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16. Abstract

The state of Texas, particularly the large urban areas, has experienced considerable population growth in recent years. This growth has produced new schools in areas near highways originally designed for low volumes and relatively high speeds. Another trend is the higher proportion of children being transported to and from schools in private vehicles. These realities, and many of the other issues associated with traffic around schools, make it important to aggressively consider the design of roadways within and around schools to ensure the safest possible traffic environment. Equally important is the consideration of the location and design of the school site, preferably during the planning stages, in order to establish safe and efficient operations.

The Texas Department of Transportation (TxDOT) is currently focusing attention on these issues through its Precious Cargo Program. Precious Cargo allows TxDOT staff to review school site plans and make recommendations before the schools are built. Since the program’s inception, more than 180 schools in 70 various school districts statewide have seen traffic safety improvements around their schools or future school sites.

This research will develop guidelines and good examples for the design and operation of roadway facilities within and around schools in order to improve safety and reduce local congestion. This report documents the first-year project activities including (a) a state-of-the-practice literature review; (b) interviews and surveys with architects, school district personnel, and consulting engineers with considerable experience in school site planning and design; (c) surveys of site review practices of TxDOT and municipal engineers; (d) findings and observations from case studies of 14 school campuses; and (e) a review of existing guidelines.

The second-year project activities will basically consist of intensive field studies at school sites throughout the state of Texas. Researchers will use these data and the review of existing guidelines to develop a final document containing design and operations guidelines for school transportation-related elements such as bus and parent drop-off/pick-up zones, pedestrian/bicycle facilities, parking lots, driveways, traffic control devices, signs, and markings.

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TRAFFIC OPERATIONS AND SAFETY AT SCHOOLS: REVIEW OF EXISTING GUIDELINES

by

Scott A. Cooner, P.E.
Assistant Research Engineer
Texas Transportation Institute

Kay Fitzpatrick, P.E.
Research Engineer
Texas Transportation Institute

Mark D. Wooldridge, P.E.
Associate Research Engineer
Texas Transportation Institute

Jason A. Crawford, P.E.
Assistant Research Engineer
Texas Transportation Institute

and

Garry L. Ford
Associate Transportation Researcher
Texas Transportation Institute

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The Texas A&M University System
College Station, Texas 77843-3135

DISCLAIMER

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The authors wish to acknowledge the following individuals who served on an advisory panel for their assistance and guidance throughout the first year of the project:

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- Mr. Mark Cantebury, A.I.A., Keller Independent School District (ISD).
- Mr. Larry Colclasure, P.E., TxDOT, Waco District.
- Mr. Wade Odell, P.E., TxDOT Research and Technology Implementation Office – Austin.
- Mr. Craig Reynolds, A.I.A., BRW Architects.
- Mr. Steve Taylor, P.E., Carter & Burgess, Inc. – Dallas.
- Mr. Bob Templeton, Keller ISD.
- Mr. Scott Young, City of Frisco.

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- Principals and other district administrators that allowed TTI researchers access to their campuses to observe and collect data.
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- The school district interview participants: Jim Saxon (Arlington), Jerry Wallace (Dallas), Jim Humphries (Duncanville), Richard Wilkinson (Frisco), Bob Templeton (Keller), Bruce Larson (Plano), Dr. Jack Rambo (Rockwall), and Gary Coffey (Waxahachie). An additional 17 school district representatives completed and returned surveys.
- The consulting engineer interview participants: Larry Cervenka (Garcia & Associates) and Steve Taylor (Carter & Burgess).
- The 27 TxDOT staff from 15 districts and nine city engineers who completed a mailout survey.
- The 32 state department of transportation (DOT) representatives who completed a survey on existing guidelines for design of transportation-related elements at school sites.

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LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
A/E	Architect/Engineer
AIA	American Institute of Architects
CAE	Committee on Architecture in Education
CEFPI	Council of Educational Facility Planners International
CEU	Continuing Education Units
DFW	Dallas/Fort Worth
DOE	Department of Education
DOT	Department of Transportation
DPS	Department of Public Safety
FHWA	Federal Highway Administration
ISD	Independent School District
ITE	Institute of Transportation Engineers
K-12	Kindergarten – Twelfth
MPO	Metropolitan Planning Organization
MUTCD	Manual on Uniform Traffic Control Devices
NHTSA	National Highway Traffic Safety Administration
P&Z	Planning and Zoning
PTA	Parent Teacher Association
PTSI	Pupil Safety Transportation Institute
REFP	Registered Education Facilities Planner
ROW	Right-of-Way
TASA	Texas Association of School Administrators
TASB	Texas Association of School Boards
TASBO	Texas Association of School Business Officials
TCD	Traffic Control Device
TEA	Texas Education Agency
TRB	Transportation Research Board
TTI	Texas Transportation Institute
TWLTL	Two-Way Left-Turn Lane
TxDOT	Texas Department of Transportation
WASHTO	Western Association of State Highway and Transportation Officials

CHAPTER 1. INTRODUCTION

BACKGROUND AND SIGNIFICANCE OF RESEARCH

The state of Texas, particularly the large urban areas, has experienced considerable population growth in recent years. This growth has produced new schools in areas near highways originally designed for lower volumes and relatively high speeds. Another trend is the higher proportion of children being transported to and from schools in private vehicles. These realities, and many of the other issues associated with traffic around schools, make it important to aggressively consider the design of roadways within and around schools to ensure the safest possible traffic environment. Equally important is the consideration of the location and design of the school site, preferably during the planning stages, in order to establish safe and efficient operations.

The Texas Department of Transportation (TxDOT) is currently focusing attention on these issues through its Precious Cargo Program (*1*, *2*). The Precious Cargo Program (see logo in Figure 1-1) allows TxDOT staff to review school site plans and make recommendations before the schools are built. Since the program's inception, more than 180 schools in 70 various school districts statewide have seen traffic safety improvements around their schools or future school sites (*3*). Precious Cargo reviews are done at no cost to schools and have been endorsed by the Federal Highway Administration (FHWA) and National Highway Traffic Safety Administration (NHTSA). The program has also won numerous awards and citations including (*4*):

- National Quality Initiative – Silver Award;
- Texas Quality Initiative Award – Partnering;
- American Association of State Highway and Transportation Officials (AASHTO) Presidents Award;
- AASHTO Pathfinder for Innovation and Quality – Team Award;
- Transportation for Livable Communities Award – Best in State (awarded by the Trans Texas Alliance);
- 2000 Communication Award (TxDOT);
- Journey Toward Excellence – 2000 Work Group/Team Award (TxDOT);
- Brazos Bravo – Community Relations Award (awarded by the International Association of Business Communicators – Brazos Valley Chapter); and
- Certificate of Quality Service (awarded by Western Association of State Highway and Transportation Officials (WASHTO)).

The Precious Cargo Program has been so successful that it is being considered in several other states, including Wisconsin (*3*, *5*). Even with the overall success of the program, improvements can still be made and that is an objective of this research. Through Precious Cargo, TxDOT staff assists school districts with application of transportation principles and fundamentals. However, their efforts are sometimes limited by the lack of knowledge of the specific problems associated with school transportation needs, the lack of acceptable guidelines, and the lack of examples using proven designs. This research addresses these limitations and offers an opportunity to enhance the Precious Cargo Program by providing TxDOT staff, school district personnel, and the other stakeholders with guidelines and good examples for the design and operation of roadway facilities around schools.

PRECIOUS

CARGO

Figure 1-1. Precious Cargo Program Logo.

Solutions to traffic-related concerns around schools typically cut across lines of responsibility, influence, and authority. Stakeholders such as traffic engineers, police officers, school district personnel, parent organizations, community associations, and other groups are often times involved. Solutions to these concerns can be expensive, especially if they are being retrofit to an existing school site. The relatively low cost of school traffic control devices (TCDs) frequently makes them the first option, even if they do not really solve the problem. This research also addresses cost and coordination issues associated with safety and operational improvements around schools.

RESEARCH WORK PLAN

A research project is more likely to be successful if it has a goal that provides focus to the research activities. All tasks in the work plan should contribute to the realization of this project goal. In order to achieve the big-picture goal, the work plan must have well-defined objectives that are used to measure progress and to determine the necessary research activities. The goal established for this project is:

> **Project Goal: Develop guidelines and good examples for the design and operation of roadway facilities within and around schools in order to improve safety and reduce local congestion**.

Using this goal as the overall guide, the research team established the following specific and well-defined objectives for this research project:

- Identify current planning methods and resources for the location and design of new school facilities used by architects, consulting engineers, and school district personnel.

- Identify current school site plan review practices used by TxDOT and cities.

- Document good and inadequate examples of school site design.

- Conduct a school issues symposium to focus attention and resources on this research effort.

- Collect safety and operational data at school sites to assess typical traffic demands and patterns and the associated problems.

- Develop guidelines for school sites that address the following issues at a minimum:

  - separation of passenger cars, school buses, pedestrians, and bicyclists;
  - storage of queues within the school site rather than on a high-speed roadway;
  - site selection process to minimize access from high-speed roadways;
  - spacing, number, and location of school driveways;
  - designs and operational practices for pedestrians and bicycles near schools;
  - best practices in signing and marking;
  - purpose and use of reduced-speed school zones;
  - parking needs (both visitor and staff parking); and
  - recommended operation of school parking lots.

- Document the developed guidelines and other significant project findings and recommendations so that they are understandable and useful to all interested stakeholders (i.e., engineers, architects, school district personnel, and the public).

- Develop other materials, as directed by the Project Advisory Committee, to improve use of the project findings (e.g., web page, CD-ROM, etc.).

The objectives outlined in the previous list will be fulfilled in the work plan. The work plan tasks are described in some detail within the following subsections. This work plan provides TxDOT and other interested stakeholders with useful, practical, and reliable information on operations and safety around school facilities.

The project is a two-year effort and is structured into two phases that basically correspond to the fiscal calendar years. The first phase took place during the first year of the project, and the research team concentrated on gaining an understanding of the myriad of transportation-related issues associated with school facilities. This research report 4286-1 documents this first phase, which includes Task 1 through Task 6. The second phase will include detailed field studies, identifying good examples for the design and operation of roadway facilities around schools and the development of the guidelines. This work will occur primarily during the second year and will be documented in the final research report.

Task 1. Establish Project Advisory Committee

The first proposed task worked toward establishing an advisory panel to help guide the research team. Table 1-1 lists the panel members' role, name, title, and current employer.

Table 1-1. Advisory Panel Members.

Panel Role	Name	Title	Employer
Prog. Coordinator	Terry Sams	Dir. of Trans. Operations	TxDOT – Dallas
Project Director	Linden Burgess	Transportation Operations	TxDOT – Dallas
Panel Members	Tony Arredondo	Deputy District Engineer	TxDOT – San Antonio
	Mark Cantebury	Staff Architect	Keller ISD
	Larry Colclasure	Dir. of Trans. Operations	TxDOT – Waco
	Wade Odell	RMC 4 Engineer	TxDOT – Austin
	Craig Reynolds	Principal	BRW Architects
	Steve Taylor	Senior Project Manager	Carter & Burgess, Inc.
	Bob Templeton	Planning Coordinator	Keller ISD
	Scott Young	Assistant City Manager	City of Frisco

Task 2. State-of-the-Practice Literature Review

The second task of the project gathered information from various sources to establish the state-of-the-practice on safety and operational problems related to the presence and design of school facilities.

Task 3. Identify Current School Site Planning Methods and Resources Used by Architects and Consulting Engineers

Through a combination of mail, telephone, fax, and Internet sources, this task identified and evaluated current transportation-related school site planning methods and procedures used by architects, consulting engineers, and school district personnel. By using a combination of interviews and surveys, the research team gathered information from current practitioners, identifying a broad cross-section of interview and survey participants within Texas. The scope of the information obtained during the interviews and surveys concentrated on the following two issues:

- resources used for site selection, planning, and layout; and
- specific guidelines, methods, or analyses relating to school traffic issues.

This task focused on the construction of new school campuses near state-owned roadways.

Task 4. Identify Existing Site Review Practices used by TxDOT and Municipalities

This task used a combination of mailout surveys and interviews, to identify existing site review practices used by TxDOT and municipalities. The scope of the information obtained during the interviews and surveys concentrated on the following issues:

- resources used for the site review;
- specific guidelines, methods, or analyses relating to school traffic issues; and
- field studies and data collection practices.

Task 5. Perform Case Studies

In order to gain a better understanding of good and inadequate examples of school site design, the research team conducted a number of observational studies at school facilities throughout the state. Another objective of the case studies was to test and evaluate different data collection procedures and methods in order to optimize efforts in the second-year field studies.

Task 6. Conduct School Issues Symposium

This task involves conducting a symposium with various stakeholders (architects, engineers, school district personnel, etc.) on school operations and safety issues. The research team believes the issues associated with this project have broad appeal throughout the state and that a symposium provides an opportunity for focused attention on these issues. No symposiums were conducted during the first year of the project; however, several are being planned for the second year. The research team did gather data from stakeholders during the interviews about what issues and topics were of most interest for inclusion in a symposium.

REPORT ORGANIZATION

This report is divided into nine chapters. Chapter 1 contains the background and significance of this research and the research work plan.

Chapter 2 (Literature Review) provides a brief summary of the literature reviewed during the first year of the project. The review included findings on site layout, parking, bus operations, parent pick-up/drop-off zones, queuing, pedestrian walkways, bicycle access and use, and traffic control devices.

Chapter 3 (Architect Interviews) explains the results of interviews and surveys conducted with architecture firm representatives. The interviews and surveys focused on the planning and design of transportation elements at school sites. Questions posed to the architects related to resources and training for planning and design, coordination issues with outside agencies, traffic access and circulation, and design guidelines for vehicle and bus loading zones, parking, driveways, and pedestrian/bicycle access.

Chapter 4 (School District Interviews) presents the results of interviews and surveys of school district personnel. The interviews and surveys provided researchers with a clearer understanding of the challenges each school district faced regarding traffic safety. Questions posed in the interviews concerned safety assessment practices, major campus access and circulation problems, the nature of complaints received inside the district and how they are handled, awareness of the Precious Cargo Program, practices monitoring student arrivals/departures related to travel mode, campus planning and design process, and processes for selecting sites for future school campuses.

Chapter 5 (Consulting Engineer Interviews) describes the findings of the interviews with consulting engineers with considerable experience in school transportation projects. The interviews concentrated on issues similar to those in the architect interviews, though more limited in scope due to the generally more limited scope of consulting engineers' work.

Chapter 6 (TxDOT and Municipality Surveys) summarizes the results and key findings of a survey of TxDOT and municipal employees with school site review responsibilities. The survey concentrated on obtaining information on how school site plans are reviewed and in identifying good (and not-so-good) examples for the design and operation of roadway and parking facilities within and around schools.

Chapter 7 (Observational Case Studies at School Campuses) includes a summary of observational case studies conducted at 14 school sites in Texas. Information on general observations, data collected, site design and layout, and other items is given for each school studied.

Chapter 8 (Review of Existing Guidelines) provides a review of existing guidelines for transportation-related elements at schools. The research team used a variety of methods including review of published documents, Internet searches, survey instruments, and direct correspondence to obtain information on existing guidelines.

Chapter 9 (First-Year Conclusions and Future Activities) includes the key conclusions and recommendations based on the activities completed during the first year of research. This chapter also provides a brief summary of future project activities.

CHAPTER 2. STATE-OF-THE-PRACTICE LITERATURE REVIEW ON DESIGN, OPERATIONS, AND SAFETY OF K-12 SCHOOL FACILITIES

A number of issues are addressed in this review of the practice. Researchers investigated the following aspects:

- site layout,
- parking,
- bus operations,
- parent pick-up/drop-off zones,
- queuing,
- pedestrian walkways,
- bicycle access and use, and
- traffic control devices.

A number of issues were not addressed in published journals or research reports, although recommendations were found at non-traditional sources such as the various state departments of transportation (DOTs) and state or local school sources. These recommendations have been included in this review of available literature for completeness of coverage, although they may not be regarded as definitive.

SITE LAYOUT

Schools have different needs for access depending upon school type and size. The North Carolina State Board of Education has provided recommendations regarding access needs and prototypical site layouts (*6*). They should provide ready access to a variety of modes of transportation, allowing use by private automobile, school buses, transit buses, pedestrians, and cyclists. The access points should be designed to provide acceptable performance during peak load periods and for special events.

Impacts on the local street system should be reasonable so that they perform adequately under the additional traffic generated by the school (*6*). Sufficient frontage on the street and highway system should be obtained to allow safe access and acceptable driveway performance. Early planning stages should examine site layout needs in view of specific locations so that assessments are made of transportation needs and available resources. Figure 2-1 shows a preliminary layout of the transportation facilities associated with a hypothetical school.

Generally, elementary schools are located within neighborhoods, and as such should provide for access by pedestrians, bicyclists, automobiles, and buses. Because younger children are less capable of judging gaps in high-speed traffic (above 35 mph [60 km/h]) it is desirable that elementary schools be located on lower-speed roadways (*7*). Carter & Burgess developed Figure 2-2 to show access patterns from the neighborhood and surrounding streets for a school (*8*). This layout provides for queuing on-site for both buses and cars and allows good visibility for the loading or unloading operations.

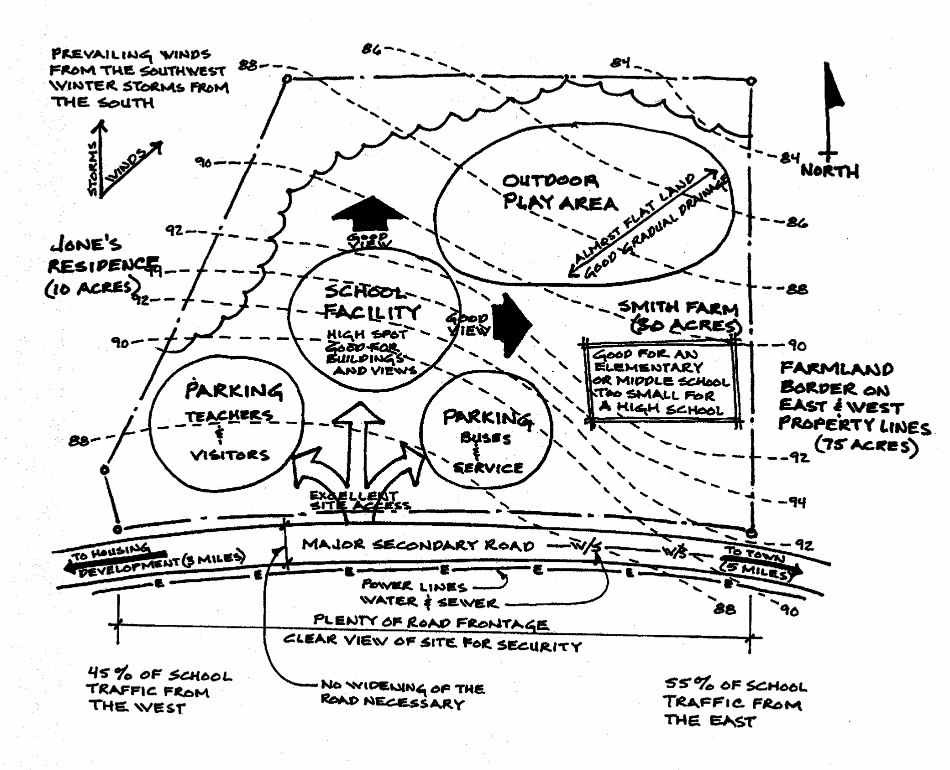


Figure 2-1. Preliminary Site Layout (*6*).

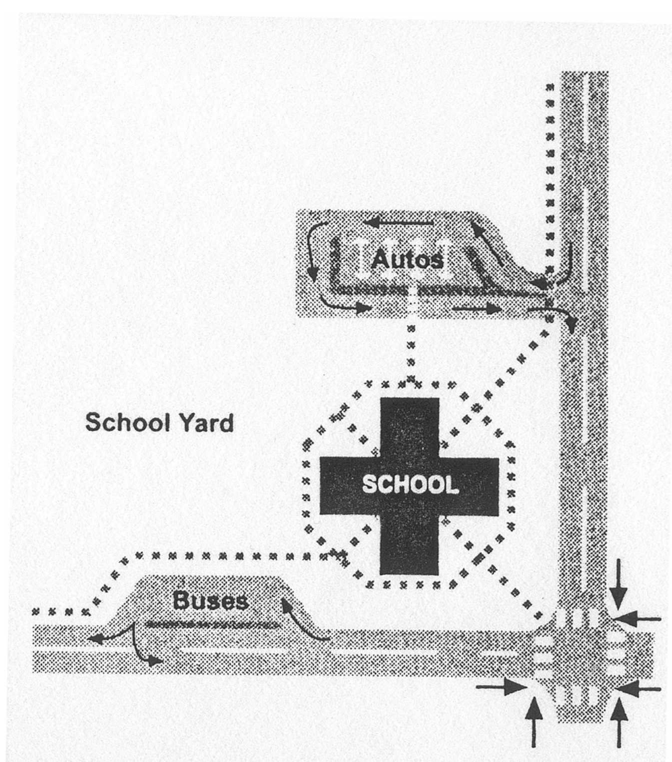


Figure 2-2. Site Layout for Elementary School (*8*).

Secondary schools typically are larger and frequently are located to have greater access to major roadways. Figure 2-3 provides an evaluation of four "typical" site locations (*8*). In the figure, the most desirable location is shown providing access from a major collector and an arterial; the least desirable provides access solely from an arterial. Separating automobile operations, bus operations, and parent pick-up/drop-off would be difficult to accomplish in a satisfactory way using layout "D".

The South Carolina DOT has developed guidelines regarding the number of driveways at schools (*9*):

- elementary school: 2-3 driveways,
- middle school: 2 driveways, and
- high school: 3-4 driveways.

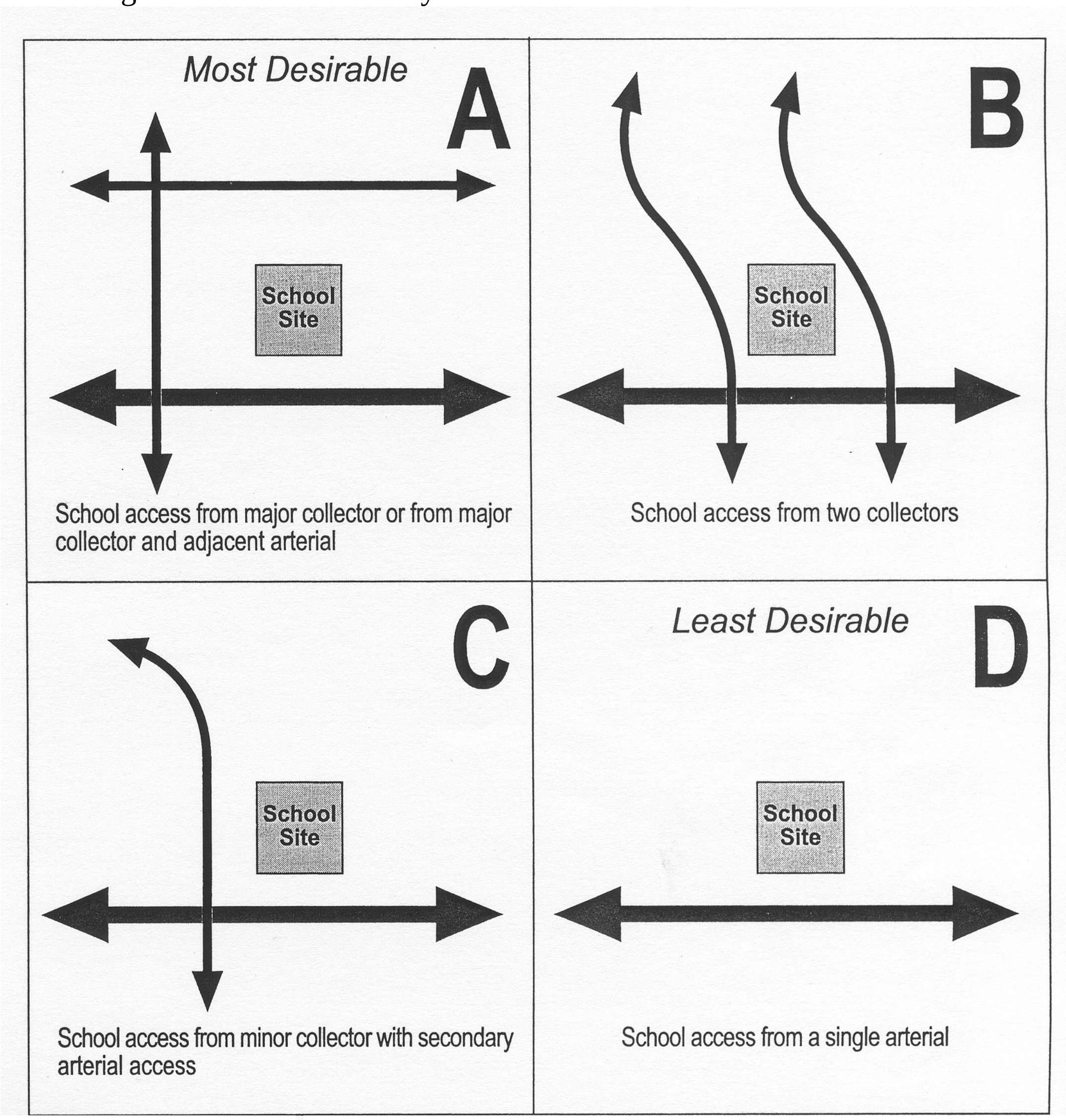


Figure 2-3. Site Layouts for Secondary Schools (*8*).

PARKING

An overall concern of the operation of parking areas and access points is that they should be separated by purpose (*10*). Design should separate buses from cars and pedestrians from vehicles. No pedestrian crosswalks should extend through loading areas, and other users should be restricted from those loading areas. An idealized view of a school facility that separates these users is shown in Figure 2-4. Off-peak uses such as special events or weekend parking could be exceptions.

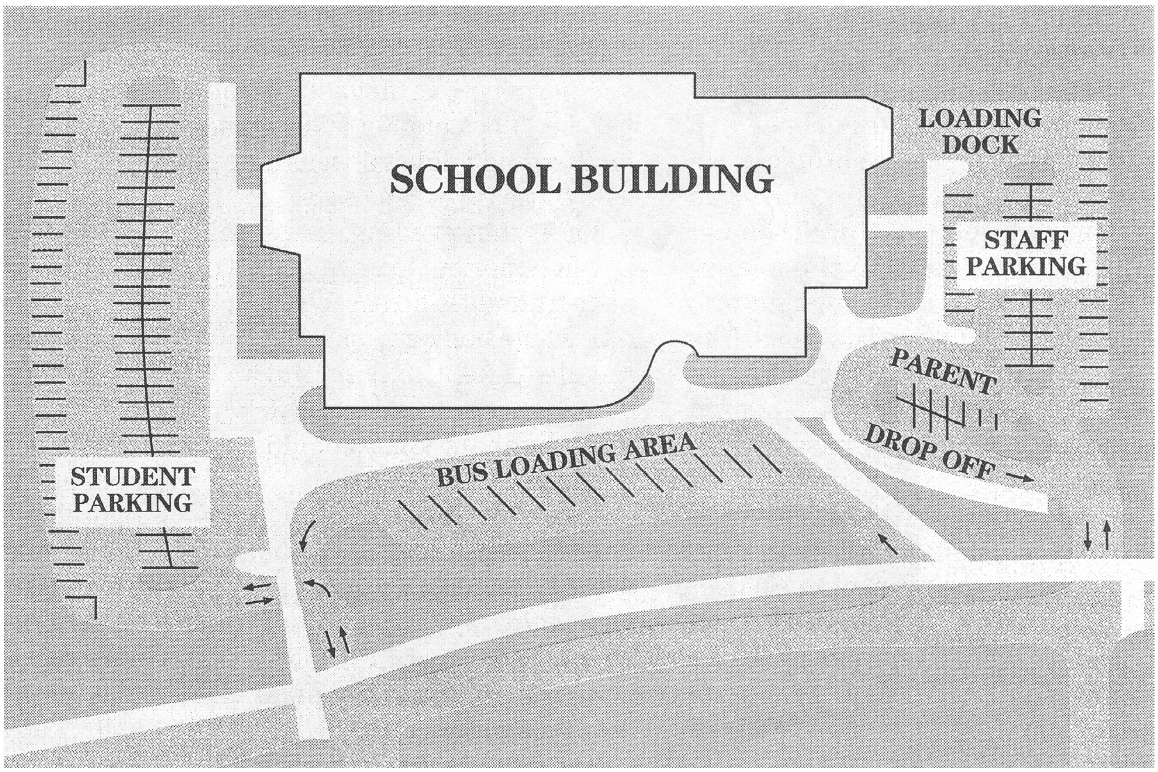


Figure 2-4. Illustration of Separation between Parent Drop-Off Zone, Staff Parking, Student Parking, and Bus Loading (*10*).

