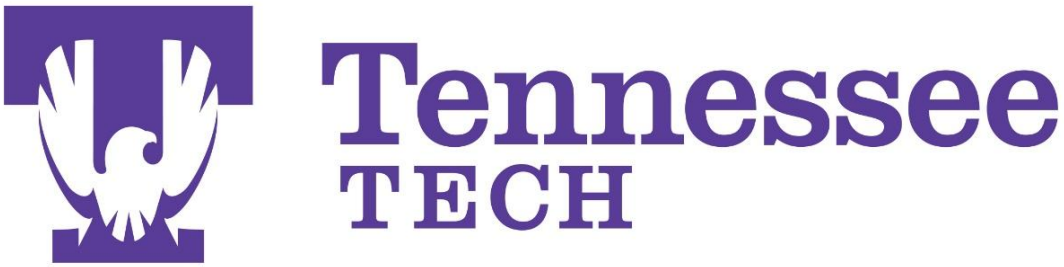
Traffic Impact Study Project Report



Tennessee Technological University

CEE 5660: Transportation Planning

Prepared by: Bahadir Kuzu

Submitted to: Prof. Daniel A. Badoe

Submission Date: December 1, 2024

1. Executive Summary

1.1 Project Overview

This Traffic Impact Study (TIS) evaluates the transportation implications of a proposed mixed-use development consisting of:

- **Home Improvement Superstore (150,000 sq. ft.)**
- **Multifamily Housing (250 dwelling units)**
- **Medical-Dental Office Building (9,000 sq. ft.)**
- **Shopping Center (40,000 sq. ft.)**

The site is located near Castle Drive, Jones Avenue, and Main Street—key roadways in the local transportation network. The study addresses existing conditions, projects future traffic volumes, and assesses the capacity and safety of nearby intersections. The ultimate goal is to provide actionable recommendations for mitigating potential traffic impacts.

1.2 Project Objectives

The study aims to:

1. Estimate Annual Average Daily Traffic (AADT) using 24-hour counts and seasonal adjustment factors.
2. Determine Peak Hour Traffic Volumes (AM and PM) at major intersections.
3. Calculate trip generation rates using the ITE Trip Generation Manual.
4. Allocate traffic directionally based on Traffic Analysis Zone (TAZ) populations.
5. Combine existing and development-related traffic to identify projected peak-hour volumes.
6. Evaluate roadway capacity requirements and recommend mitigation measures.

1.3 Study Methodology

1.3.1 Data Collection

- **Traffic Volumes**: Data was extracted from project documents for Castle Drive, Jones Avenue, and Main Street.
- **Seasonal Adjustment Factors**: Derived from the "Seasonal Factors - Permanent Count Station.xlsx" for February Thursdays.
- **Trip Generation Rates**: Sourced from the *ITE Trip Generation Manual*, used to estimate vehicle trips generated by land uses during AM and PM peak hours.

1.3.2 Analysis Techniques

1. **AADT Estimation**: Seasonal adjustment factors were applied to 24-hour counts.
    - **Castle Drive**: 2,196 vehicles/day
    - **Jones Avenue**: 4,613 vehicles/day
    - **Main Street**: 22,133 vehicles/day
2. **Peak Hour Analysis**: Calculated hourly traffic volumes, identifying AM and PM peak periods with Peak Hour Factor (PHF) values for each intersection leg.
3. **Trip Generation**: Used the 10th Edition of the ITE Trip Generation Manual for vehicle trips during AM and PM peak hours. Adjusted for 8% non-auto trips.
4. **Directional Distribution**: Allocated traffic using TAZ population data.
    - **North**: 59.6%
    - **South**: 29.5%
    - **East**: 5.4%
    - **West**: 5.5%
5. **Projected Peak Hour Volumes**: Combined development-related trips with existing traffic.
6. **Capacity Analysis**: Compared total volumes to roadway capacity (1,100 vehicles per hour per lane).

1.4 Key Findings

1.4.1 Traffic Volumes and PHF

- **AADT**:
    - Castle Drive: 2,196 vehicles/day
    - Jones Avenue: 4,613 vehicles/day
    - Main Street: 22,133 vehicles/day
- **Peak Hour Traffic Volumes**:
    - AM Peak Hour:
        - Castle Drive & Main Street: 1,369 vehicles
        - Jones Avenue & Main Street: 1,451 vehicles
    - PM Peak Hour:
        - Castle Drive & Main Street: 2,073 vehicles
        - Jones Avenue & Main Street: 2,529 vehicles
- **PHF Values**:
    - AM PHF: 0.88–0.98 (indicating consistent traffic flow)
    - PM PHF: 0.83–0.92 (indicating more variability).

Land Use	AM Trips (Adjusted)	PM Trips (Adjusted)
Home Improvement Superstore	380	454
Multifamily Housing	74	117
Medical-Dental Office	31	31
Shopping Center	276	597
Total	**760**	**1,198**

Table 1. Trip Generation Summary: *Indicates PM peak-hour trips (1,198) exceed AM (760), highlighting greater evening demand.*

1.4.2 Directional Distribution

- **North**: 59.6% of trips (primary flow direction).
- **South**: 29.5% of trips (secondary flow direction).
- **East/West**: Minimal contributions (5.4% and 5.5%, respectively).

1.4.3 Projected Traffic Volumes

Main Street Intersections: PM Peak Hour Totals: 1,301 vph and 1,368 vph exceed the 1,100 vph capacity → Widening Required/Recommended.

1.5 Recommendations

1. **Roadway Capacity Improvements**:
   Widen Main Street intersections to accommodate peak-hour demand.

2. **Traffic Signal Optimization**:
   Upgrade signal timing at major intersections to reduce congestion.

3. **Multimodal Infrastructure**:
   Add sidewalks, bike lanes, and pedestrian crossings along Main Street.

4. **Transit Enhancements**:
   Improve transit services to encourage mode shifts and reduce vehicle dependency.

5. **Long-Term Planning**:
   Incorporate projected population growth and future developments into ongoing traffic studies.

This Traffic Impact Study concludes that the proposed development will substantially increase traffic volumes during peak hours, particularly in the PM period. North-South traffic flow will dominate, reflecting the TAZ population distribution. Immediate roadway improvements, including lane widening and signal optimization, are essential to maintain acceptable traffic flow levels. Additionally, implementing multimodal solutions will enhance transportation sustainability and alleviate future congestion.

Contents

2. Introduction

2.1 Background and Context

Urban development and population growth lead to significant changes in traffic patterns, often resulting in congestion, delays, and safety issues. This study focuses on evaluating the traffic impacts of a proposed mixed-use development project, which includes a home improvement superstore, a shopping center, multifamily housing, and a medical-dental office building. Given the potential increase in traffic volume, it is critical to assess the ability of the existing roadway network to handle the projected demand. The findings of this study aim to inform stakeholders about necessary improvements and support sustainable urban planning practices.

The project is located in a suburban setting, which is highly automobile-dependent, with limited multimodal infrastructure. The surrounding area comprises residential, commercial, and institutional land uses, making this study relevant for both local mobility and regional connectivity.

2.2 Objectives of the Study

The main objectives of this study are:

1. To estimate the Annual Average Daily Traffic (AADT) at key roadway segments using seasonal adjustment factors and 24-hour counts.

2. To evaluate peak-hour traffic volumes, turning movements, and the Peak Hour Factor (PHF) at critical intersections.

3. To determine the trip generation of the proposed development using the Institute of Transportation Engineers (ITE) Trip Generation Manual.

4. To analyze directional traffic distribution using Traffic Analysis Zone (TAZ) populations.

5. To assess whether the projected traffic exceeds roadway capacity and recommend appropriate mitigation measures.

6. To highlight additional considerations in Traffic Impact Studies, such as safety, environmental impacts, and non-motorized travel options.

2.3 Scope of the Study

This report analyzes the impacts of the proposed development on the surrounding roadway network, focusing on two primary intersections:

1. **Main Street & Castle Drive**

2. **Main Street & Jones Avenue**

The scope includes:

- Data collection from provided documents, traffic counts, and seasonal factors.
- Application of statistical and engineering methodologies to calculate traffic metrics.
- Scenario analysis for existing and projected traffic conditions.
- Recommendations for roadway design, traffic management, and mitigation strategies.

2.4 Report Structure

The report is organized into the following major sections:

2.4.1 Technical Chapters

Each task is detailed in its respective chapter:

- **Task 1:** Estimation of AADT using seasonal factors.
- **Task 2:** Peak Hour Analysis and PHF Calculation for AM and PM periods.
- **Task 3:** Turning movement and peak-hour traffic volume analysis.
- **Task 4:** Trip generation calculations using ITE manual rates and equations.
- **Task 5:** Mode split estimation and vehicle trip reduction analysis.
- **Task 6:** Directional distribution of traffic using TAZ population data.
- **Task 7:** Traffic assignment and projection of development-related traffic.
- **Task 8:** Combined traffic projections and capacity analysis for turning movements.

2.4.2 Other Considerations

This section discusses additional elements that should be addressed in Traffic Impact Studies, such as:

- Public transit accessibility.
- Environmental and safety impacts.
- Non-motorized travel options.

2.4.3 Conclusions

Summarizes the major findings, implications, and actionable recommendations based on the analysis.

2.4.4 References

Provides a list of all data sources, literature, and manuals referenced throughout the study.

2.4.5 Appendix

Includes detailed calculations, raw data, additional figures, and graphs for clarity and transparency.

2.5 Review of Relevant Literature

The methodologies used in this study are grounded in industry standards and best practices. Key references include:

- **TNTech Materials:** Traffic data, TAZ data, Figures 1-4, seasonal factors, and Excel datasets.
- **Books:** Trip Generation Manual, Traffic Engineering Handbook, Highway Capacity Manual.
- **Websites:** FHWA, AASHTO, NACTO, TDOT, ITE resources.

3. Technical Chapters

3.1 Task-1: Estimation of AADT Using Seasonal Factors and 24-Hour Counts

Annual Average Daily Traffic (AADT) is a key metric in traffic studies, representing the average daily traffic over an entire year. To estimate AADT from 24-hour traffic counts, seasonal adjustment factors are applied to account for variations in traffic flow across different months and days of the week.

1. **Input Data Source**

    - **24-hour traffic counts** were taken from Figure 1: 24-Hour of the project documents.
    - Seasonal adjustment factors were derived from the provided Excel file, "Seasonal Factors - Permanent Count Station.xlsx."

2. **Coverage Stations and Traffic Counts**

    - **Castle Drive**: 2,000 vehicles/day.
    - **Jones Avenue**: 4,200 vehicles/day.
    - **Main Street**: 20,150 vehicles/day.

3. **Date of Data Collection**: February 3, 2023 (Thursday).

3.1.1 Seasonal Adjustment Factors Selection

From the Excel file, the seasonal adjustment factor for February Thursdays was determined to be **1.09842884269337**.

Seasonal Adjustment Factors

Month	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
January	1.35	1.06	1.03	1.04	1.12	0.96	1.13
February	1.34	1.11	1.13	1.05	**1.09842884269337**	0.99	1.13
March	1.19	0.95	0.97	1.01	1.12	0.96	1.03
April	1.21	1.00	0.98	0.96	0.93	0.87	0.96
May	1.05	0.98	0.97	0.94	0.93	0.89	0.93
June	1.13	0.96	0.96	0.96	0.93	0.85	0.96
July	1.18	0.94	0.93	0.98	0.93	0.89	1.03
August	1.16	0.92	0.91	0.94	0.93	0.85	0.99
September	1.17	0.98	0.94	0.93	0.90	0.85	1.00
October	1.27	0.97	1.00	0.96	0.93	0.86	1.01
November	1.27	1.00	0.97	0.96	0.99	0.95	1.07
December	1.27	1.02	1.01	1.01	0.95	1.01	1.05

Table 2. Seasonal Adjustment Factors: *Displays monthly adjustment factors by day of the week, with February Thursdays using a specific factor of 1.09842884269337 for AADT calculations.*

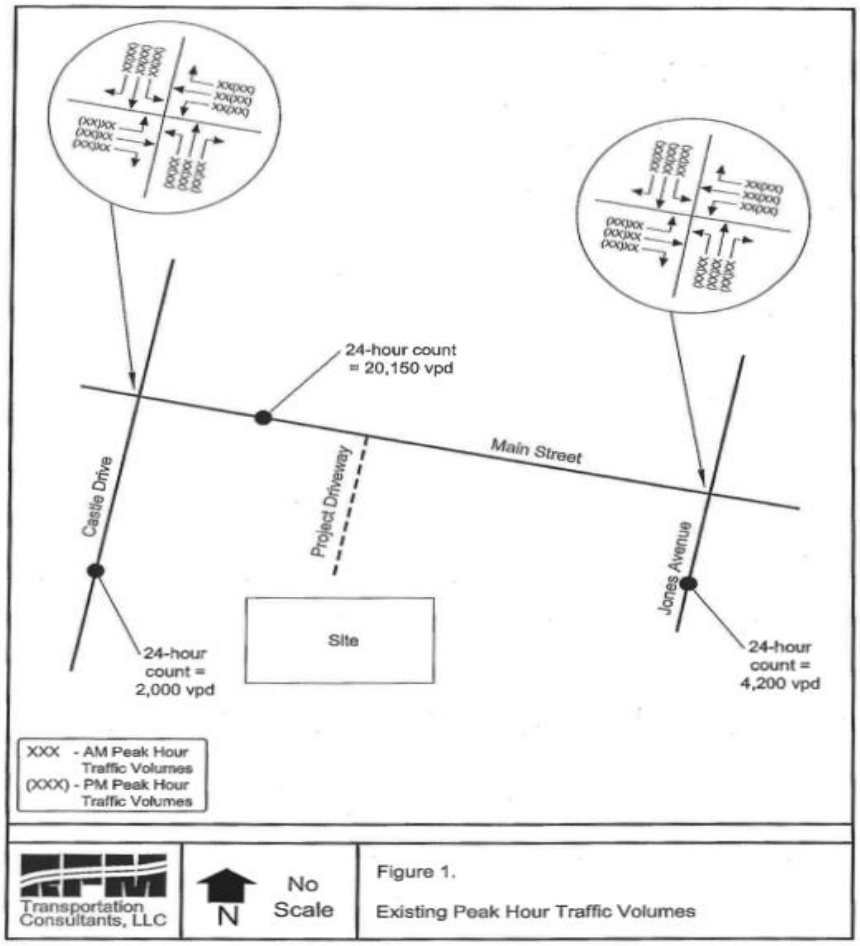


Figure 1: 24-Hour :*Provides 24-hour vehicle counts for Main Street, Castle Drive, and Jones Avenue, used with seasonal adjustment factors to calculate AADT.*

3.1.2 AADT Estimation

The formula used to estimate AADT is as follows: AADT = 24-Hour Traffic Count × Seasonal Factor

1. **Castle Drive**

   AADT = 2,000 × 1.09842884269337 = 2,196 vehicles/day

2. **Jones Avenue**

   AADT = 4,200 × 1.09842884269337 = 4,613 vehicles/day

3. **Main Street**

   AADT = 20,150 × 1.09842884269337 = 22,133 vehicles/day

3.1.3 Results Summary

The AADT estimates for each coverage station are summarized below:

Coverage Station	24-Hour Count	Seasonal Factor	AADT (vehicles/day)
Castle Drive	2,000	1.09842884269337	2,196
Jones Avenue	4,200	1.09842884269337	4,613
Main Street	20,150	1.09842884269337	22,133

Table 3. AADT Summary: AADT for Castle Drive, Jones Avenue, and Main Street derived from 24-hour counts and seasonal factor 1.0984.

1. **Significance of Seasonal Factor**

   The seasonal factor accounts for temporal variations in traffic patterns. The factor of 1.0984 for February Thursdays slightly increases the 24-hour counts to reflect annual average conditions.

2. **AADT Observations**

   - Main Street handles the largest volume, consistent with its role as a primary corridor.
   - Castle Drive and Jones Avenue show significantly lower volumes, indicative of their secondary roles.

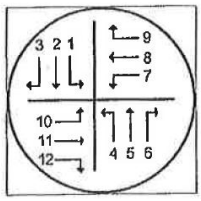
3. **Assumptions and Limitations**

   These calculations rely on the assumption that the seasonal adjustment factor accurately represents local conditions. Future studies may incorporate local seasonal data for greater precision.

3.2 Task-2: Peak Hour Analysis and PHF Calculation

This section provides a detailed analysis of the Peak Hour and PHF for both intersections (Main Street & Castle Drive and Main Street & Jones Avenue) during the AM and PM periods. The analysis includes step-by-step calculations and explanation for all steps.

