

**MASTER PLAN TRAFFIC ANALYSIS
ALLENTOWN ARENA AND MIXED-USED
DEVELOPMENT**

CITY OF ALLENTOWN, LEHIGH COUNTY, PA



For Submission To:

*Allentown Economic Development Corporation
435 Hamilton Street
Allentown, PA 18101*

Prepared By:



TRAFFIC PLANNING AND DESIGN, INC.

WWW.TRAFFICPD.COM

May 31, 2011

HCSD.A.00001

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EXECUTIVE SUMMARY

The purpose of this study is to examine the potential traffic impact associated with the proposed Arena and Mixed-Use Development on the roadway network in the City of Allentown, Lehigh County, PA. Based on this evaluation, the following conclusions were reached:

1. The project will consist of a 235,000 square foot (s.f) multi-use arena and a 100,000 s.f events center. The proposed arena will accommodate minor league hockey games, concerts, and other events. The arena capacity for a hockey game will be 8,500 attendees, and the capacity for concerts and other events will be 10,000 attendees.
2. This Traffic Analysis includes evaluations of two project milestones:
 - **Milestone A:** Includes a 235,000 square foot (s.f) multi-use arena located on the block bordered by Hamilton Street, Linden Street, 8th Street and 7th Street. For the purposes of this study, it was assumed this milestone would be reached in 2013.
 - **Milestone B:** Includes a 100,000 s.f events center located on the block bordered by Hamilton Street, Linden Street, 7th Street and 6th Street. A new parking deck with 500 spaces will also be constructed. For the purposes of this study, it was assumed this milestone would be reached in 2015.
3. It is anticipated that future stages of the project may include additional land uses. The scope of this analysis is limited to the proposed arena and events center.
4. The study area intersections included in this Traffic Analysis are as follows:
 - 7th Street (S.R. 0145) & Turner Street;
 - 6th Street (S.R. 0145) & Turner Street;
 - 9th Street & Linden Street (S.R. 0222);
 - 8th Street & Linden Street (S.R. 0222);
 - 7th Street (S.R. 0145) & Linden Street (S.R. 0222);
 - 6th Street (S.R. 0145) & Linden Street (S.R. 0222);
 - 5th Street & Linden Street;
 - 4th Street & Linden Street;
 - 9th Street & Hamilton Street;
 - 8th Street & Hamilton Street;
 - 7th Street (S.R. 0145) & Hamilton Street;
 - 6th Street (S.R. 0145) & Hamilton Street;
 - 5th Street & Hamilton Street;
 - 4th Street & Hamilton Street;
 - 7th Street (S.R. 0145) & Walnut Street (S.R. 0222);
 - 6th Street (S.R. 0145) & Walnut Street (S.R. 0222).



5. The trip generation rates for the proposed development are based upon data published by the Institute of Transportation Engineers (ITE), Urban Land Institute (ULI), and other available data for the proposed land uses. The total trip generation for each milestone is outlined below:
 - a. **Milestone A (2013)** is expected to generate 67 new vehicle-trips in the weekday AM peak hour, 1,996 new vehicle-trips in the weekday PM peak hour, and 1,996 new vehicle-trips in the Saturday midday peak hour.
 - b. **Milestone B (2015)** is expected to generate 619 new vehicle-trips in the weekday AM peak hour, 468 new vehicle-trips in the weekday PM peak hour, and 546 new vehicle-trips in the Saturday midday peak hour.
6. All study area intersections will operate with an overall intersection level of service (ILOS) C or better following full build out of Milestone A and Milestone B.
7. Based upon this Traffic Analysis, Traffic Planning and Design Inc. (TPD) offers the following recommendations:
 - Evaluate and update the coordinated signal system to optimize the signal timings in conjunction with the anticipated increase in traffic volumes. The study should include all traffic signals on 6th Street, 7th Street, and 8th Street from Union Street to Greenleaf Street, and all signals on Linden Street and Hamilton Street from 4th Street to 15th Street. Adjacent intersections on Walnut Street and Turner Street should also be evaluated.
 - Utilize wayfinding signage to direct motorists to the arena from all major approach routes, including Route 22, Interstate 78, and Route 309. Within the immediate vicinity of the arena, signage should direct motorists to the appropriate parking facilities. Signs directing motorists to Route 22, Interstate 78, and Interstate 476 should be posted to guide exiting traffic.
 - Provide pedestrian oriented wayfinding signage indicating the location of the arena and other downtown attractions at all public parking decks and other key locations throughout the study area.
 - Install a Parking Guidance and Information System, which would utilize variable message signs to indicate the number of available parking spaces in each public parking deck on a real-time basis to motorists approaching the study area on southbound 7th Street and eastbound Hamilton Street.
 - Prepare an event management plan for events at the proposed arena. Event staff may utilize traffic cones, auxiliary signage, and flagging to efficiently guide traffic to event parking.
 - Evaluate the impact of removing pedestrian-only signal phases at critical study area intersections. The effect on vehicular traffic and on pedestrian safety should be considered.
 - At capacity-constrained intersections, a peak-hour parking restriction may be implemented for a given block or blocks in order to provide an additional travel lane.

Because of the resulting loss of on-street parking, the costs and benefits should be further evaluated.

- Additional capacity analysis should be performed to evaluate the traffic conditions during the hour following the end of an event at the arena. Although traffic volumes on the adjacent roadway network are expected to be significantly lower during this late-night peak hour, the intersections adjacent to the public parking decks may require a special timing plan to facilitate efficient egress from the site.
 - Conduct a post-development study following the completion of Milestones A and B to confirm that no further roadway improvements are needed in the study area.
8. Levels of Service (LOS) for the study area intersections have been summarized in matrix form. **Tables I through III** detail the overall intersection LOS for each study area intersection.
 9. Based upon this Traffic Analysis, it is TPD's opinion that the existing roadway infrastructure can accommodate the new traffic generated by the proposed development. Conditions will be further improved with the recommended improvements.



