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MEMORANDUM

Ref: 1181
Subject: Pharmacy Pick-Up and Drop-Off Windows Queues and Volumes
From: Kim Eric Hazarvartian, Ph.D., P.E., PTOE Principal
Date: December 22, 2011

INTRODUCTION

Shops at Kelly's Corner, LLC has retained TEPP LLC to prepare this memorandum on pharmacy pick-up and drop-off windows. The memorandum includes:

- information on queues and volumes observed for pharmacy pick-up and drop-off windows including available data from previous studies
- information on bank drive-through facilities

Based on the information presented below:

- for pharmacies, the maximum observed queue ranged from one to four vehicles in total
- for banks, the maximum observed queue was seven vehicles in total

Appropriate facility design can accommodate queues for pharmacies and banks. Queuing and volumes tend to be minimal at pharmacy windows.

PHARMACIES

Table 1 shows queues and volumes observed for pharmacy pick-up and drop-off windows. The attached existing data were collected:

- at a total of four Rite-Aid, Walgreens and CVS pharmacies
- at stores in Massachusetts and Rhode Island
- during 2007 and 2008
- during the weekday AM, weekday PM and Saturday midday peak periods

Table 1. Observed pharmacy window queues and volumes.

Store, Location, Time	Maximum Queue (veh)[a]	Maximum Peak-Hour Volume (vph)[b]
Rite-Aid, 237 Broadway, Taunton, Massachusetts		
Weekday PM Street-Peak Period May 16, 2008, Friday, 4:55 to 5:40 PM	4	Not Available
Walgreens, 3336 Post Road, Warwick, Rhode Island		
Weekday AM Street-Peak Period September 20, 2007, Thursday, 7:00 to 9:00 AM	1	1
Weekday PM Street-Peak Period September 13, 2007, Thursday, 4:30 to 6:30 PM	1	5
Saturday Midday Retail-Peak Period September 15, 2007, 11:00AM to 2:00 PM	1	3
Walgreens, 2399 Warwick Avenue, Warwick, Rhode Island		
Weekday AM Street-Peak Period September 13, 2007, Thursday, 8:00 to 9:00 AM	1	3
Weekday PM Street-Peak Period September 13, 2007, Thursday, 4:00 to 6:00 PM	2	7
Saturday Midday Retail-Peak Period September 15, 2007, 11:00AM to 2:00 PM	1	7
CVS, 527 Main Street, East Greenwich, Rhode Island		
Weekday AM Street-Peak Period September 28, 2007, Friday, 7:00 to 9:00 AM	1	9
Weekday PM Street-Peak Period September 28, 2007, Thursday, 4:00 to 6:00 PM	2	20
Saturday Midday Retail-Peak Period September 29, 2007, 11:00AM to 2:00 PM	3	4

Based on data provided by RJ O'Connell & Associates, Inc.

[a]Total vehicles (veh).

[b]Total vehicles per hour (vph).

Findings are:

- the maximum observed queue ranged from one to four vehicles in total[1]
- the average observed weekday-AM-peak-hour volume was 4.33 vehicles, or an average of about one vehicle per 14 minutes

[1] Attached Traffic Data Inc. memorandum, "Vehicle Trip Generation Studies for CVS Pharmacies," (St. Louis Park, Minnesota), November 13, 2009 confirms this finding.

- the average observed weekday-PM-peak-hour volume was 10.67 vehicles, or an average of about one vehicle per six minutes
- the average observed Saturday-peak-hour volume was 4.66 vehicles, or an average of about one vehicle per 13 minutes

BANKS

TEPP LLC reported observations of drive-through queuing at four banks in Massachusetts during 2007. The maximum observed queue was seven vehicles in total. [2]

CONCLUSION

Based on the information presented above:

- for pharmacies, the maximum observed queue ranged from one to four vehicles in total
- for banks, the maximum observed queue was seven vehicles in total

Appropriate facility design can accommodate queues for pharmacies and banks. Queuing and volumes tend to be minimal at pharmacy windows.[3] A sample concept plan for a pharmacy pick-up and drop-off window is attached.[4]

Attachments: Drop-Off/Pick-Up Window Queue Study, Rite-Aid Pharmacy, Broadway, Taunton, Massachusetts, May 16, 2008, provided by RJ O'Connell & Associates, Inc.

Trip-Generation Count, Walgreens, 3336 Post Road, Warwick, Rhode Island, September 20, 13 and 15, 2007, provided by RJ O'Connell & Associates, Inc.

Trip-Generation Count, 2399 Warwick Avenue, Warwick, Rhode Island, September 13 and 15, 2007, provided by RJ O'Connell & Associates, Inc.

Trip-Generation Count, 527 Main Street, East Greenwich, Rhode Island, September 28 and 29, 2007, provided by RJ O'Connell & Associates, Inc.

[2] TEPP LLC memorandum, "Traffic Assessment Supplement, Proposed Bank, Middleton, Massachusetts" (Concord, New Hampshire), September 14, 2007, page 1. Observations conducted by New England Engineering Services, Inc.

[3] For more information on a variety of drive-through-facility types, see ITE Technical Council Committee 5D-10, "Queuing Areas for Drive-Thru Facilities," *ITE Journal*, May 1995, pages 38 to 42.

[4] RJ O'Connell & Associates, Inc., Conceptual Site Plan, CVS/pharmacy, Great Road, Acton, Massachusetts, December 20, 2011.

