>
<td>28</td>
<td>7</td>
<td>na</td>
<td>OTREC/Portland State U</td>
</tr>
</tbody>
</table>

Notes: Simple averages are shown only where at least three sites are available for similar combinations of area type, context, and rail transit availability. Sums of average mode shares may not add to 100% due to rounding. "na" designates not available or insufficient sample size.

1. Area types: (0a) regional CBD, (0b) outlying CBD, (1) urban core, (2) activity center, (3) general urban, (4) suburban business district, (5) suburban strip commercial, (6) general suburban, (7) special district, (8) rural town business district, (9) rural. Special context conditions noted are (C) adjacent to university campus, (M) within larger mixed-use development. Rail transit availability is (Ta) rail transit station within 1/4 mile or (To) rail station immediately adjacent or connected-TOD.

2. Motor vehicle trips is the sum of person trips in personal passenger vehicles and trucks.

3. Number of person trips covered by usable interviews; if two values are listed, the number of vehicles counted for vehicle occupancy is shown after the
### Table C.7 Infill Development Weekday Directional PM Peak Period Mode Share and Vehicle Occupancy Examples

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type</th>
<th>Occupied Development Units</th>
<th>ITE LUC</th>
<th>AM Mode Shares</th>
<th>Vehicle Occupancy</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast food</td>
<td>San Diego, CA</td>
<td>0a</td>
<td>1,250 sf</td>
<td>933</td>
<td>50 13 37</td>
<td>na na</td>
<td>Caltrans/Kimley-Horn</td>
<td></td>
</tr>
<tr>
<td>Fast food</td>
<td>Berkeley, CA</td>
<td>1TaC</td>
<td>4,500 sf</td>
<td>933</td>
<td>64 0 36</td>
<td>na na</td>
<td>Caltrans/Kimley-Horn</td>
<td></td>
</tr>
<tr>
<td>Fast food</td>
<td>Berkeley, CA</td>
<td>3Ta</td>
<td>5,000 sf</td>
<td>933</td>
<td>33 11 56</td>
<td>na na</td>
<td>Caltrans/Kimley-Horn</td>
<td></td>
</tr>
<tr>
<td>Coffee shop</td>
<td>San Francisco, CA</td>
<td>0aM</td>
<td>1,556 sf</td>
<td>936</td>
<td>24 18 58 0</td>
<td>na 49</td>
<td>Caltrans/UC Davis</td>
<td></td>
</tr>
<tr>
<td>Coffee shop</td>
<td>San Francisco, CA</td>
<td>0aM</td>
<td>1,097 sf</td>
<td>936</td>
<td>12 32 56 0</td>
<td>na 79</td>
<td>Caltrans/UC Davis</td>
<td></td>
</tr>
<tr>
<td>Coffee shop</td>
<td>Sacramento, CA</td>
<td>0aTaM</td>
<td>1,652 sf</td>
<td>936</td>
<td>22 18 59 1</td>
<td>na 145</td>
<td>Caltrans/UC Davis</td>
<td></td>
</tr>
<tr>
<td>Coffee shop</td>
<td>Oakland, CA</td>
<td>3M</td>
<td>1,300 sf</td>
<td>936</td>
<td>45 7 44 4</td>
<td>na 123</td>
<td>Caltrans/UC Davis</td>
<td></td>
</tr>
</tbody>
</table>

#### Notes:
- Simple averages are shown only where at least three sites are available for similar combinations of area type, context, and rail transit availability. Sums of average mode shares may not add to 100% due to rounding. "na" designates not available or insufficient sample size.
- Area types: (0a) regional CBD, (0b) outlying CBD, (1) urban core, (2) activity center, (3) general urban, (4) suburban business district, (5) suburban strip commercial, (6) general suburban, (7) special district, (8) rural town business district, (9) rural. Special context conditions noted are (C) adjacent to university campus, (M) within larger mixed-use development. Rail transit availability is (Ta) rail transit station within 1/4 mile or (To) rail station immediately adjacent or connected-TOD.
- Motor vehicle trips is the sum of person trips in personal passenger vehicles and trucks.
- Number of person trips covered by usable interviews; if two values are listed, the number of vehicles counted for vehicle occupancy is shown after...
<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type</th>
<th>ITE LUC</th>
<th>Occupied Development Units</th>
<th>Mode Shares</th>
<th>Vehicle Occupancy</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>HT sit-down restaurant</td>
<td>Portland, OR</td>
<td>3</td>
<td>2,250 sf</td>
<td>932</td>
<td>79 3 0 18</td>
<td>na</td>
<td>33</td>
<td>OTREC/Portland State U</td>
</tr>
<tr>
<td>HT sit-down restaurant</td>
<td>Portland, OR</td>
<td>3</td>
<td>1,100 sf</td>
<td>932</td>
<td>65 4 22 9</td>
<td>na</td>
<td>46</td>
<td>OTREC/Portland State U</td>
</tr>
<tr>
<td>HT sit-down restaurant</td>
<td>Portland, OR</td>
<td>3</td>
<td>2,000 sf</td>
<td>932</td>
<td>58 6 26 10</td>
<td>na</td>
<td>31</td>
<td>OTREC/Portland State U</td>
</tr>
<tr>
<td>HT sit-down restaurant</td>
<td>Burbank, CA</td>
<td>3</td>
<td>5,000 sf</td>
<td>932</td>
<td>98 1 0 1 1.89</td>
<td>na</td>
<td>86</td>
<td>Gibson Transp. Consult.</td>
</tr>
<tr>
<td>HT sit-down restaurant</td>
<td>Portland, OR</td>
<td>5</td>
<td>2,100 sf</td>
<td>932</td>
<td>90 0 10 0</td>
<td>na</td>
<td>30</td>
<td>OTREC/Portland State U</td>
</tr>
</tbody>
</table>

**Simple average - all LUC 932**
78 3 12 8 na

<table>
<thead>
<tr>
<th>Location</th>
<th>Area Type</th>
<th>ITE LUC</th>
<th>Occupied Development Units</th>
<th>Mode Shares</th>
<th>Vehicle Occupancy</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Diego, CA</td>
<td>0a</td>
<td>1,250 sf</td>
<td>933</td>
<td>17 0 83</td>
<td>na</td>
<td>na</td>
<td>Caltrans/Kimley-Horn</td>
</tr>
<tr>
<td>Berkeley, CA</td>
<td>1TaC</td>
<td>4,500 sf</td>
<td>933</td>
<td>35 8 57</td>
<td>na</td>
<td>na</td>
<td>Caltrans/Kimley-Horn</td>
</tr>
<tr>
<td>Berkeley, CA</td>
<td>3Ta</td>
<td>5,000 sf</td>
<td>933</td>
<td>57 10 33</td>
<td>na</td>
<td>na</td>
<td>Caltrans/Kimley-Horn</td>
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</tbody>
</table>

**Simple average - all LUC 933**
36 6 58

<table>
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<th>Location</th>
<th>Area Type</th>
<th>ITE LUC</th>
<th>Occupied Development Units</th>
<th>Mode Shares</th>
<th>Vehicle Occupancy</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco, CA</td>
<td>0aM</td>
<td>1,556 sf</td>
<td>936</td>
<td>31 8 61 0</td>
<td>na</td>
<td>38</td>
<td>Caltrans/UC Davis</td>
</tr>
<tr>
<td>Sacramento, CA</td>
<td>0aTaM</td>
<td>1,652 sf</td>
<td>936</td>
<td>25 9 61 5</td>
<td>na</td>
<td>44</td>
<td>Caltrans/UC Davis</td>
</tr>
<tr>
<td>Oakland, CA</td>
<td>3M</td>
<td>1,329 sf</td>
<td>936</td>
<td>93 2 5 0</td>
<td>na</td>
<td>44</td>
<td>Caltrans/UC Davis</td>
</tr>
<tr>
<td>Oakland, CA</td>
<td>3M</td>
<td>1,300 sf</td>
<td>936</td>
<td>24 10 62 4</td>
<td>na</td>
<td>49</td>
<td>Caltrans/UC Davis</td>
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</table>

**Simple average - all LUC 936**
43 7 47 2

<table>
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<th>ITE LUC</th>
<th>Occupied Development Units</th>
<th>Mode Shares</th>
<th>Vehicle Occupancy</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berkeley, CA</td>
<td>1TaC</td>
<td>12,000 sf</td>
<td>925</td>
<td>43 29 28</td>
<td>na</td>
<td>na</td>
<td>Caltrans/Kimley-Horn</td>
</tr>
</tbody>
</table>

Notes: Simple averages are shown only where at least three sites are available for similar combinations of area type, context, and rail transit availability. Sums of average mode shares may not add to 100% due to rounding. "na" designates not available or insufficient sample size.

1 Area types: (0a) regional CBD, (0b) outlying CBD, (1) urban core, (2) activity center, (3) general urban, (4) suburban business district, (5) suburban strip commercial, (6) general suburban, (7) special district, (8) rural town business district, (9) rural. Special context conditions noted are (C) adjacent to university campus, (M) within larger mixed-use development. Rail transit availability is (Ta) rail transit station within 1/4 mile or (To) rail station immediately adjacent or connected-TOD.

2 Motor vehicle trips is the sum of person trips in personal passenger vehicles and trucks.

3 Number of person trips covered by usable interviews; if two values are listed, the number of vehicles counted for vehicle occupancy is shown after the
<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type(^a)</th>
<th>Development Units</th>
<th>ITE LUC</th>
<th>Personal Passenger Vehicle</th>
<th>Truck</th>
<th>Walk</th>
<th>Transit</th>
<th>Bike</th>
<th>Vehicle Occ.</th>
<th>Sample Size</th>
<th>Mode Shares</th>
<th>Vehicle Occ.</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apartments</td>
<td>Los Angeles, CA</td>
<td>3</td>
<td>73 DU</td>
<td>220</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>na</td>
<td>na</td>
<td>72</td>
<td>0</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td>Apartments</td>
<td>Los Angeles, CA</td>
<td>3</td>
<td>72 DU</td>
<td>220</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>n</td>
<td>m</td>
<td>na</td>
<td>na</td>
<td>86</td>
<td>0</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Office</td>
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<td>82</td>
<td>3</td>
<td>13</td>
<td>0</td>
<td>2</td>
<td>1.04</td>
<td>530</td>
<td>70</td>
<td>6</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Office</td>
<td>Pasadena, CA</td>
<td>4</td>
<td>98,600</td>
<td>70</td>
<td>74</td>
<td>2</td>
<td>18</td>
<td>6</td>
<td>0</td>
<td>1.05</td>
<td>174</td>
<td>33</td>
<td>3</td>
<td>84</td>
<td>0</td>
</tr>
<tr>
<td>Office</td>
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<td>5</td>
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<td>70</td>
<td>71</td>
<td>1</td>
<td>21</td>
<td>6</td>
<td>1</td>
<td>1.07</td>
<td>207</td>
<td>54</td>
<td>4</td>
<td>42</td>
<td>0</td>
</tr>
<tr>
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<td>Seal Beach, CA</td>
<td>6</td>
<td>265,000</td>
<td>70</td>
<td>98</td>
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<td>0</td>
<td>1.04</td>
<td>393</td>
<td>74</td>
<td>26</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Table C.9 Infill Development Weekday Directional AM Peak Period Mode Share and Vehicle Occupancy Examples**

**Area types:**
- (0a) regional CBD,
- (0b) outlying CBD,
- (1) urban core,
- (2) activity center,
- (3) general urban,
- (4) suburban business district,
- (5) suburban strip commercial,
- (6) general suburban,
- (7) special district,
- (8) rural town business district,
- (9) rural,
- (C) adjacent to university campus,
- (M) within larger mixed-use development,
- (Ta) rail transit station within 1/4 mile,
- (To) rail transit station immediately adjacent or connected-TOD

**Development units in gross square feet of floor area unless otherwise indicated.**

**Notes:**
- na - not available or insufficient sample size.
- Simple average - all retail
- Simple average - all LUC

- **Inbound**
  - Vehicle Occ.:
  - Simple average - all retail
  - Simple average - all LUC
- **Mode Shares**:
  - ITE LUC
  - LUC
- **Sample Size**
  - Simple average - all retail
  - Simple average - all LUC
## Table C.10 Infill Development Weekday Directional PM Peak Period Mode Share and Vehicle Occupancy Examples

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type</th>
<th>Development Units</th>
<th>ITE LUC</th>
<th>Mode Shares</th>
<th>Vehicle Occ.</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apartments</td>
<td>Los Angeles, CA</td>
<td>3</td>
<td>73 DU</td>
<td>220</td>
<td>Personal</td>
<td>0.14</td>
<td>30</td>
<td>na na na na na na na</td>
</tr>
<tr>
<td>Apartments</td>
<td>Los Angeles, CA</td>
<td>3C</td>
<td>72 DU</td>
<td>220</td>
<td>Personal</td>
<td>0.23</td>
<td>32</td>
<td>na na na na na na na</td>
</tr>
<tr>
<td>Office</td>
<td>Calver City, CA</td>
<td>5</td>
<td>347,000</td>
<td>710</td>
<td>Vehicle</td>
<td>na</td>
<td>106</td>
<td>93 2 2 1 0.03 575</td>
</tr>
<tr>
<td>House</td>
<td>Pasadena, CA</td>
<td>4</td>
<td>98,600</td>
<td>710</td>
<td>Truck</td>
<td>0.11</td>
<td>80</td>
<td>70 2 13 3 1 1.03 183</td>
</tr>
<tr>
<td>Office</td>
<td>Los Angeles, CA</td>
<td>5</td>
<td>180,000</td>
<td>710</td>
<td>Transit</td>
<td>0.16</td>
<td>36</td>
<td>66 1 22 10 1 1.11 301</td>
</tr>
</tbody>
</table>

**Table C.10**

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type</th>
<th>Development Units</th>
<th>ITE LUC</th>
<th>Mode Shares</th>
<th>Vehicle Occ.</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shopping center</td>
<td>Los Angeles, CA</td>
<td>3</td>
<td>4,100</td>
<td>820</td>
<td>Personal</td>
<td>0.13</td>
<td>225</td>
<td>64 1 31 3 1 1.45 249</td>
</tr>
<tr>
<td>Shopping center</td>
<td>Los Angeles, CA</td>
<td>3</td>
<td>54,900</td>
<td>820</td>
<td>Personal</td>
<td>0.46</td>
<td>288</td>
<td>60 0 39 0 1 1.42 297</td>
</tr>
<tr>
<td>Retail apparel</td>
<td>Los Angeles, CA</td>
<td>3</td>
<td>41,000</td>
<td>85</td>
<td>Personal</td>
<td>0.13</td>
<td>77</td>
<td>52 1 46 1 0 1 1.12 87</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type</th>
<th>Development Units</th>
<th>ITE LUC</th>
<th>Mode Shares</th>
<th>Vehicle Occ.</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shopping center</td>
<td>Burbank, CA</td>
<td>3</td>
<td>5,000</td>
<td>80</td>
<td>Walk</td>
<td>0.13</td>
<td>30</td>
<td>90 1 2 0 1 1.88 36</td>
</tr>
</tbody>
</table>

**Table C.10**

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Location</th>
<th>Area Type</th>
<th>Development Units</th>
<th>ITE LUC</th>
<th>Mode Shares</th>
<th>Vehicle Occ.</th>
<th>Sample Size</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>High rise restaurant</td>
<td>Barbank, CA</td>
<td>3</td>
<td>5,000</td>
<td>932</td>
<td>Walk</td>
<td>0.90</td>
<td>30</td>
<td>97 0 2 0 1 1.88 36</td>
</tr>
</tbody>
</table>

**Table C.10**

1. Area types: (0a) regional CBD, (0b) outlying CBD, (1) urban core, (2) activity center, (3) general urban, (4) suburban business district, (5) suburban strip commercial, (6) general suburban, (7) special district, (8) rural town business district, (9) rural, (C) adjacent to university campus, (M) within larger mixed-use development, (T) rail transit station within 1/4 mile, (To) rail station immediately adjacent or connected TOD
2. Development units in gross square feet of floor area unless otherwise indicated.
3. Serving UCLA campus area.
Appendix D. Key Research with Transit-Friendly Site Mode Share Data

This appendix summarizes mode share data collected for several studies of sites classified as transit-oriented development (TOD).\(^5\) For each such site, information is provided on the specific land use surveyed, site size (such as number of dwelling units), location within the urban area [central business district (CBD) or non-CBD], and proximity to transit (rail or bus).\(^6\)

As an indicator of the context of the individual TOD sites, walk/bike mode shares are provided where available from the research. The numbers of pedestrians and bicyclists (and therefore the walk/bike mode share percentages of all person trips) vary significantly across the TOD sites. A site with a higher walk/bike mode share is likely to be in a more urban setting (or in a setting with more nearby complementary land uses) than a site with a lower walk/bike mode share.

In order to isolate the effect of transit service proximity and type on trip-making at the TOD site, the text and tables present the percentages of persons arriving or departing each surveyed site via transit for motorized trips. This percentage demonstrates the split between personal passenger vehicles and transit. It represents the direct effect of transit service type and proximity on TOD site trip-making. Other reductions to reflect the effects of an urban infill setting or of internal capture at a mixed-use site can be and should be addressed separately.

In some of the reference documents, transit mode share is defined as the percentage taking transit to or from a site inclusive of walk/bike access. To maintain consistency with the transit mode share definition in this \textit{Handbook} as the transit mode share for motorized trips, the tables in this appendix, in some cases, recalculate the transit percentages in the reference source. The analyst should take care in considering the materials in this appendix and in other sources to consider whether the “non-transit” percentage includes or excludes walk/bike trips.

The presentation of this material demonstrates the complexity of inter-related variables such as site density, land use diversity, location relative to transit and CBD core areas, and even demographics (such as presence of college students). The wide range of mode share data in this appendix demonstrates the value of using local data that are relevant to the study site and the importance of the continuing development of more robust databases from which mode share inferences for wider transferability can be developed.

---

\(^5\) The precise definition of TOD can (and does) vary in its many applications in research reports and local ordinances. This \textit{Handbook} uses the term transit-friendly development (TFD) to describe any development that is directly connected, immediately adjacent to, or directly oriented toward a rail station or stop (including heavy rail, light rail, streetcar, and commuter rail) or a multi-route bus transit center with high-frequency service. The term TOD is retained in this appendix text because that is the term used in the referenced research reports.

\(^6\) For the purpose of this appendix, CBD is defined as the downtown area for the core city of the metropolitan region. It typically includes good transit service, shared and priced parking both on-street and in structured garages or surface lots, an extensive pedestrian sidewalk network, multi-storied buildings, and a wide range of land uses.
Travel Characteristics of Transit-Oriented Development in California

A California Department of Transportation (Caltrans)-funded research study\(^7\) produced a report that “… presents findings from a statewide data collection effort that surveyed patrons of forty TODs—26 residential buildings, 9 office buildings, 3 hotels, and 2 retail complexes—during the spring and early summer of 2003. Sites were selected along a combination of light, heavy, and commuter rail lines in four California regions—the Bay Area and Sacramento in northern California and Los Angeles and San Diego in southern California; between the four regions, each type of rail system is represented in both northern and southern California.”

Residential

Because of concerns over sample sizes at individual residential sites, the mode share information is aggregated in the report to composite sites instead of being presented for individual station areas. As shown in Table D.1, transit mode share information was compiled for five composite locations—two heavy rail (A and B in the table), two light rail (C and D in the table), and one commuter rail (E in the table). The distance to the rail station is an average for the individual residential sites.

Information was collected on daily commute and non-commute trips made by only one household member per household—either the primary wage-earner or the person who commutes to work on the most regular basis.

Data in Table D.1 show that for the surveyed residential sites (which are typically within one-quarter mile of the rail station), transit share is not sensitive to distance from the station. Note that all sites are located outside the metropolitan area CBD.

---

\(^7\) Lund, H., R. Cervero, and R. Willson. *Travel Characteristics of Transit-Oriented Development in California*, California State Polytechnic University, University of California at Berkeley, 2004
Table D.1 Transit Mode Shares at Surveyed Residential TOD Sites in California

<table>
<thead>
<tr>
<th>Metro Area</th>
<th>Composite A</th>
<th>Composite B</th>
<th>Composite C</th>
<th>Composite D</th>
<th>Composite E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>San Francisco</td>
<td>San Francisco</td>
<td>Los Angeles</td>
<td>San Diego</td>
<td>San Francisco</td>
</tr>
<tr>
<td># Sites</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Rail Transit Type</td>
<td>Heavy</td>
<td>Heavy</td>
<td>Light</td>
<td>Light</td>
<td>Commuter</td>
</tr>
<tr>
<td>Average Distance to Rail Transit (ft.)</td>
<td>1,400</td>
<td>1,100</td>
<td>600</td>
<td>100</td>
<td>1,400</td>
</tr>
<tr>
<td>% Walk/Bike Trips</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commute</td>
<td>2%</td>
<td>1%</td>
<td>3%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Non-Commute</td>
<td>4%</td>
<td>6%</td>
<td>13%</td>
<td>1%</td>
<td>4%</td>
</tr>
<tr>
<td>% Transit for Motorized Trips 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commute</td>
<td>46%</td>
<td>38%</td>
<td>3%</td>
<td>13%</td>
<td>18%</td>
</tr>
<tr>
<td>Non-Commute</td>
<td>16%</td>
<td>15%</td>
<td>3%</td>
<td>0%</td>
<td>6%</td>
</tr>
</tbody>
</table>


Office

Table D.2 presents the results of surveys of employees at office buildings located near rail transit stations. As was the case for the residential sites, concerns over limited survey sample sizes led to the consolidation of data for several office sites into single composite values.

Table D.2 Transit Mode Shares at Surveyed Office TOD Sites in California

<table>
<thead>
<tr>
<th>Metro Area</th>
<th>Site A</th>
<th>Composite B</th>
<th>Composite C</th>
<th>Site D</th>
<th>Site E</th>
<th>Site F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>San Francisco</td>
<td>San Francisco</td>
<td>Los Angeles</td>
<td>San Diego</td>
<td>San Jose</td>
<td>Los Angeles</td>
</tr>
<tr>
<td># Sites</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rail Transit Type</td>
<td>Heavy</td>
<td>Heavy</td>
<td>Heavy</td>
<td>Light</td>
<td>Light</td>
<td>Commuter</td>
</tr>
<tr>
<td>Distance to Transit (ft.)</td>
<td>100</td>
<td>1,100</td>
<td>1,200</td>
<td>2,400</td>
<td>600</td>
<td>2,800</td>
</tr>
<tr>
<td>% Walk/Bike Trips for Employees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commute</td>
<td>12</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>% Transit for Motorized Trips</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commute</td>
<td>44</td>
<td>17</td>
<td>8</td>
<td>3</td>
<td>30</td>
<td>6</td>
</tr>
</tbody>
</table>

Note: All sites are located outside the metropolitan area CBD.


8 For the purposes of this Handbook, non-walk/bike person trips to and from a site (that is, trips in a personal passenger vehicle or truck) are called motorized trips. The percent transit values in the table represent the transit trips portion of the motorized trips.
For the surveyed office sites, the commute trip transit mode share does have a downward sloping relationship to the distance of the TOD workplace from the transit station. The farther a site is from the station, the less likely it is that an employee uses transit.

Figure D.1, excerpted from the research report, shows that “work trip transit shares fall in an exponential manner as the distance of an office site to its nearest station increases. While the small sample size of this simple plot cautions against drawing strong inferences, the presence of a relatively steep non-linear slope suggests considerable ridership benefits would accrue from clustering employment growth around … rail stations.” The best fitted curve equation has an $R^2$ value of less than 0.50.

![Figure D.1 Transit Share as a Function of Distance of Office Site to Nearest Station](image)


**Retail**

Retail site patrons were surveyed at three locations outside the metropolitan area CBD. Two sites are located near a heavy rail station; the other near a light rail station. Distances to the stations are not reported. The surveyed transit shares of the motorized commute trips were 13, 17, and 36 percent.
**Hotel Guests and Employees**

Hotel employees were surveyed at two locations, both outside the regional CBD. One site is located near a heavy rail station; the other near a light rail station. Distances to the stations are not reported. The surveyed transit shares of the motorized commute trips (based on relatively small sample sizes) were 32 and 96 percent.

**WMATA Development-Related Ridership Survey**

This Washington Metropolitan Area Transit Authority (WMATA) report presents an analysis of primary data collected at residential, office, retail, hotel, and entertainment TOD sites in the Washington, DC metropolitan area. Presented below are the report findings that are pertinent to TOD trip generation.

The table summaries for all of the data collection sites include a line item for distance between the site and the nearest transit station. The distance shown is to the nearest heavy rail station. Surface street bus service could actually be closer.

**Office**

Data were collected at 15 office buildings—13 outside downtown and two located in downtown Washington, DC. Office workers completed self-administered surveys about their travel patterns.

Intercept surveys were used to obtain information about visitors. The intercept surveys were conducted between 8:00 a.m.–5:00 p.m. Therefore, the visitor data do not necessarily reflect actual AM and PM peak period travel patterns.

Table D.3 lists the transit mode share information (for motorized trips) for the study site workers and visitors.

Data plots for the non-CBD office sites are shown. Figure D.2 presents the “percent transit for motorized trips” for commuters. Figure D.3 includes the same data for visitors.

For both plots, the trends of the relationships indicate the transit mode share decreases with increasing distance to the closest rail station. But neither plot produces a definitive and reliable regression curve.

**Residential**

Self-administered surveys were distributed to residents in 18 buildings—16 located outside downtown, two located downtown. Only the trips made by residents are captured in the surveys. Information was not collected on visitor, on-site employee, delivery, or service trips at the sites.

Table D.4 lists the transit mode share information (for motorized trips) for all trips made during the day by site residents and for work or school trips made by residents. The work or school data

---

are likely to closely resemble the actual overall AM peak period travel characteristics for the site residents. The actual overall PM peak period characteristics are likely some combination of the work/school and all day characteristics.

The first part of the table covers the non-downtown sites. The second part of the table covers the two downtown sites.