3.2.1 Intersection: Main Street and Castle Drive



North

INTERSECTION TRAFFIC VOLUME COUNTS

Location:	Main Street and Castle Drive
Date:	6-Feb-20
Recorder:	DAB
Notes:	Sunny and Warm

		S/B			N/B			W/B			E/B		
	LOCATION	Castle Drive			Castle Drive			Main Street			Main Street		
	TIME	1	2	3	4	5	6	7	8	9	10	11	12
AM	7:00-7:15			1	1		9	5	136	1	2	128	
	7:15-7:30	1					13	7	160	2	1	147	1
	7:30-7:45				2		11	9	168	2	3	167	
	7:45-8:00				1		12	8	165	2	1	151	1
	8:00-8:15	1		1			12	12	154	2	4	148	
	8:15-8:30	1			1		12	9	144	2		126	
	8:30-8:45				1		13	8	151	2	1	134	
	8:45-9:00				2		11	8	146	2	1	134	
PM	4:00-4:15	2				1	43	23	247	5	7	231	1
	4:15-4:30				1		25	19	255	3	3	224	1
	4:30-4:45			1	2		22	9	241			209	2
	4:45-5:00			1			37	18	238	2		200	
	5:00-5:15				1		30	11	259	3	1	219	
	5:15-5:30				1	1	27	14	202	5	2	228	1
	5:30-5:45	1			3		24	14	197	3	1	220	1
	5:45-6:00				3		24	13	192	3	3	211	
TOTAL		6	0	4	19	2	325	187	3055	39	30	2877	8

Table 4: Traffic Volume Counts at the Intersection of Main Street and Castle Drive:
This table presents detailed AM and PM peak hour traffic volumes for each approach at the intersection of Main Street and Castle Drive, collected on February 6, 2020. The data captures vehicle movements by direction for southbound (S/B), northbound (N/B), westbound (W/B), and eastbound (E/B) lanes.

AM Period (7:00–9:00)

Step 1: Calculate 15-Minute Totals

Time Interval	Total Vehicles
7:00–7:15	1+1+9+5+136+1+2+128=283
7:15–7:30	1+13+7+160+2+1+147+1=332
7:30–7:45	2+11+9+168+2+3+167=**362**
7:45–8:00	1+12+8+165+2+1+151+1=341
8:00–8:15	1+1+12+12+154+2+4+148=334
8:15–8:30	1+1+12+9+144+2+126=295
8:30–8:45	1+13+8+151+2+1+134=310
8:45–9:00	2+11+8+146+2+1+134=304

Table 5. AM Peak Traffic: *Highest volume (**362**) occurred between 7:30–7:45 AM.*

Step 2: Calculate Hourly Totals

Start Time	Total Volume for the Hour
7:00–8:00	283+332+362+341=1,318
7:15–8:15	332+362+341+334=**1,369** (**Peak Hour**)
7:30–8:30	362+341+334+295=1,332
7:45–8:45	341+334+295+310=1,280
8:00–9:00	334+295+310+304=1,243

Table 6. Hourly Traffic Volumes: Total hourly traffic for 7:00–9:00, with the peak hour identified at 7:15–8:15, reaching **1,369** vehicles.

Step 3: Identify Peak Hour

- **Peak Hour**: 7:15–8:15
- **Volume**: 1,369 vehicles

Step 4: Calculate PHF

PHF= Total Hourly Volume / (4 × Peak 15-Minute Volume)

Substituting values:

PHF = 1,369 / (4 × 362) = 0.9454

PM Period (4:00–6:00)

Step 1: Calculate 15-Minute Totals

Time Interval	Total Vehicles
4:00–4:15	2+1+43+23+247+5+7+231+1=**560**
4:15–4:30	25+19+255+3+3+224+1=531
4:30–4:45	1+2+22+9+241+209+2=486
4:45–5:00	1+37+18+238+2+200=496
5:00–5:15	1+30+11+259+3+1+219=524
5:15–5:30	1+1+27+14+202+5+2+228+1=480
5:30–5:45	1+3+24+14+197+3+1+220+1=463
5:45–6:00	3+24+13+192+3+3+211=449

Table 7. PM Traffic Volumes: Peaks at **560** vehicles during 4:00–4:15, showing 15-minute variations from 4:00–6:00 PM.

Step 2: Calculate Hourly Totals

Start Time	Total Volume for the Hour
4:00–5:00	560+531+486+496=**2,073** (**Peak Hour**)
4:15–5:15	531+486+496+524=2,037
4:30–5:30	486+496+524+480=1,986
4:45–5:45	496+524+480+463=1,963
5:00–6:00	524+480+463+449=1,916

Table 8. PM Peak Hour Summary: *Peak hour (4:00–5:00 PM) records* ***2,073*** *vehicles, the highest volume.*

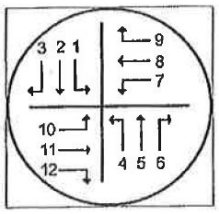
Step 3: Identify Peak Hour

- **Peak Hour**: 4:00–5:00
- **Volume**: 2,073 vehicles

Step 4: Calculate PHF

PHF = 2,073 / (4 × 560) = 0.925

3.2.2 Intersection: Main Street and Jones Avenue



North

INTERSECTION TRAFFIC VOLUME COUNTS

Location:	Main Street and Jones Avenue
Date:	6-Feb-24
Recorder:	DAB
Notes:	Sunny and Warm

		S/B			N/B			W/B			E/B		
	LOCATION	**Jones Avenue**			**Jones Avenue**			**Main Street**			**Main Street**		
	TIME	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
AM	7:00-7:15	7	2	1	27	1	2	1	114	2		91	11
	7:15-7:30	13	6		31	2	3	1	132	3	1	118	27
	7:30-7:45	17	10	1	52	4	2	2	146	6		164	34
	7:45-8:00	12	3		49	6	5	1	124	9	2	129	25
	8:00-8:15	6	2	1	25	1	8	4	130	13		143	20
	8:15-8:30	6	2		36	4	6	4	132	5	1	103	21
	8:30-8:45	7	3	1	30	2	4	3	134	6		135	13
	8:45-9:00	9	7	1	22	2	11	2	130	7		123	15
PM	4:00-4:15	12	10	6	52	9	3	3	239	16	1	216	47
	4:15-4:30	17	5	6	61	5	4	3	200	9	2	215	43
	4:30-4:45	22	4	4	39	2	8	3	190	6	4	207	40
	4:45-5:00	12	2	10	36	9	4	3	217	11		186	32
	5:00-5:15	14	4	5	48	8	8	3	198	7	3	218	35
	5:15-5:30	15	3	1	41	4	4	2	161	13	3	218	35
	5:30-5:45	11	5	8	32	4	6		181	7	4	187	29
	5:45-6:00	19	1	6	27	3	5	1	143	2	2	174	20
TOTAL		199	69	51	608	66	83	36	2571	122	23	2627	447

Table 9: Intersection Traffic Volume Counts – Main Street and Jones Avenue:
This table summarizes the AM and PM peak-hour traffic volumes for each approach at the intersection of Main Street and Jones Avenue, recorded on February 6, 2024. The data provides a detailed breakdown of vehicle movements across southbound (S/B), northbound (N/B), westbound (W/B), and eastbound (E/B) lanes, captured under sunny and warm conditions.

AM Period (7:00–9:00)

Step 1: Calculate 15-Minute Totals

Time Interval	Total Vehicles
7:00–7:15	271
7:15–7:30	334
7:30–7:45	**409**
7:45–8:00	373
8:00–8:15	335
8:15–8:30	319
8:30–8:45	306
8:45–9:00	307

Table 10. AM Traffic Volumes: *Peak at **409** vehicles (7:30–7:45 AM).*

Step 2: Calculate Hourly Totals

Start Time	Total Volume for the Hour
7:00–8:00	271+334+409+373=1,387
7:15–8:15	334+409+373+335=**1,451** (**Peak Hour**)
7:30–8:30	409+373+335+319=1,436
7:45–8:45	373+335+319+306=1,333
8:00–9:00	335+319+306+307=1,267

Table 11. AM Hourly Volumes: *Peak hour (7:15–8:15) with **1,451** vehicles.*

Step 3: Identify Peak Hour

- **Peak Hour**: 7:15–8:15
- **Volume**: 1,451 vehicles

Step 4: Calculate PHF

PHF= 1,451 / 4 x 409 = 0,887

PM Period (4:00–6:00)

Step 1: Calculate 15-Minute Totals

Time Interval	Total Vehicles
4:00–4:15	701
4:15–4:30	646
4:30–4:45	576
4:45–5:00	606
5:00–5:15	584
5:15–5:30	525
5:30–5:45	501
5:45–6:00	459

Table 12. PM 15-Minute Volumes: *Highlights peak traffic intervals, with the highest total (701 vehicles) occurring from 4:00–4:15.*

Step 2: Calculate Hourly Totals

Start Time	Total Volume for the Hour
4:00–5:00	701+646+576+606=**2,529** (**Peak Hour**)
4:15–5:15	646+576+606+584=2,412
4:30–5:30	576+606+584+525=2,291
4:45–5:45	606+584+525+501=2,216
5:00–6:00	584+525+501+459=2,069

Table 13. PM Hourly Volumes: *Indicates the highest traffic volume (**2,529** vehicles) during the 4:00–5:00 PM peak hour.*

Step 3: Identify Peak Hour

- **Peak Hour**: 4:00–5:00
- **Volume**: 2,529 vehicles

Step 4: Calculate PHF

PHF= 2,529 / 4 x 701 = 0,902

3.2.3 Discussion of Results

AM Period Observations

1. **Castle Drive Intersection**:
    - The AM peak hour had a volume of **1,369 vehicles**, with the highest traffic observed during the **7:15–8:15** interval.

- **PHF** values were relatively high, indicating consistent traffic flow during the peak hour.

2. **Jones Avenue Intersection**:

    - The AM peak hour had a volume of **1,451 vehicles**, also during the **7:15–8:15** interval.
    - Lower PHF values indicate more fluctuation in traffic flow compared to Castle Drive.

PM Period Observations

1. **Castle Drive Intersection**:

    - The PM peak hour volume was **2,073 vehicles**, recorded during the **4:00–5:00** interval.
    - Slightly lower PHF values during PM indicate more variability in traffic flow.

2. **Jones Avenue Intersection**:

    - The PM peak hour had the highest volume, **2,529 vehicles**, also during the **4:00–5:00** interval.
    - Higher traffic levels indicate increased evening activity, particularly on Main Street.

3.2.4 Peak Hour Factor (PHF) Calculations for Main Street and Castle Drive

Peak Hour: AM (7:15–8:15)

Southbound (S/B):

- **Volumes (15-minute intervals):**

    - **7:15–7:30:** 1
    - **7:30–7:45:** 0
    - **7:45–8:00:** 0
    - **8:00–8:15:** 1+1=2 (Maximum 15-Minute Volume: 2)

- **Hourly Total Volume:** 1 + 1 + 1 = 3

PHF Formula:

PHF = 3 / (4 x 2) = 0.375

Northbound (N/B):

- **Volumes (15-minute intervals):**

    - **7:15–7:30:** 13 (Maximum 15-Minute Volume: 13)
    - **7:30–7:45:** 2 + 11 = 13
    - **7:45–8:00:** 1 + 12 = 13
    - **8:00–8:15:** 12

- **Hourly Total Volume:** 13 + 13 + 13 + 12 = 51

PHF Formula:

PHF = 51 / (4 x 13) = 0.981

Westbound (W/B):

- **Volumes (15-minute intervals):**
    - **7:15–7:30:** 7 + 160 + 2 = 169
    - **7:30–7:45:** 9 + 168 + 2 = 179 (Maximum 15-Minute Volume: 179)
    - **7:45–8:00:** 8 + 165 + 2 = 175
    - **8:00–8:15:** 12 + 154 + 2 = 168
- **Hourly Total Volume:** 169 + 179 + 175 + 168 = 691

PHF Formula:

PHF = 691 / (4 x 179) = 0.965

Eastbound (E/B):

- **Volumes (15-minute intervals):**
    - **7:15–7:30:** 1 + 147 + 1 = 149
    - **7:30–7:45:** 3 + 167 = 170 (Maximum 15-Minute Volume: 170)
    - **7:45–8:00:** 1 + 151 + 1 = 153
    - **8:00–8:15:** 4 + 148 = 152
- **Hourly Total Volume:** 149 + 170 + 153 + 152 = 624

PHF Formula:

PHF = 624 / (4 x 170) = 0.918

Peak Hour: PM (4:00–5:00)

Southbound (S/B):

- **Volumes (15-minute intervals):**
    - **4:00–4:15:** 2 (Maximum 15-Minute Volume: 2)
    - **4:15–4:30:** 1
    - **4:30–4:45:** 1
    - **4:45–5:00:** 0
- **Hourly Total Volume:** 2 + 1 + 1 = 4

PHF Formula:

PHF = 4 / (4 x 2) = 0.5

Northbound (N/B):

- **Volumes (15-minute intervals):**
    - **4:00–4:15:** 1 + 43 = 44
    - **4:15–4:30:** 25
    - **4:30–4:45:** 2 + 22 = 24
    - **4:45–5:00:** 37 (Maximum 15-Minute Volume: 37)
- **Hourly Total Volume:** 44 + 25 + 24 + 37 = 130

PHF Formula:

PHF = 130 / (4 x 37) = 0.878

Westbound (W/B):

- **Volumes (15-minute intervals):**
    - **4:00–4:15:** 23 + 247 + 5 =275
    - **4:15–4:30:** 19 + 255 + 3 = 277 (Maximum 15-Minute Volume: 277)
    - **4:30–4:45:** 9 + 241 = 250
    - **4:45–5:00:** 18 + 238 + 2 = 258
- **Hourly Total Volume:** 275 + 277 + 250 + 258 = 1,060

PHF Formula:

PHF = 1060 / (4 x 277) = 0.956

Eastbound (E/B):

- **Volumes (15-minute intervals):**
    - **4:00–4:15:** 7 + 231 + 1 = 239 (Maximum 15-Minute Volume: 239)
    - **4:15–4:30:** 3 + 224 + 1 = 228
    - **4:30–4:45:** 209 + 2 = 211
    - **4:45–5:00:** 200
- **Hourly Total Volume:** 239 + 228 + 211 + 200 = 878

PHF Formula:

PHF = 878 / (4 x 239) = 0.918

Summary for Main Street and Castle Drive

Leg	Period	Hourly Volume	Max 15-Minute Volume	PHF
S/B	AM	3	2	0.375
N/B	AM	51	13	0.981
W/B	AM	691	179	0.965
E/B	AM	624	170	0.918
S/B	PM	4	2	0.500
N/B	PM	130	37	0.878
W/B	PM	1,060	277	0.956
E/B	PM	878	239	0.918

Table 14. PM 15-Minute Intervals: *Highlights vehicle counts per 15-minute interval, with the highest traffic volume of 701 vehicles between 4:00–4:15 PM.*

Main Street and Jones Avenue (AM Peak: 7:15–8:15)

Southbound (S/B):

Volumes (15-minute intervals):

- **7:15–7:30:** 13 + 6 = 19
- **7:30–7:45:** 17 + 10 + 1 = 28 (Maximum 15-Minute Volume: 28)
- **7:45–8:00:** 12 + 3 = 15
- **8:00–8:15:** 6 +2+1= 9

Hourly Total Volume: 19 + 28 + 15 + 9 = 71

PHF Formula:

PHF = Total Hourly Volume / (4 x Maximum 15-Minute Volume)

PHF = 71 / (4 x 28) = 0.634

Northbound (N/B):

Volumes (15-minute intervals):

- **7:15–7:30:** 31 + 2 + 3 = 36
- **7:30–7:45:** 52 + 4 + 2 = 58
- **7:45–8:00:** 49 + 6 + 5 = 60
- **8:00–8:15:** 25 + 1 + 8 = 34 (Maximum 15-Minute Volume: 60)

Hourly Total Volume: 36 + 58 + 60 + 34 = 188

PHF Formula:

PHF = 188 / (4 x 60) = 0.783

Westbound (W/B):

Volumes (15-minute intervals):

- **7:15–7:30:** 132 + 3 + 1 = 136
- **7:30–7:45:** 146 + 6 = 152
- **7:45–8:00:** 124 + 9 + 2 = 135
- **8:00–8:15:** 130 + 13 =143 (Maximum 15-Minute Volume: 152)

Hourly Total Volume: 136 + 152 + 135 + 143 = 566

PHF Formula:

PHF = 566 / (4 x 152) = 0.930

Eastbound (E/B):

Volumes (15-minute intervals):

- **7:15–7:30:** 118 + 27 = 145
- **7:30–7:45:** 164 + 34 = 198
- **7:45–8:00:** 129 + 25 = 154
- **8:00–8:15:** 143 + 20 = 163 (Maximum 15-Minute Volume: 198)

Hourly Total Volume: 145 + 198 + 154 + 163 = 660

PHF Formula:

PHF = 660 / (4 x 198) = 0.833

Main Street and Jones Avenue (PM Peak: 4:00–5:00)

Southbound (S/B):

Volumes (15-minute intervals):

- **4:00–4:15:** 12 + 10 + 6 = 28
- **4:15–4:30:** 17 + 5 + 6 = 28
- **4:30–4:45:** 22 + 4 + 4 = 30 (Maximum 15-Minute Volume: 30)
- **4:45–5:00:** 12 + 2 + 10 = 24

Hourly Total Volume: 28 + 28 + 30 + 24 = 110

PHF Formula:

PHF = 110 / (4 x 30) = 0.917

Northbound (N/B):

Volumes (15-minute intervals):

- **4:00–4:15:** 52 + 9 + 3 = 64
- **4:15–4:30:** 61 + 5 + 4 = 70 (Maximum 15-Minute Volume: 70)
- **4:30–4:45:** 39 + 2 + 8 = 49
- **4:45–5:00:** 36 + 9 + 4 = 49

Hourly Total Volume: 64 + 70 + 49 + 49 = 232

PHF Formula:

PHF = 232 / (4 x 70) = 0.829

Westbound (W/B):

Volumes (15-minute intervals):

- **4:00–4:15:** 239 + 16 + 1 = 256 (Maximum 15-Minute Volume: 256)
- **4:15–4:30:** 200 + 9 + 2 = 211
- **4:30–4:45:** 190 + 6 + 4 = 200
- **4:45–5:00:** 217 + 11 = 228

Hourly Total Volume: 256 + 211 + 200 + 228 = 895

PHF Formula:

895 / (4 x 256) = 0.0874

Eastbound (E/B):

Volumes (15-minute intervals):

- **4:00–4:15:** 216 + 47 = 263 (Maximum 15-Minute Volume: 263)
- **4:15–4:30:** 215 + 43 = 258
- **4:30–4:45:** 207 + 40 = 247
- **4:45–5:00:** 186 + 32 = 218

Hourly Total Volume: 263 + 258 + 247 + 218 = 986

PHF Formula:

PHF = 986 / (4 x 263) = 0.937

Summary for Main Street and Jones Avenue

Leg	Period	Hourly Volume	Max 15-Minute Volume	PHF
S/B	AM	71	28	0.634
N/B	AM	188	60	0.783
W/B	AM	566	152	0.930
E/B	AM	660	198	0.833
S/B	PM	110	30	0.917
N/B	PM	232	70	0.829
W/B	PM	895	256	0.874
E/B	PM	986	263	0.937

Table 15. PHF Summary: *Highlights PHF values, with PM peaks higher, Eastbound reaching 0.937.*

3.3 Task-3: Peak Hour Traffic Volumes and Movement Analysis

This section aims to create a figure illustrating the AM and PM peak-hour traffic volumes for the intersections of Main Street & Castle Drive and Main Street & Jones Avenue. The figure will include turning and through movement volumes, with references to specific times for clarity.

3.3.1 Intersection Movement Volume Calculations

1. Main Street & Castle Drive

AM Peak Hour (7:15–8:15):

Southbound (S/B):

- **Left Turn:** 1 + 1 = 2 (**Time-1**)
- **Through:** 0 (**Time-2**)
- **Right Turn:** 1 (**Time-3**)

Northbound (N/B):

- **Left Turn:** 2 + 1 = 3 (**Time-4**)
- **Through:** 0 (**Time-5**)
- **Right Turn:** 13 + 11 + 12 + 12 = 48 (**Time-6**)

Westbound (W/B):

- **Left Turn:** 7 + 9 + 8 + 12 = 36 (**Time-7**)
- **Through:** 160 + 168 + 165 + 154 = 647 (**Time-8**)
- **Right Turn:** 2 + 2 + 2 + 2 = 8 (**Time-9**)

Eastbound (E/B):

- **Left Turn:** 1 + 3 + 1 + 4 = 9 (**Time-10**)
- **Through:** 147 + 167 + 151 + 148 = 613 (**Time-11**)
- **Right Turn:** 1 + 1 = 2 (**Time-12**)

PM Peak Hour (4:00–5:00):

Southbound (S/B):

- **Left Turn:** 2 (**Time-1**)
- **Through:** 0 (**Time-2**)
- **Right Turn:** 1 + 1 = 2 (**Time-3**)

Northbound (N/B):

- **Left Turn:** 1 + 2 = 3 (**Time-4**)
- **Through:** 1 (**Time-5**)
- **Right Turn:** 43 + 25 + 22 + 37 = 127 (**Time-6**)

Westbound (W/B):

- **Left Turn:** 23 + 19 + 9 + 18 = 69 (**Time-7**)
- **Through:** 247 + 255 + 241 + 238 = 981 (**Time-8**)
- **Right Turn:** 5 + 3 + 2 = 10 (**Time-9**)

Eastbound (E/B):

- **Left Turn:** 7 + 3 + 1 = 11 (**Time-10**)
- **Through:** 231 + 224 + 209 + 200 = 864 (**Time-11**)
- **Right Turn:** 1 + 1 + 2 = 4 (**Time-12**)

2. Main Street & Jones Avenue

AM Peak Hour (7:15–8:15):

Southbound (S/B):

- **Left Turn:** 13 + 17 + 12 + 6 = 48 (**Time-1**)
- **Through:** 6 + 10 + 3 + 2 = 21 (**Time-2**)
- **Right Turn:** 1 + 1 = 2 (**Time-3**)

Northbound (N/B):

- **Left Turn:** 31 + 52 + 49 + 25 = 157 (**Time-4**)
- **Through:** 2 + 4 + 6 + 1 = 13 (**Time-5**)
- **Right Turn:** 3 + 2 + 5 + 8 = 18 (**Time-6**)

Westbound (W/B):

- **Left Turn:** 1 + 2 + 1 + 4 = 8 (**Time-7**)
- **Through:** 132 + 146 + 124 + 130 = 532 (**Time-8**)
- **Right Turn:** 3 + 6 + 9 + 13 = 31 (**Time-9**)

Eastbound (E/B):

- **Left Turn:** 1 + 2 = 3 (**Time-10**)
- **Through:** 118 + 164 + 129 + 143 = 554 (**Time-11**)
- **Right Turn:** 27 + 34 + 25 + 20 = 106 (**Time-12**)

PM Peak Hour (4:00–5:00):

Southbound (S/B):

- **Left Turn:** 12 + 17 + 22 + 12 = 63 (**Time-1**)
- **Through:** 10 + 5 + 4 + 2 = 21 (**Time-2**)
- **Right Turn:** 6 + 6 + 4 + 10 = 26 (**Time-3**)

Northbound (N/B):

- **Left Turn:** 52 + 61 + 39 + 36 = 188 (**Time-4**)
- **Through:** 9 + 5 + 2 + 9 = 25 (**Time-5**)
- **Right Turn:** 3 + 4 + 8 + 4 = 19 (**Time-6**)

Westbound (W/B):

- **Left Turn:** 3 + 3 + 3 + 3 = 12 (**Time-7**)
- **Through:** 239 + 200 + 190 + 217 = 846 (**Time-8**)
- **Right Turn:** 16 + 9 + 6 + 11 = 42 (**Time-9**)

Eastbound (E/B):

- **Left Turn:** 1 + 2 + 4 = 7 (**Time-10**)
- **Through:** 216 + 215 + 207 + 186 = 824 (**Time-11**)
- **Right Turn:** 47 + 43 + 40 + 32 = 162 (**Time-12**)

3.3.2 Figure Preparation

The following traffic volumes (vph) are the sums of the movements (Left Turn, Through, Right Turn) for each road during both AM and PM Peak Hours.

1. **Castle Drive Traffic Volumes (vph):**

- **Peak Hour:**
    - **Total Exiting:** 3(3) + 0(1) + 48(127) = **51(131)** vph (Time-4, Time-5, Time-6)
    - **Total Entering:** 0(0) +36(69) + 2(4) = **38(73)** vph (Time-2, Time-7, Time-12)

2. **Jones Avenue Traffic Volumes (vph):**

- **Peak Hour:**
  - **Total Exiting:** 157(188) + 13(25) + 18(19) = **188(232)** vph (Time-4, Time-5, Time-6)

  - **Total Entering:** 21(21) +8(12) + 106(162) = **135(195)** vph (Time-2, Time-7, Time-12)

3. **Main Street Traffic Volumes (vph):**

- **Peak Hour:**
  - **Total Left Lane:** 36(69) + 647(981) + 8(10) = **691(1,060)** vph (Time-7, Time-8, Time-9)

  - **Total Right Lane:** 2(2) + 48(127) + 613(864) = **663(993)** vph (Time-1, Time-6, Time-11)

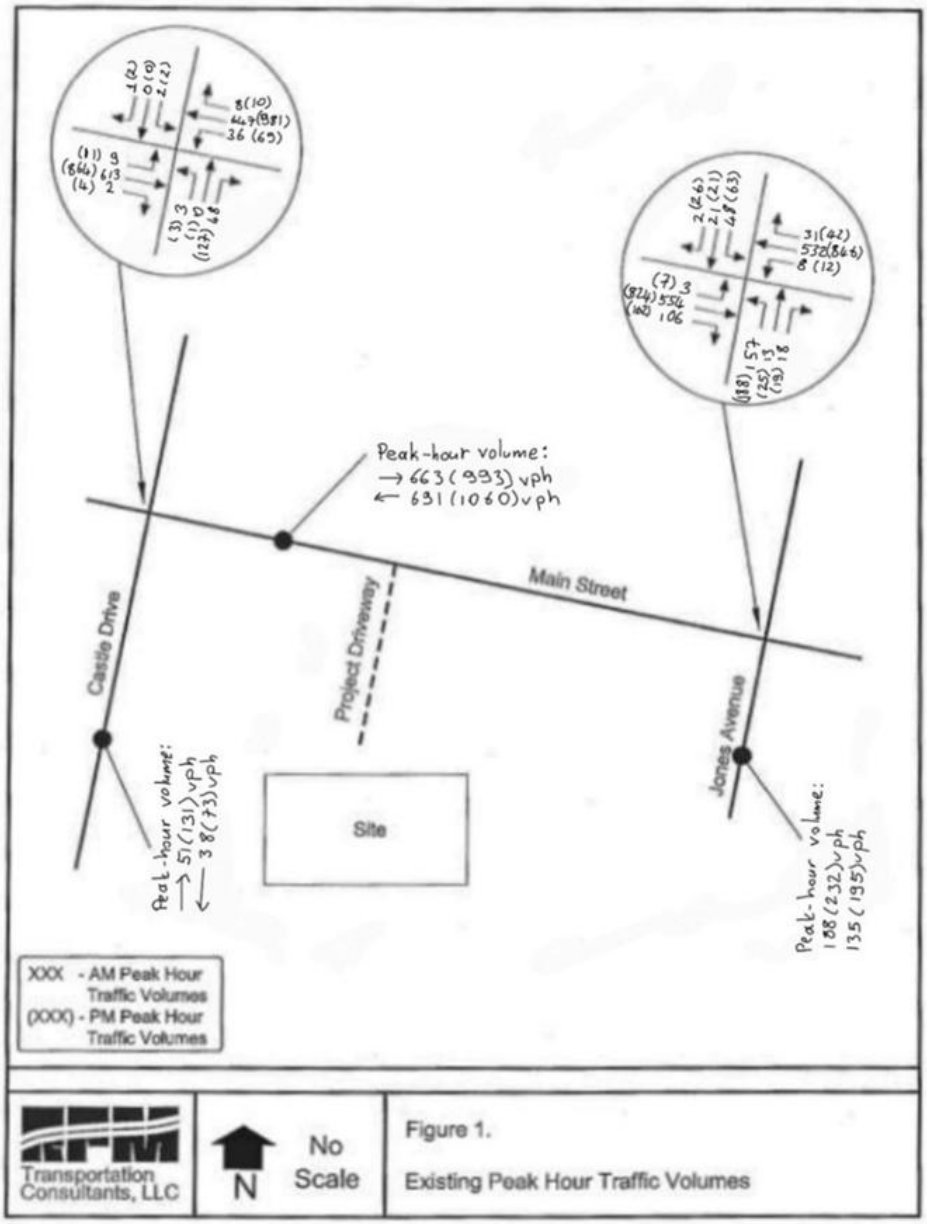


Figure 1. Existing Peak Hour Traffic Volumes: *Highlights AM and PM peak-hour volumes, including 663 vph eastbound and 631 vph westbound at Castle Drive.*

3.4 Task-4: Trip Generation Analysis

The objective of this section is to estimate the trips generated by the proposed development during the AM and PM peak hours using the 10th Edition of the ITE Trip Generation Manual. This analysis involves determining whether to use average rates or trip generation equations, applying the appropriate calculations, and projecting the entering and exiting traffic.

3.4.1 Home Improvement Superstore (ITE Code: 862)

AM Peak Hour:

- **Equation Availability:** Not provided.
- **Use of Average Rate:** 2.75 trips per 1,000 sq. ft.
- **GFA:** 510,000 sq. ft.
- **Calculation:** T = 2.75 × 150 = 412.5 trips
- **Directional Distribution:** 52% entering, 48% exiting
    - **Entering Trips:** 412.5 × 0.52 = 214.5
    - **Exiting Trips:** 412.5 × 0.48 = 198

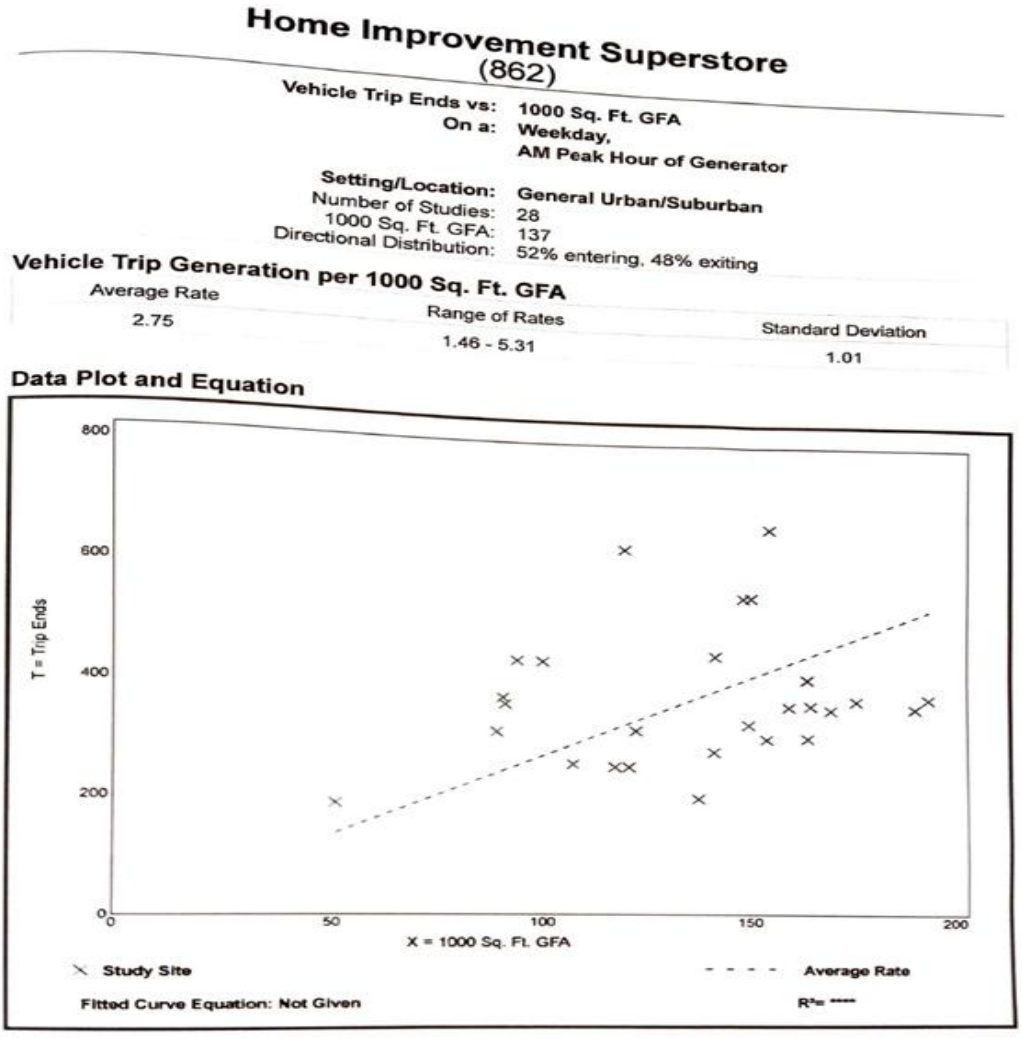


Chart 1. Home Improvement Superstore (ITE Code 862 - AM)*: Shows AM peak-hour trip rates (2.75 trips/1,000 sq. ft. GFA) with 52% entering and 48% exiting based on 28 urban/suburban studies.*