Traffic Data Inc. memorandum, “Vehicle Trip Generation Studies for CVS Pharmacies,” (St. Louis Park, Minnesota), November 13, 2009

ITE Technical Council Committee 5D-10, “Queuing Areas for Drive-Thru Facilities,” *ITE Journal*, May 1995

RJ O’Connell & Associates, Inc., Conceptual Site Plan, CVS/pharmacy, Great Road, Acton, Massachusetts, December 20, 2011

Drop-Off/Pick-Up Window Queue Study
Date: Friday, May 16, 2008
Location: RiteAid - Broadway, Taunton, MA

PM Time In	PM Time Out	Vehicles in queue	Time in Queue (min)	Weather Conditions
4:55	4:47	1	2	Light rain
4:58	5:03	1	5	Light rain
5:06	5:10	1	4	Mod. to heavy rain
5:07	5:14	2	7	Mod. to heavy rain
5:08	5:16	3	8	Mod. to heavy rain
5:10	5:18	4	8	Mod. to heavy rain
5:12	5:20	4	8	Mod. to heavy rain
5:19	5:21	2	2	Light rain
5:20	5:25	2	5	Light rain
5:32	5:36	1	4	No rain
5:33	5:37	2	4	Light rain
5:40	5:46	1	6	Light rain

Field Data Collection Form- Trip Generation Count
Date: September 20, 2007
Time: 7:00 AM to 9:00 AM
Location: Walgreens - 3336 Post Road in Warwick, RI
Counter: Scott Chandler / Christina DeBarros

Interval	Vehicles Entering			Vehicles Exiting		
	Walk-In	Drive-Through	Total	Walk-In	Drive-Through	Total
7:00 - 7:15	10	0	10	7	0	7
7:15 - 7:30	5	0	5	5	0	5
7:30 - 7:45	5	0	5	5	0	5
7:45 - 8:00	10	0	10	8	0	8
8:00 - 8:15	9	0	9	4	0	4
8:15 - 8:30	5	1	6	8	1	9
8:30 - 8:45	6	0	6	4	0	4
8:45 - 9:00	8	0	8	6	0	6

Notes:

Max Observed Queue - 1 vehicle

Field Data Collection Form- Trip Generation Count
Date: September 13, 2007
Time: 4:30 PM to 6:30 PM
Location: Walgreens - 3336 Post Road in Warwick, RI
Counter: A. Ramirez / Matt Vesey

Interval	Vehicles Entering			Vehicles Exiting		
	Walk-In	Drive-Through	Total	Walk-In	Drive-Through	Total
4:30 - 4:45	19	0	19	20	0	20
4:45 - 5:00	13	0	13	13	0	13
5:00 - 5:15	17	1	18	20	1	21
5:15 - 5:30	14	1	15	11	1	12
5:30 - 5:45	8	0	8	15	0	15
5:45 - 6:00	17	3	20	14	3	17
6:00 - 6:15	7	0	7	12	0	12
6:15 - 6:30	13	2	15	15	2	17

Notes:

Max Observed Queue - 1 vehicle

Field Data Collection Form- Trip Generation Count
Date: September 15, 2007
Time: 11:00 AM to 2:00 PM
Location: Walgreens - 3336 Post Road in Warwick, RI
Counter: Matt Vesey / Melissa Vesey

Interval	Vehicles Entering			Vehicles Exiting		
	Walk-In	Drive-Through	Total	Walk-In	Drive-Through	Total
11:00 - 11:15	18	1	19	11	1	12
11:15 - 11:30	21	0	21	17	0	17
11:30 - 11:45	10	0	10	18	0	18
11:45 - 12:00	8	0	8	14	0	14
12:00 - 12:15	12	1	13	10	1	11
12:15 - 12:30	12	0	12	10	0	10
12:30 - 12:45	18	2	20	15	2	17
12:45 - 1:00	19	0	19	16	0	16
1:00 - 1:15	21	1	22	21	1	22
1:15 - 1:30	17	0	17	18	0	18
1:30 - 1:45	19	0	19	17	0	17
1:45 - 2:00	14	0	14	18	0	18

Notes:

Max Observed Queue - 1 vehicle

Field Data Collection Form- Trip Generation Count
Date: September 13, 2007
Time: 8:00 AM to 9:00 AM - store did not open until 8:00 AM
Location: Walgreens - 2399 Warwick Avenue - Warwick, RI
Counter: Emerson O.

Interval	Vehicles Entering			Vehicles Exiting		
	Walk-In	Drive-Through	Total	Walk-In	Drive-Through	Total
8:00 - 8:15	4	1	5	2	1	3
8:15 - 8:30	5	0	5	4	0	4
8:30 - 8:45	3	1	4	2	1	3
8:45 - 9:00	4	1	5	4	1	5

Notes:

Max Observed Queue - 1 vehicle

Field Data Collection Form- Trip Generation Count
Date: September 13, 2007
Time: 4:00 PM to 6:00 PM
Location: Walgreens - 2399 Warwick Avenue - Warwick, RI
Counter: Emerson O. / John DeBarros

Interval	Vehicles Entering			Vehicles Exiting		
	Walk-In	Drive-Through	Total	Walk-In	Drive-Through	Total
4:00 - 4:15	1	0	1	2	0	2
4:15 - 4:30	6	1	7	8	1	9
4:30 - 4:45	7	0	7	5	0	5
4:45 - 5:00	7	0	7	9	0	9
5:00 - 5:15	9	2	11	8	2	10
5:15 - 5:30	4	1	5	5	1	6
5:30 - 5:45	12	3	15	9	3	12
5:45 - 6:00	5	1	6	8	1	9
6:00 - 6:15	3	1	4	2	1	3

Notes:

Max Observed Queue - 2 vehicles

Field Data Collection Form- Trip Generation Count
Date: September 15, 2007
Time: 11:00 AM to 2:00 PM
Location: Walgreens - 2399 Warwick Avenue - Warwick, RI
Counter: Emerson O. / Sandy