Table D.3 Transit Mode Shares at Non-CBD Office TOD
(metropolitan Washington, DC)

<table>
<thead>
<tr>
<th>Site</th>
<th>Site A</th>
<th>Site B</th>
<th>Site C</th>
<th>Site D</th>
<th>Site E</th>
<th>Site F</th>
<th>Site G</th>
<th>Site H</th>
<th>Site I</th>
<th>Site J</th>
<th>Site K</th>
<th>Site L</th>
<th>Site M</th>
<th>Site N</th>
<th>Site O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Square Footage (000 sf)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>584</td>
<td>235</td>
<td>619</td>
<td>165</td>
<td>74</td>
<td>163</td>
<td>784</td>
<td>412</td>
<td>512</td>
<td>153</td>
<td>87</td>
<td>230</td>
<td>303</td>
<td>484</td>
<td>149</td>
</tr>
<tr>
<td>Occupied</td>
<td>n.a.</td>
<td>210</td>
<td>555</td>
<td>165</td>
<td>69</td>
<td>n.a.</td>
<td>590</td>
<td>n.a.</td>
<td>n.a.</td>
<td>145</td>
<td>n.a.</td>
<td>265</td>
<td>430</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>Distance to Heavy Rail Transit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ft.)</td>
<td>0</td>
<td>100</td>
<td>200</td>
<td>450</td>
<td>600</td>
<td>700</td>
<td>700</td>
<td>850</td>
<td>950</td>
<td>1,400</td>
<td>1,600</td>
<td>1,900</td>
<td>2,000</td>
<td>2,600</td>
<td>3,000</td>
</tr>
<tr>
<td>% Transit for Motorized Trips</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commuter</td>
<td>24%</td>
<td>32%</td>
<td>49%</td>
<td>40%</td>
<td>18%</td>
<td>43%</td>
<td>29%</td>
<td>42%</td>
<td>38%</td>
<td>47%</td>
<td>20%</td>
<td>9%</td>
<td>18%</td>
<td>15%</td>
<td>11%</td>
</tr>
<tr>
<td>Daily Visitor</td>
<td>14%</td>
<td>14%</td>
<td>61%</td>
<td>54%</td>
<td>8%</td>
<td>n.a.</td>
<td>36%</td>
<td>41%</td>
<td>n.a.</td>
<td>17%</td>
<td>n.a.</td>
<td>11%</td>
<td>16%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

Table D.3 (Continued) Transit Mode Shares at Office TOD in CBD
(metropolitan Washington, DC)

<table>
<thead>
<tr>
<th>Site</th>
<th>Site P</th>
<th>Site Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Square Footage (000 sf)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>69</td>
<td>190</td>
</tr>
<tr>
<td>Occupied</td>
<td>69</td>
<td>170</td>
</tr>
<tr>
<td>Distance to Heavy Rail Transit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ft.)</td>
<td>0</td>
<td>1,000</td>
</tr>
<tr>
<td>% Transit for Motorized Trips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commuter</td>
<td>82%</td>
<td>74%</td>
</tr>
<tr>
<td>Daily Visitor</td>
<td>47%</td>
<td>24%</td>
</tr>
</tbody>
</table>

Figure D.2 Commuter Transit Mode Share vs. Heavy Rail Transit Proximity for Non-CBD Office Sites

![Commuter Mode Share vs Heavy Rail Proximity](image)


Figure D.3 Visitor Transit Mode Share vs. Heavy Rail Transit Proximity for Non-CBD Office Sites

![Visitor Mode Share vs Heavy Rail Proximity](image)

Table D.4 Transit Mode Shares at Non-CBD Residential TOD (metropolitan Washington, DC)

<table>
<thead>
<tr>
<th>Site</th>
<th>Dwelling Units</th>
<th>Distance to Heavy Rail Transit (ft.)</th>
<th>% Transit for Motorized Trips by Residents</th>
<th>All Trips</th>
<th>Work &amp; School Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>564</td>
<td>150</td>
<td>67%</td>
<td>77%</td>
<td>77%</td>
</tr>
<tr>
<td>B</td>
<td>345</td>
<td>550</td>
<td>65%</td>
<td>63%</td>
<td>63%</td>
</tr>
<tr>
<td>C</td>
<td>378</td>
<td>800</td>
<td>56%</td>
<td>70%</td>
<td>70%</td>
</tr>
<tr>
<td>D</td>
<td>714</td>
<td>1,100</td>
<td>58%</td>
<td>76%</td>
<td>76%</td>
</tr>
<tr>
<td>E</td>
<td>575</td>
<td>1,200</td>
<td>54%</td>
<td>66%</td>
<td>66%</td>
</tr>
<tr>
<td>F</td>
<td>509</td>
<td>1,250</td>
<td>54%</td>
<td>64%</td>
<td>64%</td>
</tr>
<tr>
<td>G</td>
<td>308</td>
<td>1,350</td>
<td>40%</td>
<td>48%</td>
<td>48%</td>
</tr>
<tr>
<td>H</td>
<td>499</td>
<td>1,400</td>
<td>41%</td>
<td>55%</td>
<td>55%</td>
</tr>
<tr>
<td>I</td>
<td>540</td>
<td>1,450</td>
<td>43%</td>
<td>65%</td>
<td>65%</td>
</tr>
<tr>
<td>J</td>
<td>858</td>
<td>1,700</td>
<td>60%</td>
<td>65%</td>
<td>65%</td>
</tr>
<tr>
<td>K</td>
<td>809</td>
<td>2,300</td>
<td>34%</td>
<td>49%</td>
<td>49%</td>
</tr>
<tr>
<td>L</td>
<td>399</td>
<td>2,500</td>
<td>34%</td>
<td>36%</td>
<td>36%</td>
</tr>
<tr>
<td>M</td>
<td>404</td>
<td>2,600</td>
<td>18%</td>
<td>36%</td>
<td>36%</td>
</tr>
<tr>
<td>N</td>
<td>120</td>
<td>2,800</td>
<td>18%</td>
<td>56%</td>
<td>56%</td>
</tr>
<tr>
<td>O</td>
<td>196</td>
<td>2,700</td>
<td>70%</td>
<td>71%</td>
<td>71%</td>
</tr>
<tr>
<td>P</td>
<td>706</td>
<td>310</td>
<td>42%</td>
<td>49%</td>
<td>49%</td>
</tr>
<tr>
<td>Q</td>
<td>385</td>
<td>500</td>
<td>68%</td>
<td>62%</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>462</td>
<td>1,700</td>
<td>82%</td>
<td>86%</td>
<td></td>
</tr>
</tbody>
</table>


Figure D.4 is a data plot that illustrates the relationship between transit mode share (for motorized trips) and rail transit station proximity at the non-CBD residential sites. The plot includes both the resident work/school trip transit mode shares and the mode shares for all resident trips.

For both plots, the trends of the relationships indicate the transit mode share decreases with increasing distance to the closest rail station. But neither plot produces a definitive and reliable fitted curve equation.
Appendix D: Key Research with Transit-Friendly Site Mode Share Data

Figure D.4 Resident Work/School Trip Transit Mode Share vs. Heavy Rail Transit Proximity for Non-CBD Residential Sites

![Graph showing transit mode share vs. distance to heavy rail station for non-CBD residential sites.]


Retail

Intercept surveys were conducted at five retail sites. Results are shown in Table D.5. The interviews took place throughout the day. One issue with data is how well the “all day” transit mode share characteristics correlate to AM or PM peak period characteristics.

Table D.5 Transit Mode Shares at Non-CBD Retail TOD (metropolitan Washington, DC)

<table>
<thead>
<tr>
<th></th>
<th>Site A</th>
<th>Site B</th>
<th>Site C</th>
<th>Site D</th>
<th>Site E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail Square Footage (000)</td>
<td>n.a.</td>
<td>151</td>
<td>490</td>
<td>108</td>
<td>n.a.</td>
</tr>
<tr>
<td>Distance to Heavy-Rail Transit (ft.)</td>
<td>0</td>
<td>0</td>
<td>800</td>
<td>1,200</td>
<td>1,700</td>
</tr>
<tr>
<td>% Transit for Motorized Trips</td>
<td>76%</td>
<td>57%</td>
<td>41%</td>
<td>64%</td>
<td>22%</td>
</tr>
</tbody>
</table>


A data plot for transit mode share of motorized trips at the non-downtown retail sites is shown in Figure D.5. The trend of the relationship indicates the transit mode share decreases with increasing distance to the closest rail station.
Figure D.5 Transit Mode Shares vs. Heavy Rail Transit Proximity at Non-CBD Retail TOD Sites


Hotel

A sample of guests and visitors at five hotels were intercepted and interviewed on a weekday between 7:00–10:00 a.m. Employees were excluded from interviews. Table D.6 summarizes the survey results. The precision of the mode share results could be questionable because of the small numbers of interviews conducted at the surveyed hotels. Data in the table should be viewed with caution.

Table D.6 AM Peak Period Transit Mode Shares for Guests and Visitors at Non-CBD Hotel TOD (metropolitan Washington, DC)

<table>
<thead>
<tr>
<th>Site</th>
<th>Site A</th>
<th>Site B</th>
<th>Site C</th>
<th>Site D</th>
<th>Site E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel Rooms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>198</td>
<td>700</td>
<td>221</td>
<td>242</td>
<td>685</td>
</tr>
<tr>
<td>Occupied</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Distance to Heavy Rail Transit (ft.)</td>
<td>0</td>
<td>550</td>
<td>1,700</td>
<td>1,800</td>
<td>4,100</td>
</tr>
<tr>
<td>% Transit for Motorized Trips by Guests</td>
<td>59%</td>
<td>59%</td>
<td>20%</td>
<td>18%</td>
<td>71%</td>
</tr>
</tbody>
</table>


Cinema/Entertainment

Patrons were interviewed at four movie theaters. The results are shown in Table D.7. The surveys were conducted on a weekday between the first and last showings. The "percent transit for motorized trips" values for three of the sites present a logical pattern, with transit percentages decreasing with...
increasing distance from a rail station. However, the one outlier in the pattern is the theater located closest to a rail station. Additional factors (such as price and availability of parking or site context) are likely to have an effect on the measured transit mode shares.

Table D.7 Transit Mode Shares at Non-CBD Movie Theater TOD (metropolitan Washington, DC)

<table>
<thead>
<tr>
<th></th>
<th>Site A</th>
<th>Site B</th>
<th>Site C</th>
<th>Site D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movie Screens</td>
<td>22</td>
<td>12</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Distance to Heavy Rail Transit (ft.)</td>
<td>700</td>
<td>800</td>
<td>1,400</td>
<td>2,200</td>
</tr>
<tr>
<td>% Transit for Motorized Trips</td>
<td>14%</td>
<td>53%</td>
<td>46%</td>
<td>37%</td>
</tr>
</tbody>
</table>


California Infill Trip Generation Study

Caltrans sponsored a project to study travel characteristics of infill development in California's metropolitan areas. The Caltrans report documents the results of trip generation data collection at 25 residential, office, retail, and restaurant infill sites. The report includes initial findings based on the limited data that were collected. The products of this study are expected to be the beginnings of a California urban infill trip generation database.

For the Caltrans study, an infill site is either within one-third mile of a rail transit station, is served by bus service at the junction of at least two major bus routes, or is located within 1,200 ft. of a BRT corridor. Because these criteria conform to the basic tenets of transit proximity for the purposes of Chapter 8 in this Handbook, trip generation data from the Caltrans sites are appropriate for inclusion as part of an overall TFD database.

Because the study sites are located in infill settings, a significant proportion of the site trips are by walk or bike. For nearly all of the residential and retail sites, more than one-third of the PM peak period trips are by walk or bike. Potential approaches for estimating these external walk/bike trips are addressed in the infill chapter (Chapter 7). Primary data of interest in this appendix are the percentage of transit trips of all motorized trips.

The modes of all trips to and from 11 residential infill sites during the morning and afternoon peak periods are reported in Table D.8. The table indicates whether the site is located in the metropolitan area CBD (three of the 11 are) and the type of transit near the site (heavy rail, light rail, or bus).

The modes of all trips to and from 10 retail infill sites during the morning and afternoon peak periods are reported in Table D.9. The table indicates the specific type of retail with the ITE Land Use Code, whether the site is located in the metropolitan area CBD (five of the 10 are), and the type of transit near the site (heavy rail, light rail, or bus).

---

Table D.10 presents the mode share information for four office sites surveyed. All four are located in the metropolitan area CBD. Two are located near heavy rail transit stations; two are located near significant bus transit service.

### Table D.8 Transit Mode Shares at Surveyed Residential TOD Sites in California

<table>
<thead>
<tr>
<th>Site A</th>
<th>Site B</th>
<th>Site C</th>
<th>Site D</th>
<th>Site E</th>
<th>Site F</th>
<th>Site G</th>
<th>Site H</th>
<th>Site I</th>
<th>Site J</th>
<th>Site K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro Area*</td>
<td>SF</td>
<td>SF</td>
<td>SF</td>
<td>SF</td>
<td>SF</td>
<td>SF</td>
<td>SD</td>
<td>SD</td>
<td>SF</td>
<td>LA</td>
</tr>
<tr>
<td>Location in CBD?</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Total Dwelling Units</td>
<td>44</td>
<td>99</td>
<td>71</td>
<td>35</td>
<td>56</td>
<td>100</td>
<td>149</td>
<td>211</td>
<td>443</td>
<td>133</td>
</tr>
<tr>
<td>Rail Transit Type</td>
<td>Heavy</td>
<td>Heavy</td>
<td>None</td>
<td>Heavy</td>
<td>Heavy</td>
<td>Heavy</td>
<td>Light</td>
<td>Light</td>
<td>Heavy</td>
<td>None</td>
</tr>
<tr>
<td>Distance to Rail Transit</td>
<td>0.17 miles</td>
<td>300 ft.</td>
<td>n.a.</td>
<td>0.17 miles</td>
<td>0.28 miles</td>
<td>0.36 miles</td>
<td>0.3 miles</td>
<td>0.3 miles</td>
<td>0.35 miles</td>
<td>n.a.</td>
</tr>
<tr>
<td>Distance to Bus Transit</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>1,200 ft.</td>
<td>1,200 ft.</td>
<td>1,200 ft.</td>
</tr>
</tbody>
</table>

| % Walk/Bike Trips | AM Peak Hour | 89% | 73% | 14% | 25% | 62% | 34% | 13% | 20% | 25% | 16% | 6% |
| PM Peak Hour | 66% | 71% | 35% | 74% | 73% | 62% | 31% | 20% | 34% | 35% | 10% |

| % Transit for Motorized Trips | AM Peak Hour | 100% | 26% | 34% | 67% | 45% | 33% | 2% | 4% | 81% | 35% |
| PM Peak Hour | 79% | 17% | 46% | 36% | 26% | 37% | 0% | 9% | 74% | 5% | 6% |


*“Metro Area” uses the following abbreviations: LA (Los Angeles), SD (San Diego), and SF (San Francisco).*

### Table D.9 Transit Mode Shares at Surveyed Retail TOD Sites in California

<table>
<thead>
<tr>
<th>Site A</th>
<th>Site B</th>
<th>Site C</th>
<th>Site D</th>
<th>Site E</th>
<th>Site F</th>
<th>Site G</th>
<th>Site H</th>
<th>Site I</th>
<th>Site J</th>
<th>Site K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro Area*</td>
<td>SD</td>
<td>SF</td>
<td>SF</td>
<td>SF</td>
<td>SF</td>
<td>SF</td>
<td>SD</td>
<td>SF</td>
<td>SF</td>
<td>SF</td>
</tr>
<tr>
<td>Location in CBD?</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Type Retail (ITE LUC)</td>
<td>850</td>
<td>920</td>
<td>Florist</td>
<td>925</td>
<td>933</td>
<td>936</td>
<td>936</td>
<td>936</td>
<td>876</td>
<td>933</td>
</tr>
<tr>
<td>Square Footage (000)</td>
<td>43.3</td>
<td>3</td>
<td>2.4</td>
<td>12</td>
<td>8</td>
<td>4.5</td>
<td>1.25</td>
<td>11</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Rail Transit Type</td>
<td>Light</td>
<td>Heavy</td>
<td>Heavy</td>
<td>Heavy</td>
<td>Heavy</td>
<td>Heavy</td>
<td>Light</td>
<td>Heavy</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Distance to Rail</td>
<td>0.3 miles</td>
<td>0.17 miles</td>
<td>0.17 miles</td>
<td>300 ft.</td>
<td>0.89 miles</td>
<td>0.28 miles</td>
<td>0.3 miles</td>
<td>50 ft.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Distance to Bus</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>50 ft.</td>
<td>50 ft.</td>
<td>50 ft.</td>
</tr>
</tbody>
</table>

| % Walk/Bike Trips | AM Peak Hour | 40% | n.a. | 0% | n.a. | 35% | 36% | 37% | n.a. | 58% | 50% |
| PM Peak Hour | 38% | 62% | 0% | 28% | 33% | 57% | 83% | 12% | 40% | 0% |

| % Transit for Motorized Trips | AM Peak Hour | 17% | n.a. | 0% | n.a. | 46% | 0% | 21% | n.a. | 20% | 0% |
| PM Peak Hour | 20% | 0% | 0% | 40% | 15% | 19% | 0% | 55% | 0% | 28% |


*“Metro Area” uses the following abbreviations: LA (Los Angeles), SD (San Diego), and SF (San Francisco).*
Table D.10 Transit Mode Shares at Surveyed Office TOD Sites in Metropolitan Area CBD

<table>
<thead>
<tr>
<th>Metro Areaa</th>
<th>Site A</th>
<th>Site B</th>
<th>Site C</th>
<th>Site D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Square Footage (000)</td>
<td>138.5</td>
<td>120</td>
<td>101.5</td>
<td>106</td>
</tr>
<tr>
<td>Rail Transit Type</td>
<td>Heavy</td>
<td>Heavy</td>
<td>none</td>
<td>None</td>
</tr>
<tr>
<td>Distance to Rail Transit</td>
<td>0.3 miles</td>
<td>0.6 miles</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Distance to Bus Transit</td>
<td>300 ft.</td>
<td>300 ft.</td>
<td>1,200 ft.</td>
<td>1,200 ft.</td>
</tr>
<tr>
<td>% Walk/Bike Trips</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM Peak Hour</td>
<td>1%</td>
<td>23%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>PM Peak Hour</td>
<td>0%</td>
<td>16%</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>% Transit for Motorized Trips</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM Peak Hour</td>
<td>4%</td>
<td>21%</td>
<td>5%</td>
<td>4%</td>
</tr>
<tr>
<td>PM Peak Hour</td>
<td>23%</td>
<td>37%</td>
<td>6%</td>
<td>2%</td>
</tr>
</tbody>
</table>

*aMetro Area* uses the following abbreviations: LA (Los Angeles), SD (San Diego), and SF (San Francisco).


Transit-Oriented Development—Trip Generation and Mode Split in the Portland, OR, Metropolitan Region

A Portland State University research report documents the collection of complete person trips by mode for two-hour periods in both the morning (7:00–9:00 a.m.) and afternoon (4:00–6:00 p.m.) for eight residential sites.11 Six of the sites are located near a light rail station; the other two are located along a major fixed-route bus line. All are outside the metropolitan area CBD.

Four of the sites are composed of only residences; the other four include relatively small amounts of first-floor commercial space along with the residences. The sites that include a commercial use have lower person trip generation rates (per dwelling unit). Therefore, it appears the commercial component of each site does not have a substantial effect on site trip generation and it is likely the site mode share information is appropriate regardless of whether the site includes a commercial use.

The report includes an analysis of potential relationships between transit mode share and residential density, and between transit mode share and apartment rental price.

Table D.11 lists the transit mode shares (for motorized trips) measured at each of the eight residential sites.

---

Table D.11 Transit Mode Shares at Surveyed Residential TOD Sites in Portland Metropolitan Area

<table>
<thead>
<tr>
<th></th>
<th>Site A</th>
<th>Site B</th>
<th>Site C</th>
<th>Site D</th>
<th>Site E</th>
<th>Site F</th>
<th>Site G</th>
<th>Site H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Units</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
<td>90</td>
<td>85</td>
<td>554</td>
<td>36</td>
<td>n.a.</td>
<td>208</td>
<td>283</td>
</tr>
<tr>
<td>Occupied</td>
<td>115</td>
<td>90</td>
<td>85</td>
<td>525</td>
<td>36</td>
<td>52</td>
<td>155</td>
<td>215</td>
</tr>
<tr>
<td>On-Site Commercial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sq. Ft. (000)</td>
<td>2.3</td>
<td>none</td>
<td>24</td>
<td>10</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>22</td>
</tr>
<tr>
<td>Distance to Transit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Rail</td>
<td>50 ft.</td>
<td>1 block</td>
<td>n.a.</td>
<td>500 ft.</td>
<td>n.a.</td>
<td>&lt; ¼ mile</td>
<td>¼–½ mile</td>
<td>¼–½ mile</td>
</tr>
<tr>
<td>Bus</td>
<td>50 ft.</td>
<td>1 block</td>
<td>1 block</td>
<td>500 ft.</td>
<td>2 blocks</td>
<td>&lt; ¼ mile</td>
<td>¼–½ mile</td>
<td>¼–½ mile</td>
</tr>
<tr>
<td>% Walk/Bike Trips</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM Peak Period</td>
<td>41%</td>
<td>16%</td>
<td>24%</td>
<td>3%</td>
<td>21%</td>
<td>7%</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>PM Peak Period</td>
<td>37%</td>
<td>10%</td>
<td>24%</td>
<td>4%</td>
<td>21%</td>
<td>8%</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>% Transit for Motorized Trips</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM Peak Period</td>
<td>48%</td>
<td>17%</td>
<td>20%</td>
<td>18%</td>
<td>11%</td>
<td>12%</td>
<td>16%</td>
<td>15%</td>
</tr>
<tr>
<td>PM Peak Period</td>
<td>42%</td>
<td>23%</td>
<td>13%</td>
<td>9%</td>
<td>13%</td>
<td>13%</td>
<td>12%</td>
<td>6%</td>
</tr>
</tbody>
</table>


A plot of the “percent transit for motorized trips” data and fitted curves for the six surveyed sites located near light rail stations is shown in Figure D.6. Both the AM and PM peak period data are shown. These transit percentages are significantly lower than the “heavy rail residential” curve presented earlier in Figure D.4. Only the residential site within 50 ft. of a light rail station has percentages that approach those measured at the Washington, DC area heavy rail stations.
Parking and Mode Split Study for Transit-Oriented Development

This report presents data collected at three apartment buildings. The sites range in size between 120 and 170 dwelling units. Based on the site descriptions, the survey sites are more like infill development than what is commonly considered TOD.

The sites are located close to the metropolitan area CBD. The sites generate high percentages of walk and bike trips (between 25 and 43 percent in the AM and between 20 and 39 percent in the PM). The nearest transit service is the Portland Streetcar.

AM and PM peak hour transit mode shares for trips (for motorized trips) to and from the three sites are listed in Table D.12.

---

Table D.12 Transit Mode Shares at Surveyed Residential TOD Sites  
(Portland, OR)

<table>
<thead>
<tr>
<th></th>
<th>Site A</th>
<th>Site B</th>
<th>Site C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>139</td>
<td>170</td>
</tr>
<tr>
<td>Occupied</td>
<td>120</td>
<td>139</td>
<td>170</td>
</tr>
<tr>
<td>On-Site Commercial (000 sf)</td>
<td>7.2</td>
<td>9.0</td>
<td>Yes</td>
</tr>
<tr>
<td>Distance to Transit</td>
<td>&lt; 1,300 ft.</td>
<td>600 ft.</td>
<td>1,200 ft.</td>
</tr>
<tr>
<td>% Walk/Bike Trips</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td>43%</td>
<td>30%</td>
<td>25%</td>
</tr>
<tr>
<td>PM</td>
<td>20%</td>
<td>26%</td>
<td>39%</td>
</tr>
<tr>
<td>% Transit for Motorized Trips</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM Peak Hour</td>
<td>16%</td>
<td>4%</td>
<td>5%</td>
</tr>
<tr>
<td>PM Peak Hour</td>
<td>18%</td>
<td>8%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Source: Data for these Tables Dxttracted from: Portland State University, ITE Student Chapter. Parking and Mode Split Study for Transit Oriented Development—Pearl District—Portland, Oregon. Portland State University, 2007.

Trip Generation and Parking Study: Oxford Plaza, Berkeley, CA

This study reports on data collected at a mid-rise apartment building for low-income households. The site has 97 dwelling units (with 95 percent occupancy) and has 40 on-site vehicle parking spaces and 54 on-site bicycle spaces. The closest BART (heavy rail transit) station is 300 ft. from the site. Bus transit service is extensive in the area.

Because of its tenant demographics and its close proximity to downtown Berkeley and the University of California campus, the site generates a high number of walk and bike trips to and from the campus (33 percent during the AM peak hour and 52 percent during the PM peak hour).

The percent transit for all motorized trips is 22 percent during the AM peak hour and 30 percent during the PM peak hour.

---

Appendix E. Database on Pass-By, Diverted, and Primary Trips

Listed in Table E.1 are the 25 land uses for which ITE has received and compiled pass-by and diverted trip data. The table denotes whether data are presented in this handbook in a table or a figure (in a data plot similar to those presented in *Trip Generation Manual* for vehicle trips data). Table E.1 also identifies the time periods for which data have been reported.

Tables E.2 through E.38 present the values for percentage of site generation that is accounted for as pass-by trips and non-pass-by trips (primary and diverted trips). For those surveys where data were available, the percentages for non-pass-by trips are further segregated by diverted trips and primary trips. The tables also provide the specific hours of data collection.

Figures E.1 through E.19 plot the average pass-by trip percentages associated with the various land uses. No plots are provided for diverted trips. These figures are provided to enable the user to visualize data scatter provided in Tables E.2 through E.38. Data plots are provided for each land use where nine or more data points are available for a specific independent variable.

For all land uses except shopping centers, data are plotted for only one independent variable. For shopping centers, data are plotted for both gross leasable area (GLA) and peak hour traffic on adjacent streets for the weekday PM peak period. GLA is also used as the independent variable for shopping centers during the mid-day Saturday time period.

A fitted curve equation is shown on the data plot if there are more than 10 points and the $R^2$ value is greater than 0.50 (which currently does not occur on any of the land use code data plots).

**Recommended guidelines for using data presented in these figures and tables are provided in Chapter 10 of this Handbook. In particular, the guidelines recommend when to use data and how to select a pass-by percentage.**

The pass-by data in this appendix were collected during **peak periods**. These pass-by relationships may differ from those during the **peak hour**.

Users of the data are cautioned that the number and geographic distribution of sites are limited. Little or no data on adjacent street traffic volumes have been collected for uses other than shopping centers. The actual pass-by and diverted trip percentages may vary by site due to the specific influences of the characteristics of passing traffic, area roadway network patterns, specific businesses in the site being analyzed, other nearby developments and so forth. Surveys of similar developments near the study site are encouraged.

