NWC Equestrian Center Apartments

Traffic Mobility memo

TO: Jonathan Popiel, DBIA, LEED AP, Hensel Phelps

FROM: Chris Vogelsang, PE, OV Consulting

DATE: January 29, 2026

RE: Assessment of Proposed Apartments Conformance with 2020 TIS and Driveway Operations

Purpose

The purpose of this memo is to review the proposed apartments located near the planned NWC Equestrian Center and determine if they are in general conformance with the overall NWC TIS (October 2020) assumptions and transportation operations conclusions.

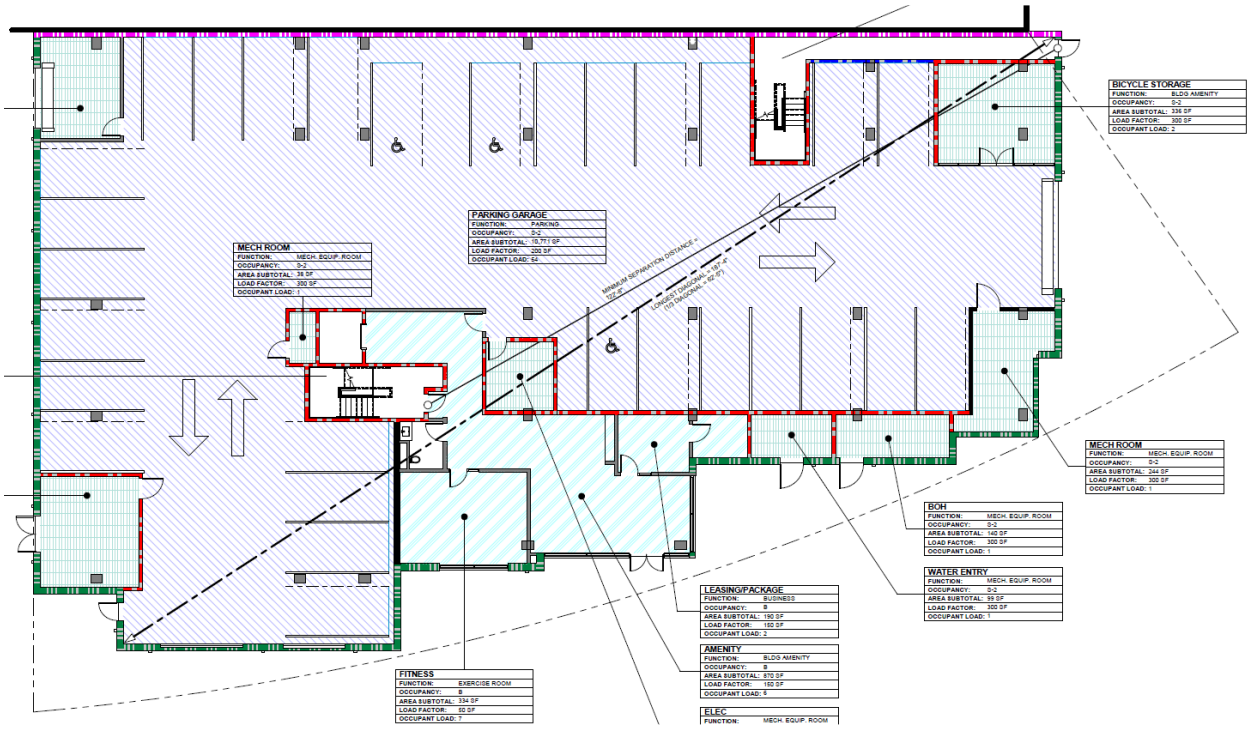
Introduction

We have examined the apartment building proposed to be located in the western part of the NWC campus, abutting part of the Equestrian Center's northwestern wall. This examination covered traffic generation and transportation operations with respect to the incremental effects beyond those documented in the 2020 Traffic Impact Study (TIS) that supported the overall Campus Placemaking Study. This mobility assessment is based on the available schematic architectural design (4240 Architecture, dated 1/9/26), previous campus buildout assumptions, and current assumptions about the future internal and surrounding street circulation network as well as on updated information about the expected trip making characteristics associated with the apartment building.

Trip Generation

The current plan shows 44 total dwelling units, ranging from about 700 to 1,350 square feet, in five floors above ground-level parking. The ground floor layout, excerpted from the architects' schematic life safety plan sheet, is shown in Exhibit 1.

Exhibit 1. Apartment Building Ground Floor Layout.



This apartment building has been proposed for market rate housing for the general public. The 2020 TIS traffic scenario utilized for this analysis was the "normal weekday" PM peak hour scenario and that is the basis of the operations comparison documented in this memo.

The apartment schematic plans were reviewed and the proposed number of units per floor were added together to ascertain the total number of proposed dwelling units. While interior details for each apartment are not yet final, the building location and characteristics indicate that it is appropriate for consideration under the Institute of Transportation Engineers current (11th edition) Trip Generation guidelines for ITE Land Use Code 221 Multifamily Housing (Mid-Rise), which covers buildings from 4 through 10 stories. Since the proposed apartment building location is within ½ mile of a rail transit station, the Land Use Subcategory Close to Rail Transit was used. The proposed building location also meets the criteria for the Setting/Location of Dense Multi-Use Urban. Therefore ITE Land Use Code 221- Multifamily Housing (Mid-Rise) with the Land Use Subcategory Close to Rail Transit and the Setting/Location of Dense Multi-Use Urban was utilized for trip generation purposes.

The apartment building's PM peak hour trip generation was estimated from the average rates provided in the ITE database for this land use and compared with the estimate from the 2020 TIS. A summary of this comparison is shown in Exhibit 2.

Exhibit 2. Apartment Daily and PM Peak Hour Trip Generation Comparison

	2020 TIS		Revised Estimate	
Land Use Assumption	15 bedrooms		44 Dwelling Units	
ITE Housing Category	225 – Off-campus (low-rise)		221 – Multifamily Housing (mid-rise)	
	Daily	PM Peak Hour	Daily	PM Peak Hour
Rate per bedroom	3.15	0.25	2.01	0.25
Trips	47	4 (2 in, 2 out)	88	11 (8 in, 3 out)

The trip generation comparison indicates overall traffic generation of the proposed apartments is very similar to the information presented in the NWC TIS (October 2020). The expected trips associated with proposed apartments are anticipated to compose a small percentage of PM Peak Hour total traffic on National Western Drive North (11 of 728 total PM peak hour trips or 1.5% of total traffic).

Access and Transportation Assessment

The proposed apartment building's parking area would access National Western Drive North (abbreviated NWD) at the existing driveway immediately north of the CSU Animal Health & Equine Sports Medicine Center. This driveway is located about 350' north of Bettie Cram Drive (BCD) and the future 48th Avenue bridge across the South Platte River. Each of these streets features one travel lane in each direction with detached sidewalks, and BCD currently has on-street parking east of its intersection with NWD. NWD has been configured to allow on-street (parallel) parking on both sides during non-event conditions, but during large events it could be repurposed with a temporary 4-lane configuration through the prohibition of on-street parking.

Both NWD and BCD have been designed at neighborhood scale, with such features as alignment details, limited building setbacks, lighting, street furniture, and landscaping that encourage pedestrian presence and slower vehicle speeds. Traffic signals at both ends of the block on which the student housing building will be located are expected to help manage both vehicle speeds and gaps in traffic that will help the driveway function well from a vehicle operations standpoint.

In addition to these elements, updates to the existing mid-block pedestrian (and equestrian) crossing have previously been evaluated for implementation on NWD just north of the driveway apartment traffic would use. Evaluation of the crossing using the Denver Uncontrolled Pedestrian Crossing Guidelines with future traffic conditions indicates that adding a Rectangular Rapid-Flashing Beacon to the crosswalk would be justified in the future. The RRFB's activation would be expected to create gaps in traffic for vehicles leaving the apartment building that are headed south (that is, turning left) onto NWD.

Traffic Assignment and Driveway Operations Assessment

The proposed National Western Center buildout plan's transportation success is predicated on a robust internal walking network, the grouping of parking capacity on the edges of the overall site, and available transit service.

Trips generated by the proposed apartments were assigned to the street network according to the relative NWD percentages documented in the 2020 TIS. The assignment documented here only concerns the driveway (access point) apartment traffic will use. Apartment building traffic would use the existing driveway to NWD about 350 feet north of BCD/48th that currently serves the CSU SPUR's north parking area. This existing SPUR driveway was

not examined for the 2020 TIS, and the parking areas it currently serves would be replaced by new NWC equine facilities.

The PM peak hour inbound and outbound trips generated by the apartment building were examined here as though they would be the only trips using the driveway, with 60% of driveway traffic assumed to be oriented to the south and 40% to the north. The future buildout traffic volume estimates at the driveway would be as follows:

Southbound Through	Southbound Left		
252	3		
		1	Westbound Right
		2	Westbound Left
428	5		
Northbound Through	Northbound Right		

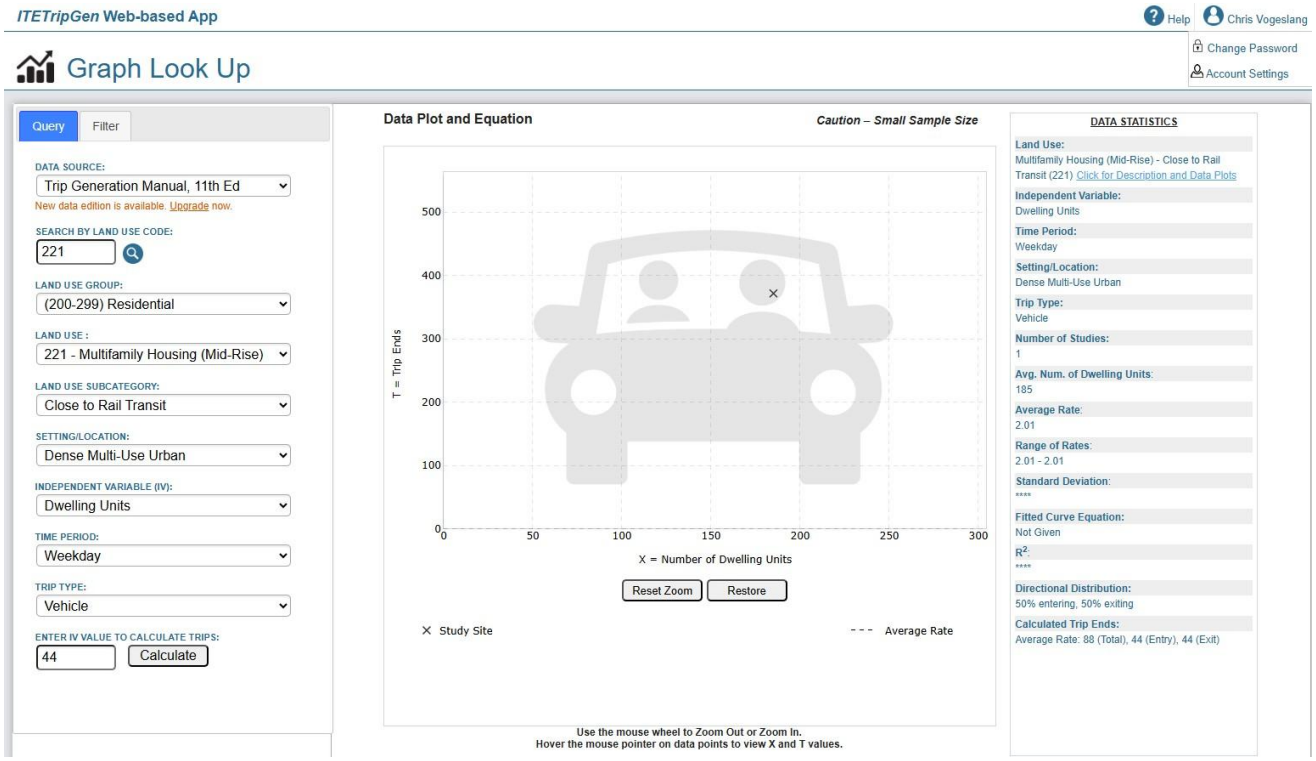
These volumes were analyzed in the same way as a typical stop-controlled intersection. Through movements and the northbound right do not yield to other vehicles.

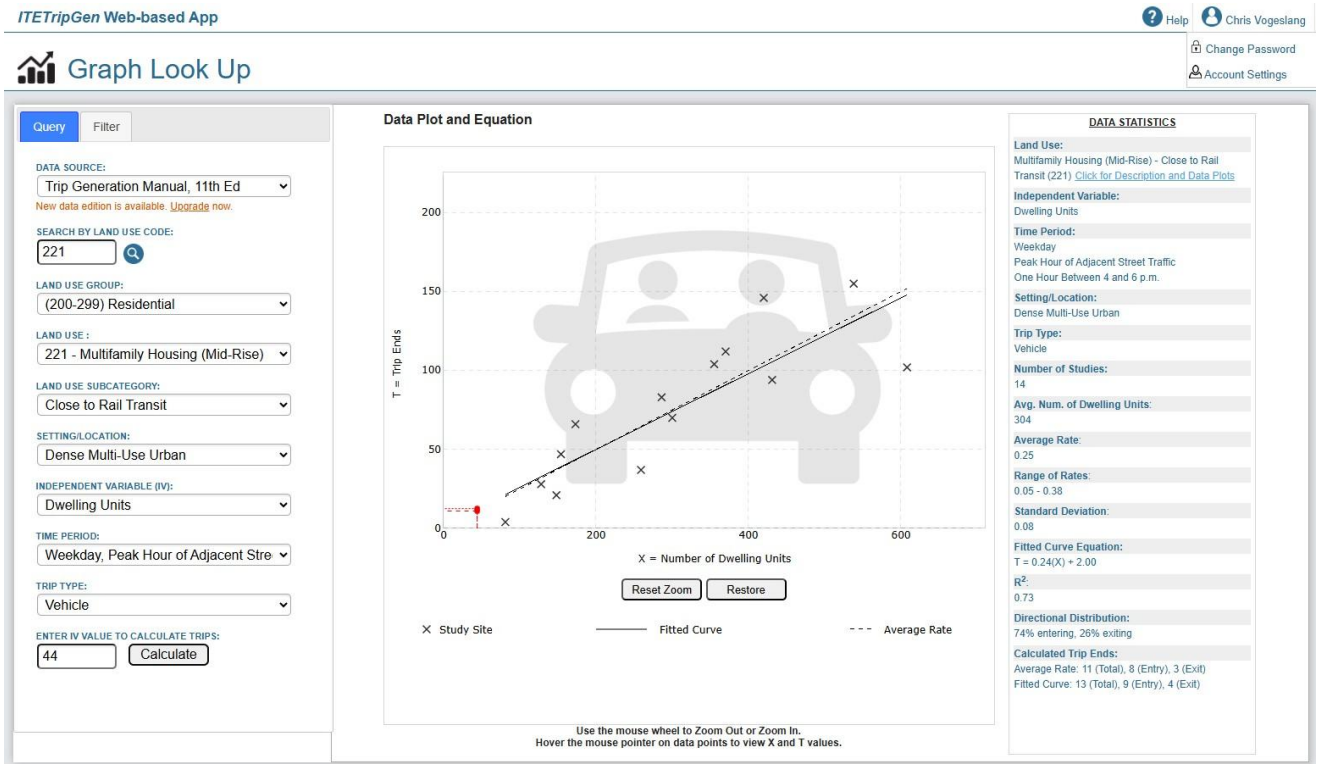
The analysis of intersection operations was conducted with the same general method used in the 2020 TIS (delay and Level of Service), and under basic assumptions without such considerations as pedestrians crossing the driveway, on-street parking activity on NWD, or bus service. This analysis indicates that the driveway exiting traffic would experience an average delay of about 13.4 seconds per vehicle, consistent with LOS B. The southbound left turn movement, which must yield to northbound vehicles, would operate at LOS A.

Conclusions

The review of the plans provided for the proposed apartments, the transportation analysis, and a comparison to the NWC TIS (October 2020) assumptions lead to the following conclusions:

- Proposed apartments are similar in anticipated use to the assumptions of the NWC TIS (October 2020).
- There are more bedrooms proposed than were assumed in the NWC TIS (October 2020) and they are anticipated to generate slightly more trips.
- The anticipated apartment related trip volumes are low and comprise a small percentage of the projected overall traffic on NWC Drive (north).
- The apartment driveway is expected to operate acceptably in the key analysis period that reflects the Full Build Out Normal Day PM Peak Hour that was included in the NWC TIS (October 2020).
- The proposed apartments are in conformance with the assumptions included in the NWC TIS (October 2020) and are not expected to degrade projected transportation operations as documented in the NWC TIS (October 2020).


ITETripGen Web-based App
Help
Chris Vogeslang
Change Password
Account Settings
Graph Look Up
Query
Filter
DATA SOURCE:
Trip Generation Manual, 11th Ed
New data edition is available. Upgrade now.
SEARCH BY LAND USE CODE:
221
LAND USE GROUP:
(200-299) Residential
LAND USE :
221 - Multifamily Housing (Mid-Rise)
LAND USE SUBCATEGORY:
Close to Rail Transit
SETTING/LOCATION:
Dense Multi-Use Urban
INDEPENDENT VARIABLE (IV):
Dwelling Units
TIME PERIOD:
Weekday
TRIP TYPE:
Vehicle
ENTER IV VALUE TO CALCULATE TRIPS:
44
Calculate
Data Plot and Equation
Caution – Small Sample Size
T = Trip Ends
X = Number of Dwelling Units
Reset Zoom
Restore
Study Site
Average Rate
Use the mouse wheel to Zoom Out or Zoom In.
Hover the mouse pointer on data points to view X and T values.
DATA STATISTICS
Land Use:
Multifamily Housing (Mid-Rise) - Close to Rail Transit (221) Click for Description and Data Plots
Independent Variable:
Dwelling Units
Time Period:
Weekday
Setting/Location:
Dense Multi-Use Urban
Trip Type:
Vehicle
Number of Studies:
1
Avg. Num. of Dwelling Units:
185
Average Rate:
2.01
Range of Rates:
2.01 - 2.01
Standard Deviation:
****
Fitted Curve Equation:
Not Given
R2:
****
Directional Distribution:
50% entering, 50% exiting
Calculated Trip Ends:
Average Rate: 88 (Total), 44 (Entry), 44 (Exit)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LAND USE :
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LAND USE SUBCATEGORY:
Close to Rail Transit
SETTING/LOCATION:
Dense Multi-Use Urban
INDEPENDENT VARIABLE (IV):
Dwelling Units
TIME PERIOD:
Weekday, Peak Hour of Adjacent Stre
TRIP TYPE:
Vehicle
ENTER IV VALUE TO CALCULATE TRIPS:
44
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X = Number of Dwelling Units
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Study Site
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Average Rate
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DATA STATISTICS
Land Use:
Multifamily Housing (Mid-Rise) - Close to Rail Transit (221) Click for Description and Data Plots
Independent Variable:
Dwelling Units
Time Period:
Weekday
Peak Hour of Adjacent Street Traffic
One Hour Between 4 and 6 p.m.
Setting/Location:
Dense Multi-Use Urban
Trip Type:
Vehicle
Number of Studies:
14
Avg. Num. of Dwelling Units:
304
Average Rate:
0.25
Range of Rates:
0.05 - 0.38
Standard Deviation:
0.08
Fitted Curve Equation:
T = 0.24(X) + 2.00
R2:
0.73
Directional Distribution:
74% entering, 26% exiting
Calculated Trip Ends:
Average Rate: 11 (Total), 8 (Entry), 3 (Exit)
Fitted Curve: 13 (Total), 9 (Entry), 4 (Exit)

Intersection	
Int Delay, s/veh	0.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	2	1	428	5	3	252
Future Vol, veh/h	2	1	428	5	3	252
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	2	1	465	5	3	274

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	748	468	0	0	470	0
Stage 1	468	-	-	-	-	-
Stage 2	280	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	380	595	-	-	1092	-
Stage 1	630	-	-	-	-	-
Stage 2	767	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	379	595	-	-	1092	-
Mov Cap-2 Maneuver	379	-	-	-	-	-
Stage 1	630	-	-	-	-	-
Stage 2	765	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	13.4	0	0.1
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	431	1092	-
HCM Lane V/C Ratio	-	-	0.008	0.003	-
HCM Control Delay (s)	-	-	13.4	8.3	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0	0	-

Land Use: 221
Multifamily Housing (Mid-Rise)

Description

Mid-rise multifamily housing includes apartments and condominiums located in a building that has between four and 10 floors of living space. Access to individual dwelling units is through an outside building entrance, a lobby, elevator, and a set of hallways.