According to the Arizona Department of Transportation *School Safety Program Guidelines*, parking areas should provide direct access to the school, without requiring crossing driveways or access roadways (*11*). Faculty and student parking can be located further away from the school. Figure 2-5 provides an example of a parking lot that segregates staff, student, and visitor parking within one overall parking lot.

Navin and Hamilton identified a number of principles (*12*):

> "<u>Localization</u> of traffic functions in order to specify and reduce traffic conflicts.
> <u>Separation</u> of different types of vehicles in space and time in order to eliminate conflicts.
> <u>Differentiation</u> within each road system with regard to functions and properties to ensure homogeneous traffic flows.
> <u>Visibility</u> when forming a traffic environment to facilitate decision processing."

Navin and Hamilton also recommend that students should be concentrated to enhance their visibility as pedestrians.

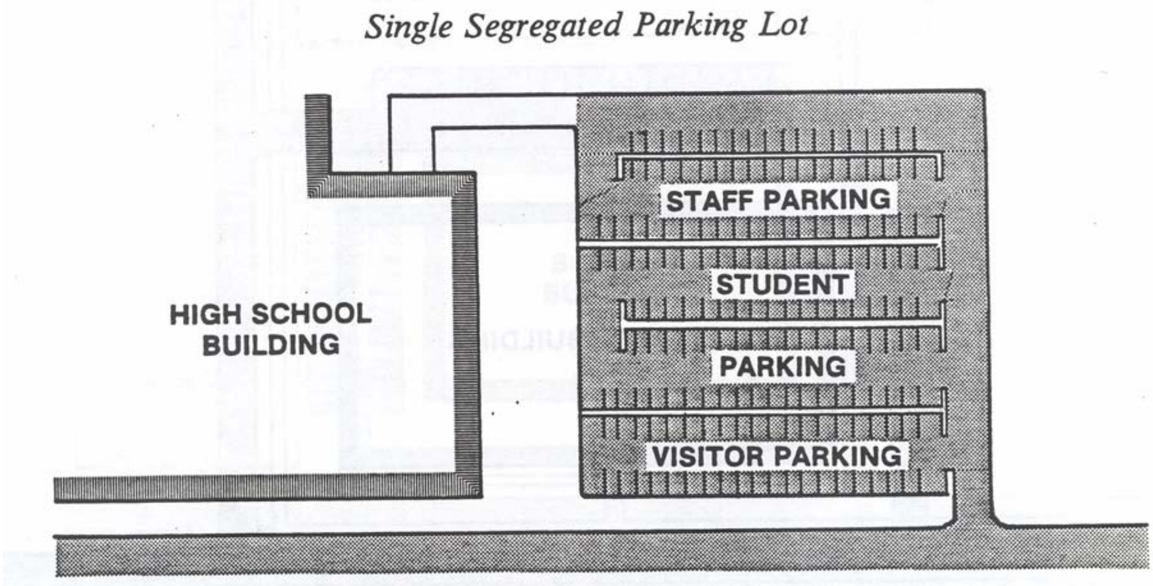


Figure 2-5. Parking Lot Segregated by Use (*11*).

Access needs may differ by facility type. Planners should give consideration to those different needs in the overall layout of the school facility. According to guidelines developed by Carter & Burgess, Inc., elementary school entrances and exits may need to be via multiple streets to disperse the impact on surrounding neighborhood streets, although high school entrances and exits may need to be concentrated to allow traffic signalization on a major thoroughfare (*8*). Figure 2-6 shows an illustration of their guideline's recommendation.

Size

The Idaho Division of Professional-Technical Education has recommended that local parking regulations should be consulted to help determine parking lot capacities and ensure that sufficient parking should be provided to accommodate students, staff, and visitors (*13*). The Arizona DOT estimates that staff and visitor parking needs at non-secondary schools would be met by providing one parking space per staff member in the staff lot and an additional 10 percent in the visitor lot (*11*).

Another consideration in designing parking areas is the provision of special event parking space. Walkways, driveways, and lighting should be designed to accommodate special events as well as normal activities (*11*).

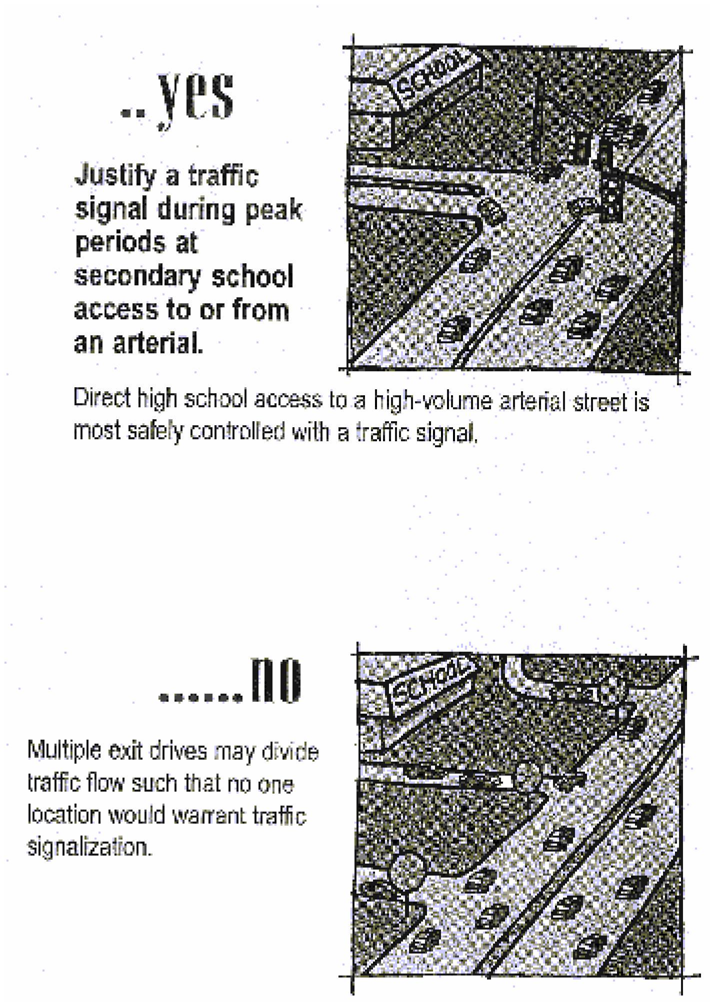


Figure 2-6. Concentration of Access Points to Allow Signalization at a Secondary School (*8*).

According to guidelines developed by Carter & Burgess, Inc., parking lot size should be selected so special events are accommodated (*8*). Nearby residents and streets can be severely impacted if these events are not considered. The Arizona DOT advises that for high schools student parking areas should be designed to also accommodate special event parking (*11*).

Layout

Access to the school site should be from more than one direction and roadway, helping to ensure reduced congestion (*8*). A design of this type can help disperse traffic and reduce school impacts on the street network. Recommendations have been made by the South Carolina DOT that most new school sites should include turning lanes to reduce the impacts that schools have on adjacent intersections and roadways (*9*).

Visitors. Visitor parking areas should be provided in an easily accessible, highly visible location. Figure 2-5 shows a parking lot that provides separate visitor parking at the front (*11*). If separate parking areas are not provided, visitor parking will be limited and in undesirable locations because of student and staff spillover (*8*).

Staff. According to Matthews, staff parking lots require the least amount of accessibility because the staff members generally arrive before and leave after other users (*10*).

Students. In general, these parking areas can be treated similarly to staff parking, although consideration should be given to the relative inexperience of teenage drivers (*10*). Separation from other school areas should be provided. Separate entrances and exits for student parking lots are desirable.

If the campus is "open," consideration should be given to the exit requirements for student vehicles at lunch (*11*). This may require multiple entrances and exits to provide the necessary capacity.

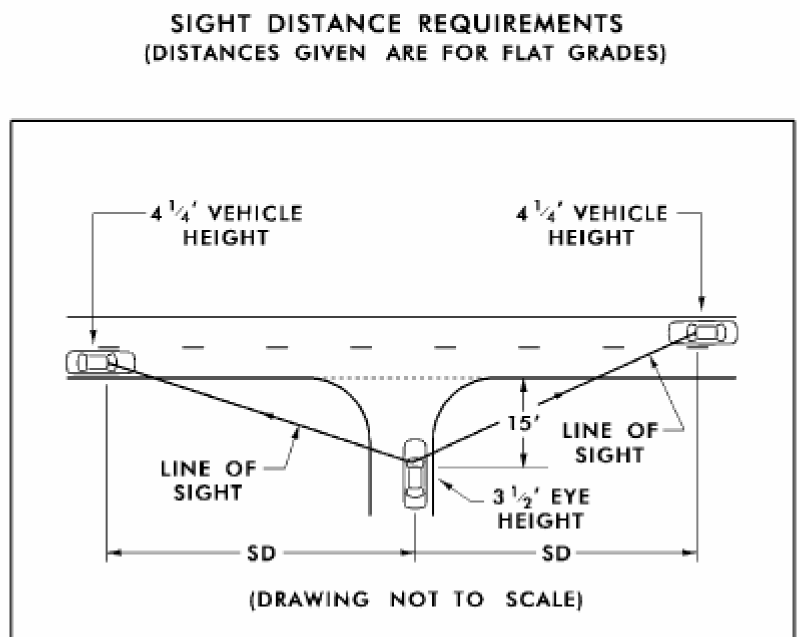
Service Vehicles. Access for service vehicles to support service areas should be provided (*13*). This access should be in a form that allows easy egress and ingress into the school property, preferably via loop or circular drives.

Driveway Characteristics

If multiple driveways are provided, the South Carolina DOT recommends a minimum spacing of 600 ft (183 m) between the driveways (*9*). The driveways should also be spaced at least 75 ft (23 m) away from any roadway intersections, measured between the intersecting road's nearest edge and the driveway radius offset. The South Carolina DOT also recommends that driveways meet sight distance requirements, shown in Figure 2-7.

Matthews states that driveways for buses should use at least a 50 ft radius, although an additional 15 ft (4.6 m) should be provided if circular drives or waiting areas are used (*10*). The North Carolina DOT recommends a 45 ft (13.7 m) outside and 26 ft (7.9 m) inside turning ratio, and the South Carolina DOT recommends a 40 ft (12.2 m) radius and provides a recommended design that includes a taper on the inbound side of the driveway (see Figure 2-8) (*6*, *9)*. The American Association of State Highway and Transportation Officials has recently added school bus turning templates suitable for use by designers for examining accessibility for buses (*14*).

Other general recommendations regarding driveways are for 12 ft (3.7 m) lanes (wider if curves are used), limiting grades to no more than 8 percent, right- and left-turn exit lanes are desirable, and that buses should enter the street from an area upstream of automobiles (thus gaining priority and reducing bus delay) (*8*, *11*).



DESIGN VEHICLE ENTERING ARTERIAL	SIGHT DISTANCE (SD) PER 10 MPH OF ARTERIAL SPEED FOR ARTERIAL WIDTH OF:		
	2 LANES	4 LANES	6 LANES
	FEET	FEET	FEET
PASSENGER CAR	100	120	130
SCHOOL BUS	130	150	170

Figure 2-7. Sight Distance Requirements (*9*).

BUS OPERATIONS

The design of bus loading, parking, and driveway areas is critical to pedestrian safety. Students are three times as likely to be killed during loading or unloading operations than while occupying the bus (*14*).

Matthews recommends that unloading should be with the door to the right-hand curb, with students able to go to the school without crossing other driveways (*10*). Buses should never be oriented with the left front wheel toward the curb or school because of the possibility of students entering the area in front of the bus. Supervising personnel (preferably including administrative offices) should have a clear view of the bus loading operation. To reduce possible conflicts, the Arizona DOT recommends that movements of school buses on or near school grounds should be accomplished through one-way operations, preferably in a counterclockwise movement (*11*).

Matthews reviewed several options available for bus operations (see Figure 2-9) (*10*). A preferred method is for buses to line up against the right-hand curb with loading from that point. This method allows students to board without going between buses or into the driveway, however, this method is obviously space-intensive. The next preferred method is "single-lane chevron loading." This method angles the buses toward the curb, with the right-hand front closest to the curb.

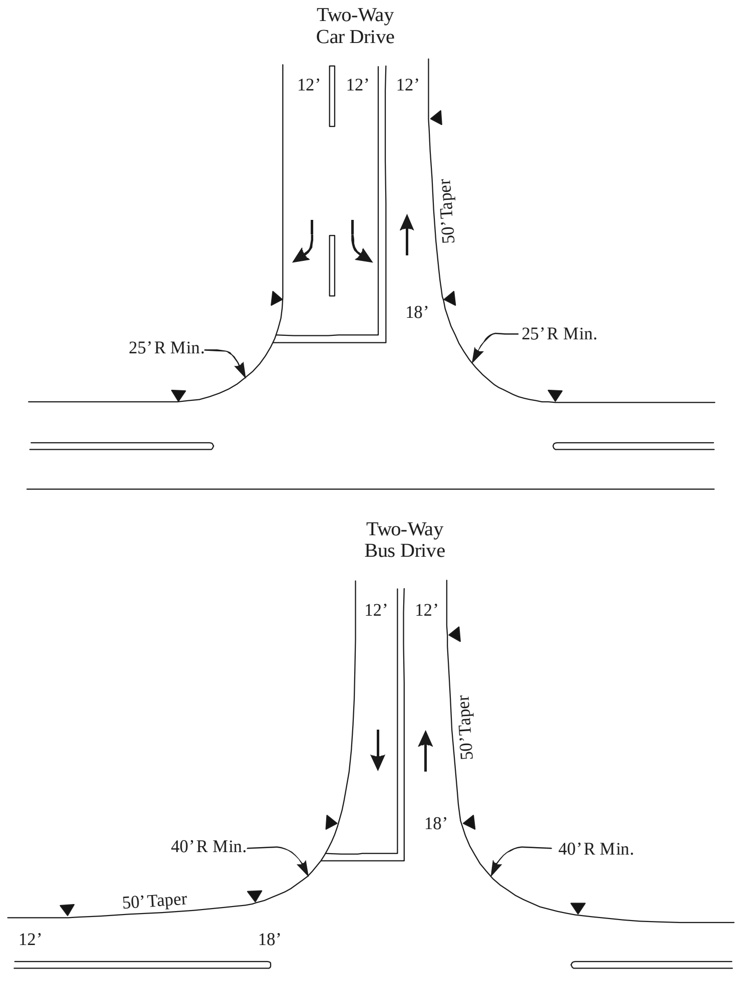


Figure 2-8. Driveway Lane Widths and Corner Radii (*9*).

Students do not have to pass between the buses to board. The next method is the "multiple-lane chevron." Two or more rows or angled buses are provided, allowing efficient space utilization. This comes at the expense of routing students between the buses, however. The least preferred layout is the "multiple-lane parallel." In this strategy, buses line up head-to-tail in side-by-side lanes. Students again pass between the buses.

Figure 2-10 shows another pattern, providing an alternative for sites with reduced amounts of space (*11*). In this layout, buses are confined to a recessed area along a street. Buses entering the traffic stream from such a design may reduce capacity for the street and obscure motorists' view of pedestrians, however (*8*).

Bus loading and unloading zones should be provided with sufficient pedestrian areas to accommodate the student users, according to Matthews (*10*). The area should be separated from the driveway with a fence or guardrail. Shelter for the students is desirable, although it may be cost prohibitive. The loading area should be reasonably flat.

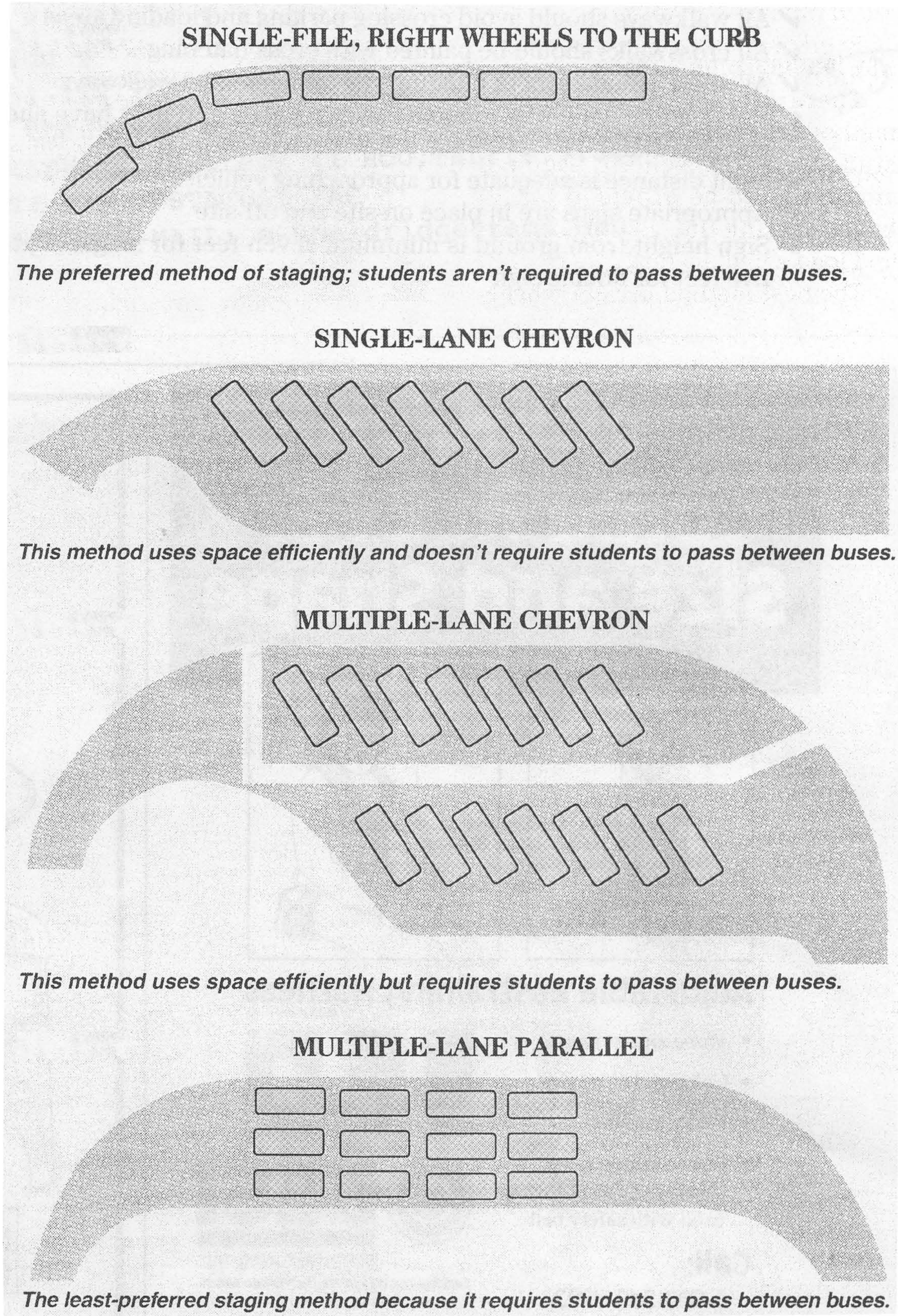


Figure 2-9. Staging Options for School Bus Loading (*10*).

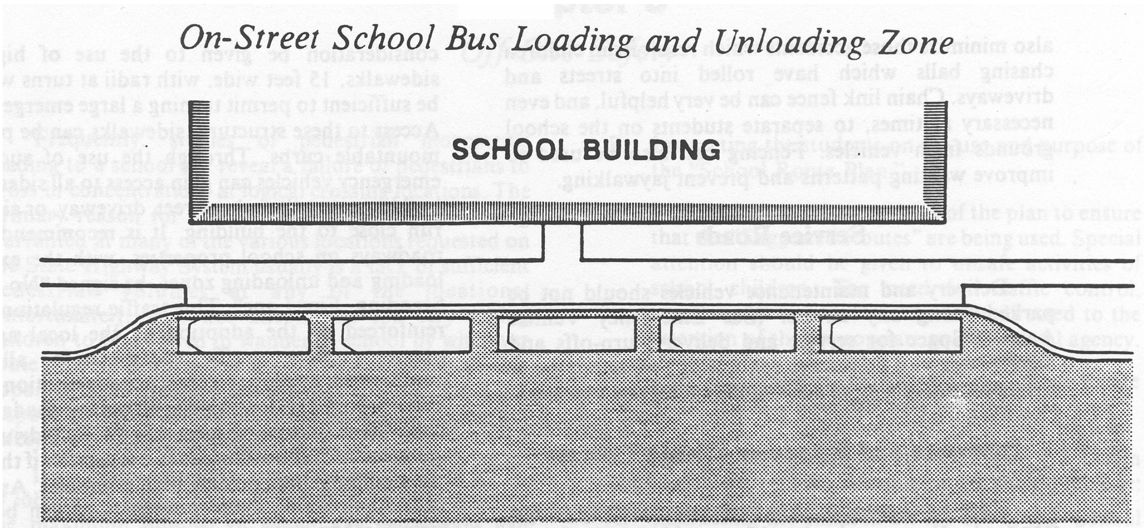


Figure 2-10. On-Street Bus Parking (*11*).

Access for handicapped bus operations should also be assured, and physically challenged individuals may need to be provided with a separate drop-off area (*10*, *15*). Consideration to the use of lower curb heights was also suggested in this area. Finally, in areas with bus operations, avoid fixed objects within 4 ft (1.2 m) of the curb line (*10*).

PARENT DROP-OFF/PICK-UP

Parent pick-up and drop-off is a source of pedestrian conflict and congestion if conducted along city streets rather than on-site (*8*).

Parent pick-up and drop-off driveways should allow easy entry and exits that do not require backing up (*11*). Circular drives allow freedom of movement for cars. Traffic movement should be accomplished in a one-way, counterclockwise direction to reduce conflicts with pedestrians and allow exiting students to step directly onto the sidewalk (*11*).

Driveways for parent pick-up/drop-off zones and bus operations should be separated, as shown in Figure 2-11 (*11*). This separation reduces conflicts and congestion in the area.

In some situations parent pick-up/drop-off zones are integrated into a parking lot. If this is done, the layout of the parking lot should be arranged to accommodate a counterclockwise movement and direct sidewalk access (*11*). Figure 2-12 provides an example of this type of design.

North Carolina has developed recommended operational practices for parent pick-up/drop-off areas, shown in Figure 2-13 (*16*). The recommendations are intended to enhance safety and operations in the loading zones and include items related to geometric layout, supervision, and student behavior.

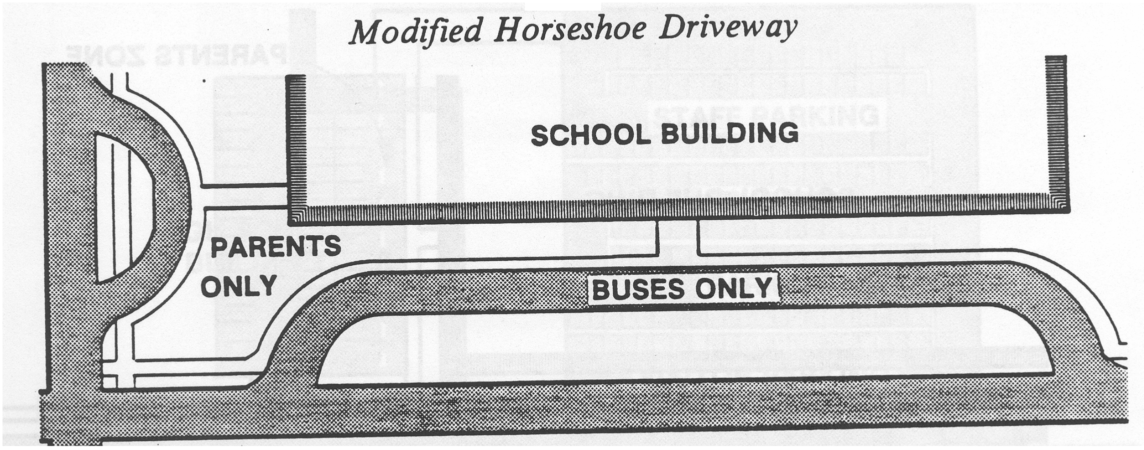


Figure 2-11. Parent Pick-Up/Drop-Off Zone Separated from Bus Pick-Up/Drop-Off Zone(*11*).