Interval	Vehicles Entering			Vehicles Exiting		
	Walk-In	Drive-Through	Total	Walk-In	Drive-Through	Total
11:00 - 11:15	6	1	7	6	1	7
11:15 - 11:30	5	0	5	6	0	6
11:30 - 11:45	4	4	8	5	4	9
11:45 - 12:00	8	2	10	4	2	6
12:00 - 12:15	8	0	8	9	0	9
12:15 - 12:30	10	0	10	8	0	8
12:30 - 12:45	10	3	13	7	3	10
12:45 - 1:00	14	0	14	12	0	12
1:00 - 1:15	9	0	9	12	0	12
1:15 - 1:30	9	0	9	13	0	13
1:30 - 1:45	9	0	9	6	0	6
1:45 - 2:00	11	3	14	8	3	11

Notes:

Max Observed Queue - 1 vehicle

Field Data Collection Form- Trip Generation Count
Date: September 28, 2007
Time: 7:00 AM to 9:00 AM
Location: CVS - 527 Main Street - East Greenwich, RI
Counter: Jim S.

Interval	Vehicles Entering			Vehicles Exiting		
	Walk-In	Drive-Through	Total	Walk-In	Drive-Through	Total
7:00 - 7:15	6	0	6	1	0	1
7:15 - 7:30	3	0	3	2	0	2
7:30 - 7:45	5	2	7	4	2	6
7:45 - 8:00	8	1	9	6	1	7
8:00 - 8:15	5	1	6	6	1	7
8:15 - 8:30	8	3	11	7	3	10
8:30 - 8:45	10	2	12	6	2	8
8:45 - 9:00	12	3	15	12	3	15

Notes:

Max Observed Queue - 1 vehicle

Field Data Collection Form- Trip Generation Count
Date: September 28, 2007
Time: 4:00 PM to 6:00 PM
Location: CVS - 527 Main Street - East Greenwich, RI
Counter:

Interval	Vehicles Entering			Vehicles Exiting		
	Walk-In	Drive-Through	Total	Walk-In	Drive-Through	Total
4:15 - 4:30	12	0	12	24	0	24
4:30 - 4:45	20	3	23	19	3	22
4:45 - 5:00	17	3	20	21	3	24
5:00 - 5:15	21	7	28	21	6	27
5:15 - 5:30	21	6	27	17	7	24
5:30 - 5:45	16	4	20	22	4	26
5:45 - 6:00	15	2	17	15	2	17
6:00 - 6:15	11	0	11	14	0	14

Notes:

Max Observed Queue - 2 vehicles

Field Data Collection Form- Trip Generation Count
Date: September 29, 2007
Time: 11:00 AM to 2:00 PM
Location: CVS - 527 Main Street - East Greenwich, RI
Counter: Anthony

Interval	Vehicles Entering			Vehicles Exiting		
	Walk-In	Drive-Through	Total	Walk-In	Drive-Through	Total
11:00 - 11:15	13	1	14	13	1	14
11:15 - 11:30	18	2	20	24	2	26
11:30 - 11:45	24	0	24	28	0	28
11:45 - 12:00	23	1	24	22	1	23
12:00 - 12:15	22	0	22	24	0	24
12:15 - 12:30	26	0	26	25	0	25
12:30 - 12:45	24	1	25	27	1	28
12:45 - 1:00	23	1	24	23	1	24
1:00 - 1:15	20	2	22	23	2	25
1:15 - 1:30	23	0	23	24	0	24
1:30 - 1:45	18	0	18	26	0	26
1:45 - 2:00	22	0	22	24	0	24

Notes:

Max Observed Queue - 3 vehicles

Memorandum

To: Kevin McGhee, The Velmeir Companies

From: Mike Spack, P.E.

Date: November 13, 2009

Re: Vehicle Trip Generation Study for CVS Pharmacies
Northeast Corner of 69th Street and York Avenue in Edina, MN

Background

CVS Pharmacy is proposing to build an approximately 13,000 square foot store with two drive-through windows on the northeast corner of 69th Street and York Avenue in Edina, MN. A traffic study was previously done for the site and assumed generic "shopping center" development on the site. The purpose of this study is to document existing traffic patterns generated by suburban CVS Pharmacies within the Twin Cities metropolitan area of Minnesota so the previous traffic study can be appropriately modified for the proposed CVS Pharmacy.

The specific objectives of this study are:

1. Determine the A.M. Peak Hour trip generation rate between 7 and 9 a.m. on typical weekdays for CVS Pharmacies within the Twin Cities suburbs.
2. Determine the P.M. Peak Hour trip generation rate between 4 and 6 p.m. on typical weekdays for CVS Pharmacies within the Twin Cities suburbs.
3. Determine the Peak Hour of Generator trip generation rate on Saturdays for CVS Pharmacies within the Twin Cities suburbs.
4. Determine the Daily trip generation rate on typical weekdays for CVS Pharmacies within the Twin Cities suburbs.
5. Determine the Daily trip generation rate on typical Saturdays for CVS Pharmacies within the Twin Cities suburbs.
6. Determine the peak parking rate between 4 and 6 p.m. on typical weekdays for CVS Pharmacies within the Twin Cities suburbs.
7. Determine the peak drive through queue between 4 and 6 p.m. on typical weekdays for CVS Pharmacies within the Twin Cities suburbs.

Methodology

TDI staff identified six typical suburban CVS stores in the Twin Cities where data collection could be collected with mechanical tube counters. Each store has approximately 13,000 square feet and two drive-through windows. Mechanical tube counters were placed at each store driveway and data was collected in 15

minute intervals from Tuesday, November 3, 2009 through Saturday, November 7, 2009 (due to an equipment issue, data collection at the Eden Prairie site started on Wednesday, November 4, 2009). This summary data is contained in Appendix A.