PM Peak Hour:

- **Equation Availability:** Not provided.
- **Use of Average Rate:** 3.29 trips per 1,000 sq. ft. GFA.
- **Calculation:** T = 3.29 × 137 = 450.73 trips
- **Directional Distribution:** 52% entering, 48% exiting
    - **Entering Trips:** 450.73 × 0.52 = 234.38
    - **Exiting Trips:** 450.73 × 0.48 = 216.35

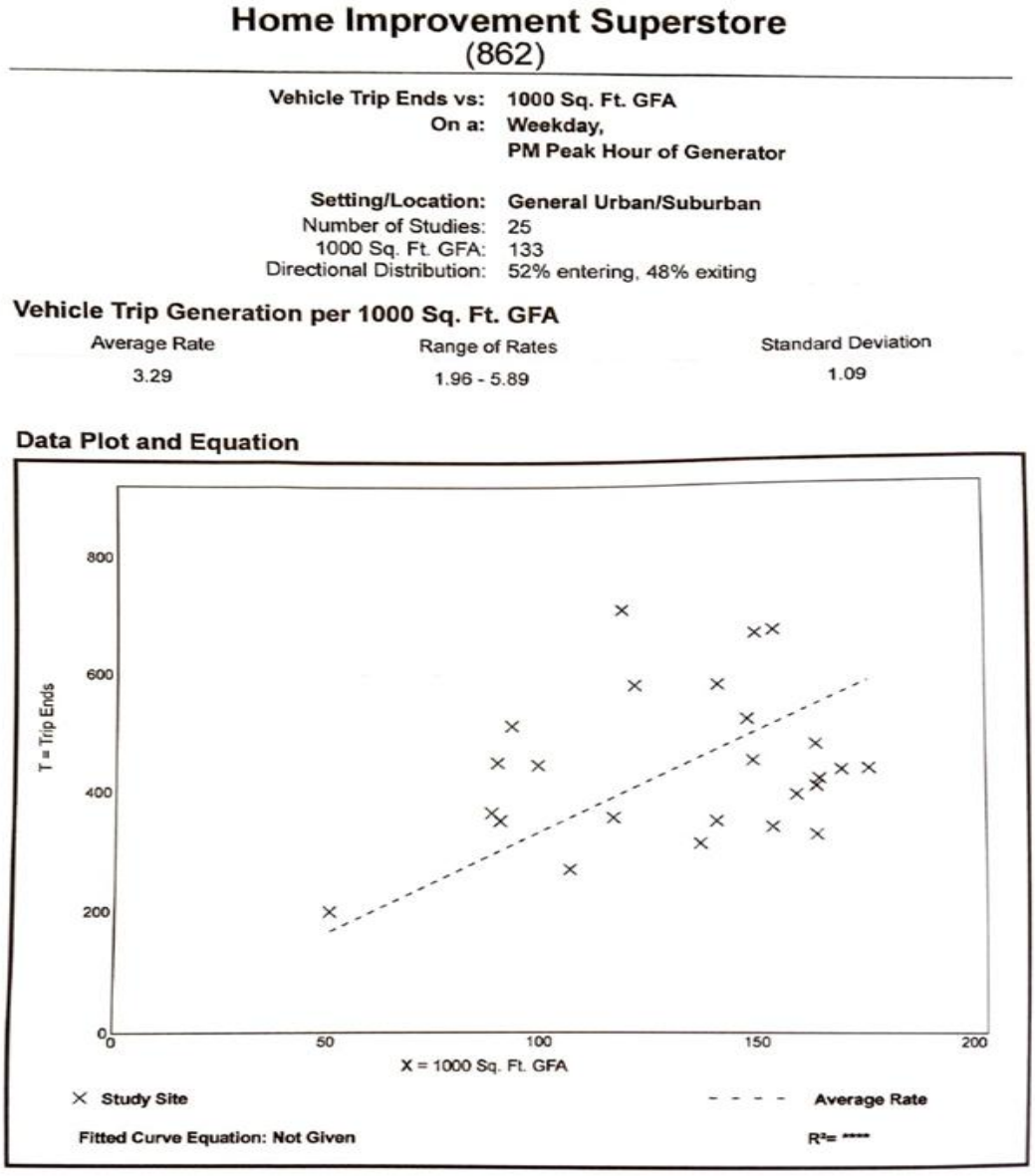


Chart 2. Home Improvement Superstore (ITE Code 862 - PM): *Depicts PM peak-hour trip rates (3.29 trips/1,000 sq. ft. GFA) with a directional split of 52% entering and 48% exiting, based on 25 urban/suburban studies.*

3.4.2 Multifamily Housing (Mid-Rise) (ITE Code: 221)

AM Peak Hour:

- **Equation Used:** T = 0.31X + 3.40
- **Number of Units:** 250
- **Calculation:** T = 0.31 × 250 + 3.40 = 80.9 trips
- **Directional Distribution:** 27% entering, 73% exiting
    - **Entering Trips:** 80.9 × 0.27 = 21.843.80.9
    - **Exiting Trips:** 80.9 × 0.73 = 59.057

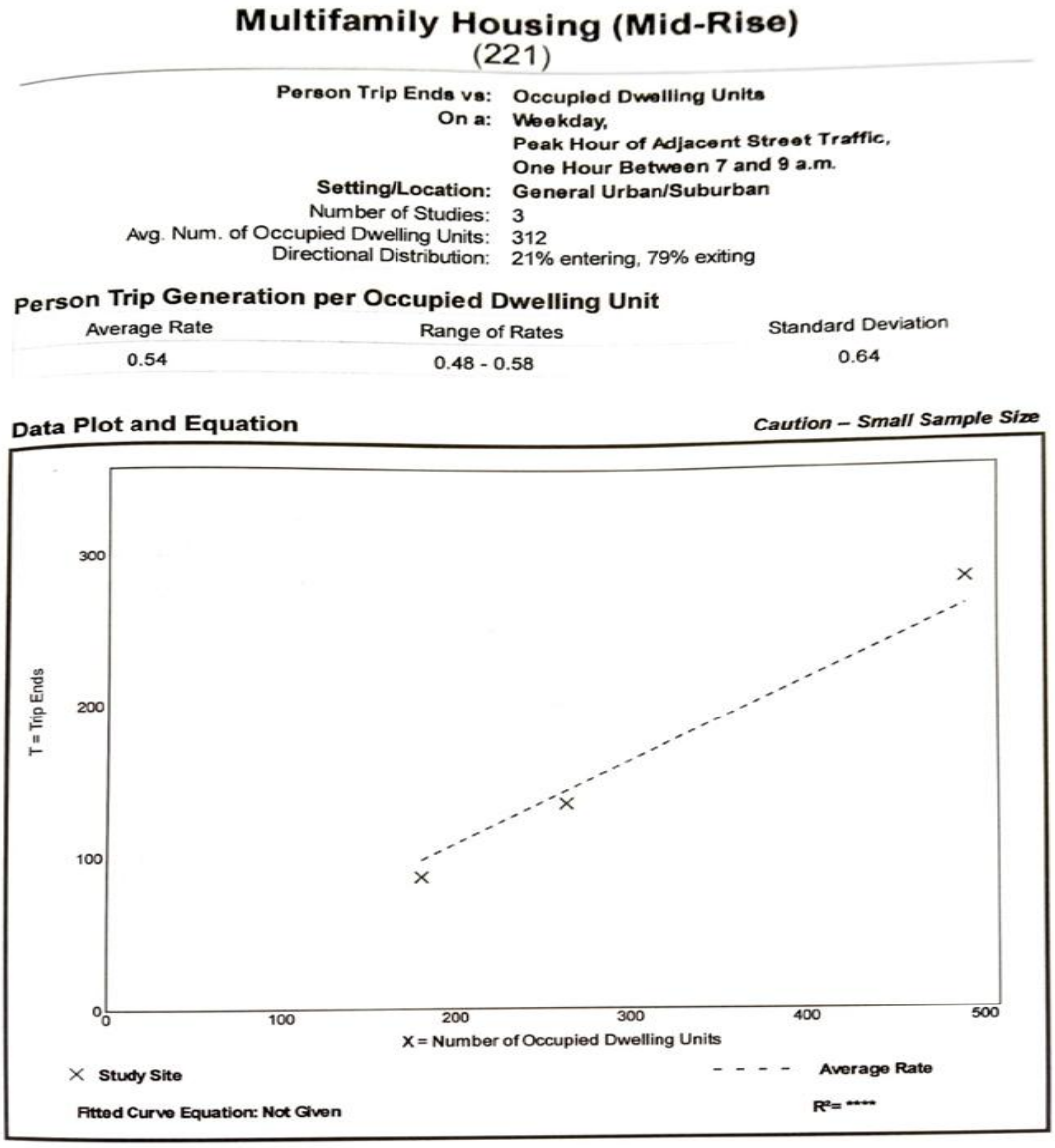


Chart 3. Multifamily Housing (Mid-Rise) (ITE Code 221 - AM)*: Illustrates AM peak-hour trip rates (0.54 trips per occupied dwelling unit) with 21% entering and 79% exiting, based on three urban/suburban studies. Small sample size noted.*

PM Peak Hour:

- **Equation Used:** T = 0.47X + 9.34
- **Calculation:** T = 0.47 × 250 + 9.34 = 126.84 trips
- **Directional Distribution:** 61% entering, 39% exiting
    - **Entering Trips:** 126.84 × 0.61 = 77.37
    - **Exiting Trips:** 126.84 × 0.39 = 49.47

Multifamily Housing (Mid-Rise)
(221)

Person Trip Ends vs:	Dwelling Units
On a:	Weekday, PM Peak Hour of Generator
Setting/Location:	General Urban/Suburban
Number of Studies:	9
Avg. Num. of Dwelling Units:	262
Directional Distribution:	61% entering, 39% exiting

Person Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.50	0.46 - 1.00	0.08

Data Plot and Equation

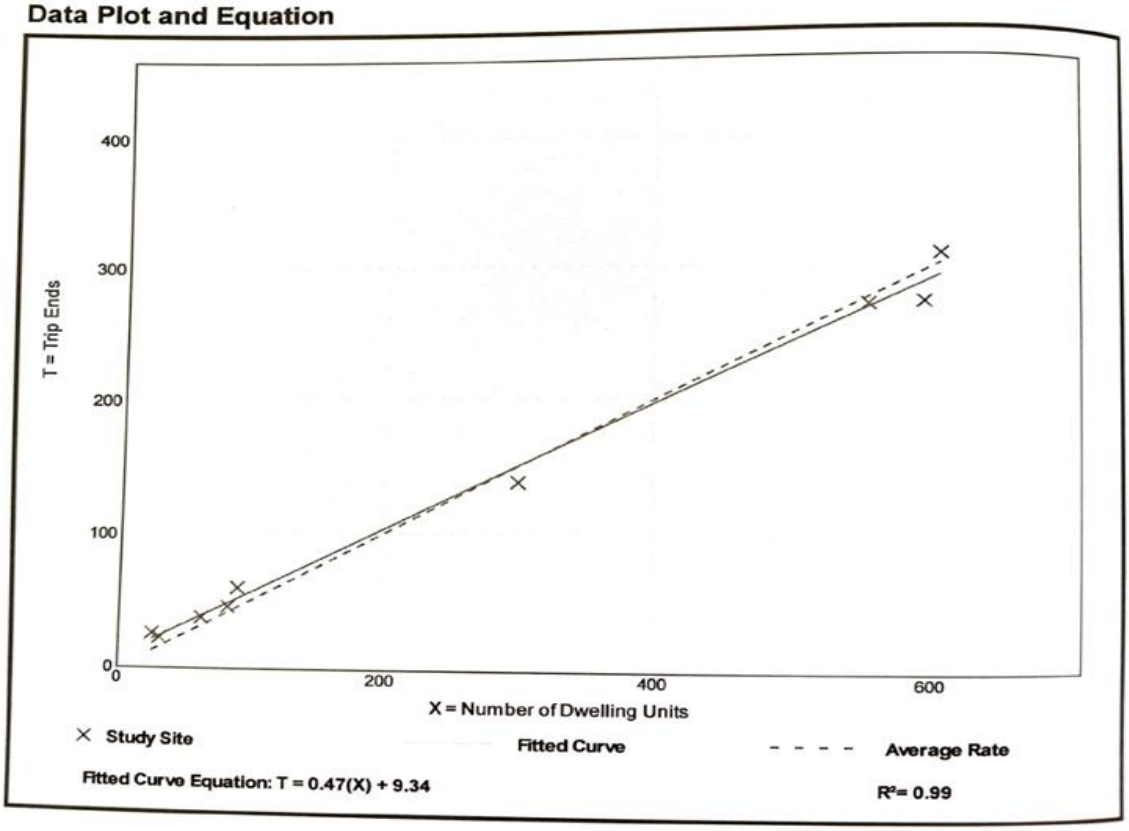


Chart 4. Multifamily Housing (Mid-Rise) (ITE Code 221 - PM)*:: Depicts PM peak-hour trip rates (0.50 trips per dwelling unit), with 61% entering and 39% exiting, based on nine urban/suburban studies. Includes fitted curve: T = 0.47(X) + 9.34 (R^2 = 0.99).*

3.4.3 Medical-Dental Office Building (ITE Code: 720)

AM Peak Hour:

- **Equation Used:** T = 3.43X + 2.57
- **GFA:** 9,000 sq. ft.
- **Calculation:** T = 3.43 × 9 + 2.57 = 33.44 trips
- **Directional Distribution:** 62% entering, 38% exiting
    - **Entering Trips:** 33.44 × 0.62 = 20.73
    - **Exiting Trips:** 33.44 × 0.38 = 12.71