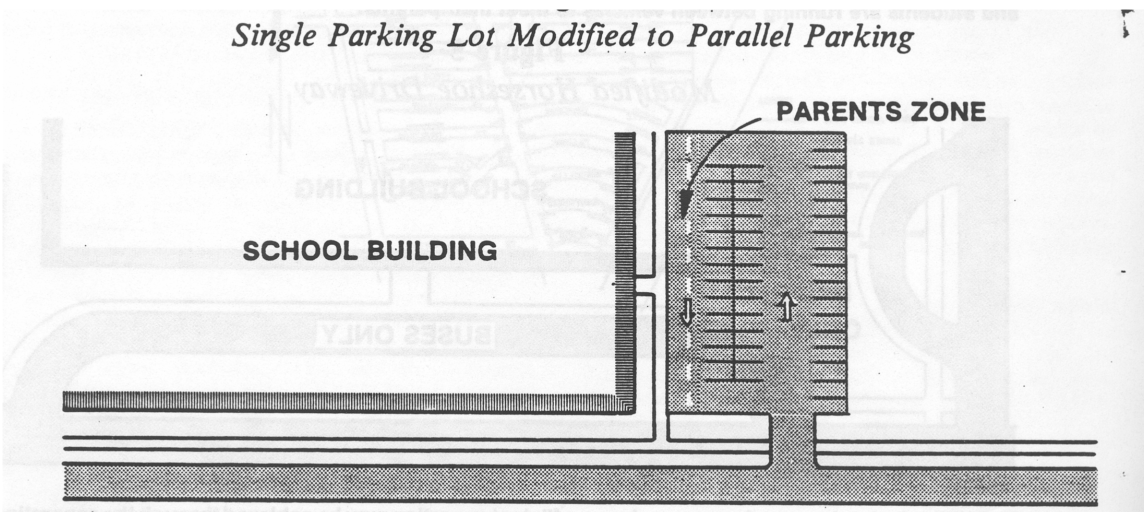
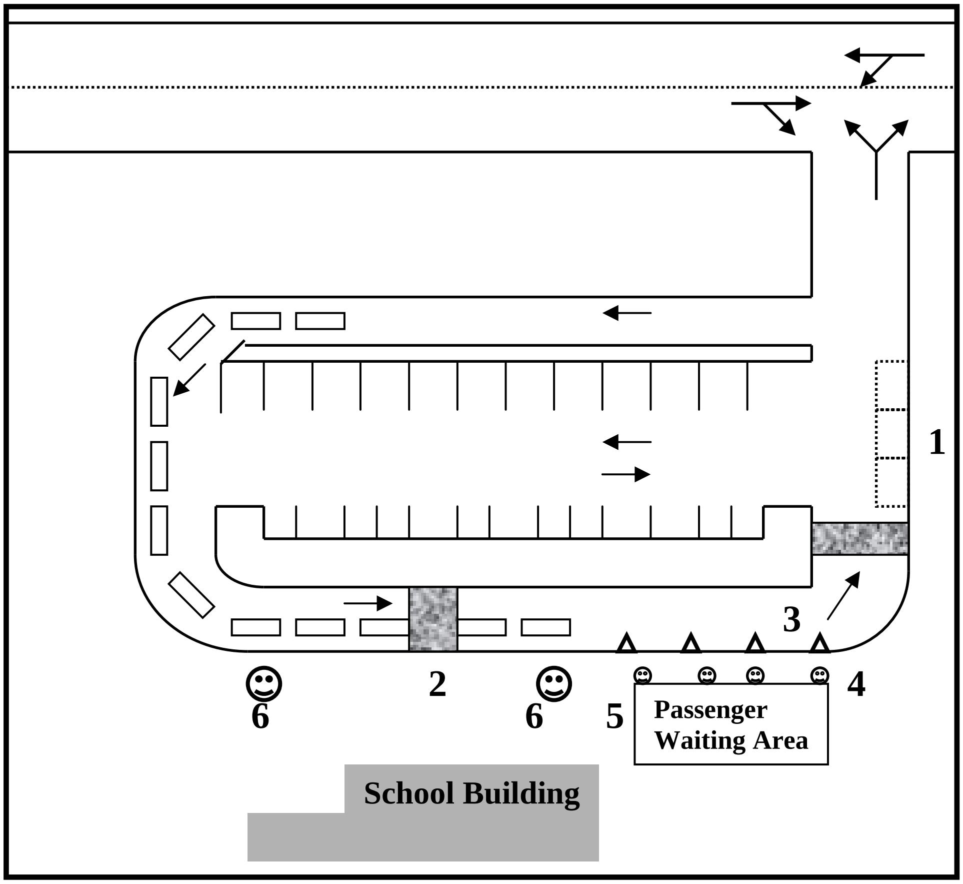


Figure 2-12. Parent Pick-Up/Drop-Off Zone in a Parking Lot (*11*).



1. Short-term parking spaces should be identified past the student loading area and near the building entrance. These spaces can be identified by installing 'Visitor Parking' signs at the designated spaces and should be used for parents requiring an extended period of time to load or unload.
2. Crosswalks should be clearly marked with the first choice location being before the loading area and the second choice location after the loading area.
3. Make sure there is clear demarcation of the bays in the loading area.
    a. Paint the loading area into separate bays by installing 4-inch white solid pavement markings; each bay should be a minimum of 8 feet wide.
    b. The end bays should be at least a minimum length of 20 feet and the middle bays should be at least a minimum length of 30 feet. There should be a maximum of 4-5 bays.
4. Each bay should have its own safety assistant, trained by teachers at the beginning of every school year.
    a. One safety assistant should be present in each loading bay.
    b. This safety assistant is responsible for assisting the child(ren) into or out of their vehicle.
    c. Each safety assistant should wear an orange safety vest to provide visibility and to be easily identified by children and drivers.
5. At the end of the school day, have children wait in an organized fashion in the loading area or adjacent to it.
    a. Organization allows for children to pay attention and hear their name or number called.
    b. This helps to expedite the loading process by getting children to their vehicles quicker.
    c. It also helps the carpool time to be safe, as children will not be left to run around unsupervised.
6. Implement an Advanced Passenger Identification system using numbers or name cards placed in the windshield of the vehicle waiting in the carpool.
    a. This will require at least two people. The first person should stand five or six cars before the loading area and call out the names of the children over a walkie-talkie to the second person.
    b. The second staff member should be standing in the loading area itself relaying the names or numbers with a speaker system and directing students to the appropriate bay.

Figure 2-13. North Carolina State Best Practices for Loading/Unloading Students (*16*).

QUEUING

Consideration should be given to the development of queues on and around school areas. Access to and from the local street network should be accomplished in a manner that is safe and efficient. Congestion can be a major problem during school rush time periods, as queues develop around schools. Turning lanes and turning patterns that limit conflicts are desirable (*11*).

Any queue prediction technique should be based on verifiable assumptions about traffic generation. Cawley reports the results of four school safety case studies in Dearborn, Michigan, finding that only 10-15 percent of students walked during good weather days (*17*). Occupancy in passenger vehicles was found to average 1.65 students per vehicle. The bulk of the traffic occurred in a 15-20 minute time period.

Elefteriadou and Vecellio reported the development of a modeling technique to predict queue length using computer simulation (*18*). Using General Purpose Simulation System (GPSS/PC), they modeled the queues from two different schools. Three empirical distributions were used in the model to represent arrival times from two directions and service time for the drop-off point. The model's predicted queues were tested against observed queues resulting in a conclusion that the models were satisfactory for use.

Figure 2-14 shows another queuing prediction tool (*19*). Developed by the North Carolina Department of Transportation Municipal and School Traffic Assistance unit, the software provides estimates of queue length and trip generation based on the student population, number of buses, and number of faculty members.

The South Carolina Department of Transportation has developed recommendations regarding the length of queuing facilities (*9*). Shown in Table 2-1, the recommendations are based on student population and school type. It further recommended consideration of separate parking areas or drop-off areas if kindergarten students are present at the school.

The use of modeling to examine queuing allows the development of alternative arrival strategies such as incentives for early drop-off, splitting parking traffic from the drop-off queue, etc., to reduce the extent of the queues and the likelihood for them to exceed driveway capacities (*11*).

North Carolina's School Transportation Group reports that a study on traffic circulation on elementary school campuses is underway (*20*). The study is examining congestion caused by the increased number of parents driving their children to school. Approximately 20 elementary schools have been selected for inclusion in the study based on school bus ridership.

The study is examining geometric characteristics of the queuing areas, student loading practices, carpooling characteristics, and conflicts between students and vehicles. The study will produce a best practice report.

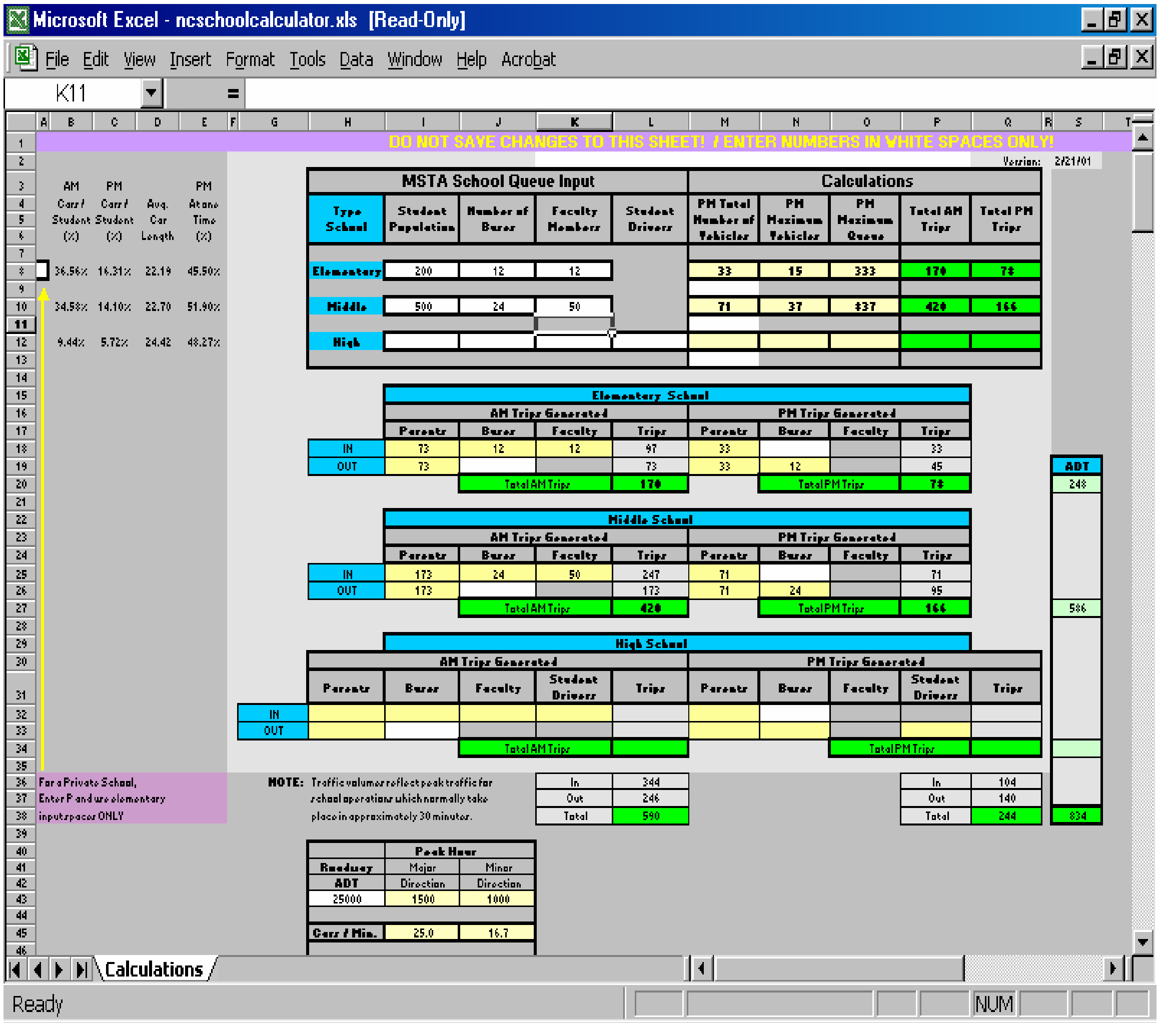


Figure 2-14. Queuing Prediction Spreadsheet (*19*).

Table 2-1. South Carolina DOT Recommendations for Queuing Facilities (*9*).

School Type	Student Population	Loop Drive Stacking Length (linear feet) (m)
Elementary	200-600 600-1400	900-1200 (274.5 – 366) 1200-1500 (366 – 457.5)
Middle	200-600 600-1200	900-1200 (274.5 – 366) 1200-1500 (366 – 457.5)
High	400-800 800-2500	800-1200 (244 – 366) 1200-1500 (366 – 457.5)
Note: For high school populations greater than 2500 students, consider two separate student pick-up/drop-off loops.		

OPERATIONAL PRACTICES

Specific guidelines for the operations in drop-off/pick-up zones vary widely. Some schools control the operations tightly with teacher supervision of students and detailed rules for drivers, while others merely designate drop-off/pick-up zones. Researchers reviewed these practices through use of documents available on the Internet at school websites. It is recognized that this does not represent a random sampling, but it does provide an overview of those schools' practices that have published guidelines.

Those sites reporting a particular practice are shown:

- Speed limits on-site, 5 mph (8.1 km/h)
  Elementary school (*21*)
- Multiple vehicles loading/unloading encouraged in the same line
  Elementary school (*21*)
- Restrictions to single-side (usually right) only loading
  Elementary schools (*21*, *22*, *23*, *24*)
- Parking restricted in drop-off/pick-up zone
  Elementary schools (*21*, *24*, *25*, *26*, *27*, *28*, *29)*
  City school recommendation (*30*)
- Parking assistance provided
  Elementary schools (*21*, *27*, *29*, *31*, *32*)
- Adult or safety patrol opens car doors for students
  Elementary school (*21*)

Significant comments

- Encouragement is provided for students to "walk, in-line skate, cycle, or take transit to school," with driving by private car discouraged (*31*).
- All student drop-off/pick-ups must take place in designated areas (*25*).
- All students are escorted from the parking lot to the classroom by an adult (*31*).
- Bikes must be walked when students are on school property (*33*).
- Allow only right-turn entry into parking lots for drop off/pick up (*33*).
- Allow only left-turn exit in the afternoon (*34*).

PEDESTRIAN WALKWAYS

Walkways should desirably not cross driveways, although if this is necessary the crossings should be provided in areas where vehicle movements are limited (i.e., a single-lane entrance), avoiding parking lots (*11*).

Separate pedestrians from vehicles and children. Norwegian experience shows that a 30 percent reduction in accident risk is realized by accomplishing this separation (*12*).

Concentrating pedestrians into a minimum number of crossings has also been identified as a safety measure by Cawley (*17*). Accomplishing this safety measure heightens driver awareness of the pedestrians by providing a minimum number of locations to focus on. In another location, Cawley reports the use of chokers and cross-hatching to enhance the visibility of crosswalks at a school site.

In a study of 10 school zones, Zegeer et al. found that four events were the most common (*35*):

1. slow or stop for pedestrians,
2. pedestrians running across the street,
3. previous conflicts, and
4. pedestrian stopping in road.

In a study of pedestrian behavior, Reiss examined the characteristics of pedestrians and their responses to various situations (*36*). He concluded that younger pedestrians were much more likely to listen to their parents regarding route selection than older pedestrians. When reviewing an existing site for problems, this idea becomes important when re-routing students. If the new path is perceived as less advantageous, older students may be unlikely to follow the desired path. Peer groups may be more effective for these students.

Crosswalks should be marked at intersections on established routes to schools where there are substantial conflicts between pedestrians, bicyclists, and motor vehicles (*11*, 37). The *Manual on Uniform Traffic Control Devices* (*MUTCD*) shows several crosswalk marking patterns although the standard marking is two parallel transverse white lines (*37*). Additional transverse markings may be added to (or substituted for) the transverse markings for improved visibility; these additional markings are noted as being preferred in some references (*11*).

The success or failure of various traffic-calming measures may be measured in a number of ways, but one way suggested in a traffic committee report in Los Altos, California, is whether parents allow their children to walk or ride bicycles to school (*38*).

Because of the safety impacts on pedestrian travel, elementary schools are best located within residential neighborhoods and away from high-volume roadways (*8*). Further, if schools are located within residential neighborhoods they should avoid residential driveways to reduce pedestrian and vehicular conflicts.

Direct connections between surrounding neighborhoods and school sites can help increase the numbers of students walking or cycling to school, reducing the amount of school-related traffic (*8*). Providing sidewalks along roadways leading to schools can also enhance the number of pedestrians.

BICYCLE ACCESS AND USE

Bicycle access to the campus should be accomplished in such a way as to allow students to safely enter the facility and park their bicycles in a secure location. Direct connections between neighborhoods and the school grounds are a desirable feature for school sites (*8*).

The South Carolina DOT recommends that bicyclists have a designated safe route between any roadway and the school building (*9*).

SCHOOL TRAVEL RISKS

A recent review of risks related to school travel examined available crash databases (*39*). In the United States approximately 800 school-aged children are killed and 152,000 are injured annually. A breakdown of these deaths and injuries is provided in Tables 2-2 and 2-3, together with their relative rates.

Table 2-2. Student Fatalities and Rates by Mode (*39*).

Mode	Fatalities		Per 100 Million Student Trips	Per 100 Million Student-Miles
	Number	Percent		
School Bus	20	2	0.3	0.1
Other Bus	1	<1	0.1	<0.1
Passenger Vehicle, Adult Driver	169	20	1.6	0.3
Passenger Vehicle, Teen Driver	448	55	13.2	2.4
Bicycle	46	6	9.6	12.2
Walking	131	16	4.6	8.7
Overall	**815**	**100**	**3.5**	**0.7**

Table 2-3. Student Injuries and Rates by Mode (*39*).

Mode	Injuries		Per 100 Million Student Trips	Per 100 Million Student-Miles
	Number	Percent		
School Bus	6000	4	100	20
Other Bus	550	<1	120	20
Passenger Vehicle, Adult Driver	51,000	33	490	90
Passenger Vehicle, Teen Driver	78,000	51	2300	430
Bicycle	7700	5	1610	2050
Walking	8800	6	310	590
Overall	**152,050**	**100**	**650**	**130**

Interpretation of Tables 2-2 and 2-3 should be undertaken after consideration of relative trip lengths (i.e., bicycle and walking trips tend to be relatively short, affecting rates based on trip length).

Examining available data, it is readily concluded that some trip modes have significantly different risks. Infrastructure and behavioral changes can greatly affect the risks associated with those modes, however (*39*). Risk management approaches to safety should be undertaken to determine responses to perceived risks. These approaches might include assessments of sidewalk, bicycle facility, and crosswalk availability and adequacy or other infrastructure and safety needs.

TRAFFIC CONTROL DEVICES

Traffic control devices at schools frequently are not in conformance with current standards, violating placement, height, and message requirements (*17*). The use of unnecessary signs may also contribute to driver compliance problems. The *MUTCD* should be used to review signing and marking practices to ensure that the devices are selected and placed appropriately (*37*).

FIRE SAFETY AND BUILDING SECURITY

Access around the perimeter of the building should be provided to allow adequate access by fire department vehicles. When reviewing site access for adequacy of design, fire truck usage should be included in any study of parking lot or driveway adequacy (*6*).

This review of security needs focused on security related to transportation facilities. The need for security lighting in bus drop-off zones and vehicle parking lots was noted in Idaho's *Prototypical Facility Educational Specifications* (*13*).

CHAPTER 3. ARCHITECT INTERVIEWS

BACKGROUND

Architecture firms are normally the lead entity on most school construction projects, whether a retrofit of an existing facility or construction of an entirely new campus. When the project is construction of an entirely new campus, the architect is responsible for a number of important elements including the building design and placement, utilities, outdoor recreation areas, and general site development (i.e., grading, drainage, sidewalks, driveways, parking facilities, etc.). In general, the majority of the planning time and also the associated training for the architect is on the building-related elements (i.e., classrooms, common areas, administrative offices, etc.). A wealth of information and guidelines exists about how to design classrooms and other spaces within a school building to create an efficient and successful learning environment. There are even well-documented design guidelines for outdoor recreation areas such as playground equipment, athletic fields, natural laboratories, etc. One element of the school campus that does not have as many documented guidelines and/or good practices is for transportation-related elements such as driveways, loading zones (bus and vehicle), parking facilities, etc.

In order to gain a clearer understanding of the challenges, issues, and methods used to plan and design K-12 educational facilities, researchers conducted personal interviews with six architecture firms located in the Dallas/Fort Worth (DFW) area. The interviews focused on the planning and design of the transportation elements associated with school sites. Questions posed to the architects related to resources and training for planning and design, coordination issues with outside agencies, traffic access and circulation, and design guidelines for vehicle and bus loading zones, parking, driveways, and pedestrian access.

ORGANIZATION

This chapter is organized into two remaining sections. The first section lists the responses, by question, from those interviewed. This section also includes some additional information obtained from four architects in other regions via a supplemental survey that was distributed by electronic mail. The last section contains a brief summary of the key findings obtained from the interviews.

SUMMARY OF INDIVIDUAL RESPONSES

Responses are listed in tables or summarized below each of the questions asked of the interview and survey participants.

1. What percentage of your firm's work is related to the design of educational (K-12) facilities?

Interview participants 1 through 4 reported their firm dedicates 10 to 25 percent of their work to K-12 facilities, while participants 5 and 6 indicated that more than 75 percent of their firm's work stems from educational projects. Two of the e-mail survey respondents also had 75 percent or more of their work related to school design, the third one had between 50 to 75 percent, and the final one had between 25 to 50 percent.

2. Do you have transportation engineers, general civil engineers, or both on staff?

Two of the architecture firms interviewed had general civil engineers on staff. One of these firms also had a transportation engineer. None of the e-mail survey respondents had either on staff.

3. Please list the names of recently completed school design projects in Texas.

Participants provided a list of 12 elementary school, 10 middle school, and 7 high school projects on which they worked.

4. What resources do you typically use or reference for the planning and design of K-12 educational facilities (e.g., American Institute of Architects (AIA), Texas Education Agency (TEA), ISD, state, or city guidelines)?

Interviewees reported a number of resources, presented in Table 3-1.

Table 3-1. Resources/References for K-12 Educational Facilities Design.

ID	Response
1	• Council of Facility Education Planners (CEFPI) – have regional and local chapter meetings • local zoning • TEA • National Clearinghouse for School Facilities • State of Washington and State of Ohio Departments of Education (DOEs) design manuals
2	• ISD technical and educational specifications (space inside) • CEFPI has a number of guidelines • AIA is more generic
3	• TEA • Texas Association of School Administrators (TASA) • Texas Association of School Boards (TASB) have written guidelines • ISD – from teachers and some have written guidelines • City – planning building, written controls • CEFPI and AIA have generalized guidelines that they usually try to adhere to and take to ISD

Table 3-1. Resources/References for K-12 Educational Facilities Design (continued).

ID	Response
4	• TEA – guidelines • ISD – educational specifications • Building codes and zoning ordinances • Architectural graphic standards • ISD vision for school – main tool in the operational design
5	• TEA has some • ISD provides performing criteria • Experience tends to be most important aspect
6	No resources specific to transportation and also use TEA guidelines for room sizes

5. Did you receive special training in K-12 facilities?

Most participants stated they have not received formal training, but specified their sources of knowledge as listed in Table 3-2.

Table 3-2. Special Training in K-12 Facilities Design.

ID	Response
1	• Registered Education Facilities Planner (REFP) comes through CEFPI (years of experience and continuing education units) • Workshops – University of Georgia, University of Wisconsin, & University of California-Riverside • Texas has very few school administrators
2	No, gained knowledge from seminars and conferences
3	No, ongoing classes
4	No, from working on schools
5	Nothing academic, but gain through on the job experience
6	No

6. What professional development opportunities exist for K-12 facilities?

All responded that CEFPI offers professional opportunities; nearly all interview participants provided additional names of other organizations (see Table 3-3).

Table 3-3. Professional Development Opportunities for K-12 Facilities.

ID	Response
1	CEFPI, AIA, TASB (low), Texas Association of School Business Officials (TASBO) (not strong), AIA Committee on Architecture in Education (CAE) committee
2	CEFPI main one utilized. The programs and data are invaluable.
3	CEFPI classes (3 conferences in state). TASA and TASB have conferences and classes
4	AIA continuing education, CEFPI local chapter, and statewide annual meeting; TASB and TASA are geared to the ISD; Texas Society of Architects
5	CEFPI and AIA
6	CEFPI and AIA CAE; TASA co-sponsors workshops with CEFPI

7. Do other offices share the same planning/design philosophy for schools?

Table 3-4 displays each reply.

Table 3-4. Planning/Design Philosophy between Offices and Schools.

ID	Response
1	Every project is new (client and site), it is not a kit of parts
2	Yes, consistent among firm
3	Yes, all planning is the same and the designs are based on the districts
4	No other offices
5	No other offices
6	Yes, it is a unified approach

8. What funding programs are you aware of that are available or will soon be available to help design or retrofit school sites with safer access and circulation?

Only one participant stated awareness of a funding program. He reported his school district as the source of payment through city funds set aside for any developers' unfunded mandates.

9. Are you aware of the Precious Cargo Program offered by the Texas Department of Transportation?

Half (3 of 6) of the interview participants indicated that they were aware of the TxDOT Precious Cargo Program. One of those aware of the program had only heard of it once. None of the four respondents to the e-mail survey were aware of the Precious Cargo Program.

10. Have you ever had a TxDOT representative review a school site plan prior to the construction of a new school campus?

Only two of the interview participants had ever had a TxDOT representative review a school site plan prior to construction of a new school campus. In contrast, the majority (3 of 4) of the e-mail survey respondents had previously had a school site plan reviewed.

11. Do you interact with the following departments during planning and design? How frequently (seldom, occasionally, frequently)? In what capacity?

Survey answers revealed varying degrees of interaction with city departments (Table 3-5). Of all departments, architects reported the least amount of consultation with police.

Table 3-5. Departmental Interaction during Planning and Design.

ID	City Planning	Fire	Police	City Engineering
1	Very frequently, when they exist	Standard	Seldom	Often, part of city review; to get a curb cut; fairly standard in suburbs
2	Frequently – platting, road closure, zoning	Occasionally – couple of meetings on every project	Seldom – for security issues	Regularly with public works, occasionally with traffic (early on-site work)
3	Every job – main contact; they take all interests into account	Every job, but seldom (three reviews) in the process	Very seldom	They get a look and are involved for specific problems
4	Always and frequently in the process	Always – more at the start during plan review and for building permit	No response	Part of the building permit process; occasionally city will require a traffic study
5	Always and frequently in the process	Occasionally	Seldom – dictated by city to provide input	Occasionally
6	Frequently – give heads up through design review	Frequently	No response	Frequently

12. What permits or requirements for transportation-related elements are typically required for a new school site plan? (Check all that apply.)

Table 3-6 lists permits and requirements.

Table 3-6. Permits or Requirements in New School Site Plans.

ID	Driveways	Traffic Impact Analysis	Signing & Marking	Other
1	Yes	Bringing info to them	Yes	Turn lanes, signals, stop signs, parking, queuing lanes
2	None	None	None	Curb and median cuts
3	None	Haven't been required yet	Yes – in most cities	Planning and zoning, council approval of site plan
4	None	None	City engineer does plan review; civil engineers talk to TxDOT if the site is on a state road	None

Table 3-6. Permits or Requirements in New School Site Plans (continued).

ID	Driveways	Traffic Impact Analysis	Signing & Marking	Other
5	Yes – city controls unless on a state road	Yes – case-by-case basis	Yes – part of planning process, up to architect	None
6	Yes – nearly all have ordinances	Problem at high schools in AM	Yes–rarely for message board near streets	None
SR*	Yes – 4 of 4	Yes – 3 of 4	Yes – 2 of 4	None

*Survey respondents from e-mail survey

13. What are the initial steps in planning and designing K-12 facilities?

Participants identified steps taken in the early planning/design stages, as shown in Table 3-7.

Table 3-7. Initial Steps in Planning and Designing K-12 Facilities.

ID	Response
1	• Identify the mission and needs of the ISD • Identify existing capacity then define project scope and goals in writing so that priority issues are solved
2	• Overall scope • Site investment/analysis – context, access to, egress from, topography, and utilities • Soils, environmental assessment, and floodplain issues • Easements, setbacks, and encroachments
3	• Determine where the major streets are and site building close to them • Determine circulation on site and around building – separating parents, staff, and buses
4	• Separate bus/parent and pedestrian traffic • Grade level – parking requirement • Public transportation • Topography, utilities, building orientation, shape of site, and floodplain issues • After hours use of facility
5	• Determine the site – some ISDs consult, others do not • How the site fits in with its surroundings • Differences for parking
6	• Placement of building and how many frontages the site has

14. Does this include a traffic impact analysis?

Only one responded his firm includes a traffic impact analysis in the initial steps (see Table 3-8).

Table 3-8. Traffic Impact Analysis.

ID	Yes	No
1	X – in non-urban ISD; depends on ISD; sometimes TIA is done before Architect/Engineer (A/E) is hired when ISD buys the site; more sophisticated ISDs do this, less sophisticated ones get free site with liabilities	
2	X – but only at new high school campuses	
3 - 6		X, unless required

15. What factors do you consider when planning the location and orientation of the building?

All mentioned factoring environmental issues into their plans, as well as traffic, streets, or vehicular use, among other factors (Table 3-9).

Table 3-9. Factors in Building Location and Orientation Plans.