**TABLE I
LEVEL OF SERVICE DELAY (SECONDS) SUMMARY
WEEKDAY AM PEAK HOUR**

Intersection	Existing Conditions	2013 Base Conditions (No Development)	2013 Projected Conditions (Milestone A)	2015 Base Conditions (No Development)	2015 Projected Conditions (Milestone B)
7th Street & Turner Street	B	B	B	B	B
6th Street & Turner Street	A	B	A	B	A
9th Street & Linden Street	B	A	A	A	A
8th Street & Linden Street	B	A	A	A	B
7th Street & Linden Street	A	A	A	A	A
6th Street & Linden Street	A	A	A	A	A
5th Street & Linden Street	B	B	B	B	B
4th Street & Linden Street	B	B	B	B	B
9th Street & Hamilton St.	B	A	A	A	B
8th Street & Hamilton St.	C	B	B	B	B
7th Street & Hamilton St.	A	A	A	A	A
6th Street & Hamilton St.	C	B	B	B	B
5th Street & Hamilton St.	B	B	B	B	B
4th Street & Hamilton St.	B	B	B	B	B
7th Street & Walnut Street	A	A	A	A	A
6th Street & Walnut Street	B	B	B	B	B



**TABLE II
LEVEL OF SERVICE DELAY (SECONDS) SUMMARY
WEEKDAY PM PEAK HOUR**

Intersection	Existing Conditions	2013 Base Conditions (No Development)	2013 Projected Conditions (Milestone A)	2015 Base Conditions (No Development)	2015 Projected Conditions (Milestone B)
7th Street & Turner Street	B	B	B	B	B
6th Street & Turner Street	B	A	B	A	B
9th Street & Linden Street	B	A	B	A	B
8th Street & Linden Street	B	A	B	A	B
7th Street & Linden Street	A	A	B	A	B
6th Street & Linden Street	A	A	B	A	C
5th Street & Linden Street	B	B	B	B	B
4th Street & Linden Street	B	B	B	B	B
9th Street & Hamilton St.	B	B	C	B	C
8th Street & Hamilton St.	C	C	C	C	C
7th Street & Hamilton St.	B	A	C	A	B
6th Street & Hamilton St.	C	C	C	C	C
5th Street & Hamilton St.	B	B	B	B	B
4th Street & Hamilton St.	B	B	B	B	B
7th Street & Walnut Street	A	A	B	A	B
6th Street & Walnut Street	B	A	B	A	B



**TABLE III
LEVEL OF SERVICE DELAY (SECONDS) SUMMARY
SATURDAY MIDDAY PEAK HOUR**

Intersection	Existing Conditions	2013 Base Conditions (No Development)	2013 Projected Conditions (Milestone A)	2015 Base Conditions (No Development)	2015 Projected Conditions (Milestone B)
7th Street & Turner Street	B	B	B	B	B
6th Street & Turner Street	A	A	B	A	B
9th Street & Linden Street	B	A	A	A	B
8th Street & Linden Street	B	B	B	B	B
7th Street & Linden Street	B	A	B	A	B
6th Street & Linden Street	A	A	A	A	B
5th Street & Linden Street	B	A	B	A	B
4th Street & Linden Street	B	B	B	B	B
9th Street & Hamilton St.	A	B	B	B	B
8th Street & Hamilton St.	C	B	C	C	C
7th Street & Hamilton St.	A	A	A	A	B
6th Street & Hamilton St.	C	B	C	B	C
5th Street & Hamilton St.	B	B	B	B	B
4th Street & Hamilton St.	B	A	A	A	B
7th Street & Walnut Street	B	A	A	A	B
6th Street & Walnut Street	A	A	B	A	B

INTRODUCTION

Traffic Planning and Design, Inc. (TPD) has completed a Traffic Analysis for the proposed Arena and Mixed-Use Development in the City of Allentown, Lehigh County, Pennsylvania. The Traffic Analysis includes evaluations of two project milestones:

- **Milestone A:** Includes a 235,000 square foot (s.f) multi-use arena located on the block bordered by Hamilton Street, Linden Street, 8th Street and 7th Street. For the purposes of this study, it was assumed this milestone would be reached in 2013.
- **Milestone B:** Includes a 100,000 s.f events center located on the block bordered by Hamilton Street, Linden Street, 7th Street and 6th Street. A new parking deck with 500 spaces will also be constructed. For the purposes of this study, it was assumed this milestone would be reached in 2015.

It is anticipated that future stages of the project may include additional land uses. The scope of this analysis is limited to the proposed arena and events center. A map of the study area is shown in **Figure 1**.

LAND USE CONTEXT

PennDOT's *Smart Transportation Guidebook* encourages transportation engineers and public officials to consider the surrounding land use context when designing transportation improvements. The land use context refers to the surrounding land uses, building setbacks, architectural types, and other physical characteristics. The land use context within the study area is consistent with the description of the Urban Core designation in Chapter 4 of the guidebook:

Urban Core, "Downtown areas consisting of blocks of higher density, mixed use buildings. Buildings vary in height from 3 to 60+ stories..."

The design of any roadway improvements within the study area should be based upon a clear understanding of the land use context. Design guidelines for an Urban Core area are provided in Chapter 6 of the *Smart Transportation Guidebook*.

EXISTING ROADWAY NETWORK

A field review of the existing roadway system in the study area was conducted. The existing roadway characteristics within the study area are summarized in **Table 1**. The existing lane configuration and intersection controls for the study area intersections are shown in **Figure 2**. The Average Daily Traffic (ADT) volumes are based on data obtained from PennDOT's Internet Traffic Monitoring System (iTMS) in May 2011. Photographs of the study area intersections are included as **Appendix A**, and the signal permit diagrams for each intersection are included in **Appendix B**.