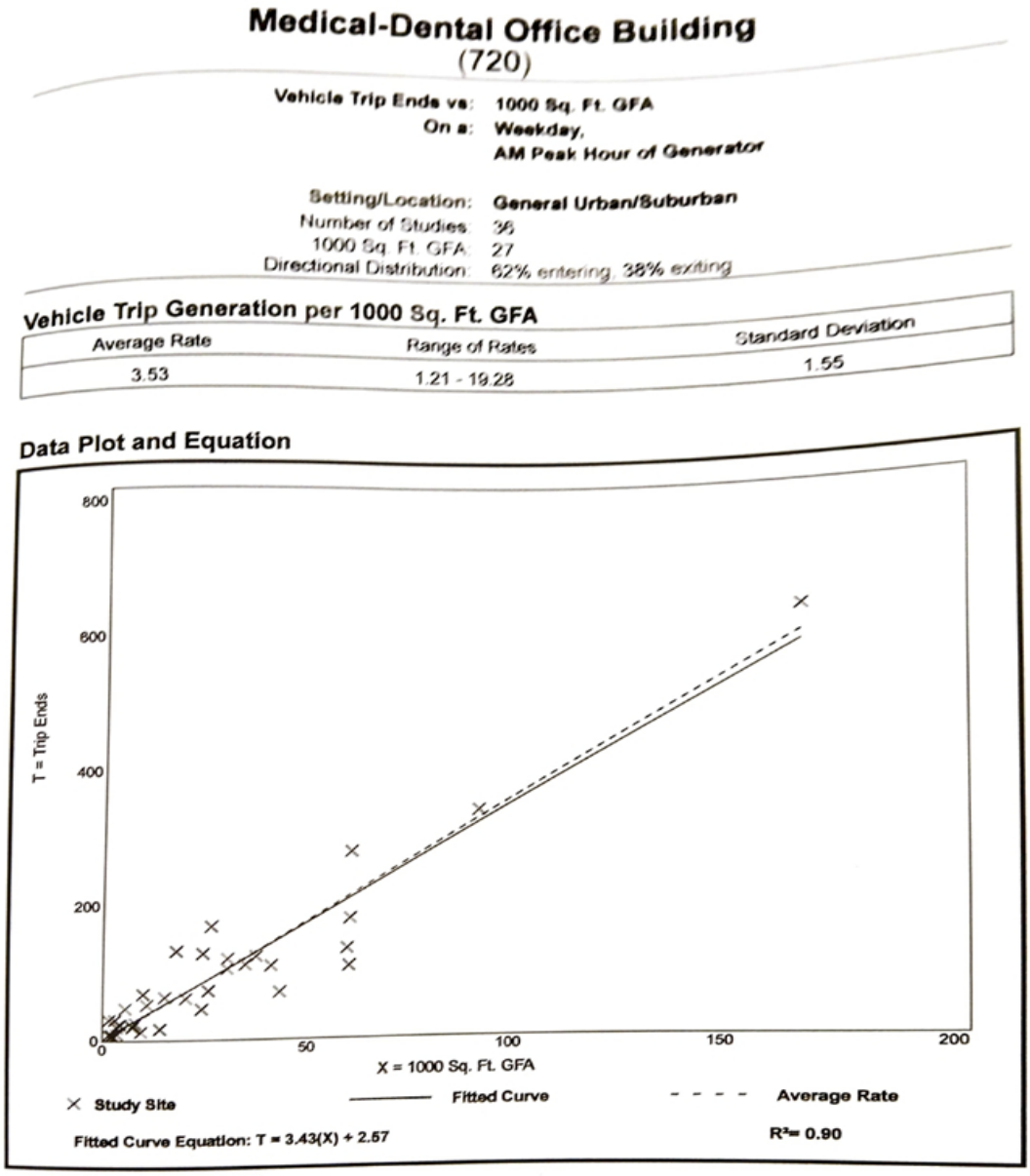


Chart 5. Medical-Dental Office Building (ITE Code 720 - AM)*: Displays AM peak-hour trip rates (3.53 trips per 1,000 sq. ft. GFA), with 62% entering and 38% exiting, based on 36 urban/suburban studies. Fitted curve: T = 3.43(X) + 2.57 (R^2 = 0.90).*

PM Peak Hour:

- **Equation Used:** T = 4.27X − 4.63
- **Calculation:** T = 4.27 × 9−4.63 = 33.8 trips
- **Directional Distribution:** 39% entering, 61% exiting
    - **Entering Trips:** 33.8 × 0.39 = 13.182
    - **Exiting Trips:** 33.8 × 0.61 = 20.618

Medical-Dental Office Building
(720)

Vehicle Trip Ends vs: 1000 Sq. Ft. GFA
On a: Weekday,
PM Peak Hour of Generator

Setting/Location: General Urban/Suburban
Number of Studies: 42
1000 Sq. Ft. GFA: 26
Directional Distribution: 39% entering, 61% exiting

Vehicle Trip Generation per 1000 Sq. Ft. GFA

Average Rate	Range of Rates	Standard Deviation
4.10	1.49 - 15.55	1.44

Data Plot and Equation

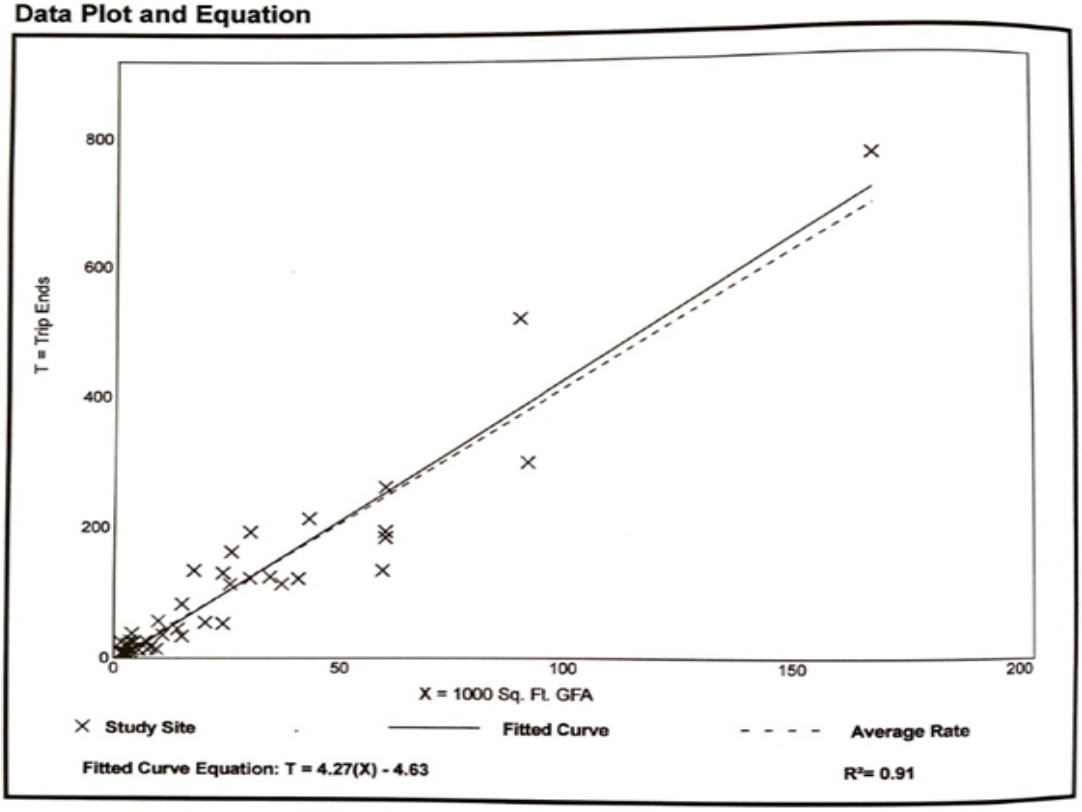


***Chart 6. Medical-Dental Office Building (ITE Code 720 - PM)**:: Illustrates PM peak-hour trip rates (4.10 trips per 1,000 sq. ft. GFA), with 39% entering and 61% exiting, based on 42 urban/suburban studies. Fitted curve: T = 4.27(X) - 4.63 (R^2 = 0.91).*

3.4.4 Shopping Center (ITE Code: 820)

AM Peak Hour:

- **Equation Used:** ln(T) = 0.86 ln(X) + 2.53
- **GFA:** 40,000 sq. ft.
- **Calculation:** T = e^ ((0.86 ln(40) + 2.53)) = e^ (5.7024) = 299.585 trips
- **Directional Distribution:** 54% entering, 46% exiting
    - **Entering Trips:** 299.585 × 0.54 = 161.177
    - **Exiting Trips:** 299.585 × 0.46 = 137.809

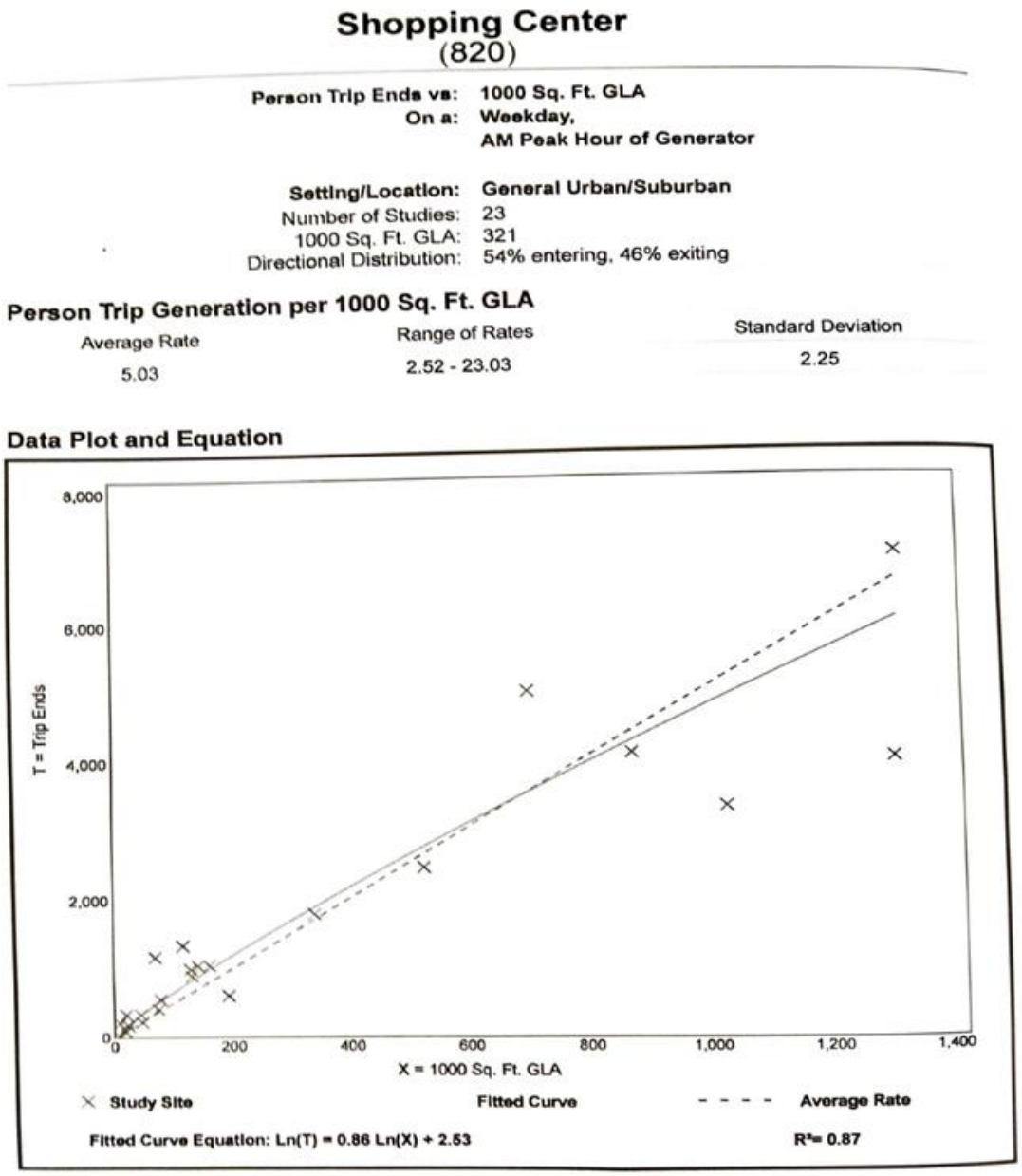


Chart 7: Shopping Center (ITE Code 820 - AM)*: This shows AM peak-hour trip generation averages 5.03 trips per 1,000 sq. ft. GLA, with 54% entering and 46% exiting. The data demonstrates a strong correlation between trip ends and building size.*

PM Peak Hour:

- **Equation Used:** ln(T) = 0.66 ln(X) + 4.04
- **Calculation:** T = e^ ((0.66 ln(40) + 4.04)) = e^ (6.47466) = 648.498 trips

- **Directional Distribution:** 50% entering, 50% exiting
    - **Entering Trips:** 648.498 × 0.50 = 324.249
    - **Exiting Trips:** 648.498 × 0.50 = 324.249

Shopping Center
(820)

Person Trip Ends vs:	**1000 Sq. Ft. GLA**
On a:	**Weekday,**
	PM Peak Hour of Generator
Setting/Location:	**General Urban/Suburban**
Number of Studies:	25
1000 Sq. Ft. GLA:	312
Directional Distribution:	50% entering, 50% exiting

Person Trip Generation per 1000 Sq. Ft. GLA

Average Rate	Range of Rates	Standard Deviation
7.49	4.11 - 37.41	4.45

Data Plot and Equation

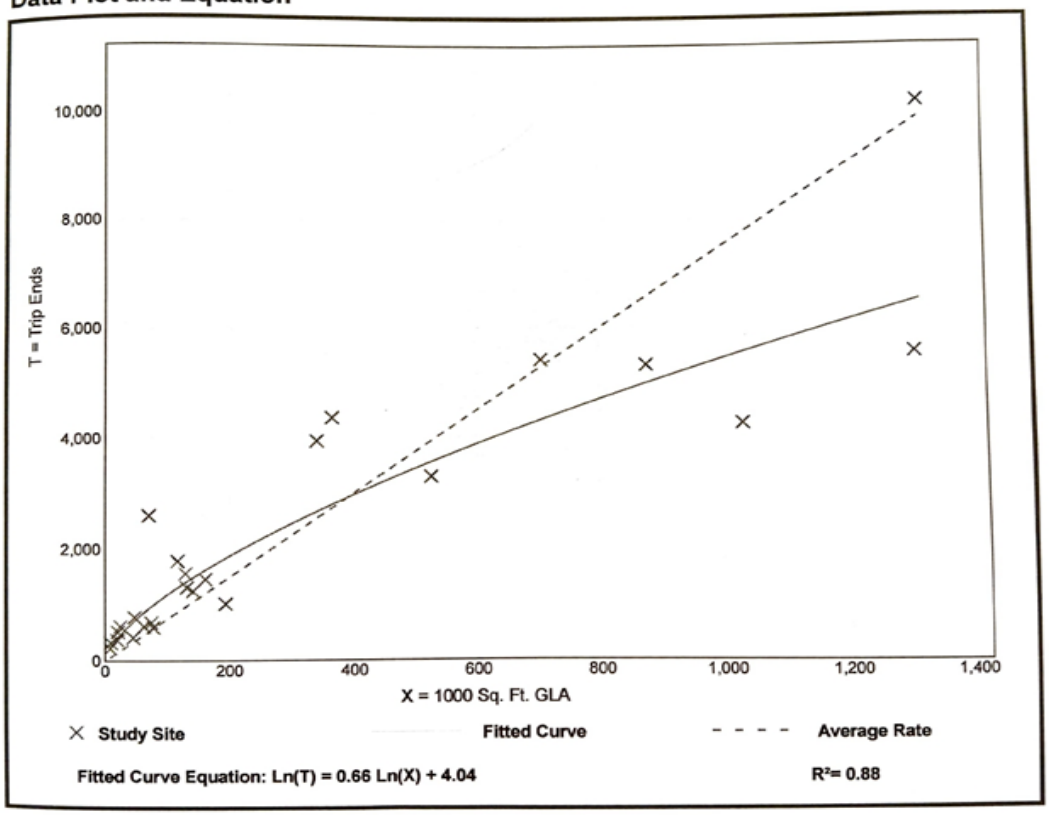


Chart 8: Shopping Center (ITE Code 820 - PM)*: PM peak-hour trip generation averages 7.49 trips per 1,000 sq. ft. GLA, with a balanced directional distribution of 50% entering and 50% exiting. The relationship between building size and trip ends is evident in the data trends.*

Land Use	Peak Hour	Total Trips	Entering Trips	Exiting Trips
Home Improvement Superstore (ITE Code: 862)	AM	412.5	214.5	198
	PM	493.5	256.62	236.88
Multifamily Housing Mid-Rise (ITE Code: 221)	AM	80.9	21.843	59.057
	PM	126.84	77.37	49.47
Medical-Dental Office Building (ITE Code: 720)	AM	33.44	20.73	12.71
	PM	33.8	13.182	20.618
Shopping Center (ITE Code: 820)	AM	299.585	161.177	137.809
	PM	648.498	324.249	324.249

Table 16. Trip Generation Summary: *Shopping Center leads with 648.5 PM trips, followed by the Home Improvement Superstore with 493.5.*

3.4.5 Discussion of Results

1. **Home Improvement Superstore**:
    - Generates significant trips due to its size (150,000 sq. ft.).
    - PM peak hour trips (493.5) are higher than AM trips (412.5), consistent with its function as a retail destination.
    - Approximately 52% of trips occur during the PM peak entering the site.
2. **Multifamily Housing**:
    - Generates lower trips relative to other land uses due to the residential nature of the units.
    - PM trips (126.84) are higher than AM trips (80.9), reflecting evening activities and returns from work.
    - A higher proportion of trips exit the site in the AM compared to the PM.
3. **Medical-Dental Office Building**:
    - Generates fewer trips due to its smaller GFA (9,000 sq. ft.).
    - AM trips (33.44) and PM trips (33.8) are nearly identical, indicating consistent demand for medical-dental services throughout the day.
    - AM trips have a higher entering percentage (62%) compared to PM trips (39%).
4. **Shopping Center**:
    - Generates a significant number of trips, especially during the PM peak (648.498 trips) compared to AM peak (299.585 trips).

- Even distribution of trips entering and exiting during the PM peak reflects the retail nature of the site.