Mechanical tube counters are designed to collect data on straight road segments where vehicles cross the tubes at moderate speeds. The CVS driveways are less than ideal conditions for mechanical tube counters because vehicles cross them at low speeds, may queue over the tubes, and may cross the tubes at an angle because they are in the middle of a turning maneuver. The six sites were chosen based on their driveway configurations in an attempt to minimize inaccurate counting.

Manual counts were taken at the driveways from 4 to 6 p.m. on Wednesday, November 4, 2009. The manual count data is contained in Appendix B. This data set includes entering/exiting volumes at each driveway, maximum queues in the drive through lanes (total vehicles waiting in both lanes), and data on the number of vehicles parked in the lot.

It is assumed any inaccuracies in the mechanical tube count data collected at the driveways were systematic. The mechanical tube count data for each inbound and outbound movement at each driveway was factored based on the entering/exiting volumes from 4 to 6 p.m. contained in Appendix B. The resulting calibrated volumes from Tuesday through Saturday are contained in Appendix C.

Findings

Trip Generation Rates

Statistics and data plots for each trip generation period studied are contained in Appendix D. The data in these summary sheets is based on the data in Appendix C. A summary of the MN average trip generation rates is shown in Table 1 alongside the trip generation rates from the Institute of Transportation Engineers' *Trip Generation, 8th Edition* (ITE Code 881).

Table 1 – Average Trip Generation Rates for Pharmacy/Drugstore with Drive Through Windows per 1,000s of Sq Ft of Gross Floor Area

	Twin Cities CVS Pharmacies	Nationwide Average from *Trip Generation, 8th Edition*
Weekday	87.95	88.16
Weekday A.M. Peak Hour (between 7-9 a.m.)	3.99	2.66
Weekday P.M. Peak Hour (between 4-6 p.m.)	8.94	10.35
Saturday	83.76	n-a
Saturday Peak Hour	7.63	7.85

The results in Table 1 show CVS Pharmacies in the Twin Cities generate traffic at a rate consistent with pharmacies nationwide. The slight exception is during the p.m. peak hour where the Twin Cities rate of 8.94 trips per 1000s of square feet is lower than the national average of 10.35 trips per 1000s of square feet.

Drive Through Lane Queuing

The manual p.m. peak hour count data in Appendix B shows the maximum queue observed in the drive through lanes during each fifteen minute period. The values shown are the maximum number of vehicles observed in both drive through lanes at one time. The maximum queue observed was three vehicles.

Parking Rates

The manual p.m. peak hour count data in Appendix B also shows the number of parked vehicles in the lot during each fifteen minute period. The total number of parked vehicles in the lot was counted at 4 p.m. Then the entering volumes were added to that total and the exiting volumes were subtracted to give the sum of the vehicles parked in the lot during each fifteen minute period. The maximum number of vehicles parked in a CVS Pharmacy lot during the p.m. peak period observed was 33 vehicles (representing a rate of 2.54 parked stalls per 1,000s of square feet).

Queuing Areas For Drive-Thru Facilities

BY ITE TECHNICAL COUNCIL COMMITTEE 5D-10

ITE Technical Council Committee 5D-10 was formed to collect and analyze basic information that may be used to estimate and evaluate lengths of automobile queues at drive-thru facilities. In addition to fulfilling this objective, this Informational Report constitutes a starting point for compiling a database for drive-thru facility queue length information.

Introduction

When faced with the need to evaluate the future impacts of a planned development, the transportation engineer often employs some form of analogy, estimating the future impacts of as-yet unbuilt development by using the attributes of existing land uses having a similar nature. For instance, the engineer may refer to published trip generation rates, derived from observations made at existing developments, to obtain a figure by which to estimate volumes that will occur at the proposed development.

Many types of businesses (such as fast-food restaurants, banks and cleaners) utilize drive-thru systems. A similar form of drive-thru operation can be found at sites where passenger pick-up operations occur (such as parents picking up schoolchildren). These drive-thru systems are comprised of a server position (often at a service "window"), and vehicle queuing space in advance

QUEUING DATA SHEET

1.	Type of Service Provided	_____
2.	Day(s) of Week	Sun Mon Tue Wed Thu Fri Sat
3.	Time(s) of Day	_____
4.	Type of Area	CBD ☐ Surburban ☐ Rural ☐
5.	Competition in Area (For Same Services)	High ☐ Medium ☐ Low ☐
6.	Service Rate Measured (Per Window or Aisle or Lane)	_____ Vehicles/Time
7.	Arrival Rate Measured (Per Window or Aisle or Lane)	Avg ____ Max ____ Vehicles/Time
8.	Uniformity Rating	_____ (1 - 10)
9.	Capacity of Queue Storage Area	_____ (Vehicles)
10.	Measured Average Queue	_____ (Vehicles)
11.	Measured Maximum Queue	_____ (Vehicles)
12.	Excess Demand Volume	_____ (Vehicles)
13.	Excess Demand Frequency	_____
14.	Size Sample or Length of Count Data	_____
15.	Narrative Description of Service	_____

Figure 1. Data gathering form used in survey.

J. L. Gattis, P.E., was Chair of Technical Council Committee 5D-10. He is an Assistant Professor in the Department of Civil Engineering at the University of Arkansas in Fayetteville, Ark. He is a Member of ITE.

of the service position, for waiting in line as those ahead are served first.