Because data are limited for many of the land uses, the analyst is encouraged to collect pass-by trip data and transmit the data to ITE. Pass-by trips should be surveyed for the desired analysis hours. Adjacent street traffic volumes should also be determined for these hours. Chapter 12 of this *Handbook* provides guidance on conducting a pass-by and diverted trip survey, desirable sample sizes, and the suggested survey instrument.
<table>
<thead>
<tr>
<th>Land Use Code and Title</th>
<th>Time Period</th>
<th>Table</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>565 Day Care Center</td>
<td>Weekday, PM Peak Period</td>
<td>F.2</td>
<td>—</td>
</tr>
<tr>
<td>813 Free-Standing Discount Superstore</td>
<td>Weekday, PM Peak Period</td>
<td>F.3</td>
<td>F.1/F.2</td>
</tr>
<tr>
<td></td>
<td>Saturday, Mid-day Peak Period</td>
<td>F.4</td>
<td>F.3</td>
</tr>
<tr>
<td>814 Variety Store</td>
<td>Weekday, PM Peak Period</td>
<td>F.5</td>
<td>—</td>
</tr>
<tr>
<td>815 Free-Standing Discount Store</td>
<td>Weekday, PM Peak Period</td>
<td>F.6</td>
<td>F.4/F.5</td>
</tr>
<tr>
<td></td>
<td>Saturday, Mid-day Peak Period</td>
<td>F.7</td>
<td>F.6</td>
</tr>
<tr>
<td>816 Hardware/Paint Store</td>
<td>Weekday, PM Peak Period</td>
<td>F.8</td>
<td>—</td>
</tr>
<tr>
<td>820 Shopping Center</td>
<td>Weekday, PM Peak Period</td>
<td>F.9</td>
<td>F.7/F.8</td>
</tr>
<tr>
<td></td>
<td>Saturday, Mid-day Peak Period</td>
<td>F.10</td>
<td>F.9</td>
</tr>
<tr>
<td>843 Automobile Parts Sales</td>
<td>Weekday, PM Peak Period</td>
<td>F.11</td>
<td>—</td>
</tr>
<tr>
<td>848 Tire Store</td>
<td>Weekday, PM Peak Period</td>
<td>F.12</td>
<td>—</td>
</tr>
<tr>
<td>850 Supermarket</td>
<td>Weekday, PM Peak Period</td>
<td>F.13</td>
<td>F.10</td>
</tr>
<tr>
<td>851 Convenience Market (Open 24 Hours)</td>
<td>Weekday, PM Peak Period</td>
<td>F.14</td>
<td>—</td>
</tr>
<tr>
<td>853 Convenience Market with Gasoline Pumps</td>
<td>Weekday, AM Peak Period</td>
<td>F.15</td>
<td>F.11</td>
</tr>
<tr>
<td></td>
<td>Weekday, PM Peak Period</td>
<td>F.16</td>
<td>F.12/F.13</td>
</tr>
<tr>
<td>854 Discount Supermarket</td>
<td>Weekday, PM Peak Period</td>
<td>F.17</td>
<td>F.14</td>
</tr>
<tr>
<td>857 Discount Club</td>
<td>Weekday, PM Peak Period</td>
<td>F.18</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Saturday, Mid-day Peak Period</td>
<td>F.19</td>
<td>—</td>
</tr>
<tr>
<td>862 Home Improvement Superstore</td>
<td>Weekday, PM Peak Period</td>
<td>F.20</td>
<td>—</td>
</tr>
<tr>
<td>863 Electronics Superstore</td>
<td>Weekday, PM Peak Period</td>
<td>F.21</td>
<td>—</td>
</tr>
<tr>
<td>880 Pharmacy/Drugstore without Drive-Through Window</td>
<td>Weekday, PM Peak Period</td>
<td>F.22</td>
<td>—</td>
</tr>
<tr>
<td>881 Pharmacy/Drugstore with Drive-Through Window</td>
<td>Weekday, PM Peak Period</td>
<td>F.23</td>
<td>—</td>
</tr>
<tr>
<td>890 Furniture Store</td>
<td>Weekday, PM Peak Period</td>
<td>F.24</td>
<td>—</td>
</tr>
<tr>
<td>912 Drive-In Bank</td>
<td>Weekday, AM Peak Period</td>
<td>F.25</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Weekday, Mid-day Peak Period</td>
<td>F.26</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Weekday, PM Peak Period</td>
<td>F.27</td>
<td>F.15</td>
</tr>
<tr>
<td></td>
<td>Saturday, Mid-day Peak Period</td>
<td>F.28</td>
<td>—</td>
</tr>
<tr>
<td>931 Quality Restaurant</td>
<td>Weekday, PM Peak Period</td>
<td>F.29</td>
<td>—</td>
</tr>
<tr>
<td>932 High-Turnover (Sit-Down) Restaurant</td>
<td>Weekday, PM Peak Period</td>
<td>F.30</td>
<td>F.16</td>
</tr>
<tr>
<td>934 Fast-Food Restaurant with Drive-Through Window</td>
<td>Weekday, AM Peak Period</td>
<td>F.31</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Weekday, PM Peak Period</td>
<td>F.32</td>
<td>F.17</td>
</tr>
<tr>
<td>938 Coffee/Donut Shop with Drive-Through Window and No Indoor Seating (Coffee/Espresso Stand)</td>
<td>Weekday</td>
<td>F.33/F.34</td>
<td>—</td>
</tr>
<tr>
<td>944 Gasoline/Service Station</td>
<td>Weekday, AM Peak Period</td>
<td>F.35</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Weekday, PM Peak Period</td>
<td>F.36</td>
<td>—</td>
</tr>
<tr>
<td>945 Gasoline/Service Station with Convenience Market</td>
<td>Weekday, AM Peak Period</td>
<td>F.37</td>
<td>F.18</td>
</tr>
<tr>
<td></td>
<td>Weekday, PM Peak Period</td>
<td>F.38</td>
<td>F.19</td>
</tr>
</tbody>
</table>
### Table E.2 Pass-By and Non-Pass-By Trips
**Weekday, PM Peak Period**
**Land Use Code 565—Day Care Center**

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIP (%)</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5</td>
<td>Eugene, OR</td>
<td>May 2003</td>
<td>21</td>
<td>4:00–6:00 p.m.</td>
<td>0</td>
<td>42</td>
<td>58</td>
</tr>
<tr>
<td>8.3</td>
<td>Eugene, OR</td>
<td>May 2003</td>
<td>40</td>
<td>4:00–6:00 p.m.</td>
<td>0</td>
<td>46</td>
<td>54</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 0

### Table E.3
**Pass-By and Non-Pass-By Trips**
**Weekday, PM Peak Period**
**Land Use Code 813—Free-Standing Discount Superstore**

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIP (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>146</td>
<td>North Olmstead, OH</td>
<td>Sept. 1996</td>
<td>210</td>
<td>2:45–6:45 p.m.</td>
<td>35</td>
<td>—</td>
<td>69</td>
<td>3,346</td>
</tr>
<tr>
<td>130</td>
<td>Ashtabula, OH</td>
<td>Sept. 1996</td>
<td>204</td>
<td>2:45–6:45 p.m.</td>
<td>43</td>
<td>—</td>
<td>57</td>
<td>1,066</td>
</tr>
<tr>
<td>102</td>
<td>Bryan, OH</td>
<td>Nov. 1996</td>
<td>100</td>
<td>2:45–6:45 p.m.</td>
<td>37</td>
<td>—</td>
<td>63</td>
<td>737</td>
</tr>
<tr>
<td>102</td>
<td>Oxford, OH</td>
<td>Oct. 1996</td>
<td>137</td>
<td>2:45–6:45 p.m.</td>
<td>44</td>
<td>—</td>
<td>56</td>
<td>1,714</td>
</tr>
<tr>
<td>218</td>
<td>Euclid, OH</td>
<td>Sept. 1996</td>
<td>185</td>
<td>2:45–6:45 p.m.</td>
<td>29</td>
<td>—</td>
<td>71</td>
<td>1,764</td>
</tr>
<tr>
<td>173</td>
<td>Mansfield, OH</td>
<td>Oct. 1996</td>
<td>158</td>
<td>2:45–6:45 p.m.</td>
<td>17</td>
<td>—</td>
<td>83</td>
<td>1,622</td>
</tr>
<tr>
<td>167</td>
<td>Hillsboro, OH</td>
<td>Oct. 1996</td>
<td>172</td>
<td>2:45–6:45 p.m.</td>
<td>32</td>
<td>—</td>
<td>68</td>
<td>1,165</td>
</tr>
<tr>
<td>167</td>
<td>Mentor, OH</td>
<td>Sept. 1996</td>
<td>205</td>
<td>2:45–6:45 p.m.</td>
<td>26</td>
<td>—</td>
<td>74</td>
<td>1,771</td>
</tr>
<tr>
<td>205</td>
<td>Louisville, KY</td>
<td>Sept./Nov. 2007</td>
<td>196</td>
<td>3:00–7:00 p.m.</td>
<td>32</td>
<td>—</td>
<td>68</td>
<td>7,048</td>
</tr>
<tr>
<td>216</td>
<td>Pasadena, TX</td>
<td>Sept.-Nov. 2007</td>
<td>404</td>
<td>3:00–7:00 p.m.</td>
<td>26</td>
<td>—</td>
<td>74</td>
<td>10,832</td>
</tr>
<tr>
<td>213</td>
<td>Cedar Falls, IA</td>
<td>Sept.-Nov. 2007</td>
<td>197</td>
<td>3:00–7:00 p.m.</td>
<td>36</td>
<td>—</td>
<td>64</td>
<td>8,411</td>
</tr>
<tr>
<td>204</td>
<td>Puebla, CO</td>
<td>Sept.-Nov. 2007</td>
<td>180</td>
<td>3:00–7:00 p.m.</td>
<td>14</td>
<td>—</td>
<td>86</td>
<td>3,524</td>
</tr>
<tr>
<td>185</td>
<td>Plano, IL</td>
<td>Sept.-Nov. 2007</td>
<td>182</td>
<td>3:00–7:00 p.m.</td>
<td>13</td>
<td>—</td>
<td>87</td>
<td>3,957</td>
</tr>
<tr>
<td>217</td>
<td>Shabghoan, WI</td>
<td>Sept.-Nov. 2007</td>
<td>490</td>
<td>3:00–7:00 p.m.</td>
<td>25</td>
<td>—</td>
<td>75</td>
<td>8,835</td>
</tr>
<tr>
<td>213</td>
<td>San Antonio, TX</td>
<td>Sept.-Nov. 2007</td>
<td>621</td>
<td>3:00–7:00 p.m.</td>
<td>29</td>
<td>—</td>
<td>71</td>
<td>12,523</td>
</tr>
<tr>
<td>226</td>
<td>Colonial Heights, VA</td>
<td>Sept.-Nov. 2007</td>
<td>288</td>
<td>3:00–7:00 p.m.</td>
<td>24</td>
<td>—</td>
<td>76</td>
<td>13,026</td>
</tr>
<tr>
<td>220</td>
<td>Milford, PA</td>
<td>Sept.-Nov. 2007</td>
<td>119</td>
<td>3:00–7:00 p.m.</td>
<td>34</td>
<td>—</td>
<td>66</td>
<td>5,809</td>
</tr>
<tr>
<td>222</td>
<td>Marysville, CA</td>
<td>Sept.-Nov. 2007</td>
<td>686</td>
<td>3:00–7:00 p.m.</td>
<td>34</td>
<td>—</td>
<td>66</td>
<td>6,910</td>
</tr>
<tr>
<td>199</td>
<td>Pensacola, FL</td>
<td>May 2010</td>
<td>341</td>
<td>3:00–8:00 p.m.</td>
<td>29</td>
<td>—</td>
<td>71</td>
<td>1,360</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 29

"—" means no data were provided
Figure E.1 Free-Standing Discount Superstore (813)

Average Pass-By Trip Percentage vs: 1000 Sq. Feet Gross Floor Area
On a: Weekday, P.M. Peak Period

Number of Studies: 19
Average 1000 Sq. Feet GFA: 186

Data Plot

Actual Data Points

Fitted Curve Equation: Not given

$R^2 = ****$
Figure E.2 Free-Standing Discount Superstore (813)

Average Pass-By Trip Percentage vs: P.M. Peak Hour Traffic on Adjacent Street
On a: Weekday, P.M. Peak Period
Number of Studies: 11
Avg. P.M. Peak Hr. Traf. on Adj. Street: 7,476

Data Plot

Fitted Curve Equation: Not given

$R^2 = ****$
### Table E.4 Pass-By and Non-Pass-By Trips Saturday, Mid-Day Peak Period

**Land Use Code 813—Free-Standing Discount Superstore**

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIP (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Louisville, KY</td>
<td>Sept.-Nov. 2007</td>
<td>360</td>
<td>12:00–4:00 p.m.</td>
<td>28</td>
<td>—</td>
<td>72</td>
<td>6,144</td>
</tr>
<tr>
<td></td>
<td>Pasadena, TX</td>
<td>Sept.-Nov. 2007</td>
<td>240</td>
<td>12:00–4:00 p.m.</td>
<td>16</td>
<td>—</td>
<td>84</td>
<td>11,898</td>
</tr>
<tr>
<td></td>
<td>Cedar Falls, IA</td>
<td>Sept.-Nov. 2007</td>
<td>156</td>
<td>12:00–4:00 p.m.</td>
<td>13</td>
<td>—</td>
<td>87</td>
<td>7,484</td>
</tr>
<tr>
<td></td>
<td>Pueblo, CO</td>
<td>Sept.-Nov. 2007</td>
<td>300</td>
<td>12:00–4:00 p.m.</td>
<td>11</td>
<td>—</td>
<td>89</td>
<td>4,764</td>
</tr>
<tr>
<td></td>
<td>Plano, IL</td>
<td>Sept.-Nov. 2007</td>
<td>162</td>
<td>12:00–4:00 p.m.</td>
<td>18</td>
<td>—</td>
<td>82</td>
<td>3,871</td>
</tr>
<tr>
<td></td>
<td>Sheboygan, WI</td>
<td>Sept.-Nov. 2007</td>
<td>441</td>
<td>12:00–4:00 p.m.</td>
<td>22</td>
<td>—</td>
<td>78</td>
<td>8,256</td>
</tr>
<tr>
<td></td>
<td>San Antonio, TX</td>
<td>Sept.-Nov. 2007</td>
<td>748</td>
<td>12:00–4:00 p.m.</td>
<td>28</td>
<td>—</td>
<td>72</td>
<td>12,332</td>
</tr>
<tr>
<td></td>
<td>Colonial Heights, VA</td>
<td>Sept.-Nov. 2007</td>
<td>270</td>
<td>12:00–4:00 p.m.</td>
<td>26</td>
<td>—</td>
<td>74</td>
<td>12,995</td>
</tr>
<tr>
<td></td>
<td>Milford, PA</td>
<td>Sept.-Nov. 2007</td>
<td>123</td>
<td>12:00–4:00 p.m.</td>
<td>26</td>
<td>—</td>
<td>74</td>
<td>7,024</td>
</tr>
<tr>
<td></td>
<td>Marysville, CA</td>
<td>Sept.-Nov. 2007</td>
<td>810</td>
<td>12:00–4:00 p.m.</td>
<td>25</td>
<td>—</td>
<td>75</td>
<td>5,429</td>
</tr>
</tbody>
</table>

*Average Pass-By Trip Percentage: 21*

*"—" means no data were provided*
Figure E.3 Free-Standing Discount Superstore (813)

Average Pass-By Trip Percentage vs: 1000 Sq. Feet Gross Floor Area
On a: Saturday, Midday Peak Period
Number of Studies: 10
Average 1000 Sq. Feet GFA: 212

Data Plot

Fitted Curve Equation: Not given

Actual Data Points

R² = ****
### Table E.5 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period

**Land Use Code 814—Variety Store**

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIP (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PRIMARY</td>
<td>DIVERTED</td>
<td>TOTAL</td>
</tr>
<tr>
<td>8</td>
<td>Tallahassee, FL</td>
<td>May 2010</td>
<td>145</td>
<td>3:00–7:00 p.m.</td>
<td>39</td>
<td>—</td>
<td>70</td>
</tr>
<tr>
<td>10</td>
<td>Jacksonville, FL</td>
<td>May 2010</td>
<td>127</td>
<td>3:00–7:00 p.m.</td>
<td>34</td>
<td>—</td>
<td>66</td>
</tr>
<tr>
<td>10</td>
<td>Tampa, FL</td>
<td>May 2010</td>
<td>247</td>
<td>3:00–7:00 p.m.</td>
<td>40</td>
<td>—</td>
<td>60</td>
</tr>
<tr>
<td>17</td>
<td>Tampa, FL</td>
<td>May 2010</td>
<td>50</td>
<td>3:00–7:00 p.m.</td>
<td>22</td>
<td>—</td>
<td>78</td>
</tr>
<tr>
<td>10</td>
<td>Daytona Beach, FL</td>
<td>May 2010</td>
<td>154</td>
<td>3:00–7:00 p.m.</td>
<td>44</td>
<td>—</td>
<td>56</td>
</tr>
</tbody>
</table>

**Average Pass-By Trip Percentage: 34**

“—” means no data were provided

### Table E.6 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period

**Land Use Code 815—Free-Standing Discount Store**

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIP (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PRIMARY</td>
<td>DIVERTED</td>
<td>TOTAL</td>
</tr>
<tr>
<td>116</td>
<td>Auburn, NY</td>
<td>Nov. 1994</td>
<td>80</td>
<td>4:00–6:00 p.m.</td>
<td>29</td>
<td>34</td>
<td>71</td>
</tr>
<tr>
<td>116</td>
<td>Fredonia, NY</td>
<td>Nov. 1994</td>
<td>80</td>
<td>4:00–6:00 p.m.</td>
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<td>122</td>
<td>Marlton, NJ</td>
<td>Nov. 1994</td>
<td>73</td>
<td>4:15–5:15 p.m.</td>
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<td>23</td>
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<td>Nov. 1994</td>
<td>137</td>
<td>4:00–5:00 p.m.</td>
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<td>Nov. 1994</td>
<td>89</td>
<td>4:00–5:00 p.m.</td>
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<td>60</td>
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<tr>
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<td>Nov. 1994</td>
<td>48</td>
<td>4:15–5:15 p.m.</td>
<td>8</td>
<td>42</td>
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<tr>
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<td>Nov. 1994</td>
<td>58</td>
<td>4:00–5:00 p.m.</td>
<td>14</td>
<td>47</td>
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<tr>
<td>126</td>
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<td>Feb. 1994</td>
<td>45</td>
<td>4:30–5:30 p.m.</td>
<td>7</td>
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<td>22</td>
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<td>Sept. 1994</td>
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<td>Sept. 1994</td>
<td>83</td>
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<td>Sept. 1994</td>
<td>117</td>
<td>4:30–5:30 p.m.</td>
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<td>47</td>
<td>73</td>
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<td>—</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>23</td>
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<td>—</td>
<td>4:00–6:00 p.m.</td>
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<td>100</td>
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<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>29</td>
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<td>51</td>
</tr>
<tr>
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<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>19</td>
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<td>19</td>
<td>21</td>
<td>60</td>
</tr>
</tbody>
</table>

**Average Pass-By Trip Percentage: 17**

“—” means no data were provided
Figure E.4 Free-Standing Discount Store (815)

Average Pass-By Trip Percentage vs: 1000 Sq. Feet Gross Floor Area
On a: Weekday, P.M. Peak Period
Number of Studies: 22
Average 1000 Sq. Feet GFA: 118

Data Plot

Fitted Curve Equation: Not given

R² = ****
Figure E.5 Free-Standing Discount Store (815)

Average Pass-By Trip Percentage vs: P.M. Peak Hour Traffic on Adjacent Street
On a: Weekday, P.M. Peak Period
Number of Studies: 17
Avg. P.M. Peak Hr. Traf. on Adj. Street: 1,941

Data Plot

Fitted Curve Equation: Not given
$R^2 = ****$
Figure E.6 Free-Standing Discount Store (815)

Average Pass-By Trip Percentage vs: 1000 Sq. Feet Gross Floor Area
On a: Saturday, Midday Peak Period
Number of Studies: 9
Average 1000 Sq. Feet GFA: 125

Data Plot

Fitted Curve Equation: Not given  \( R^2 = **** \)
Table E.7 Pass-By and Non-Pass-By Trips Saturday, Mid-Day Peak Period
Land Use Code 815—Free-Standing Discount Store

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIMEPERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>116</td>
<td>Auburn, NY</td>
<td>Oct. 1994</td>
<td>80</td>
<td>11:30 a.m.–12:30 p.m.</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>70</td>
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<tr>
<td>116</td>
<td>Fredonia, NY</td>
<td>Nov. 1994</td>
<td>80</td>
<td>11:00 a.m.–12:00 p.m.</td>
<td>46</td>
<td>34</td>
<td>20</td>
<td>54</td>
</tr>
<tr>
<td>122</td>
<td>Marlton, NJ</td>
<td>Nov. 1994</td>
<td>36</td>
<td>1:45–2:45 p.m.</td>
<td>25</td>
<td>42</td>
<td>33</td>
<td>75</td>
</tr>
<tr>
<td>127</td>
<td>Toms River, NJ</td>
<td>Nov. 1994</td>
<td>112</td>
<td>12:30–1:30 p.m.</td>
<td>15</td>
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<td>11</td>
<td>85</td>
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<tr>
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<td>61</td>
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<td>80</td>
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<tr>
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<td>8</td>
<td>58</td>
<td>34</td>
<td>92</td>
</tr>
<tr>
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<td>Feb. 1994</td>
<td>94</td>
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<td>11</td>
<td>88</td>
<td>1</td>
<td>89</td>
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<td>131</td>
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<td>85</td>
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<td>96</td>
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<td>44</td>
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</table>

Average Pass-By Trip Percentage: 23

Table E.8 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 816—Hardware/Paint Store

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Aloha, OR</td>
<td>Nov. 1999</td>
<td>64</td>
<td>4:00–6:00 p.m.</td>
<td>30</td>
<td>44</td>
<td>26</td>
</tr>
<tr>
<td>7.5</td>
<td>Cedar Hills, OR</td>
<td>Nov. 1999</td>
<td>33</td>
<td>4:00–6:00 p.m.</td>
<td>21</td>
<td>46</td>
<td>33</td>
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</table>

Average Pass-By Trip Percentage: 26
Table E.9 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 820—Shopping Center

<table>
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<tr>
<th>SIZE (1,000 SQ. FT. GLA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIP (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>AVERAGE 24-HOUR TRAFFIC</th>
<th>SOURCE</th>
</tr>
</thead>
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<tr>
<td>53</td>
<td>Port Orange, FL</td>
<td>1993</td>
<td>162</td>
<td>2:00–6:00 p.m.</td>
<td>59</td>
<td>—</td>
<td>41</td>
<td>—</td>
<td>TPD Inc.</td>
</tr>
<tr>
<td>9</td>
<td>Kissimmee, FL</td>
<td>1994</td>
<td>107</td>
<td>2:00–6:00 p.m.</td>
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<td>20</td>
<td>14</td>
<td>34</td>
<td>TPD Inc.</td>
</tr>
<tr>
<td>77</td>
<td>Edgewater, FL</td>
<td>1992</td>
<td>365</td>
<td>2:00–6:00 p.m.</td>
<td>46</td>
<td>—</td>
<td>54</td>
<td>—</td>
<td>TPD Inc.</td>
</tr>
<tr>
<td>82</td>
<td>Deltona, FL</td>
<td>1992</td>
<td>336</td>
<td>2:00–6:00 p.m.</td>
<td>34</td>
<td>—</td>
<td>66</td>
<td>—</td>
<td>TPD Inc.</td>
</tr>
<tr>
<td>78</td>
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<td>1991</td>
<td>702</td>
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<td>22</td>
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<tr>
<td>45</td>
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<td>844</td>
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<td>56</td>
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<td>20</td>
<td>44</td>
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<tr>
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<td>58</td>
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<tr>
<td>17</td>
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<td>196</td>
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<td>158</td>
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<tr>
<td>118</td>
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<td>Barton-Aschman Assoc.</td>
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</tr>
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<td>22</td>
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<td>ICSC</td>
</tr>
<tr>
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<tr>
<td>SIZE (1,000 SQ FT GLA)</td>
<td>LOCATION</td>
<td>WEEKDAY</td>
<td>SURVEY DATE</td>
<td>NO. OF INTERVIEWS</td>
<td>TIME PERIOD</td>
<td>PASS-BY TRIP (%)</td>
<td>NON-PASS-BY TRIP (%)</td>
<td>ADJ. STREET PEAK HOUR VOLUME</td>
<td>AVERAGE 24-HOUR TRAFFIC</td>
</tr>
<tr>
<td>------------------------</td>
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<td>228</td>
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<td>240</td>
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<td>73</td>
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### Table E.9 (Cont’d) Pass-By and Non-Pass-By Trips Weekday, PM

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<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIP (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>AVERAGE 24-HOUR TRAFFIC</th>
<th>SOURCE</th>
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Appendix E: Database on Pass-By, Diverted, and Primary Trips 189
Table E.9 (Cont’d) Pass-By and Non-Pass-By Trips Weekday, PM Peak Period Land Use Code 820—Shopping Center

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<tr>
<th>SIZE (1,000 SQ. FT. GLA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIP (%)</th>
<th>ADJ. STREET PEAK HOUR TRAFFIC</th>
<th>AVERAGE 24-HOUR TRAFFIC</th>
<th>SOURCE</th>
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Table E.9 (Cont’d) Pass-By and Non-Pass-By Trips Weekday, PM Peak Period Land Use Code 820—Shopping Center

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<th>SIZE (1,000 SQ. FT. GLA)</th>
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<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIP (%)</th>
<th>ADJ. STREET PEAK HOUR TRAFFIC</th>
<th>AVERAGE 24-HOUR TRAFFIC</th>
<th>SOURCE</th>
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<tr>
<td>150</td>
<td>Portland, OR</td>
<td>—</td>
<td>655</td>
<td>4:00–6:00 p.m.</td>
<td>65</td>
<td>7</td>
<td>28</td>
<td>35</td>
<td>—</td>
</tr>
<tr>
<td>760</td>
<td>Calgary, Alberta</td>
<td>Oct.-Dec. 1987</td>
<td>15,436</td>
<td>4:00–6:00 p.m.</td>
<td>20</td>
<td>39</td>
<td>41</td>
<td>80</td>
<td>—</td>
</tr>
<tr>
<td>178</td>
<td>Bordentown, NJ</td>
<td>Apr. 1989</td>
<td>154</td>
<td>2:00–6:00 p.m.</td>
<td>35</td>
<td>—</td>
<td>65</td>
<td>—</td>
<td>37,983</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 34
“—” means no data were provided
Figure E.7 Shopping Center (820)