ID	Response
1	• Environmental – orientation for sun, terrain, weather exposure, and visitors • Traffic/separation of vehicles – bus, visitors, staff, and students • Site activity – playgrounds, sports, and after-hours usage • #1 safety & security – behind and in front of building and wayfinding (security related) • In some cases, push building back for queuing
2	• Site access for the fire department (ID front door) – different for urban vs. suburban • Environmental (sun, etc.) and topographical (grade, trees to save, etc.) issues • Generally push the building to the front; this saves utility and driveway costs and helps separate recreational areas from traffic; also makes the building visible from the road
3	• Main streets • Locations of play areas – where it is best to locate them • Solar issues (environmental)
4	• Size of site – in line with demand of use? • Front door faces road • Environmental • Surrounding properties may influence location • Kids do not cross driveways • Service traffic separation – usually can control when they come to the campus
5	• Elementary - Circulation of parents and separate bus circulation is the driving force - Placement of safe play areas - Parking for staff/visitors and fire lanes - Service needs – e.g., concerns with vehicle size and turning radius for trash pickup • Middle/High - Public interface for athletic facilities - Internal site – pedestrian traffic – varies on ISD and demographics
6	• Environmental issues (topography and play areas) • Grade level • Separation of traffic types – service vehicles, buses, and parent traffic

16. How much awareness/consideration is given to landforms and transportation beyond the project's property lines?

Responses are contained within Table 3-10.

Table 3-10. Other Landform and Transportation Awareness/Consideration.

ID	Response
1	Responsible design, about vision – becomes very important (critical to education & transportation)
2	More so at middle and high school levels (more cars going in and out); landforms – a good amount of consideration if unique architecture exists around the site; building might reflect this; transportation – near Interstate (or other freeways) might deal with sound
3	Where adjacent green space and major streets are located; high schools are on big streets and smaller schools are on smaller streets; natural features you want to keep on the site
4	Not enough is given; try to be sensitive to neighbors; off-site elements are important
5	Always affect the design; context is always in the design; rural areas are somewhat self-contained (sidewalks go to the end of the property with good faith letters from city to connect to them); roadway geometry and parcel geometry are important
6	A lot of consideration to surroundings (scale & character); elementary is typically near residential and middle/high are near commercial

17. How integrated is traffic circulation with building location and orientation?

Each participant emphasized the great extent of integration between traffic circulation and building location and orientation (Table 3-11).

Table 3-11. Integration between Traffic Circulation and Building Location/Orientation.

ID	Response
1	Critical, and the way there isn't one size fits all and varying degrees of access/topography
2	Very much so; handle separation of traffic types and uniqueness of the site
3	Very much so; consider main entrances for bus/parent, spread staff parking, and provide a "herding" area to queue students before they board buses
4	Entrances are very integrated; everyone wants to be at the front door; kids in and out
5	Very much and many times it is controlling
6	Very – can't consider one without the other

18. How important is traffic access/circulation to the overall success of the facility?

All interviewees conveyed a strong link between a successful facility and its traffic access/circulation (Table 3-12).

Table 3-12. Importance of Traffic Access and Circulation to Facility Success.

ID	Response
1	Really important; adds frustration to administrators and stakeholders when it doesn't work; other options and suggestions so it does not take too much site development costs
2	Can be crucial; not done well it is a disaster; designers get one shot at it; depends on the type of population (how do they arrive)
3	It is important because it is how parents/staff look at the site; minimize the peak influence
4	Very important; look at where are they coming from and how they want to get out
5	Important factor
6	Is a nightmare if not handled properly: works well = out of mind; not working = problem

19. What is the most challenging problem with traffic access and circulation at education facilities?

Table 3-13 presents the problems which interview and survey participants reported.

Table 3-13. Challenges with Traffic Access and Circulation.

ID	Response
1	Parents and parent drop-off – ISD finds these hardest to control and separating buses
2	Safety – separation of traffic types so that buses aren't blocked, still allow access for emergency vehicles, and provide ample parking at site
3	Fire department – keep them happy, keep fire lanes open, without paving much of the site
4	• Queue space because fewer elementary kids walk/bike to school and more parents drop them off • Parents walking the child into the school
5	Working with TxDOT who recommend no access to on-system roadway and prefer to shift burden to adjacent local street; recommendation came late in the process and reviewers were not consistent in their comments and required actions
6	Separating traffic (parent/bus/teacher/student). Would like more curb cuts for separate drives
SR	All 4 survey respondents said that separating bus and vehicle traffic was most challenging.

20. What planning and design differences are there between urban facilities and more rural facilities?

Participants cited various differences between urban and rural planning (see Table 3-14).

Table 3-14. Urban and Rural Facility Differences.

ID	Response
1	• Urban – complexity of multi-lanes, one-way streets, traffic volumes, and inability to do queuing off-site, demographics/economics – rich/poor = cars • Highways degrade communities
2	Urban – less acreage, old infrastructure, access is aging and inadequate, safety Suburban – sites more planned as school sites (raw property)
3	Urban is more difficult. In rural/suburban settings, schools are close to the first thing built and everyone else builds to the school

Table 3-14. Urban and Rural Facility Differences (continued).

ID	Response
4	• Suburban has the opportunity to acquire land that makes it easier to provide queue space. Temporary one-way in urban settings is using city streets the best you can. • Rural has biggest opportunity for more land.
5	Rural sites are almost always on a state roadway. It seems everyone drives a car. Urban can be less free to do things because of a lack of land. Easier to do new site to accommodate 60 passenger bus. Who is driving the cars?
6	Site size – urban smaller lots so the building goes vertical; suburban/rural land is plentiful. Security concerns greater in urban and less so in rural.

21. What factors do you consider during the planning of vehicle circulation at school sites?

Table 3-15 displays a list of factors.

Table 3-15. Factors in Vehicle Circulation Planning.

ID	Response
1	• Elementary – pre-kindergarten different from rest (full day/partial day different) • Buses, service delivery, student, staff, and the general population • Parking for volunteers
2	• Protect outdoor areas • Adequate queuing space (AM is wider window and PM is narrower window) • More access – more choices/options • Deliveries in the AM before and away from pedestrian and vehicle traffic
3	Space for bus queue without being in fire lane; easy in/out for parents to flow quickly
4	• Queuing (separate parking from queue drivers and provide multiple queue lanes) • Median cuts into site • One-way queue lane where the traffic flow has the passenger to curb right • Use more rumble strips • Schools zones can be dangerous when people watch their speedometers – not the road
5	• Queue space on-site; elementary to high school, parents pick up their kids • Don't want kids to feel like they came in back door from separation of traffic • Large facility – break up streets and parking so they don't become drag strips • Staff observations of kids getting picked up • Flow of traffic to avoid gridlock • Open/closed campus issues – try to limit students coming and going • School zone and other off-site traffic signs – are they city/state responsibility?
6	See road volumes at time when it functions – light/heavy streets

22. What factors do you consider during the planning of pedestrian circulation to/from and on the site?

Participants reported several factors taken into consideration during pedestrian circulation plans which can be viewed in Table 3-16.

Table 3-16. Factors in Pedestrian Circulation Planning.

ID	Response
1	Houston school – many parents take their kids to school and create a gathering area to accommodate the adult pedestrians
2	• Keep them away from traffic • Younger – get them out of the car and into the building • Don't put drop-off between parking and school
3	Where there is adjacent housing, where they are coming from; try to link building to playground, parks, and other features
4	• Texas Accessibility Standards for Americans with Disabilities Act (ADA) • Paved path from public transportation to front door • Fairly level site for pedestrians (accommodating handicapped) • Security concerns have focused entrance/exit into one entry
5	Sidewalks – new or future – in proximity of roads Handicap ramps – accessibility regulations; must send plans in for ADA review
6	Not much control to/from – an attendance zone issue; parents won't allow pedestrian if it crosses major thoroughfare

23. How are parking, bus, and drop-off needs accommodated and balanced at the site?

Along with other recommendations, the majority of interviewees reported some type of separation of traffic types or needs as necessary for balance (Table 3-17).

Table 3-17. Parking, Bus, and Drop-Off Accommodations.

ID	Response
1	Separation of unique ones is critical; student parking with faculty; locked student parking; open use of these for big events
2	Take all into consideration; all are independent issues and require addressing; free-flowing buses to pick up next set of kids
3	Separate lanes for bus and drop-off; spread parking around the building so there is no sea of parking in front of the building
4	Separation between traffic types is best; avoiding parent/bus conflicts is biggest issue
5	• Separate traffic types (ability for buses to become unencumbered) • Parents • Student mix with less impact • Assign spaces at high schools (number of visitor spaces) • Ingress/egress • Parking
6	• Parents want to drop kids at front door • Provide queuing on-site instead of on street • Bus demand in short time • Consider service vehicles (trash and food)

24. How much focus and attention is given to the structure and its interior as compared to the location, footprint, and traffic access/circulation?

Table 3-18 provides responses.

Table 3-18. Internal/Structural vs. External/Traffic Focus.

ID	Response
1	More detail is on the inside but more time on the relationship internal/external at the start
2	Initially – the site and how it works; topography still plays a role; they are parallel but coordinated tracks; identify problems with prototype design
3	Combination of both; they are about equal in planning stage
4	More interior overall; equal amount in the preliminary step
5	Simultaneous and evolves; site plan early; master planning
6	Everything has to flow in and out of the building

25. Do you typically receive data from the ISD or other sources for the (check all that apply):

A. Projected student enrollment
B. Projected number of faculty and staff serving at the school campus
C. Estimated percentage of students requiring bus transportation
D. Estimated number of buses that will access the school campus
E. Estimated percentage of students walking
F. Estimated percentage of students biking to school
G. Estimated number of vehicle trips generated by the school site

Table 3-19 presents the responses of participants and respondents.

Table 3-19. Types of Data Received from ISD or Other Sources.

ID	A	B	C	D	E	F	G
1	Y	Y	Y	Y	Y	Y	N
2	Y	Y	Y	Y	Y	Y	N
3	Y	Y	Y	Y	N	N	N
4	Y	Y	Y	Y	Y	Y–usually	N
5	Y	Y	Y	Y	N	N	N
6	Y	Y	Y	Y	Y	Y	N
SR	4 of 4	4 of 4	3 of 4	3 of 4	1 of 4	1 of 4	0 of 4

26. At what stage in the site design process are transportation-related elements (i.e., parking, internal roadways, driveway locations, etc.) considered?

A. Early on in the process
B. After the building location has been determined
C. After the building design has been completed
D. Near the end of the process
E. Other

Both interview and survey participants stated consideration of transportation-related elements occurs early in the process (Table 3-20). Three interviewees also reported additional stages.

Table 3-20. Stage When Transportation-Related Elements Are Considered.

ID	A	B	C	D	E
1	Y – new sites	Y – new sites			Retrofit projects – after
2	X		Prototype design		
3	X – before they purchase the site				All are ongoing until final approval
4	X				
5	X				
6	X – and throughout				
SR	All 4 stated this				

27. Do you subcontract traffic circulation plans, pavement markings, and signage plans or conduct the work in-house?

The majority of interviewees use in-house talent (see Table 3-21).

Table 3-21. Use of Civil/Transportation Consultants for Transportation-Related Elements.

ID	General Civil	Transportation	Comment
1	Y	N	None
2	N	N	Traffic study required then they subcontract
3	Y	N	Circulation and pavement; signage is done in-house
4	N	N	Subcontract to general civil engineering firms; rely on city engineer to upgrade intersection to a signal
5	N	N	In-house; city requires or suggests for permits; leveraged/proposed from districts.
6	N	N	In-house

28. How often does your firm use a traffic/civil engineering consultant to assist with the design of the transportation-related elements?

Responses can be seen in Table 3-22.

Table 3-22. Frequency of Civil/Transportation Consultations.

ID	Never do this	Less than 25 %	25 to 50 %	Greater than 50 %
1				X
2		X		
3				X
4				X
5		X – for special conditions		
6				X
SR		2 of 4	1 of 4	1 of 4

29. Do you typically design the school to accommodate peak traffic demands within the site (i.e., enough storage to prevent vehicles and/or buses from queuing on adjacent roads)?

Most of the interview and survey participants attempt to accommodate peak traffic demands (Table 3-23). One respondent answered both yes and no, providing a more detailed explanation as seen in Table 3-23.

Table 3-23. Accommodation of Peak Traffic Demands.

ID	Yes	No	Comment
1		Not possible	None
2	X		Goal of design but site unique or value is greater than expected
3	X	X	Y–most of the middle and high school demand is handled but never all of the demand. N–elementary sites are never big enough
4	X		Goal ideally
5	X		Try to keep it off streets unless area can accommodate it
6	X		None
SR	4 of 4		None (survey form did not ask for comments)

30. Do you gather planning and design input from clients or other interested groups? What methods do you use? How effective do you think they are? How frequently?

Table 3-24 presents the interview responses.

Table 3-24. Client and Interest Group Input into Planning and Design.

ID	Response
1	Deals with the management style of the ISD; design professional would like to do this, but client dictates (political sensitivity and culture of ISD)
2	Yes, typically from the community in urban sites
3	Yes, if in place; neighborhood, Parent Teacher Association (PTA) – the city and ISD make sure the architect has worked with these groups. They want the neighborhood to be happy.
4	Yes through public meetings; ISD policy issue to decide how much public involvement there is
5	Yes, if community meetings are requested or organized by ISD; like to have community committee to work on planning and design of school
6	Yes – mostly from PTA and neighborhoods; try to listen; more input is more ownership

31. Do you consult with the ISD regarding access to/from the site and internal circulation? At what times in the process? What items are typically discussed?

All reported ISD consultation occurs concerning access to/from the site and internal circulation; further comments are visible in Table 3-25.

Table 3-25. Site Access and Internal Circulation Consultation with ISD.

ID	Response
1	Yes, depends on ISDs with transportation department or people that are engaged with it
2	Early on in the process; big concern to the ISD; other consulting on an as-needed basis
3	Throughout the process; everything is discussed; playground-gym locations, students accessing road on/off site, staff parking
4	Yes, throughout; everything is discussed–pavement, lighting, curb, and gutter to fire lanes
5	Yes, more at the beginning; most ISDs are very astute with transportation in terms of queue space, parking, defining separate loops for loading, and flexibility of design (principal may switch drop-off zones); where are students queued for buses; need to keep teacher sight lines to these areas and to buses; big porches or covered overhangs
6	Yes, throughout

32. Have you advocated one-way streets around school sites for before and after school times? In what way? Were you successful?

Table 3-26 displays these responses.

Table 3-26. Advocating One-Way Streets around School Sites.

ID	Response
1	None
2	Yes, in urban areas; just about any campus in Dallas
3	Yes, result of narrow street and couldn't control/improve it; was successful
4	This is an ISD policy.
5	It happens and there are examples. I haven't pushed for it. Circulation on-site is one-way.
6	Yes – occasionally successful. Neighbors drive the process.

33. How is the length of the drop-off/pick-up zone determined?

A. Sized according to the layout of the parcel of land
B. Designed to accommodate certain number of cars based on projected site traffic
C. Use a standard length based on school type (elementary, middle, or high school)
D. Other method (please describe)

Responses are arranged in Table 3-27.

Table 3-27. Method of Determining Length of Drop-Off/Pick-Up Zone.

ID	A	B	C	D	Comment
1	X	X			Combination of both
2		X	X		None
3	X	X			Accommodate buses; size for cars is a function of site – try to maximize
4	X	X	X		A – use as much as you can; depends on where the queue will go out
5		X		X	B – cross-check with ISD and D – by reference to another school
6	X	X			Starts with B, limited by A
SR*	3	2	0	1	ISD experience

*Number of responses out of 4

34. How is the width (number of lanes and designation) of the drop-off/pick-up zone determined?

A. Sized according to the layout of the parcel of land
B. Designed to accommodate certain number of cars based on projected site traffic
C. Use a standard width based on school type (elementary, middle, or high school)
D. Other method (please describe)

Table 3-28 lists interview participant and survey respondent answers and comments.

Table 3-28. Method of Determining Width of Drop-Off/Pick-Up Zone Roadway.

ID	A	B	C	D	Other
1				X	Fire department requirements and what needs to remain open; ISD policy and supervision of – no super multi-lanes problem
2					Generally 3-4 lanes – dependent on how much bus traffic exists if traffic types are not separated, with buses in a 4th lane Freeflow Attended Vehicles Unattended Vehicles
3				X	Help of the city; 24 ft (7.32 m) fire lane, 12 ft (3.66 m) lanes for bus/car off of the fire lane
4				X	Fire lane; normally a single lane wide; 30 ft (9.15 m) fire lane + drop off; kids between cars
5				X	Cross check with fire marshal
6				X	Lane width varies as to where it is; widens in street area; more room side-to-side to get kids out and in school
SR*	3	2	1	1	ISD owner experience

*Number of responses out of 4

35. Do you typically design the drop-off/pick-up zone roadway to allow parallel parking for vehicles during school hours?

Interviewees and survey respondents provided mostly opposite responses, as seen in Table 3-29.

Table 3-29. Placement of Parallel Parking in Drop-Off/Pick-Up Zones.

ID	Yes	No	Comment
1		X	Not during school day, but for big events; one can destroy design – good in theory, bad in practice
2	X		None
3		X	None
4		X	None
5		X	None
6		X	Parallel parking is not a smart design for fire lanes.
SR	3	1	None

36. Do you normally include a covered area adjacent to the drop-off/pick-up zone to accommodate students during inclement weather?

A. Yes, the entire length of the drop-off/pick-up zone

B. Yes, but only the walkway to the main school entrance is covered

C. No, covered area is provided near the curb of the loading zone

Responses are organized in Table 3-30.

Table 3-30. Placement of Covered Area near Drop-Off/Pick-Up Zone.

ID	A	B	C	Comment
1				Some require, it is desirable, budget constraints, could be done later and is often a phased issue
2		X		None
3			X	Principals and staff are encouraging the addition of covered areas.
4		X		Provide sight lines for inside queue location
5		X		Portacache is rare. Structures for special education students are more common.
6	X			Should be for entire length; very dependent on site and limited to funding, but is very important part

37. Do you typically separate traffic types at drop-off/pick-up zones?

All of the interview participants and survey respondents reported separating or attempting to separate traffic at such zones. One interviewee further stated that separation depends on the site.

38. What types of traffic do you separate?

Responses are arranged in Table 3-31.

Table 3-31. Types of Traffic Separated at Schools.

ID	Parent	Bus	Day Care	Visitor	Student	Staff	Service
1	X	X	X	X	X	X	
2	X	X					X
3*	X	X	X				
4**	X	X	X				X
5***	X	X	X				X
6	X	X	X		X		X

*Bus and day care vans are together.

**Day care vans go into either bus or parent areas. It is more of an ISD call and they do not typically know how large this is.

***Tend to be grouped

39. What is the preferred design for a bus loading zone?

- **A. Single-file (buses staged in parallel – students load with right wheels on curb)**
- **B. Single-lane chevron (buses parked at an angle – students load between buses)**
- **C. Multiple-lane parallel (buses use multiple lanes)**
- **D. Multiple-lane chevron (buses parked at angle in multiple lanes)**
- **E. Other method (please describe)**

All respondents and participants reported single file as their preferred design (Table 3-32). Four of the six participants also selected the multi-lane parallel design.

Table 3-32. Bus Loading Design Preference(s).

ID	A	B	C	D	E	Comment
1	X		X			A is preferred. Backing up is an issue in chevron configuration.
2	X					Safest option
3	X		X			A is the best. C is the second choice. There is never enough room for chevron configurations.
4	X					A – big horseshoe. Chevron problem is bus backing out.
5	X		X			C is the second option. The problem with a chevron is that no one wants to back up a bus. Angled configurations are best.
6	X		X			C is most common. A is second choice. It is difficult to convince for a chevron unless there are multiple lanes.
SR	4					All survey respondents said single file was the preferred design.

40. Do you use any design guidelines for the design of drop-off/pick-up zones?

Table 3-33 displays these responses.

Table 3-33. Guidelines for Design of Drop-Off/Pick-Up Zones.

ID	Yes	No	Source(s) of Guidelines
1	X		Mentioned earlier, bus companies
2	X		Graphic standards – general sizes
3		X	None
4	X		General knowledge of turning radii; fire truck is the design vehicle
5		X	Based on experience
6	X		Bus turning radius (avoid tipping); remove curb in bus area and try to make it wider
SR	3	1	Experience, graphics standards, building codes, accessibility standards

41. Do you design drop-off/pick-up zones to accommodate what percent of the vehicle queue?

Percentages are marked off in Table 3-34.

Table 3-34. Design of Drop-Off/Pick-Up Zone for Queue Accommodation.

ID	25%	50%	75%	100%	Other	Comment
1	X	X				None
2					X	ISD tells how many based on number of vehicles
3				X		100 percent for buses; tt varies for cars
4					X	Varies, but shoot for maximum; until design, you don't know what you can accommodate
5	X	X				A at high schools and B at elem./middle schools
6					X	Queue can change year-to-year or within a year; give as much room as possible; ISD can control buses by staging
SR		2		1	1	One respondent did not answer this question.

42. What methods do you recommend for handling traffic demands to reduce street congestion impacts?

Table 3-35 presents the interviewees' recommendations.

Table 3-35. Recommended Methods to Reduce Street Congestion.

ID	Response
1	Coordination with city traffic engineer goes beyond the site. Other access points?
2	More streets with access to school site is best. Consider widening street in urban conditions. Use police to enforce some rules.
3	Get as many cars off of the street as possible. This is a function of site size.
4	Police officer, parent-student-teacher education to function effectively, and more kids to walk/bike; encourage a safe environment to reduce parent demand
5	Organized exit flow has some effect (multiple access for parking); schedule deliveries after school hours; stagger the school start times; the latter two are concerned about the peak
6	School – possible different release times for high school Street – part-time traffic cops, signals, stop signs? Turn and acceleration lanes are helpful

43. How do you determine the size of the parking lots?

A. Size is based on the projected vehicle load for faculty/staff, visitors, and students
B. Use a standard size based on school type (elementary, middle, or high school)
C. Sized according to parking requirements contained in local ordinances
D. Other method (please describe)

One half of the interview participants cited more than one method of determining parking lot sizes, and more than half cited parking requirements as at least one method (Table 3-36).

Table 3-36. Methods of Determining Parking Lot Size.

ID	A	B	C	D
1			X	
2	X – add volunteers			
3*	X – added	ISD has this	X – starts here	
4		X	X – first step	
5			X	
6			X	20 percent of permanent for visitors
SR	4	1	2	Owner requested, event size (PTA)

* ISDs have different requirements.

44. Do you typically separate the parking areas for faculty/staff from visitors and/or students?

View responses in Table 3-37.

Table 3-37. Separation between Faculty/Staff, Visitors, and Students in Parking Areas.

ID	Yes	No	Comment
1	X		For some students
2	X		None
3	X		Designed that way
4	X		None
5	X		None
6	X		None
SR	3	1	None (survey respondents were not asked for comments)

45. Are there any special design considerations for student drivers?

Table 3-38 displays these responses.

Table 3-38. Special Designs for Student Drivers.

ID	Yes	No	Comment
1	X		Queuing off-site, no left turns across traffic, and landscaping (sight distance)
2		X	
3		X	
4		X	Not much high school work but nothing special
5		X	
6	X		Speed bumps – more likely to have issues in parking lots

46. Do you use design guidelines for parking lot design?

Table 3-39 presents these responses.

Table 3-39. Guidelines for Parking Lot Design.

ID	Yes	No	Comment
1	X		City code and budget
2	X		ISD will dictate or by site, municipalities
3		X	Different site to site; layout and widths are standardized by city/graphic tools
4	X		Mitigated by city requirements; up to firm and designers
5	X		City requirements
6	X		Local ordinance; size of space; design standard books
SR	4	0	Graphics standards; city guidelines; building codes

47. Which of the following are considered when deciding the location and design of driveways to access the school site? (Check all that apply.)

A. Applicable state and municipal laws
B. Separation distance between access points and nearby intersections
C. Placement relative to driveways on the property opposite the school site
D. Provision of space for turning movements (left and right turns) from the site
E. Bus turning characteristics
F. Sight distance
G. Other considerations (please describe)

Responses are organized in Table 3-40.

Table 3-40. Methods to Determine Location of School Driveways.

ID	A	B	C	D	E	F	G	Comment
1	X	X	X	X	X	X	X	None
2	X	X		X	X	X		F – should be taken care of from other issues
3	X	X	X	X	X	X		Central Texas cities control this
4		X		X		X	X	B and C – ordinances; D – starting point; F – less knowledge; and G – median cuts and storm sewers
5	X	X	X	X	X	X		Success is how well each are done
6	X	X	X	X	X	X		None
SR	4	4	2	4	4	4	1	Site security

48. Do you use any design guidelines for deciding the location and placement of driveways to the school site?

Responses are visible in Table 3-41.

Table 3-41. Guidelines for Driveway Location and Placement.

ID	Yes	No	Comment
1		X	All unique
2	X		City or county provided but no standards
3			No answer
4	X		Municipal ordinances; civil engineers
5	X		City requirements – differences between state (which are hard to figure out) and the city or even between cities
6		X	Take what the site provides
SR	4	0	Local ordinances; city guidelines; graphics standards; and TxDOT standards

49. Do you design turn bays from the adjacent streets into the school site?

Responses are reported in Table 3-42.

Table 3-42. Turn Bay Designs from Adjacent Streets.

ID	Never	Sometimes	Frequently	Always
1				X
2			X	
3				X
4*		X – when city requires it		
5		Money has to be justified.		
6				X

*Turn bays are designed for bus turning radii.

50. How do you try and control access to/from the site?

Table 3-43 lists the responses.

Table 3-43. Methods of Controlling Site Access.

ID	Response
1	Location of queuing lanes; placement of buses
2	Angle drive to discourage wrong-way movements; maybe do not make median cut
3	Elementary schools have 5 access points – bus in/out, visitor in/out, parking
4	One-way in and one-way out: gates to route traffic
5	Answered previously
6	Signage; traffic signals

51. Do you use standard turning templates to design for their operation on site?

All interviewees stated they use standard turning templates (see Table 3-44).

Table 3-44. Use of Design Vehicle and Templates for School Design.

ID	Yes	No	Comment
1	X		Minimum radii; use a fire vehicle to design with, it is more critical than bus
2	X		Graphic standards
3	X		None
4	X		Civil engineers; fire truck is the design vehicle
5	X		City; trash trucks, buses are design vehicles; fire vehicles become a separate set of rules
6	X		Fire truck is the design vehicle; they don't turn as well as a school bus

52. Do you design sites to minimize pedestrian street crossings?

Responses are displayed in Table 3-45.

Table 3-45. Design Methods to Minimize Pedestrian Street Crossings.

ID	Response
1	Yes, but make them appropriate to other pedestrian ways
2	Not an issue at sites I've worked on; would consider it if applicable; maybe taken into consideration during site selection
3	Yes when on-site. Off-site isn't as critical but still a known need.
4	Yes if you can; crosswalks are dictated by the city; accessible parking and getting them across the road are challenges; in some cases it is unavoidable
5	Don't put a sidewalk right against the curb but use some type of landscape buffer. This will help limit where people tend to cross.
6	Yes, but not much they can do to force movements. Try to recognize potential problems and put in solution.

53. How do you mitigate pedestrian conflicts on site with access circulation?

Table 3-46 shows the methods of mitigation which participants provided.

Table 3-46. Mitigation of On-Site Pedestrian Conflicts.

ID	Response
1	Need to not cross any lanes of traffic
2	Where parking is located – not cross road to get to building; no road building-play area; discourage 2-3 parking to let parent out
3	Elementary – not have a loop road all around the building; Middle/high – congregate functions to limit the number of crossings
4	Limit or make more evident crossing with striping and pavers so that these areas are clear to both drivers and pedestrians; use barriers

Table 3-46. Mitigation of On-Site Pedestrian Conflicts (continued).