When attempting to project lengths of automobile queues at proposed drive-thru facilities, the municipal or private consulting engineers may not find available data by which a projection can be made. While such data may be known by larger business chains that have drive-thru operations, the data do not seem to be generally available to the average traffic engineer trying to size or evaluate automobile queue storage area. True, some publications present results of queuing studies or equations for estimating queue lengths based on known system arrival and service rates.[1-9] But the proposed-site arrival and service rates may be unknown, and the proposed system may not possess attributes (such as negative exponential service time rates) needed for certain equations to properly predict queue lengths.

Drive-thru facilities are perceived as time-savers; as a convenience to the physically challenged, elderly and parents with young children; and as a way to avoid going out into inclement weather. Due to vehicle idling while in line, drive-thru facilities may also be viewed as causing unnecessary fuel consumption and air pollution. The popularity of drive-thru services creates a need to evaluate the queuing capacities of the varied drive-thru facilities. This report provides some basic drive-thru facility queue length information. It is hoped that the database will continue to grow, so that a comprehensive analytical tool may be available for the transportation professional.

Methods

The queue length data gathering form shown in Figure 1 was distributed to committee members in November 1987. The form was accompanied by specific user-instructions to ensure uniformity of procedures and compatibility of results.

Completed forms were returned to the committee chair and data were cataloged by land-use type. The maximum observed queue lengths and the maximum observed queue length frequencies were compiled. Cumulative frequencies and the probability that queues would not exceed an absolute maximum were calculated and shown graphically.

Table 1. Ranges of Fast Food Queue Lengths by Food Type

Food Type	*Maximum Queue Range (# in system)*	*Average Maximum Queue (# in system)*	*Studies*
Donuts	4	4	2
Steak	4	4	2
Chicken	2–9	5	5
Fish	5	5	1
Sandwiches	5	5	1
Mexican	7	7	1
Roast Beef	6–8	7	2
Hamburgers	4–13	7	27

Table 2. Fast Food Queue Lengths

Maximum Queue Length (# in system)	*Frequency*	*Cumulative Frequency*	*P(q≤N)*
1	0	0	0.00
2	2	2	0.05
3	0	2	0.05
4	6	8	0.18
5	4	12	0.27
6	7	19	0.43
7	10	29	0.66
8	7	36	0.82
9	5	41	0.93
10	1	42	0.95
11	0	42	0.95
12	1	43	0.98
13	1	44	1.00

Note: P(q≤N) indicates probability, based on sample, of queue length "q" not exceeding length "N".

Findings

Within this report, data have been compiled for banks, car washes, day care facilities, dry cleaners and fast-food restaurants.

Fast Food

This category includes restaurants characterized by food being prepared in advance of, or shortly after, ordering; by high turnover for eat-in customers; and by long business hours. The ITE land-use codes (LUCs) for this use are LUC 834 (*Trip Generation*, 1991) and 836 (*Parking Generation*, 1987).

Forty-four fast-food restaurants were observed for this study. They ranged from those serving chicken to the hamburger chains. All sites were suburban locations. Queuing was observed mainly during the weekday mid-day peak from the 1970s through the 1990s, at sites in Florida, Kansas, Illinois, Minnesota, Montana, New Jersey, Oklahoma, Pennsylvania and Texas. All fast-food facilities observed for this study had a single-window drive-thru system. The industry is changing, with double- and even triple-window systems being utilized. Further information will be needed on queuing characteristics of these facilities.

The average observed service rate was 54 vehicles per hour (vph); the maximum rate was 108 vph. The maximum observed queue lengths (number of vehicles in line, including vehicle at service position) ranged from two to 13 vehicles (see Table 1). Where there was a menu-order board followed by a service window, the combined total of vehicles in both sequential lines was reported.

The restaurants featuring hamburgers had maximum queues in the upper part of the range. Table 2 shows the frequencies of the observed maximum queue lengths, as well as a probability of a queue of less than a given number

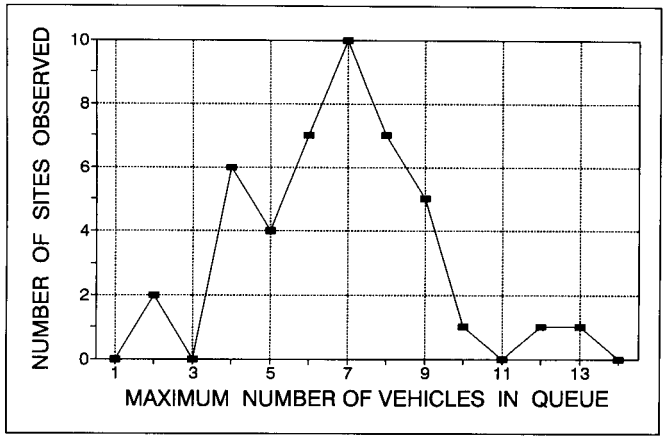

Figure 2. Maximum queue lengths at fast-food.

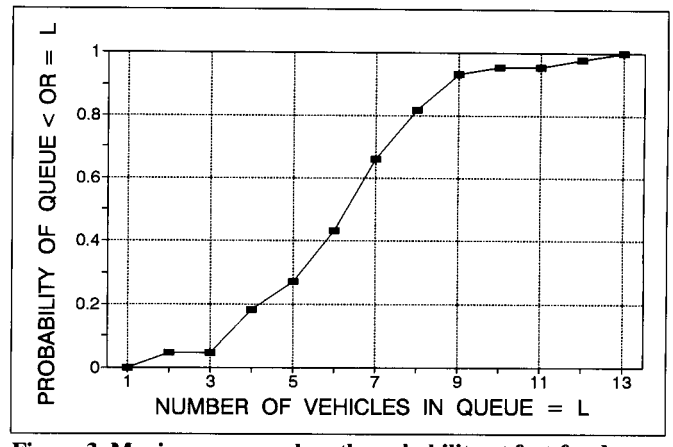

Figure 3. Maximum queue length probability at fast-food.

of vehicles. Figure 2 plots maximum queue length against the observed frequency of occurrence. Figure 3 depicts the probability that at any fast-food site, the queue will not exceed a given maximum queue length. From Table 2 or Figure 3, it can be seen that there was a 95 percent probability that the maximum queue at a site would be no more than 10 vehicles.