Average Pass-By Trip Percentage vs: 1000 Sq. Feet Gross Leasable Area
On a: Weekday, P.M. Peak Period

Number of Studies: 100
Average 1000 Sq. Feet GLA: 329

Data Plot

X = 1000 Sq. Feet Gross Leasable Area

T = Average Pass-By Trip Percentage

Actual Data Points

Fitted Curve Equation: Not given

\( R^2 = **** \)
Figure E.8 Shopping Center (820)

Average Pass-By Trip Percentage vs: PM Peak Hour Traffic on Adjacent Street
On: Weekday, PM Peak Period
Number of Studies: 28
Average PM Peak Hr. Traf. On Adj. Street: 3,122

Data Plot

- Actual Data Points
- Fitted Curve Equation: Not given
- $R^2 = ****$
### Table E.10 Pass-By and Non-Pass-By Trips Saturday, Mid-Day Peak Period

#### Land Use Code 820—Shopping Center

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>720</td>
<td>Framingham, MA</td>
<td>Feb. 1984</td>
<td>258</td>
<td>11:00 a.m.–4:00 p.m.</td>
<td>23</td>
<td>34</td>
<td>43</td>
<td>77</td>
</tr>
<tr>
<td>600</td>
<td>Brandywine, DE</td>
<td>Apr. 1983</td>
<td>256</td>
<td>10:00 a.m.–3:00 p.m.</td>
<td>17</td>
<td>50</td>
<td>33</td>
<td>83</td>
</tr>
<tr>
<td>880</td>
<td>Christiana, DE</td>
<td>July 1984</td>
<td>198</td>
<td>11:00 a.m.–4:00 p.m.</td>
<td>5</td>
<td>55</td>
<td>40</td>
<td>95</td>
</tr>
<tr>
<td>234</td>
<td>Huntington LI, NY</td>
<td>Nov. 1985</td>
<td>223</td>
<td>11:00 a.m.–3:00 p.m.</td>
<td>39</td>
<td>22</td>
<td>39</td>
<td>61</td>
</tr>
<tr>
<td>658</td>
<td>Wayne, NJ</td>
<td>Sept. 1984</td>
<td>329</td>
<td>11:00 a.m.–4:00 p.m.</td>
<td>46</td>
<td>44</td>
<td>10</td>
<td>54</td>
</tr>
<tr>
<td>622</td>
<td>Ramsey Cnty, MN</td>
<td>Nov. 1985</td>
<td>119</td>
<td>11:00 a.m.–3:00 p.m.</td>
<td>23</td>
<td>21</td>
<td>56</td>
<td>77</td>
</tr>
<tr>
<td>736</td>
<td>Pensacola, FL</td>
<td>Oct. 1985</td>
<td>680</td>
<td>11:00 a.m.–3:00 p.m.</td>
<td>20</td>
<td>31</td>
<td>49</td>
<td>80</td>
</tr>
<tr>
<td>430</td>
<td>Ross, PA</td>
<td>June 1980</td>
<td>425</td>
<td>11:00 a.m.–4:00 p.m.</td>
<td>22</td>
<td>—</td>
<td>—</td>
<td>78</td>
</tr>
<tr>
<td>176</td>
<td>Tampa Springs, FL</td>
<td>May 1986</td>
<td>188</td>
<td>11:00 a.m.–3:00 p.m.</td>
<td>31</td>
<td>42</td>
<td>27</td>
<td>69</td>
</tr>
<tr>
<td>144</td>
<td>Manalapan, NJ</td>
<td>July 1990</td>
<td>264</td>
<td>11:00 a.m.–3:15 p.m.</td>
<td>31</td>
<td>47</td>
<td>22</td>
<td>69</td>
</tr>
<tr>
<td>549</td>
<td>Natick, MA</td>
<td>Feb. 1989</td>
<td>—</td>
<td>2:15–3:15 p.m.</td>
<td>28</td>
<td>39</td>
<td>33</td>
<td>72</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 26

“—” means no data were provided.
Figure E.9 Shopping Center (820)

Average Pass-By Trip Percentage vs: 1000 Sq. Feet Gross Leasable Area
On a: Saturday
Number of Studies: 11
Average 1000 Sq. Feet GLA: 523

Data Plot

Fitted Curve Equation: Not given  \( R^2 = \text{****} \)
### Table E.11 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period

**Land Use Code 843—Automobile Parts Sales**

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Orlando, FL</td>
<td>1995</td>
<td>409</td>
<td>2:00–6:00 p.m.</td>
<td>43</td>
<td>44 13 57</td>
<td>—</td>
<td>TPD Inc.</td>
</tr>
</tbody>
</table>

"—" means no data were provided

### Table E.12 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period

**Land Use Code 848—Tire Store**

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.9</td>
<td>Orlando, FL</td>
<td>1995</td>
<td>178</td>
<td>2:00–6:00 p.m.</td>
<td>23</td>
<td>67 10 77</td>
<td>—</td>
<td>TPD Inc.</td>
</tr>
<tr>
<td>2.8</td>
<td>Land O’ Lakes, FL</td>
<td>1995</td>
<td>46</td>
<td>2:00–6:00 p.m.</td>
<td>26</td>
<td>— — 74</td>
<td>—</td>
<td>TPD Inc.</td>
</tr>
<tr>
<td>4.7</td>
<td>Orlando, FL</td>
<td>1988</td>
<td>22</td>
<td>2:00–6:00 p.m.</td>
<td>36</td>
<td>— — 64</td>
<td>—</td>
<td>TPD Inc.</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 28

"—“ means no data were provided
Table E.13 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period

Land Use Code 850—Supermarket

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>AVERAGE DAILY TRAFFIC</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Overland Park, KS</td>
<td>1987</td>
<td>40</td>
<td>4:30–5:30 p.m.</td>
<td>32</td>
<td>48 20 68</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>&lt;25</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>155</td>
<td>3:00–6:00 p.m.</td>
<td>56</td>
<td>— — 44</td>
<td>—</td>
<td>Kenig, O'Hara, Humes, Flock</td>
</tr>
<tr>
<td>&lt;25</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>191</td>
<td>3:00–6:00 p.m.</td>
<td>57</td>
<td>— — 43</td>
<td>—</td>
<td>Kenig, O'Hara, Humes, Flock</td>
</tr>
<tr>
<td>&lt;25</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>113</td>
<td>3:00–6:00 p.m.</td>
<td>56</td>
<td>— — 44</td>
<td>—</td>
<td>Kenig, O'Hara, Humes, Flock</td>
</tr>
<tr>
<td>34</td>
<td>Omaha, NE</td>
<td>—</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>44</td>
<td>29 27 56</td>
<td>15,200</td>
<td>University of Nebraska–Lincoln</td>
</tr>
<tr>
<td>66</td>
<td>Omaha, NE</td>
<td>—</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>23</td>
<td>30 47 77</td>
<td>63,000</td>
<td>University of Nebraska–Lincoln</td>
</tr>
<tr>
<td>70</td>
<td>Omaha, NE</td>
<td>—</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>26</td>
<td>30 44 74</td>
<td>34,300</td>
<td>University of Nebraska–Lincoln</td>
</tr>
<tr>
<td>31</td>
<td>Omaha, NE</td>
<td>—</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>19</td>
<td>36 45 81</td>
<td>48,700</td>
<td>University of Nebraska–Lincoln</td>
</tr>
<tr>
<td>31</td>
<td>Omaha, NE</td>
<td>—</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>28</td>
<td>40 32 72</td>
<td>23,500</td>
<td>University of Nebraska–Lincoln</td>
</tr>
<tr>
<td>55</td>
<td>Omaha, NE</td>
<td>—</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>27</td>
<td>35 38 73</td>
<td>27,200</td>
<td>University of Nebraska–Lincoln</td>
</tr>
<tr>
<td>65</td>
<td>Omaha, NE</td>
<td>—</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>25</td>
<td>25 50 75</td>
<td>44,700</td>
<td>University of Nebraska–Lincoln</td>
</tr>
<tr>
<td>31</td>
<td>Orlando, FL</td>
<td>1993</td>
<td>440</td>
<td>2:00–6:00 p.m.</td>
<td>35</td>
<td>— — 65</td>
<td>—</td>
<td>TPD Inc.</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 36

“—” means no data were provided
Figure E.10 Supermarket (850)

Average Pass-By Trip Percentage vs: 1,000 Sq. Ft. Gross Floor Area
On: Weekday, PM Peak Period
Number of Studies: 9
Average 1,000 Sq. Ft. GFA: 46

Data Plot

Actual Data Points

Fitted Curve Equation: Not given

$r^2 = ****$
Table E.14 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 851—Convenience Market (Open 24 Hours)

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PRIMARY</td>
<td>DIVERTED</td>
<td>TOTAL</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>34</td>
<td></td>
<td>53</td>
<td>13</td>
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<tr>
<td></td>
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<td></td>
<td>50</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Billings, MT</td>
<td>1987</td>
<td>461</td>
<td>4:00–6:00 p.m.</td>
<td>62</td>
<td></td>
<td>13</td>
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</tr>
<tr>
<td></td>
<td></td>
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<td>28</td>
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<td>---</td>
<td>---</td>
</tr>
<tr>
<td>+50.0</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>72</td>
<td>3:00–6:00 p.m.</td>
<td>78</td>
<td></td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>+50.0</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>54</td>
<td>3:00–6:00 p.m.</td>
<td>69</td>
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<td>---</td>
<td>---</td>
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<tr>
<td>+50.0</td>
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<td>1987</td>
<td>34</td>
<td>3:00–6:00 p.m.</td>
<td>69</td>
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<td>100</td>
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<td>63</td>
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<td>+50.0</td>
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<td>1987</td>
<td>43</td>
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<td>135</td>
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<td>39</td>
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<td>---</td>
</tr>
<tr>
<td>+50.0</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>74</td>
<td>3:00–6:00 p.m.</td>
<td>53</td>
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<tr>
<td>+50.0</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>80</td>
<td>3:00–6:00 p.m.</td>
<td>64</td>
<td></td>
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</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 51
"—" means no data were provided

Table E.15 Pass-By and Non-Pass-By Trips Weekday, AM Peak Period
Land Use Code 853—Convenience Market with Gasoline Pumps

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>PRIMARY</td>
<td>DIVERTED</td>
<td>TOTAL</td>
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</tr>
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<td>6</td>
<td>38</td>
</tr>
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<td></td>
<td>67</td>
<td></td>
<td>4</td>
<td>29</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 63
"—" means no data were provided
Figure E.11 Convenience Market with Gasoline Pumps (853)

Average Pass-By Trip Percentage vs: 1000 Sq. Feet Gross Floor Area
On a: Weekday, A.M. Peak Period
Number of Studies: 9
Average 1000 Sq. Feet GFA: 3

Data Plot

Fitted Curve Equation: Not given

R² = ****
Table E.16 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 853—Convenience Market with Gasoline Pumps

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY</th>
<th>SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>62</td>
<td>11</td>
<td>27</td>
<td>38</td>
</tr>
<tr>
<td>2.4</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>58</td>
<td>13</td>
<td>29</td>
<td>42</td>
</tr>
<tr>
<td>4.2</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>61</td>
<td>4:00–6:00 p.m.</td>
<td>58</td>
<td>26</td>
<td>16</td>
<td>42</td>
</tr>
<tr>
<td>2.6</td>
<td>Crestwood, KY</td>
<td>1993</td>
<td>68</td>
<td>4:00–6:00 p.m.</td>
<td>67</td>
<td>15</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td>3.7</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>70</td>
<td>4:00–6:00 p.m.</td>
<td>61</td>
<td>16</td>
<td>23</td>
<td>39</td>
</tr>
<tr>
<td>3.0</td>
<td>New Albany, IN</td>
<td>1993</td>
<td>80</td>
<td>4:00–6:00 p.m.</td>
<td>65</td>
<td>15</td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>2.3</td>
<td>Louisville, KY</td>
<td>1993</td>
<td>67</td>
<td>4:00–6:00 p.m.</td>
<td>57</td>
<td>16</td>
<td>27</td>
<td>43</td>
</tr>
<tr>
<td>2.2</td>
<td>New Albany, IN</td>
<td>1993</td>
<td>115</td>
<td>4:00–6:00 p.m.</td>
<td>48</td>
<td>16</td>
<td>36</td>
<td>52</td>
</tr>
<tr>
<td>3.6</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>60</td>
<td>4:00–6:00 p.m.</td>
<td>56</td>
<td>17</td>
<td>27</td>
<td>44</td>
</tr>
<tr>
<td>2.6</td>
<td>Seminole Co., FL</td>
<td>1989</td>
<td>82</td>
<td>4:00–6:00 p.m.</td>
<td>73</td>
<td>20</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>2.6</td>
<td>Seminole Co., FL</td>
<td>1989</td>
<td>98</td>
<td>4:00–6:00 p.m.</td>
<td>81</td>
<td>15</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>2.6</td>
<td>Seminole Co., FL</td>
<td>1989</td>
<td>115</td>
<td>4:00–6:00 p.m.</td>
<td>69</td>
<td>18</td>
<td>15</td>
<td>31</td>
</tr>
<tr>
<td>2.6</td>
<td>Volusia Co., FL</td>
<td>1989</td>
<td>98</td>
<td>4:00–6:00 p.m.</td>
<td>74</td>
<td>15</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>2.4</td>
<td>Volusia Co., FL</td>
<td>1989</td>
<td>38</td>
<td>4:00–6:00 p.m.</td>
<td>74</td>
<td>24</td>
<td>2</td>
<td>26</td>
</tr>
<tr>
<td>2.7</td>
<td>Volusia Co., FL</td>
<td>1989</td>
<td>82</td>
<td>4:00–6:00 p.m.</td>
<td>87</td>
<td>8</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>2.6</td>
<td>Seminole Co., FL</td>
<td>1989</td>
<td>99</td>
<td>2:00–4:00 p.m.</td>
<td>64</td>
<td>28</td>
<td>8</td>
<td>36</td>
</tr>
<tr>
<td>2.4</td>
<td>Volusia Co., FL</td>
<td>1989</td>
<td>38</td>
<td>2:00–4:00 p.m.</td>
<td>68</td>
<td>21</td>
<td>11</td>
<td>32</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 66
“—“ means no data were provided
Appendix E: Database on Pass-By, Diverted, and Primary Trips

Figure E.12 Convenience Market with Gasoline Pumps (853)

Average Pass-By Trip Percentage vs: 1000 Sq. Feet Gross Floor Area
On a: Weekday, P.M. Peak Period
Number of Studies: 17
Average 1000 Sq. Feet GFA: 3

Data Plot

Actual Data Points

Fitted Curve Equation: Not given

$R^2 = ****$
Figure E.13 Convenience Market with Gasoline Pumps (853)

Average Pass-By Trip Percentage vs: P.M. Peak Hour Traffic on Adjacent Street
On a: Weekday, P.M. Peak Period

Number of Studies: 9
Avg. P.M. Peak Hr. Traf. on Adj. Street: 1,933

Data Plot

Actual Data Points

Fitted Curve Equation: Not given

R² = ****
Table E.17 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 854—Discount Supermarket

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PRIMARY</td>
<td>DIVERTED</td>
<td>TOTAL</td>
</tr>
<tr>
<td>50</td>
<td>Overland Park, KS</td>
<td>July 1998</td>
<td>33</td>
<td>4:30–5:30 p.m.</td>
<td>9</td>
<td>70</td>
<td>21</td>
</tr>
<tr>
<td>79</td>
<td>Clark Cnty., WA</td>
<td>Nov. 2001</td>
<td>884</td>
<td>4:00–6:00 p.m.</td>
<td>34</td>
<td>39</td>
<td>27</td>
</tr>
<tr>
<td>80</td>
<td>Reno, NV</td>
<td>Apr. 2002</td>
<td>476</td>
<td>4:00–6:00 p.m.</td>
<td>38</td>
<td>44</td>
<td>18</td>
</tr>
<tr>
<td>72</td>
<td>Salem, OR</td>
<td>Nov. 2001</td>
<td>827</td>
<td>4:00–6:00 p.m.</td>
<td>31</td>
<td>51</td>
<td>18</td>
</tr>
<tr>
<td>75</td>
<td>Hillsboro, OR</td>
<td>Nov. 2001</td>
<td>786</td>
<td>4:00–6:00 p.m.</td>
<td>33</td>
<td>40</td>
<td>27</td>
</tr>
<tr>
<td>79</td>
<td>Eugene, OR</td>
<td>Nov. 2001</td>
<td>637</td>
<td>4:00–6:00 p.m.</td>
<td>13</td>
<td>52</td>
<td>35</td>
</tr>
<tr>
<td>79</td>
<td>Yuba City, CA</td>
<td>Apr. 2002</td>
<td>547</td>
<td>4:00–6:00 p.m.</td>
<td>15</td>
<td>64</td>
<td>21</td>
</tr>
<tr>
<td>79</td>
<td>Chico, CA</td>
<td>Apr. 2002</td>
<td>798</td>
<td>4:00–6:00 p.m.</td>
<td>20</td>
<td>58</td>
<td>22</td>
</tr>
<tr>
<td>80</td>
<td>Antelope, CA</td>
<td>May 2002</td>
<td>617</td>
<td>4:00–6:00 p.m.</td>
<td>12</td>
<td>68</td>
<td>20</td>
</tr>
<tr>
<td>80</td>
<td>Elk Grove, CA</td>
<td>May 2002</td>
<td>538</td>
<td>4:00–6:00 p.m.</td>
<td>25</td>
<td>52</td>
<td>23</td>
</tr>
<tr>
<td>94</td>
<td>Gresham, OR</td>
<td>June 2010</td>
<td>536</td>
<td>4:00–6:00 p.m.</td>
<td>7</td>
<td>45</td>
<td>48</td>
</tr>
<tr>
<td>93</td>
<td>Kent, WA</td>
<td>Apr. 2010</td>
<td>440</td>
<td>4:00–6:00 p.m.</td>
<td>21</td>
<td>41</td>
<td>38</td>
</tr>
<tr>
<td>88</td>
<td>Orangevale, CA</td>
<td>Sept. 2010</td>
<td>497</td>
<td>4:00–6:00 p.m.</td>
<td>15</td>
<td>49</td>
<td>36</td>
</tr>
<tr>
<td>66</td>
<td>Portland, OR</td>
<td>June 2010</td>
<td>382</td>
<td>4:00–6:00 p.m.</td>
<td>18</td>
<td>47</td>
<td>35</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 21
"—" means no data were provided
Figure E.14 Discount Supermarket (854)

Average Pass-By Trip Percentage vs: 1000 Sq. Feet Gross Floor Area
On a: Weekday, P.M. Peak Period

Number of Studies: 14
Average 1000 Sq. Feet GFA: 78

Data Plot

- Actual Data Points

Fitted Curve Equation: Not given

$R^2 = ****$
## Table E.18 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 857—Discount Club

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>VEHICLE FUELING POSITIONS</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIP (%)</th>
<th>PRIMARY</th>
<th>DIVERTED</th>
<th>TOTAL</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>137</td>
<td>12</td>
<td>Lancaster, PA</td>
<td>June 2009</td>
<td>160</td>
<td>4:00-6:00 p.m.</td>
<td>38</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>62</td>
<td>719</td>
</tr>
<tr>
<td>149</td>
<td>12</td>
<td>Harrisburg, PA</td>
<td>June 2009</td>
<td>228</td>
<td>4:00-6:00 p.m.</td>
<td>33</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>67</td>
<td>719</td>
</tr>
<tr>
<td>149</td>
<td>12</td>
<td>Robinson, PA</td>
<td>June 2009</td>
<td>147</td>
<td>4:00-6:00 p.m.</td>
<td>29</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>71</td>
<td>719</td>
</tr>
<tr>
<td>149</td>
<td>12</td>
<td>Cranberry, PA</td>
<td>June 2009</td>
<td>218</td>
<td>4:00-6:00 p.m.</td>
<td>50</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>50</td>
<td>719</td>
</tr>
<tr>
<td>149</td>
<td>12</td>
<td>Frederick, MD</td>
<td>July 2010</td>
<td>255</td>
<td>4:00-6:00 p.m.</td>
<td>34</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>68</td>
<td>719</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 37

"—" means no data were provided

## Table E.19 Pass-By and Non-Pass-By Trips Saturday, Mid-Day Peak Period
Land Use Code 857—Discount Club

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>VEHICLE FUELING POSITIONS</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIP (%)</th>
<th>PRIMARY</th>
<th>DIVERTED</th>
<th>TOTAL</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>137</td>
<td>12</td>
<td>Lancaster, PA</td>
<td>June 2009</td>
<td>462</td>
<td>12:00-3:00 p.m.</td>
<td>26</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>74</td>
<td>719</td>
</tr>
<tr>
<td>149</td>
<td>12</td>
<td>Harrisburg, PA</td>
<td>June 2009</td>
<td>203</td>
<td>12:00-3:00 p.m.</td>
<td>16</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>84</td>
<td>719</td>
</tr>
<tr>
<td>149</td>
<td>12</td>
<td>Robinson, PA</td>
<td>June 2009</td>
<td>240</td>
<td>12:00-3:00 p.m.</td>
<td>37</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>63</td>
<td>719</td>
</tr>
<tr>
<td>149</td>
<td>12</td>
<td>Cranberry, PA</td>
<td>June 2009</td>
<td>267</td>
<td>12:00-3:00 p.m.</td>
<td>39</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>61</td>
<td>719</td>
</tr>
<tr>
<td>149</td>
<td>12</td>
<td>Frederick, MD</td>
<td>July 2010</td>
<td>209</td>
<td>12:00-3:00 p.m.</td>
<td>31</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>69</td>
<td>719</td>
</tr>
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</table>

Average Pass-By Trip Percentage: 30

"—" means no data were provided

## Table E.20 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 862—Home Improvement Superstore

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>107</td>
<td>Casselberry, FL</td>
<td>1992</td>
<td>488</td>
<td>2:00-4:00 p.m.</td>
<td>44</td>
<td>32</td>
<td>24</td>
<td>56</td>
</tr>
<tr>
<td>91</td>
<td>Daytona Beach, FL</td>
<td>1993</td>
<td>111</td>
<td>2:00-4:00 p.m.</td>
<td>46</td>
<td>—</td>
<td>—</td>
<td>54</td>
</tr>
<tr>
<td>100</td>
<td>Orlando, FL</td>
<td>1993</td>
<td>147</td>
<td>2:00-4:00 p.m.</td>
<td>54</td>
<td>—</td>
<td>—</td>
<td>46</td>
</tr>
<tr>
<td>142</td>
<td>Clearwater, FL</td>
<td>May 2010</td>
<td>153</td>
<td>2:00-4:00 p.m.</td>
<td>25</td>
<td>—</td>
<td>—</td>
<td>75</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 42

"—" means no data were provided
## Table E.21 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
### Land Use Code 863—Electronics Superstore

<table>
<thead>
<tr>
<th>Size (1,000 SQ. FT. GFA)</th>
<th>Location</th>
<th>Weekday Survey Date</th>
<th>No. of Interviews</th>
<th>Time Period</th>
<th>Pass-By Trip (%)</th>
<th>Non-Pass-By Trips (%)</th>
<th>Adj. Street Peak Hour Volume</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Altamonte Springs, FL</td>
<td>1995</td>
<td>1,329</td>
<td>2:00–6:00 p.m.</td>
<td>40</td>
<td>27</td>
<td>33</td>
<td>60</td>
</tr>
</tbody>
</table>

“—” means no data were provided

## Table E.22 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
### Land Use Code 880—Pharmacy/Drugstore without Drive-Through Window

<table>
<thead>
<tr>
<th>Size (1,000 SQ. FT. GFA)</th>
<th>Location</th>
<th>Weekday Survey Date</th>
<th>No. of Interviews</th>
<th>Time Period</th>
<th>Pass-By Trip (%)</th>
<th>Non-Pass-By Trips (%)</th>
<th>Adj. Street Peak Hour Volume</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Orange City, FL</td>
<td>1992</td>
<td>42</td>
<td>2:00–6:00 p.m.</td>
<td>65</td>
<td>—</td>
<td>—</td>
<td>TPD Inc.</td>
</tr>
<tr>
<td>10</td>
<td>Deltona, FL</td>
<td>1992</td>
<td>54</td>
<td>2:00–6:00 p.m.</td>
<td>60</td>
<td>—</td>
<td>—</td>
<td>TPD Inc.</td>
</tr>
<tr>
<td>9.6</td>
<td>Kissimmee, FL</td>
<td>1995</td>
<td>190</td>
<td>2:00–6:00 p.m.</td>
<td>30</td>
<td>57</td>
<td>13</td>
<td>70</td>
</tr>
<tr>
<td>8.6</td>
<td>Orlando, FL</td>
<td>1995</td>
<td>369</td>
<td>2:00–6:00 p.m.</td>
<td>60</td>
<td>25</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>13</td>
<td>New Smyrna Beach, FL</td>
<td>1993</td>
<td>55</td>
<td>2:00–6:00 p.m.</td>
<td>53</td>
<td>—</td>
<td>—</td>
<td>47</td>
</tr>
<tr>
<td>12</td>
<td>Apopka, FL</td>
<td>1993</td>
<td>365</td>
<td>2:00–6:00 p.m.</td>
<td>52</td>
<td>—</td>
<td>—</td>
<td>48</td>
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</tbody>
</table>

Average Pass-By Trip Percentage: 53
“—” means no data were provided

## Table E.23 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
### Land Use Code 881—Pharmacy/Drugstore with Drive-Through Window