Multifamily housing (low-rise) (Land Use 220), multifamily housing (high-rise) (Land Use 222), off-campus student apartment (mid-rise) (Land Use 226), and mid-rise residential with ground-floor commercial (Land Use 231) are related land uses.

Land Use Subcategory

Data are presented for two subcategories for this land use: (1) not close to rail transit and (2) close to rail transit. A site is considered close to rail transit if the walking distance between the residential site entrance and the closest rail transit station entrance is ½ mile or less.

Additional Data

For the six sites for which both the number of residents and the number of occupied dwelling units were available, there were an average of 2.5 residents per occupied dwelling unit.

For the five sites for which the numbers of both total dwelling units and occupied dwelling units were available, an average of 96 percent of the total dwelling units were occupied.

The technical appendices provide supporting information on time-of-day distributions for this land use. The appendices can be accessed through either the ITETripGen web app or the trip generation resource page on the ITE website (https://www.ite.org/technical-resources/topics/trip-and-parking-generation/).

It is expected that the number of bedrooms and number of residents are likely correlated to the trips generated by a residential site. To assist in future analysis, trip generation studies of all multifamily housing should attempt to obtain information on occupancy rate and on the mix of residential unit sizes (i.e., number of units by number of bedrooms at the site complex).

The sites were surveyed in the 1990s, the 2000s, the 2010s, and the 2020s in Alberta (CAN), California, District of Columbia, Florida, Georgia, Illinois, Maryland, Massachusetts, Minnesota, Montana, New Jersey, New York, Ontario (CAN), Oregon, Utah, and Virginia.

Source Numbers

168, 188, 204, 305, 306, 321, 818, 857, 862, 866, 901, 904, 910, 949, 951, 959, 963, 964, 966, 967, 969, 970, 1004, 1014, 1022, 1023, 1025, 1031, 1032, 1035, 1047, 1056, 1057, 1058, 1071, 1076

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

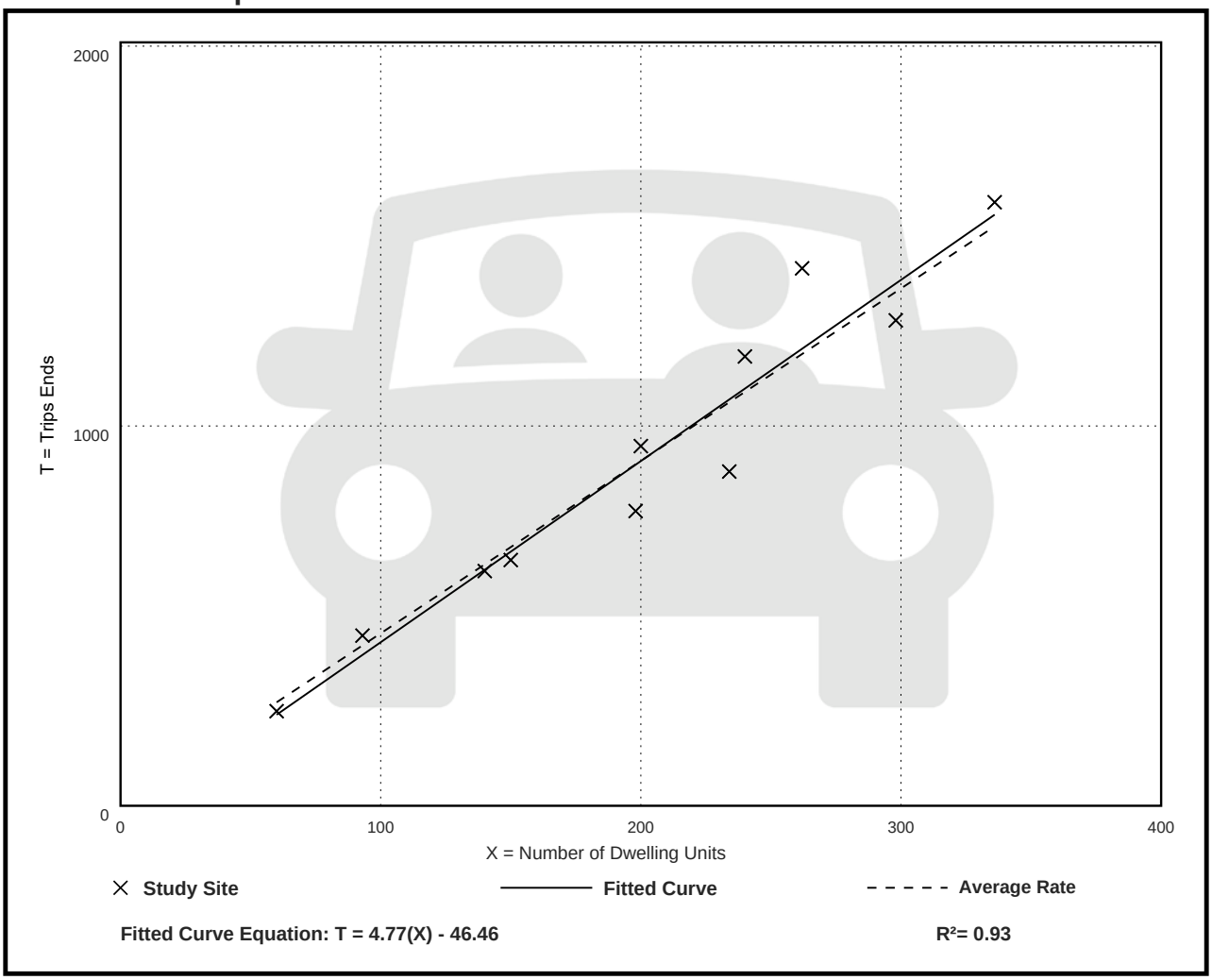
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 11
Avg. Num. of Dwelling Units: 201
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
4.54	3.76 - 5.40	0.51

Data Plot and Equation



Fitted Curve Equation: T = 4.77(X) - 46.46

R^2= 0.93

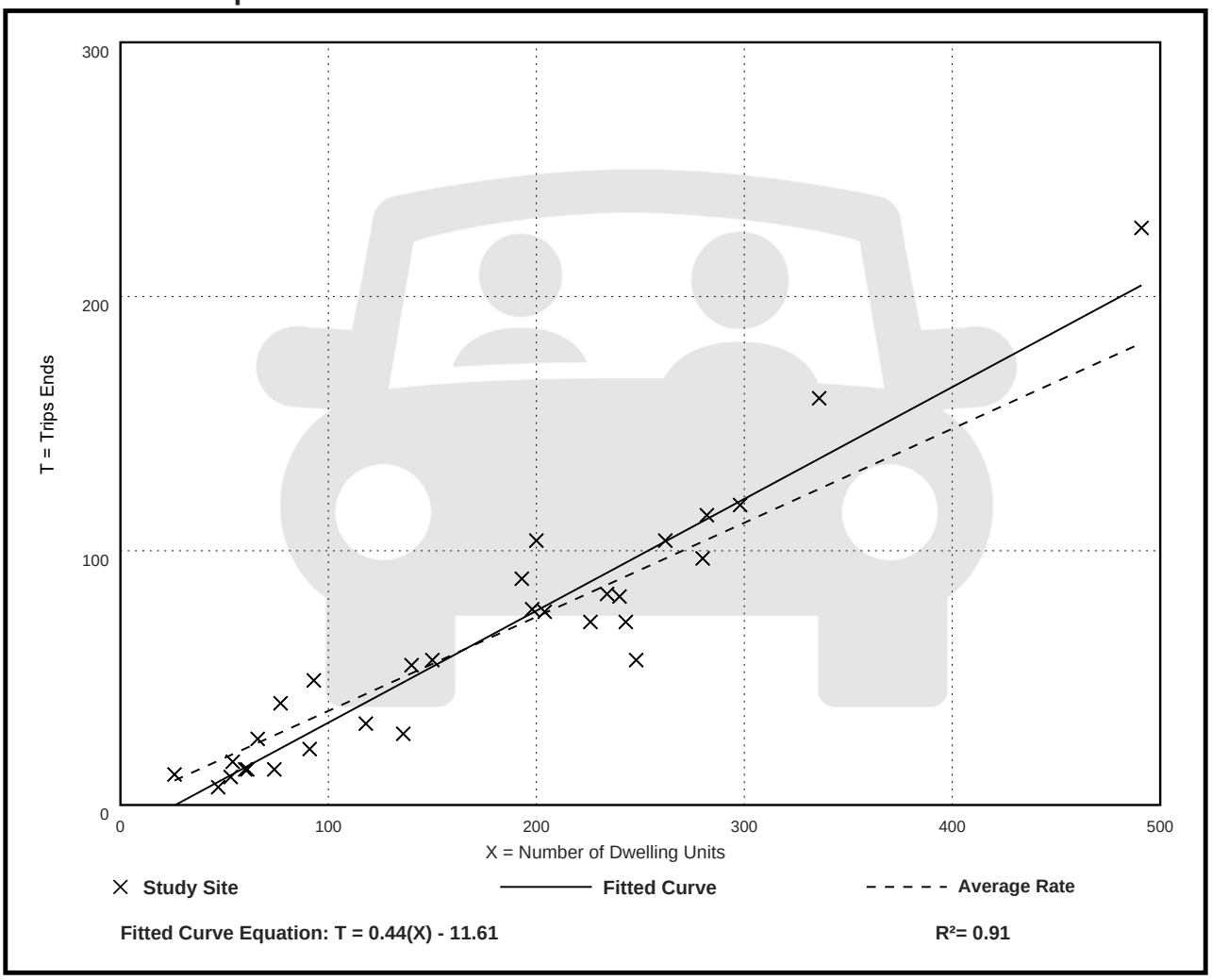
Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: General Urban/Suburban
Number of Studies: 30
Avg. Num. of Dwelling Units: 173
Directional Distribution: 23% entering, 77% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.37	0.15 - 0.53	0.09

Data Plot and Equation



Fitted Curve Equation: T = 0.44(X) - 11.61

R^2= 0.91

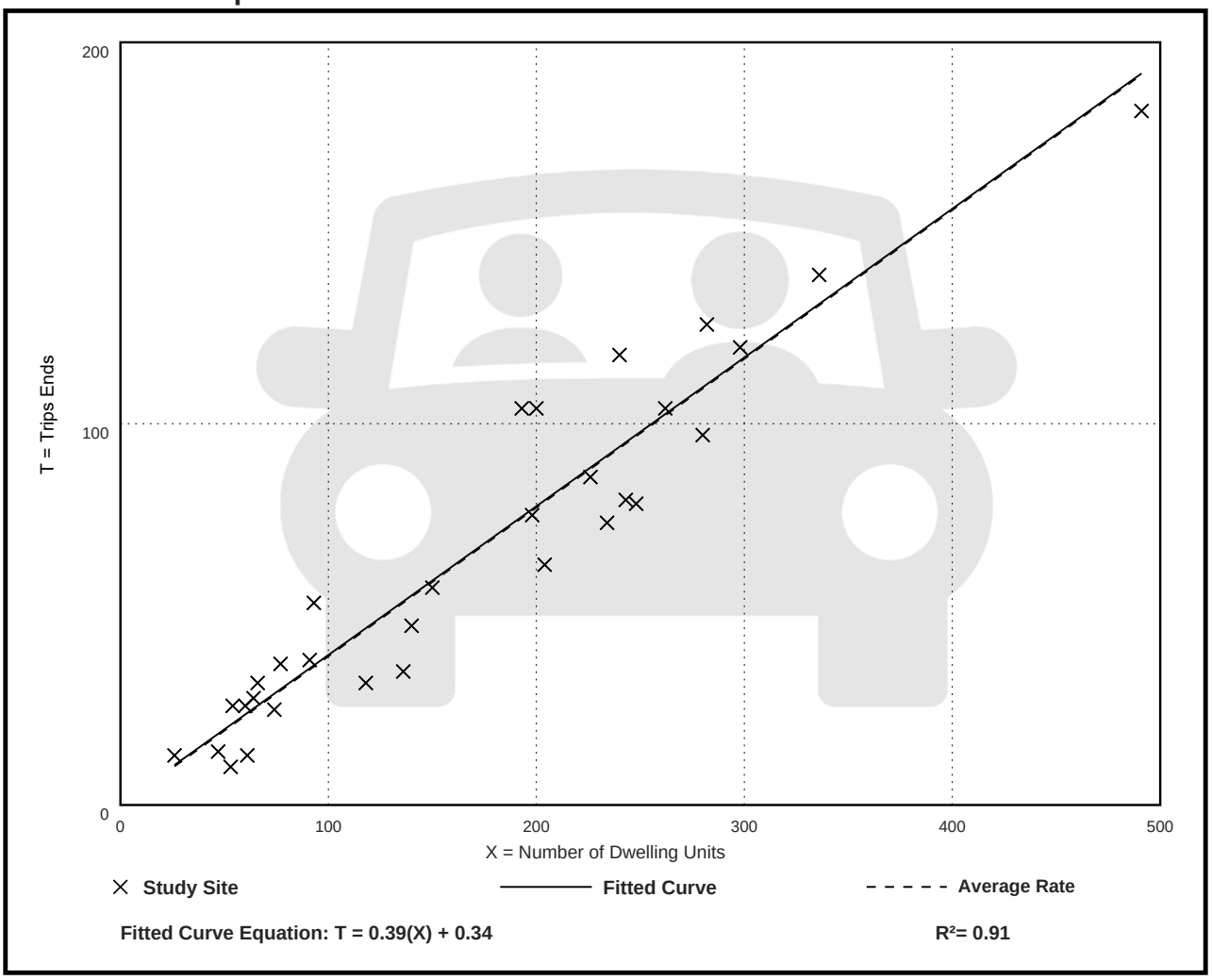
Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 31
Avg. Num. of Dwelling Units: 169
Directional Distribution: 61% entering, 39% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.39	0.19 - 0.57	0.08

Data Plot and Equation



Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

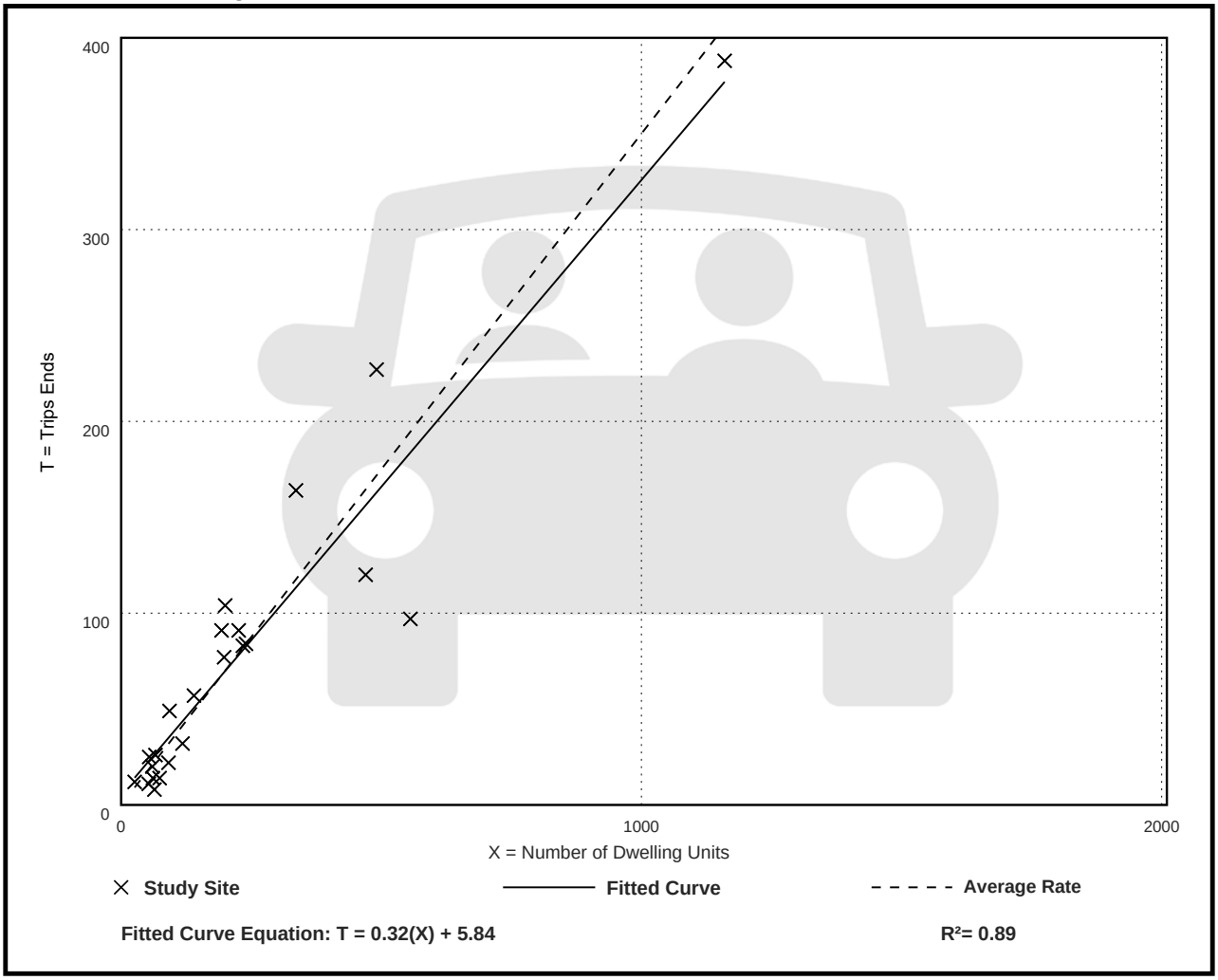
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
AM Peak Hour of Generator

Setting/Location: General Urban/Suburban
Number of Studies: 23
Avg. Num. of Dwelling Units: 226
Directional Distribution: 26% entering, 74% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.35	0.13 - 0.53	0.11