The maximum queues were evaluated against days of the week and were found to have no statistical relationship. Likewise, when evaluated against different levels of competition within the area and against service rates, there was no statistical relationship.

Bank

This category includes savings-and-loans with or without automatic teller machines (ATMs) and commercial banks with or without ATMs. Although there were historical differences between banks and savings-and-loans, they are now often indistinguishable to the public. The ITE land-use codes for this use are LUC 912 and 914 (*Trip Generation*, 1991) and LUC 912 (*Parking Generation*, 1987).

The studies analyzed were conducted from the late 1960s through the late 1980s; many were in Illinois, Minnesota, New Jersey and Texas. The size of the bank drive-thru facilities ranged from a minimum of one lane with one teller-window up to an institution with 10 lanes and four tellers.

Observed service rates for these institutions went up to a maximum of 35 vehicles per lane-hour. Maximum observed queues per lane ranged from two to eight vehicles. The maximum system queue lengths (all lanes combined) ranged from five to 29 vehicles. At two sites, it was observed that a queue length exceeding eight vehicles per lane was not tolerated by customers. When the queue length became excessive, customers would park and use walk-in facilities rather than the drive-thru. Thus the collected data reflect a maximum queue per lane of eight vehicles.

Table 3 shows the observed frequency of occurrence of maximum queue lengths per lane. Figure 4 plots the maximum number of vehicles per lane observed. On the basis of the studies received, there is a 100 percent probability that the queue length at a bank drive-thru facility will not exceed eight vehicles per lane, as Figure 5 shows.

Table 4 presents the maximum number of vehicles in an entire drive-thru system (all lanes combined) by ranges, along with the frequency of occurrence. This table shows that the most common maximum number-in-the-system at a bank drive-thru facility fell between six and 10 vehicles, as most observed facilities consisted of two lanes. Table 4 also

Table 3. Bank Queue Lengths

	Maximum Queue Per Lane		
Queue Length	*Frequency*	*Cumulative Frequency*	*P(q≤N)*
0	0	0	0.00
1	0	0	0.00
2	1	1	0.07
3	4	5	0.33
4	2	7	0.47
5	4	11	0.73
6	1	12	0.80
7	2	14	0.93
8	1	15	1.00

Note: P(q≤N) indicates probability, based on sample, of queue length "q" not exceeding length "N".

Table 4. Maximum Number of Vehicles in Bank System (All Lanes)

# in system	*Frequency*	*Cumulative Frequency*	*P(q≤N)*
0 – 5	2	2	0.13
6 – 10	6	8	0.53
11 – 15	3	11	0.73
16 – 20	2	13	0.87
21 – 25	1	14	0.93
26 – 30	1	15	1.00

Note: P(q≤N) indicates probability, based on sample, of queue length "q" not exceeding length "N".

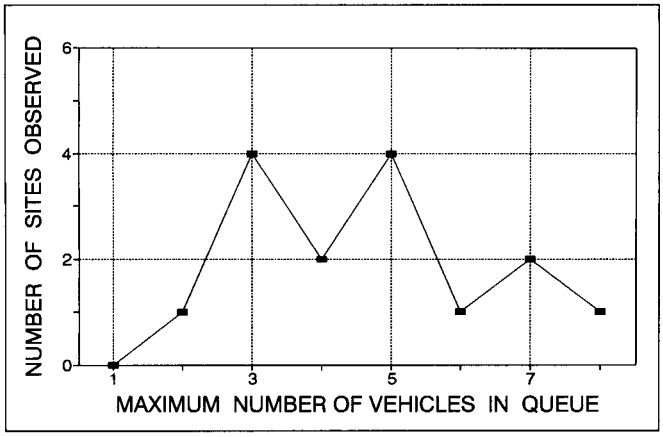

Figure 4. Maximum queue length per lane at bank.

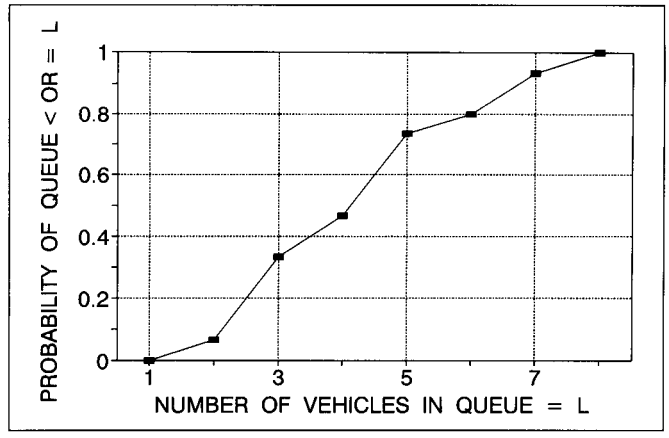

Figure 5. Maximum per lane queue length probability at bank.

gives the probability, based on the studies received, that the number of vehicles in the system will not exceed a certain range.

It should be noted that queuing lengths may be affected by time-of-day banking habits. There may be differences between the central city and a suburb. An area with a large proportion of retired persons may experience unique banking-time behaviors. In addition, the effects of banks incorporating ATMs into drive-thru aisles may also need to be investigated in future queuing studies.