<table>
<thead>
<tr>
<th>Size (1,000 SQ. FT. GFA)</th>
<th>Location</th>
<th>Weekday Survey Date</th>
<th>No. of Interviews</th>
<th>Time Period</th>
<th>Pass-By Trip (%)</th>
<th>Non-Pass-By Trips (%)</th>
<th>Adj. Street Peak Hour Volume</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.6</td>
<td>Orlando, FL</td>
<td>1995</td>
<td>370</td>
<td>2:00–6:00 p.m.</td>
<td>47</td>
<td>40</td>
<td>13</td>
<td>53</td>
</tr>
<tr>
<td>16</td>
<td>Orlando, FL</td>
<td>1995</td>
<td>385</td>
<td>2:00–6:00 p.m.</td>
<td>41</td>
<td>50</td>
<td>9</td>
<td>59</td>
</tr>
<tr>
<td>16</td>
<td>Orlando, FL</td>
<td>1995</td>
<td>522</td>
<td>2:00–6:00 p.m.</td>
<td>58</td>
<td>25</td>
<td>17</td>
<td>42</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 49
“—” means no data were provided
Table E.24 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 890—Furniture Store

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>Altamonte Springs, FL</td>
<td>1995</td>
<td>212</td>
<td>2:00–6:00 p.m.</td>
<td>49</td>
<td>20</td>
<td>31</td>
<td>51</td>
</tr>
<tr>
<td>17</td>
<td>Daytona Beach, FL</td>
<td>1994</td>
<td>39</td>
<td>2:00–6:00 p.m.</td>
<td>69</td>
<td>—</td>
<td>—</td>
<td>31</td>
</tr>
<tr>
<td>24</td>
<td>Orlando, FL</td>
<td>1991</td>
<td>103</td>
<td>2:00–6:00 p.m.</td>
<td>42</td>
<td>—</td>
<td>—</td>
<td>58</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 53
“—” means no data were provided

Table E.25 Pass-By and Non-Pass-By Trips Weekday, AM Peak Period
Land Use Code 912—Drive-in Bank

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.8</td>
<td>Camp Hill Mall, PA</td>
<td>March 2005</td>
<td>11</td>
<td>7:45–8:45 a.m.</td>
<td>27</td>
<td>—</td>
<td>73</td>
<td>—</td>
</tr>
<tr>
<td>3.8</td>
<td>Exeter Twp, PA</td>
<td>March 2005</td>
<td>9</td>
<td>8:00–9:00 a.m.</td>
<td>24</td>
<td>—</td>
<td>76</td>
<td>—</td>
</tr>
<tr>
<td>3.8</td>
<td>York, PA</td>
<td>March 2005</td>
<td>22</td>
<td>7:45–8:45 a.m.</td>
<td>34</td>
<td>—</td>
<td>66</td>
<td>—</td>
</tr>
<tr>
<td>3.8</td>
<td>Mountain Road, PA</td>
<td>March 2005</td>
<td>30</td>
<td>8:00–9:00 a.m.</td>
<td>27</td>
<td>—</td>
<td>73</td>
<td>—</td>
</tr>
<tr>
<td>3.8</td>
<td>Muhlenberg, PA</td>
<td>March 2005</td>
<td>7</td>
<td>8:00–9:00 a.m.</td>
<td>27</td>
<td>—</td>
<td>73</td>
<td>—</td>
</tr>
<tr>
<td>3.8</td>
<td>York, PA</td>
<td>March 2005</td>
<td>15</td>
<td>8:00–9:00 a.m.</td>
<td>16</td>
<td>—</td>
<td>84</td>
<td>—</td>
</tr>
<tr>
<td>3.8</td>
<td>Derry Street, PA</td>
<td>March 2005</td>
<td>27</td>
<td>8:00–9:00 a.m.</td>
<td>36</td>
<td>—</td>
<td>64</td>
<td>—</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 29
“—” means no data were provided

Table E.26 Pass-By and Non-Pass-By Trips Weekday, Mid-Day Peak Period
Land Use Code 912—Drive-in Bank

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>Arlington, WA</td>
<td>Sept. 2007</td>
<td>—</td>
<td>11:00 a.m.–12:00 p.m.</td>
<td>34</td>
<td>42</td>
<td>24</td>
<td>66</td>
</tr>
<tr>
<td>2.7</td>
<td>Lynnwood, WA</td>
<td>Sept. 2007</td>
<td>—</td>
<td>11:00 a.m.–12:00 p.m.</td>
<td>26</td>
<td>58</td>
<td>16</td>
<td>74</td>
</tr>
<tr>
<td>2.8</td>
<td>Redmond, WA</td>
<td>Sept. 2007</td>
<td>—</td>
<td>11:00 a.m.–12:00 p.m.</td>
<td>30</td>
<td>53</td>
<td>17</td>
<td>70</td>
</tr>
<tr>
<td>3.6</td>
<td>Snohomish, WA</td>
<td>July 2007</td>
<td>—</td>
<td>11:00 a.m.–12:00 p.m.</td>
<td>15</td>
<td>—</td>
<td>—</td>
<td>85</td>
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</tbody>
</table>

Average Pass-By Trip Percentage: 26
“—” means no data were provided
Table E.27 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 912—Drive-in Bank

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.0</td>
<td>Overland Park, KS</td>
<td>Dec. 1988</td>
<td>20</td>
<td>4:30–5:30 p.m.</td>
<td>15</td>
<td>55</td>
<td>30</td>
<td>85</td>
</tr>
<tr>
<td>3.3</td>
<td>Louisville area, KY</td>
<td>July 1993</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>48</td>
<td>22</td>
<td>30</td>
<td>52</td>
</tr>
<tr>
<td>3.4</td>
<td>Louisville area, KY</td>
<td>July 1993</td>
<td>—</td>
<td>4:00–8:00 p.m.</td>
<td>64</td>
<td>22</td>
<td>14</td>
<td>36</td>
</tr>
<tr>
<td>3.4</td>
<td>Louisville area, KY</td>
<td>July 1993</td>
<td>75</td>
<td>4:00–6:00 p.m.</td>
<td>57</td>
<td>11</td>
<td>32</td>
<td>43</td>
</tr>
<tr>
<td>3.5</td>
<td>Louisville area, KY</td>
<td>June 1993</td>
<td>53</td>
<td>4:00–6:00 p.m.</td>
<td>47</td>
<td>32</td>
<td>21</td>
<td>53</td>
</tr>
<tr>
<td>6.4</td>
<td>Louisville area, KY</td>
<td>June 1993</td>
<td>66</td>
<td>4:00–6:00 p.m.</td>
<td>53</td>
<td>20</td>
<td>27</td>
<td>47</td>
</tr>
<tr>
<td>3.8</td>
<td>Colonial Park, PA</td>
<td>March 2005</td>
<td>56</td>
<td>4:00–5:00 p.m.</td>
<td>43</td>
<td>—</td>
<td>—</td>
<td>57</td>
</tr>
<tr>
<td>3.8</td>
<td>Camp Hill Mall, PA</td>
<td>March 2005</td>
<td>38</td>
<td>4:15–5:15 p.m.</td>
<td>41</td>
<td>—</td>
<td>—</td>
<td>59</td>
</tr>
<tr>
<td>3.8</td>
<td>Exeter Twp, PA</td>
<td>March 2005</td>
<td>14</td>
<td>4:00–5:00 p.m.</td>
<td>24</td>
<td>—</td>
<td>—</td>
<td>76</td>
</tr>
<tr>
<td>3.8</td>
<td>York, PA</td>
<td>March 2005</td>
<td>63</td>
<td>4:00–5:00 p.m.</td>
<td>29</td>
<td>—</td>
<td>—</td>
<td>71</td>
</tr>
<tr>
<td>3.8</td>
<td>York, PA</td>
<td>March 2005</td>
<td>70</td>
<td>4:00–5:00 p.m.</td>
<td>29</td>
<td>—</td>
<td>—</td>
<td>71</td>
</tr>
<tr>
<td>3.8</td>
<td>Palmyra, PA</td>
<td>March 2005</td>
<td>29</td>
<td>4:15–5:15 p.m.</td>
<td>27</td>
<td>—</td>
<td>—</td>
<td>73</td>
</tr>
<tr>
<td>3.8</td>
<td>Mountain Road, PA</td>
<td>March 2005</td>
<td>41</td>
<td>4:00–5:00 p.m.</td>
<td>25</td>
<td>—</td>
<td>—</td>
<td>75</td>
</tr>
<tr>
<td>3.8</td>
<td>Hummelstown, PA</td>
<td>March 2005</td>
<td>37</td>
<td>4:00–6:00 p.m.</td>
<td>31</td>
<td>—</td>
<td>—</td>
<td>69</td>
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<tr>
<td>3.8</td>
<td>Muhlenberg, PA</td>
<td>March 2005</td>
<td>19</td>
<td>4:00–6:00 p.m.</td>
<td>29</td>
<td>—</td>
<td>—</td>
<td>71</td>
</tr>
<tr>
<td>3.8</td>
<td>York, PA</td>
<td>March 2005</td>
<td>34</td>
<td>4:00–6:00 p.m.</td>
<td>21</td>
<td>—</td>
<td>—</td>
<td>79</td>
</tr>
<tr>
<td>3.8</td>
<td>Derry Street, PA</td>
<td>March 2005</td>
<td>36</td>
<td>4:00–6:00 p.m.</td>
<td>29</td>
<td>—</td>
<td>—</td>
<td>71</td>
</tr>
<tr>
<td>3.6</td>
<td>Arlington, WA</td>
<td>Sept. 2007</td>
<td>—</td>
<td>4:00–4:00 p.m.</td>
<td>42</td>
<td>50</td>
<td>8</td>
<td>58</td>
</tr>
<tr>
<td>2.7</td>
<td>Lynnwood, WA</td>
<td>Sept. 2007</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>26</td>
<td>68</td>
<td>8</td>
<td>74</td>
</tr>
<tr>
<td>2.8</td>
<td>Redmond, WA</td>
<td>Sept. 2007</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>21</td>
<td>55</td>
<td>24</td>
<td>79</td>
</tr>
<tr>
<td>3.6</td>
<td>Snohomish, WA</td>
<td>July 2007</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>29</td>
<td>—</td>
<td>—</td>
<td>71</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 35
“—” means no data were provided
Figure E.15 Drive-in Bank (912)

Average Pass-By Trip Percentage vs: 1000 Sq. Feet Gross Floor Area
On a: Weekday, P.M. Peak Period
Number of Studies: 21
Average 1000 Sq. Feet GFA: 4

Data Plot

Fitted Curve Equation: Not given

R² = ****
Table E.28 Pass-By and Non-Pass-By Trips Saturday, Mid-Day Peak Period
Land Use Code 912—Drive-in Bank

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.8</td>
<td>Colonial Park, PA</td>
<td>March 2005</td>
<td>63</td>
<td>11:15 a.m.–12:15 p.m.</td>
<td>33</td>
<td>—</td>
<td>67</td>
<td>—</td>
</tr>
<tr>
<td>3.8</td>
<td>Camp Hill Mall, PA</td>
<td>March 2005</td>
<td>103</td>
<td>11:00 a.m.–12:00 p.m.</td>
<td>77</td>
<td>—</td>
<td>23</td>
<td>—</td>
</tr>
<tr>
<td>3.8</td>
<td>Exeter Twp, PA</td>
<td>March 2005</td>
<td>34</td>
<td>10:30–11:30 a.m.</td>
<td>37</td>
<td>—</td>
<td>63</td>
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</tbody>
</table>

Average Pass-By Trip Percentage: 38
"—" means no data were provided

Table E.29 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 931—Quality Restaurant

<table>
<thead>
<tr>
<th>SEATS</th>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>240</td>
<td>12</td>
<td>Louisville area, KY</td>
<td>July 1993</td>
<td>38</td>
<td>4:00–6:00 p.m.</td>
<td>26</td>
<td>36</td>
<td>38</td>
<td>74</td>
</tr>
<tr>
<td>—</td>
<td>8</td>
<td>Orlando, FL</td>
<td>1992</td>
<td>168</td>
<td>4:00–8:00 p.m.</td>
<td>45</td>
<td>—</td>
<td>—</td>
<td>55</td>
</tr>
<tr>
<td>—</td>
<td>8.8</td>
<td>Orlando, FL</td>
<td>1992</td>
<td>84</td>
<td>2:00–6:00 p.m.</td>
<td>44</td>
<td>40</td>
<td>16</td>
<td>56</td>
</tr>
<tr>
<td>—</td>
<td>6.5</td>
<td>Orlando, FL</td>
<td>1995</td>
<td>173</td>
<td>2:00–6:00 p.m.</td>
<td>62</td>
<td>—</td>
<td>—</td>
<td>38</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 44
"—" means no data were provided
Table E.30 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 932—High-Turnover (Sit-Down) Restaurant

<table>
<thead>
<tr>
<th>SEATS</th>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.8</td>
<td></td>
<td>Orlando, FL</td>
<td>1992</td>
<td>150</td>
<td>2:00–6:00 p.m.</td>
<td>32</td>
<td>—</td>
<td>—</td>
<td>68</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Casselberry, FL</td>
<td>1992</td>
<td>65</td>
<td>2:00–6:00 p.m.</td>
<td>58</td>
<td>—</td>
<td>—</td>
<td>42</td>
</tr>
<tr>
<td>168</td>
<td>5.3</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>24</td>
<td>4:00–6:00 p.m.</td>
<td>50</td>
<td>37</td>
<td>13</td>
<td>50</td>
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<tr>
<td>169</td>
<td>2.9</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>41</td>
<td>4:00–6:00 p.m.</td>
<td>37</td>
<td>27</td>
<td>36</td>
<td>63</td>
</tr>
<tr>
<td>150</td>
<td>3.1</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>21</td>
<td>4:00–6:00 p.m.</td>
<td>38</td>
<td>29</td>
<td>33</td>
<td>62</td>
</tr>
<tr>
<td>250</td>
<td>7.1</td>
<td>New Albany, IN</td>
<td>1993</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>23</td>
<td>23</td>
<td>54</td>
<td>77</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Kissimmee, FL</td>
<td>1995</td>
<td>664</td>
<td>2:00–6:00 p.m.</td>
<td>40</td>
<td>39</td>
<td>21</td>
<td>60</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Orlando, FL</td>
<td>1996</td>
<td>267</td>
<td>2:00–6:00 p.m.</td>
<td>38</td>
<td>43</td>
<td>19</td>
<td>62</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Orlando, FL</td>
<td>1996</td>
<td>317</td>
<td>2:00–6:00 p.m.</td>
<td>29</td>
<td>51</td>
<td>20</td>
<td>71</td>
</tr>
<tr>
<td>4.6</td>
<td></td>
<td>Orlando, FL</td>
<td>1992</td>
<td>276</td>
<td>2:00–6:00 p.m.</td>
<td>63</td>
<td>—</td>
<td>—</td>
<td>37</td>
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<tr>
<td>5.7</td>
<td></td>
<td>Orlando, FL</td>
<td>1994</td>
<td>308</td>
<td>2:00–6:00 p.m.</td>
<td>57</td>
<td>—</td>
<td>—</td>
<td>43</td>
</tr>
<tr>
<td>6.2</td>
<td></td>
<td>Orlando, FL</td>
<td>1995</td>
<td>521</td>
<td>2:00–6:00 p.m.</td>
<td>46</td>
<td>43</td>
<td>11</td>
<td>54</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 43

"—" means no data were provided
Figure E.16 High-Turnover (Sit-Down) Restaurant (932)

Average Pass-By Trip Percentage vs: 1,000 Sq. Ft. Gross Floor Area
On a: Weekday, PM Peak Period
Number of Studies: 12
Average 1,000 Sq. Ft. GFA: 6.4

Data Plot

Actual Data Points

Fitted Curve Equation: Not given

$R^2 = ****$
<table>
<thead>
<tr>
<th>SEATS</th>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>&lt;5</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>84</td>
<td>7:00–9:00 a.m.</td>
<td>44</td>
<td>—</td>
<td>56</td>
<td>Kenig, O'Hara, Humes, Flock</td>
</tr>
<tr>
<td>88</td>
<td>1.4</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>—</td>
<td>7:00–9:00 a.m.</td>
<td>62</td>
<td>22</td>
<td>16</td>
<td>Barton-Aschman Assoc.</td>
</tr>
<tr>
<td>100</td>
<td>3.6</td>
<td>Louisville, KY</td>
<td>1993</td>
<td>—</td>
<td>7:00–9:00 a.m.</td>
<td>32</td>
<td>47</td>
<td>21</td>
<td>Barton-Aschman Assoc.</td>
</tr>
<tr>
<td>87</td>
<td>4.2</td>
<td>New Albany, IN</td>
<td>1993</td>
<td>—</td>
<td>7:00–9:00 a.m.</td>
<td>46</td>
<td>23</td>
<td>31</td>
<td>Barton-Aschman Assoc.</td>
</tr>
<tr>
<td>150</td>
<td>3.0</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>—</td>
<td>7:00–9:00 a.m.</td>
<td>43</td>
<td>14</td>
<td>43</td>
<td>Barton-Aschman Assoc.</td>
</tr>
<tr>
<td>—</td>
<td>3.3</td>
<td>varies</td>
<td>1996</td>
<td>—</td>
<td>6:00–9:00 a.m.</td>
<td>68</td>
<td>—</td>
<td>32</td>
<td>Oracle Engineering</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 49

“—” means no data were provided
### Table E.32 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 934—Fast-Food Restaurant with Drive-Through Window

<table>
<thead>
<tr>
<th>SEATS</th>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>~2.6</td>
<td>Minn-St. Paul, MN</td>
<td>1987</td>
<td>50</td>
<td>3:00–7:00 p.m.</td>
<td>25</td>
<td>27</td>
<td>48</td>
<td>75</td>
</tr>
<tr>
<td>—</td>
<td>&lt;5.0</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>80</td>
<td>3:00–6:00 p.m.</td>
<td>38</td>
<td>—</td>
<td>—</td>
<td>62</td>
</tr>
<tr>
<td>—</td>
<td>&lt;5.0</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>100</td>
<td>3:00–6:00 p.m.</td>
<td>55</td>
<td>—</td>
<td>—</td>
<td>45</td>
</tr>
<tr>
<td>—</td>
<td>&lt;5.0</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>159</td>
<td>3:00–6:00 p.m.</td>
<td>56</td>
<td>—</td>
<td>—</td>
<td>44</td>
</tr>
<tr>
<td>—</td>
<td>&lt;5.0</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>225</td>
<td>3:00–6:00 p.m.</td>
<td>48</td>
<td>—</td>
<td>—</td>
<td>52</td>
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<tr>
<td>—</td>
<td>&lt;5.0</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>88</td>
<td>3:00–6:00 p.m.</td>
<td>35</td>
<td>—</td>
<td>—</td>
<td>65</td>
</tr>
<tr>
<td>—</td>
<td>&lt;5.0</td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>84</td>
<td>3:00–6:00 p.m.</td>
<td>44</td>
<td>—</td>
<td>—</td>
<td>56</td>
</tr>
<tr>
<td>88</td>
<td>1.3</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>68</td>
<td>22</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>120</td>
<td>1.9</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>33</td>
<td>4:00–6:00 p.m.</td>
<td>67</td>
<td>24</td>
<td>9</td>
<td>33</td>
</tr>
<tr>
<td>87</td>
<td>4.2</td>
<td>New Albany, IN</td>
<td>1993</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>56</td>
<td>25</td>
<td>19</td>
<td>44</td>
</tr>
<tr>
<td>150</td>
<td>3.0</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>31</td>
<td>31</td>
<td>38</td>
<td>69</td>
</tr>
<tr>
<td>—</td>
<td>3.1</td>
<td>Kissimmee, FL</td>
<td>1995</td>
<td>28</td>
<td>2:00–6:00 p.m.</td>
<td>71</td>
<td>—</td>
<td>—</td>
<td>29</td>
</tr>
<tr>
<td>—</td>
<td>3.1</td>
<td>Apopka, FL</td>
<td>1996</td>
<td>29</td>
<td>2:00–6:00 p.m.</td>
<td>38</td>
<td>—</td>
<td>—</td>
<td>62</td>
</tr>
<tr>
<td>—</td>
<td>2.8</td>
<td>Winter Springs, FL</td>
<td>1995</td>
<td>47</td>
<td>2:00–6:00 p.m.</td>
<td>66</td>
<td>—</td>
<td>—</td>
<td>34</td>
</tr>
<tr>
<td>—</td>
<td>4.3</td>
<td>Longwood, FL</td>
<td>1994</td>
<td>304</td>
<td>2:00–6:00 p.m.</td>
<td>62</td>
<td>—</td>
<td>—</td>
<td>38</td>
</tr>
<tr>
<td>—</td>
<td>3.2</td>
<td>Altamonte Springs, FL</td>
<td>1996</td>
<td>202</td>
<td>2:00–6:00 p.m.</td>
<td>40</td>
<td>39</td>
<td>21</td>
<td>60</td>
</tr>
<tr>
<td>—</td>
<td>2.9</td>
<td>Winter Park, FL</td>
<td>1996</td>
<td>271</td>
<td>2:00–6:00 p.m.</td>
<td>41</td>
<td>41</td>
<td>18</td>
<td>59</td>
</tr>
<tr>
<td>—</td>
<td>3.3*</td>
<td>several</td>
<td>1996</td>
<td>varies</td>
<td>4:00–6:00 p.m.</td>
<td>62</td>
<td>—</td>
<td>—</td>
<td>38</td>
</tr>
</tbody>
</table>

*Average of several combined studies.
Average Pass-By Trip Percentage: 50
“—” means no data were provided
Figure E.17 Fast-Food Restaurant with Drive-Through Window (934)

Average Pass-By Trip Percentage vs: 1,000 Sq. Ft. Gross Floor Area
On a: Weekday, PM Peak Period
Number of Studies: 12
Average 1,000 Sq. Ft. GFA: 3.0

Data Plot

Fitted Curve Equation: Not given

Actual Data Points

$R^2 = *****$
Table E.33 Pass-By and Non-Pass-By Trips Weekday
Land Use Code 938—Coffee/Donut Shop with Drive-Through Window and No Indoor Seating (Coffee/Espresso Stand)

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>Vancouver, WA</td>
<td>Nov. 1997</td>
<td>69</td>
<td>6:00 a.m.–6:00 p.m.</td>
<td>83</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

"—" means no data were provided

Table E.34 Pass-By and Non-Pass-By Trips Weekday
Land Use Code 938—Coffee/Donut Shop with Drive-Through Window and No Indoor Seating (Coffee/Espresso Stand)

<table>
<thead>
<tr>
<th>EMPLOYEES</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vancouver, WA</td>
<td>Nov. 1997</td>
<td>70</td>
<td>6:00 a.m.–6:00 p.m.</td>
<td>83</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1</td>
<td>Woodburn, OR</td>
<td>Feb. 1998</td>
<td>109</td>
<td>6:00 a.m.–6:00 p.m.</td>
<td>95</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1</td>
<td>Vancouver, WA</td>
<td>Feb. 1998</td>
<td>83</td>
<td>6:00 a.m.–1:00 p.m.</td>
<td>89</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 89
"—" means no data were provided

Table E.35 Pass-By and Non-Pass-By Trips Weekday, AM Peak Period
Land Use Code 944—Gasoline/Service Station

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>VEHICLE FUELING POSITIONS</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3</td>
<td>6</td>
<td>Gaithersburg, MD</td>
<td>1992</td>
<td>37</td>
<td>7:00–9:00 a.m.</td>
<td>32</td>
<td>41</td>
<td>27</td>
<td>68</td>
</tr>
<tr>
<td>2.1</td>
<td>6</td>
<td>Bethesda, MD</td>
<td>1992</td>
<td>26</td>
<td>7:00–9:00 a.m.</td>
<td>58</td>
<td>23</td>
<td>19</td>
<td>42</td>
</tr>
<tr>
<td>1.7</td>
<td>6</td>
<td>Wheaton, MD</td>
<td>1992</td>
<td>21</td>
<td>7:00–9:00 a.m.</td>
<td>67</td>
<td>14</td>
<td>19</td>
<td>33</td>
</tr>
<tr>
<td>2.0</td>
<td>8</td>
<td>Gaithersburg, MD</td>
<td>1992</td>
<td>46</td>
<td>7:00–9:00 a.m.</td>
<td>87</td>
<td>13</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>1.2</td>
<td>6</td>
<td>Damascus, MD</td>
<td>1992</td>
<td>21</td>
<td>7:00–9:00 a.m.</td>
<td>43</td>
<td>28</td>
<td>29</td>
<td>57</td>
</tr>
<tr>
<td>0.3</td>
<td>12</td>
<td>Wheaton, MD</td>
<td>1992</td>
<td>36</td>
<td>7:00–9:00 a.m.</td>
<td>61</td>
<td>8</td>
<td>31</td>
<td>39</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 58
"—" means no data were provided
### Table E.36 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 944—Gasoline/Service Station

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>VEHICLE FUELING POSITIONS</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>48</td>
<td>3:00–7:00 p.m.</td>
<td>21</td>
<td>—</td>
<td>79</td>
<td>Kenig, O’Hara, Humes, Flock</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>34</td>
<td>3:00–6:00 p.m.</td>
<td>25</td>
<td>—</td>
<td>75</td>
<td>Kenig, O’Hara, Humes, Flock</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chicago suburbs, IL</td>
<td>1987</td>
<td>42</td>
<td>3:00–6:00 p.m.</td>
<td>20</td>
<td>—</td>
<td>80</td>
<td>Kenig, O’Hara, Humes, Flock</td>
</tr>
<tr>
<td>2.3</td>
<td>6</td>
<td>Gaithersburg, MD</td>
<td>1992</td>
<td>55</td>
<td>4:00–6:00 p.m.</td>
<td>40</td>
<td>11</td>
<td>49</td>
<td>60</td>
</tr>
<tr>
<td>2.1</td>
<td>6</td>
<td>Bethesda, MD</td>
<td>1992</td>
<td>30</td>
<td>4:00–6:00 p.m.</td>
<td>53</td>
<td>20</td>
<td>27</td>
<td>47</td>
</tr>
<tr>
<td>1.7</td>
<td>6</td>
<td>Wheaton, MD</td>
<td>1992</td>
<td>18</td>
<td>4:00–6:00 p.m.</td>
<td>61</td>
<td>6</td>
<td>33</td>
<td>39</td>
</tr>
<tr>
<td>2.0</td>
<td>8</td>
<td>Gaithersburg, MD</td>
<td>1992</td>
<td>47</td>
<td>4:00–6:00 p.m.</td>
<td>62</td>
<td>23</td>
<td>15</td>
<td>38</td>
</tr>
<tr>
<td>1.2</td>
<td>6</td>
<td>Damascus, MD</td>
<td>1992</td>
<td>26</td>
<td>4:00–6:00 p.m.</td>
<td>58</td>
<td>11</td>
<td>31</td>
<td>42</td>
</tr>
<tr>
<td>0.3</td>
<td>12</td>
<td>Wheaton, MD</td>
<td>1992</td>
<td>52</td>
<td>4:00–6:00 p.m.</td>
<td>38</td>
<td>10</td>
<td>52</td>
<td>62</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 42