Data Plot and Equation



Fitted Curve Equation: T = 0.32(X) + 5.84

R^2= 0.89

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

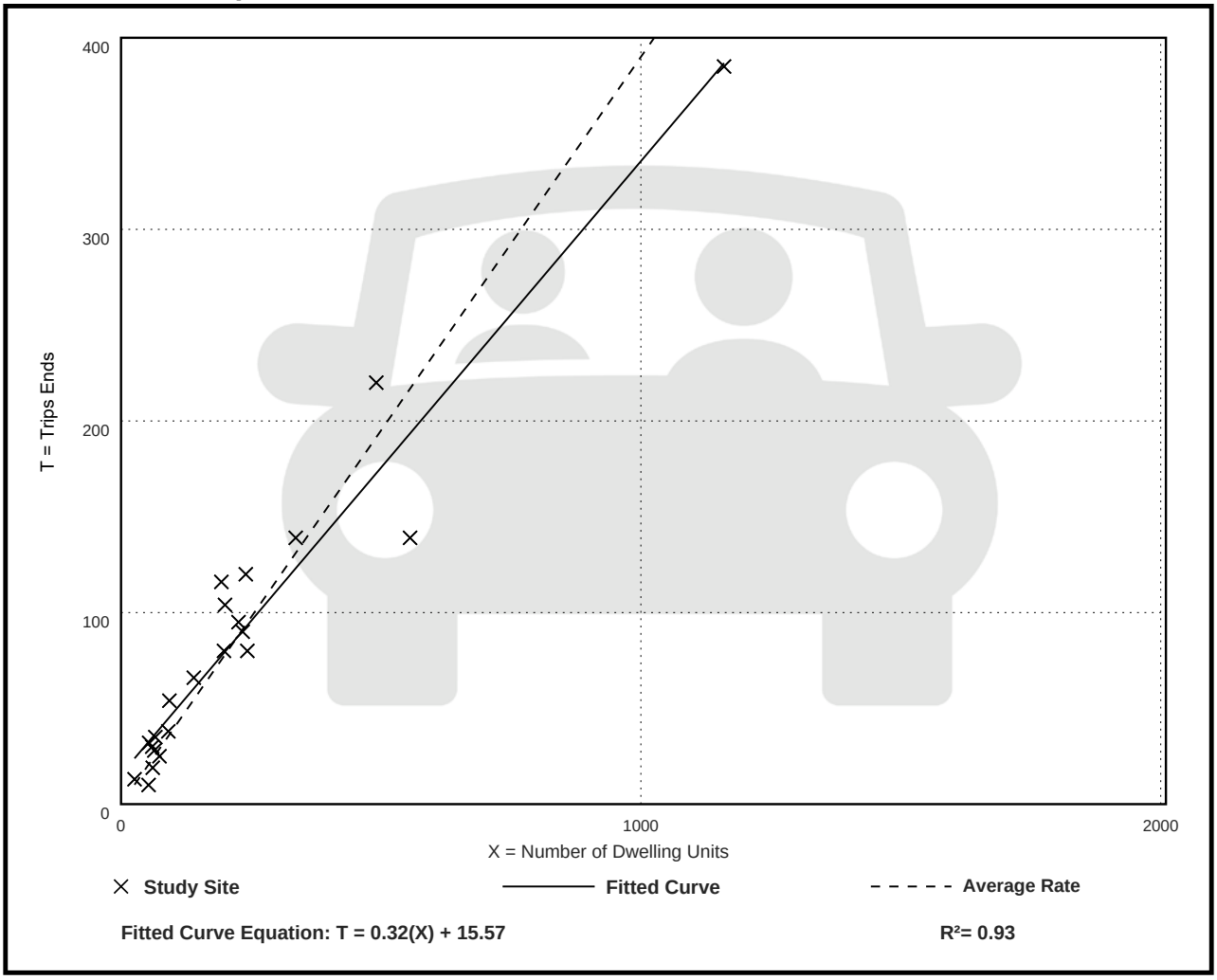
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
PM Peak Hour of Generator

Setting/Location: General Urban/Suburban
Number of Studies: 22
Avg. Num. of Dwelling Units: 221
Directional Distribution: 60% entering, 40% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.39	0.19 - 0.60	0.10

Data Plot and Equation



Fitted Curve Equation: T = 0.32(X) + 15.57

R^2= 0.93

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

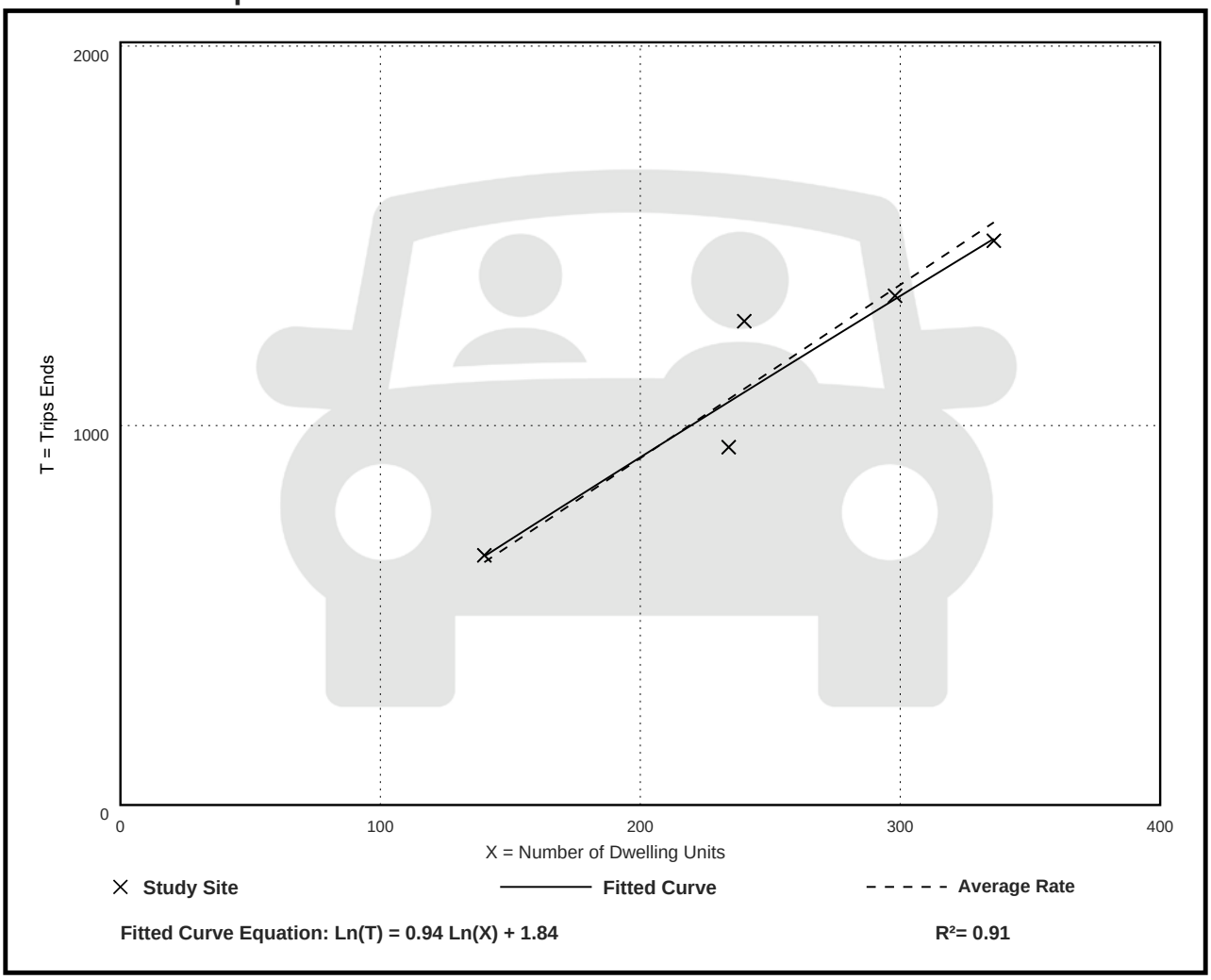
Vehicle Trip Ends vs: Dwelling Units
On a: Saturday

Setting/Location: General Urban/Suburban
Number of Studies: 5
Avg. Num. of Dwelling Units: 250
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
4.57	4.03 - 5.31	0.46

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.94 Ln(X) + 1.84

R^2= 0.91

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

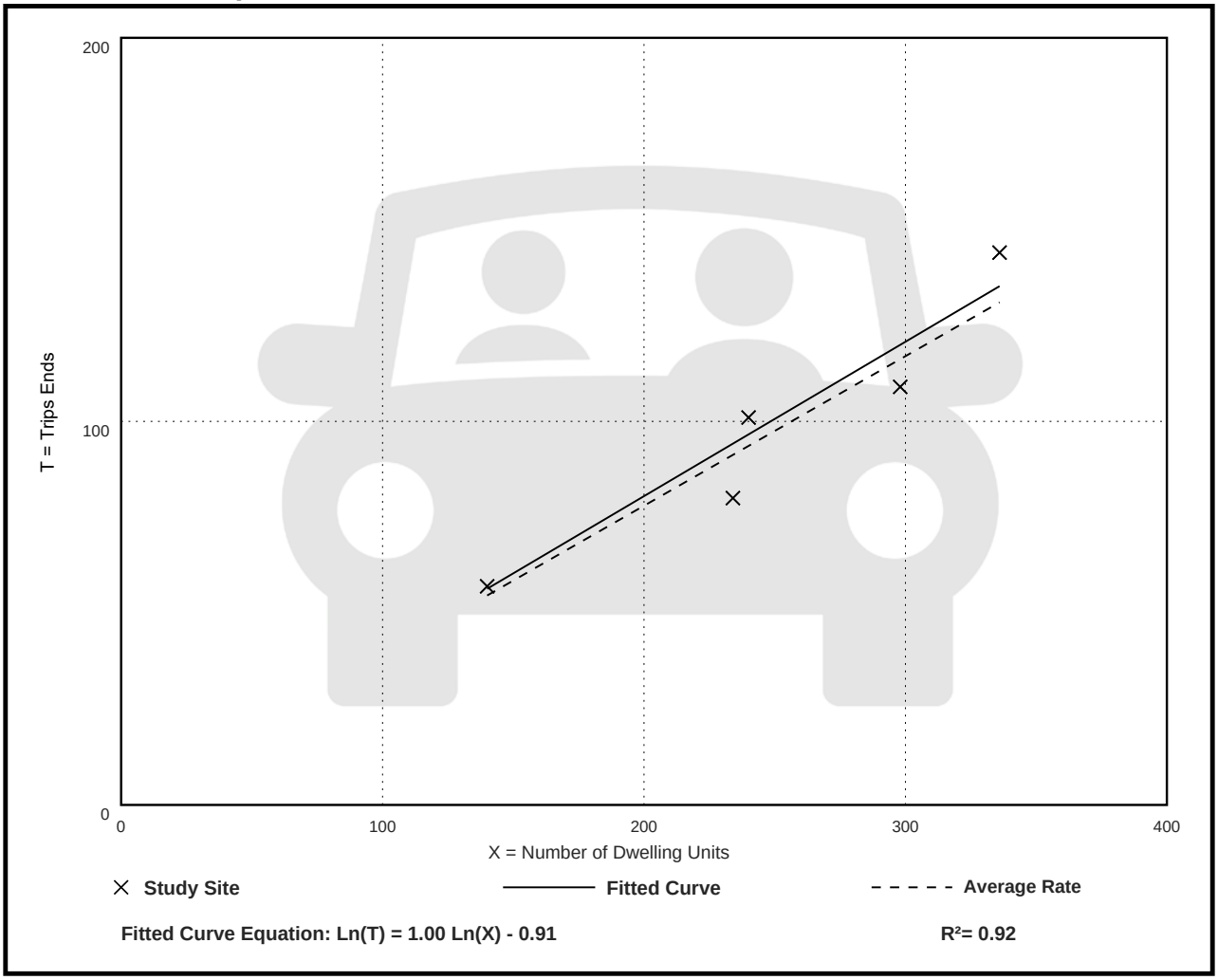
Vehicle Trip Ends vs: Dwelling Units
On a: Saturday, Peak Hour of Generator

Setting/Location: General Urban/Suburban
Number of Studies: 5
Avg. Num. of Dwelling Units: 250
Directional Distribution: 51% entering, 49% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.39	0.34 - 0.43	0.04

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 1.00 Ln(X) - 0.91

R^2= 0.92

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

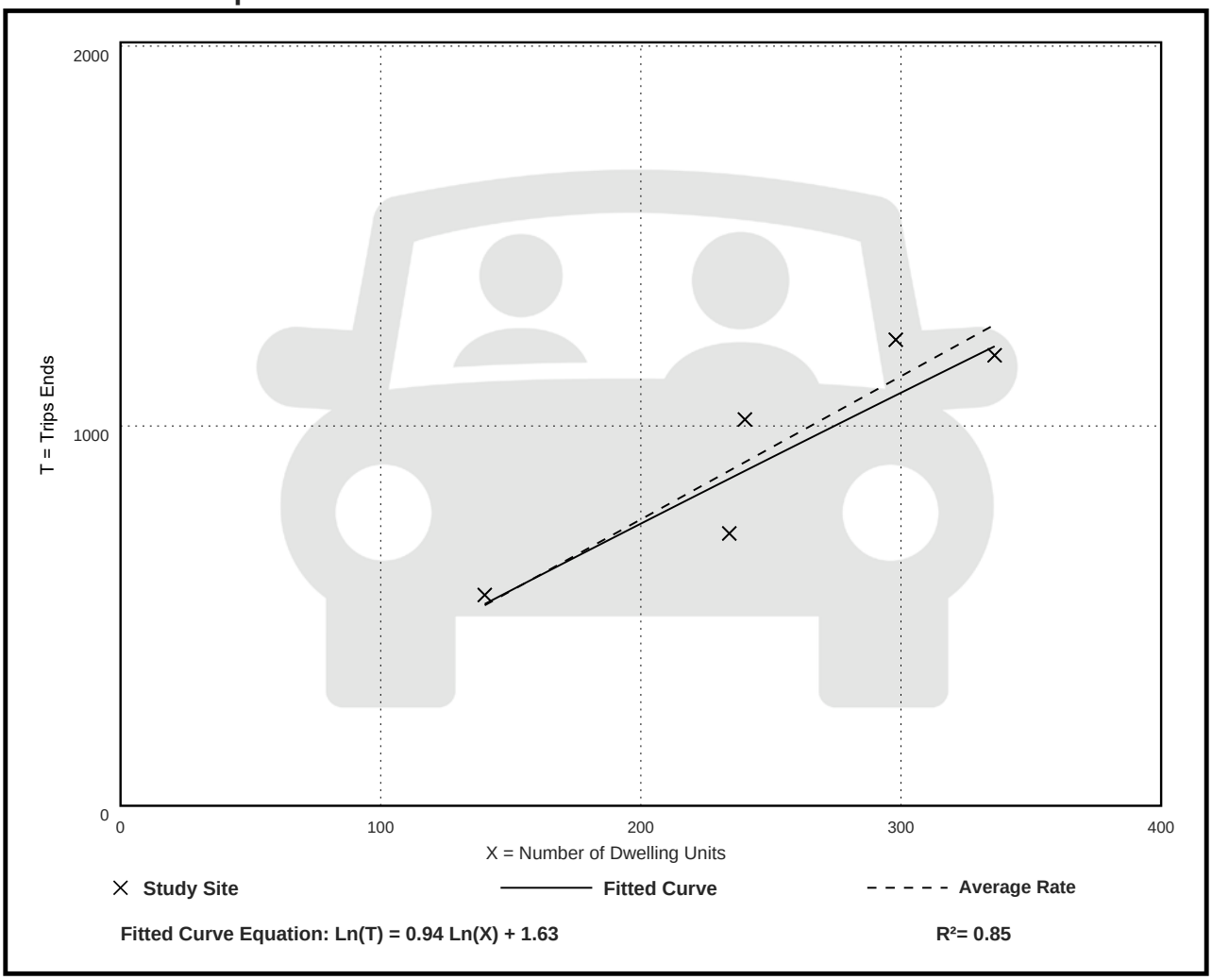
Vehicle Trip Ends vs: Dwelling Units
On a: Sunday

Setting/Location: General Urban/Suburban
Number of Studies: 5
Avg. Num. of Dwelling Units: 250
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
3.77	3.06 - 4.24	0.48

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.94 Ln(X) + 1.63

R^2= 0.85

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

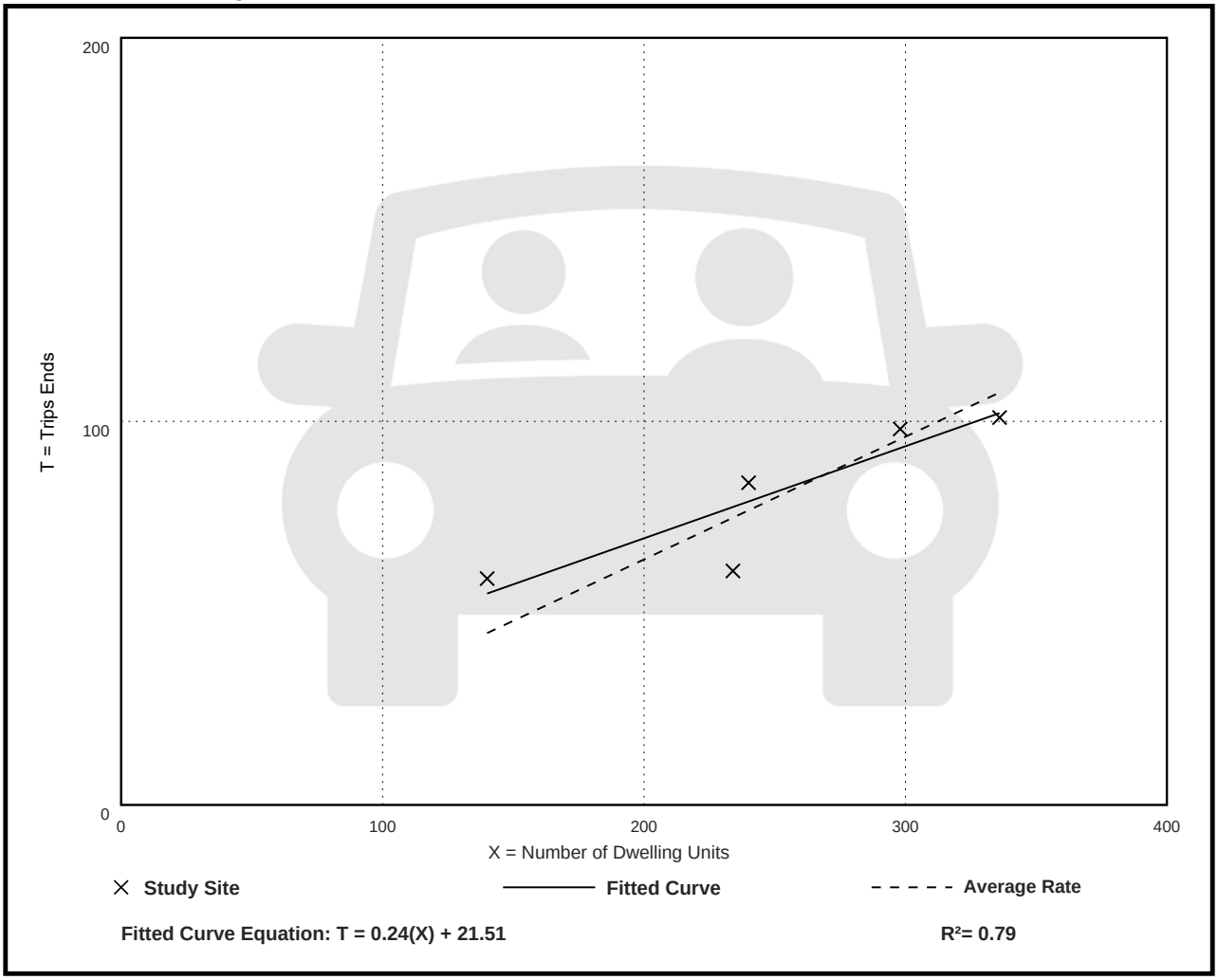
Vehicle Trip Ends vs: Dwelling Units
On a: Sunday, Peak Hour of Generator