Car Wash

This category includes full-service car washes (offering vacuuming and towel-drying services), exterior tunnel operation (vacuuming and towel drying not a part of the "in-line" operation, but may be offered at separate stations to the side), and self-service car washes (where customers pull into a wash bay, insert coins into a box, and proceed to wash). The ITE land-use code for these uses is LUC 847 (*Trip Generation*, 1991). This land use was not included in the 1987 *Parking Generation* report.

The studies analyzed were conducted from the late 1960s through the late 1980s in Kansas, Illinois, Montana, New Jersey and Texas. They included seven full service car washes, two exterior tunnel car washes, and nine self-service car washes. The number of self-service bays ranged from six to 14 per site. The self-service car washes typically had one or more parallel wash bays; the full-service car wash operations tended to have a single tunnel to serve customers.

Studies at the full-service car washes were made during winter or early spring months. Both full-service car washes consisted of a single tunnel. Observed service rates were 35 vph (maximum queue of nine vehicles) and 27 vph (maximum queue of 26 vehicles). At the site with a 26-vehicle queue, the queue extended off the site and onto an adjacent private street with light traffic volumes.

The self-service car wash studies were conducted on Saturday and Thursday, during late spring and/or summer months. Service rates at self-service car washes ranged from 4.1 vehicles per bay-hour to 5.4 vehicles per bay-hour. The average service rate was 4.77 vehicles per bay-hour. The maximum queue observed at two study sites was three vehicles, and at a third study site the maximum observed was one vehicle. No distinction was made as to whether these were maximum queues per bay or total maximum queues (per entire operation).

Day Care

This category includes facilities that provide a place for children during the day, often while parents are at work. After-school care may also be provided. The ITE land-use code is LUC 565 (*Trip Generation*, 1991). This land use was not included in the 1987 *Parking Generation* report.

Data were submitted for one day-care facility in Texas, during the evening peak hour. The facility had 99 children enrolled and 94 present the day the study was conducted. The day-care facility handled children age 2 through first grade. The facility was operated in a manner that required the parents to park their cars and go inside to get their children.

The hour service rate was 46 vehicles. A maximum of eight vehicles in

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Members of Technical Council Committee 5D-10 were J. L. Gattis, P.E. (M), Chair; Grant A. Bacchus, P. Eng. (F); Benedict G. Barkan (F); Robert R. Marvin, P.E. (M); Dale B. McKinney, P.E. (F); Robert A. Nelson, P.E. (F); Seyed M. Safavian (M); James M. Schoen (A); David K. Sorenson, P.E. (A); Mark J. Stuecheli (M); and Jack Wierzenski (A).

Members of the Technical Council Department 5 Standing Committee at the time of approval of this report were Dennis O'Malley (F), Chair; Carol H. Walters, P.E. (M), Assistant Chair; Robert D. McMillen, P.E. (FL); Wamahdri W. Williams (A); and Donald J. Galloway, P.E. (F). Brian S. Bochner, P.E. (F), was the Chair of Technical Council, and John M. Mason, P.E. (F), was the Assistant Chair.

Table 5. Summary of Observed Queue Distances at Drive-Thru Facilities

	Near-maximum number of queued vehicles observed in system (does not include vehicle at service position)	*Lane Length needed to store near-maximum queue (does not include) vehicle at service position)*
Fast-Food (Hamburger)	10 – 1 = 9	60 m (198 feet)
Bank	8 – 1 = 7	47 m (154 feet)
Car Wash (self-service)	3 – 1 = 2	13 m (44 feet)
Day Care	10 – 1 = 9	can store in parallel
Dry Cleaner	3 – 1 = 2	13 m (44 feet)

5 minutes (if sustained, equivalent to 96 vph) were observed; a 20-minute period had 28 vehicles (84 per hour). The maximum number of waiting vehicles was 10 vehicles.

VanWinkle and Kinton reported the results of 29 field studies at day-care establishments in Tennessee. Their findings are in the July 1994 *ITE Journal*.[8]

Dry Cleaners

This category includes facilities that clean clothing and other fabrics that should not be laundered. Often a walk-up window is present. No information is provide for this land use in either the ITE 1991 *Trip Generation* report or the ITE 1987 *Parking Generation* report.

One study was conducted at a dry cleaner with drive-thru facilities in Montana during a weekday p.m. peak period. An average service rate of 41 vph was measured at the single window. The observed maximum queue was three vehicles long. Forty-five percent of the customers used the drive-thru facility.

Conclusions

Table 5 summarizes the observed maximum or near-maximum observed queue lengths, and also lists the stacking distance needed to accommodate these observed queues, based on a front bumper-to-front bumper space occupied length of 22 feet (ft) per vehicle. This 22 ft may not be the exact space that vehicles occupy, but a value ranging from 20 ft to 25 ft seems appropriate for many situations. Because only one day-care facility was observed, and because parents picking up children may park in parallel or in a lot instead of in a single-file line, no stacking length was calculated for this land use.

Due to a change of committee personnel during the course of the data-gathering effort, some of the original forms submitted by committee members are not available. There are some apparent errors in the tables. For instance, the number of studies tallied in Table 1 is 41, while the number in Table 2 is 44. It is not known whether three studies were not included in Table 1, or whether there was double counting in Table 2. The unavailability of the original data forms makes it impossible to recheck the numbers.

The size of this drive-thru facility queuing characteristic database was limited. There is a need to accumulate and analyze more drive-thru queuing system data, so transportation engineers and site planners can be better informed. Additional observations of service rates are also needed in order to determine relationships between service rates and queue lengths, and to evaluate long-term trends in service rates. Finally, investigations of the amount of space occupied per vehicle within a queue are needed so that engineers will have the ability to project not only the number of vehicles that will be in the maximum queue for a given site, but also the queue storage length required for a site.