“—” means no data were provided

### Table E.37 Pass-By and Non-Pass-By Trips Weekday, AM Peak Period
Land Use Code 945—Gasoline/Service Station with Convenience Market

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>VEHICLE FUELING POSITIONS</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>8</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>61</td>
<td>7:00–9:00 a.m.</td>
<td>60</td>
<td>15</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>0.6</td>
<td>8</td>
<td>Louisville, KY</td>
<td>1993</td>
<td>48</td>
<td>7:00–9:00 a.m.</td>
<td>68</td>
<td>13</td>
<td>19</td>
<td>32</td>
</tr>
<tr>
<td>0.7</td>
<td>10</td>
<td>Louisville, KY</td>
<td>1993</td>
<td>47</td>
<td>7:00–9:00 a.m.</td>
<td>67</td>
<td>11</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>0.7</td>
<td>8</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>—</td>
<td>7:00–9:00 a.m.</td>
<td>56</td>
<td>22</td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td>0.7</td>
<td>10</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>—</td>
<td>7:00–9:00 a.m.</td>
<td>46</td>
<td>42</td>
<td>12</td>
<td>54</td>
</tr>
<tr>
<td>0.3</td>
<td>—</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>75</td>
<td>7:00–9:00 a.m.</td>
<td>72</td>
<td>15</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>0.8</td>
<td>8</td>
<td>Silver Spring, MD</td>
<td>1992</td>
<td>36</td>
<td>7:00–9:00 a.m.</td>
<td>47</td>
<td>14</td>
<td>39</td>
<td>53</td>
</tr>
<tr>
<td>0.4</td>
<td>8</td>
<td>Derwood, MD</td>
<td>1992</td>
<td>46</td>
<td>7:00–9:00 a.m.</td>
<td>75</td>
<td>0</td>
<td>25</td>
<td>25</td>
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<tr>
<td>2.2</td>
<td>8</td>
<td>Kensington, MD</td>
<td>1992</td>
<td>31</td>
<td>7:00–9:00 a.m.</td>
<td>47</td>
<td>34</td>
<td>19</td>
<td>53</td>
</tr>
<tr>
<td>1</td>
<td>8</td>
<td>Silver Spring, MD</td>
<td>1992</td>
<td>35</td>
<td>7:00–9:00 a.m.</td>
<td>78</td>
<td>9</td>
<td>13</td>
<td>22</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 62

“—” means no data were provided
Figure E.18 Gasoline/Service Station with Convenience Market (945)

Average Pass-By Trip Percentage vs: 1,000 Sq. Ft. Gross Floor Area
On a: Weekday, AM Peak Period
Number of Studies: 10
Average 1,000 Sq. Ft. GFA: 0.8

Data Plot

Fitted Curve Equation: Not given

$R^2 = ****$
Table E.38 Pass-By and Non-Pass-By Trips Weekday, PM Peak Period
Land Use Code 945—Gasoline/Service Station with Convenience Market

<table>
<thead>
<tr>
<th>SIZE (1,000 SQ. FT. GFA)</th>
<th>VEHICLE FUELING POSITIONS</th>
<th>LOCATION</th>
<th>WEEKDAY SURVEY DATE</th>
<th>NO. OF INTERVIEWS</th>
<th>TIME PERIOD</th>
<th>PASS-BY TRIP (%)</th>
<th>NON-PASS-BY TRIPS (%)</th>
<th>ADJ. STREET PEAK HOUR VOLUME</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>8</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>83</td>
<td>4:00–6:00 p.m.</td>
<td>52</td>
<td>8</td>
<td>40</td>
<td>48</td>
</tr>
<tr>
<td>0.6</td>
<td>8</td>
<td>Louisville, KY</td>
<td>1993</td>
<td>60</td>
<td>4:00–6:00 p.m.</td>
<td>53</td>
<td>20</td>
<td>27</td>
<td>47</td>
</tr>
<tr>
<td>0.7</td>
<td>10</td>
<td>Louisville, KY</td>
<td>1993</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>57</td>
<td>19</td>
<td>24</td>
<td>43</td>
</tr>
<tr>
<td>0.7</td>
<td>8</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>72</td>
<td>7</td>
<td>21</td>
<td>28</td>
</tr>
<tr>
<td>0.7</td>
<td>10</td>
<td>Louisville area, KY</td>
<td>1993</td>
<td>—</td>
<td>4:00–6:00 p.m.</td>
<td>55</td>
<td>16</td>
<td>29</td>
<td>45</td>
</tr>
<tr>
<td>0.8</td>
<td>8</td>
<td>Silver Spring, MD</td>
<td>1992</td>
<td>36</td>
<td>4:00–6:00 p.m.</td>
<td>67</td>
<td>14</td>
<td>19</td>
<td>33</td>
</tr>
<tr>
<td>0.4</td>
<td>8</td>
<td>Derwood, MD</td>
<td>1992</td>
<td>46</td>
<td>4:00–6:00 p.m.</td>
<td>46</td>
<td>11</td>
<td>43</td>
<td>54</td>
</tr>
<tr>
<td>2.1</td>
<td>8</td>
<td>Kensington, MD</td>
<td>1992</td>
<td>31</td>
<td>4:00–6:00 p.m.</td>
<td>52</td>
<td>13</td>
<td>35</td>
<td>48</td>
</tr>
<tr>
<td>1</td>
<td>8</td>
<td>Silver Spring, MD</td>
<td>1992</td>
<td>35</td>
<td>4:00–6:00 p.m.</td>
<td>54</td>
<td>3</td>
<td>43</td>
<td>46</td>
</tr>
</tbody>
</table>

Average Pass-By Trip Percentage: 56
“—” means no data were provided
Figure E.19 Gasoline/Service Station with Convenience Market (945)

Average Pass-By Trip Percentage vs: 1,000 Sq. Ft. Gross Floor Area
On a: Weekday, PM Peak Period
Number of Studies: 9
Average 1,000 Sq. Ft. GFA: 0.9

Data Plot

\[ T = \text{Average Pass-By Trip Percentage} \]
\[ X = 1000 \text{ Sq. Feet Gross Floor Area} \]

Actual Data Points

Fitted Curve Equation: Not given

\[ R^2 = **** \]
Appendix F. Example Application of Recommended Process For Mixed-Use Development

This appendix is an example application of the recommended procedure for estimating trip generation and internal trip capture at a mixed-use development. The example uses the spreadsheet estimator tool.

Site Description

A proposed mixed-use development site consists of the following development program, with the estimated single-use site vehicle trip generation for the PM street peak hour as shown in Table F.1.

Table F.1 Development Characteristics for Example 1

<table>
<thead>
<tr>
<th>Land Use</th>
<th>ITE LUC</th>
<th>Size</th>
<th>Units</th>
<th>Total Vehicle Trips</th>
<th>Total Entering Vehicles</th>
<th>Total Exiting Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>710</td>
<td>600,000</td>
<td>Sq. Ft.</td>
<td>750</td>
<td>127</td>
<td>623</td>
</tr>
<tr>
<td>Retail</td>
<td>820</td>
<td>200,000</td>
<td>Sq. Ft.</td>
<td>953</td>
<td>457</td>
<td>496</td>
</tr>
<tr>
<td>Restaurant</td>
<td>932</td>
<td>70,000</td>
<td>Sq. Ft.</td>
<td>690</td>
<td>414</td>
<td>276</td>
</tr>
<tr>
<td>Cinema</td>
<td>445</td>
<td>10 Screens</td>
<td></td>
<td>136</td>
<td>61</td>
<td>75</td>
</tr>
<tr>
<td>Residential</td>
<td>220</td>
<td>1,500</td>
<td>Dwelling Units</td>
<td>1,518</td>
<td>987</td>
<td>531</td>
</tr>
<tr>
<td>Hotel</td>
<td>310</td>
<td>400</td>
<td>Total Rooms</td>
<td>240</td>
<td>122</td>
<td>118</td>
</tr>
<tr>
<td>Total All Land Uses</td>
<td>4,287</td>
<td>2,168</td>
<td></td>
<td>2,119</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: An adaptation of a figure in NCHRP 684 (called Tables 103 and 104).

The objective is to estimate total external trip generation and internal trip capture for the PM peak hour of adjacent street traffic. The steps described below follow the recommended procedure presented in Section 6.5 of Chapter 6. The calculations reference the estimator tool also described in Section 6.5.

Step 1: Determine Whether Methodology is Appropriate for Study Site

Based on a review of the site plan and context in the proposed mixed-use development vicinity, the analyst determines that the recommended methodology is appropriate.

Step 2: Estimate Trip Generation for Individual Land Uses

PM peak hour directional vehicle trip generation estimates for each land use from *Trip Generation Manual*, are provided in Table F.1. Vehicle occupancy is assumed to be 1.00 person per vehicle for
all land uses and directions of travel. All the external trips are assumed made to be in a vehicle (that is, there are no walk, bike, or transit trips). The single-use trip generation estimates are entered in Table 1 of the estimator (as shown in Figure F.1). Table 2 remains empty as this example is using the default values.

**Step 3: Estimate Proximity between Individual On-Site Land Use Pairs**

From a preliminary site plan, the following are the average distances between on-site land use pairs:
- Office-Retail: 400 ft.
- Office-Restaurant: 400 ft.
- Office-Residential: 1,600 ft.
- Residential-Retail: 900 ft.
- Residential-Restaurant: 800 ft.
- Residential-Cinema: 800 ft.
- Residential-Hotel: 1,300 ft.

The proximity distances are entered in Table 3 of the estimator tool. The distances between the following pairs of land uses are not measured because no proximity-adjustment factors described in Chapter 6 are available for these pairs: office-cinema, office-hotel, retail-restaurant, retail-cinema, retail-hotel, restaurant-cinema, restaurant-hotel, and cinema-hotel.

**Step 4: Estimate Unconstrained Internal Trip Capture Rates with Proximity Adjustment**

**Step 4A: Estimate Base Unconstrained Internal Trip Capture Rates**

For the PM peak hour, use the unconstrained internal trip capture rates under the “PM Peak Hour” column of Tables 6.1 and 6.2. For example, for the retail-residential land use pair, the following values are used.
- From Retail to Residential (Origin End): 26 percent (Table 6.1)
- From Residential to Retail (Origin End): 42 percent (Table 6.1)
- To Retail from Residential (Destination End): 10 percent (Table 6.2)
- To Residential from Retail (Destination End): 46 percent (Table 6.2)

**Step 4B: Apply Proximity-Adjustment Factors**

Based on the distances estimated in Step 3, the estimator tool automatically calculates several proximity-adjustment factors. For the retail-residential land use pair, the proximity-adjustment factors are calculated as follows:
- From Retail to Residential (Origin End): 0.960 (shown in Table 10.1 of the estimator tool)
- From Residential to Retail (Origin End): 0.790 (Table 10.1)
- To Retail from Residential (Destination End): 0.790 (Table 10.2)
- To Residential from Retail (Destination End): 1.000 (Table 10.2)
Step 4C: Calculate Proximity-Adjusted Internal Trip Capture Rates

The results from Steps 4A and 4B are multiplied together to calculate the proximity-adjusted internal trip capture rates:
- From Retail to Residential (Origin End): 26% * 0.960 = 25.0%
- From Residential to Retail (Origin End): 42% * 0.790 = 33.2%
- To Retail from Residential (Destination End): 10% * 0.790 = 7.9%
- To Residential from Retail (Destination End): 46% * 1.000 = 46.0%

Step 5: Estimate Unconstrained Demand between On-Site Land Use Pairs

The “unconstrained demand” volumes are computed by multiplying the directional trip generation value by the proximity-adjusted internal trip capture rates. For example,
- From Retail to Residential (Origin End): 496 outbound trips * 25.0% = 124 trips
- From Residential to Retail (Origin End): 531 outbound trips * 33.2% = 176 trips
- To Retail from Residential (Destination End): 457 inbound trips * 7.9% = 36 trips
- To Residential from Retail (Destination End): 987 inbound trips * 46.0% = 454 trips

Outbound trips are shown in Table 8(O) on Page 2 of the estimator tool. Inbound trips are shown in Table 8(D) on Page 2 of the estimator tool.

Step 6: Estimate Balanced Demand between On-Site Land Use Pairs

The controlling value (that is, the lower value) is selected for each pair of land uses for each direction. For example, using the numbers calculated in Step 5 above:
- For trips from Retail to Residential, the residential could receive as many as 454 trips; however, the retail can only generate 124 trips to residential. The controlling value is 124 trips.
- For trips from Residential to Retail, the residential could generate as many as 176 trips; however, the retail can only receive 36 trips. The controlling value is 36 trips.

The balanced demand is shown in Table 4 on Page 1 of the estimator tool.

Step 7: Estimate Total Internal Trips

The balanced origin-destination matrix is shown in Table 4. The total internal trips for each land use pair and direction is estimated by computing the row sum (trip origins) then the column sum (trip destinations) for each land use. For example, the on-site retail generates a total of 291 exiting trips with internal destinations and 208 entering trips with internal origins. Entering trips are shown in Table 9(D) on Page 2 of the estimator tool. Exiting trips are shown in Table 9(O) on Page 2 of the estimator tool.

Step 8: Estimate Total External Trips for Each Land Use

For each land use and direction, subtract the total internal trips from Step 7 from the total person-trip generation estimates obtained in Step 2. For example, the retail generates 496–291 or 205 external trips.
exiting and 457–208 or 249 external trips entering. *Entering trips are shown in Table 9(D) on Page 2 of the estimator tool. Exiting trips are shown in Table 9(O) on Page 2 of the estimator tool.*

**Step 9: Calculate Total External Vehicle Trip Generation and Internal Trip Capture Rate**

The total external trip generation is the sum of the “External” column in Tables 9(O)/(D). The right three columns of Tables 9(O)/(D) distribute these external trips by mode based on the user-entered vehicle occupancy and mode share data. The total external vehicle trips and total external person trips by transit and non-motorized modes are shown in Table 5 of the estimator tool. There are a total of 4,287 person trips generated by the on-site land uses at the proposed mixed-use development, of which 2,811 have an end outside of the study site. To calculate the internal trip capture rate, the sum of the “Internal” columns of Table 9(O) and Table 9(D) is divided by the sum of the “Total” columns from the same table. In this example, the total internal trip capture rate is estimated to be 34 percent. The calculated internal trip capture rates for each land use and direction are shown in Table 6.
Figure F.1 NCHRP 684 Trip Capture Estimation Tool

### Appendix F: Example Application of Recommended Process For Mixed-Use Development

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Example 1 Worksheet</th>
<th>Organization:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Location:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scenario Description:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis Year:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis Period:</td>
<td>PM Street Peak Hour</td>
<td></td>
</tr>
</tbody>
</table>

### Table 1-PM: Base Vehicle Trip Generation Estimates (Single-Use Site Estimate)

<table>
<thead>
<tr>
<th>Land Use</th>
<th>ITE LUCs</th>
<th>Quantity</th>
<th>Units</th>
<th>Estimated Vehicle Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>710</td>
<td>600,000</td>
<td>1000 sf GFA</td>
<td>Total: 750, Entering: 127, Exiting: 623</td>
</tr>
<tr>
<td>Retail</td>
<td>820</td>
<td>200,000</td>
<td>1000 sf GFA</td>
<td>Total: 953, Entering: 457, Exiting: 496</td>
</tr>
<tr>
<td>Restaurant</td>
<td>932</td>
<td>70,000</td>
<td>1000 sf GFA</td>
<td>Total: 690, Entering: 414, Exiting: 276</td>
</tr>
<tr>
<td>Residential</td>
<td>220</td>
<td>1,500 DU</td>
<td>Total Rooms</td>
<td>Total: 1516, Entering: 987, Exiting: 531</td>
</tr>
<tr>
<td>Hotel</td>
<td>310</td>
<td>400</td>
<td>Total Rooms</td>
<td>Total: 240, Entering: 122, Exiting: 118</td>
</tr>
<tr>
<td>All Other Land Uses(^2)</td>
<td></td>
<td></td>
<td></td>
<td>Total: 4287, Entering: 2168, Exiting: 2119</td>
</tr>
</tbody>
</table>

### Table 2-PM: Baseline Mode Split and Vehicle Occupancy Estimates

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Entering Person Trips</th>
<th>Exiting Person Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Veh. Occ.</td>
<td>% Transit</td>
</tr>
<tr>
<td>Retail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restaurant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Other Land Uses(^2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 3-PM: Average Land Use Interchange Distances (Walking Distance in Feet)

<table>
<thead>
<tr>
<th>Origin (From)</th>
<th>Destination (To)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Retail</td>
</tr>
<tr>
<td>Office</td>
<td>400</td>
</tr>
<tr>
<td>Retail</td>
<td></td>
</tr>
<tr>
<td>Restaurant</td>
<td></td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td></td>
</tr>
<tr>
<td>Hotel</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4-PM: Internal Person Trip Origin-Destination Matrix\(^*\)

<table>
<thead>
<tr>
<th>Origin (From)</th>
<th>Destination (To)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Retail</td>
</tr>
<tr>
<td>Office</td>
<td>34</td>
</tr>
<tr>
<td>Retail</td>
<td>10</td>
</tr>
<tr>
<td>Restaurant</td>
<td>8</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>2</td>
</tr>
<tr>
<td>Residential</td>
<td>21</td>
</tr>
<tr>
<td>Hotel</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 5-PM: Computation Summary

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Entering</th>
<th>Exiting</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Person Trips</td>
<td>4,287</td>
<td>2,168</td>
<td>2,119</td>
</tr>
<tr>
<td>Internal Capture Percentage</td>
<td>34%</td>
<td>34%</td>
<td>35%</td>
</tr>
</tbody>
</table>

### Table 6-PM: Internal Trip Capture Percentages by Land Use

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Entering Trips</th>
<th>Exiting Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>32%</td>
<td>8%</td>
</tr>
<tr>
<td>Retail</td>
<td>46%</td>
<td>59%</td>
</tr>
<tr>
<td>Restaurant</td>
<td>50%</td>
<td>76%</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>59%</td>
<td>49%</td>
</tr>
<tr>
<td>Residential</td>
<td>19%</td>
<td>23%</td>
</tr>
<tr>
<td>Hotel</td>
<td>46%</td>
<td>25%</td>
</tr>
</tbody>
</table>

\(^1\)Land Use Codes (LUCs) from Trip Generation Manual, published by Institute of Transportation Engineers.

\(^2\)Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator.

\(^3\)Vehicle trips computed using the mode split and vehicle occupancy values provided in Table 2-PM.

\(^*\)Person trips

\(\ast\)Indicates computation that has been rounded to the nearest whole number.

Estimation Tool Developed by Texas A&M Transportation Institute

Appendix F: Example Application of Recommended Process For Mixed-Use Development
### Table 7-PM: Conversion of Vehicle Trip Ends to Person Trip Ends

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Veh. Occ.</th>
<th>Vehicle Trips</th>
<th>Person Trips*</th>
<th>Veh. Occ.</th>
<th>Vehicle Trips</th>
<th>Person Trips*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>1.00</td>
<td>127</td>
<td>127</td>
<td>1.00</td>
<td>623</td>
<td>623</td>
</tr>
<tr>
<td>Retail</td>
<td>1.00</td>
<td>457</td>
<td>457</td>
<td>1.00</td>
<td>406</td>
<td>406</td>
</tr>
<tr>
<td>Restaurant</td>
<td>1.00</td>
<td>414</td>
<td>414</td>
<td>1.00</td>
<td>276</td>
<td>276</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>1.00</td>
<td>61</td>
<td>61</td>
<td>1.00</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Residential</td>
<td>1.00</td>
<td>987</td>
<td>987</td>
<td>1.00</td>
<td>531</td>
<td>531</td>
</tr>
<tr>
<td>Hotel</td>
<td>1.00</td>
<td>122</td>
<td>122</td>
<td>1.00</td>
<td>118</td>
<td>118</td>
</tr>
</tbody>
</table>

### Table 8-PM (O): Internal Person Trip Origin-Destination Matrix (Computed at Origin)

<table>
<thead>
<tr>
<th>Origin (From)</th>
<th>Office</th>
<th>Retail</th>
<th>Restaurant</th>
<th>Cinema/Entertainment</th>
<th>Residential</th>
<th>Hotel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>117</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Retail</td>
<td>10</td>
<td>144</td>
<td>20</td>
<td>124</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Restaurant</td>
<td>8</td>
<td>113</td>
<td>22</td>
<td>49</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>2</td>
<td>16</td>
<td>23</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Residential</td>
<td>21</td>
<td>176</td>
<td>91</td>
<td>0</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Hotel</td>
<td>0</td>
<td>19</td>
<td>80</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 8-PM (D): Internal Person Trip Origin-Destination Matrix (Computed at Destination)

<table>
<thead>
<tr>
<th>Origin (From)</th>
<th>Office</th>
<th>Retail</th>
<th>Restaurant</th>
<th>Cinema/Entertainment</th>
<th>Residential</th>
<th>Hotel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>34</td>
<td>8</td>
<td>1</td>
<td>39</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Retail</td>
<td>39</td>
<td>120</td>
<td>16</td>
<td>454</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>Restaurant</td>
<td>35</td>
<td>229</td>
<td>20</td>
<td>158</td>
<td>87</td>
<td>0</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>8</td>
<td>12</td>
<td>39</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Residential</td>
<td>72</td>
<td>48</td>
<td>0</td>
<td>39</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Hotel</td>
<td>0</td>
<td>9</td>
<td>21</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 9-PM (D): Internal and External Trips Summary (Entering Trips)

<table>
<thead>
<tr>
<th>Destination Land Use</th>
<th>Person Trip Estimates</th>
<th>External Trips by Mode*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>Office</td>
<td>41</td>
<td>86</td>
</tr>
<tr>
<td>Retail</td>
<td>208</td>
<td>249</td>
</tr>
<tr>
<td>Restaurant</td>
<td>209</td>
<td>205</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>36</td>
<td>25</td>
</tr>
<tr>
<td>Residential</td>
<td>188</td>
<td>799</td>
</tr>
<tr>
<td>Hotel</td>
<td>56</td>
<td>66</td>
</tr>
<tr>
<td>All Other Land Uses²</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 9-PM (O): Internal and External Trips Summary (Exiting Trips)

<table>
<thead>
<tr>
<th>Origin Land Use</th>
<th>Person Trip Estimates</th>
<th>External Trips by Mode*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>Office</td>
<td>51</td>
<td>572</td>
</tr>
<tr>
<td>Retail</td>
<td>291</td>
<td>205</td>
</tr>
<tr>
<td>Restaurant</td>
<td>209</td>
<td>67</td>
</tr>
<tr>
<td>Cinema/Entertainment</td>
<td>37</td>
<td>38</td>
</tr>
<tr>
<td>Residential</td>
<td>120</td>
<td>411</td>
</tr>
<tr>
<td>Hotel</td>
<td>30</td>
<td>88</td>
</tr>
<tr>
<td>All Other Land Uses²</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

1Vehicle trips computed using the mode split and vehicle occupancy values provided in Table 2-PM
2Person Trips
3Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator
*Indicates computation that has been rounded to the nearest whole number.

In addition to the resource documents referenced in the *Handbook* chapters, several research projects have been completed or were currently ongoing (at the time this *Handbook* was compiled) to collect data and/or develop computational methods to estimate trip generation for infill and mixed-use development. Some of the methods are more fully developed or more broadly applicable than others. Important characteristics of the known methods and datasets are described below. More details regarding the uses and limitations of the methods and data are available in the cited source documents.

**Evaluation of Trip Generation in Highly Urbanized Areas, District Department of Transportation (Washington, DC)**

The District Department of Transportation (DDOT) collected modal trip generation data at 62 residential and residential mixed-use (with first-floor retail) sites within Washington, DC. Initial results in the analysis found a strong relationship between total person-trips and the number of dwelling units plus the retail square footage. Best fit linear equations were developed.

DDOT continues to collect data, refine the study findings and explore additional models for predicting person and vehicle trips that better account for environmental factors.

**Caltrans Smart Growth Trip Generation (SGTG) Study (Phase 2)**

The goal of the Caltrans study was to produce a validated estimation method and tool to accurately estimate trip generation for smart growth developments in California and beyond. The product is a database and estimation method that enables and justifies its regular use by public agencies and consultants to assess traffic impacts of proposed smart growth land use developments.

Caltrans collected and compiled AM and PM peak hour person trip data by mode for 29 apartment sites and 22 office sites. On average, the smart growth apartment sites generate 44 percent fewer peak hour vehicle trips than would be estimated using ITE *Trip Generation Manual* rates and equations. On average, the smart growth office sites generate 49 percent fewer peak hour vehicle trips.

The study produced models that estimate peak hour vehicle trips for smart growth apartment and office sites. The data required for the models are the number of occupied units at the site (dwelling units for an apartment building and gross square footage for an office building) and the number of intersections within a half-mile radius of the study site (as a surrogate measure for pedestrian network connectivity).

**Caltrans Smart Growth Trip Generation (SGTG) Study (Phase 1)**

UC Davis researchers collected trip-generation data at 30 smart growth sites and used this information, along with trip generation data from other studies, to develop a method embedded in a spreadsheet tool that can be used to adjust available trip-generation rates for “smart growth” land
use projects proposed in California. The spreadsheet tool includes site and context variables that represent different aspects of smart growth (e.g., residential population density, job density, number of peak-hour bus stops and train stops, bicycle facility presence, and sidewalk coverage).

The tool is only appropriate for sites in smart growth areas, as determined by the criteria presented in the spreadsheet. The trip estimates produced by the tool are intended for planning-level analysis at single-use sites or for single land uses that are a part of multi-use sites. The tool does not apply to multi-use developments as a whole. While the accuracy of the spreadsheet tool could be improved in the future by basing the underlying model on more study sites, it provides important contextual considerations related to trip generation. The spreadsheet tool and more details are available at: http://ultrans.its.ucdavis.edu/projects/smart-growth-trip-generation.

Urbemis

The Urban Emissions Model (URBEMIS), originally developed by the California Air Resources Board, is used to estimate the impact of vehicle emissions associated with certain urban actions, including new development, in California. It estimates daily (not peak hour) vehicle trips for smart growth development based on various land use, locational, and transportation characteristics. The model has withstood legal challenges.