**TABLE 1
ROADWAY CHARACTERISTICS WITHIN STUDY AREA**

Roadway	Ownership	PennDOT Functional Classification	Directional Orientation	Average Daily Traffic	Speed Limit
4 th Street	City	Urban Collector	Bi-Directional	6,119	25 mph
5 th Street	City	Urban Collector	Southbound	Not Available	Not Posted
6 th Street	State (S.R. 0145)	Urban Principal Arterial	Northbound	7,769	Not Posted
7 th Street	State (S.R. 0145)	Urban Principal Arterial	Southbound	14,368	30 mph
8 th Street	City	Urban Collector	Northbound	7,112	Not Posted
9 th Street	City	Urban Collector	Southbound	6,924	Not Posted
Turner Street	City	Urban Collector	Eastbound	4,320	30 mph
Linden Street	State (S.R. 0222)	Urban Principal Arterial	Westbound	8,040	25 mph
Hamilton Street	City	Urban Principal Arterial	Eastbound*	9,539	30 mph
Walnut Street	State (S.R. 0222)	Urban Collector	Eastbound	4,165	Not Posted

*Hamilton Street accommodates bi-directional traffic east of 6th Street

PEDESTRIAN FACILITIES

Downtown Allentown has a wide range of business, residential, and recreational land uses in a compact, walkable area. The majority of available parking spaces are clustered in parking decks and municipal parking lots throughout the area. As a result, there are significant pedestrian volumes, especially along Hamilton Street. To accommodate the high level of pedestrian activity, sidewalks are provided on every block throughout the study area. Additionally, crosswalks and pedestrian oriented signal heads are provided at all study area intersections. Several traffic signals along Hamilton Street also include pedestrian-only phases.

TRANSIT FACILITIES

Public transportation in Lehigh and Northampton Counties is provided by LANTA (Lehigh and Northampton Transportation Authority). LANTA operates a network of 30 fixed bus routes throughout the Lehigh Valley. Based upon data published by LANTA, more than 380,000 people live within walking distance of a LANTA Metro route. Nine bus routes serve downtown

Allentown, providing bus service to points throughout the region. The bus routes are summarized in **Table 2** below, and a map of the routes is included as **Appendix C**.

The Allentown Transportation Center, built in 2007, is located at the intersection of 6th Street & Linden Street, within a two-block walk of most of the proposed development. All bus routes in the vicinity of the proposed development stop at the transportation center. Additionally, there are several bus stops along Hamilton Street and other roadways throughout the study area.

TABLE 2
LANTA BUS ROUTES SERVING DOWNTOWN ALLENTOWN

Route Number	Route Description
A	From West Allentown (Village West) to Bethlehem
D	From Northampton to Emmaus
E	To Bethlehem and Easton
G	From Bethlehem to South Allentown (Susquehanna Street)
H	From South Whitehall (Dorney Park) to Hanover Township (LVI Airport)
J	From South Allentown (South Mall) to South Whitehall (Crest Plaza)
K	From Lehigh Valley Hospital (Cedar Crest Blvd.) to Whitehall
L	From Allentown to Lehigh Valley Mall
W	From Allentown to Orefield and Slatington

EXISTING TRAFFIC CONDITIONS

Manual traffic counts were conducted on 15-minute intervals during the weekday morning (7:00 to 9:00 AM), weekday evening (4:00 to 6:00 PM) and Saturday midday (11:00 AM to 1:00 PM) peak periods. The peak hour of each traffic count consists of the four consecutive 15-minute intervals where the highest traffic volumes occur. Data pertaining to heavy vehicles, pedestrians and transit vehicles were also observed during the manual counts. Peak hours and count dates for the study area intersections are identified in **Table 3**.

Existing Condition traffic volumes for the weekday AM, weekday PM, and Saturday peak hours are illustrated in **Figures 3, 10, and 17**, respectively. Manual traffic count data sheets are provided in **Appendix D**.