When collecting queuing data, the recorder should clearly indicate whether the number of vehicles recorded includes or excludes the vehicle(s) in the service position (that is, at the window). The data record must indicate which numbers are for a single queuing line and which totals are for the entire system of multiple queuing lines. An observer should also note instances of arriving vehicles balking or refusing to enter a queue due to excessive length, and how many vehicles were in the queue when the next arrival balked.

Other types of drive-thru operations that could be studied include those at credit unions, funeral homes, gas stations (either gas only, full-service, self-service, or a combination with convenience stores or car washes), libraries, liquor stores, movie theater ticket booths, parking lots and garages (either pick-up ticket or pay, or key, tag, or card), post offices, pre-schools, baby-sitting or school combinations, lower grade schools, stadium ticket sales machines, truck stops and places of worship.

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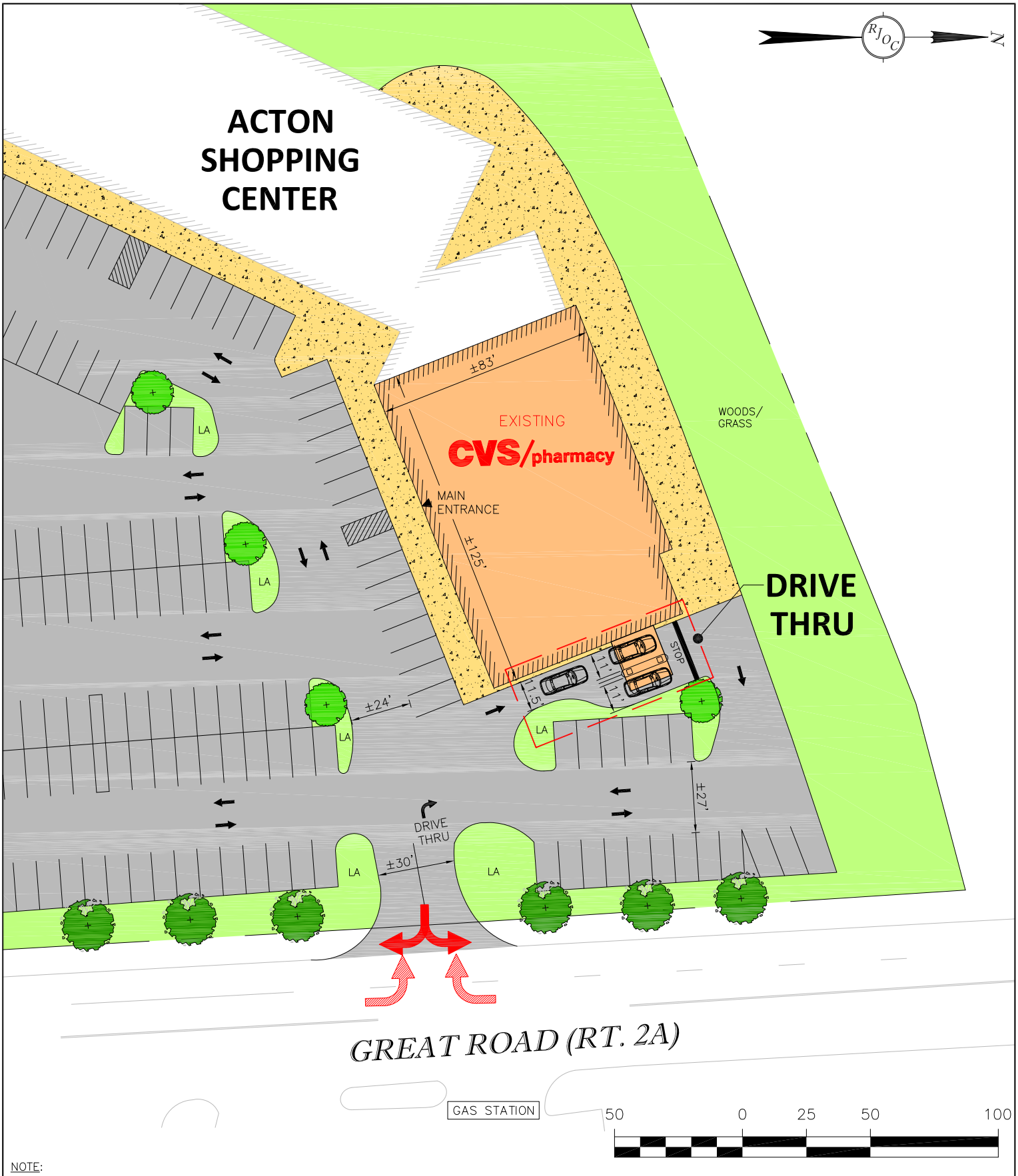

NOTE:

1. CONCEPTUAL SITE PLAN SHOW IS FOR A PROPOSED DRIVE–THRU ADDITION TO AN EXISTING CVS BUILDING.

THIS PLAN IS COMPILED FROM AVAILABLE EXISTING INFORMATION AND IS FOR CONCEPTUAL PLANNING ONLY, FURTHER RESEARCH MAY BE REQUIRED TO VERIFY DIMENSIONS, ZONING REQUIREMENTS, WETLAND LIMITS, FIRE CODES, STATE AND LOCAL PERMITTING, PHYSICAL RESTRAINTS ON SITE, AND TRAFFIC CIRCULATION.

Project Name: CVS/pharmacy 13,013 SF TYPE A COLONIAL STORE NUMBER: [redacted]	Drawing Name: CONCEPTUAL SITE PLAN	Drawing No.: SP-1 Project No.: 11045

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