URBEMIS uses ITE daily trip generation rates for all land uses included in Trip Generation Manual and permits user input of additional land uses for which trip generation data are available. Documentation for the latest version of URBEMIS, available as of pre-publication review of this edition of the Handbook, states that Trip Generation Manual, 7th Edition data are reflected in the model.

URBEMIS documentation describes the detailed computations made by the model. The model uses a series of fitted curve equations to estimate daily trip generation through a freeware program. Context variables such as density, mixed-use, transit, street connectivity, bicycle and pedestrian facilities, and transportation demand management measures can be input. Adjustments for each action are additive, so there is potential for double-counting. There is an option to account for multiple adjustments, but it is not clear that it eliminates all potential overlapping adjustments.

MXD+ Tool

The MXD+ estimator was developed for estimating trip generation for mixed-use development as well as infill and transit-oriented development. The tool is an outgrowth of research and analysis conducted by EPA and Sandag. MXD+ combines features of NCHRP 684 and EPA MXD. The developers sought to address the fact that each method has strengths relative to the other and to create a method that is more accurate than either of the individual methods alone.

The MXD+ tool incorporates the underlying data sources and logic that the two methods share. It offers the ability to assess the effects of spatial separation of uses and recognition of specific land-use categories and to consider the dynamic influences of local development context, regional

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accessibility, transit availability, development density and walkability factors, and the characteristics of residents.

**California Infill Trip Generation Study**

Caltrans sponsored a project (Trip-Generation Rates for Urban Infill Land Uses in California) to study travel characteristics of infill development in California’s metropolitan areas. The Caltrans report documents the results of trip generation data collection at 25 multi-family residential, office, and very limited retail and restaurant infill sites. The report includes initial findings for trip generation rates for weekday AM and PM peak periods based on the limited data that were collected. The products of this study are expected to be the beginnings of a California urban infill trip generation database.

For the Caltrans study, an infill site is either within one-third mile of a rail transit station, is served by bus service at the junction of at least two major bus routes, or is located within 1,200 ft. of a bus rapid transit (BRT) corridor. This definition of infill may be too restrictive for some sites considered infill in this Handbook. Therefore, its data may be biased toward sites with significant transit service.

**Trip Generation Rates for Transportation Impact Analyses of Infill Developments (NCHRP Project 8-66)**

NCHRP Project 8-66 pursued estimation methods that would not require development of a new database for both urban and suburban infill sites. The project report (NCHRP Report 758) identifies two approaches for obtaining adjustment factors for mode share and automobile occupancy to apply to ITE rates. The recommended method for estimating trip generation for infill sites (presented in Chapter 7) is similar to the first approach. The data requirements for the second approach may be too demanding for use in a single site analysis, but could become viable if an MPO assembles the needed data for use in analyzing development sites in its area.

The first approach is to collect mode share and vehicle occupancy data at the study site (if it exists) or at nearby similar proxy sites within the same context as the study site (at build-out) and use the results to adjust the person trip equivalents of ITE vehicle trip generation data.

The second approach can be used within any MPO area with urban travel surveys and a travel forecasting model. The approach uses local household travel survey linked trip data to extract mode share and vehicle occupancy data by trip purpose (representing land use) within groups of traffic analysis zones that represent a specific context zone. The resulting mode shares and vehicle occupancy are used to adjust person trip equivalents of ITE vehicle trip generation data. A key step for this approach is to assign each trip purpose associated with its activity-based destination to identify a trip for specific land uses.

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OTREC-Funded Urban Context-Based Rate Adjustment Study

The Oregon Transportation Research and Education Consortium (OTREC) funded a Portland State University research project that developed a model using small sample data from the Portland, OR region. The study produced nine distinct models using nine different built environment measures.

The research used small sample interviews (fewer than 100 per site) to collect PM peak period person trip generation data as well as surrounding context data for 78 infill sites. Smart growth characteristics were not required for these infill sites.

The land uses studied were convenience stores, high-turnover restaurants, and drinking establishments. The study found a consistent trend between the personal passenger vehicle mode share and the urban area location type. For example, the personal passenger vehicle mode share percentage tended to be lowest in a central business district, with increasing percentages, in order, for urban core, regional center, suburban town center, and general suburban settings. Likewise, the walk mode share percentages increased from the suburban settings to the CBD settings. Researchers also found for convenience markets and restaurants that person trip rates in very dense urban contexts are higher than in suburban settings.

The OTREC-funded method is at this point limited to the land uses from which it was developed and tested. The model also is limited to use for PM peak period conditions because no AM peak data were collected. The method was validated and verified for Portland-area use based on its accuracy of estimates. The model developers plan to test for broader applicability using Caltrans project data.

Additional Data Collection and Analysis Efforts

The California Department of Transportation (Caltrans) has also funded a separate 3-year project to investigate modal trip generation at affordable housing developments. A similar study has been funded by the National Institute for Transportation and Communities to research travel characteristics of residents in new multifamily housing products such as micro-apartments, co-housing, and housing with zero or reduced parking.

In 2015, New York City Department of Transportation collected 24-hour person counts by video and mode choice surveys at 80 residential, office, local retail, and hotel sites. The department has initiated another substantial data collection project to cover another 60 sites that include medical offices, supermarkets/fresh markets and fast food and quality restaurants.

Arlington County, VA, USA has collected trip generation and mode split data at residential, office, and hotel sites and sites with a mix of these uses with retail. The Arlington Mobility Lab prepared the first aggregate analysis of these data in 2013 on a sample of 16 primarily residential buildings. A similar analysis of 16 office buildings is underway as is an update to the residential analysis increasing the building sample size to 36. The analyses are also assessing

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the influence of neighborhood, building, parking, and TDM characteristics on mode choice and trip-making behavior.

There continue to be advances in understanding of trip-making at transit-oriented (TOD) and mixed-use (MXD) development, whether located in an urban or suburban setting. University of Utah researchers are collecting trip and parking generation data at TOD. The initial results from Seattle data, although currently unpublished, suggest that well-supported TOD areas have vehicle trip generation rates that range between 30 and 50 percent less than for comparable suburban, vehicle-oriented areas.

**Florida Department of Transportation** collected data at four suburban MXD with varying combinations of residential, medical office, big-box supermarket, ground-floor retail and restaurant, entertainment center, hotel, shopping center, and retail-themed town center uses.

All the studies cited above are based on data collected at individual sites. Other studies have adapted regional travel survey databases to successfully estimate site trip generation.
Appendix H. Transportation Demand Management

Background

Transportation demand management (TDM) techniques are intended to
- Shift travel mode (away from single-occupant personal passenger vehicle);
- Shift time period of travel (away from peak periods of travel by motorized vehicle); and
- Eliminate trips completely (for example, through telecommuting).

TDM techniques include the following:
- Hiring or subsidizing a transportation coordinator or using the services of a transportation management association;
- Providing subsidies or other incentives to encourage employees to not commute in a single-occupant personal passenger vehicle, such as reduced parking fees for carpools/vanpools or free/subsidized transit passes;
- Encouraging carpooling/vanpooling (potential elements include providing carpool matching, parking fee discounts, preferential parking, and guaranteed ride home);
- Providing access to company fleet vehicles or car-share vehicles for employees who do not drive to work;
- Modifying work schedules (such as flextime or four-day work week);
- Enabling and encouraging work-at-home programs;
- Charging for on-site parking and reducing number of on-site parking spaces;
- Providing internal shuttle service; and
- Promoting pedestrian and bicycle transportation (for example, constructing on- or off-site pedestrian or bicycle facilities and providing inter-parcel access, bike lockers and secure storage areas, showers, and changing facilities).

Each of these techniques can be effective under the right circumstances, but are ineffective under inappropriate conditions. As an example, a ridesharing program can be effective for a large employer sponsoring its own program. For a small company, a ridesharing program operated singly is usually ineffective in terms of vehicle trip reductions. As another example, modified work schedules (flextime or staggered work hours) can produce a substantial spreading of peak-period traffic if implemented at a site where there are many employees and where most employees are on identical schedules. If, however, there are few employees or if employees already work staggered schedules, modified work schedules may have little or no impact on vehicle trip generation.

Research on TDM Effects

Translation of the effects of TDM programs (as measured in research) to site-specific trip generation impacts is not straightforward for several reasons:
- The data are typically survey-based, not count-based;
- The data typically involve commuters only (that is, not all trips generated by the site); and
- Many measures are geared to affect total daily travel rather than peak-hour travel;
The research contains very little controlled before-and-after analysis; and
Many trip generation reductions are either driven by an individual employer or implemented at a regional or subregional scale (that is, are not site driven).

An example of a research product with direct relevance for the estimation of vehicle trip reductions for baseline sites as a result of TDM measures is the California Air Pollution Control Officers Association (CAPCOA) TDM Tool. The tool is based on a meta-analysis of more than 40 practical tools and academic references that explore how travel is related to the built environment, policy, and socioeconomic characteristics.

In general, the CAPCOA Tool can be applied in both urban and suburban contexts and sometimes, but rarely, in rural contexts with specific characteristics. The method can be applied to residential, retail, office, industrial, and mixed-use study sites.

The CAPCOA Tool considers a variety of variables within the following five categories related to travel behavior:

- Land use/location;
- Neighborhood/site enhancement;
- Parking policy/pricing;
- Transit system improvements; and
- Commute trip reduction.

Trip reductions for each variable are provided from a variety of different studies. Vehicle trip reductions in each category are constrained to avoid double-counting the impacts of related variables. A maximum reduction is set for each category.

Advantages of the CAPCOA Tool include the following:

- It can be applied to a wide range of land uses.
- It can be applied to any time period.
- Trip reductions are identified for a wide range of strategies, including land use planning, roadway design, and transportation demand management programs.
- Trip reductions are based on more than 40 empirical studies of travel behavior.
- Trip reduction caps in each category reduce the potential for double-counting trip reductions.
- The method has been validated at sites in the San Francisco Bay Area.
- The method inputs and outputs can be displayed on a single spreadsheet. All background calculations can be programmed into the spreadsheet so the user does not have to do them by hand.

Limitations of the CAPCOA Tool include the following:

Trip reduction caps in each category are based on California travel survey data. They are not based on a cross-comparison of actual trip reductions due to different combinations of strategies.

The method is based on some studies that evaluated changes in vehicle trips and other studies that evaluated changes in vehicle miles traveled (VMT) due to certain contextual conditions and TDM strategies. The method assumes that percent changes in VMT are equivalent to percent changes in vehicle trips.

Some strategies are best practices and others are used in general planning processes, but their impacts on travel behavior have not been studied in detail. These strategies are less quantifiable.

Appendix G documents recent and ongoing research with specific application for trip generation estimates for infill and mixed-use development. Several of the cited resource documents also address potential TDM effects.

**Coordination with Other Guidance in Handbook**

For the purposes of this Handbook, any TDM adjustments should be to reflect site design, service, or programmatic conditions or commitments that are distinct from the effects of nearby transit that could lead to site-generated transit trips (addressed in Chapter 8) and the effects of nearby development that could lead to site-generated walk trips (covered in Chapter 7). The ITE recommended practice, *Transportation Impact Analyses for Site Development*, identifies a range of typical TDM approaches, and best practices for evaluating their applicability to given development site characteristics.
Appendix I. Truck Trip Generation Research and Data

The following resource documents provide information that pertains to the estimation of truck trips generated by a development site.

Freight Trip Generation and Land Use (NCHRP Report 739 and NCFRP Report 19)\(^2\)

NCHRP Report 739/NCFRP Report 19 examine strategies for determining truck trip generation based on land use classifications. The research highlights the need to differentiate between freight trip generation (both vehicle trips and truck trips) and freight generation (volume of cargo transported by vehicles).

The research found commonly used variables (such as square footage and number of employees) have significantly different levels of explanatory power as independent variables for truck trips. For example, employment level is likely to be a better explanatory variable where it is likely to rise and fall with the level of economic activity at a site (and the number of truck trips generated). Alternatively, if a variable such as square footage is to be used, it should be complemented with additional parameters that represent the percent of capacity being used (such as full production or minimum production) or other metrics that contribute to a better understanding of the activity level at a site.

In order to develop a series of case study truck trip generation models, the research used establishment surveys from 362 receivers of supplies in Manhattan and Brooklyn, New York, 339 carrier companies in Northern New Jersey and New York City, a furniture store chain in Midwestern states, and supermarkets in the Puget Sound, WA, region and Manhattan.

The report presents a series of linear regression models for freight trip attraction and freight trip production. The models fall into one of the following classes:

- **Type S**: Constant freight trip generation by truck per establishment; only the intercept is statistically significant and conceptually valid, indicating the truck trip generation does not depend on business size.
- **Type E**: Trip rate per employee; only the coefficient of employment is statistically significant and conceptually valid.
- **Type C**: Constant and rate per employee; both the intercept and the coefficient of employment are significant and conceptually valid.

The models show a significant amount of variation. As an example, the preferred models for freight trip attractions are as follows:

- For 53 percent of industry segments, the preferred truck trip generation model contained only a constant (Type S), indicating no dependency on business size;

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For 28 percent of the cases the model was a function of a constant and a rate applied to an establishment’s employment (Type C); and

For the remaining 19 percent of cases, the preferred model was proportional to employment and a constant truck trip rate (Type E).

The fact that the most commonly used approach in practice (that is, the constant truck trip rate per employee) was the best model in only a minority of cases should be a concern to the analyst when using older studies that relied entirely on the number of employees as the independent variable for estimating truck trips.

ITE Trip Generation Manual

The Trip Generation Manual data volumes contain truck trip generation information for 18 land uses. Truck trips are presented either as vehicle counts or as percentages of all vehicle trips at a site. Table I.1 contains a summary of this truck trip generation information.

The analyst is cautioned about relying solely on these data (or similar data in other databases) because of potential inconsistencies in the definitions of trucks, inconsistencies in the definitions of truck trips, the underlying economic conditions and production practices, the age of the data, the use of broad land use categories, and the use of independent variables that are appropriate for vehicle trip generation but may not be appropriate for truck trip generation.

Freight Trip Generation Access Database

NCFRP Report 19 compiles truck trip parameters from a large number of previous studies. These data are assembled in an ACCESS database hosted by Rensselaer Polytechnic Institute (http://transp.rpi.edu/~NCFRP25/FTG-Database.rar). The website includes a tutorial for accessing the literature, the models, and the parameters. While these individual parameters can be useful in many cases, there is little or no documentation or validation to support them. The analyst should review the studies provided on the website and determine which studies are closely related to the question under consideration.

NCHRP Syntheses

Five recent NCHRP synthesis reports also touch on the subject of truck trip generation:

All these documents contain relevant information regarding truck trips, but none focuses directly on the issues associated with improving the reliability of truck trip generation rates.

**Table I.1 Truck Trip Generation Information in Trip Generation Manual, 9th Edition**

<table>
<thead>
<tr>
<th>Land Use Code</th>
<th>Land Use</th>
<th>Truck Trips Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>010</td>
<td>Waterport/Marine Terminal</td>
<td>Truck trips accounted for approximately 38 percent of the total weekday traffic at container terminals and 60 percent at break-bulk terminals.</td>
</tr>
<tr>
<td>021</td>
<td>Commercial Airport</td>
<td>Truck trips accounted for less than 1 percent of the weekday and weekend traffic at the sites surveyed.</td>
</tr>
<tr>
<td>022</td>
<td>General Aviation Airport</td>
<td>Truck trips accounted for 3 to 5 percent of the weekday traffic at the airports surveyed.</td>
</tr>
<tr>
<td>030</td>
<td>Intermodal Truck Terminal</td>
<td>At one site, 70 percent of the site-generated driveway volume was truck traffic. At an additional site located on the waterfront, 34 percent of the driveway volume was truck traffic.</td>
</tr>
<tr>
<td>130</td>
<td>Industrial Park</td>
<td>Truck trips accounted for 1 to 31 percent of the weekday traffic. The average was approximately 13 percent. This average was based on all sites surveyed.</td>
</tr>
<tr>
<td>150</td>
<td>Warehousing</td>
<td>Truck trips accounted for 20 percent of the weekday traffic at one of the sites surveyed.</td>
</tr>
<tr>
<td>151</td>
<td>Mini-Warehouse</td>
<td>Truck trips accounted for 2 to 15 percent of the weekday traffic at the sites where data were available.</td>
</tr>
</tbody>
</table>
Peak truck activities typically occur outside the peak hour of adjacent street traffic. Truck trips accounted for 9 to 29 percent of the peak hour traffic at the sites that provided truck trip information.

Average truck trip generation rates for five rural sites are summarized in the table below. The average GFA of these facilities is 1 million sq. ft.

<table>
<thead>
<tr>
<th>Day/Time Period</th>
<th>Weighted Average Truck Trip Generation Rate (trip ends per 1,000 sq. ft. GFA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>0.64</td>
</tr>
<tr>
<td>Weekday AM Peak Hour of Adjacent Street Traffic</td>
<td>0.03</td>
</tr>
<tr>
<td>Weekday PM Peak Hour of Adjacent Street Traffic</td>
<td>0.04</td>
</tr>
<tr>
<td>Weekday AM Peak Hour of Generator</td>
<td>0.02</td>
</tr>
<tr>
<td>Weekday PM Peak Hour of Generator</td>
<td>0.04</td>
</tr>
<tr>
<td>Saturday</td>
<td>0.49</td>
</tr>
<tr>
<td>Saturday Peak Hour of Generator</td>
<td>0.03</td>
</tr>
<tr>
<td>Sunday</td>
<td>0.48</td>
</tr>
<tr>
<td>Sunday Peak Hour of Generator</td>
<td>0.03</td>
</tr>
</tbody>
</table>
Table I.1 (continued) Truck Trip Generation Information in *Trip Generation Manual*, 9th Edition

<table>
<thead>
<tr>
<th>Land Use Code</th>
<th>Land Use</th>
<th>Truck Trips Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>254</td>
<td>Assisted Living</td>
<td>Truck traffic was captured for some studies in this land use code and is presented in the following table. Although truck traffic was very low overall, most trips occurred during the mid-day period on a weekday.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time Period</th>
<th>% Trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday Morning (6:30 a.m.–9:30 a.m.)</td>
<td>1</td>
</tr>
<tr>
<td>Weekday Mid-Day (11:00 a.m.–1:30 p.m.)</td>
<td>9</td>
</tr>
<tr>
<td>Weekday Evening (2:45 p.m.–6:45 p.m.)</td>
<td>2</td>
</tr>
<tr>
<td>Saturday Mid-Day (11:00 a.m.–2:00 p.m.)</td>
<td>4</td>
</tr>
<tr>
<td>Saturday Evening (3:00 p.m.–6:00 p.m.)</td>
<td>0</td>
</tr>
<tr>
<td>Sunday Mid-Day (11:00 a.m.–2:00 p.m.)</td>
<td>1</td>
</tr>
<tr>
<td>Sunday Evening (3:00 p.m.–6:00 p.m.)</td>
<td>0</td>
</tr>
</tbody>
</table>

| 731           | State Motor Vehicles Department | Truck trips accounted for 0.44 percent of the weekday traffic at the motor vehicles department sites surveyed (range of 0.12 percent to 0.85 percent). |
| 732           | United States Post Office       | Truck trips accounted for 1.2 percent of the weekday traffic at the post office sites surveyed. |
| 760           | Research and Development Center | Truck trips accounted for 1.84 percent of the weekday traffic at the research and development center sites surveyed (range of 0.4 percent to 4.0 percent). |
The weighted average truck trip generation rates from approximately 30 sites surveyed for this land use are summarized in the table below. The average GFA of these facilities is 206,000 sq. ft.

<table>
<thead>
<tr>
<th>Day/Time Period</th>
<th>Weighted Average Truck Trip Generation Rate (trip ends per 1,000 sq. ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>0.87</td>
</tr>
<tr>
<td>Weekday AM Peak Hour of Adjacent Street Traffic</td>
<td>0.05</td>
</tr>
<tr>
<td>Weekday PM Peak Hour of Adjacent Street Traffic</td>
<td>0.03</td>
</tr>
<tr>
<td>Weekday AM Peak Hour of Generator</td>
<td>0.06</td>
</tr>
<tr>
<td>Weekday PM Peak Hour of Generator</td>
<td>0.04</td>
</tr>
<tr>
<td>Saturday</td>
<td>0.59</td>
</tr>
<tr>
<td>Saturday Peak Hour of Generator</td>
<td>0.04</td>
</tr>
<tr>
<td>Sunday</td>
<td>0.43</td>
</tr>
<tr>
<td>Sunday Peak Hour of Generator</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Appendix J. Calculation of Weighted Average and Standard Deviation

Unweighted Average, Variance, and Standard Deviation

The unweighted average rate for a sample set of data points can be expressed as

\[ \overline{R \text{ATE}} = \frac{1}{N} \sum_{i=1}^{N} T_i \]

where

\( T_i \) = trips at observation, \( i \);
\( X_i \) = independent variable value (such as employees, GFA, or seats) at observation, \( i \);
\( i \) = \( \{1, N\} \) observations;
\( N \) = total number of observations; and
\( T_i \) = the trip rate for observation, \( i \).

Variance is the average of the summed squares of the differences between individual data point rates and the average rate for the complete dataset. For a dataset considered a sample of the population, the sample variance is calculated by multiplying the variance value by the factor \( \frac{N}{(N - 1)} \). The sample variance of the data points can be expressed as

\[ \sigma^2 = \left( \frac{1}{N - 1} \right) \sum_{i=1}^{N} \left( \frac{T_i}{X_i} - \overline{R \text{ATE}} \right)^2 \]

Standard deviation is the square root of the calculated sample variance.

Weighted Average, Variance, and Standard Deviation

The *Trip Generation Manual* average rates are weighted. Insertion of a generic weighting function in the “average trip rate” equation presented above produces the following equation. Because the sum of the weights equals unity (\( \sum_{i=1}^{N} w_i = 1 \)), the simplified formula at the right end of the equation is produced.

\[ \overline{R \text{ATE}}_{\text{weighted}} = \frac{\sum_{i=1}^{N} w_i \left( \frac{T_i}{X_i} \right)}{\sum_{i=1}^{N} w_i} = \frac{\sum_{i=1}^{N} w_i \left( \frac{T_i}{X_i} \right)}{1} \]
The weighting function is based on the independent variable values, expressed as

\[ w_i = \frac{X_i}{\sum_{i=1}^{N} X_i} \]

Plugging the weighting formula into the “weighted rate” equation presented above produces the following equation:

\[ RATE_{weighted} = \sum_{i=1}^{N} \frac{X_i}{X_i} \left( \frac{T_i}{X_i} \right) = \sum_{i=1}^{N} \frac{T_i}{\sum_{i=1}^{N} X_i} \]

The far-right formula is simply “the sum of all trips counted” divided by “the sum of the independent variable values” for all the data points.

Calculation of the sample variance uses the same weights as for the average weighted rate. The averaging factor \((1 / N)\) in the unweighted variance calculation is not necessary for the weighted variance calculation because the weighting factors sum to 1. The sample factor \((N / (N—1))\) is still included. Weighted sample variance can be expressed as

\[ \sigma^2_{weighted} = \frac{N}{(N—1)} \sum_{i=1}^{N} w_i \left( \frac{T_i}{X_i} \right) - RATE_{weighted} \]

Weighted standard deviation is the square root of the weighted sample variance.

**Calculation Examples**

For this example, the objective is to calculate weighted average and weighted standard deviation for a sample set of five data points. Table J.1 lists the independent variable value and number of trips recorded for five sites. The sum of trips for the sites is 233; the sum of the independent variable values is 193. The **weighted average rate is 1.21** (calculated as 233 divided by 193) per unit value of the independent variable.
Appendix J: Calculation of Weighted Average and Standard Deviation

Table J.1 Data for Example Calculation of Weighted Average

<table>
<thead>
<tr>
<th>Site</th>
<th>Independent Variable Value</th>
<th>Number of Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>43</td>
<td>11</td>
</tr>
<tr>
<td>B</td>
<td>49</td>
<td>83</td>
</tr>
<tr>
<td>C</td>
<td>15</td>
<td>34</td>
</tr>
<tr>
<td>D</td>
<td>48</td>
<td>65</td>
</tr>
<tr>
<td>E</td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>193</td>
<td>233</td>
</tr>
</tbody>
</table>

Calculation of weighted standard deviation requires the calculation of values shown in Columns D through H in Table J.2.

- Column D is the trip rate for each individual site (Column C divided by Column B). The value shown in Column D in the “Total” row is the weighted average rate.
- Column E is the difference between the site trip rate (Column D) and the weighted average rate for the entire data set (1.21).
- Column F is the value in Column E squared.
- Column G is the value in Column B divided by the sum of all values in Column B.
- Column H is the product of Columns F and G for each individual site.

Table J.2 Data for Example Calculation of Weighted Standard Deviation

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indep. Variable Value</td>
<td>Number of Trips</td>
<td>Trip Rate</td>
<td>Site Trip Rate minus Weighted Average Rate</td>
<td>Value</td>
<td>Value Squared</td>
<td>Weight</td>
</tr>
<tr>
<td>A</td>
<td>43</td>
<td>11</td>
<td>0.26</td>
<td>-0.95</td>
<td>0.91</td>
<td>0.22</td>
<td>0.20</td>
</tr>
<tr>
<td>B</td>
<td>49</td>
<td>83</td>
<td>1.69</td>
<td>0.49</td>
<td>0.24</td>
<td>0.25</td>
<td>0.06</td>
</tr>
<tr>
<td>C</td>
<td>15</td>
<td>34</td>
<td>2.27</td>
<td>1.06</td>
<td>1.12</td>
<td>0.08</td>
<td>0.09</td>
</tr>
<tr>
<td>D</td>
<td>48</td>
<td>65</td>
<td>1.35</td>
<td>0.15</td>
<td>0.02</td>
<td>0.25</td>
<td>0.01</td>
</tr>
<tr>
<td>E</td>
<td>38</td>
<td>40</td>
<td>1.05</td>
<td>-0.15</td>
<td>0.02</td>
<td>0.20</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>193</td>
<td>233</td>
<td>1.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Values in Columns D through H are rounded.

Variance 0.36
Factor (5/4) 1.25
Weighted Sample Variance 0.45
Weighted Standard Deviation 0.67
The weighted variance for the set of data is the sum of the values in Column H—for this example, 0.36. Because the data represent a sample of the total population, the size of the sample must be factored in the variance calculation using the ratio \( \frac{N}{N - 1} \)—for this example \( \frac{5}{4} \). The sample variance is \( \frac{5}{4} \times 0.36 \), or 0.45.