- During the AM peak, more trips enter (54%) than exit (46%).

3.5 Task-5: Mode Split Estimation and Reduction Analysis

The objective of this section is to estimate the mode split for the trips generated by the proposed mixed-use development and determine whether a reduction in the calculated vehicle trip generation is required. This analysis considers the mode split for transit, pedestrian/bicycle, and automobile trips. The results of the adjusted trip generation calculations are presented with detailed explanations.

3.5.1 Mode Split Estimation

1. Factors Affecting Mode Split

The mode split estimation is based on the following site-specific conditions:

- **Transit**: Limited transit service along Main Street, with no infrastructure to encourage higher transit use.

- **Pedestrian/Bicycle**: Absence of sidewalks, bike lanes, or bikeways reduces the likelihood of non-motorized trips.

- **Automobile**: The site is highly automobile-dependent due to the lack of alternative transportation options.

2. Estimated Mode Split

Based on these factors:

- **Transit Trips**: 5%
- **Pedestrian/Bicycle Trips**: 3%
- **Automobile Trips**: 92%

3.5.2 Adjusted Vehicle Trip Generation

The adjusted vehicle trip generation is calculated as:

Adjusted Vehicle Trips (T') = Total Vehicle Trips (T) × (1−Non-Auto Mode Share)

Where:

Non-Auto Mode Share = Transit + Pedestrian/Bicycle = 5% + 3% = 8%.

Below are the corrected calculations for all land uses and peak hours.

1. Home Improvement Superstore (ITE Code: 862)

1. **AM Peak Hour**:
   - **Original Trips (T)**: 412.5
   - **Adjusted Trips (T')**: T′ = 412.5 × (1−0.08) = 412.5 × 0.92 = 379.5 trips

2. **PM Peak Hour**:
   - **Original Trips (T)**: 493.5
   - **Adjusted Trips (T')**: T′ = 493.5 × (1−0.08) = 493.5 × 0.92 = 454.02

2. Multifamily Housing (ITE Code: 221)

1. **AM Peak Hour**:
   - **Original Trips (T)**: 80.9
   - **Adjusted Trips (T')**: T′ = 80.9 × (1−0.08) = 80.9 × 0.92 = 74.428 trips

2. **PM Peak Hour**:
   - **Original Trips (T)**: 126.84
   - **Adjusted Trips (T')**: T′ = 126.84 × (1−0.08) = 126.84 × 0.92 = 116.692 trips

3. Medical-Dental Office Building (ITE Code: 720)

1. **AM Peak Hour**:
   - **Original Trips (T)**: 33.44
   - **Adjusted Trips (T')**: T′ = 33.44 × (1−0.08) = 33.44 × 0.92 = 30.764 trips

2. **PM Peak Hour**:
   - **Original Trips (T)**: 33.8
   - **Adjusted Trips (T')**: T′ = 33.8 × (1−0.08) = 33.8 × 0.92 = 31.096 trips

4. Shopping Center (ITE Code: 820)

1. **AM Peak Hour**:
   - **Original Trips (T)**: 299.585
   - **Adjusted Trips (T')**: T′ = 299.585 × (1−0.08) = 299.585 × 0.92 = 275.618 trips

2. **PM Peak Hour**:
   - **Original Trips (T)**: 648.498
   - **Adjusted Trips (T')**: T′ = 648.498 × (1−0.08) = 648.498 × 0.92 = 596.618 trips

Land Use	Peak Hour	Total Trips (T)	Adjusted Total Trips (T')	Entering Trips (Original)	Exiting Trips (Original)	Entering Trips (Adjusted)	Exiting Trips (Adjusted)
Home Improvement Superstore	AM	412.5	379.5	214.5	198	197.34	182.16
	PM	493.5	454.02	256.62	236.88	236.09	217.93
Multifamily Housing Mid-Rise	AM	80.9	74.428	21.843	59.057	20.095	54.332
	PM	126.84	116.692	77.37	49.47	71.18	45.521
Medical-Dental Office	AM	33.44	30.764	20.73	12.71	19.072	11.694
	PM	33.8	31.096	13.182	20.618	12.125	18.968
Shopping Center	AM	299.585	275.618	161.177	137.809	148.283	126.784
	PM	648.498	596.618	324.249	324.249	298.309	298.309
AM Total		826.425	760.31	418.25	407.576	384.79	374.97
PM Total		1302.638	1198.428	671.421	631.237	617.704	580.728
Grand Total (AM + PM)		2129.063	1958.738	1089.671	1038.813	1002.494	955.698

Table 17. Adjusted Trip Generation Summary: *AM trips adjusted from 826.4 to 760.3; PM trips adjusted from 1,302.6 to 1,198.4, reflecting an 8% non-auto trip deduction.*

3.5.3 Discussion of Results

1. **Mode Split Analysis**:
    - An 8% reduction accounts for transit and non-motorized trips.
    - Automobile trips dominate, reflecting the suburban and auto-centric nature of the area.
2. **Adjusted Vehicle Trips**:
    - The adjusted trips are more representative of actual conditions in a suburban setting with limited multimodal infrastructure.
    - PM peak hour trips for all land uses are higher than AM peak hour trips, consistent with commuting and shopping behaviors.
3. **Future Considerations**:
    - Improvements in transit, sidewalks, and bike infrastructure could further reduce vehicular dependency and support sustainable transportation modes.
    - Incorporating local travel behavior data could refine the mode split estimation.

3.6 Task-6: Directional Distribution of Traffic Entering and Exiting the Site

The objective of this task is to determine the directional distribution of traffic entering and exiting the proposed development site based on the population totals provided for the Traffic Analysis Zones (TAZ) in Figure 2. The calculation considers the roadway network and adjacent TAZ populations to estimate the flow of traffic in the north, south, east, and west directions.

The population data for TAZs is given as:

- **TAZ 1**: 810
- **TAZ 2**: 1240
- **TAZ 3**: 2258
- **TAZ 4**: 620
- **TAZ 5**: 1608
- **TAZ 6**: 1384
- **TAZ 7**: 261
- **TAZ 8**: 152
- **TAZ 9**: 58
- **TAZ 10**: 72
- **TAZ 11**: 368
- **TAZ 12**: 326
- **TAZ 13**: 160
- **TAZ 14**: 120
- **TAZ 15**: 1982
- **TAZ 16**: 1134
- **TAZ 17**: 452
- **TAZ 18**: 380

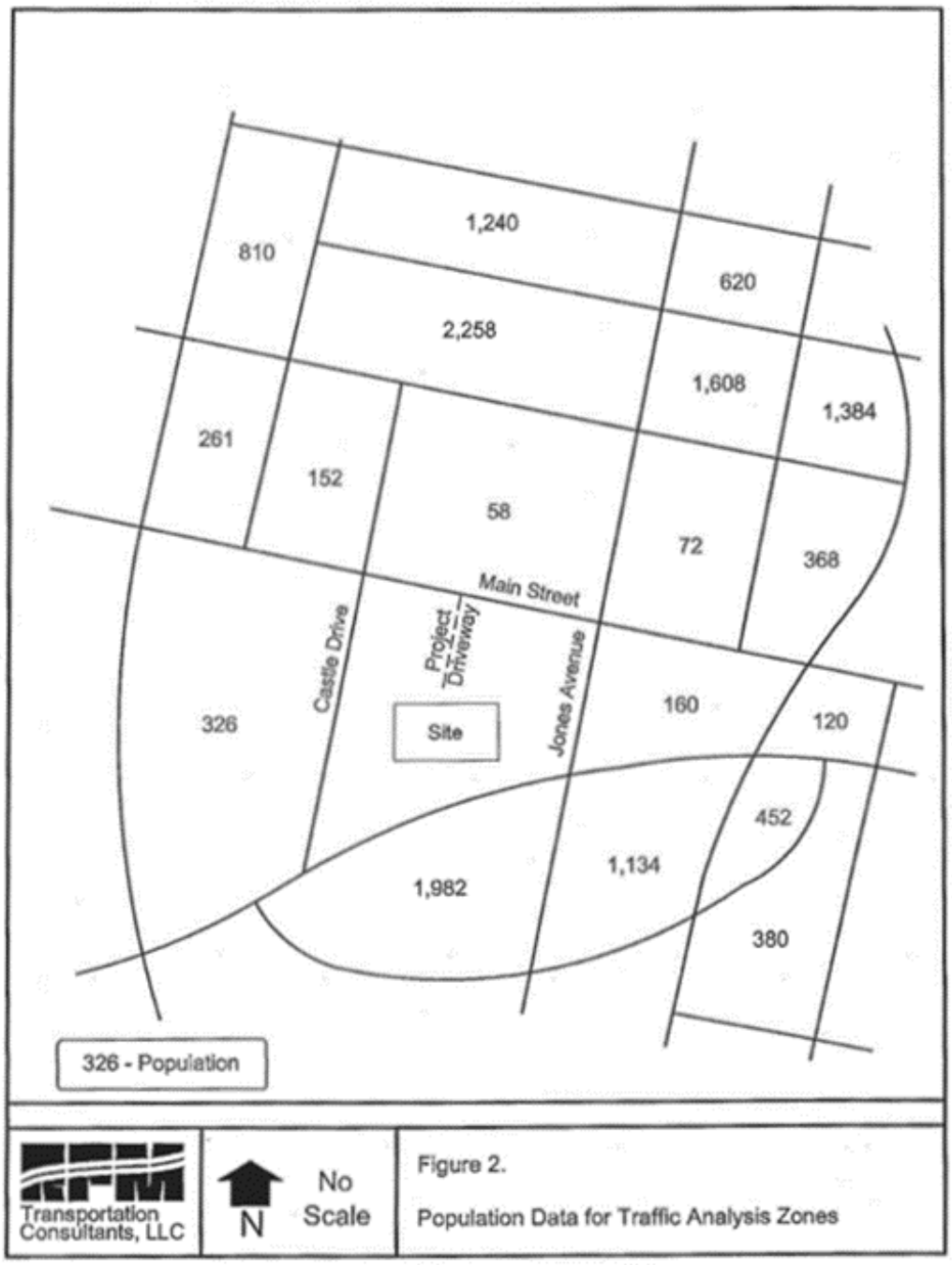


Figure 2. Population Distribution: *Displays Traffic Analysis Zones (TAZs) with population data, critical for calculating directional traffic distributions.*

3.6.1 Directional Grouping of TAZs

The TAZs are grouped by their geographic orientation relative to the site:

- **North**: TAZ 1, 2, 3, 4, 5, 6, 9

  Population = 810 + 1240 + 2258 + 620 + 1608 + 1384 + 58 = 7978

- **East**: TAZ 10, 11, 13, 14

  Population = 72 + 368 + 160 + 120 = 720

- **West**: TAZ 7, 8, 12

  Population = 261 + 152 + 326 = 739

- **South**: TAZ 15, 16, 17, 18

  Population = 1982 + 1134 + 452 + 380 = 3948

3.6.2 Total Population

The total population across all TAZs is calculated as:

Total Population =7978 + 720 + 739 + 3948 = 13,385

3.6.3 Directional Distribution Percentages

The directional distribution percentages are calculated as follows:

- **North**:

  Percentage = (797813385) × 100 = 59.6%

- **East**:

  Percentage = (72013385) × 100 = 5.4%

- **West**:

  Percentage = (73913385) × 100 = 5.5%

- **South**:

  Percentage = (394813385) × 100 = 29.5%

3.6.4 Application to Traffic Flows

To estimate the traffic entering and exiting the site, these directional percentages can be applied to the trip generation totals calculated in **Task 4**. For each peak hour (AM and PM), the trips are divided proportionally among the directions based on the percentages above.

Direction	Population	Percentage
North	7978	59.6%
East	720	5.4%
West	739	5.5%
South	3948	29.5%
Total	**13,385**	**100%**

Table 18. Directional Distribution: *North leads with 59.6%, South follows at 29.5%, while East and West contribute 5.4% and 5.5%.*

3.6.5 Discussion of Results

1. **North Dominance**: The majority of the population is concentrated to the north of the site, contributing nearly 60% of the trips. This indicates a likely heavier flow of traffic in the northward direction.

2. **South as Secondary Direction**: The south contributes 29.5% of the traffic, reflecting its role as the secondary contributor to site-related trips.

3. **Minimal East and West Contributions**: The east and west directions contribute equally small proportions of traffic due to lower populations in these zones.

4. **Implications for Roadway Design**: The findings highlight the need for capacity improvements and traffic management strategies primarily for the north and south approaches to the site.

3.7 Task-7: Directional Distribution of Traffic Entering and Exiting the Site

The objective of this task is to determine and visually represent the directional distribution of traffic entering and exiting the proposed development site during the AM and PM peak hours. Using the peak hour movement volumes from Task 3 and the population-based distribution from Task 6, we will calculate the percentages of traffic flowing in each direction and present this data on a figure similar to Figure 3 in the project documents.

1. **Data Integration:**

    - Use peak hour traffic volumes for AM and PM periods provided in Task 3.

    - Apply directional distribution percentages derived in Task 6 to calculate the traffic volumes in each direction.

2. **Formulas Used:**

    - **Directional Traffic Volume (DTV):** DTV direction=Total Trips hour × Directional Percentage direction

      where; Directional Percentage direction is the percentage calculated for North, East, South, and West.

3. **Assumptions:**

    - Traffic entering and exiting the site is distributed proportionally to the population in surrounding Traffic Analysis Zones (TAZs).

    - Peak hour traffic flow is consistent with directional percentages calculated in Task 6.

3.7.1 Calculation Steps

Step 1: Extract Total Trips

From Task 4 and Task 5, the total adjusted trips entering and exiting the site are:

- **AM Peak Hour:** 760.31 vehicles
- **PM Peak Hour:** 1198.43 vehicles

Step 2: Apply Directional Percentages

Directional percentages derived in Task 6 are as follows:

- North: 59.6%
- East: 5.4%
- West: 5.5%
- South: 29.5%

For each direction, calculate traffic volumes using the formula.

AM Peak Hour:

- North: 760.31 × 0.596 = 453.21 vehicles
- East: 760.31 × 0.054 = 41.06 vehicles
- West: 760.31 × 0.055 = 41.82 vehicles
- South: 760.31 × 0.295 = 224.22 vehicles

PM Peak Hour:

- North: 1198.43 × 0.596 = 714.24 vehicles
- East: 1198.43 × 0.054 = 64.91 vehicles
- West: 1198.43 × 0.055 = 65.91 vehicles
- South: 1198.43 × 0.295 = 353.36 vehicles

3.7.2 Results

1. Traffic Distribution by Direction

Direction	AM Peak Hour Volume (vehicles)	PM Peak Hour Volume (vehicles)	Entering AM Peak Hour	Entering PM Peak Hour	Existing AM Peak Hour	Existing PM Peak Hour
North	453.21	714.24	229.50	368.89	223.27	346.53
East	41.06	64.91	20.79	33.36	20.26	31.33
West	41.82	65.91	21.14	33.97	20.62	31.94
South	224.22	353.36	113.22	182.22	110.07	171.87
Total	**760.31**	**1198.43**	**384.79**	**617.70**	**374.97**	**580.73**

Table 19. Directional Traffic: *North leads AM (453) and PM (714) volumes; South follows, with minimal East/West input.*

2. Directional Distribution Using Entering and Exiting Volumes

1. **Entering and Exiting Traffic Volumes** From the **trip generation calculations**, the total **entering** and **exiting traffic volumes** during the AM and PM peak hours are:

    - **AM Peak Hour (760.31 total trips):**
        - **Entering Traffic**: 384.79 vehicles
        - **Exiting Traffic**: 374.97 vehicles

    - **PM Peak Hour (1,198.43 total trips):**
        - **Entering Traffic**: 617.70 vehicles
        - **Exiting Traffic**: 580.73 vehicles

2. **Applying Directional Percentages** The directional percentages based on **Traffic Analysis Zone (TAZ) populations** are:

    - **North**: 59.6%
    - **East**: 5.4%
    - **West**: 5.5%
    - **South**: 29.5%

    These percentages will be applied separately to the entering and exiting traffic volumes.