Setting/Location: General Urban/Suburban
Number of Studies: 5
Avg. Num. of Dwelling Units: 250
Directional Distribution: 55% entering, 45% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.32	0.26 - 0.42	0.05

Data Plot and Equation



Fitted Curve Equation: T = 0.24(X) + 21.51

R^2= 0.79

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

Vehicle Trip Ends vs: Residents
On a: Weekday

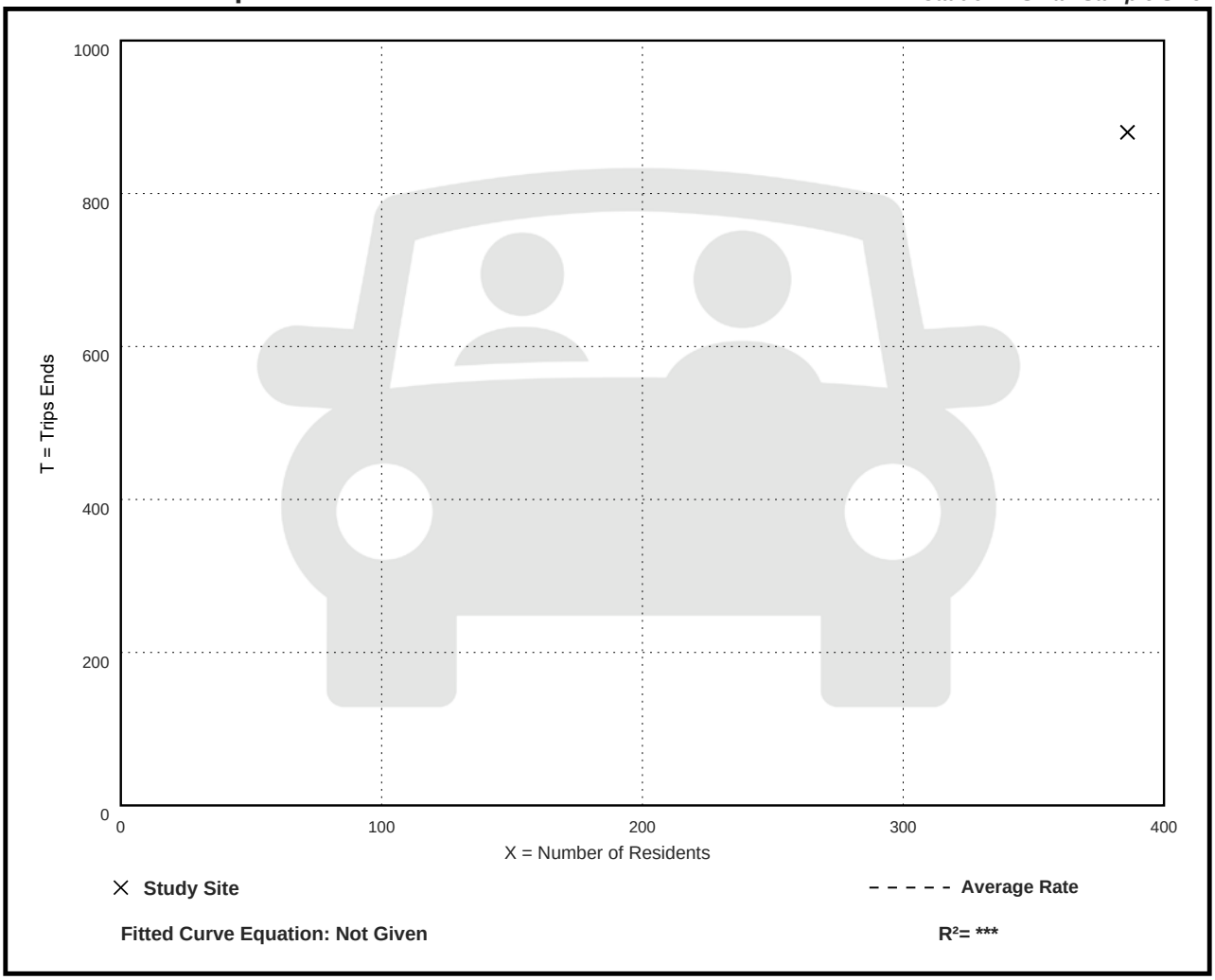
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Residents: 386
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
2.28	2.28 - 2.28	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

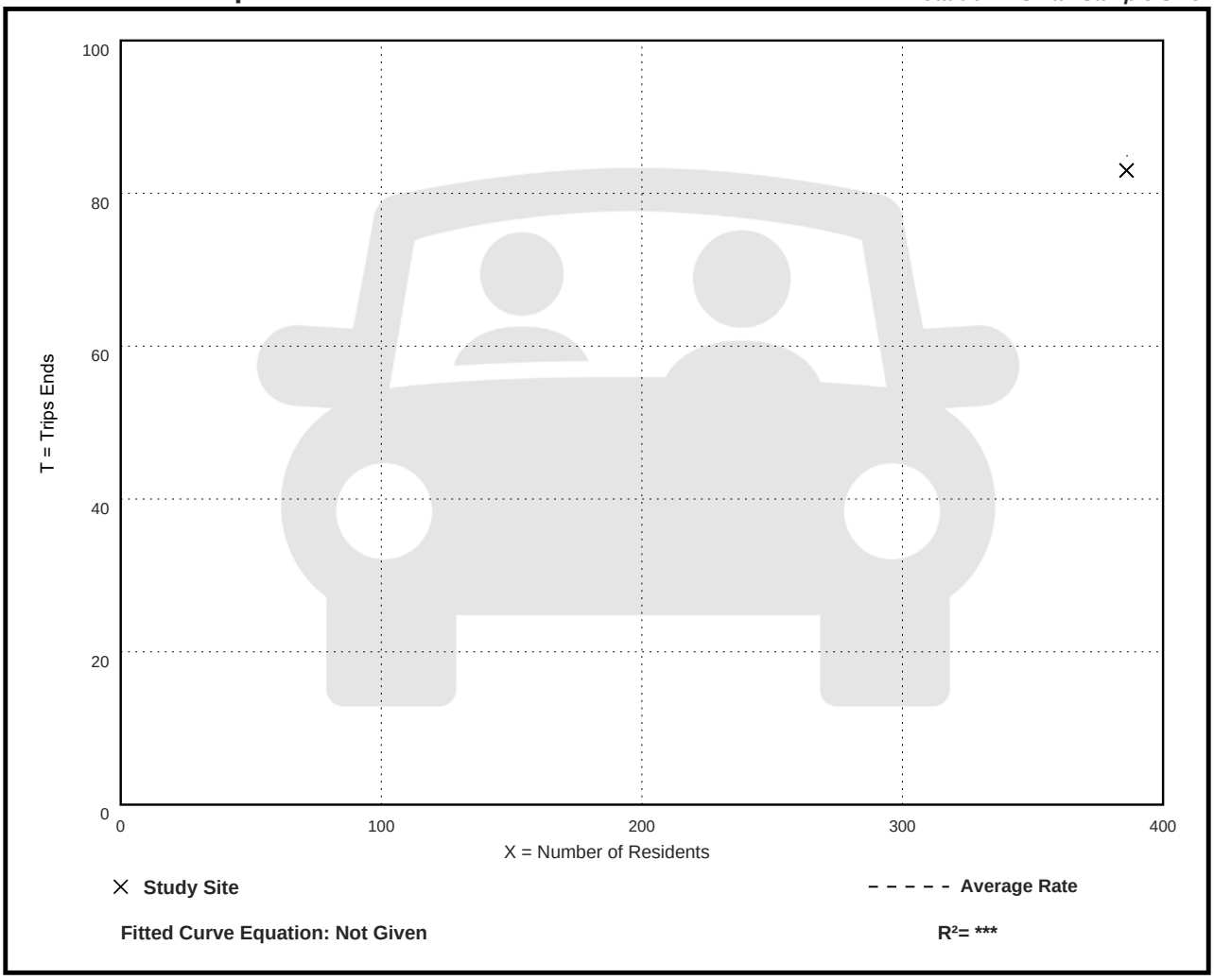
Vehicle Trip Ends vs: Residents
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Residents: 386
Directional Distribution: 20% entering, 80% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
0.22	0.22 - 0.22	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

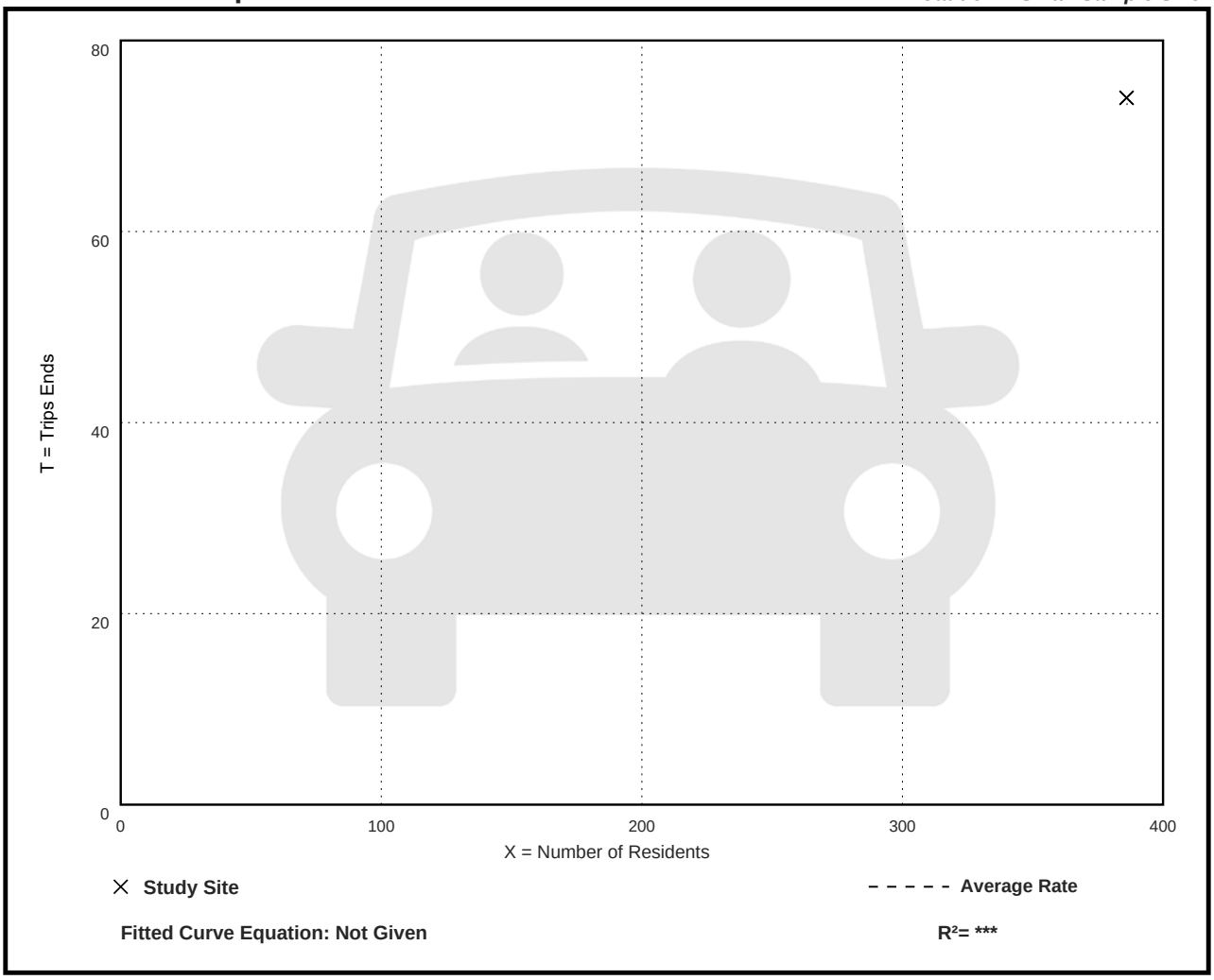
Vehicle Trip Ends vs: Residents
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Residents: 386
Directional Distribution: 64% entering, 36% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
0.19	0.19 - 0.19	***

Data Plot and Equation

Caution – Small Sample Size



Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

Vehicle Trip Ends vs: Residents
On a: Weekday,
AM Peak Hour of Generator

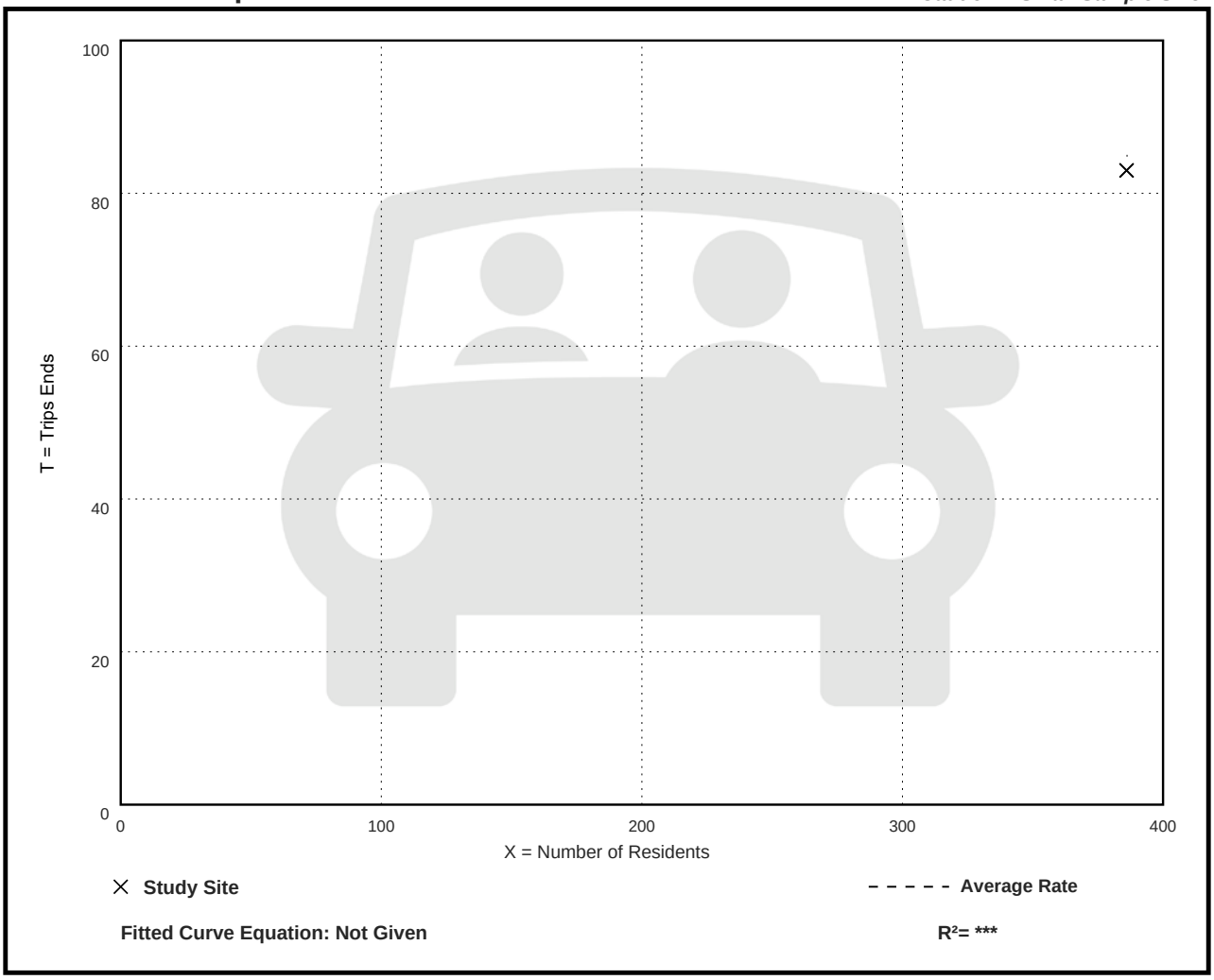
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Residents: 386
Directional Distribution: 20% entering, 80% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
0.22	0.22 - 0.22	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

Vehicle Trip Ends vs: Residents
On a: Weekday,
PM Peak Hour of Generator

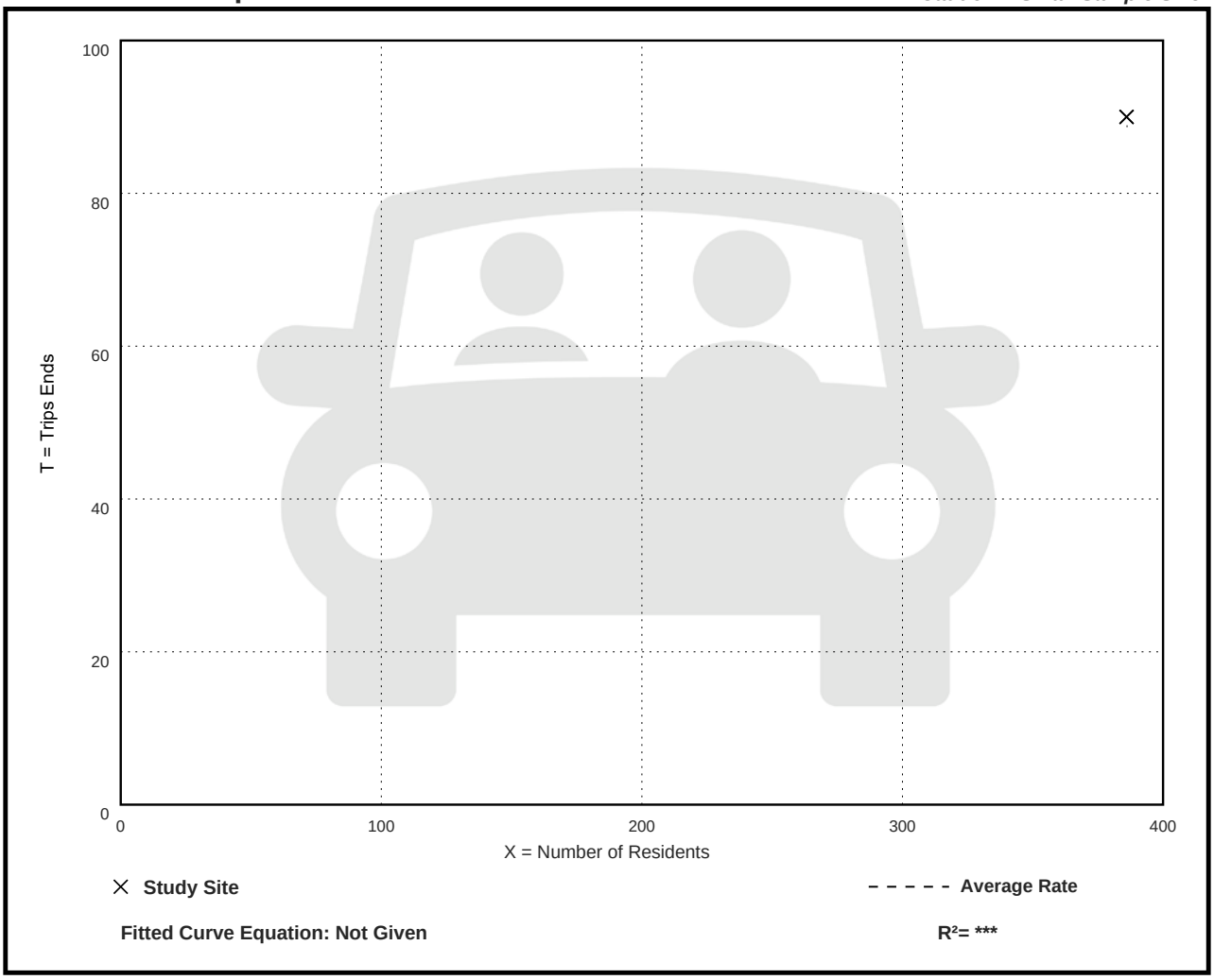
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Residents: 386
Directional Distribution: 64% entering, 36% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
0.23	0.23 - 0.23	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