ID	Response
5	Provide as good a drop-off location as possible. Determine where traffic flow is and place crosswalks; closing public streets that cut through (special cases)
6	Faculty/staff involvement outside to keep kids on sidewalks; tendency to take shortest path even crossing traffic lanes

54. Would you be interested in receiving an invitation to and attending a half- to full-day symposium with other architects, engineers, school officials, and other stakeholders regarding transportation-related school site issues?

All interview participants and survey respondents expressed an interest in attending a symposium. One participant suggested he would be interested in meeting with school officials (ISD). A second participant suggested that Continuing Education Units (CEUs) be offered to symposium attendees.

55. If you are interested, please rank the following topics you would like to see addressed (1 for most important and 10 for least important)?

Table 3-47 lists the topics which the interview participants and survey respondents ranked.

Table 3-48 provides the rankings for the topics based on high (ranked 1-3), medium (ranked 4-7), and low (ranked 8-10) ratings, as well as the overall sum of rankings. For example, of the six interview participants, three rated Topic A with a score of 1, and one participant rated Topic A with a score of 3 in the high range. One participant gave Topic A the score of 5 in the medium range, and one participant ranked Topic A with a score of 8 within the low range. Altogether, the rankings by the six interview participants that rated Topic A resulted in a sum of 19.

Table 3-49 gives the combined rankings of the interview participants and survey respondents.

Table 3-47. Potential Topics for School Safety Symposium (Architects).

Topic	Description
A	Coordination between designers, schools, and state and city transportation departments
B	Pedestrian and bicycle access/safety
C	Design and operation of drop-off and pick-up zones
D	Traffic impact analysis (volumes, modal estimation)
E	Design and operation of parking facilities
F	Retrofit options (design & operations) for schools with existing transportation problems
G	School site selection criteria
H	Safe Routes to School (recently passed Matthew Brown Act in the Texas legislature)
I	Signing, marking, and other traffic control issues for roadways around the school site
J	Special event (i.e., athletic games, after-school meetings, etc.) traffic issues

Table 3-48. Symposium Topic Ratings from Architect Interview and Survey Participants.

Topic	Interview Participants				Survey Respondents			
	H	M	L	Total	H	M	L	Total
A	4	1	1	19	3	1	0	7
B	3	3	0	23	0	3	1	25
C	5	0	1	19	3	1	0	11
D	1	4	1	27	2	2	0	18
E	2	4	0	32	0	2	2	27
F	5	1	0	14	2	1	1	18
G	5	0	1	14	1	2	1	22
H	3	2	1	22	1	1	2	26
I	3	2	1	27	0	1	3	33
J	2	3	1	30	0	2	2	33

Table 3-49. Combined Ratings for Symposium Topics for Architect Personnel.

Topic	H	M	L	Total	Average	Rank
A	7	2	1	26	2.6	1
C	8	1	1	30	3.0	2
F	7	2	1	32	3.2	3
G	6	2	2	36	3.6	4
D	3	6	1	45	4.5	5
B	3	6	1	48	4.8	T6
H	4	3	3	48	4.8	T6
E	2	6	2	59	5.9	8
I	3	3	4	60	6.0	9
J	2	5	3	63	6.3	10

56. Any other comments on a symposium?

Table 3-50 lists the comments.

Table 3-50. Additional Symposium-Related Comments.

ID	Response
1	• On the Symposium: encourage TxDOT to seek partners – CEFPI, TEA, TASBO, TASB • Use TEA service centers to invite guests • See products distributed – article in newsletters
2	• Carpooling – decrease of this over time • Is there a way to reduce the amount of traffic at a school? • More safe routes might reduce vehicle demand
3	None

Table 3-50. Additional Symposium-Related Comments (continued).

ID	Response
4	• Subject is of interest to CEFPI, TASB, and TASA. Case studies to illustrate concerns and solutions would be helpful. • Don't focus enough off-site • Traffic engineering varies city to city. There isn't a state standard to answer some of these questions. Rural areas do not have traffic engineering resources for review and do not have anyone to enforce guidelines. Would this be under the umbrella of TEA?
5	• Emphasize practicality of recommendation and requirements. Avoidance of more rules and regulations • Would prefer to see guidelines • Precious Cargo Program gets pushed as a requirement when it was perceived as suggestion. Could get TxDOT input earlier in the process.
6	None

KEY FINDINGS

The following list presents the key findings from the architect interviews. The numbers in parentheses at the end of each finding represent the question number where additional information can be found in the section where responses to individual questions are summarized.

- There were a number of resources cited by the participants used for the planning and design of K-12 educational facilities; however, most of these do not provide any substantial guidance on transportation-related issues (Q4).
- Knowledge gained from previous experience and during seminars and conferences is basically the extent of special training for K-12 facilities (Q5 and Q6).
- Only three of the six participants were aware of the Precious Cargo Program offered by TxDOT, and two firms had a school site plan reviewed by a TxDOT representative (Q9 and Q10).
- Coordination during planning and design frequently occurs with the city planning, engineering, and fire departments, but seldom with police departments (Q11 and Q12).
- There was some discrepancy in the factors considered when planning the location and orientation of the building footprint. One participant indicated that they generally push the building to the front of the site to save costs for utilities and driveways; whereas, another participant indicated that the building is pushed back in some cases to accommodate queuing (Q15).
- All participants indicated that traffic access/circulation is important to the overall success of the facility (Q18).
- Three respondents indicated that the most challenging problem with traffic access and circulation at educational facilities relates to separating vehicle, bus, and pedestrian

traffic. One respondent indicated that working with TxDOT was the most challenging because reviewers were inconsistent in their comments and required actions (Q19).

- Five respondents attempt to design the school to accommodate peak traffic demands within the site (i.e., enough storage to prevent vehicles and/or buses from queuing on adjacent roads); however, one indicated that this is not possible and another commented that elementary sites are never big enough (Q29).

- There was no consensus on a method for determining the length of the drop-off/pick-up zone, though all participants determine the width (number of lanes) based on fire department requirements (Q33 and Q34).

- All but one participant indicated that parallel parking during school hours should not be part of the drop-off/pick-up zone roadway (Q35).

- The consensus was that single-file (buses staged in parallel where students load with right wheels to the curb) was the preferred design for a bus loading zone (Q39).

- The size of parking lots is determined primarily based on requirements contained in local ordinances (Q43).

- A fire truck was the design vehicle used by the majority of the architects (Q51).

- All participants expressed interest in a symposium with other architects, engineers, school officials, and other stakeholders regarding transportation-related school site issues. Some of the suggestions included (Q54 and Q56):

    - Discuss how to reduce vehicle demand.
    - Use case studies to illustrate concerns and solutions.
    - Focus more off-site.
    - Emphasize practicality of recommendations and avoid more rules and regulations.

- The three most important issues to the architect participants for a symposium were (Q55):

    - coordination between designers, schools, and state and city transportation departments;
    - design and operation of drop-off/pick-up zones; and
    - retrofit options (design and operations) for schools with existing transportation problems.

CHAPTER 4. SCHOOL DISTRICT INTERVIEWS

BACKGROUND

As the baby boom generation's offspring rise through the public educational system, the demand for expanded building space and educational facilities has increased. The expansion and renovation of existing schools and construction of new ones is occurring at a record pace throughout the United States. According to figures released by the United States Department of Commerce Census Bureau on school construction expenditures, the total amount spent has more than doubled over the last 10-year period (*40*).

The State of Texas had led in the development and renovation of school campuses. Between 1992 and 2000, no state spent more money (over 19 billion) on construction of K-12 school facilities than Texas (see Table 4-1). While the census data are not yet available for 2001 and 2002, the evidence of Texas being a leader in school construction is continuing. In fact, the Dallas Independent School District recently passed a record 1.37 billion dollar bond package for renovation of existing schools and construction of new campuses (*41*). This bond package will fund the building of 20 new schools, additions to 37 schools, and renovations to 181 other schools over the next five to eight years. Several other large Texas ISDs are also undergoing large construction programs.

The annual School Construction Report produced by the School Planning and Management Magazine collects information (costs, size, and facilities) on individual school construction throughout the United States (*42*). Some of the school construction data are divided by geographic region; Texas is included with Arkansas, Louisiana, and Oklahoma in Region 9. School districts in Region 9 lead the nation with almost 57 percent of total spending going into construction of new schools. Table 4-2 provides a national profile of new schools currently being built and those that are due for completion during the 2002 calendar year. The figures shown in Table 4-2 are medians rather than averages, so that the influence of special-case schools that may be extremely expensive or inexpensive is minimized.

Table 4-1. School Construction Spending in Texas and the United States (*42*).

Year	Construction Spending In Texas (Billions)	Construction Spending in the United States (Billions)
2000	3.6	31.7
1999	3.0	28.5
1998	2.6	24.8
1997	2.4	22.5
1996	2.0	18.7
1995	1.5	15.9
1994	1.1	14.4
1993	1.3	13.7
1992	1.6	14.0
Total	19.1	184.2

Table 4-2. Profile of New School Construction in the US [Construction Ending in 2002] (*40*).

National Medians	# of Students	Building Size, ft^2 (m^2)	Building Cost ($ 000's)
Elementary	650	70,000 (6510)	$8,500
Middle	800	105,000 (9765)	$13,000
High	1200	160,000 (14,880)	$20,087
Low Quartile	**# of Students**	**Building Size, ft^2 (m^2)**	**Building Cost ($000's)**
Elementary	500	56,117 (5,218.881)	$6,250
Middle	650	84,000 (7812)	$9,500
High	750	98,388 (9,150.084)	$11,000
High Quartile	**# of Students**	**Building Size, ft^2 (m^2)**	**Building Cost ($000's)**
Elementary	775	90,000 (8370)	$11,132
Middle	1000	140,000 (13,020)	$19,000
High	1600	236,000 (21,948)	$37,748
Top 10 Percent	**# of Students**	**Building Size, ft^2 (m^2)**	**Building Cost ($000's)**
Elementary	900	100,000 (9300)	$16,800
Middle	1200	175,000 (16,275)	$27,000
High	2000	310,000 (28,830)	$46,000

Table 4-2 shows that the median elementary school in the United States costs $8.5 million to build and has 650 students in a 70,000 square foot (SF) (6510 m^2) building. The national median middle school housed 800 students in a 105,000 SF (9765 m^2) building that cost $13 million to construct. The median high school in the United States has 160,000 SF (14,880 m^2) of space to house 1200 students at a cost just in excess of $20 million. These data are based on 335 elementary schools, 137 middle schools, and 116 high schools throughout the nation.

All of these data mean that Texas is building a large number of schools, more and more of which are being located on or near state-maintained roadway facilities. In order to gain a better understanding of the perspective of school districts in dealing with the transportation-related elements of school-related construction projects, the research team interviewed staff from eight ISDs in the north Texas area during January and February 2002. Of eight ISDs interviewed, six are considered suburban and the remaining two are considered as urban districts.

The personal interviews provided researchers with a clearer understanding of the challenges each ISD faced regarding traffic safety. Questions posed in the interviews concerned the ISD's safety assessment practices; major campus access and circulation problems; the nature of complaints received inside the ISD and how they are handled; awareness of the Precious Cargo Program; practices monitoring student arrivals/departures related to travel mode; campus planning and design process; and processes for selecting sites for future school campuses.

The research team also distributed a survey through the mail to a selected number of school districts in Texas. The survey contained a majority of the interview questions in order to validate some of the findings and to broaden the results to be more representative of the entire state. The survey was distributed to 34 school districts (11 urban, 12 suburban, and 11 rural), and 17 responses were received (6 urban, 6 suburban, and 5 rural). The responses represented the east, west, south, and central portions of the state. Most of the respondents held the position as the director of the facilities/construction or transportation departments.

ORGANIZATION

This chapter summarizes the findings from the personal interviews of school district staff and the mailout survey. It contains two primary sections. The first section lists the responses, by question, from the interview participants. This section also contains a comparison of the interview and supplemental survey results. The last section contains a brief summary of the key findings obtained from the interviews and surveys.

SUMMARY OF INDIVIDUAL RESPONSES

A summary of the interview and survey responses is included below each question. The tables following each question list the paraphrased statements made by the interview participants. These statements should not be considered direct quotes.

1. Is traffic safety to/from your campuses in your mission statement?

Summary of Interview Results. Though general student safety may be included in an ISD's mission statement, only one interview participant stated that traffic safety, specifically, was included in the mission statement. Three interviewees stated that traffic safety was not a part of their mission statement, and two were unable to answer the question. Table 4-3 lists the paraphrased responses to Question 1 for each of the interview participants.

Comparison of Survey Results. The supplemental survey responses indicated that six of the 17 school districts had safe access to campuses as part of their overall mission statement. Combining the survey and interview results, approximately 30 percent of the school districts have traffic safety specifically included in their mission statement.

Table 4-3. Inclusion of Traffic Safety in Mission Statement.

ID	Paraphrased Responses of Interview Participants
1	I don't know
2	I don't think traffic safety is per se, but safety in general is
3	I don't think so
4	No, safety in general is, but it isn't specific to traffic
5	No, safety in general is
6	Yes, traffic safety is in it
7	No
8	No

2. **Do you conduct annual school safety site assessments? Is traffic safety part of that assessment? Do you review on- and off-campus safety? How do you perform your assessment? Do you use the services of a transportation engineer? Are recommendations developed from the assessment? How are they implemented? Is there a periodic review to ensure compliance with the assessment's recommendations?**

Summary of Interview Results. The majority of interview participants indicated that their ISD conducts school safety site assessments, though the frequency of such assessments is not uniform. Three participants noted that assessments are made on a regular basis and two participants stated that assessments were made as needed. Assessments are conducted more frequently at primary campuses and less often at secondary campuses. In all cases, assessments begin on-campus and may move off-campus as the issues present themselves.

Assessments are overwhelmingly made through visual observation by ISD staff or campus administrative staff, whereas only one interviewee stated that actual traffic counts were used during assessments. As part of the assessment, five participants stated that coordination and consultation with the city traffic engineers routinely occurred, and one participant stated there was coordination between the police and fire departments. Only one participant stated that a traffic engineer is used to make assessments.

In the majority of cases, recommendations are developed from the assessments. These recommendations are sometimes shared with the city council or other departments and the school board. In some cases, the recommended solutions may be counter to the desires of the city council or the school board. Two participants stated that the recommendations were reviewed to ensure that corrective actions were taken. In some cases, corrective actions cannot be taken due to a lack of available funding. Table 4-4 contains the individual responses to Question 2.

Comparison of Survey Results. The supplemental survey responses basically validated the interview results. Survey respondents indicated that most of the ISDs (12 of 17) conduct school safety site assessments. This percentage (70 percent) is slightly higher than the interview results (63 percent); however, it supports the finding that a majority of school districts utilize some form of school safety site assessment. As in the interviews, the survey respondents reported that traffic engineers are involved in the assessments about half of the time. The only noticeable difference in the interview and survey results was that slightly more of the survey respondents (four of 17) used traffic counts during assessments than the interview participants.

Table 4-4. School Safety Site Assessments.

ID	Paraphrased Responses of Interview Participants
1	I am not directly familiar with these assessments.
2	Assessments are not routinely performed. When they are performed, traffic safety is part of it. Both on- and off-campus safety are reviewed. Assessments are made by a site visit or observations by campus personnel and the transportation department. When problem areas are found, the ISD A/E is involved for on-campus issues and the city or TxDOT are called upon for issues off-campus. The effectiveness is reviewed after implementation.
3	Regular safety assessments are made and traffic safety is a part of them. We work closely with the city engineering staff. We are currently working on new designs for two elementary schools and a reconfiguration of a high school. We have had several meetings with both city officials and TxDOT Precious Cargo representatives on campuses from neighborhood schools to larger campuses with buses. Changes have been made to plans based on the results of these meetings. Recommendations are made from the assessments and there is follow up to make sure they are implemented. Not all recommendations are implemented as quickly as we would like due to funding availability.
4	We do not conduct assessments in a formal situation. The old executive director conducted many of the assessments. Our ISD takes site management seriously. Campus principals have the responsibility for site management. Assessments are made on-campus and off-campus. We don’t separate traffic types on our campus and this is a bad problem.
5	School site assessments are conducted with traffic safety as a part of that assessment. Assessments are usually performed on campus, but can move off-campus. Visual inspection is most often used but in some cases, staff may request a traffic study performed by the city (Planning and Fire Departments). Site circulation is reviewed, followed by bus operations, and then possibly a full assessment. Other than the city traffic engineer, no other transportation engineering services are used. The recommendations/suggestions developed from the assessments are shared with the ISD board and the city council. An example assessment was reviewing a parallel parking lane on a local street in front of a school.
6	On-site assessments are conducted each year except at secondary campuses. During the assessment we observe traffic flows and record traffic counts at elementary campuses. We work with the facilities director to get data. The facilities director is the person who works with the city to change traffic patterns around campuses. Recommendations developed from the assessment are implemented and shared with the city.
7	Safety assessments are conducted in coordination with the city. We have a citizen safety advisory committee (comprised of different safety-related organizations which meets each month) that deals with school zones, crossing guards, and sidewalks. The assessments are performed both on- and off-campus. The problems are discussed and visually inspected. We rely heavily on the city traffic engineers to help with the assessment and recommendations. Most of the recommendations are implemented, but some are counter to city/ISD desires.
8	Safety assessments are performed at least once annually at each campus, and sometimes three to four times per year if necessary. The assessments cover both on- and off-campus areas. Through visual observation and conferencing we watch how things work and confer with the police departments, city engineers, and on-site campus administrators about school zones, school crossings, and crossing guards. A traffic engineer is used during the assessment. We work closely with the architect/engineer on school site development. The A/E, ISD staff, and traffic engineer meet with the city to review the assessments.

3. **In your opinion, what are the top four access and circulation problems for elementary, middle school, and high school campuses? Do they differ by campus type? How?**

Summary of Interview Results. The most common issue identified was site access (eight responses). Specifically, access to adjacent streets was noted five times. These problems included schools located on or very near major roads and a perceived disconnect between city street design guidelines and the traffic needs of the school campus. Other site access problems were a lack of sidewalks beyond the site and lack of access management treatment (too few deceleration/turn lanes into campuses, lack of right-in-right-out, and the presence of median cuts). Table 4-5 provides a summary of the individual participant responses to Question 3.

The second most noted issue (mentioned five times) was the separation of traffic types on campus. This is a problem at all campuses. Specifically, separation of the various vehicle types was mentioned five times. Participants cited the most common vehicle conflicts as parent/bus and bus/day care van. Pedestrian/vehicle conflicts (on- and off-campus property and going between buses or other vehicles) were noted five times. Conflicts between bicyclists and other modes were also noted.

A negative effect associated with student drivers was noted four times. Student drivers' inexperience is a potential hazard at the campus interface to public roadways. This inexperience may be demonstrated by irregular gap acceptance or ingress/egress vehicle speeds.

Three times, participants noted problems stemming from parent-caused vehicle queues (frequently referred to as "stacking"). This problem is caused by a short period of high vehicle demand for driveway space resulting in vehicle queues extended onto public roadways and interfering with traffic flow. Other issues mentioned one time each were the lack of on-site bus storage, lack of police traffic control to assist with bus and student driver egress, parents ignoring campus drop-off/pick-up rules, and the public ignoring general traffic laws.

Comparison of Survey Results. The survey results were very comparable to the interview results for the top access and circulation problems at the different campus types. Respondents were asked to write out their problems so researchers had to do some categorization to make sense of the data provided. The separation of traffic types was the biggest problem category, especially at elementary campuses. The second most cited problem was basically a tie between too much traffic (congestion, queuing, etc.) and limited access on and/or from neighboring streets.

Table 4-5. Access and Circulation Problem Responses.

ID	Paraphrased Responses of Interview Participants
1	• separation of traffic types (bus, parent, and pedestrian) • additional vehicles of student drivers at high schools • location of campuses – it is important that the nature of the roadways is considered and thought is given to students going into and leaving the campus
2	• separating bus/auto traffic from one another • separating bus/auto traffic from pedestrian movements • providing adequate turn lanes into sites – cannot build them long enough for the queue

Table 4-5. Access and Circulation Problem Responses (continued).

ID	Paraphrased Responses of Interview Participants
3	• separating bus and car traffic at all campuses • students walking between vehicles – this is dangerous situation • not having police assistance to empty student parking lots or buses from the campuses • lack of feeder roads to let traffic flow faster
4	• campus circulation is very congested because of one ingress/egress point – about 50% of elementary campuses have this problem • not enough access to property – this is the case for 80% of our campuses • presence of student drivers at high school campuses • mixing of cars and buses – these two don't mix • on-site bus storage
5	• parent drop-offs and the resulting vehicle queues • ordinance problems – discontinuity between school campus needs and street widths • dual use of pavement (example, fire access bulb/play yard) – gates leading to this area to protect children from traffic are not allowed due to fire department requirements • median cuts
6	• Parents do not observe drop-off/pick-up locations (mainly at elementary campuses) • Child pedestrians on and around school campuses – it is also a problem off the school site when children do not use defined crosswalks with assistance from crossing guards • Student vehicles – a high demand for them leaving after the school releases. We are building a 9th grade campus to take pedestrians away from conflict with student drivers. • Drivers ignore school buses as they load students and have their red lights flashing. • Length of time railroad crossings are blocked – sometimes a train can block the crossing for 30-45 minutes. This causes major problems for buses completing routes.
7	• The abundance of cars – because older schools only have front access, this causes a traffic circulation problem. Parents typically drive small kids causing heavy congestion. • Some old schools don't have sidewalks on the perimeter. We are working with the city to install sidewalks on city right-of-way (ROW) surrounding school campuses. • School attendance zones are near major thoroughfares. Generally try to avoid this, but there are exceptions. Those responsible for site selection do not consult with safety group.
8	• separating bus from parent traffic at all campuses • ingress/egress from all campuses – prefer to have only right-hand turns for ingress/egress • need for queuing space at elementary campuses • elementary students walking between cars and buses during loading • number of traffic crossings for pedestrians and bicyclists – try to minimize these • student drivers at high school campus • access to roadways – we look for access to more than one road from our campuses

4. **What complaints do you hear most often from parents, bus drivers, and the children about access and circulation?**

Summary of Interview Results. Complaints come mostly from parents of children attending or the residents surrounding the school campuses. Both vehicle queuing and the conflict between various vehicle types (private auto, school bus, day care vans) and pedestrians were noted four times. Vehicle queuing is a result of sharp increases in vehicle demands in a short period of time. Traffic conflicts are present both on- and off-campus. Pedestrians come in close contact to private vehicles, buses, or day care vans as they pass between them during loading/unloading. Pedestrian conflicts at school crossing zones were also noted. One participant suggested that more school crossing guards are needed to assist children across streets.

Parking issues and the time children spend on a school bus were noted twice each. Parking complaints may be partially due to the vehicle queuing. As vehicle queues extend off of the campus property, cars may be parked in front of private residences. Vehicle queuing also results when private vehicles park in fire lanes as drivers wait for the children to enter the vehicle.

Other issues mentioned once each were parents not following drop-off/pick-up rules, vehicles running the flashing red lights on school buses, the public not understanding that buses must stop before crossing railroad tracks, and fast moving or speeding traffic. Table 4-6 summarizes the individual participant responses to Question 4.

Comparison of Survey Results. The top complaint heard from parents (11 of 17), bus drivers (eight of 17), and the public (10 of 17) was too much traffic around the school site during the morning and afternoon peak time periods. This complaint corresponds to the top complaint from the interviews regarding vehicle queuing. The second most cited complaint in the survey, appearing nearly as frequently as the top complaint, was limited access to the site.

Table 4-6. Common Complaints about Access and Circulation at School Sites.

ID	Paraphrased Responses of Interview Participants
1	Complaints come from campus staff regarding remodel projects. The day-to-day complaints don't get to my office.
2	Parents often complain that the buses are in the way of their vehicles. Parents also note the amount of vehicle queuing. Some parents identify conflicts between pedestrians and cars.
3	Competition for space between buses, parents, and day care vans
4	Receive 30-40 complaints daily. Ten complaints usually come from parents about school parking lots. Half of the complaints come from one high school campus.
5	Vehicle queuing that results in cars parking in fire lanes and in front of homes. Principals do on-site coordination – they turn in a traffic circulation plan at the beginning of each year.
6	Parents complain about student drop-off rules. Bus drivers see people ignoring the red flashing lights and drivers who do not know that they must stop at railroad crossings. We run buses along their routes 2 weeks before school to remind the public to observe buses.
7	Need more officers to slow down cars and more crossing guards to help kids across streets
8	Bus drivers report amount of traffic and that kids are on the bus for too long. Parents report the length of time to get their kid from school (waiting in vehicle queue and before bell). Some resident complaints are taken on vehicle queuing on city streets.

5. **How are these complaints and problems addressed within the district?**

Summary of Interview Results. Complaints are handled in a variety of manners. Most are logged within the ISD at some point. Persistent complaints are typically investigated more thoroughly by ISD staff. One ISD noted that many conflicts are registered at the beginning of the school year and taper off as parents become accustomed to site conditions and the bell schedule. Table 4-7 lists the individual participant responses to Question 5.

Comparison of Survey Results. This question was not asked in the supplemental survey.

Table 4-7. School District Methods of Addressing Complaints and Problems.

ID	Paraphrased Responses of Interview Participants
1	Nothing
2	List and review them.
3	Investigate the situation.
4	If the complaints are from the public about bus drivers then the driver is called into the office. The driver gets the complaint and has five days for rebuttal. Managers also look at trends of drivers and complaint types.
5	Built additional parking; talked to city about establishing NO PARKING zones in front of school and communicated with after school programs to not park in front of residences.
6	Investigate the problem when the number of complaints goes up. On-site inspection is then made. All complaints result in a call back to parents. We also use VCR tape on buses to review reported traffic or student incidents (retain most current two weeks of videotape).
7	Log calls and respond that corrective actions require funding. Because of a lack of funding they are unable to help in most cases.
8	Calls to ISD administration get referred to the director of planning. Most complaints come at the beginning of the school year (about bell times and parents adjusting to them). Persistent complaints result in visual inspection by staff of problem.

6. **Do you consult with city or county engineering staff or state DOT staff about any of these issues?**

Summary of Interview Results. ISDs typically consult with their city engineering staff to solve problems identified through complaints, though not every participant specifically stated this. Some (three responses) consult with TxDOT on these matters. One response each was made for county engineering staff and the Department of Public Safety (DPS). Table 4-8 provides the individual participant responses to Question 6.

Comparison of Survey Results. Almost every survey respondent (16 of 17) stated that they had consulted with city (13 of 17), county (six of 17), and/or TxDOT (seven of 17) regarding transportation-related problems and complaints.

Table 4-8. Consultation with Engineering/State DOT Staff.

ID	Paraphrased Responses of Interview Participants
1	We are building a major complex in a rapidly growing area. We met with county and TxDOT staff – the county is taking a proactive role at this location. The ISD is making improvements in the immediate area, but TxDOT's funding of improvements to the two-lane road is uncertain. In fact, the improvements haven't been identified as a TxDOT project and therefore are unfunded at this point in time.
2	Yes
3	We have a working relationship and good communication with the city engineering staff and the Precious Cargo contacts at TxDOT.
4	Yes, the city is good about communicating road construction plans so that buses can be rerouted; but the relationships with the police department are problematic. The police do not seem to want to help on a major arterial at a high school campus to evacuate buses. This causes problems for traffic on the arterial as the buses pull out into heavy traffic.
5	Yes
6	We are always working with TxDOT on both school crossing light schedules and improving intersection signalization (we work to get more green time to evacuate buses from campuses). The Department of Public Safety also gives us two programs per year on safety issues and uses videotapes from local instances where safety could be improved.
7	Yes, with the city engineering staff mainly; TxDOT presented Precious Cargo some time ago and our superintendent was the only superintendent there; others had sent assistants
8	Yes, with the exception of TxDOT

7. Are you aware of the TxDOT's Precious Cargo Program?

Summary of Interview Results. One half of the interview participants were not aware of the TxDOT Precious Cargo Program. Only two participants who stated they were aware of the program had actually taken part in a review with TxDOT staff. Table 4-9 lists the paraphrased responses to Question 7 for each of the interview participants.