3. Calculations

AM Peak Hour:

- **Entering Traffic (384.79 vehicles):**
    - **North:** 384.79 × 0.596 = 229.50 vehicles
    - **East:** 384.79 × 0.054 = 20.79 vehicles
    - **West:** 384.79 × 0.055 = 21.14 vehicles
    - **South:** 384.79 × 0.295 = 113.22 vehicles

- **Exiting Traffic (374.97 vehicles):**
  - **North:** 374.97 × 0.596 = 223.27 vehicles
  - **East:** 374.97 × 0.054 = 20.26 vehicles
  - **West:** 374.97 × 0.055 = 20.62 vehicles
  - **South:** 374.97 × 0.295 = 110.07 vehicles

PM Peak Hour:

- **Entering Traffic (617.70 vehicles):**
  - **North:** 617.70 × 0.596 = 368.89 vehicles
  - **East:** 617.70 × 0.054 = 33.36 vehicles
  - **West:** 617.70 × 0.055 = 33.97 vehicles
  - **South:** 617.70 × 0.295 = 182.22 vehicles

- **Exiting Traffic (580.73 vehicles):**
  - **North:** 580.73 × 0.596 = 346.53 vehicles
  - **East:** 580.73 × 0.054 = 31.33 vehicles
  - **West:** 580.73 × 0.055 = 31.94 vehicles
  - **South:** 580.73 × 0.295 = 171.87 vehicles

4. Results

AM Peak Hour (760.31 trips):

Direction	Entering (vehicles)	Exiting (vehicles)
North	229.50	223.27
East	20.79	20.26
West	21.14	20.62
South	113.22	110.07

Table 20. AM Peak Hour Traffic Summary: *North leads with 230 entering and 223 exiting trips, while East, West, and South show significantly lower volumes.*

PM Peak Hour (1,198.43 trips):

Direction	Entering (vehicles)	Exiting (vehicles)
North	368.89	346.53
East	33.36	31.33
West	33.97	31.94
South	182.22	171.87

Table 21. PM Peak Hour Traffic Summary: *North dominates with 369 entering and 347 exiting trips, followed by South, while East and West show minimal volumes.*

Directional Distribution Adjustments: The original entering and exiting traffic volumes for AM and PM peak hours were divided by 2 as an approximation to simplify calculations and represent averages. The results were then rounded down to the nearest whole number for practical use in Figures 3 and 4.

AM Peak Hour Adjusted Volumes (380 trips):

Direction	Entering (vehicles)	Exiting (vehicles)
North	114	111
East	10	10
West	10	10
South	56	55

Table 22. AM Peak Hour Adjusted Volumes: *North dominates with 114 entering, 111 exiting; other directions show lower, balanced flows.*

PM Peak Hour Adjusted Volumes (599 trips):

Direction	Entering (vehicles)	Exiting (vehicles)
North	184	173
East	16	15
West	16	15
South	91	85

Table 23. PM Peak Hour Adjusted Volumes: *North leads with 184 entering, 173 exiting; South follows with 91 entering, 85 exiting. East and West show minimal traffic.*

Rounded Down Values for Practical Use:

Direction	Divided by 2
North	29.8%
East	2.7%
West	2.75%
South	14.75%

Table 24. Rounded Percentages: *North leads at 29.8%, South at 14.75%, with East and West contributing 2.7% and 2.75%.*

5. Purpose of Adjustment:

- The division and rounding were applied to create proportional traffic flows for use in Figures 3 and 4, representing the **average directional traffic distribution**.
- These adjustments help simplify the analysis for assigning development-related traffic to the network while maintaining practical representation of traffic volumes.

AM Peak Hour:

- **Entering Traffic:**
  - North: 229.50 ÷ 2 = 114.75
  - East: 20.79 ÷ 2 = 10.395
  - West: 21.14 ÷ 2 = 10.57
  - South: 113.22 ÷ 2 = 56.61

- **Exiting Traffic:**
    - North: 223.27 ÷ 2 = 111.635
    - East: 20.26 ÷ 2 = 10.13
    - West: 20.62 ÷ 2 = 10.31
    - South: 110.07 ÷ 2 = 55.035

PM Peak Hour:

- **Entering Traffic:**
    - North: 368.89 ÷ 2 = 184.445
    - East: 33.36 ÷ 2 = 16.68
    - West: 33.97 ÷ 2 = 16.98
    - South: 182.22 ÷ 2 = 91.11

- **Exiting Traffic:**
    - North: 346.53 ÷ 2 = 173.265
    - 0East: 31.33 ÷ 2 = 15.665
    - West: 31.94 ÷ 2 = 15.97
    - South: 171.87 ÷ 2 = 85.935

AM Peak Hour:

Direction	Entering (vehicles)	Exiting (vehicles)
North	114	111
East	10	10
West	10	10
South	56	55

Table 25. AM Peak Hour: *North leads with 114 entering, 111 exiting; South follows with 56 entering, 55 exiting. East/West: 10 each.*

PM Peak Hour:

Direction	Entering (vehicles)	Exiting (vehicles)
North	184	173
East	16	15
West	16	15
South	91	85

Table 26. PM Peak Hour: *North dominates with 184 entering, 173 exiting; South has 91 entering, 85 exiting. East/West: 16 each entering, 15 exiting.*

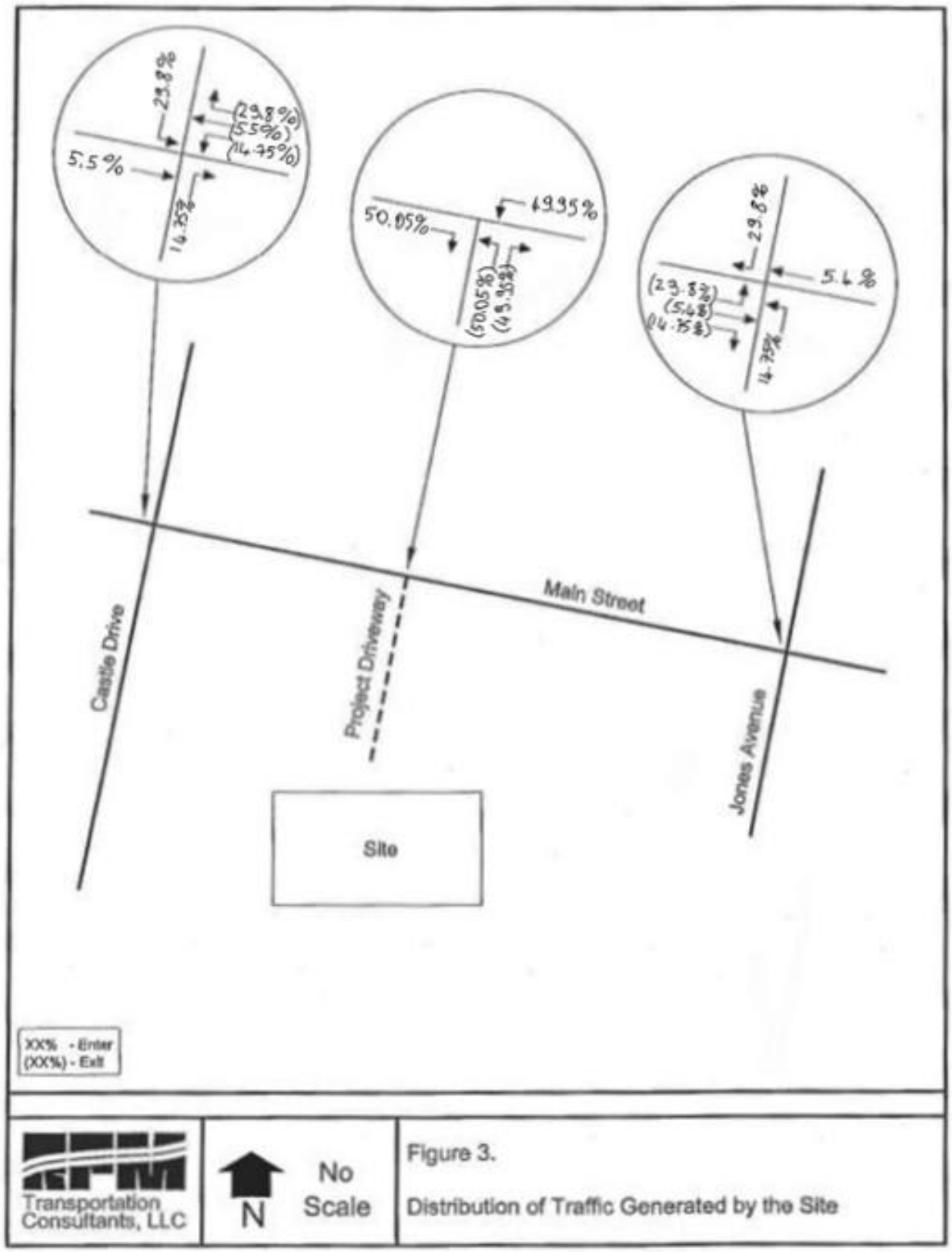


Figure 3. Traffic Distribution: *Demonstrates site-generated traffic split across intersections, highlighting directional percentages for entering and exiting vehicles.*

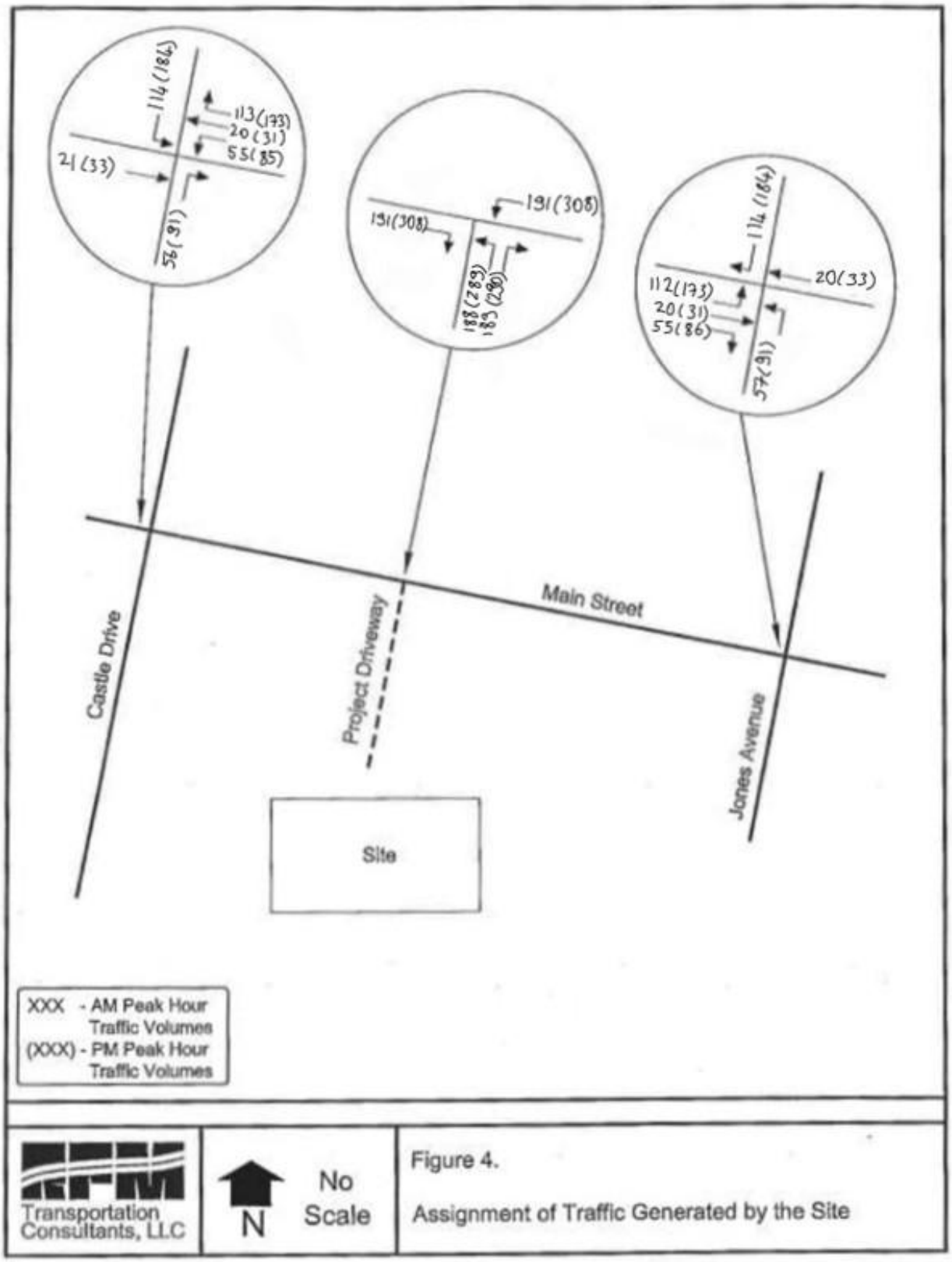


Figure 4. Traffic Assignment: *Depicts AM and PM peak-hour volumes assigned to key intersections, showing directional flow patterns for site-generated traffic.*

3.8 Task-8: Projected Peak Hour Traffic Volumes and Turning Movement Analysis

This section addresses the task of determining the total projected peak hour traffic volumes based on the completion of the proposed development. The analysis combines existing traffic volumes with development-related traffic at each study intersection. Calculations are provided for each turning movement, and the results are summarized in a final figure. The methodology and results are structured into detailed chapters to ensure clarity and alignment with the objectives.

The methodology for Task 8 involves the following steps:

1. **Identifying Existing and Development-Related Traffic Volumes:**
    - Use the data provided in **Figure 1** for existing traffic volumes.
    - Use the results from **Figure 4** for development-related traffic volumes.

2. **Combining Traffic Volumes:**
    - For each intersection, sum the existing traffic volumes and development-related traffic volumes for both AM and PM peak hours.
    - Apply the formula: Total Projected Traffic=Existing Traffic+Development TrafficTotal

3. **Analysis of Each Turning Movement:**
    - Northbound, Southbound, Eastbound, and Westbound turning movements are calculated separately for each intersection.
    - Summation is performed for **Entering** and **Exiting** traffic volumes.
4. **Results Presentation:**
    - Present results as detailed calculations with clear summations.
    - Summarize results in a technical table and figure to display total projected traffic volumes.

3.8.1 Calculations of Traffic Projections

1. Assumption:

- Lane capacity is **1,100 vehicles per hour per lane (vph)**.
- Evaluate the combined traffic volumes for **Castle Drive & Main Street** for both **AM and PM peak hours** and compare them to the lane capacity.

2. Calculation for Entering (Left):

- 114(184) + 21(33) + 56(91) + 2(2) + 613(864) + 48(127)

    - **AM Peak Hour Total**: 114 + 21 + 56 + 2 + 613 + 48 = 854 vph
    - **PM Peak Hour Total**: 184 + 33 + 91 + 2 + 864 + 127 = 1,301 vph

3. Calculation for Entering (Right):

- 114(184) + 20(33) + 57(91) + 2(26) + 532(846) + 157(188)

    - **AM Peak Hour Total**: 114 + 20 + 57 + 2 + 532 + 157 = 882 vph
    - **PM Peak Hour Total**: 184 + 33 + 91 + 26 + 846 + 188 = 1,368 vph

3.8.2 Capacity Analysis of Traffic Projections

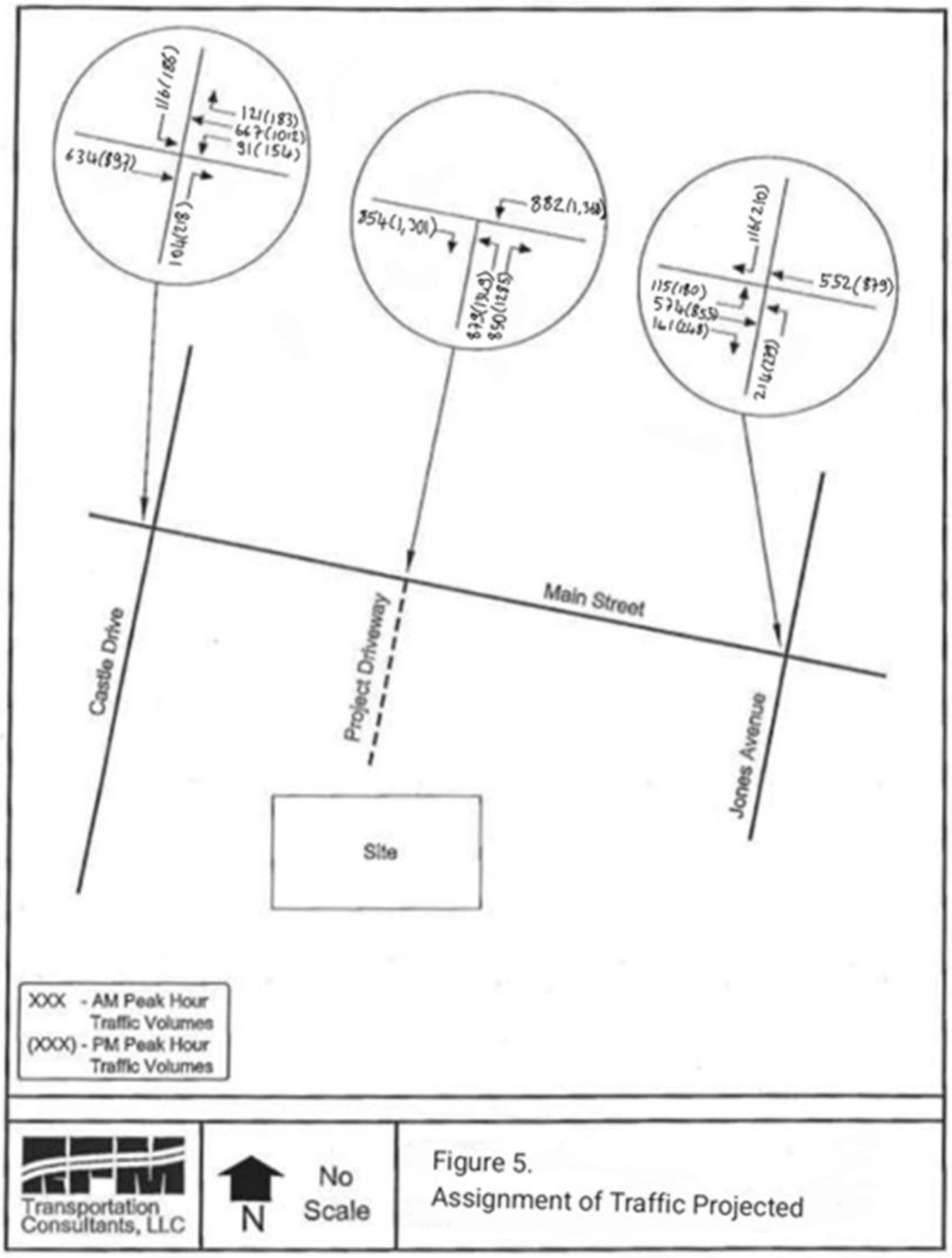


Figure 5. Traffic Projections: *Illustrates projected AM and PM peak-hour traffic volumes at intersections, accounting for both existing and site-generated traffic.*

4. Comparison with Lane Capacity:

- Lane capacity per hour per lane = **1,100 vph**.