Vehicle Trip Ends vs: Residents
On a: Saturday

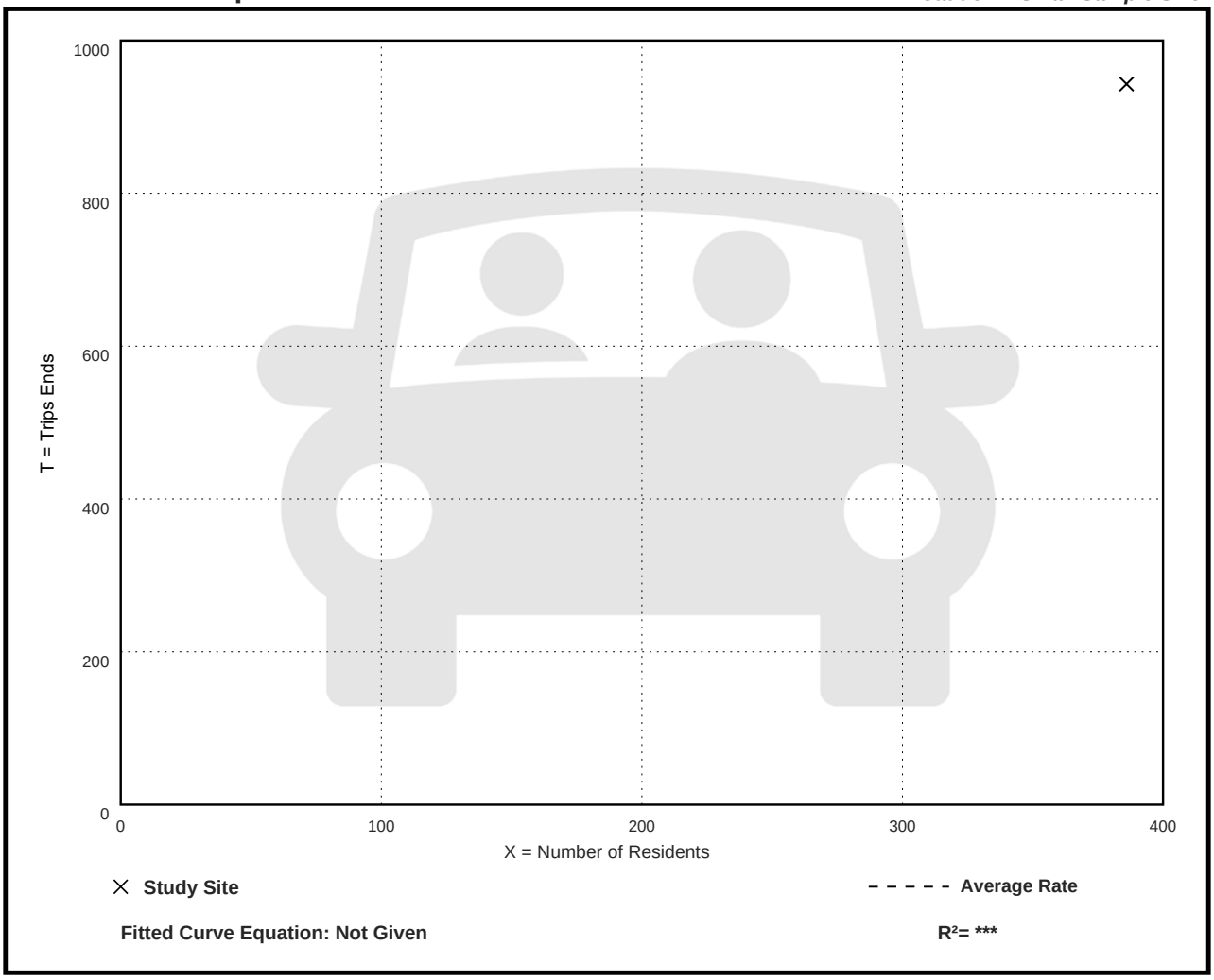
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Residents: 386
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
2.44	2.44 - 2.44	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

Vehicle Trip Ends vs: Residents
On a: Saturday, Peak Hour of Generator

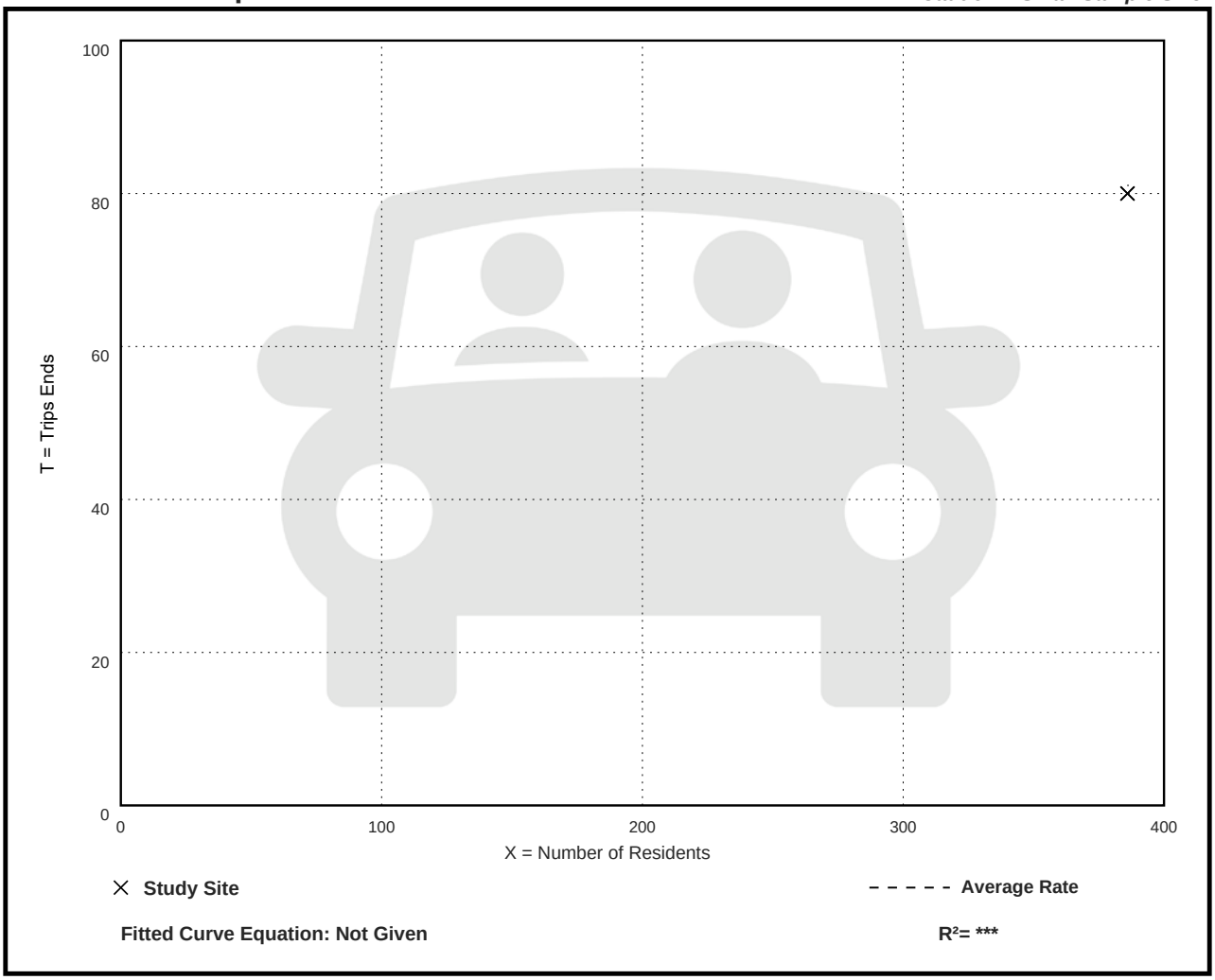
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Residents: 386
Directional Distribution: 53% entering, 47% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
0.21	0.21 - 0.21	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

Vehicle Trip Ends vs: Residents
On a: Sunday

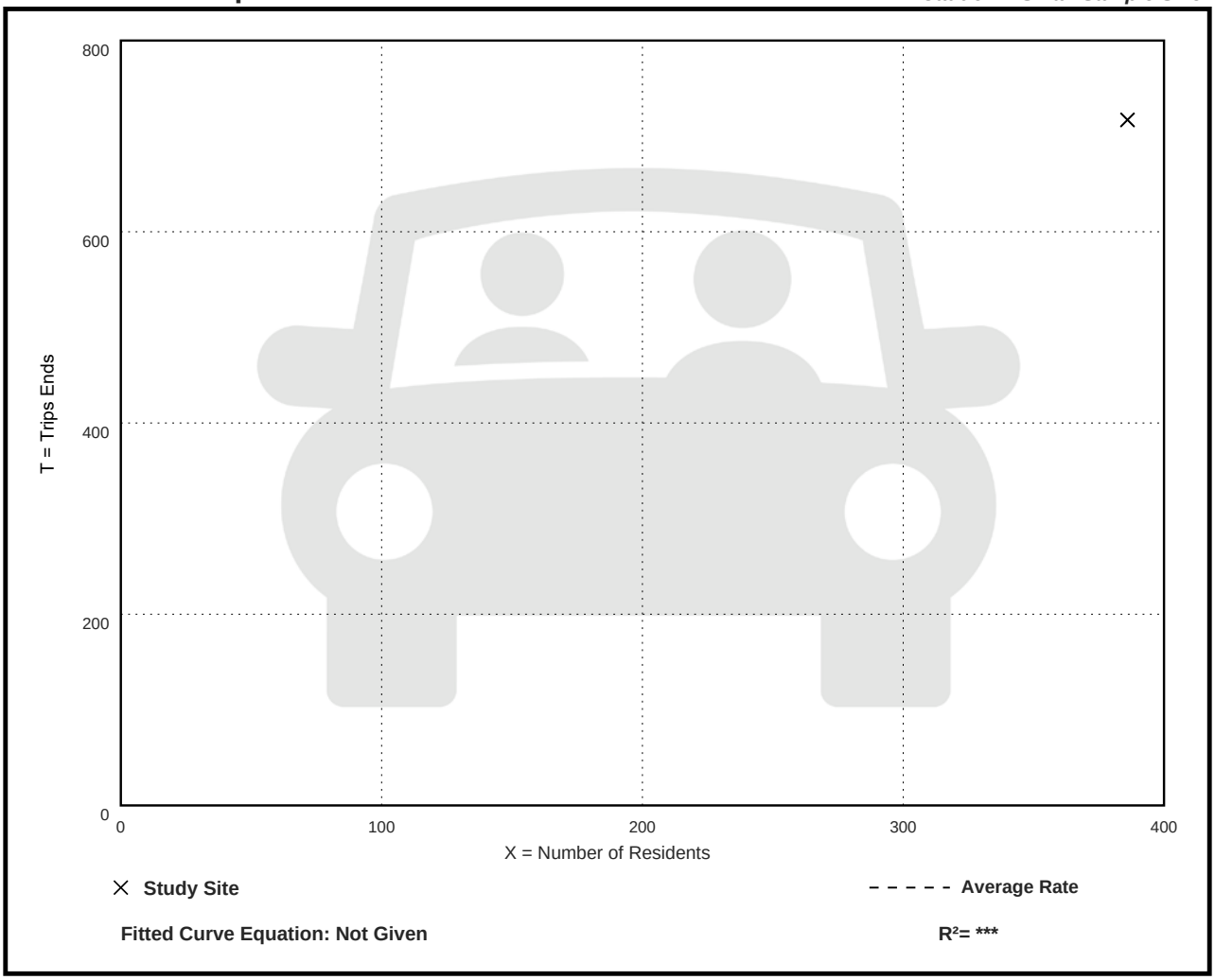
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Residents: 386
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
1.86	1.86 - 1.86	***

Data Plot and Equation

Caution – Small Sample Size



Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

Vehicle Trip Ends vs: Residents
On a: Sunday, Peak Hour of Generator

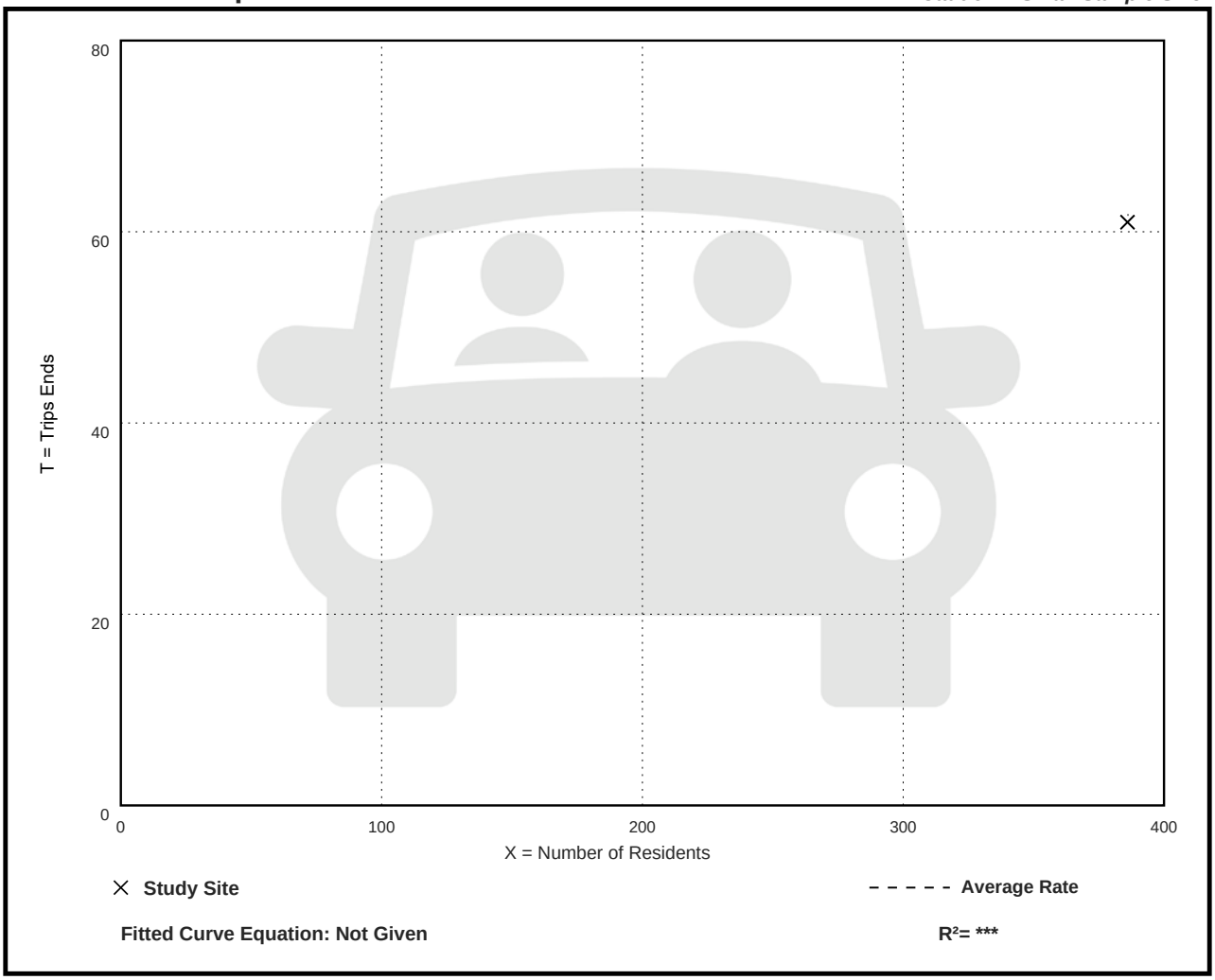
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Residents: 386
Directional Distribution: 62% entering, 38% exiting

Vehicle Trip Generation per Resident

Average Rate	Range of Rates	Standard Deviation
0.16	0.16 - 0.16	***

Data Plot and Equation

Caution – Small Sample Size



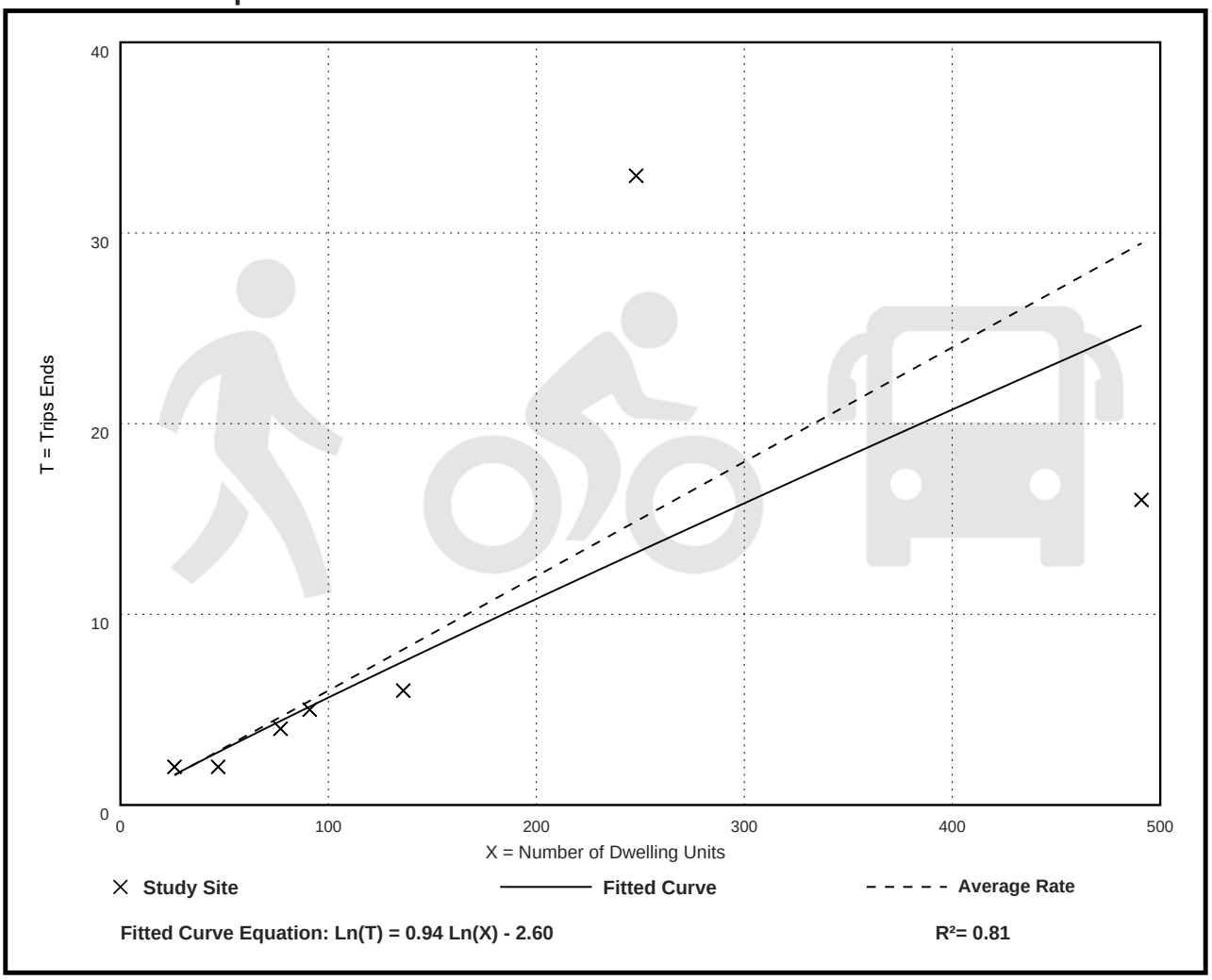
Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