Comparison of Survey Results. Ten of the 17 survey respondents were aware of the TxDOT Precious Cargo Program, representing approximately 10 percent higher awareness than the interview participants.

Table 4-9. Awareness of TxDOT Precious Cargo Program.

ID	Paraphrased Responses of Interview Participants
1	The program was mentioned one time in a meeting that I attended. I didn't pursue it after TxDOT mentioned it wasn't for larger projects.
2	No
3	Yes
4	No
5	No, but the director of transportation probably has.
6	Yes, I used to use it in Dallas with a previous position.
7	Yes
8	No, please send me two Precious Cargo progress report packets.

8. **Have you ever had a TxDOT representative review a school site plan prior to the construction of a new school campus?**

Summary of Interview Results. Only one quarter of the interviewees stated that TxDOT staff had previously reviewed school site plans. Half of the participants have not had TxDOT review plans. Two of these school district representatives are currently trying to get TxDOT involvement by working within the ISD to use the resource and by offering meetings with TxDOT to the consultant. One quarter of the participants were unsure if TxDOT reviews had occurred in the past. Table 4-10 gives the individual responses to Question 8.

Comparison of Survey Results. Almost half (eight of 17) of the survey respondents indicated that they had a TxDOT representative review a site plan prior to the construction of a new school campus. This is almost double the frequency cited by the interview participants. Also, six school districts' representatives also responded that they had a TxDOT representative review a school site plan prior to the reconstruction or retrofit of an existing school campus with transportation-related improvements.

Table 4-10. Site Plan Review by TxDOT Representative.

ID	Paraphrased Responses of Interview Participants
1	Yes, TxDOT reviews plans when schools are located on on-system roads. The ISD A/E is primarily involved in the review process.
2	Yes, it is a normal part of the process.
3	No, TxDOT reviews have not been conducted to date. I have offered a meeting with TxDOT to my consultants.
4	Unsure
5	No
6	No, usually a city engineer reviews the site plans.
7	Unsure. I am trying to get the ISD to take advantage of TxDOT resources now that we are moving forward on the 1st bond program in 5 years.
8	No, but State requires plans be sent to Austin for accessibility (Americans with Disabilities Act-related) review.

9. **Do you track the number of students arriving by mode? Are there plans to continue or begin this type of data effort? How frequently do you gather this data? How extensive is the dataset (campuses, days, etc.)?**

Summary of Interview Results. Half of the interview participants stated that they did record the number of student arrivals by mode to some degree. Two participants indicated that their ISD did not perform such activity and two others were unsure if student arrivals were tracked.

For those recording arrival information, campus staff and bus drivers are responsible for collecting this information. Highest attention is given to bus ridership through roster checks. This is followed by bicycle use and parent drop-offs, which are collected through visual means. None of the interview participants indicated that they record or track the number of pedestrian arrivals. Data collected on the number of bicyclists are used to justify additional bike racks.

The frequency of data collection was varied. Some routinely collect data and others collect data only when needed, such as a particular problem the ISD is beginning to address. Student arrivals may be recorded for as little as one day up to one week. Table 4-11 contains the individual participant responses to Question 9.

Comparison of Survey Results. The survey results closely resemble the interview results. Just over half the survey respondents (nine of 17) indicated that they track the number of students arriving at their schools by mode. All nine track student arrival by bus with the majority (seven of nine) using a roster check as the tracking method. Bicycle, parent, and pedestrian traffic arrivals were tracked by four to six of the respondents using visual methods exclusively. As in the interviews, the frequency of data collection varied widely from daily to annually.

Table 4-11. Tracking Modes of Student Arrival.

ID	Paraphrased Responses of Interview Participants
1	I don't know for sure.
2	Yes, we do look at how students arrive to campus. We do not routinely do this unless there is a problem. When we do record student arrivals, campus personnel observe for a couple of days up to a week.
3	No
4	We do not track all modes, but we do track for bus purposes.
5	We do count the number of students arriving by both bus and bike on a bi-annual basis at best. We count bicyclists to justify the addition of new bike racks. On-site staff observe student arrivals for several days (~3 days).
6	We count the number of parent drop-offs using visual methods. This is performed a couple of times after the school year starts. Only a couple of campuses have significant foot traffic so that counting is infrequent. Bus drivers take head counts on the 1st Wednesday of each month using a roster and collecting roll.
7	We don't do this, but we really should and should apply the process district wide.
8	The transportation department may do this. I do not know about the frequency of counts.

10. Do you participate in the planning and design process for your school campuses? In what role do you participate? How is your vision incorporated by the architect/engineer? Does the city traffic engineer or transportation consultant participate in this process representing the ISD interests?

Summary of Interview Results. All interviewees participate in the planning and design process for their school campuses. Most (five responses) act as the owner's representative. Many of these staff had architecture backgrounds. The next most common role (three responses) was that of the transportation director/manager. Two participants stated that they have had difficulty with the architect incorporating the school district's vision into the campus site plan. One participant noted that the city traffic engineer participates in the process. His level of involvement is not consistent, being very involved in some, and minimally involved in others. Table 4-12 provides the individual responses to Question 10.

Comparison of Survey Results. The survey results were very comparable to the results of the interviews. Only one survey respondent indicated that they had no role in the planning and design process of new school campuses. The primary role for the survey respondents was as a representative of the transportation department (10 of 16) with the remainder acting as owner representatives.

Table 4-12. Involvement and Role in School Campus Planning and Design.

ID	Paraphrased Responses of Interview Participants
1	I participate in the planning and design process as the owner's representative. I select and hire the A/E and facilitate their meetings with ISD staff. I have an active coordinator role in the function and scope of the school. The vision of the future campus starts with defining the project scope within the ISD's educational specifications and from regular meetings with academic departments. The traffic issue is project dependent. It is included early in the conceptual phase. We meet with many city departments for them to raise many issues, not just traffic ones. We have follow-up meetings with the city departments as the project progresses. By the time the ISD goes to get the construction permit, everyone has a good idea of what will be built.
2	I oversee the planning and design process. The city engineering staff is involved throughout the process, from when the ISD purchases the land through how the building is located on the parcel.
3	I do participate in dual roles of owner and transportation director. I am concerned with how the site will function. We look at how special events will be accommodated at the facilities. Overall, it can be battle to convey my vision to the architect/consultant. We have not used the city traffic engineer or transportation consultant to represent the ISD.
4	I am getting involved in the process now at several campuses. My role is only for providing information such as the number of buses and transportation logistics. I am sure city engineers participate in the process.
5	I participate as an owner and I seek the successful operation of the site. The city has its first traffic engineer (newly created and filled position), but he does participate in the review process.
6	I participate in the process as it relates to school bus traffic for the ISD. Our vision isn't always incorporated into the final design. For example, the A/E didn't check with us on our estimate for the number of buses at the campus and it was built with less space than was needed. So we had to change the original function of the site by moving bus operations to another area to accommodate the number of buses. The city engineer does participate in the process but it isn't a priority for him.
7	We do participate though not on the basis I desire and expect. The A/E will call for my area to get involved. It seems as if safety is pushed aside during the planning and design process and is categorized as an "out there thing."
8	I actively participate in the process to make sure that the ISD standards are met and that our vision of the campus is met. City traffic engineers do participate in the process reviewing and commenting on plans as well as occasional use of transportation consultants.

11. How are school sites selected in your ISD? When receiving donated or reduced price property, do you consult with architects/engineers about its suitability for a campus? What criteria are used to make this assessment?

Summary of Interview Results. The interview participants indicated that their school districts acquire future schools' sites through negotiated purchase, donations by developers, and exchange. Those interviewed most often negotiate the purchase of new parcels and tracts (five positive responses) in anticipation of future enrollment. The interviewees cited donated parcels as the second most common method of land acquisition for future school sites. Donations are primarily given by land developers, either through their initiative or as a result of suggestions from local government (planning and zoning commissions or city councils) in approving the developer's plat. The local government acts to prepare their city for the eventual demands for new schools caused by large developments. The least common method of acquiring land is through exchange.

Three participants stated they do consult with their own staff architect and/or the ISD A/E to determine the suitability of a parcel. This consideration typically involves assessment of building size and placement on the lot given its property lines and elevation relief.

The overwhelming primary criterion for site selection, by no surprise, is future demographics or future student demand. Geography was mentioned but was referred to in the sense of placing schools where students are located, in essence a result of demographics. Second to this criterion is access to the site in terms of utilities (gas, electric, and water) and roads. Parcels are more attractive if utilities are available or very nearby. Access to four or more low-volume roadways around the parcel is ideal. Other criteria mentioned for selected parcels were the size (to accommodate the needed size of building and support facilities), topography (elevation relief), and environmentally safe area (free of toxics and hazards). Table 4-13 contains the paraphrased responses of the interview participants for Question 11.

Comparison of Survey Results. The survey results strongly resembled the interview results. Survey respondents cited purchase/negotiation as the most frequent method of obtaining future school sites. As in the interview results, donated parcels were the second most common method of land acquisition for future school sites, and the least common method of land acquisition was through exchange.

Table 4-13. School Site Selection and Acquisition.

ID	Paraphrased Responses of Interview Participants
1	School sites are acquired by various methods. The process is handled through higher levels within the ISD. I get asked for input when it is needed. Sites are placed somewhere in the vicinity of the projected growth need. Developers come to ISD to locate sites on large developments. Also the school seeks out parcels.
2	The ISD purchases parcels and does consult with A/Es about the suitability of the site. There are basically two criteria used to select sites: geography and site access. Geography relates to where the students live and how to relieve partial or real overcrowding at campuses. Site access covers the availability of electric, gas, and water utilities and access to roads. An effort is made to get access from more than one side of the parcel. Ideally access would be on all four sides, with a preference for access on two sides. We prefer sites that have the least amount of traffic on the adjacent streets. We prefer options to put the structure farther back on the parcel, away from the street, but city doesn't always want it near the back of the parcel.
3	ISD looks at its anticipated growth in student populations. Elementary campuses are preferred in the center of neighborhoods. A/Es are consulted about suitability of the parcel for campus needs.
4	No
5	Demographics are the first criteria used to select future school sites. The demographics come from the ISD's long-range plan. The city will send notices on large plats that an elementary campus should be included. We planned our middle school and high school campuses this way. The ISD negotiates the purchase of parcel and also encourages donations by developers. The A/E reviews the adequacy of the site in terms of what structure and supporting facilities can be developed, what infrastructure will be needed, and how the structure might be positioned on the parcel. The city, through planning and zoning, will require that parcels for elementary campuses be reserved by developers and to have the developers work with the ISD to make a right fit that meets building needs and other space requirements.
6	Our school site selection starts with finding where the student growth will occur. Developers donate land or it is purchased/swapped. We recently sold a large parcel but kept some of it to build a school with the funds generated from the land sale. One large corporation donated a lot of land on the west side of town. The architect/engineer will also review the site to see what type of structure could be built on the site.
7	In general terms, schools are located where the needs are. The primary method of site acquisition is through land purchases, but donations do happen. There is a limited amount of land exchange. The two criteria are that the site must be environmentally safe and that it allows for the development of an appropriate size building. The architect provides recommendations on the latter criterion.
8	A team representing demographics, bus transportation, district A/E, superintendent, A/E consultant, and traffic engineering consultant review potential school sites. Our criteria for selecting future school sites are: demographics, access, topography, and utilities. In a master planned development, the ISD worked with the developer to set aside school sites as part of the development. We also seek raw land for future needs based on demographic forecasts.

12. Would you be interested in receiving an invitation to and attending a half- to full-day symposium with other architects, engineers, school officials, and other stakeholders regarding transportation-related school site issues?

Summary of Interview Results. The interview participants expressed unanimous interest in attending a school safety symposium.

Comparison of Survey Results. Over 80 percent of survey respondents indicated an interest in attending an organized symposium to gather architects, engineers, and school district staff together to exchange best practices through presentations or panel discussions.

13. If you are interested, please rank the following issues you would like to see addressed (1 for most important and 10 for least important)?

Summary of Interview and Survey Results. Interview participants and survey respondents were asked to rank their interest in 10 topics (see Table 4-14) that potentially would be part of a school safety symposium.

Table 4-15 summarizes the rankings for the topics based on high (ranked 1-3), medium (ranked 4-7), and low (ranked 8-10) ratings, as well as the overall sum of rankings. For example, Topic A was rated by five interview participants with a score of 1 and by one participant with a score of 2 in the high range. One participant gave Topic A the score of 4 (a medium range value), and no participants ranked Topic A within the low range. Altogether, the rankings by the seven interview participants that rated Topic A resulted in a sum of 11.

Table 4-16 gives the combined rankings of the interview participants and survey respondents.

Table 4-14. Potential Topics for School Safety Symposium (ISD).

Topic	Description
A	Coordination between designers, schools, and state and city transportation departments
B	Pedestrian and bicycle access/safety
C	Design and operation of drop-off and pick-up zones
D	Traffic impact analysis (volumes, modal estimation)
E	Design and operation of parking facilities
F	Retrofit options (design & operations) for schools with existing transportation problems
G	School site selection criteria
H	Safe Routes to School (recently passed Matthew Brown Act in the Texas legislature)
I	Signing, marking, and other traffic control issues for roadways around the school site
J	Special event (i.e., athletic games, after-school meetings, etc.) traffic issues

Table 4-15. Symposium Topic Ratings for School District Interview and Survey Participants.

Topic	Interview Participants*				Survey Respondents**			
	H	M	L	Total	H	M	L	Total
A	6	1	0	11	7	3	3	55
B	6	1	0	19	8	3	2	52
C	6	1	0	12	11	2	0	23
D	5	2	0	16	10	2	1	37
E	4	3	0	22	5	5	2	53
F	5	2	0	20	11	2	0	25
G	5	1	1	21	6	3	4	61
H	4	2	0	16	11	3	0	37
I	5	2	0	16	7	4	1	45
J	3	4	0	26	4	5	3	64

* Only seven of eight interviewed provided rankings.

** Three of the survey respondents did not provide rankings; two respondents provided partial rankings.

Table 4-16. Combined Ratings for Symposium Topics for School District Personnel.

Topic	H	M	L	Total	Average	Rank
C	17	3	0	35	1.75	1
F	16	4	0	45	2.25	2
H	15	5	0	53	2.65	T3
D	15	4	1	53	2.65	T3
I	12	6	1	61	3.21	5
A	13	4	3	66	3.30	6
B	14	4	2	71	3.55	7
E	9	8	2	75	3.95	8
G	11	4	5	82	4.10	9
J	7	9	3	90	4.74	10

KEY FINDINGS

The following list presents the key findings from the school district interviews and supplemental surveys. The numbers in parentheses at the end of each finding represent the question number where additional information can be found in the Summary of Individual Responses section.

- Very few ISDs' mission statements (approximately 30 percent) mention safe access to campuses for their students, although there is general reference to student safety (Q1).

- Some ISDs conduct school-safety site assessments where traffic access and circulation are reviewed. Visual observation by ISD administrative or campus staff, not traffic counts, is the primary means of data collection for these assessments. Traffic engineers are typically involved in these assessments about half the time, mostly in a coordination and review role (Q2).

- Within the range of site access issues, separation of traffic types (bus/private-vehicle/day care van and vehicle/pedestrian) was the highest problem area of all campus types. The second most cited problem was basically a tie between too much traffic (congestion, queuing, etc.) and limited access on and/or from neighboring streets (Q3).

- Parents of school children and residents surrounding school campuses voice the most public complaints to the ISD. The three top complaints received from interview participants and survey respondents were the amount of traffic at the school sites, conflicts between the various vehicle types (autos, school bus, day care vans) and pedestrians, and limited access to the site (traffic signals, nearby intersections, driveways, etc.) (Q4).

- Public complaints are handled in a variety of ways; however, ISDs investigate persistent complaints more thoroughly. Typically, ISDs most frequently consult with their city engineering staff to solve problems identified by complaints. Approximately half of the ISDs had consulted with TxDOT for solutions to the complaints in the past (Q5 and Q6).

- Half of the interview participants were unaware of the Precious Cargo Program (Q7). Slightly more of the survey respondents (60 percent) indicated an awareness of Precious Cargo.

- Only one quarter of the interview participants have had TxDOT review school site plans. Almost double the frequency of survey respondents had used TxDOT for plan review on a new campus and several for review of transportation-related improvements at existing campuses (Q8).

- Approximately 50 percent of the ISDs have recorded student arrival mode. The modes recorded were (in order of decreasing interest): bus ridership, bicycle use, and parent drop-off. Data collection methods varied widely in frequency and length of data collection (Q9).

- The most common roles shared among respondents in the planning and design process for new schools were owner's representative and transportation director/manager (Q10).

- Future ISD school sites are acquired through (in order of decreasing frequency): negotiated purchase, donation, and exchange. Some ISDs consult their own staff architect or an independent architect prior to the parcel's acquisition (Q11).

- The criteria for selecting a future school site are (in order of decreasing importance): demographics, utility and roadway access, parcel size, and topography (Q11).

- Respondents expressed a strong interest in a school issues symposium. The highest rated topics were:

  - design and operation of drop-off and pick-up zones;
  - retrofit options (design and operations) for schools with existing transportation problems; and a tie between
  - traffic impact analysis (volumes, modal estimation) and Safe Routes to School (recently passed Matthew Brown Act in the Texas legislature) (Q12 and Q13).

CHAPTER 5. CONSULTING ENGINEER INTERVIEWS

BACKGROUND

The safety of student transportation, whether by bus, private auto, or other means, is a growing concern among parents, school officials, and designers. Architects are the primary consultant in the design of school facilities. Consulting engineers (general civil or transportation engineering) support architects on many school construction projects, whether a retrofit of an existing facility or construction of an entirely new campus. The interaction between these technical designers is important to the process, as well as the design principles used by consulting engineers.

In order to gain a clearer understanding of the challenges, issues, and methods used to plan and design K-12 educational facilities, the research team conducted telephone interviews with two consulting engineers in the North Texas area between June 13 – 20, 2002. The interviews focused on the design aspects of the transportation elements associated with school sites. Questions posed to the engineers related to coordination issues with the prime contractor and client, traffic access and circulation, and design guidelines for vehicle and bus loading zones, parking, driveways, and pedestrian access.

ORGANIZATION

The remainder of this chapter is organized into two sections. The first section lists the responses, by question, from those interviewed. The last section contains a brief summary of the key findings obtained from the interviews.

SUMMARY OF INDIVIDUAL RESPONSES

1. What permits or requirements for transportation-related elements are typically required for a new school site plan? (check all that apply)

Table 5-1 lists the responses.

Table 5-1. Permits or Requirements in New School Site Plans.

ID	Driveway Locations	Traffic Impact Analysis	Signing & Marking Plan	Other
1	Yes – city reviews and has biggest say; can be conflict between ISD and city	Yes – sometimes, but not always		Building permit; Certificate of Occupancy can be held up by driveway locations.
2		Yes – Very common part of a larger planned development		Construction access permits on state facilities

2. **How often do you perform a traffic impact analysis for a school site?**

Table 5-2 displays these responses.

Table 5-2. Traffic Impact Analysis.

ID	Never	Seldom	Occasionally	Frequently	Always
1		X (2-3 per year)			
2			X (depends on if large development or site specific)		

3. **How integrated is traffic circulation with building location and orientation?**

Table 5-3 presents these responses.

Table 5-3. Integration between Traffic Circulation and Building Location/Orientation.

ID	Response
1	The building's location and orientation is usually a done deal when the traffic engineer becomes involved. Opined that the traffic engineer should be involved earlier in the process.
2	They are key issues and very seldom considered. Traffic engineers typically fix problems with circulation after the building is open.

4. **What is the most challenging problem with traffic access and circulation at education facilities?**

Table responses are reported in Table 5-4.

Table 5-4. Challenges with Traffic Access and Circulation.

ID	Response
1	Parents want to walk their children into the classrooms (park and walk). Visitor and volunteer parking needs are growing.
2	Vehicle queuing for drop-offs and on roadways.

5. **What planning and design differences are there between urban facilities and more rural facilities?**

Table 5-5 lists responses.

Table 5-5. Urban and Rural Facility Differences.

ID	Response
1	Suburban or rural is more often dealing with two-lane roadway (ditches, more circulation problems). Solutions are to add left-turn lanes or restrict parking.
2	More pedestrians in urban settings; rural areas have an advantage of roadway shoulders to use for queuing.

6. **What factors do you consider during the planning of vehicle circulation to/from and on the site?**

Table 5-6 provides these responses.

Table 5-6. Factors in Vehicle Circulation Planning.

ID	Response
1	• How do school buses and parents interact (separate traffic types) • Adequate parent parking and teacher parking • Where children are coming from (needs for crossing guards other traffic control devices) • Parking restrictions on adjacent streets.
2	• How drop-offs will be handled • The staging of vehicles in the queue • Most queue impacts are at elementary and middle school campuses • Using school staff to help control traffic and facilitate drop-offs

7. **Do you typically receive data from the school district or from other sources related to the: (check all that apply)**
   - **A. Projected student enrollment**
   - **B. Projected number of faculty and staff serving at the school campus**
   - **C. Estimated percentage of students requiring bus transportation**
   - **D. Estimated number of buses that will access the school campus**
   - **E. Estimated percentage of students walking or biking to school**
   - **F. Estimated number of vehicle trips generated by the school site**

The responses are arranged in Table 5-7.

Table 5-7. Types of Data Received from ISD or Other Sources.

ID	A	B	C	D	E	F
1	Y	Y	Y (sometimes available)	Y (ISD knows this)	N	N
2	Y	Y	N	Y	Y	N (calculated from other data)

8. **At what stage in the site design process are transportation-related elements (i.e., parking, internal roadways, driveway locations, etc.) considered?**
   A. **Early on in the process**
   B. **After the building location has been determined**
   C. **After the building design has been completed**
   D. **Near the end of the process**
   E. **Other:**

Table 5-8 presents these responses.

Table 5-8. Stage When Transportation-Related Elements Are Considered.

ID	A	B	C	D	E
1				X	
2		X	X		Too late

9. **Do you typically design the school to accommodate peak traffic demands within the site (i.e., enough storage to prevent vehicles and/or buses from queuing on adjacent roads)?**

Responses are listed in Table 5-9.

Table 5-9. Accommodation of Peak Traffic Demands.

ID	Yes	No	Comment
1		X	
2		X	Never can dedicate enough space

10. **Have you advocated one-way streets around school sites for before and after school times? In what way? Were you successful?**

Table 5-10 displays these responses.

Table 5-10. Advocating One-Way Streets around School Sites.

ID	Response
1	No – have found that parking restrictions can be used to essentially create one-way streets; may cause problems for resident parking
2	Yes – currently pursuing at a location now; considering temporary (during student movements) and permanent operations

11. How is the length of the drop-off/pick-up zone determined?
- **A. Sized according to the layout of the parcel of land**
- **B. Designed to accommodate certain number of cars based on projected site traffic**
- **C. Use a standard length based on school type (elementary, middle, or high school)**
- **D. Other method (please describe):**

Responses are organized in Table 5-11.

Table 5-11. Method of Determining Length of Drop-Off/Pick-Up Zone.

ID	A	B	C	D	Comment
1				X	What land is available after other elements are designed; corner clearance sets drive locations
2	X			X	Dictated by architect

12. How is the width (number of lanes and designation) of the drop-off/pick-up zone roadway determined?
- **A. Sized according to the layout of the parcel of land**
- **B. Designed to accommodate certain number of cars based on projected site traffic**
- **C. Use a standard width based on school type (elementary, middle, or high school)**
- **D. Other method (please describe):**

Table 5-12 lists interview participant answers and comments.

Table 5-12. Method of Determining Width of Drop-Off/Pick-Up Zone Roadway.

ID	A	B	C	D	Other
1				X	Dictated first by fire lane (24 ft [7.32 m]) and second by parking needs; prefer to design for three vehicles abreast (30 ft [9.15 m]) so that two lanes can stop and one can be open and free-flowing
2				X	75% of design is for one lane drop-off location; may put in one by-pass lane or seek other alternative access

13. Do you typically design the drop-off/pick-up zone roadway to allow parallel parking for vehicles during school hours?

Responses are provided in Table 5-13.

Table 5-13. Placement of Parallel Parking in Drop-Off/Pick-Up Zones.

ID	Yes	No	Comment
1	X		
2	X		May have visitors for short term but do not designate as such

14. Do you typically separate traffic types at drop-off/pick-up zones?

Both respondents reported either separating or attempting to separate traffic types (Table 5-14).

Table 5-14. Separation of Traffic Types at Drop-Off/Pick-Up Zones.

ID	Yes	No	Comment
1	X		Try to do this
2	X		

15. What types of traffic do you separate?

Responses are arranged in Table 5-15.

Table 5-15. Types of Traffic Separated at Schools.

ID	Parent	Bus	Day Care	Service	Volunteer/Staff
1	X	X	*	*	*
2	X	X	**	**	X

* – advisable that day care, service vehicles, and volunteer/staff be separated. Whole issue complicated by changes during the day (e.g., children line up in afternoon to leave school).
** – Day care vans use parent area and service vehicles use bus area.

16. What is the preferred design for a bus loading zone?

- **A. Single-file (buses staged in parallel – students load with right wheels on curb)**
- **B. Single-lane chevron (buses parked at an angle – students load between buses)**
- **C. Multiple-lane parallel (buses use multiple lanes)**
- **D. Multiple-lane chevron (buses parked at angle in multiple lanes)**
- **E. Other method (please describe):**

Responses are presented in Table 5-16.

Table 5-16. Bus Loading Design Preference.

ID	A	B	C	D	E	Comment
1	X					
2				X		Buses can pull straight out, provides minimal queue length, better visibility of bus numbers for children's wayfinding

17. Do you use any design guidelines for the design of drop-off/pick-up zones?

Table 5-17 displays these responses.

Table 5-17. Guidelines for Design of Drop-Off/Pick-Up Zones.

ID	Yes	No	Comment
1	X		Sketches; architects don't have written guidelines
2	X		In-house sources

18. Do you design drop-off/pick-up zones to accommodate what percent of the expected vehicle queue?

Percentages are marked off in Table 5-18.

Table 5-18. Design of Drop-Off/Pick-Up Zone for Queue Accommodation.

ID	25%	50%	75%	100%	Other	Comment
1	X low		X high			AM – 2/3 arrive on time; PM – 1/3 arrive early, 1/3 arrive on time, 1/3 arrive late
2					X	35% - 40%

19. What methods do you recommend for handling traffic demands to reduce street congestion impacts?

Methods are reported in Table 5-19.

Table 5-19. Traffic Methods to Handle Traffic Demands.

ID	Response
1	Crossing guards can cause or relieve congestion; traffic control devices manual had suggestions for using crossing guards; use signs when warranted; use speed zones through studies and following city ordinances
2	Use left-right turn lanes and shoulders; use on-street traffic control (police officer or signal), treatment depends on the street type

20. How do you determine the size of the parking lots?

A. Size is based on the projected vehicle load for faculty/staff, visitors, and students
B. Use a standard size based on school type (elementary, middle, or high school)
C. Sized according to parking requirements contained in local ordinances
D. Other method (please describe):

Responses are organized in Table 5-20.

Table 5-20. Methods of Determining Parking Lot Size.