**TABLE 3
MANUAL TRAFFIC COUNT INFORMATION**

Intersection	Date of Traffic Counts	Time Period	Intersection Peak Hour
7th Street & Turner Street	Wednesday, April 27, 2011	Weekday AM	7:30 to 8:30 AM
		Weekday PM	4:15 to 5:15 PM
	Saturday, April 30, 2011	Saturday Midday	12:00 AM to 1:00 PM
6th Street & Turner Street	Wednesday, April 27, 2011	Weekday AM	7:30 to 8:30 AM
		Weekday PM	4:15 to 5:15 PM
	Saturday, April 30, 2011	Saturday Midday	12:00 AM to 1:00 PM
9th Street & Linden Street	Wednesday, April 27, 2011	Weekday AM	7:15 to 8:15 AM
		Weekday PM	4:00 to 5:00 PM
	Saturday, April 30, 2011	Saturday Midday	12:00 AM to 1:00 PM
8th Street & Linden Street	Wednesday, April 27, 2011	Weekday AM	7:15 to 8:15 AM
		Weekday PM	4:15 to 5:15 PM
	Saturday, April 30, 2011	Saturday Midday	12:00 AM to 1:00 PM
7th Street & Linden Street	Wednesday, April 27, 2011	Weekday AM	7:15 to 8:15 AM
		Weekday PM	4:00 to 5:00 PM
	Saturday, April 30, 2011	Saturday Midday	12:00 AM to 1:00 PM
6th Street & Linden Street	Wednesday, April 27, 2011	Weekday AM	7:30 to 8:30 AM
		Weekday PM	4:00 to 5:00 PM
	Saturday, April 30, 2011	Saturday Midday	12:00 AM to 1:00 PM
5th Street & Linden Street	Wednesday, April 27, 2011	Weekday AM	7:30 to 8:30 AM
		Weekday PM	4:00 to 5:00 PM
	Saturday, April 30, 2011	Saturday Midday	12:00 AM to 1:00 PM
4th Street & Linden Street	Wednesday, April 27, 2011	Weekday AM	7:30 to 8:30 AM
		Weekday PM	4:00 to 5:00 PM
	Saturday, April 30, 2011	Saturday Midday	12:45 AM to 1:45 PM
9th Street & Hamilton Street	Thursday, April 28, 2011	Weekday AM	7:30 to 8:30 AM
		Weekday PM	4:00 to 5:00 PM
	Saturday, April 30, 2011	Saturday Midday	11:30 AM to 12:30 PM
8th Street & Hamilton Street	Thursday, April 28, 2011	Weekday AM	7:45 to 8:45 AM
		Weekday PM	4:15 to 5:15 PM
	Saturday, April 30, 2011	Saturday Midday	12:00 AM to 1:00 PM
7th Street & Hamilton Street	Thursday, April 28, 2011	Weekday AM	7:30 to 8:30 AM
		Weekday PM	4:00 to 5:00 PM
	Saturday, April 30, 2011	Saturday Midday	12:00 AM to 1:00 PM
6th Street & Hamilton Street	Thursday, April 28, 2011	Weekday AM	7:45 to 8:45 AM
		Weekday PM	4:15 to 5:15 PM
	Saturday, April 30, 2011	Saturday Midday	12:00 AM to 1:00 PM
5th Street & Hamilton Street	Thursday, April 28, 2011	Weekday AM	7:30 to 8:30 AM
		Weekday PM	4:00 to 5:00 PM
	Saturday, April 30, 2011	Saturday Midday	11:00 AM to 12:00 PM
4th Street & Hamilton Street	Thursday, April 28, 2011	Weekday AM	7:30 to 8:30 AM
		Weekday PM	4:00 to 5:00 PM
	Saturday, April 30, 2011	Saturday Midday	11:45 AM to 12:45 PM
7th Street & Walnut Street	Thursday, April 28, 2011	Weekday AM	7:30 to 8:30 AM
		Weekday PM	4:30 to 5:30 PM
	Saturday, April 30, 2011	Saturday Midday	12:00 AM to 1:00 PM
6th Street & Walnut Street	Thursday, April 28, 2011	Weekday AM	7:30 to 8:30 AM
		Weekday PM	4:00 to 5:00 PM
	Saturday, April 30, 2011	Saturday Midday	11:45 AM to 12:45 PM

BASE (NO-BUILD) CONDITIONS

A background growth factor for traffic in the study area was developed based on growth factors for July 2010 to July 2011 obtained from the PennDOT Bureau of Planning and Research (BPR). The growth rate accounts for potential increases in study area traffic due to development in the surrounding area. The PennDOT BPR suggests using a background growth trend factor of 1.22% per year in Lehigh County for urban non-interstate roadways.

The additional traffic volumes due to background growth were added to the existing traffic data to produce 2013 and 2016 Base Condition (no-build) traffic volumes.

SCHEDULED ROADWAY IMPROVEMENTS

Based upon the Lehigh Valley Surface Transportation Plan prepared by the Lehigh Valley Planning Commission in October 2010, there are scheduled roadway improvements that, if completed, may affect traffic patterns in the vicinity of the proposed development.

A new link will be added to the regional roadway network with the completion of the proposed American Parkway Bridge over the Lehigh River. The project is currently in the final stages of the design process and construction on the project is expected to begin in late 2011. The new bridge connecting Airport Road to Front Street in Allentown will provide a direct route to downtown Allentown from Route 22. The bridge will provide an alternative to the congested Route 22/MacArthur Road interchange and the Route 22 Bridge over the Lehigh River. The proposed bridge will be located approximately 1.5 miles outside the study area.

Improvements are also proposed at the Route 22/MacArthur Road interchange in Whitehall Township. The Route 22 Section 400 Phase I project would replace two ramps at the interchange in order to eliminate weaving sections and improve safety at the interchange. This project is not expected to significantly impact the capacity of the interchange. If approved, construction of the project could begin as soon as 2011.

The 15th Street/Ward Street Bridge over the Little Lehigh Creek in Allentown is currently closed to northbound traffic indefinitely. The 15th Street Bridge was used by an estimated 20,000 vehicles per day prior to the partial closure in November 2010. It is TPD's understanding that the bridge is scheduled to be completely replaced, and that the design for the project is currently underway. The bridge is located approximately 1.5 miles outside the study area. It is expected that the bridge will be replaced prior to Milestone A of the proposed development (2013).

The City of Allentown has also completed a long-range plan for pedestrian and bicycle facilities in the city. The "Connecting Our Community" plan aims to connect Allentown's existing parks and trails and to provide safe pedestrian and bicycle connections to destinations throughout the city. The plan will be implemented on an incremental basis as funding for individual projects becomes available. The City is currently working with a transportation consultant to evaluate the potential for bicycle and pedestrian improvements along Linden Street and Turner Street. No definite design or construction schedule for the project has been released.

TRIP GENERATION

The trip generation rates for the proposed development are based upon data published by the Institute of Transportation Engineers (ITE), Urban Land Institute (ULI), and other available data for the proposed land uses.

ITE Trip Generation Manual

The ITE *Trip Generation* manual, Eighth Edition, 2008, is the primary source utilized by traffic engineers to determine the trip generation characteristics of a given land use. The statistics in *Trip Generation* are empirical data based on more than 4,800 trip generation studies. The data are categorized by Land Use Codes, with total vehicular trips for a given land use estimated using an independent variable and statistically generated rates or equations.

Arena Trip Generation

The published data in the *Trip Generation* manual for arenas (ITE Land Use Code 460) is based upon a single site surveyed in California in 1970. The data is limited to the number of trips generated over the course of an average weekday. Because the data is based upon a single study completed more than four decades ago, TPD determined this information was not a reliable indicator of the traffic that will be generated by the proposed arena.