Walk+Bike+Transit Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: General Urban/Suburban
Number of Studies: 7
Avg. Num. of Dwelling Units: 159
Directional Distribution: 27% entering, 73% exiting

Walk+Bike+Transit Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.06	0.03 - 0.13	0.04

Data Plot and Equation



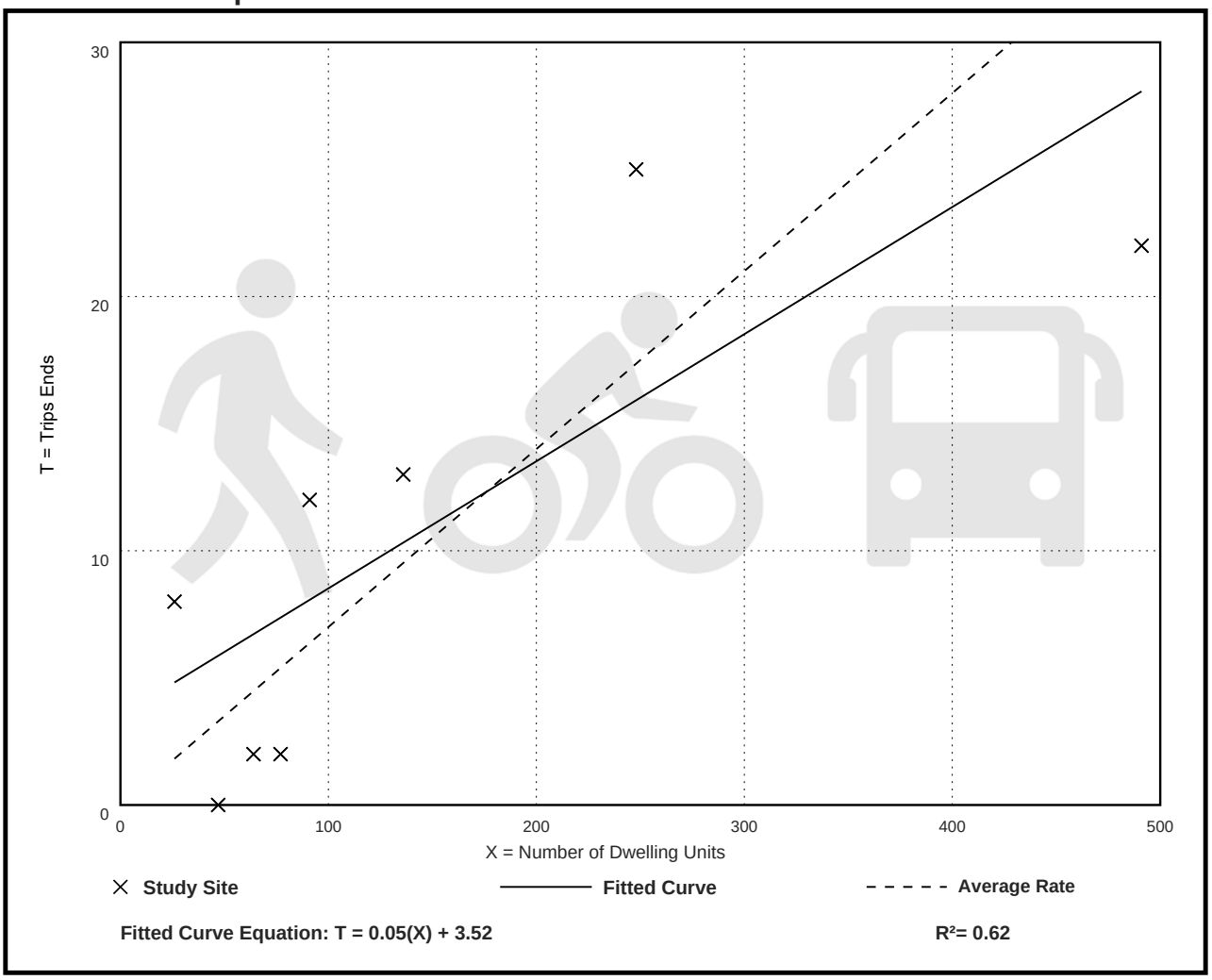
Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

Walk+Bike+Transit Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 8
Avg. Num. of Dwelling Units: 148
Directional Distribution: 55% entering, 45% exiting

Walk+Bike+Transit Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.07	0.00 - 0.31	0.05

Data Plot and Equation



Fitted Curve Equation: T = 0.05(X) + 3.52

R^2= 0.62

Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

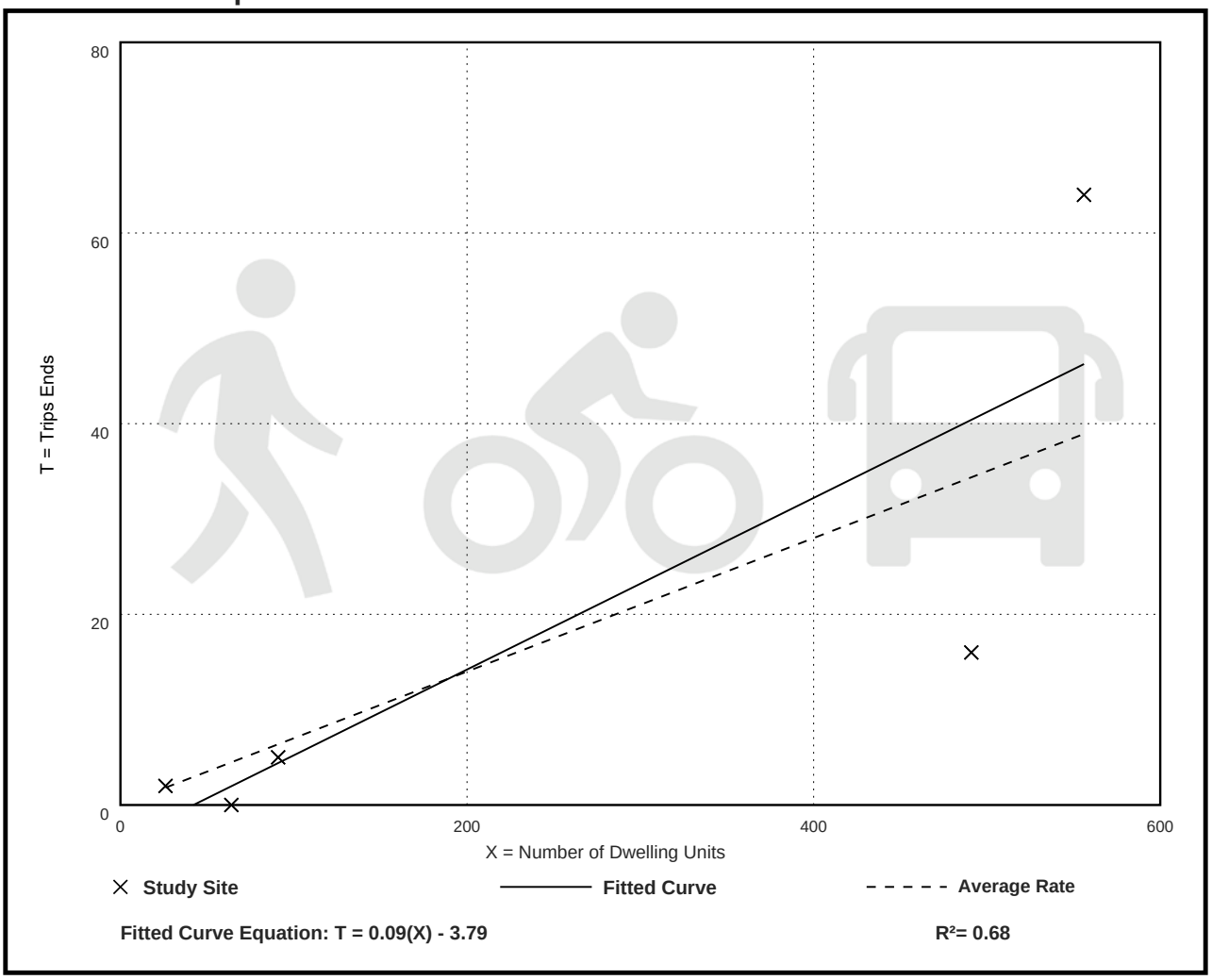
Walk+Bike+Transit Trip Ends vs: Dwelling Units
On a: Weekday,
AM Peak Hour of Generator

Setting/Location: General Urban/Suburban
Number of Studies: 5
Avg. Num. of Dwelling Units: 246
Directional Distribution: Not Available

Walk+Bike+Transit Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.07	0.00 - 0.12	0.05

Data Plot and Equation



Multifamily Housing (Mid-Rise)
Not Close to Rail Transit (221)

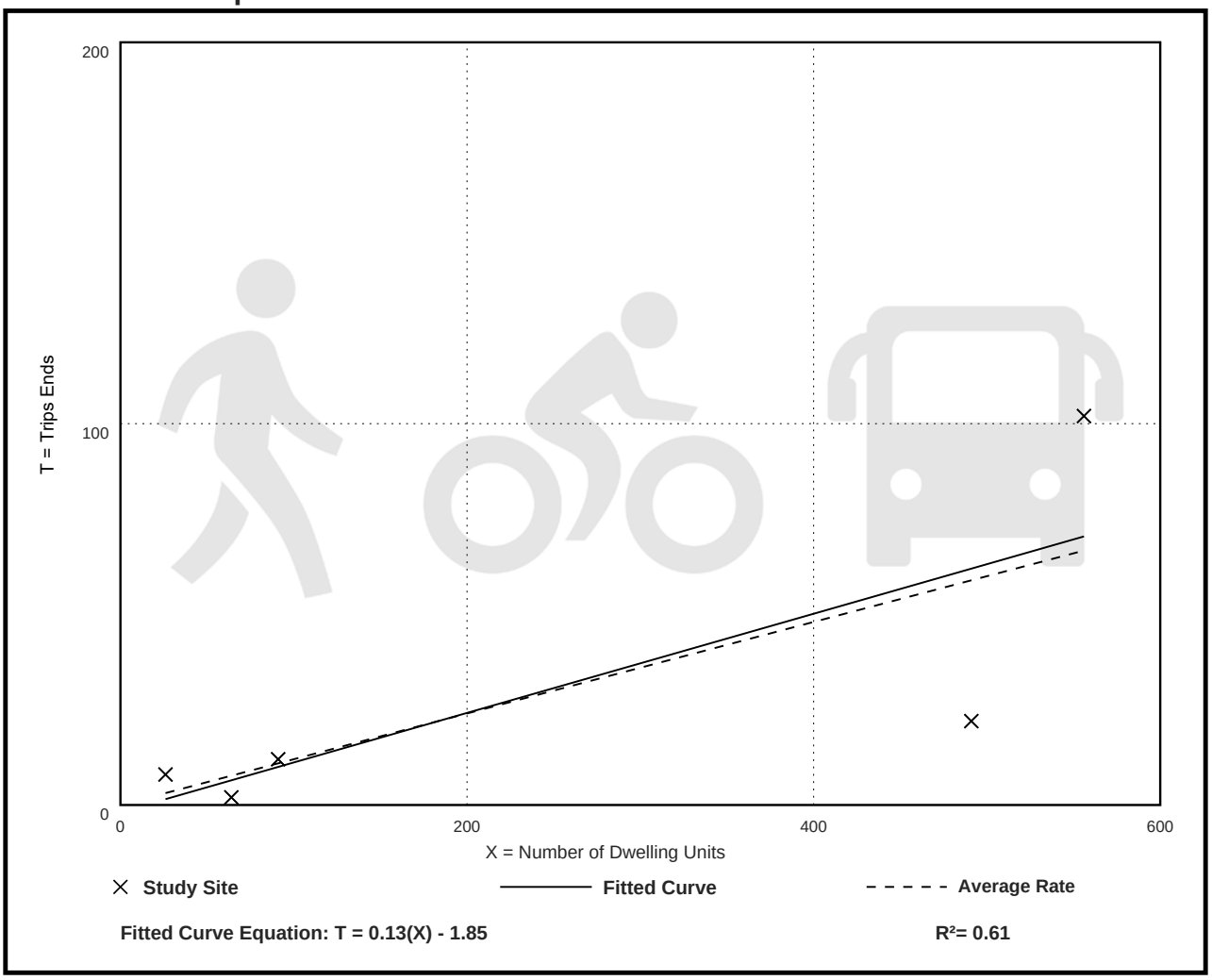
Walk+Bike+Transit Trip Ends vs: Dwelling Units
On a: Weekday,
PM Peak Hour of Generator

Setting/Location: General Urban/Suburban
Number of Studies: 5
Avg. Num. of Dwelling Units: 246
Directional Distribution: Not Available

Walk+Bike+Transit Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.12	0.03 - 0.31	0.08

Data Plot and Equation



Fitted Curve Equation: T = 0.13(X) - 1.85

R^2= 0.61

Multifamily Housing (Mid-Rise)
Close to Rail Transit (221)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

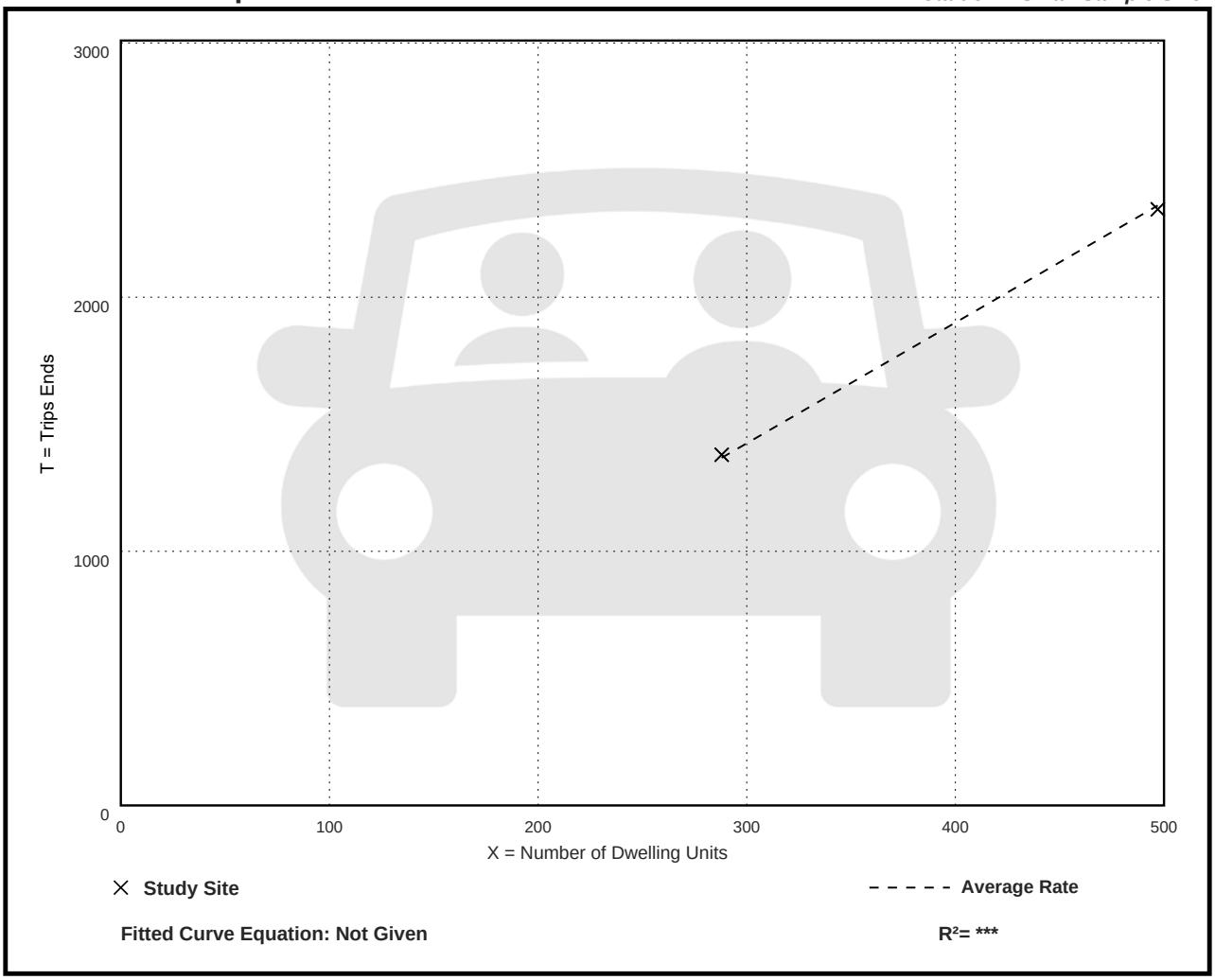
Setting/Location: General Urban/Suburban
Number of Studies: 2
Avg. Num. of Dwelling Units: 393
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
4.75	4.72 - 4.79	***