ID	A	B	C	D
1			X	X*
2		X**		

* – availability of land; nominal amount for visitors
** – ISDs have this or base judgment on past experience

21. Do you typically separate the parking areas for faculty/staff from visitors and/or students?

Responses can be viewed in Table 5-21.

Table 5-21. Separation between Faculty/Staff, Visitors, and Students in Parking Areas.

ID	Yes	No	Comment
1	X		Should be guidelines for visitor parking or short-term parking
2	X		

22. Are there any special design considerations for student drivers?

Table 5-22 displays these responses.

Table 5-22. Special Designs for Student Drivers.

ID	Yes	No	Comment
1		X	Not very involved with high school campuses
2	X		Depends on how access is controlled; may minimize access through turning movement and lane controls, provide angled parking (easier to maneuver for experience level), provide one way in and one way out; may have one- or two-way parking circulation depending on land available

23. Do you use design guidelines (i.e., formula for number of spaces, average space needed for a parking space, parallel vs. angled vs. conventional, etc.) for parking lot design?

Table 5-23 presents these responses.

Table 5-23. Guidelines for Parking Lot Design.

ID	Yes	No	Comment
1	X		Institute of Transportation Engineers handbook. 9'x18' (2.745 m x 5.49 m) parking stall, head-in (majority of time)
2	X		*Dimensions of Parking* is primary source.

24. Which of the following are considered when deciding the location and design of driveways to access the school site located? (check all that apply)

A. Applicable state and municipal laws
B. Separation distance between access points and nearby intersections
C. Placement relative to driveways on the property opposite the school site
D. Provision of space for turning movements (left and right turns) from the site
E. Bus turning characteristics
F. Sight distance
G. Other considerations (please describe)

Responses are organized in Table 5-24.

Table 5-24. Methods to Determine Location of School Driveways.

ID	A	B	C	D	E	F	G	Comment
1	X	X			X			A is overriding; B is somewhat; E in some cases for new campuses but not for existing campuses
2		X	X	X	X	X		

25. Do you use any design guidelines for deciding the location and placement of driveways to the school site?

Responses are visible in Table 5-25.

Table 5-25. Guidelines for Driveway Location and Placement.

ID	Yes	No	Comment
1	X		City requirements; *Traffic Engineers Handbook*; ITE design guidelines
2		X	Use good practice

26. Do you design turn bays from the adjacent streets into the school site?

Responses are reported in Table 5-26.

Table 5-26. Turn Bay Designs from Adjacent Streets.

ID	Never	Sometimes	Frequently	Always
1		X		X*
2			X	

* – Always if given the opportunity. City engineer needs to review this and resolve conflicts. Very critical issue is left turn design into campus is affected by street width. Less than 37 ft (11.8 m) width causes problems. Critical issue is to restrict left out access.

27. How do you try and control access to/from the site?

Table 5-27 lists the responses.

Table 5-27. Methods of Controlling Site Access.

ID	Response
1	Typically through traffic controls and parking regulations (one of the best tools); determine where parking should be restricted; crossing guards might allow left turns and how they operate site (children and vehicles)
2	Number of driveways, their location and placement on streets; high schools may warrant signals (need primarily for AM peak period)

28. Do you use standard turning templates to design for bus operation on site?

All interviewees stated they use standard turning templates (see Table 5-28).

Table 5-28. Use of Design Vehicle and Templates for Bus Operations on Site.

ID	Yes	No	Comment
1	X		Schools have different templates; use single-unit truck to approximate turning radius for standard school bus.
2	X		AutoTurn

29. Do you design sites to minimize pedestrian street crossings?

Responses are displayed in Table 5-29.

Table 5-29. Design Methods to Minimize Pedestrian Street Crossings.

ID	Response
1	Yes – minimize street crossing and driveway crossings once on school property
2	Yes – most important to restrict off-site drop-offs; design dictated by the location (parcel and structure orientation) of the campus; access to school is also a factor; only allow crossings at intersections and control this by traffic control devices or crossing guards

30. How do you mitigate pedestrian conflicts on-site with access circulation?

The methods of mitigation which participants provided are shown in Table 5-30.

Table 5-30. Mitigation of On-Site Pedestrian Conflicts.

ID	Response
1	Use a clearly marked circular driveway with adult supervisors to facilitate student entry/exit; avoid children walking between buses or other cars; use of school safety patrols to open/close doors for other children (similar to valet service); campus principal (a key ally), an active PTA, and crossing guards are keys to success
2	Use of sidewalk on the perimeter of the school site

31. Please rank the following issues you would like to see addressed (1 for most important and 10 for least important) at a half- to full-day symposium with other architects, engineers, school officials, and other stakeholders regarding transportation-related school site issues.

Table 5-31 lists the topics which the interview participants ranked. Table 5-32 organizes the ratings provided by the participants, the total sum of those ratings, and the final rank of each topic based on that sum. Comments made by participants are displayed in Table 5-33.

Table 5-31. Potential Topics for School Safety Symposium (Consulting Engineers).

Topic	Description
A	Coordination between designers, schools, and state and city transportation departments
B	Pedestrian and bicycle access/safety
C	Design and operation of drop-off and pick-up zones
D	Traffic impact analysis (volumes, modal estimation)
E	Design and operation of parking facilities
F	Retrofit options (design & operations) for schools with existing transportation problems
G	School site selection criteria
H	Safe Routes to School (recently passed Matthew Brown Act in the Texas legislature)
I	Signing, marking, and other traffic control issues for roadways around the school site
J	Special event (i.e., athletic games, after-school meetings, etc.) traffic issues

Table 5-32. Symposium Topic Ratings from Interview Participants.

Topic	Respondent		Total	Rank
	1	2		
A	1	1	2	1
B	1	5	6	4
C	1	1	2	1
D	5	2	7	8
E	2	4	6	4
F	1	5	6	4
G	5	2	7	8
H	1	2	3	3
I	1	5	6	4
J	5	3	8	10

Table 5-33. Additional Symposium-Related Comments.

ID	Response
1	None
2	Discussion on school zones (location, length, and times) is important. • How are they defined? • What problems arise between governments, engineers, and public? • Place zones immediately adjacent to school or where students travel? Other issues of concern are grouped educational facilities and staggered start times.

KEY FINDINGS

The following list presents the key findings from the consulting engineer interviews. The numbers in parentheses at the end of each finding represent the question number where additional information can be found in the section where responses to individual questions are summarized.

- The integration of traffic circulation with the building's location and orientation is very important, but consulting engineers are typically brought late into the design process if at all. Engineers may be called upon after construction to devise solutions to access and circulation problems (Q3 and Q8).

- Student drop-off and pick-up was the most important factor in planning vehicle circulation to/from the school site. Both engineers noted the use of crossing guards and traffic control devices to facilitate proper vehicle movement (Q6).

- Neither engineer suggested that they design the school site to accommodate peak traffic demands within the site. One noted that enough space can never be dedicated (Q9).

- Engineers were split on the use of one-way roads around school sites. One prefers the use of parking control to maximize capacity of surrounding streets, and the other has been successful at implementing short-term and permanent one-way street designations (Q10).

- The length of drop-off/pick-up zones was driven by the architect's decision to place the building and defining space functions around the site. The width of the zone is a minimum of 24 ft (7.32 m) to accommodate fire/emergency vehicles. A bypass lane may be added to the section width. Parallel parking in the zone during school hours may be permitted but not formally signed or designated as such (Q11, Q12, and Q13).

- Parent, bus, and volunteer/staff traffic is separated on the school site. Students typically access day care vans in the parent drop-off/pick-up zone, and service vehicles access the site from the bus entry/exit (Q15).

- There was no consensus on a preferred design for a bus loading zone. Parallel and multiple-lane chevron configurations were indicated (Q16).

- Design guidelines for drop-off/pick-up zones are sketches or other in-house sources. No written guidelines are used (Q17).

- Parking lot size is determined by local ordinances or a standard size the ISD has previous experience with at a similar location. Faculty/staff parking is separated from visitors and students (Q20 and Q21).

- Driveway location and design are typically controlled by applicable state and municipal laws, the separation distance between access points and nearby intersections, and school bus operations (Q24). Engineers use a variety of guidelines for driveway design including municipal requirements, *Traffic Engineers Handbook*, published guidelines from the Institute of Transportation Engineers, and good common practice (Q25).

- Turn bays into the school site are frequently designed by the consulting engineers. Problems may arise with narrow street widths in accommodating the necessary design requirements for left-turn bays (Q26).

- Engineers do use turning templates to design for bus operations on-site. The templates may be commercially available (e.g., AutoTurn) or available from the school district. Single-unit trucks are used as surrogate design vehicles for the standard school bus (Q28).

- Regarding pedestrian street crossings, engineers design to restrict and minimize crossings at intersections and driveways on the school site (Q29). Pedestrian conflicts are mitigated through the use of a perimeter sidewalk and clearly marked driveways. Adult supervisors or school safety patrols can facilitate student entry/exit (Q30).

- The three most important issues to the consulting engineer participants for a symposium with other architects, engineers, school officials, and stakeholders regarding transportation-related school site issues were (Q31):

    - coordination between designers, schools, and state and city transportation departments;
    - design and operation of drop-off and pick-up zones; and
    - Safe Routes to Schools (recently passed Matthew Brown Act in the Texas legislature).

CHAPTER 6. TxDOT AND MUNICIPALITY SURVEYS

BACKGROUND

Recent trends include considerable increases in population, higher proportion of children being transported to and from schools in automobiles, and the location of schools near high-speed facilities. These realities, and many of the other issues associated with traffic around schools, make it important to aggressively consider the design of roadways within and around schools to ensure the safest possible traffic environment. Equally important is the consideration of the location and design of the school site, preferably during the planning stages, in order to establish safe and efficient operations. Within a Texas Department of Transportation research project, the Texas Transportation Institute (TTI) is developing guidelines and examples on designs and operations that would improve safety and reduce congestion.

To assist with the development of the guidelines, a mail-out survey was conducted of TxDOT districts and Texas cities. In the survey, we requested their help in gaining a better understanding of how school site plans are developed or reviewed, and in identifying good (and not-so-good) examples for the design and operation of roadway and parking facilities within and around schools. We asked that they provide the survey to the person in the district or city that reviews school site plans. The survey was mailed to the 25 TxDOT districts and to 24 Texas cities.

ORGANIZATION

This chapter summarizes the findings from the mail-out survey. The remaining sections cover the following:

- State Responses – lists the responses, by question, from those who work for TxDOT;
- City Responses – lists the responses, by question, from those who work for cities; and
- Key Findings – summarizes the findings from the surveys.

STATE RESPONSES

Twenty-four responses representing 18 districts were received from the mail-out survey sent to the TxDOT districts. The surveys yielded the following results.

1. Have you reviewed a school site plan in the past 6 months?

- Yes – 10
  - If yes, how frequent?
    - Once – 3
    - Twice – 1
    - Three or more – 6
- No – 13
- No response – 2

2. Has your district participated in any of the following with respect to a school site in the past year? (check all that apply)

- 16 (67%) assisting with establishing a driveway location?
- 12 (50%) developing signing and marking plan for surrounding streets?
- 9 (38%) developing signing and marking plan within a school site?
- 5 (21%) establishing no parking zone?
- 7 (29%) installing a traffic signal near a school?
- 11 (46%) adjusting signal timing for a signal near a school?

3. What resources do you use when reviewing a proposed or existing school site plan?

- 10 (42%) Precious Cargo materials,
- 15 (63%) *Roadway Design Manual* (*43*),
- 22 (92%) *Manual on Uniform Traffic Control Devices* (*37*),
- 22 (92%) engineering judgment, or
- 5 (21%) other:
  - existing conditions, *AASHTO Green Book* (*14*);
  - general safety; example: school closes driveways with chain cable **–** we ask them to use construction safety fencing;
  - driveway guidelines;
  - *Traffic Operations Manual: Procedure for Establishing Speed Zones* (*44*); and/or
  - past history of performance.

4. Do you have any schools with signalized access?

- Yes – 12
  - If yes, where: 12 respondents provided suggestions
- No – 11
- No response – 1

5. **Please provide locations of schools where an issue listed below works well or doesn't work well (see Table 6-1).**

Table 6-1. Number of Locations Suggested by State Respondents.

Issue	Location that works well	Location that doesn't work well
Parking (faculty, staff, or students)	13 responses	8 responses
Pick-up area	15 responses	20 responses
Drop-off area	13 responses	12 responses
Pedestrian access	5 responses	9 responses
Bike access	4 responses	8 responses
Internal circulation	11 responses	9 responses
Overflow queue storage	6 responses	15 responses
Turn bays into school	17 responses	7 responses
Driveway location	10 responses	10 responses
Bus access	10 responses	7 responses
Crossing guards	8 responses	2 responses
Roadway crossing	3 responses	4 responses
School zone	10 responses	8 responses
Special events	4 responses	5 responses
Other:___________	No response	No response

6. **Do you have schools in your district where the operations or safety along the state highway have been discussed or investigated?**

- Yes – 19
  - If yes, please describe a sample of the locations: 49 responses provided
- No – 1
- No response – 4

7. **Do you have any additional comments or suggestions regarding roadway and parking facilities around schools?**

- Traffic studies should be required early. TxDOT should be involved in review of parking and traffic patterns on school property. Architects are more interested in buildings than in traffic operations. School districts need to involve TxDOT a minimum of two years prior to opening date of the school! When TxDOT is not contacted early and traffic problems result, the public's perception is the school is the "victim" and the state is the "problem" – when it is actually the opposite.

  Schools should not be located on or adjacent to FM or state highways, especially if they are high speed (55 mph [88.55 km/h] or above). School districts should approach TxDOT with their plans in advance (two years) before school opening, to enable TxDOT to make adjustments to the State's transportation facilities.

Any proposed school site should not have direct driveway access from the State transportation facility, but rather have access from a collector road or roads within the school site.

All access from schools to State facilities should be minimized. By serving on a school board for nine years, experience says that access is the school district's lowest priority. Number one is the cost of available land and number two is location (does it fall within the student demand area). School districts typically contact TxDOT within 60 days of a campus opening as construction is almost complete.

When TxDOT has tried to assist a school in a new location and with access issues, our recommendations are not taken. The schools have taken the attitude from these meetings that they are now aware of the possible problems, and it is TxDOT's responsibility to correct them.

- When queues of vehicles park along the roadways, we normally propose that the school expand the school site parking. We do not normally make roadway improvement to encourage parking off school property.

- Coordination needs to happen as early as possible in the school site planning stage. Location is often considered after the estimated cost of the future site.

- Schools need to consider traffic impacts before buying property.

- Establish coordination with school district during early planning stages so that traffic issues can be recognized and resolved before construction begins.

- Most believe that a traffic signal is the best answer to their problems. Many times this belief stems from seeing other schools receive a signal.

- Most of the schools in our district, if not all, do not abut the highway system. That is, they abut existing streets and roads. Therefore, most of our concentration has been dealing with improving intersection capacity.

- I think TxDOT in recent review at a local elementary school was more concerned with what enhancements might need to be made on a TxDOT district-wide basis if a flashing light was added to a crosswalk sign. I think MUTCD represents a minimum of signing and does not preclude TxDOT from adding to it on a case-by-case basis. FYI, I am also on this school's ISD School Board.

- In my opinion, schools should be allowed only on low-speed local roadways, not on or adjacent to high-speed, high average daily traffic (ADT) highways.

- Need guidelines for traffic and pedestrians design in and around schools. PR info – good in Precious Cargo data, but little or no info on design guidelines. Guidelines needed for: school speed zone criteria, pedestrian crossings, driveway, drop-off and pick-up zones.

Many of the local cities are great examples of what not to do. If we go talk to schools we need good examples to suggest.

- Not at present time.

- How do we keep them from moving out of town and building on 70 mph (113 km/h) highways?

- We as a department understand highway operations. School operations are a different issue. I hope the results of this help us gain a better understanding so that we can assist architects and schools study their parking and circulation issues.

- We do need guidelines/best practices so we can work more effectively with schools.

- Schools that locate their parking and drop-off/pick-up area away from the highways with adequate storage for queues seem to function better.

- We are redesigning SH-19 in Sulphur Springs from two lanes and shoulders to a five-lane curb and gutter section. Also to have turn out lanes to help at Early Learning Center. Will assist school by channelizing driveway with islands. In return, school will allow elimination of school zone on SH-19.

- Need to ensure adequate throat length to drop-off and pick-up areas. Also adequate off-street parking for special events.

8. Would you like to receive a copy of the survey results?

- Yes – 20
- No – 2
- No response – 2

CITY RESPONSES

Nine city responses were received. The results are listed below.

1. Has your city participated in any of the following with respect to a school site? (check all that apply)

- 5 (56%) designing a school site (e.g., deciding on how large the parking lots will be, etc.)?
- 8 (89%) assisting with driveway locations?
- 9 (100%) developing signing and marking plan for surrounding streets?
- 4 (44%) developing signing and marking plan within a school site?
- 8 (89%) reviewing a school site plan?
- 9 (100%) establishing no parking zone?

- 9 (100%) installing a traffic signal near a school?
- 8 (89%) adjusting signal timing for a signal near a school?

2. Does your city require:

- 4 (44%) traffic impact analysis?
- 8 (89%) submission of a site plan before construction?
- 1 (11%) public involvement?

3. Does your city have a permit process (ordinance)?

- Yes – 7
  - If yes, please attach a copy: 2 responses
- No – 1
- No response – 1

4. Does your city require that the driveway to the school be a minimum distance from an intersection?

- Yes – 8
  - If yes, what is the distance?
    - 30 ft (9.15 m),
    - 100 ft (30.5 m),
    - 10 (3.05 m),
    - 50 (15.25 m),
    - 50 ft (15.25 m),
    - engineering design depends on the site, or
    - varies according to driveway ordinance.
- No – 1

5. What resources do you use when reviewing a school site plan?

- 6 (67%) city developed guidelines (please provide or identify method for obtaining a copy),
- 0 (0%) state developed guidelines (please provide or identify method for obtaining a copy),
- 8 (89%) *Manual on Uniform Traffic Control Devices* (*37*),
- 3 (33%) consultant,
- 8 (89%) engineering judgment, or
- 0 (0%) other: ____.

6. Does your city's development plan provide an area for future school sites?

- Yes – 1
- No – 7

- No response – 1

7. Does your city require school driveways or access points to be in alignment with existing or proposed streets? Why?

- Yes – 5
  - If it would provide a more safe entrance, it is required.
  - When on-site conditions require, alignment with roadways is encouraged for traffic control purposes, simplifying ingress and egress.
  - Driveways must be aligned or offset by variable distance (depending upon roadway classification).
  - Ordinance and good engineering practice.
  - Eliminate left-turn “hooking.”

- No – 7
  - In the development process (building permits, etc.) schools are treated like other development. We don’t have requirements for development that address driveway alignment.
  - Streets must offset each other a minimum distance of 125 ft (38 m). Driveways are governed by the driveway ordinance.

- No Response – 1
  - We do not “require,” however, where it makes sense we “strongly encourage.”

8. Do you have any schools with signalized access?

- Yes – 4
  - If yes, where: 3 respondents provided suggestions.
- No – 5

9. Please provide locations of schools where an issue listed below works well or doesn't work well (see Table 6-2).

Table 6-2. Number of Locations Suggested by City Respondents.

Issue	Location that works well	Location that doesn't work well
Parking (faculty, staff, or students)	6 locations	5 locations
Pick-up area	7 locations	6 locations
Drop-off area	7 locations	6 locations
Pedestrian access	5 locations	3 locations
Bike access	3 locations	2 locations
Bus access	3 locations	3 locations
Internal circulation	3 locations	3 locations
Overflow queue storage	3 locations	4 locations
Turn bays into school	1 location	3 locations
Driveway location	4 locations	4 locations
Crossing guards	5 locations	5 locations
Roadway crossing	2 locations	2 locations
School zone	2 locations	3 locations
Special events	1 location	1 location
Other:_______	No response	No response

10. Do you have schools in your city where the operations or safety along a major roadway have been discussed or investigated?

- Yes – 7
  - If yes, please describe a sample of the locations: 3 suggestions provided.
- No – 1
- No response – 1

11. Do you have any additional comments or suggestions regarding roadway and parking facilities around schools?

- Most difficulties arise when older, urban school sites are updated or upgraded. Existing on-site conditions and adjacent roadway geometrics can at times be challenging.

- Elementary schools that are neighborhood-only are no longer practical. Therefore, they should not be located in the midst of a residential neighborhood but on at least a collective level of street.

- A lot of schools request one way. As a solution to their congestion, one experience proved it does not solve congestion by restricting parking, which is only supported by the principal 10% of the time, since parking is at a premium, it is a two-edged sword.

12. Would you like to receive a copy of the survey results?

Yes – 8 No – 1

KEY FINDINGS

Key findings from the 24 TxDOT district and nine city respondents to the mail-out survey include the following:

- About half of the state respondents have reviewed a school site plan in the past 6 months.
- About half of the state and city respondents have a school in their area with a signalized access.
- The areas that most districts have been involved in with respect to a school site are establishing driveway location (67 percent) and developing signing and marking plans for surrounding streets (50 percent). Cities' respondents are more actively involved with schools and participate in developing signing and marking plans for surrounding streets (100 percent), establishing a no parking zone (100 percent), installing a traffic signal near a school (100 percent), reviewing a school site plan (89 percent), adjusting signal timing for a signal near a school (89 percent), assisting with driveway locations (89 percent), and designing a school site (56 percent).
- Eight of the nine city respondents (89 percent) require submission of a site plan before construction. Only four cities (44 percent) require a traffic impact analysis.
- The city respondents stated that the distance a (school) driveway must be from an intersection ranged from 10 ft (3.1 m) to 100 ft (31 m).
- When reviewing a plan, the districts and cities are overwhelmingly using the *Manual on Uniform Traffic Control Devices* (*37*) and engineering judgment (each were about 90 percent). The majority of the districts are also using the *Roadway Design Manual* (*43*) (63 percent), and the cities are using city developed guidelines (67 percent).
- Only one of the nine city respondents indicated that their city's development plan provides an area for future school sites.
- Slightly more than half of the city respondents stated that their city requires school driveways or access points to be in alignment with existing or proposed streets.
- Several state respondents indicated that TxDOT needs to be involved very early in the school site planning process. ("When TxDOT is not contacted early and traffic problems result, the public's perception is the school is the "victim" and the state is the "problem" when it is actually the opposite.") Several respondents commented on the need for guidelines for traffic and pedestrian designs in and around schools.

- Comments made by city respondents included the challenges with upgrading urban schools, practicality of where school can be located, and the frequency of requests for one-way operations.

Both state and city participants listed several suggestions on sites that work well and sites that do not work well.

CHAPTER 7. OBSERVATIONAL CASE STUDIES AT SCHOOL CAMPUSES

In order to gain a better understanding of good and inadequate examples of school site design, the research team conducted a number of preliminary observations studies at school facilities throughout the state. Studies were conducted at a total of 14 school sites covering 15 schools (one site had two schools). The schools were either classified as elementary, middle, or high school. Elementary schools typically ranged from pre-kindergarten or kindergarten to 5th grade. The high schools covered the typical range of 9th to 12th grades. The remaining category, middle school, represented all the schools that were not classified as elementary or high school. Characteristics of the schools studied are listed in Table 7-1.

Table 7-1. General Characteristics of Schools Where Observations Studies Were Performed.

School	Site #	Students	Faculty/Staff	Num Buses	% Buses	% Auto	% Walk	% Bike
Elementary	1	582	55	6	49	49	1	1
	2	663	55	6	55	45	0	0
	3	1070	123	Not available				
	4	551	72	6	73	23	1	1
	5	910	90	13	85	14	1	0
	6	1090	101	13	90	8	2	0
	7	400	50	5	27	45	18	9
Middle School	1	600 750	80 60	24	75	25	0	0
	2	1225	100	19	75	20	5	1
	3	650	66	14	35	30	20	10
	4	585	52	16	41	46	6	7
	5	840	90	12	42	56	2	0
High School	1	1900	187	Not available				
	2	3100	200	51	50	50	1	0

During the initial contacts of the school districts and principals, several concerns were expressed regarding the research study. These concerns included how the data would be used, whether we could photograph or videotape operations at the school, and privacy rights of the students. In one example, the school requested that the researchers obtain signatures from all parents before recording any activities around the school, an approach that would obviously have great impacts on our ability to document "normal" operations. The school revised their request upon receiving additional information on the intent of the research study. At the opposite extreme, the research team was encouraged to observe even additional schools in the district. In consideration for the privacy concerns, the names of the schools have been removed from this report.

Before each observation study, the research team obtained permission by the school principal and by the school district assistant superintendent (when requested by the principal). At several locations, the principals along with research team members had to respond to questions regarding the research team's activities and purpose at the school.

STUDY METHODOLOGY

Another objective of the observational case studies was to test and evaluate different data collection procedures in order to optimize efforts in the second-year field studies. Each method began with a request for the principal to provide an overview of the traffic conditions at the site. Figure 7-1 shows a copy of the form sent to the school. In addition to the information requested on the form, researchers met with the principal to discuss how the observation study will be conducted, which days the researchers would be present, the general operations (both vehicular and pedestrians) at the school, and to request a copy of the site plan.

At most schools, the observational study required only one day. In a few situations, the study was spread between two or three days due to the number of driveways that needed to be observed or because weather conditions limited when the observations could be made. In general the research team would arrive approximately 1 hour prior to the start time of the drop-off or pick-up periods. Observations were made of the drop-off/pick-up performance using one of three techniques: manual data collection, video, or laptop computers. Table 7-2 lists the key characteristics of the techniques.

Table 7-2. Data Collection Techniques Used in Observational Studies.

Technique*	General Characteristics
Manual	• Stop watches • Paper and pencil • Manual recording of arrivals and departure times
Video	• Video supplements manual technique • Video cameras aimed at driveways
Laptop Computers	• Travel time software • Laptop computers
*Note: All techniques also included recording site conditions using photographs, observations, and sketches.	

Manual Data Collection

In the manual data collection process, researchers record the time and type of vehicle entering and exiting the school site on the *4286 Drop-Off/Pick-Up Arrival Form* (see Figure 7-2). One data collector is stationed at the entrance driveway and another at the exit driveway to the main parent zone with synchronized stopwatches. Each person recorded all vehicles by description (make and model) and their corresponding arrival/departure time (hour/minute/second). The data from the forms would then be used to calculate the average service time (i.e., the average amount of time a vehicle takes to travel through the entire loading zone) during both the morning and afternoon periods.

Observational School Study Advanced Information Form

School Name:

School Type: ❑ Elementary ❑ Middle ❑ High

The speed limit in the school zone is: _____MPH during school hours, _____MPH other times

What are the school hours: _____________ AM to ________________ PM

Number of faculty/staff: _______________ Is parking a concern? ❑ Yes ❑ No

Does faculty/staff arrive at the same time as the students? ❑ Yes ❑ No

How many buses serve the school? __________ Estimated number of passengers: __________

Does bus loading happen in a facility separate from other vehicles? ❑ Yes ❑ No

Student population: Existing _________ Maximum __________

Do students walk to and from school? ❑ Yes ❑ No

Are there established walking paths (sidewalks)? ❑ Yes ❑ No

	Bus	Car	Walking	Bicycle
Estimated percentage of students arriving by				

Describe the existing traffic pattern in the parent/child loading zone (attach diagram if necessary).

Provide a brief opinion on the existing traffic conditions (problem areas, issues, etc.)

Figure 7-1. Advanced Information Form for Observational School Studies.