Therefore, TPD researched applicable data for stadiums, arenas, and concerts. **Table 4** below summarizes the occupancy rates (persons per car) for vehicles arriving at arenas or similar facilities:

**TABLE 4
VEHICLE OCCUPANCY DATA**

Data Source	Vehicle Occupancy Rate
1994 ITE Report on Stadia and Arenas	3.0 to 3.5
ULI Shared Parking Manual (p. 62) - Arena (Concerts)	2.0
ULI Shared Parking Manual (p. 63) - Arena Public Parking	3.0
ULI Shared Parking Manual (p. 69) – Stadium (Football Game)	3.3
ITE Discussion Group – 2003 San Antonio Amphitheatre Study (9,000 attendees)	2.60 -2.75
Average	2.88

The proposed arena will be designed to seat 8,500 attendees for hockey games, and up to 10,000 attendees for concerts and other events. In order to provide a conservative analysis, TPD evaluated the trip generation for a sold-out event with 10,000 attendees, and estimated that the vehicle occupancy rate will be 2.75 persons per car. This would result in a total of 3,636 vehicles.

In 2002, The Traffic Group conducted a post-development study for a 6,000 seat minor league baseball stadium in Aberdeen, Maryland. The results of this study indicated that 61% of attendees arrived at the stadium during the hour prior to the event beginning. Additionally, a study published by the Transportation Research Board in 2001 found that for large special events approximately 60% of attendees will arrive within one hour of the start of the event.

Based upon these studies, it was assumed that 61% of the 3,636 vehicles generated by a sold-out event would arrive in the hour prior to the start of the event. By applying this percentage to the



3,636 total trips, it was determined that the arena will generate a total of 2,218 peak hour trips. This number was applied for the weekday PM peak hour and Saturday midday peak hour.

Comparison to Minor League Baseball Stadiums

In order to verify these results, TPD reviewed trip generation data for two minor league stadiums. The above-referenced study in Aberdeen, MD concluded that a typical sold-out minor league baseball game (6,000 attendees) generated a total of 1,607 additional trips when compared to a non-game day. As noted above, 61% of traffic arrived in the hour prior to the event. This indicates a peak hour trip generation rate of 0.164 trips per hour per attendee.

As a final comparison, TPD conducted trip generation counts at Coca-Cola Park in Allentown, Pennsylvania. Coca-Cola Park was constructed in 2008 and is home to the Lehigh Valley Iron Pigs, AAA-affiliate of the Philadelphia Phillies. The capacity of the stadium is 10,000 fans. The counts were conducted from 5:00-7:30 PM on Friday, May 13, 2011. The first pitch of the game was at 7:05, and the attendance for the game was 9,660. A total of 2,709 trips were generated by the stadium between 5:00-7:30. 1,651 trips (61% of traffic) arrived from 6:00-7:00, which is consistent with the studies outlined above. A summary of data collected at Coca-Cola Park is included in **Appendix E. Table 5** below compares the trip generation calculations conducted by TPD to the data collected at the minor league baseball stadiums.

**TABLE 5
TRIP GENERATION COMPARISON**

Data Source	Trip Generation Rate	Resulting Peak Hour Trips
Ripken Stadium (Aberdeen, MD)	$T = 0.164*(X)$	1,634
Coca-Cola Park (Allentown, PA)	$T = 0.170*(X)$	1,701
Calculations Based Upon Vehicle Occupancy Data	N/A	2,218

T = number of site-generated vehicular trips
X = independent variable (attendees)

Based upon the data summarized in **Table 5**, TPD is confident that the trip generation calculations for the proposed arena represent a conservative estimate.

Weekday AM Peak Hour

To evaluate the trip generation characteristics of an arena during the weekday AM peak hour, TPD utilized data published in the ITE *Trip Generation* manual for an office, as shown in **Table 6**. TPD assumed that the arena will have approximately 100 daytime employees.

**TABLE 6
ITE TRIP GENERATION DATA**

Land Use	ITE #	Time Period	Equations/Rates	Entering %	Exiting %
Office	710	Weekday AM Peak Hour	$\ln(T) = 0.86*\ln(X) + 0.24$	88%	12%

T = number of site-generated vehicular trips
X = independent variable (employees)



Events Center Trip Generation

Similarly, the ITE *Trip Generation* manual does not provide trip generation data for an events center. Therefore, the trip generation of the proposed event center was based upon data collected by TPD for two trade events at the Greater Reading Expo Center in 2008. The data for the two trade events is summarized in **Table 7**.

**TABLE 7
TRIP GENERATION SUMMARY – STUDIED TRADE EVENTS**

Time Period	Attendees	Event Trips			Rate	Directional Distribution	
		Enter	Exit	Total		Entering	Exiting
World Congress on Disabilities Expo Show – Friday (9:00 AM-5:00 PM)							
Weekday Event Peak Hour (9:00-10:00 AM) ¹	714	135	26	161	0.225	84%	16%
Weekday PM Peak Hour (4:00-5:00 PM) ²		13	122	135	0.189	10%	90%
Pennsylvania Gift Show – Tuesday (9:00 AM-6:00 PM)							
Weekday Event Peak Hour (9:00-10:00 AM) ¹	1298	250	34	284	0.219	88%	12%
Weekday PM Peak Hour (4:00-5:00 PM) ²		28	174	202	0.156	14%	86%
World Congress on Disabilities Expo Show – Saturday (9:00 AM-5:00 PM)							
Saturday Event Peak Hour (9:30-10:30 AM) ¹	610	123	11	134	0.220	92%	8%
Weekend Peak Hour (12:15-1:15 PM) ²		63	64	127	0.208	50%	50%
Pennsylvania Gift Show – Sunday (9:00 AM-5:00 PM)							
Saturday Event Peak Hour (9:00-10:00 AM) ¹	1801	311	26	337	0.187	92%	8%
Weekend Peak Hour (12:00-1:00 PM) ²		105	101	206	0.114	51%	49%

¹Peak hour of the generator

²Peak hour of adjacent street traffic

Trip generation rates were determined based upon the total peak hour trips for the two events divided by the total number of attendees. The resulting rates are shown in **Table 8** below.