- For **AM Peak Hour**:

    - **Entering (Left)**: 854 vph < 1,100 vph → **No widening needed** for this lane.
    - **Entering (Right)**: 882 vph < 1,100 vph → **No widening needed** for this lane.

- For **PM Peak Hour**:
    - **Entering (Left)**: 1,301 vph > 1,100 vph→ **Widening needed** for this lane.
    - **Entering (Right)**: 1,368 vph > 1,100 vph → **Widening needed** for this lane.

5. Recommendation

Based on the **PM Peak Hour** analysis, the projected traffic volumes exceed the lane capacity of **1,100 vph** for both the **left and right entries** at the Castle Drive & Main Street intersection. This suggests that **widening of the roadway** is necessary to accommodate the increased traffic during the PM peak period.

4. Other Important Considerations in the Conduct of Traffic Impact Studies

4.1. Traffic Signal Warrants Analysis

- **Description**: This analysis involves determining whether a new traffic signal is justified at specific intersections based on the *Manual on Uniform Traffic Control Devices (MUTCD)*. Factors such as traffic volume thresholds, pedestrian counts, and accident history are considered.

- **Key Steps**:

    - Collect intersection traffic data (vehicular, pedestrian, and cyclist counts).

    - Compare against MUTCD signal warrants (e.g., minimum vehicular volumes, interruption of continuous traffic flow).

    - Analyze pedestrian crossing needs, especially near schools, hospitals, or retail centers.

- **Importance**: Avoids unnecessary signal installations that may disrupt traffic flow and ensures signals are placed where they improve safety and efficiency.

4.2. Queuing Analysis

- **Description**: This analysis identifies whether the current or projected turn lane lengths are sufficient to handle peak traffic volumes without spillover into through lanes.

- **Key Steps**:

    - Calculate queue lengths based on traffic volumes, signal timing, and vehicle arrival patterns.

    - Simulate peak hour conditions using traffic modeling software (e.g., Synchro, VISSIM).

    - Identify intersections or turn lanes with insufficient capacity.

- **Importance**: Prevents backups at intersections, maintains smooth traffic flow, and reduces the risk of rear-end collisions caused by queuing in through lanes.

4.3. Intersection Level of Service (LOS) Analysis

- **Description**: LOS measures the performance of an intersection by assessing delays, queue lengths, and vehicle throughput under existing and projected conditions.

- **Key Steps**:

    - Use the *Highway Capacity Manual (HCM)* to calculate LOS for all movements at the intersection.

    - Identify intersections operating at LOS D, E, or F, which indicate congestion or delays.

- Propose improvements, such as signal timing adjustments or additional lanes, to improve LOS.

- **Importance**: Ensures intersections operate efficiently, minimizing delays and congestion during peak periods.

4.4. Public Transit Accessibility

- **Description**: Assess the availability, frequency, and capacity of public transit options near the development and their ability to accommodate new riders.

- **Key Steps**:

  - Map transit routes, stops, and schedules near the site.

  - Evaluate the proximity of the development to transit hubs and the adequacy of facilities (e.g., shelters, seating, bike racks).

  - Assess if transit services can handle the additional ridership generated by the development.

- **Importance**: Promotes the use of sustainable transportation, reduces reliance on private vehicles, and aligns with goals to reduce emissions and traffic congestion.

4.5. Pedestrian and Bicycle Infrastructure Assessment

- **Description**: Review the adequacy of sidewalks, crosswalks, bike lanes, and other non-motorized travel facilities, and recommend new infrastructure if needed.

- **Key Steps**:

  - Assess existing pedestrian and bicycle facilities within a 1-mile radius of the site.

  - Identify gaps in connectivity, such as missing sidewalks or bike paths.

  - Propose improvements, such as adding protected bike lanes or enhancing pedestrian crossings.

- **Importance**: Enhances safety for vulnerable users, promotes active transportation, and aligns with multimodal transportation goals.

4.6. Emergency Evacuation Routes

- **Description**: Evaluate the impact of the development on emergency evacuation routes and ensure sufficient capacity and access during emergencies.

- **Key Steps**:

  - Identify designated evacuation routes in the area.

- Analyze the potential impact of increased traffic on these routes.
- Ensure roadways provide adequate access for emergency vehicles during peak traffic periods.

- **Importance**: Maintains public safety and ensures timely responses in emergencies like natural disasters or major accidents.

4.7. Noise and Air Quality Impacts

- **Description**: Assess the development's potential to increase noise levels and emissions, particularly in residential areas or near schools and hospitals.

- **Key Steps**:
  - Use noise and air quality models (e.g., FHWA Traffic Noise Model) to predict impacts.
  - Assess compliance with local noise ordinances and air quality standards.
  - Propose mitigation measures, such as vegetation buffers or quieter pavement materials.

- **Importance**: Protects public health, ensures environmental compliance, and minimizes negative community impacts.

4.8. Coordination with Adjacent Developments

- **Description**: Consider the cumulative traffic impacts of other planned or ongoing developments in the area.

- **Key Steps**:
  - Gather data on nearby developments, including land use and expected trip generation.
  - Combine projected traffic volumes from all developments in the traffic model.
  - Evaluate the combined impact on key intersections and roadways.

- **Importance**: Prevents underestimating traffic impacts and ensures that proposed infrastructure improvements are adequate for long-term needs.

4.9. Parking Demand and Management

- **Description**: Analyze the development's parking needs and its impact on surrounding areas, including the potential for spillover parking.

- **Key Steps**:
  - Calculate parking demand using industry standards, such as the *ITE Parking Generation Manual*.

- Assess the adequacy of proposed on-site parking facilities.
- Propose parking management strategies, such as shared parking agreements or demand-based pricing.

- **Importance**: Ensures efficient land use, avoids parking shortages, and minimizes spillover effects on neighboring properties.

4.10. Construction Traffic Management Plan

- **Description**: Develop a plan to manage temporary traffic disruptions during the construction phase.
- **Key Steps**:
  - Identify potential disruptions, such as road closures or detours.
  - Propose mitigation strategies, such as temporary traffic signals, clear signage, or alternate routes.
  - Coordinate with local authorities to minimize impacts on peak hour traffic.
- **Importance**: Maintains traffic flow, reduces delays, and ensures the safety of workers and road users during construction.

These considerations are essential for creating a well-rounded Traffic Impact Study (TIS) that addresses not only immediate traffic needs but also long-term sustainability and community impacts.

5. Conclusion

5.1. Significant Traffic Impacts of Proposed Development

The study conclusively demonstrates that the proposed mixed-use development will substantially increase traffic volumes on the surrounding roadway network during both AM and PM peak hours. The development is expected to generate **760 vehicles during the AM peak hour** and **1,198 vehicles during the PM peak hour**, adding a significant burden to existing traffic flows at major intersections. This increase, if unmitigated, could lead to unacceptable levels of service (LOS), increased delays, and potential congestion.

5.2. North-South Traffic Flow Dominance

Analysis of the Traffic Analysis Zones (TAZs) reveals that the majority of the new traffic generated by the development—approximately **59.6%**—will flow northward, while **29.5%** will flow southward. Eastward and westward contributions are minimal, accounting for **5.4%** and **5.5%**, respectively. This directional split underscores the importance of improving north-south roadway connections, as these will bear the majority of the development's traffic impacts.

5.3. Intersection Capacity Issues

The intersections of **Main Street and Castle Drive** and **Main Street and Jones Avenue** will experience significant operational challenges, particularly during the PM peak hour. The following issues were identified:

- **Castle Drive and Main Street**:
    - The left-turn lane will face **1,301 vehicles per hour (vph)** during the PM peak, exceeding the standard capacity of **1,100 vph** per lane.
    - The right-turn lane will experience a volume of **1,368 vph**, also exceeding capacity.
- **Jones Avenue and Main Street**:
    - Total volumes at this intersection will reach **1,529 vph** during the PM peak hour, necessitating lane expansions and signal timing adjustments.

These findings indicate that without roadway improvements, both intersections will operate over capacity, leading to delays, queuing, and potential safety concerns.

5.4. Need for Multimodal Infrastructure

The study identified a critical gap in multimodal infrastructure. The surrounding area lacks sufficient sidewalks, pedestrian crossings, and bike lanes, making non-motorized travel options impractical. Public transit service is also limited, further emphasizing the community's reliance on personal vehicles. Addressing these gaps will encourage alternative transportation modes, reduce vehicular traffic, and enhance overall accessibility.

5.5. Importance of Roadway Improvements

Roadway capacity improvements are essential to address the anticipated traffic increases. Specific recommendations include:

- **Intersection Widening**: Adding new lanes at both Castle Drive and Jones Avenue intersections.
- **Signal Optimization**: Upgrading traffic signals to accommodate peak-hour flows and minimize delays.
- **Lane Additions**: Expanding turn lanes to improve intersection efficiency and reduce queuing.

These improvements will be critical for ensuring that the surrounding roadways can handle the projected traffic volumes while maintaining safety and efficiency.

5.6. Significant PM Peak Hour Demand

The PM peak hour is projected to have consistently higher traffic volumes compared to the AM peak hour. This pattern is driven by the mixed-use nature of the development, where retail and residential components generate significant evening activity. For example:

- PM peak hour traffic at **Castle Drive and Main Street** is expected to exceed **1,300 vph**, while the AM peak hour traffic is significantly lower at **854 vph**.
- Similarly, PM traffic at **Jones Avenue and Main Street** will peak at **1,529 vph**, compared to **1,451 vph** in the AM.

This finding highlights the need to prioritize PM peak hour improvements, as this period will experience the greatest traffic stress.

5.7. Development’s Positive Economic Potential

While the traffic impacts of the proposed development are substantial, the project also offers considerable economic benefits, including:

- **Increased Local Amenities**: The inclusion of a shopping center, medical office, and housing units enhances the area's appeal and convenience for residents.
- **Job Creation**: The development will create employment opportunities in retail, construction, and professional services.
- **Economic Growth**: Increased consumer activity and property values will contribute to local revenue generation.

Properly managing traffic impacts will ensure these benefits are realized without compromising the quality of life for existing residents.

5.8. Critical Need for Safety Enhancements

Increased traffic volumes will elevate safety risks, particularly at intersections. Without proactive measures, higher accident rates are likely. To address this, the following improvements are recommended:

- **Pedestrian Crossings**: Adding signalized crosswalks and raised pedestrian islands.
- **Lighting Improvements**: Enhancing visibility at key intersections.
- **Lane Separation**: Installing protective barriers or markings to reduce conflict points.

These safety measures will help mitigate the risks associated with increased traffic volumes and ensure the well-being of all road users.

5.9. Necessity of Long-Term Planning

The study underscores the importance of incorporating long-term planning into transportation infrastructure decisions. The projected population growth and regional development will further strain the roadway network in the coming years. Key recommendations include:

- **Traffic Projections**: Incorporate future growth trends into traffic modeling to avoid underestimating demand.
- **Integrated Planning**: Collaborate with local authorities to align traffic improvements with regional development goals.
- **Periodic Reviews**: Conduct periodic traffic impact assessments to evaluate the effectiveness of implemented measures and identify new challenges.

Long-term planning will ensure the sustainability and resilience of the transportation network.

5.10. Overall Feasibility of Proposed Development

Despite the projected traffic impacts, the proposed mixed-use development is feasible, provided that the recommended mitigation measures are implemented. These include roadway widening, signal optimization, multimodal infrastructure enhancements, and long-term planning. By addressing these traffic challenges, the development can integrate seamlessly into the community, offering economic benefits while maintaining acceptable traffic flow levels.

This Traffic Impact Study concludes that with careful planning and targeted improvements, the proposed development can be successfully accommodated within the existing transportation network.

6. List of References

TNTech University Course-Provided Materials:

- Tennessee Technological University, Department of Civil and Environmental Engineering. **CEE 4660/5660 - Traffic Impact Study Project Resources**, including:
  - Traffic volume data for Main Street, Castle Drive, and Jones Avenue intersections.
  - Population data for Traffic Analysis Zones (TAZs).
  - Figures 1-4 from project materials.
  - Seasonal adjustment factor worksheets.
  - Excel datasets for traffic volume monitoring and projections.

Books:

- Trip Generation Manual, 11th Edition. Institute of Transportation Engineers (ITE). Comprehensive manual detailing methodologies for estimating trip generation based on land use types.
- Traffic Engineering Handbook, 7th Edition. Institute of Transportation Engineers (ITE). Standard resource for understanding traffic flow dynamics and analysis.
- Highway Capacity Manual, 6th Edition. Transportation Research Board (TRB). Provides guidelines for analyzing roadway capacities and levels of service.

Websites:

- Federal Highway Administration (FHWA). **Traffic Monitoring Guide**. https://www.fhwa.dot.gov.
- American Association of State Highway and Transportation Officials (AASHTO). **Traffic Data Guidelines**. https://www.transportation.org.
- National Association of City Transportation Officials (NACTO). **Urban Street Design Guide**. https://nacto.org.
- State of Tennessee Department of Transportation. **Traffic Data and Reports**. https://www.tn.gov/tdot.
- Institute of Transportation Engineers. **Technical Resources**. https://www.ite.org.

7. Appendix

7.1. Traffic Volume Data Analysis

- Detailed raw data for AM and PM peak hour traffic counts at Main Street, Castle Drive, and Jones Avenue intersections.
- Breakdown of turning movements (left, through, right) for all intersections.
- Seasonal adjustment factors applied to extrapolate annual average daily traffic (AADT) from the raw counts.

7.2. Population and Traffic Analysis Zone (TAZ) Data

- Population distribution data for TAZs around the study area.
- Allocation of traffic generation and attraction rates based on population density and land use within each TAZ.

7.3. Trip Generation Calculations

- Step-by-step application of ITE Trip Generation Manual methodologies.
- Calculation of average vehicle trip ends and trip generation rates for residential and commercial land uses.
- Validation of regression equations and determination coefficients (R^2).

7.4. Traffic Distribution and Assignment

- Traffic assignment to roadways based on directional splits derived from existing traffic patterns.
- Distribution of entering and exiting trips at intersections using percentage allocation methods.

7.5. Figures and Tables

- Supplementary figures and tables referenced in the analysis but not included in the main report, such as:
    - Extended traffic volume charts.
    - Additional intersection diagrams.
    - Detailed tables of calculated traffic volumes and growth rates.