Data Plot and Equation

Caution – Small Sample Size



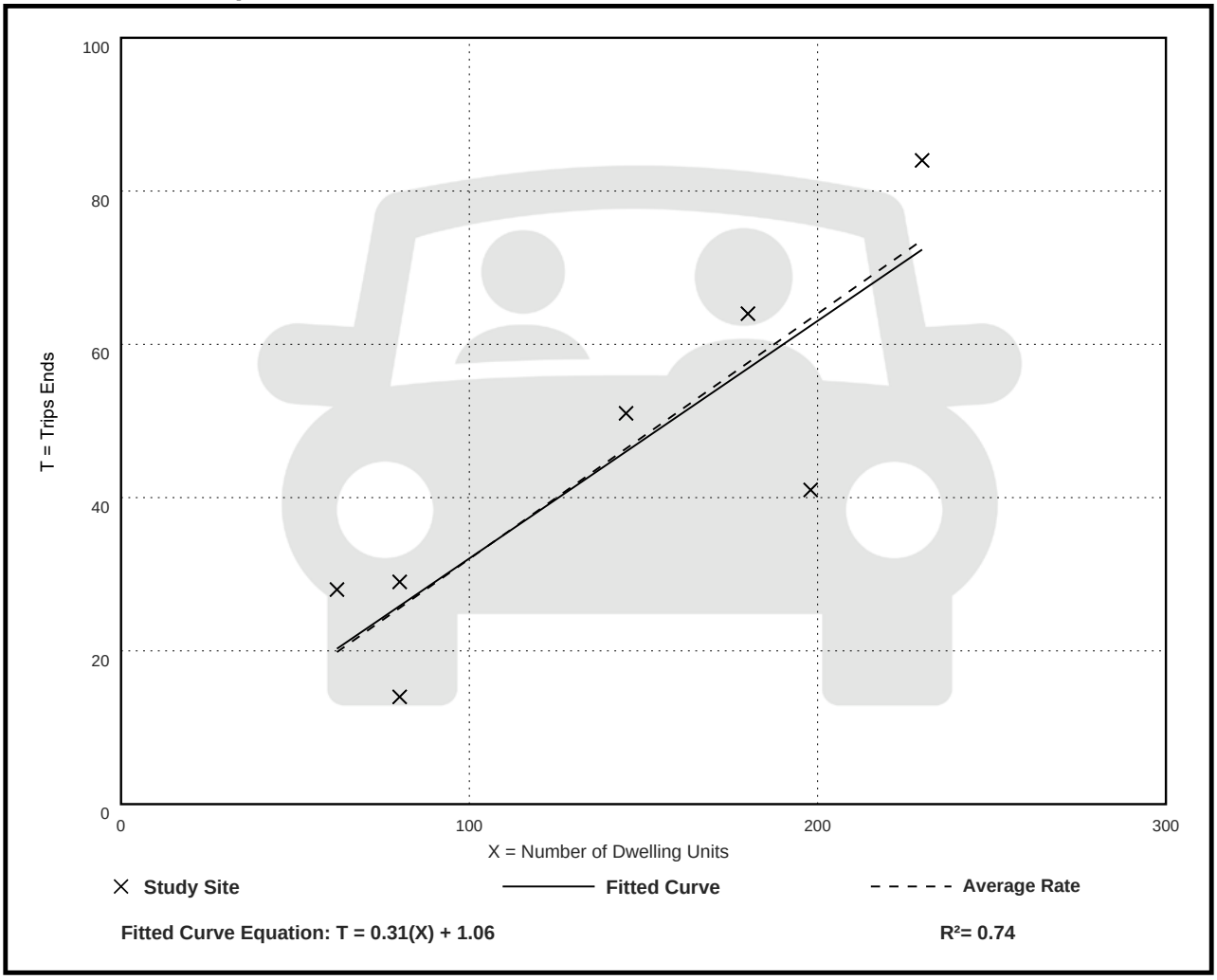
Multifamily Housing (Mid-Rise)
Close to Rail Transit (221)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: General Urban/Suburban
Number of Studies: 7
Avg. Num. of Dwelling Units: 139
Directional Distribution: 56% entering, 44% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.32	0.18 - 0.45	0.09

Data Plot and Equation



Fitted Curve Equation: T = 0.31(X) + 1.06

R^2= 0.74

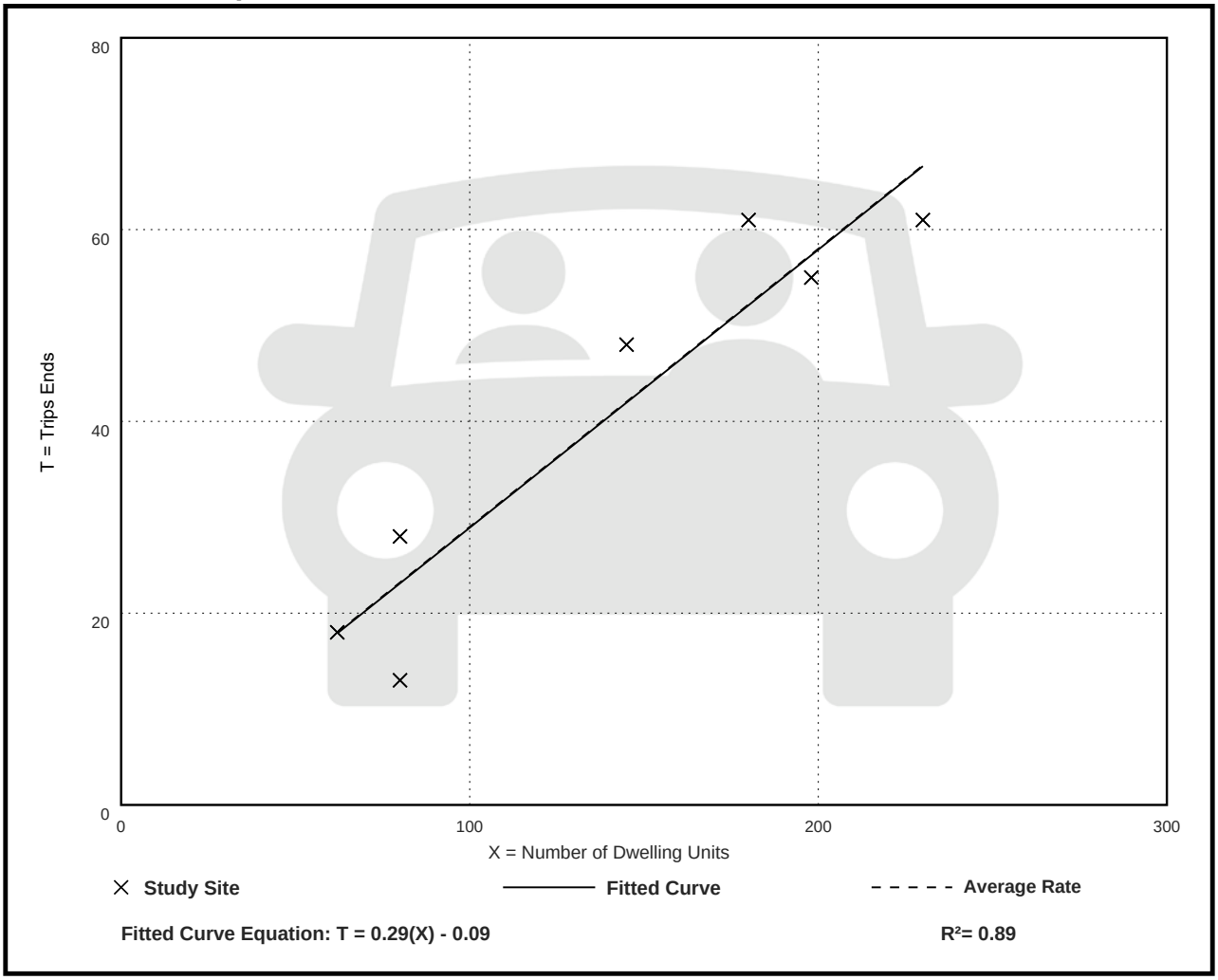
Multifamily Housing (Mid-Rise)
Close to Rail Transit (221)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 7
Avg. Num. of Dwelling Units: 139
Directional Distribution: 43% entering, 57% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.29	0.16 - 0.35	0.05

Data Plot and Equation



Fitted Curve Equation: T = 0.29(X) - 0.09

R^2= 0.89

Multifamily Housing (Mid-Rise)
Close to Rail Transit (221)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
AM Peak Hour of Generator

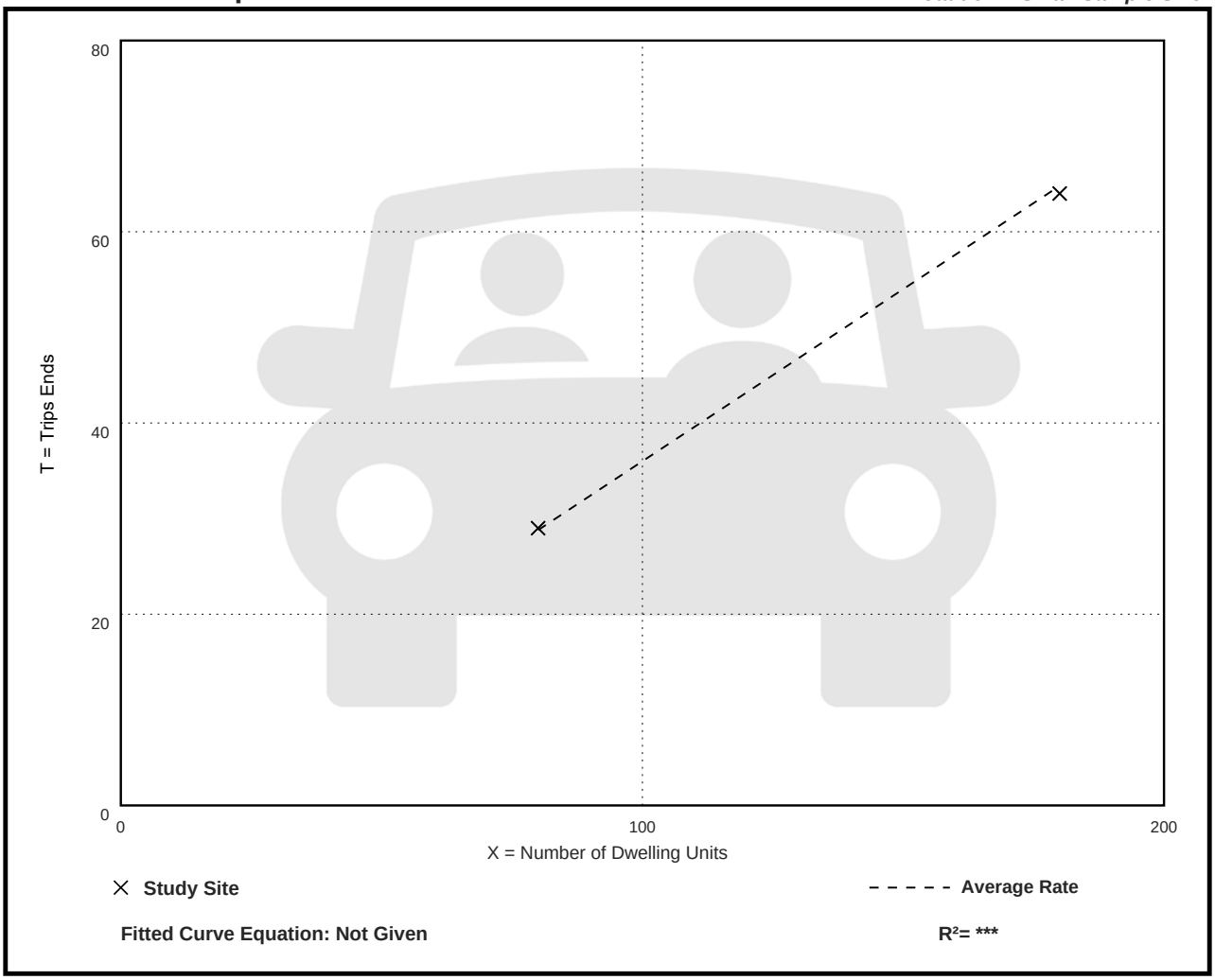
Setting/Location: General Urban/Suburban
Number of Studies: 2
Avg. Num. of Dwelling Units: 130
Directional Distribution: 38% entering, 62% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.36	0.36 - 0.36	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

Multifamily Housing (Mid-Rise)
Close to Rail Transit (221)

Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
PM Peak Hour of Generator

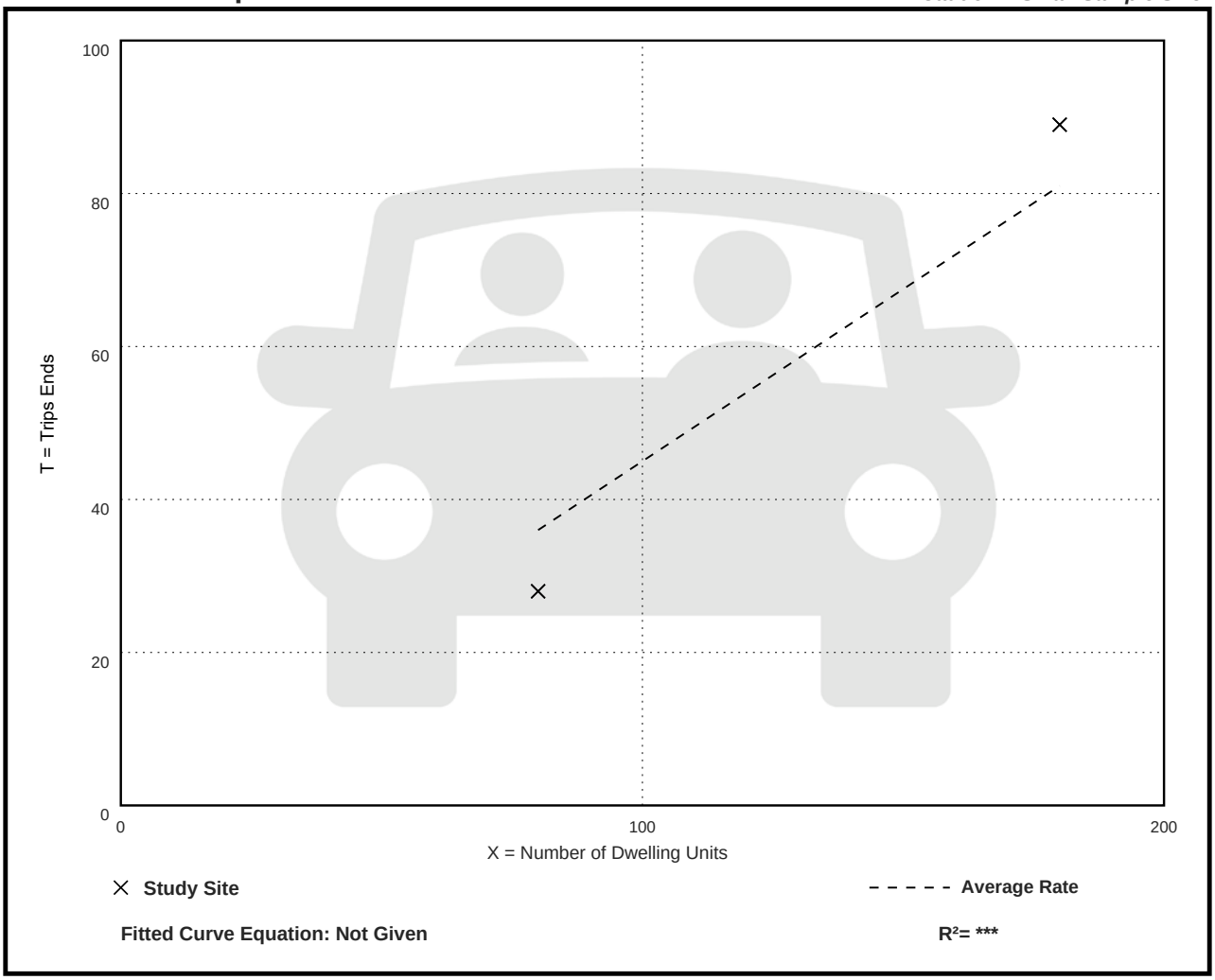
Setting/Location: General Urban/Suburban
Number of Studies: 2
Avg. Num. of Dwelling Units: 130
Directional Distribution: 75% entering, 25% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.45	0.35 - 0.49	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

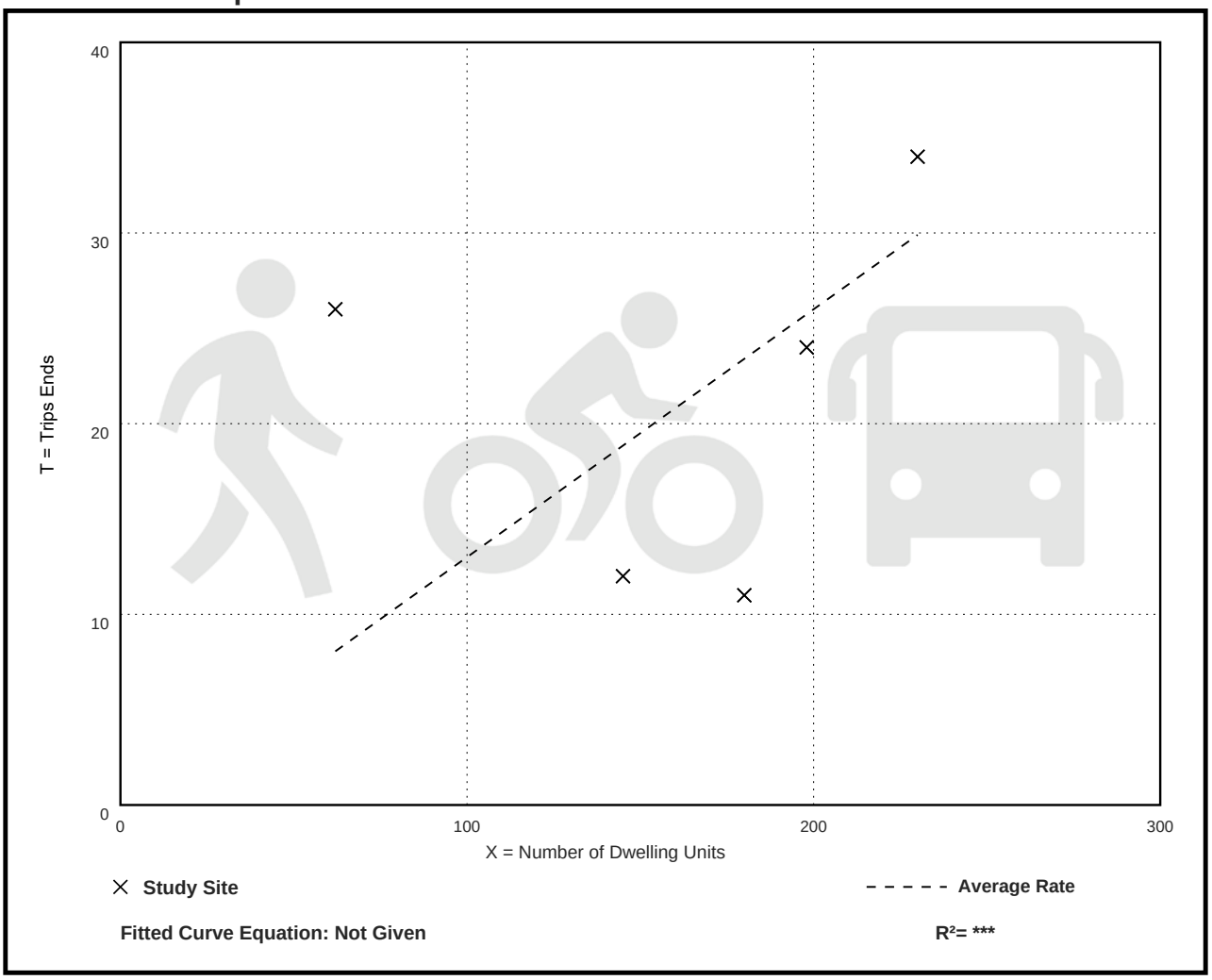
Multifamily Housing (Mid-Rise)
Close to Rail Transit (221)

Walk+Bike+Transit Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: General Urban/Suburban
Number of Studies: 5
Avg. Num. of Dwelling Units: 163
Directional Distribution: 57% entering, 43% exiting

Walk+Bike+Transit Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.13	0.06 - 0.42	0.10