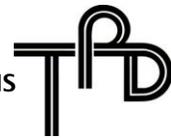
**TABLE 8
EVENTS CENTER TRIP GENERATION DATA**

Land Use	Time Period	Equations/Rates	Independent Variable	Entering %	Pass-By %
Events Center	Weekday AM Peak Hour	T = 0.221*(X)	attendees	87%	0%
	Weekday PM Peak Hour	T = 0.167*(X)	attendees	12%	0%
	Saturday Midday Peak Hour	T = 0.195*(X)	attendees	92%	0%

T = number of site-generated vehicular trips

X = independent variable

Because the trip generation rates are based upon the number of attendees, an investigation was performed to determine the number of attendees that may be accommodated by the proposed events center on a daily basis. The ULI *Shared Parking* manual includes case studies for convention



centers in Anaheim and Indiana. For each facility, the manual states both the nominal maximum attendance per 1,000 s.f. and the actual maximum daily attendance on the busiest days. A summary of the relevant data is included in **Table 9** below.

**TABLE 9
EVENTS CENTER TRIP GENERATION DATA**

Convention Center Location	Floor Area	Maximum Daily Attendance	Calculated Maximum Daily Attendance/1,000 s.f.	Nominal Daily Attendance/1,000 s.f.
Anaheim	961,250	25,000 attendees	26	35
Indiana	536,925	10,900 attendees	20	28

The average of the rates listed above is 27.25 daily attendees per 1,000 s.f. A rate of 28 attendees per 1,000 s.f. was applied to the proposed 100,000 s.f. events center, and it was estimated that the proposed events center will have a peak attendance of 2,800 attendees per day.

Transit/Pedestrian/Bicycle Facilities

The trip generation rates published in the ITE *Trip Generation* manual are based upon data collected at isolated suburban locations that are primarily dependent on automobiles. For developments that accommodate alternative modes of transportation (i.e. rail, bus, bicycle and pedestrians), it is expected that a percentage of site-generated traffic will be non-vehicular trips. As noted above, the proposed development will be located in an urban core area with high-quality pedestrian accommodations and access to mass transit provided by LANTA. To account for non-vehicular trips, a 10% reduction factor was applied to the weekday PM and Saturday midday peak hour trip generation calculations for the proposed arena. In order to be conservative, no multimodal reduction was applied.

The total trip generation of the proposed development is summarized in **Table 10**.

**TABLE 10
TRIP GENERATION SUMMARY**

Land Use	Time Period	Total Trips	Multimodal Reduction	Vehicular Trips		
				Total	Enter	Exit
Multi-Use Arena (Milestone A)	Weekday AM Peak Hour	67	0	67	59	8
	Weekday PM Peak Hour	2218	-222	1996	1996	0
	Saturday Midday Peak Hour	2218	-222	1996	1996	0
Events Center (Milestone B)	Weekday AM Peak Hour	619	0	619	539	80
	Weekday PM Peak Hour	468	0	468	56	412
	Saturday Midday Peak Hour	546	0	546	502	44

TRIP DISTRIBUTION

The distribution and assignment of new trips generated by the proposed development was based upon a gravity model analysis performed using 2010 U.S. Census population data. The gravity model utilized data from all counties located within a sixty-minute drive of the proposed development. Data from the following counties was evaluated: Luzerne, Carbon, Monroe, Schuylkill, Lehigh, Northampton, Berks, Montgomery, Bucks, Philadelphia, Warren (NJ), and Hunterdon (NJ). For counties where only a portion of the county was within a sixty-minute drive, an equivalent percentage of the county's population was utilized for the gravity model. For Lehigh and Northampton counties, each individual municipality was accounted for based upon its population and driving distance from downtown Allentown. All calculations utilized for the gravity model are included in **Appendix F**.

The traffic from each surrounding municipality was then assigned to one of nine primary routes to enter/exit downtown Allentown. The total traffic utilizing each approach route was based upon the gravity model calculations outlined above. The new trips for the proposed development were distributed to the local roadway network based on the percentages shown in **Table 11**.

**TABLE 11
TRIP DISTRIBUTION PERCENTAGES**

Direction To/From	Route	Distribution %
East	Route 22	18%
	Tilghman Street	6%
	Hamilton Street	6%
West	Route 22	27%
	Tilghman Street	5%
	Hamilton Street	10%
North	Route 145	8%
South	6 th Street/7 th Street/8 th Street	13%
	15 th Street	7%
TOTAL		100%

The following figures illustrate how the trips were assigned to the roadway network for each milestone:

- Milestone A (AM Peak Hour) – **Figure 5**;
- Milestone A (PM Peak Hour) – **Figure 12**;
- Milestone A (Saturday Peak Hour) – **Figure 19**;
- Milestone B (AM Peak Hour) – **Figure 8**;
- Milestone B (PM Peak Hour) – **Figure 15**;
- Milestone B (Saturday Peak Hour) – **Figure 22**.

It should be noted that the trip distribution figure for Milestone B **includes traffic generated by Milestone A**.

PROJECTED (BUILD) CONDITION TRAFFIC VOLUMES

The site-generated trips for the proposed development were added to the Base Condition (no-build) volumes to develop 2013 and 2015 Projected Condition (build) traffic volumes.