The sample standard deviation is the square root of the sample variance—for this example, 0.67.
Appendix K. Presentation Material

The following slides present suggested content for a presentation that explains the contents of *Trip Generation Manual* and its proper application.

### Institute of Transportation Engineers
- International organization of professionals in public agencies, academia, and private companies
- Facilitates research and exchange of professional information
- Most widely used clearinghouse for transportation engineering data in the United States

### Trip Generation Manual
- Provides survey data on the traffic generated by 172 different land use types
- Data are screened for quality to produce nationally relevant averages
- It is by far the most commonly used reference for this type of information

[insert relevant data plot from *Trip Generation Manual*]

### Use of Trip Generation Manual
- *Manual* provides objective trip generation measurements
- Data available
  - Suburban and urban sites
  - Single-use and mixed-use sites
  - Pedestrian, transit, and personal passenger vehicle trips
Appendix L. Use of *Trip Generation Manual* Data for a Travel Demand Model Special Generator

Special generators in travel demand forecasting models are land use types or large activity centers for which trip rates cannot be fully explained using standard trip production and attraction trip generation relationships. They are normally non-residential in nature and are classified in such studies as trip attractors. Where typical trip attraction rates solely based on employment would inaccurately represent the site’s trip generation, a special generator may be designated. Each special generator can have its own trip generation estimation method. Standard modeling practice discourages the use of special generators except where truly needed for representative modeling.

Examples of special generators include, but are not limited to, the following:

- Military base—self-contained facilities that include residential, work, and retail on-site;
- College or university—the number of students is a more significant factor than employment;
- Commercial airport—enplanements is a more significant influence than number of employees;
- Large recreational area, park, or beach—the size and type of recreational amenities is a more significant factor than employees; and
- Large regional shopping mall—employees are not included as a usable independent variable in the *Trip Generation Manual* data volumes.

In order for trip generation data to be used in a standard travel demand model, the special generator trips need to be in units of person trips by trip purpose (and typically on a daily basis). The *Trip Generation Manual* data are generally in units of vehicles (not persons) and are not disaggregated by trip purpose. In addition, the peak hour data sets tend to be larger and have greater precision than the daily data sets.

**Procedures to convert between vehicle trips and person trips are presented in Chapter 5 of this Handbook.** Another approach for converting between vehicle and person trips (and one which is compatible with the need of a travel demand model to disaggregate total trips into trips by purpose) is to first estimate the percent trips by purpose. A predominant trip purpose can be surmised for many land use codes (for example, home-based shop and non-home-based are the predominant trip purposes for a shopping center). To some extent, each site should already include an estimate of home-based work trips based on standard trip attraction rates used in the given model so this should not be an obstacle in the special generator process. A predominant purpose is somewhat more difficult to estimate for a multifaceted site such as a military base or commercial airport.

With the total trips split into purposes, the second step is to estimate an appropriate vehicle occupancy rate for each trip purpose. NCHRP Report 716 provides vehicle occupancy rates for home-based work, home-based non-work, and non-home-based purposes for different urban area size categories. Another potential source is the *Analysis Brief on Auto Occupancy* which provides vehicle occupancy rates from the 2009 National Household Transportation Survey (NHTS) for

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different land use types such as shopping, going to school, running errands, or going to work that are a bit more disaggregated than those found in NCHRP Report 716.

Additional background and guidance on the use of special generators can be found in several research reports funded by the Florida Department of Transportation (FDOT), among other agencies and institutions. FDOT also provides guidance on the special generator process in its online model training program.


25 [www.fsutmsonline.net/online_training/index.html](http://www.fsutmsonline.net/online_training/index.html).
Appendix M. Overview of Travel Survey Types

This appendix reviews several types of travel surveys with varying degrees of relevance to the measurement of site-generated trips. Table M.1 summarizes the attributes of eight survey types. For each type, the table provides
- Survey Purpose—the specific components of trip generation (vehicle trips, person trips, pass-by, internal capture, trucks) that could be covered;
- Travel Modes—the travel modes (such as vehicle, transit, pedestrian, bicycle, or freight) that could be covered;
- Scale—geographic focus of survey such as site, corridor, or region; and
- Instrument—the type of survey instrument (or data source) typically used.

Caution must be exercised in the use of non-site-specific surveys for the estimation of site-specific trip generation characteristics.

There are several limitations of which the analyst should be aware in order to make best use of existing travel surveys to estimate trip generation. In general, site intercept surveys offer the most promise for determining site peak hour or peak period travel characteristics. Household travel surveys are best suited to estimating daily trip generation. Nevertheless, all survey types mentioned in the table have the potential to provide useful information.
### Table M.1 Data Collection Survey Types

<table>
<thead>
<tr>
<th>Survey Type</th>
<th>Survey Purpose</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building or Site Intercept</td>
<td>Vehicle Trips, Person Trips (by Mode), Pass-By, Internal Capture</td>
<td>Travel Modes: All; Scale: Building or Site; Instrument: Intercept Interview</td>
</tr>
<tr>
<td>Household Travel Diary</td>
<td>Person Trips (by Mode), Internal Capture, Pass-By</td>
<td>Travel Modes: All; Scale: Region-wide; Instrument: Telephone Interview or Mailout/Mailback</td>
</tr>
<tr>
<td>Roadside Intercept</td>
<td>Pass-By</td>
<td>Travel Modes: Auto &amp; Truck; Scale: Corridor or Subarea; Instrument: Intercept Interview; Postcard/License Plate Mailout/ Mailback; Bluetooth</td>
</tr>
<tr>
<td>Transit Onboard</td>
<td>Person Trips (by Transit)</td>
<td>Travel Modes: Transit; Scale: Transit Routes; Instrument: Onboard Interview</td>
</tr>
<tr>
<td>Workplace</td>
<td>Person Trips (by Mode), Internal Capture</td>
<td>Travel Modes: All; Scale: Employment Sites; Instrument: Workplace Interview</td>
</tr>
<tr>
<td>Freight/ Truck</td>
<td>Truck Trips</td>
<td>Travel Modes: Truck; Scale: Building or Site; Instrument: On-site Interview or GPS</td>
</tr>
<tr>
<td>GPS</td>
<td>Vehicle Trips, Person Trips (by Mode)</td>
<td>Travel Modes: All; Scale: Region-wide; Instrument: GPS</td>
</tr>
<tr>
<td>Online Computer</td>
<td>Vehicle Trips, Person Trips (by Mode), Pass-By, Internal Capture</td>
<td>Travel Modes: All; Scale: Region-wide or Subarea; Instrument: Web-based</td>
</tr>
</tbody>
</table>

Beyond the abbreviated discussion of survey types provided in this section, the analyst is encouraged to visit the *Online Travel Survey Manual*[^26] or its predecessor document, the *FHWA Travel Survey Manual*.[^27]

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[^26]: www.travelsurveymanual.org/. Chapter 5 of the *On-Line Travel Survey Manual* provides substantial guidance on statistical reliability and effectiveness of travel surveys. Chapter 6 of that document provides guidance on sampling, while Chapter 15 is focused on intercept surveys and Chapter 18 discusses workplace and establishment surveys.

Building or Site Intercept Survey

An intercept survey at a specific site can provide more data than a person or vehicle count, including trip origin and destination (for internal capture or pass-by trips), travel mode, vehicle occupancy, and traveler demographics. Specific attributes of an intercept survey are presented in detail in Chapter 12.

Household Travel Diary Survey

With a focus on an entire day (or more) of travel, a household travel survey is the most comprehensive in terms of travel characteristics obtained on a regional basis. However, the survey can have serious sampling issues when used at a small level of geography.

Household survey data are best suited to the residential end of trip making, serving as a potential source for estimating trip production rates. Household surveys can include an identification of household characteristics such as dwelling unit type, enabling separate trip rates to be calculated for single-family dwelling units and several different categories of multi-family dwelling types, assuming the sample size is robust enough to distinguish such groupings.

Using household surveys for non-residential land use types is largely limited to aggregate categories, such as retail, service, and industrial properties, rather than subcategories such as shopping centers, office parks, and manufacturing plants.

The 2009 NHTS is unique in its connection to workplace types and provides greater potential than most household surveys do at site type characteristics, due to the addition of the Claritas variables that describe workplace trip end locations by a more comprehensive set of categories. In any event, calculation of trip "attraction" rates from household surveys requires some degree of supplemental information or assumptions, including a workplace survey under ideal circumstances.

Roadside Intercept Survey

The roadside intercept survey is traditionally conducted along a regional transportation study boundary or other strategic location to identify the split of through and non-through trips, and to obtain origin-destination patterns for trips passing through survey locations. It could be used to obtain information on pass-by, diverted, and primary trip characteristics. In contrast to a household survey, the focus of the roadside intercept survey is on a single trip rather than a set of daily travel patterns.

Transit Onboard Survey

A transit onboard survey collects information on transit traveler trip-making (including origin and destination) and sometimes traveler characteristics such as personal passenger vehicle availability. An onboard survey can be done using face-to-face interviews or mailback postcards. Mailback response rates are typically much lower than response rates for face-to-face interviews.

For a transit stop within a specific development site (for example, at a regional shopping center), a boarding count can be used to estimate the number of transit person trips entering and exiting the site. However, a boarding count alone for a transit service that passes near a development site does not provide the necessary transit person trip information, specifically the actual trip origin and destination.
Workplace Survey

For a workplace survey, much of the focus is on employees and less on visitors. But adjustments can be made to the typical approach to include non-employee trips. For example, a workplace survey at a retail facility would need to be supplemented with surveys of shoppers in order to obtain a more complete picture of site travel characteristics (such as trip generation, mode share, and vehicle occupancy).

Freight/Truck Survey

Freight/truck surveys are less commonly done than other survey types. The potential exists to enumerate truck trips to and from sites through the use of classification counts. Chapters 11 and 12 in this Handbook provide additional guidance.

GPS Survey

GPS surveys can take many different forms. In its most sophisticated form, GPS can be used as part of a household travel survey to obtain more accurate information on trip origins, destinations, and travel times. At its most basic, such surveys could amount to data on origin-destination patterns only such as those focused on commercial travel. The concept of GPS surveys extends to cellular and Bluetooth data that depend on the locations of such devices.

Challenges exist in the interpretation of all passively collected data, including
- Determining whether a vehicle becoming stationary after moving represents a long congestion delay or a short pass-by stop, especially where triangulation algorithms play a significant role in estimating device movements;
- Addressing issues related to understanding the technology absorption rate (for example, how to deal with person or vehicle trips made without Bluetooth or a cell phone); and
- Drawing additional conclusions, such as trip purpose, based on repetitive patterns.

Online Computer Survey

The primary difference between an online survey and a traditional household survey is the sampling approach. Instead of sampling based on a set of random telephone numbers, respondents are contacted through other outreach methods, such as social media, and directed to a website for survey entry. This approach might have a potential advantage over a traditional household survey in terms of targeting specific travelers and demographic markets within a geographic subarea or visitors to a specific site. What is lacking with an online survey is the interface with professional interviewers who can probe respondents for additional clarification and error correction.

As is the case with all surveys described in this appendix, the analyst should address any bias associated with the online survey. Population randomness is not guaranteed. For example, different demographics (such as age or household income) could produce different survey access and response rates.
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Appendix O. Index

A
Acre, 14, 78, 132
Activity center, 131
Actual data point, 24, 136
Adjacent street traffic, 15, 25, 30, 31, 48, 75, 95–96, 118, 137
peak hour of, 132
Adjusted vehicle trip, 34, 35
Aggregate approach, 18
Alighting, 18, 137
AM/PM peak hour traffic on adjacent street, 132
See also Peak hour of adjacent street traffic
Analysis, 11
impact, 1, 95, 139, 281
objectives, 15–16
regression, 24
site, 139
for site trip generation estimation, 12
time period for, 48
Area types, 129, 131
See also specific area types
Attendee, 132
Atypical tenant mix, 63
Average flights per day, 132
Average number of independent variable, 136
Average rate, 3, 23–24, 34, 94
See also Weighted average rate
selection process, 27–30
Average vehicle trip ends, 136

B
Based aircraft, 132
Baseline database, 34, 38, 39, 69, 197
See also specific data
Baseline site, 6, 11, 33, 34, 38, 39, 69–70, 137
Baseline site mode shares and vehicle occupancy, 38–39, 197–201
infill development and, 69, 72–73, 74
Batting cage, 133
Bed, 133
occupied, 134
Berth, 133, 135
Bicycle trip, 40, 71, 77, 101, 129
Boarding, 137
Bowling lanes, 133

C
Cautionary notes
data plots, 25
diverted trip, 94
internal capture rates, 62–63
local trip generation data, 85–86
mixed-use development trip generation estimation, 62–63
pass-by trip, 94–95
Central business district (CBD), 72, 81–83
Coefficient of determination, 136
Commercial flights per day, 133
Competing markets, 63
Complementary land uses, 11, 33, 39, 40, 43, 44, 47, 63, 65, 80, 137, 138, 211
Convenient frequent transit, 137
Cordon count, 137
Counter
machine, 137
manual, 137
Counting personnel, 137
Court, 133

D
Data
See also Local data; Local trip generation data;
National database; Person trip data;
specific data
adapted, 80–82
age, 7–8
average rate or equation selection, 27–30
Data collection, 1, 2, 7, 101–102

See also specific methods

basics, 104–106
components, 105
duration, 107
field crew
staffing and training, 107–108
supervision, 108
interview
factoring, 109–110
intercept, 138, 305
internal capture survey, 63, 64, 119–120
logistics, 109
pass-by/diverted trip survey, 115–116, 117, 118
person trip generation, 40
survey types, 138, 303–306
tavel mode survey, 112, 114, 115
truck trip, 127, 306
local, 26, 30, 31, 40–41, 71
local trip generation, 86
minimum sample size, 115
at mixed-use development, 63–64
observation count and, 104–105, 110–111
permission and cooperation, 107
person trip versus vehicle trip, 105
primary, 100
secondary, 100
site-specific plan, 106–107
time period, 104
truck trip, 100, 126–127

Data points
cautionary notes, 25
content and format, 21
independent variable selection, 25–26
information provided in, 23–24
reported statistics, 23
sample, 22

Day care center, 229
Destination trip end, 5
Development
See also specific development types
densities, 14
location, 47
size, 47
type, 47
Directional count, 138
Directional distribution, 136
Disaggregate approach, 18–19
Diverted trip, 91–92, 93, 129, 227
cautions notes, 95
diverted trip survey, 115–116, 117, 118
recommended process, 95–96, 97, 98
Door count, 138
sample form, 113
Drive-in lane, 133
Drive-through lane, 133
Dwelling unit, 14, 78, 133

E
Employee, 133, 215
Equation selection process, 27–30
Expansion factor, 138
External person trips, 12, 17, 52, 61–62, 95

F
Family members, 133, 134
FAR. See Floor-to-area ratio
Field crew
staffing and training, 107–108
supervision, 108
Fields, 133
Fitted curve, 26, 30, 136
Flights per day
average, 132
commercial, 133
Floor-to-area ratio (FAR), 14, 138
Freight movement at site, 99–100
Freight trip generation, 289
Freight/truck survey, 306
Full-time doctor, 134

G
General suburban area, 131
General urban area, 131
GFA. See Gross floor area
GLA. See Gross leasable area
GPS survey, 306
Gross floor area (GFA), 134
Gross leasable area (GLA), 134

H
Household travel diary survey, 305

I
Impact analysis, 1
traffic, 95, 139
transportation, 139, 281
Inbound trip, 129
Independent variables, 14, 132–136
average number of, 136
selection, 25–26
Infill development, 138
assumptions, 66–69
background, 65
definition of, 66
person trip data for, 203–210
site trip generation estimation for, 65
transportation impact analysis of, 281
vehicle occupancy and, 69
Infill development trip generation
research, 277–283
Infill development trip generation estimation
baseline mode shares and vehicle occupancy, 69,
72–73, 74
process, 69
recommended process examples, 72–75
study site mode shares and vehicle occupancy and,
70–71, 72–73, 74
vehicle trip for study site, 72, 73, 74
Institute of Transportation Engineers (ITE), 1–2
data submittal to, 128
Intercept interview survey, 138, 305
Internal capture interview survey, 119–120
Internal capture rates, 44, 138
balancing, 45–46
cautions, 45–46
with proximity adjustment, 55–60
for trip destination, 58
for trip origins, 57
Internal capture trip, 17, 129
at mixed-use development, 45–46, 50–51
Interview (survey), 104–105
diverted trips, 115–116, 117, 118
factoring, 109–110
intercept, 138, 305
internal capture, 119–120
logistics, 109
pass-by trips, 115–116, 117, 118
person trip generation, 40
required, 106
trip mode, 112, 114, 115
trip survey types, 138, 303–306
truck trip, 127, 306
types, 304
Isolated site, 104–105, 138
person trip data processing, 120–121
ITE. See Institute of Transportation Engineers

L
Land use, 13–14, 21
See also On-site land use
category, 138
complementary, 137
mix, 48
mixed-use development classified as single, 44–45
person trip for, 61
TFD, 78–79
with time period distribution data, 16
truck trip generation and, 289–290
vehicle trip generation by, 48–49, 52
Land use code (LUC), 45, 138
Lift, 134
Loading bay, 134
Local data
collection, 26, 30, 31, 40–41, 71
pass-by trip and, 93–94
proxy site, 37, 40–41, 71, 74–75
trip generation estimation using, 85–98
weighted average rate, 86–87, 88–90

Local trip generation data
cautions, 85–86
collection, 86
consolidated rate, 87
documentation, 88
recommended processes for, 88–90
stand-alone rate or equation, 86–87

LUC. See Land use code

M

Member, 133, 134
Metropolitan travel survey, 138
Mixed-use development, 138
assumptions, 45–46
background, 43
classified as single land use, 44–45
data collection at, 63–64
definition of, 43–44
external vehicle trip generation for, 62
internal capture rate
  for trip destination within, 58
  for trip origins within, 57
internal capture trip at, 45–46, 50–51
mode share and, 52
recommended process, 273–278
research, 277–283
site trip generation estimation and, 43
vehicle occupancy and, 52
Mixed-use development trip generation estimation, 43, 46
cautions, 62–63
demand between on-site land use pairs, 60–61
external vehicle trip generation, 46, 62–63
internal capture rates with proximity adjustment, 55–60
methodology for, 47–48
on-site land use pair proximity, 53–54
person trip generation for individual on-site land uses, 48–52
person trips for land use and, 61
spreadsheet tool for, 50–51
Mode share, 34, 36–40, 139, 203
  See also Baseline site mode shares and vehicle occupancy; Study site mode shares and vehicle occupancy; Transit mode share estimates, 36–41
mixed-use development and, 52
Motorized trip, 17, 129
transit mode share of, 79
Multimodal site, 11, 33, 139
  person trips, 34–35
  site trip generation estimation, 17–19
Multi-use development, 139

N

National database, 21, 37, 39, 40, 70–73, 79, 85–90
pass-by trip and, 93–94
National Household Transportation Study (NHTS), 41, 301, 305
Net rentable area, 134
NHTS. See National Household Transportation Study
Non-directional count, 138
Non-isolated site, 104–105, 139
  person trip data processing, 122–125
Non-motorized trip. See Motorized trip
Non-pass-by trip, 93, 227
  See also Diverted trip; Pass-by trip; Primary trip
Non-vehicle person trips, 17
Number of studies, 137

O

Observation counts, 104–105, 110, 112
forms, 111
Occupied beds, 134
Occupied dwelling, 135
Occupied dwelling unit. See Dwelling unit
Occupied gross floor, 134
Occupied gross floor area. See Gross floor area
Occupied gross leasable area. See Gross leasable area
Occupied room. See Room
Occupied space. See Parking
Occupied storage unit. See Storage unit
Occupied unit. See Unit
Off-site, 139
Online computer survey, 306
On-site land use
demand between pairs, 60–61
pair proximity, 53–54
person trip generation for, 48–52
Origin trip end, 5
Other terms, 137–139
Outbound trip, 129

P
Parking
shared, 63, 139
space, 135
Pass-by trip, 63, 91–92, 93, 130, 227
cautory notes, 94–95
estimation process, 93–94
example application of, 97
interview survey, 115–116, 117, 118
local data and, 93–94
national database and, 93–94
recommended process, 95–96
Peak hour of adjacent street traffic, 132
Peak hour of generator, 132
Permission and cooperation, 107
Person, 1
Personal passenger vehicle, 17, 139
Person trip, 5, 35, 130
adjusted, 34
assumption, 33–34
background, 33
baseline, 34, 38
baseline site mode shares and vehicle occupancy, 38–39
estimating process for, 34–35
external, 12, 17, 52, 61–62, 95
for land use, 61
by mode, 34, 38
multimodal site, 34–35
non-vehicle, 17
observation count, 111, 112
study site mode shares and vehicle occupancy, 36–41
by vehicle, 38, 102
vehicle trip conversion to, 35–36
Person trip data
collection, 2
for infill development, 202–209
national proxy site, 39–40
processing
isolated site, 120–121
non-isolated site, 122–125
vehicle trip data collection versus, 105
Person trip generation
for individual on-site land use, 48–52
survey at study site, 40
PM peak hour traffic on adjacent street. See AM/PM peak hour traffic on adjacent street
Primary mode of travel, 139
Primary trip, 91–92, 93, 115, 130, 227
example application of, 97
recommended process, 98
Procedure, 4
Professional judgment, 3
Proximity adjustment, 53–54
internal capture rates with, 55–60
Proxy site, 6, 139
local, 37, 40–41, 71, 74–75
national, 39–40
TFD and, 79–80
R
Range of rate, 137
Recommended process, 2, 27
diverted trips, 95–96, 97, 98
for infill development, 72–75
for local trip generation data, 88–90
mixed-use development, 273–278
for pass-by trips, 95–96
primary trip, 98
Regional CBD, 131
Regression analysis, 24
Roadside intercept survey, 305
Room, 135
Rural area, 131
Rural (town) business district, 131
S
Sample size, 62
Saturday, peak hour of generator, 132
Service bay, 135
Service stall, 135
Servicing position, 135
Shared parking, 63, 139
Shopping center, 44–45
Site
See also specific sites
analysis, 139
baseline, 6, 11, 33, 34, 38, 39, 69–70, 137
costomer, 14–15
freight movement at, 99–100
plan, 13
proxy site, 6, 139
local, 37, 40–41, 71, 74–75
national, 39–40
TFD and, 79–80
study site, 6, 18, 139
defining, 13–14
person trip and, 36–41
person trip generation survey at, 40
vehicle trip for, 72, 73, 74
Study site mode shares and vehicle occupancy, 36–41
infill development and, 70–71, 72–73, 74
Suburban area, general, 131
Suburban business district, 131
Suburban strip commercial area, 131
Sunday, peak hour of generator, 132
Survey. See Interview; specific surveys

T
TDM. See Transportation demand management
Tee, driving position, 135
Tennis court, 133, 135
TFD. See Transit-friendly development
Time period, 15–16, 132
See also specific time periods
for analysis, 48
data collection, 104
distribution data with land uses, 16
pass-by and non-pass-by trips and LUC with, 227
TOD. See Transit-oriented development
Traffic
See also Adjacent street traffic
added, 91
impact analysis, 95, 139
Transit data, 101–102
Transport-friendly development (TFD), 77, 139
adapted data and, 80–82
proxy site data and, 79–80
site, 33
site design and land use, 78–79
transit trip estimation, 79–83
transit use at, 78–79
Transit mode share, 211–226
of motorized trips, 79
Transit onboard survey, 305
Transit-oriented development (TOD), 77, 139, 211-226
Transit service, 78, 82–83
Transit trip, 19, 40, 130
estimation at TFD, 79–83
Appendix O: Index

Transit use, 78–79

Transportation demand management (TDM), 15, 19, 33 139, 285–287

Transportation impact analysis, 139
of infill developments, 281

Travel
behavior, 5
demand model special generator, 301–302
diary survey, 305
survey types, 138, 303–306

Travel mode, 15, 101–102
interview survey, 112, 114, 115
primary, 139

Trip, 5
See also specific trip types and data
capture estimation tool, 277–278
destination, 56, 58
generator, 5
inbound, 129
modes, 129–130
origins, 56, 57
outbound, 129
types, 15, 129–130

Trip ends, 5, 130
average vehicle, 136

Trip generation database, 48, 102
See also specific data
age, 7–8
collection, 7
sources of, 6
storage, 7

Trip generation estimation
See also Baseline Database; Data; Site trip
generation estimation; study site; specific trip types
communication of, 8–9
evolution of, 8
local data use for, 85–98
procedure, 27–30

Truck berth, 133, 135

Truck trip
data collection, 100, 126–127
interview survey, 127, 306

Truck trip generation, 289–294
estimation
data collection, 100
freight movement at site, 99–100
objectives, 99
stakeholders, 99

U

Unit, 135
Urban area, general, 131
Urban core area, 131
Urban infill. See Infill development

V

Vehicle, 1, 5, 135
fueling positions, 136
personal passenger, 17, 139
person trip by, 38, 102

Vehicle occupancy, 34, 139
See also Baseline site mode shares and vehicle occupancy; Study site mode shares and vehicle occupancy
baseline, 36–39, 197–198, 201
convenience store example, 207
estimates, 36–41
infill development and, 69
mixed-use development and, 52
observation count, 110
study site, 36–41

Vehicle trip, 33, 101, 130
adjusted, 34
baseline, 17, 34, 38, 129
ends, 136
observation count, 110, 111
person trip conversion to, 35–36
person trip data collection versus, 105
for study site, 72, 73, 74
types, 91

Vehicle trip generation, 21
baseline, 33–34, 38
external, 46, 62–63
by land use, 48–49, 52

W

Walk trip, 19, 39, 102, 130

Wash stall, 136

Weighted average rate, 23–24, 26, 30, 31
calculation of, 295–298
local data, 86–87, 88–90

Weighted standard deviation. See standard deviation

Workplace survey, 305
Appendix P. Comment Form

We Want Your Comments...
The Institute of Transportation Engineers (ITE) would like to know what you think about the *Trip Generation Handbook*, 3rd Edition, a recommended practice. ITE encourages and welcomes your views and opinions on the topics discussed in this report.

1. Please describe any errors or inconsistencies you have noted in this report. Please note page numbers and, if possible, a copy of the page(s) containing the error. Attach additional sheets if needed.
   Description and page(s):

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