Data Plot and Equation



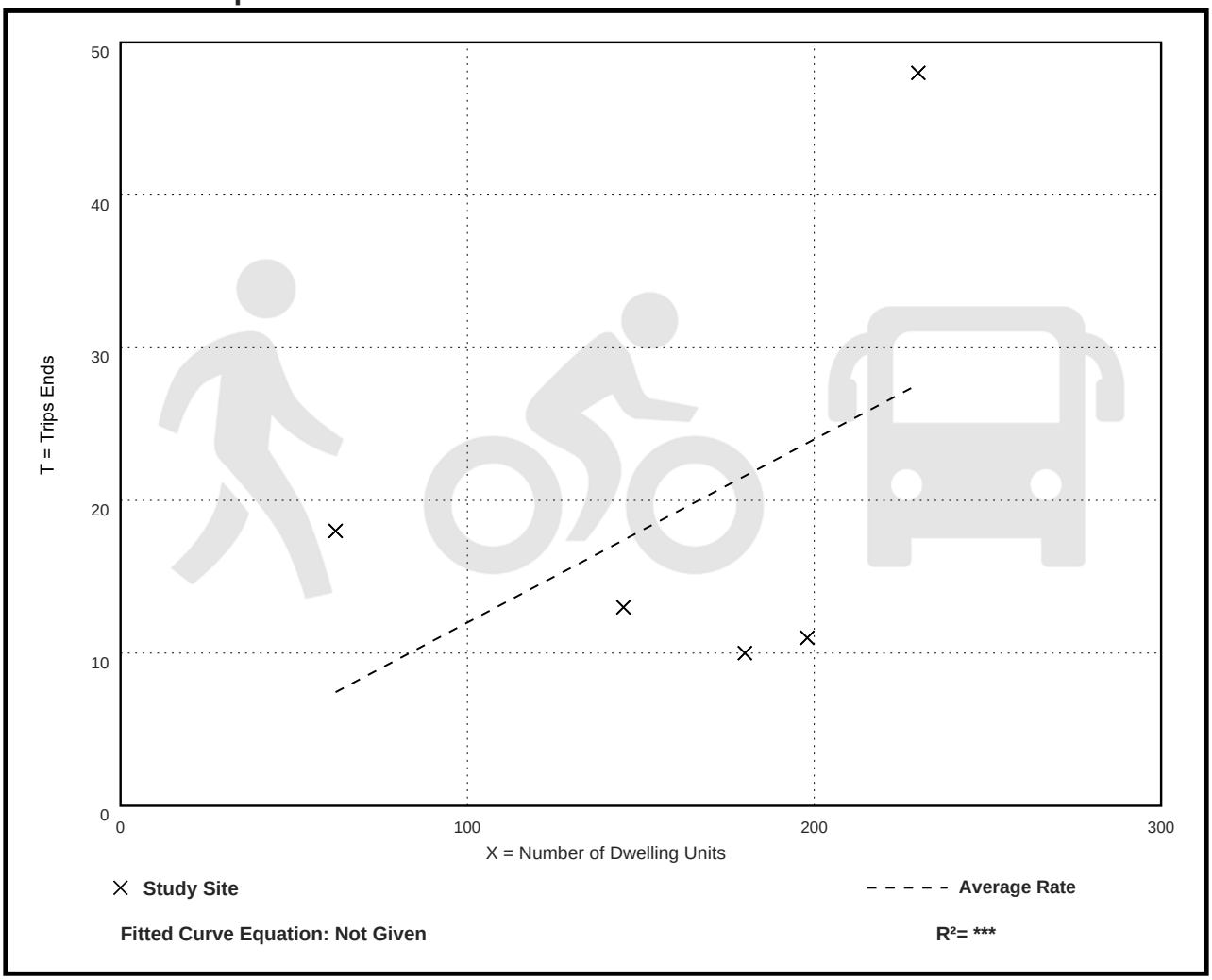
Multifamily Housing (Mid-Rise)
Close to Rail Transit (221)

Walk+Bike+Transit Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 5
Avg. Num. of Dwelling Units: 163
Directional Distribution: 42% entering, 58% exiting

Walk+Bike+Transit Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.12	0.06 - 0.29	0.09

Data Plot and Equation



Fitted Curve Equation: Not Given

R^2= ***

Multifamily Housing (Mid-Rise)
Close to Rail Transit (221)

Walk+Bike+Transit Trip Ends vs: Dwelling Units
On a: Weekday,
AM Peak Hour of Generator

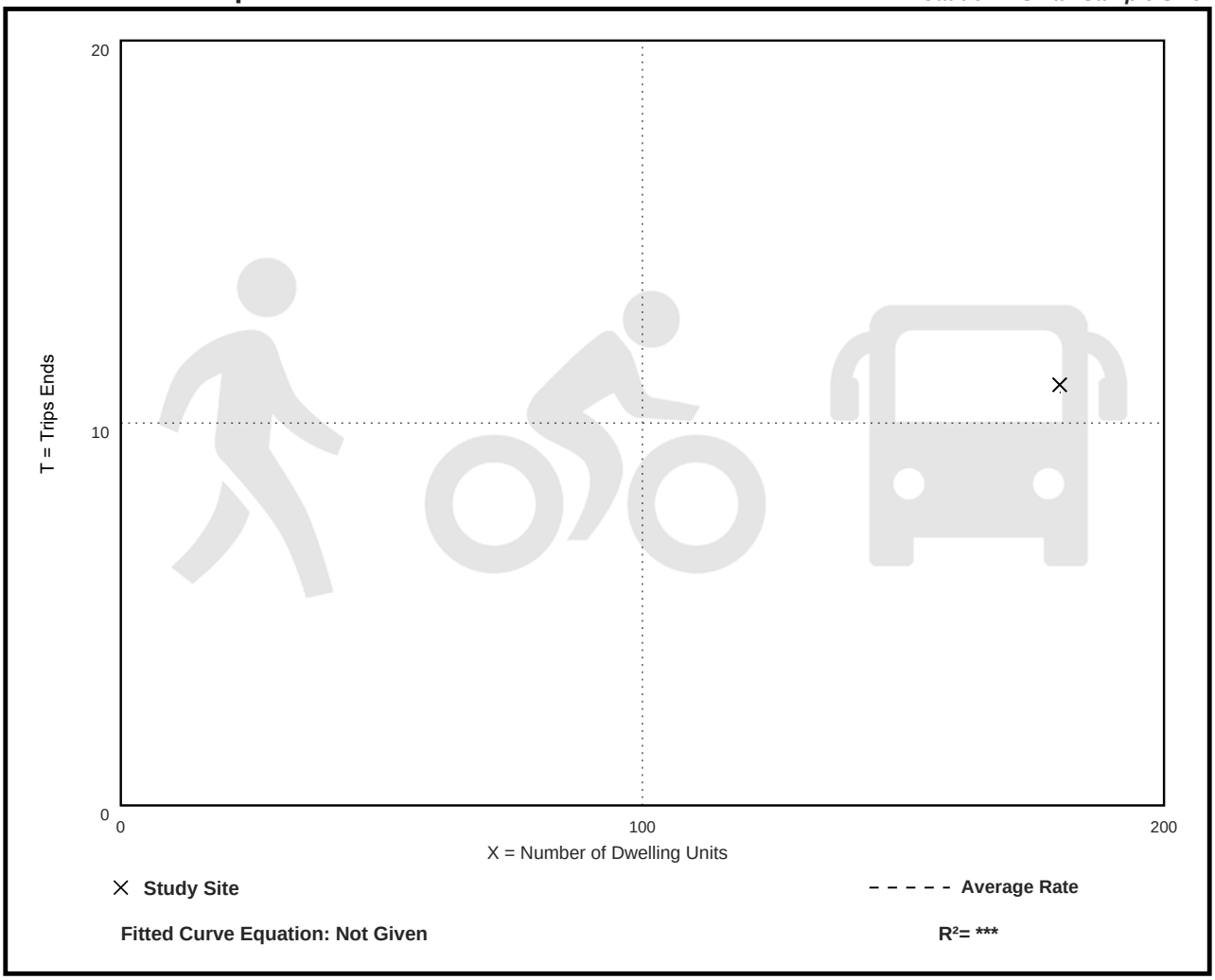
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Dwelling Units: 180
Directional Distribution: Not Available

Walk+Bike+Transit Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.06	0.06 - 0.06	***

Data Plot and Equation

Caution – Small Sample Size



Multifamily Housing (Mid-Rise)
Close to Rail Transit (221)

Walk+Bike+Transit Trip Ends vs: Dwelling Units
On a: Weekday,
PM Peak Hour of Generator

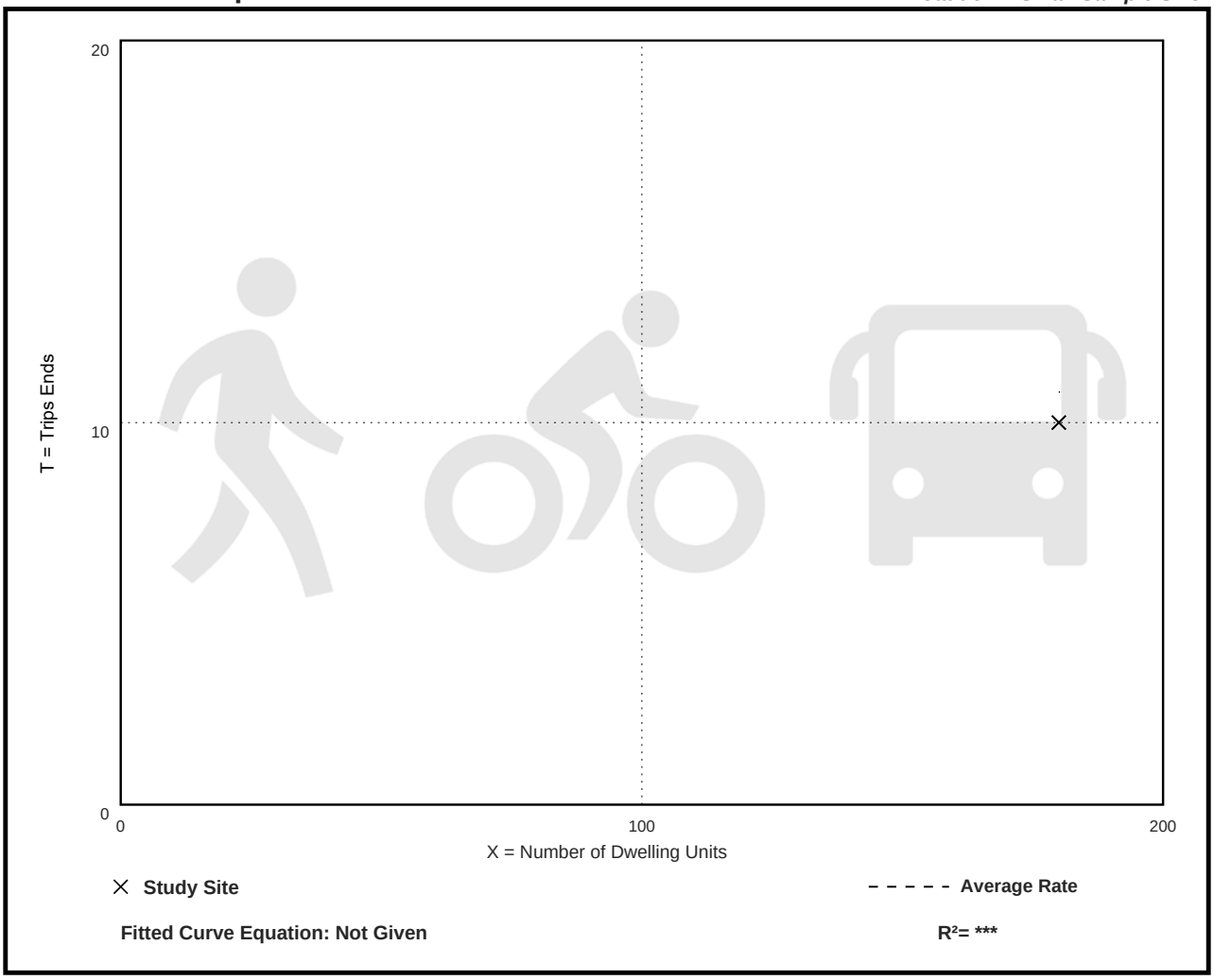
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. Num. of Dwelling Units: 180
Directional Distribution: Not Available

Walk+Bike+Transit Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.06	0.06 - 0.06	***

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= *

4 Definition of Terms

The definitions presented in this chapter are intended for use in *Trip Generation Manual*. The terms are grouped as follows:

- Trip Types and Trip Modes
- Setting/Location
- Time Periods
- Independent Variables
- Data Page Terms

Trip Types and Trip Modes

Bicycle Trip—an inbound or outbound person trip where the greatest distance between the trip origin and trip destination is traveled by a bicycle or any pedal-powered vehicle.

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 separate person trips.

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 being used for commercial purposes.

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. A taxi, paratransit vehicle, or vanpool is considered a personal passenger vehicle and not transit.

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 and exiting a single site.

Truck Trip—the movement of a commercial cargo transport vehicle that transports cargo across a site cordon line. A vehicle parked off-site that is loaded or unloaded with cargo destined from or to a study site is considered a truck trip generated by that site. Commercial cargo is typically

transported in either medium-duty or heavy-duty trucks. A service vehicle entering or exiting a site is not considered a truck trip.

Vehicle Trip—the movement of a personal passenger vehicle or truck that transports a person across the site cordon line. A person can cross the cordon line as a passenger in a vehicle or as a pedestrian having been transported to the site in a vehicle. For example, if a person drives a personal passenger vehicle from home, parks off-site, and walks from the parking facility to an office building, the trip is considered an entering vehicle trip generated by the office building (as well as an exiting vehicle trip at the place of residence). However, if a person is transported to the vicinity of a site in a bus or rail transit and walks the remainder of the distance to the site, the trip represents a transit trip and not 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, scooter, skates, or skateboard).

Walk+Bike+Transit Trip—an inbound or outbound person trip that is either a walk trip, bicycle trip, or transit trip.

Setting/Location

Center City Core—the downtown area for a major metropolitan region at the focal point of a regional light- or heavy-rail transit system. This area type is typified by multi-storied buildings, a wide range of land uses, an extensive pedestrian sidewalk network, and shared and priced parking both on-street and in structured garages or surface lots. The area typically has more jobs than residents and therefore is typically an employment destination. The area also includes the immediate vicinity of the commercial core.

Dense Multi-Use Urban—a fully-developed area (or nearly so), with diverse and interacting complementary land uses, good pedestrian connectivity, and convenient and frequent transit. This area type can be a well-developed urban area outside a major metropolitan downtown or a moderate size urban area downtown. The land use mix typically includes office, retail, residential, and often entertainment, hotel, and other commercial uses. The residential uses are typically multifamily or single-family on lots no larger than one-fourth acre. The commercial uses often have little or no setback from the sidewalk. Because the motor vehicle still represents the primary mode of travel to and from the area, there typically is on-street parking and often off-street public parking. The complementary land uses provide the opportunity for short trips within the Dense Multi-Use Urban area, made convenient by walking, biking, or transit. The area is served by significant transit (either rail or bus) that enables a high level of transit usage to and from area development.

General Urban/Suburban—an area associated with almost homogeneous vehicle-centered access. Nearly all person trips that enter or exit a development site are by personal passenger or commercial vehicle. The area can be fully developed (or nearly so) at low-medium density with a mix of residential and commercial uses. The commercial land uses are typically concentrated at intersections or spread along commercial corridors, often surrounded by low-density, almost entirely residential development. Most commercial buildings are located behind the parking area or surrounded by parking. The mixing of land uses is only in terms of their proximity, not in terms of function. A retail land use may focus on serving a regional clientele whereas a service land use may

target motorists or pass-by vehicle trips for its customers. Even if the land uses are complementary, a lack of pedestrian, bicycling, and transit facilities or services limit non-vehicle travel.

Rural—agricultural or undeveloped except for scattered parcels and at very low densities.

Time Periods

Friday, Peak Hour of Generator—the hour with the highest volume of vehicle trips (or person trips, as appropriate) entering and exiting a site on a Friday. It may occur during either the AM or PM.

Friday, Peak Hour of Adjacent Street Traffic—the one hour within the morning and evening commuter peak periods when the combination of site-generated vehicle traffic and the traffic on the adjacent street is the highest on a Friday. 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 commuter peak periods between 7:00 and 9:00 a.m. or 4:00 and 6:00 p.m.

Saturday, Midday Peak Hour of Generator—the hour with the highest volume of vehicle trips (or person trips, as appropriate) entering and exiting a site on a Saturday between 11 a.m. and 1 p.m.

Saturday, Peak Hour of Generator—the hour with the highest volume of vehicle trips (or person trips, as appropriate) entering and exiting a site on a Saturday. It may occur during either the AM or PM.

Sunday, Peak Hour of Generator—the hour with the highest volume of vehicle trips (or person trips, as appropriate) 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 weekday commuter peak periods when the combination of site-generated vehicle traffic and the traffic on the adjacent street is the highest (typically from data collected Monday through Friday). 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 weekday commuter 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 Generator—the hour of highest volume of vehicle trips (or person trips, as appropriate) 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 percent of developed acreage and 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.

Bed—a designated place to sleep for a group quarters resident or medical facility patient.

Bedroom—a designated room for sleeping with one or more beds.

Berth—a designated place where a boat can anchor at a marina or wharf.

Bowling Lane—a single lane available for the purposes of bowling.

Cage—a designated location available for the purpose of a single person hitting baseballs or softballs within a contained area.

Car Wash Tunnel—an enclosed series of stationary car wash components that can process a single row of motor vehicles, typically with the aid of a conveyor system.

Daily Customer—a person who visits a building to conduct personal business at any time during a single day.

Daily Trail User—a person who visits a park and walks along a designated trail at any time during a single day.

Drive-In Lane—an individual lane at a banking facility used for financial transactions. A lane used only for Automated Teller Machine (ATM) transactions is included.

Drive-Through Lane—a travel lane at a restaurant that enables a series of motorists to pick-up food or beverages without leaving their vehicles. A single pick-up window fed by dual order lanes is considered a single drive-through lane.

Dwelling Unit—a residential location such as a house, apartment, condominium, townhouse, mobile home, or manufactured home in which people may live.

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 hour or day the data are collected.

Family Members—the total number of family members who are considered members of a specific worship facility. **Member** is a similar term.

Field—any area constructed, equipped, and/or marked for outdoor activities and sports.

Food Cart—a mobile kitchen that enables its operator to market and sell cooked food to customers.

Gaming Position—an individual seat at which a person may engage in a gaming activity at a slot machine.

Gross Floor Area (GFA)—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. 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)—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. 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.

Hole—a single combination of a tee, fairway, and green on a golf course.

Lift—a mechanism used to transport skiers up a ski area slope and is commonly in the form of seats or benches attached to an overhead cable.

Member—an individual who belongs to a group or organization. Family Member is a similar term.

Member Family—a family that belongs to a group or organization.

Movie Screen—a room within a movie theater that contains seats and the presentation of a movie.

Municipal Population—a count of all persons having their primary residence within the municipality.

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 Campsite—a place used for an overnight stay in the outdoors. An occupied campsite is a campsite that is currently being used.

Occupied Parking Space (see Parking Space)

Occupied Room (see Room)

Occupied Storage Unit (see Storage 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)

Resident—a person who resides in the given dwelling unit.

Rink—an enclosed area for skating.

Room—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.

Seat—a place on which an individual can sit; multiple seats may be present on a bench or pew.

Service Bay—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 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.

Unit—a group of rooms intended for dwelling within Land Use Code 255 (Continuing Care Retirement Community). Storage Unit is a similar term with a different definition.

Vehicle Fueling Position—is defined by 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.

Vendor—a single person or company offering something for sale.

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

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 vehicle or person 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. 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.

Trip Ends, T—vehicle or person 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 that describes the study site or baseline site (for example, gross floor area) and that 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.

Study Site—a data point plotted on the graph based on a study performed for the specific land use code.