CAPACITY ANALYSIS METHODOLOGY

Capacity analyses were conducted for the weekday AM, weekday PM, and Saturday midday peak hours at the study area intersections. These analyses were conducted according to the methodologies contained in the 2000 *Highway Capacity Manual* (HCM) using *Synchro 7* software, a Trafficware product. The following conditions were analyzed:

- Existing Conditions;
- 2013 Base Conditions (with **no** development);
- 2013 Projected Conditions (with completion of Milestone A);
- 2015 Base Conditions (with **no** development);
- 2015 Projected Conditions (with completion of Milestone A and B).

Signal timings within the study area were optimized for all future conditions (Base Conditions and Projected Conditions) scenarios, in accordance with PennDOT policy. Capacity analysis worksheets are included in **Appendix G**.

LEVELS OF SERVICE IN THE STUDY AREA

For analysis of intersections, level of service is defined in terms of delay, which is a measure of driver discomfort and frustration, fuel consumption, and lost travel time. LOS criteria is stated in terms of control delay per vehicle for a one-hour analysis period. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. The criteria are shown in **Table 12**. Delay, as it relates to level of service, is a complex measure and is dependent upon a number of variables. For signalized intersections, these variables include the quality of vehicle progression, the cycle length, the green time ratio, and the volume/capacity ratio for the lane group in question. For unsignalized intersections, delay is related to the availability of gaps in the flow of traffic on the major street and the driver's discretion in selecting an appropriate gap for a particular movement from the minor street (straight across, left or right turn).

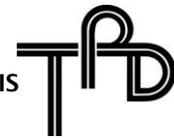
TABLE 12
LEVEL OF SERVICE CRITERIA
UNSIGNALIZED AND SIGNALIZED INTERSECTIONS¹

Level of Service	Control Delay Per Vehicle (Seconds)	
	Signalized	Unsignalized
A	≤ 10	≤ 10
B	> 10 and ≤ 20	> 10 and ≤ 15
C	> 20 and ≤ 35	> 15 and ≤ 25
D	> 35 and ≤ 55	> 25 and ≤ 35
E	> 55 and ≤ 80	> 35 and ≤ 50
F	> 80	> 50

¹ Obtained from Exhibits 16-2 and 17-2 of the Transportation Research Board's *Highway Capacity Manual*, 2000 Edition

Level of service (LOS) is a qualitative measure representing the driver's perception of the operating conditions. It should be noted that the level of service does not account for differences in driver expectation based on context. For instance, a driver may be frustrated with an average delay of 60 seconds at an intersection within rural areas, but accepting of a 60-second delay, and in general lower levels of service within urban areas.

Levels of service (LOS) at the study area intersections are summarized in **Figures 24 through 28** for the weekday AM peak hour, **Figures 29 through 33** for the weekday PM peak hour, and **Figures 35 through 38** for the Saturday midday peak hour. Level of service (LOS) matrices for the study area intersections are shown in **Tables 13 through 15** for the weekday AM, weekday PM, and Saturday midday peak hours.



**TABLE 13
LEVEL OF SERVICE DELAY (SECONDS) SUMMARY
WEEKDAY AM PEAK HOUR**

Intersection	Existing Conditions	2013 Base Conditions (No Development)	2013 Projected Conditions (Milestone A)	2015 Base Conditions (No Development)	2015 Projected Conditions (Milestone B)
7th Street & Turner Street	B	B	B	B	B
6th Street & Turner Street	A	B	A	B	A
9th Street & Linden Street	B	A	A	A	A
8th Street & Linden Street	B	A	A	A	B
7th Street & Linden Street	A	A	A	A	A
6th Street & Linden Street	A	A	A	A	A
5th Street & Linden Street	B	B	B	B	B
4th Street & Linden Street	B	B	B	B	B
9th Street & Hamilton St.	B	A	A	A	B
8th Street & Hamilton St.	C	B	B	B	B
7th Street & Hamilton St.	A	A	A	A	A
6th Street & Hamilton St.	C	B	B	B	B
5th Street & Hamilton St.	B	B	B	B	B
4th Street & Hamilton St.	B	B	B	B	B
7th Street & Walnut Street	A	A	A	A	A
6th Street & Walnut Street	B	B	B	B	B



**TABLE 14
LEVEL OF SERVICE DELAY (SECONDS) SUMMARY
WEEKDAY PM PEAK HOUR**

Intersection	Existing Conditions	2013 Base Conditions (No Development)	2013 Projected Conditions (Milestone A)	2015 Base Conditions (No Development)	2015 Projected Conditions (Milestone B)
7th Street & Turner Street	B	B	B	B	B
6th Street & Turner Street	B	A	B	A	B
9th Street & Linden Street	B	A	B	A	B
8th Street & Linden Street	B	A	B	A	B
7th Street & Linden Street	A	A	B	A	B
6th Street & Linden Street	A	A	B	A	C
5th Street & Linden Street	B	B	B	B	B
4th Street & Linden Street	B	B	B	B	B
9th Street & Hamilton St.	B	B	C	B	C
8th Street & Hamilton St.	C	C	C	C	C
7th Street & Hamilton St.	B	A	C	A	B
6th Street & Hamilton St.	C	C	C	C	C
5th Street & Hamilton St.	B	B	B	B	B
4th Street & Hamilton St.	B	B	B	B	B
7th Street & Walnut Street	A	A	B	A	B
6th Street & Walnut Street	B	A	B	A	B



**TABLE 15
LEVEL OF SERVICE DELAY (SECONDS) SUMMARY
SATURDAY MIDDAY PEAK HOUR**

Intersection	Existing Conditions	2013 Base Conditions (No Development)	2013 Projected Conditions (Milestone A)	2015 Base Conditions (No Development)	2015 Projected Conditions (Milestone B)
7th Street & Turner Street	B	B	B	B	B
6th Street & Turner Street	A	A	B	A	B
9th Street & Linden Street	B	A	A	A	B
8th Street & Linden Street	B	B	B	B	B
7th Street & Linden Street	B	A	B	A	B
6th Street & Linden Street	A	A	A	A	B
5th Street & Linden Street	B	A	B	A	B
4th Street & Linden Street	B	B	B	B	B
9th Street & Hamilton St.	A	B	B	B	B
8th Street & Hamilton St.	C	B	C	C	C
7th Street & Hamilton St.	A	A	A	A	B
6th Street & Hamilton St.	C	B	C	B	C
5th Street & Hamilton St.	B	B	B	B	B
4th Street & Hamilton St.	B	A	A	A	B
7th Street & Walnut Street	B	A	A	A	B
6th Street & Walnut Street	A	A	B	A	B

As shown in **Tables 13, 14, and 15**, all study area intersections will operate with an overall intersection level of service (ILOS) C or better for with full build out of Milestone A and Milestone B.

RECOMMENDATIONS

Based upon this Traffic Analysis, Traffic Planning and Design Inc. (TPD) offers the following recommendations:

1. Evaluate and update the coordinated signal system to optimize the signal timings in conjunction with the anticipated increase in traffic volumes. The study should include all traffic signals on 6th Street, 7th Street, and 8th Street from Union Street to Greenleaf Street, and all signals on Linden Street and Hamilton Street from 4th Street to 15th Street. Adjacent intersections on Walnut Street and Turner Street should also be evaluated.
2. Utilize wayfinding signage to direct motorists to the arena from all major approach routes, including Route 22, Interstate 78, and Route 309. Within the immediate vicinity of the arena, signage should direct motorists to the appropriate parking facilities. Signs directing motorists to Route 22, Interstate 78, and Interstate 476 should be posted to guide exiting traffic.
3. Provide pedestrian oriented wayfinding signage indicating the location of the arena and other downtown attractions at all public parking decks and other key locations throughout the study area.
4. Install a Parking Guidance and Information System, which would utilize variable message signs to indicate the number of available parking spaces in each public parking deck on a real-time basis to motorists approaching the study area on southbound 7th Street and eastbound Hamilton Street.
5. Prepare an event management plan for events at the proposed arena. Event staff may utilize traffic cones, auxiliary signage, and flagging to efficiently guide traffic to event parking.
6. Evaluate the impact of removing pedestrian-only signal phases at critical study area intersections. The effect on vehicular traffic and on pedestrian safety should be considered.
7. At capacity-constrained intersections, a peak-hour parking restriction may be implemented for a given block or blocks in order to provide an additional travel lane. Because of the resulting loss of on-street parking, the costs and benefits should be further evaluated.
8. Additional capacity analysis should be performed to evaluate the traffic conditions during the hour following the end of an event at the arena. Although traffic volumes on the adjacent roadway network are expected to be significantly lower during this late-night peak hour, the intersections adjacent to the public parking decks may require a special timing plan to facilitate efficient egress from the site.
9. Conduct a post-development study following the completion of Milestones A and B to confirm that no further roadway improvements are needed in the study area.

CONCLUSIONS

Based on the results of the Traffic Analysis, TPD offers the following conclusions:

- The project will consist of a 235,000 square foot (s.f) multi-use arena and a 100,000 s.f events center. The proposed arena will accommodate minor league hockey games, concerts, and other events. The arena capacity for a hockey game will be 8,500 attendees, and the capacity for concerts and other events will be 10,000 attendees.
- This Traffic Analysis includes evaluations of two project milestones:
 - **Milestone A:** Includes a 235,000 square foot (s.f) multi-use arena located on the block bordered by Hamilton Street, Linden Street, 8th Street and 7th Street. For the purposes of this study, it was assumed this milestone would be reached in 2013.
 - **Milestone B:** Includes a 100,000 s.f events center located on the block bordered by Hamilton Street, Linden Street, 7th Street and 6th Street. A new parking deck with 500 spaces will also be constructed. For the purposes of this study, it was assumed this milestone would be reached in 2015.
- It is anticipated that future stages of the project may include additional land uses. The scope of this analysis is limited to the proposed arena and events center.
- The study area intersections included in this Traffic Analysis are as follows:
 - 7th Street (S.R. 0145) & Turner Street;
 - 6th Street (S.R. 0145) & Turner Street;
 - 9th Street & Linden Street (S.R. 0222);
 - 8th Street & Linden Street (S.R. 0222);
 - 7th Street (S.R. 0145) & Linden Street (S.R. 0222);
 - 6th Street (S.R. 0145) & Linden Street (S.R. 0222);
 - 5th Street & Linden Street;
 - 4th Street & Linden Street;
 - 9th Street & Hamilton Street;
 - 8th Street & Hamilton Street;
 - 7th Street (S.R. 0145) & Hamilton Street;
 - 6th Street (S.R. 0145) & Hamilton Street;
 - 5th Street & Hamilton Street;
 - 4th Street & Hamilton Street;
 - 7th Street (S.R. 0145) & Walnut Street (S.R. 0222);
 - 6th Street (S.R. 0145) & Walnut Street (S.R. 0222).
- The trip generation rates for the proposed development are based upon data published by the Institute of Transportation Engineers (ITE), Urban Land Institute (ULI), and other available data for the proposed land uses. The total trip generation for each milestone is outlined below:
 - **Milestone A** (2013) is expected to generate 67 new vehicle-trips in the weekday AM peak hour, 1,996 new vehicle-trips in the weekday PM peak hour, and 1,996 new vehicle-trips in the Saturday midday peak hour.



-
- **Milestone B** (2015) is expected to generate 619 new vehicle-trips in the weekday AM peak hour, 468 new vehicle-trips in the weekday PM peak hour, and 546 new vehicle-trips in the Saturday midday peak hour.
 - All study area intersections will operate with an overall intersection level of service (ILOS) C or better following full build out of Milestone A and Milestone B.
 - Based upon this Traffic Analysis, it is TPD's opinion that the existing roadway infrastructure can accommodate the new traffic generated by the proposed development. Conditions will be further improved with the recommended improvements.