Video Cameras

Video cameras were used at several locations and were typically set up across the school campus. The cameras would focus on the driveways accessing the school and were used to capture vehicles arriving and departing the school site. When students started regularly arriving at the school, the two researchers would record vehicle information (make, model, color) and the time the vehicle arrived or departed the school on the *4286 Drop-Off/Pick-Up Arrival Form* (see Figure 7-2). The driveway video and the *4286 Drop-Off/Pick-Up Arrival Form* were later reduced in the office to determine service time at the parent drop-off/pick-up zones. Additionally, the video was used to verify and document traffic operations observed in the field.

Drop-Off/Pick-Up Arrival Form				
School:			**Data Collector:**	
Study Date:			**Start/End Times:**	
Vehicle Number	**Vehicle Description**			**Time of Arrival/Departure at School Driveway (Hr/Min/Sec)**
	Make	**Model**	**Color Code**	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Etc.				

Figure 7-2. Drop-Off/Pick-Up Arrival Form.

Laptop Computers

The laptop computer approach for collecting service time used a travel time software program installed on laptop computers. One staff member would be stationed at the entrance driveway of the parent drop-off zone and another at the exit driveway of the parent drop-off zone. Each staff member had a laptop computer with the necessary software. The software records entrance and exit times of vehicles when the staff member types the first three digits/letters of the license plates. A description of the cars entering and exiting the parking lot could also be recorded and used by the research team as time permitted. In some situations, the flow of traffic was sufficient to prevent recording any additional data. After the field studies, staff would match the entrance and exit data. For entries that did not have a match for the first three digits/letters of the license plate, researchers used the description to obtain the match. After pairing the vehicle entries, a spreadsheet was used to calculate the amount of time the vehicles took to travel through the drop-off or pick-up zones.

Site Conditions

Between the morning drop-off and the afternoon pick-up periods, members of the research team observed and took photographs of operations and existing conditions on adjacent roadways, at the school driveways, sidewalks, parent drop-off zones, bus drop-off zone, and all parking lots. Observation information was recorded on the *4286 Site Observations Sheets* (see Figures 7-3 and 7-4). At some of the schools, members of the research team were able to photograph during the drop-off or pick-up periods. Photographs of this time period were only taken if the school indicated they were comfortable with the research team taking pictures when students were present. Specific tasks included the following:

- Take pictures of site with camera.
- Document the signs and markings in and adjacent to the school site.
- Document prominent school site features and observations.
- Draw sketch of school site noting the following items:
  - signs,
  - markings,
  - use of barrels/cones or other traffic control devices for channelization purposes,
  - turn bays (including length and taper),
  - number of lanes on surrounding streets,
  - driveway locations,
  - turn restrictions (by time of day),
  - distance between driveways and cross streets,
  - nearest intersections (signalized?),
  - drop-off zones (buses and cars),
  - pick-up zones (buses and cars), and
  - entrance to school (in relation to drop-off/pick-up zones).

Site Observations Sheet (page 1)					
School:					
Study Date:					
Traffic Control on School Site					
	Yes	**No**	**Describe (if yes)**		
Parents assisting drop-off/pick-up					
Teacher/staff assisting drop-off/pick-up					
Students assisting drop-off/pick-up					
Barrels/cones					
Turn restrictions (from site)					
Drop-Off/Pick-Up Zone Observations					
	Yes	**No**	**Describe**		
Buses separate from vehicles?					
	1	**2**	**3**	**Total Width (ft)**	**Total Length (ft)**
# of lanes in bus drop-off/pick-up zone					
# of lanes in car drop-off/pick-up zone					
	Start	**End**	**Comments**		
Morning congestions during drop-off period (please note if queue goes off of site onto adjacent roadways)					
Afternoon congestion during pick-up period (please note if queue goes off of the site onto adjacent roadways)					
Morning queue length (est.)					
Afternoon queue length (est.)					

Figure 7-3. Site Observations Sheet (page 1).

Site Observations Sheet (page 2)

Information on Surrounding Streets

Street Name	# of Lanes	Speed Limit		Turn Bays	
		School Zone	Normal	Direction	Length

	Distance from the school	Type of traffic control (stop, signal, etc.)
Nearest intersection		

Parking Information

	total # of spaces	# of unused spaces	Describe location
Faculty/staff			
Bus			
Visitors			
Student (if at a high school)			

Pedestrian and Bicycle Information

	Marked	Crossing Guard	Estimated Pedestrian Usage		
			Low (0-50)	Med (50-100)	High (100+)
Crosswalks					

	Bike Racks		Estimated # of Bicycles		
	Yes	No	Low (0-50)	Med (50-100)	High (100+)
Bicycles					

Overall Safety Assessment and Other Comments

Figure 7-4. Site Observations Sheet (page 2).

ELEMENTARY SCHOOL, CASE STUDY SITE 1

Background

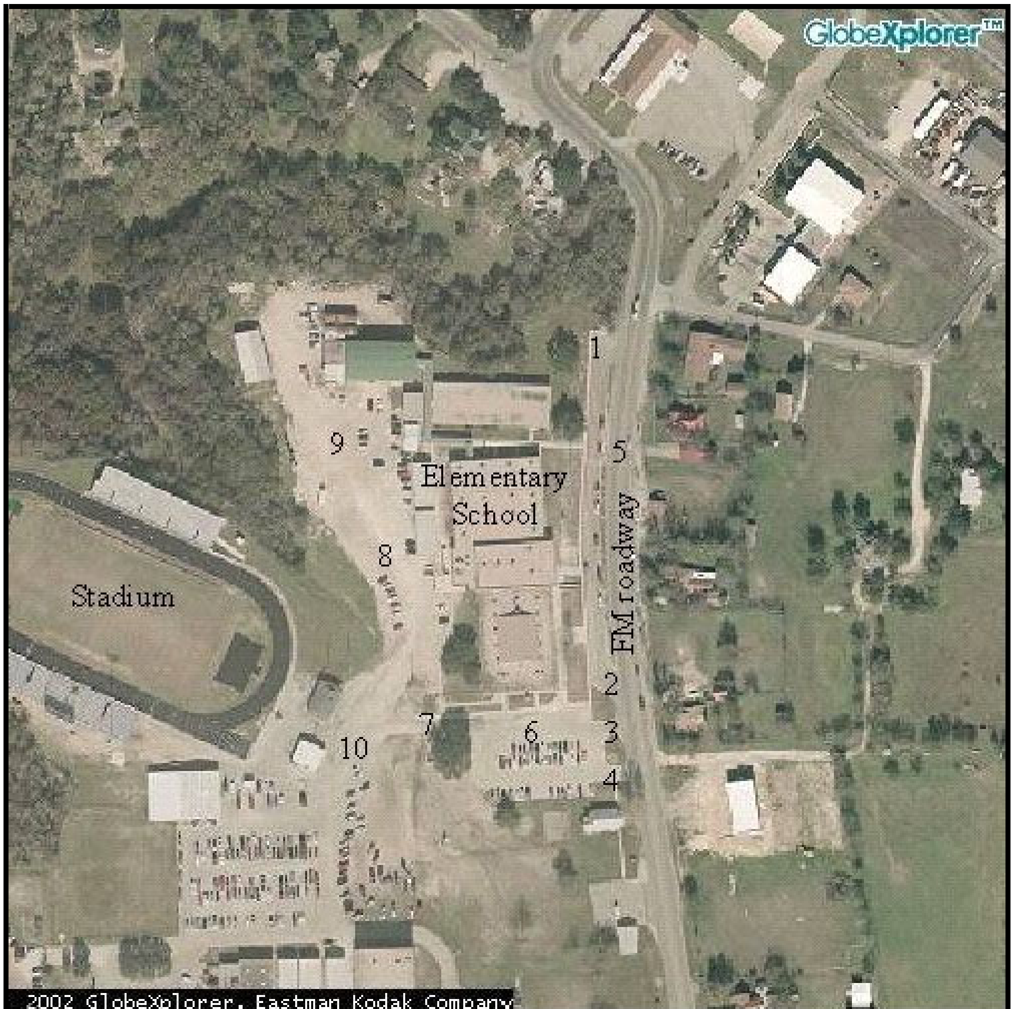
A case study was conducted at an elementary school campus located in a suburb. This school is one of the three existing elementary campuses within a rapidly growing school district. Five hundred and eighty-two students were enrolled at the time of the study. Fifty-five faculty and staff are employed at the school and arrive before the students. According to the school, approximately 49 percent of students use the six buses serving the school. Forty-nine percent of the students arrive by automobile, 1 percent walk, and 1 percent bicycle to school. The normal school hours are from 8:00 a.m. to 3:00 p.m. TTI staff conducted the traffic observation study on April 25, 2002, with clear weather conditions. A manual data collection technique was used to count traffic entering and exiting the school site and to calculate the average service time (i.e., the average amount of time a vehicle takes to travel through the entire loading zone) during both the morning and afternoon periods (see Table 7-2).

Field Observations

Four driveways from the adjacent roadway provided access to the school site (Figure 7-5 – north at top). The northernmost driveway, Driveway 1, is the entrance to the parent drop-off/pick-up zone. Driveway 2 is the exit from the parent drop-off/pick-up zone. Driveway 3 is the entrance to the faculty parking lot and is also used by buses to access the bus loading zone located in the rear of the school building. Driveway 4 is the exit from the faculty parking lot; however, buses do not use it to exit the site. All buses exit the site via an internal roadway through an adjacent school campus that used to be a high school but is now being converted to a middle school.

This school has one faculty parking lot located on the south side of the school building and additional parking in the rear of the school and adjacent to the stadium (Figure 7-5). A two-way roadway from the front to the rear of the school site connects these two areas.

The roadway adjacent to the school site is a two-lane rural farm-to-market facility with 4 ft (1.2 m) shoulders. There is a two-way center left-turn lane that provides access to Driveways 3 and 4 and the business (Texaco gas station) located across the street. The turn lane ends just north of Driveway 2 and the cross section returns to only two lanes. There are no turn lanes into Driveway 1, the entrance to the parent drop-off/pick-up zone. The section of roadway directly in front of the school is designated as a school zone with a speed limit of 20 mph (32.2 km/h) during morning drop-off and afternoon pick-up periods (Figure 7-6). The normal speed on the facility is 30 mph (48.3 km/h).



1	Driveway 1 – entrance to parent drop-off/pick-up zone
2	Driveway 2 – exit from parent drop-off/pick-up zone
3	Driveway 3 – entrance for buses and faculty parking lot
4	Driveway 4 – exit from faculty parking lot
5	Marked crosswalk across FM roadway
6	Faculty parking lot and secondary parent drop-off/pick-up zone
7	Two-way roadway from faculty parking to stadium parking and bus loading zone
8	Bus loading zone
9	Auxiliary parking for faculty and staff
10	Bus exit

Figure 7-5. Elementary School, Case Study Site 1 (Base Aerial Photograph Is from GlobeXplorer (*45*)).

Morning Drop-Off Period

An adult supervisor was stationed near the main school entrance at 7:30 a.m. At approximately the same time, a crossing guard was stationed at the marked crosswalk and used a stop paddle to assist a small amount of pedestrians (less than 15) across the FM roadway. The adult supervisor in the parent drop-off zone supervised five fifth graders that served as Courtesy Patrol volunteers. These students, selected on the basis of good citizenship and grades, wore orange reflective vests and helped open the passenger doors of vehicles in the drop-off zone (Figure 7-7).

Figure 7-6. School Zone on Northbound Approach.

Figure 7-7. Courtesy Patrol Assisting during AM Drop-Off Period.

The bus and parent loading zones and access driveways are completely separated at this elementary school. Figure 7-8 provides a diagram of the overall layout of the school site with pertinent features labeled. Six full-size buses load students in the rear of the school (Figure 7-9), and enter the site via the driveway to the faculty parking area, and exit onto the FM roadway using an alternate exit. The parent lane is located in front of the school, in very close proximity to the FM roadway (only separated by 6 ft [1.8 m] raised median). The parent lane is almost 500 ft (152.5 m) long and 28 ft (8.5 m) wide (Figure 7-10). In the morning, it operates as a one-lane facility with two separate drop-off zones: one designated for kindergarten students, about one-third of the lane past the entrance, and for all other students, the remaining 2/3 of the lane, to provide access directly into the main entrance.

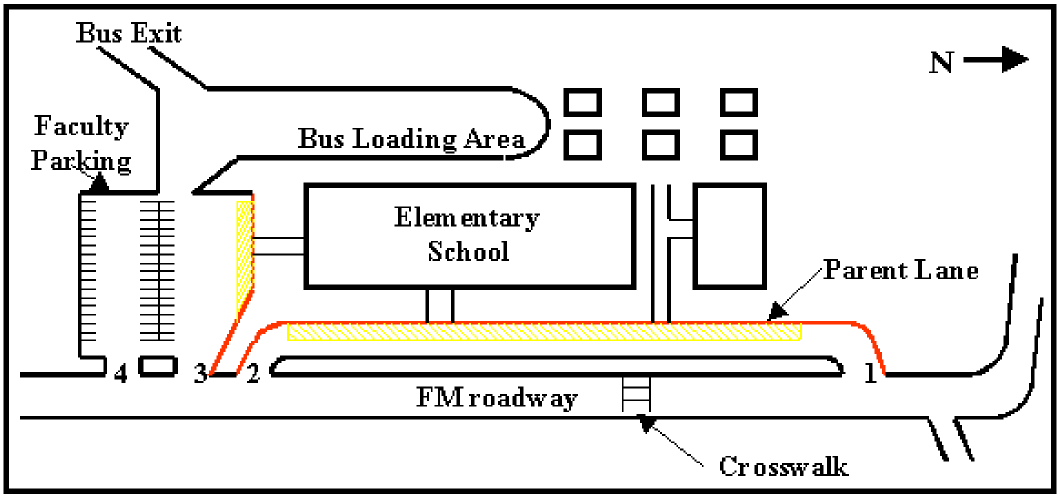


Figure 7-8. Elementary School Site Layout.

Figure 7-9. Buses Staged in Rear of Elementary for Afternoon Pick-Up Period.

Figure 7-10. Looking North at the Parent Drop-Off/Pick-Up Zone.

Traffic in the parent lane was congested between 7:53 and 8:06 a.m. The queue of vehicles in the drop-off zone backed up to the entrance driveway several times, but not out onto the FM roadway. There was substantial congestion on the FM roadway between 7:30 and 8:15 a.m. A number of parents, estimated as approximately 15 percent of the total traffic, used the faculty parking lot as a secondary drop-off zone (Figure 7-11). The most buildup occurred in the vicinity of the parent lane exit/faculty parking entrance driveways. School officials indicated that it typically backs up more than what occurred on May 17. Between 7:45–8:00 a.m., 56 vehicles unloaded students in the parent zone (under a four minute average service time). An additional 30 cars unloaded students after the first bell. The research team estimated that approximately 100 vehicles utilized the parent zone. Only one car was observed unloading a child on the northbound side of the FM roadway across from the school site.

Figure 7-11. Secondary Drop-Off/Pick-Up Zone on South Side of School.

Afternoon Pick-Up Period

TTI staff arrived at the school at 2:30 p.m., approximately 30 minutes prior to the release of students. By 2:45 p.m. the entire length of the parent lane was occupied with queued vehicles (Figure 7-12). The afternoon pick-up periods were more hectic than in the morning. Several teachers were spread out throughout the length of the pick-up zone; however, no students were involved as in the morning.

Researchers observed a few parents parked on the shoulders of the FM roadway instead of in the parent drop-off/pick-up zone to pick up students. A large number of children, accompanied by four adults, used the crosswalk across the FM roadway to go to an after school day care center that is located within walking distance. Approximately 30 parents utilized the side pick-up zone in the teacher parking lot. Two small buses and one van also used the side pick-up zone. The main loading zone in front of the school processed 62 vehicles in under 15 minutes (the campus was basically cleared out by 3:15 p.m.). Vehicles queued back from the parent lane onto the FM roadway approximately 150 ft (46 m) off of the site. The congestion on the FM roadway was not as extensive as during the morning observational study.

Figure 7-12. Pick-Up Zone Full of Vehicles 15 Minutes Prior to Afternoon Dismissal.

Other Observations

- Most of the on-site signing and marking was consistent with accepted MUTCD standards.
- The major problem at this site was the close proximity to the FM roadway that creates a relatively short space (475 ft [145 m]) for the parent drop-off/pick-up zone.
- Other challenges at this site are the lack of a turn lane from the FM roadway into the parent lane and the close proximity of the parent loop exit to the teacher parking entrance driveways (only 50 ft [15 m] apart).
- One positive element was the use of students during the morning drop-off periods that seemed to help increase the efficiency by reducing the amount of time for vehicles to unload children.

ELEMENTARY SCHOOL, CASE STUDY SITE 2

Background

Elementary case study site 2 was conducted at an elementary school campus in a north Texas suburb. Six hundred and sixty-three students were enrolled at this campus during the 2001-02 school year. According to the school principal, the school design can accommodate a maximum of 690 students. Fifty-five faculty and staff are employed at the school and arrive before the students. The school principal indicated that approximately 55 percent of students use the six buses serving the school. Forty-five percent of the students arrive by automobile and no students regularly walk or ride a bicycle to school. The normal school hours are from 8:00 a.m. to 3:00 p.m. A traffic observation study was conducted on May 9, 2002, with clear weather conditions. A manual data collection technique (see Table 7-2) was used to count traffic entering and exiting the school site and also to estimate average service times.

Field Observations

Three driveways provide access to the school site from an FM roadway (see Figure 7-13 – north is at top of figure). Driveway 1, the southernmost driveway, is the entrance to the parent zone and a visitor/staff parking lot. Driveway 2 is the exit from the parent drop-off/pick-up zone and parking lot. Driveway 3 is the entrance to the bus loading zone located in the rear of the school building and an auxiliary parking lot. This elementary has one faculty parking lot located on the northwest side of the school building and additional parking in the rear adjacent to a new municipal park (Figure 7-13). These parking areas are separated.

The bus-only drop-off/pick-up zone is located directly in back of the school building. The parent drop-off/pick-up zone is located in front of the school and is separated by a raised concrete median from the front visitor/staff parking lot. The three-lane-wide (40 ft [12 m]) parent drop-off/pick-up zone operates as one-way in the counterclockwise direction. Figure 7-14 illustrates the parent drop-off/pick-up zone.

The FM roadway, a two-lane undivided suburban arterial, connects to the school site. This facility accesses a number of residential neighborhoods, which allows commuters to access freeways connecting to the nearby city. The section of the FM roadway on the west of the school site is a school zone and has a speed limit of 25 mph (40.25 km/h) during morning drop-off and afternoon pick-up periods (Figure 7-15). The normal speed limit on this facility is 45 mph (73 km/h). There are no turn lanes for any of the school driveways.

Morning Drop-Off Period

TTI staff arrived at the school at 7:00 a.m., approximately one hour prior to the beginning of school. A crossing guard was stationed at an on-site crosswalk beginning at 7:15 a.m. This crosswalk extends across the parent drop-off/pick-up zone from the raised median. Orange traffic cones placed on the raised median near the crosswalk remind students to stand back and wait in line until the crossing guard directs them across (see Figure 7-14). Researchers observed no other personnel (staff, parent, or student) assisting with the morning drop off.

1	Driveway 1 – entrance to parent loop and visitor/staff parking lot
2	Driveway 2 – exit from parent loop and visitor/staff parking lot
3	Driveway 3 – entrance/exit to bus zone and auxiliary parking lot
4	Visitor/staff parking lot and secondary drop-off/pick-up zone
5	Primary parent drop-off/pick-up zone
6	Bus loading zone
7	Auxiliary parking lot
8	Fire lane/emergency vehicle access for the rear of the school

Figure 7-13. Elementary School Case Study Site 2 (Base Aerial Photograph Is from North Central Texas Council of Governments (*46*)).

The bus zone, parent zones, and access driveways are completely separated at this elementary site. Buses unload students in back of the school and enter and exit the site at the northernmost driveway from the FM roadway. The parent loop is located in front of the school. Figure 7-16 provides a picture of how the parent zone operates during the morning drop-off period. The parent zone operates as three lanes; unloading occurs along both the right curb (students able to go directly into the main entrance) and raised median on the left (students file towards the on-site crosswalk and wait for direction from the crossing guard). The middle lane is reserved for through traffic.

Figure 7-14. Parent Drop-Off/Pick-Up Zone.

Figure 7-15. Beginning of the School Zone on Northbound Approach of the FM Roadway.

Figure 7-16. Parent Zone during Morning Drop-Off Period.

Heavy traffic in the parent loop occurred between 7:40 and 8:05 a.m. The queue of vehicles in the drop-off zone backed up several times all the way to the entrance driveway, though not onto the FM road. Substantial queuing arose on the FM roadway adjacent to the school site especially from the nearest intersection (top right corner of Figure 7-13) which is stop controlled. The eastbound traffic backed up almost to the parent loop exit (approximately 500 ft [153 m]) several times. The westbound traffic on the FM roadway backed up across the parent loop exit on several occasions while waiting to turn left into the site. No stray pedestrians were observed wandering through the school site. Children waited and crossed in an orderly fashion at the on-site crosswalk from the raised median across the parent loop roadway. A number of parents, estimated as approximately 20 percent of the total entering traffic, used the faculty parking area as a secondary drop-off zone (vehicle in the leftmost portion of Figure 7-16 is using this area). The data collection revealed that 252 vehicles utilized the parent loop during morning drop-off period. The service time sample revealed that, on average, a vehicle was able to enter and exit the site in 2 minutes, 38 seconds (low of 1 minute, 25 seconds and high of 4 minutes, 7 seconds).

Afternoon Pick-Up Period

TTI staff arrived at the school at 2:15 p.m., approximately 45 minutes prior to the release of students. The same crossing guard was stationed at the on-site crosswalk beginning at 2:45 p.m. The orange traffic cones, now placed on the waiting area adjacent to the main school entrance, reminded students to stand back and wait in line until the crossing guard directs them across. The afternoon pick-up period is organized by grade level, with two to three teachers per grade level supervising the loading of their students at designated locations. Table 7-3 describes how the afternoon pick-up period in the parent zone is organized at this suburban elementary school site.

Table 7-3. Description of Afternoon Pick-Up Period in Parent Loop.

Grade Levels	Description of Location for Loading
Second + Fifth	Faculty parking loop – vehicles go through parking in counterclockwise fashion and load students from the raised median
Third + Fourth	Far end of parent loop – students sit in groups and wait for parent's vehicle to get up
Kindergarten + First	Near end of parent loop – students sit in groups and wait for parent's vehicle to get up

Traffic in the parent loop grew heavy between 2:45 and 3:15 p.m. The queue of vehicles in the pick-up zone never backed out of the site onto the FM roadway. The congestion and queuing on the FM roadway was not as significant as in the morning observations. The data collection revealed that 123 vehicles utilized the parent loop during afternoon pick-up period. The service time sample was much more variable than in the morning as many vehicles arrived on-site significantly before the school dismissal time. According to several teachers who were helping monitor the student loading, the congestion was not what it normally was during the afternoon pick-up period because over 100 students were not being picked up until after 4:00 p.m. because they were part of a school honor choir.

Other Observations

- Most of the on-site signing and marking is not consistent with accepted MUTCD standards.
- A sign (brown background with white text) located at the entrance driveway to the parent loop indicates that the roadway is for parent drop, visitors, and staff parking. A similar sign located at the bus driveway indicates that the roadway is for bus drop, staff parking, and service vehicles.
- The pavement markings for the pavement arrows and on-site crosswalk are almost exclusively yellow when they should be white.

ELEMENTARY SCHOOL, CASE STUDY SITE 3

Background

Case study site 3 is an elementary school located within a master planned subdivision. It is one of eight existing elementary campuses in the school district. One thousand and seventy students were enrolled at this campus during the 2001-02 school year. The design capacity of the school, which opened in 1996, is significantly less than the current enrollment according to the school principal. One hundred and twenty-three faculty and staff are employed at the school and arrive before the students. School officials did not provide any estimates of the percentage of students arriving by the different modes to their facility. The normal school hours are from 8:00 a.m. to 3:00 p.m. TTI staff performed a traffic observation study on Friday, May 17, 2002. A manual data collection technique (see Table 7-2) was used to count traffic as it entered and exited the school site and also to estimate the average service time.

Field Observations

Four driveways service the elementary school site (see Figure 7-17 – north is up). The northernmost driveway off of the minor collector, Driveway 1, is the entrance to the bus-only drop-off/pick-up zone. Driveway 2, also off of the minor collector, is the exit from the parent drop-off/pick-up zone and visitor parking. Driveway 3, off of a local street, is the entrance to the parent drop-off/pick-up zone and visitor parking. Driveway 4, also off of a local street, serves as both the bus exit and faculty parking lot entrance. Neither of the exit driveways have any turn restrictions. This campus has one faculty parking lot located on the southern side of the school building. This lot contains a total of 101 parking spaces with four reserved for the handicapped. The visitor parking is located within the parent drop-off/pick-up zone as parallel parking stalls. There are a total of 20 stalls for use by visitors.

The bus-only drop-off/pick-up zone is located directly in back of the school and operates as a one-way road in a clockwise direction. Figure 7-18 shows the bus loading zone. The parent drop-off/pick-up zone is located in front of the school and operates one-way in a counterclockwise direction. The zone has a total width of 55 ft (17 m) and includes three driving lanes and two rows of parallel parking for visitors on the left and right curbs. Figure 7-19 shows the pavement markings at the beginning of the parent zone.

1	Driveway 1 – entrance to the bus-only lane
2	Driveway 2 – exit from the parent drop-off/pick-up zone
3	Driveway 3 – entrance to the parent drop-off/pick-up zone
4	Driveway 4 – entrance to faculty parking and exit for buses
5	Primary parent drop-off/pick-up zone (parking for visitors)
6	Faculty parking lot
7	Bus loading zone
8	Neighborhood amenities center parking lot

Figure 7-17. Elementary School Case Study Site 3
(Base Aerial Photograph Is from GlobeXplorer (*45*)).

The minor collector that runs in front of the school site is a two-lane roadway with a total width of approximately 44 ft (13 m) (see Figure 7-20). The section of roadway in front of the school is designated as a school zone and has a speed limit of 20 mph (32 km/h) during morning drop-off and afternoon pick-up periods. The regulatory speed limit on the minor collector is 30 mph (48 km/h). Standard school zone signing exists in both directions on the minor collector, including School Advance signs on both sides of the roadway and a School Speed Limit sign with flashing beacons and a When Flashing plaque on both ends of the school zone. There is a marked crosswalk across the minor collector. This crosswalk connects the southeast corner of a neighborhood amenities center to a sidewalk located between Driveways 1 and 2 of the elementary school site. This crosswalk is a raised speed hump with zebra-style pavement markings (see Figure 7-21).

Figure 7-18. Bus Loading Zone in the Rear of Elementary School Site.

Figure 7-19. Pavement Markings at the Start of the Parent Drop-Off/Pick-Up Zone.

Figure 7-20. Minor Collector Roadway Directly in Front of Elementary School Case Study Site 3.

Figure 7-21. Raised Crosswalk across the Minor Collector Roadway in Front of the School.

The other roadway with access to the school site is a two-lane local street with a regulatory speed limit of 30 mph (48 km/h). There is no school zone on this roadway. There is a marked crosswalk that connects to the east side of the Driveway 3 (see Figure 7-22).

Morning Drop-Off Period

TTI staff arrived at the school at 7:00 a.m., approximately one hour prior to the start of school. A custodian was placing traffic cones in the parent drop-off zone (see Figure 7-23). The cones served two purposes: (1) block access from the parent zone to the faculty parking lot; and (2) block a portion of the middle lane in the drop-off zone. The parent zone operates as two lanes with unloading from the right lane (along the right curb where students are able to go directly into the main entrance) and from the left lane (into the blocked portion of the middle lane students file towards the on-site crosswalk with the crossing guards).

Two crossing guards were positioned in the parent zone to regulate vehicle flow in the left and right lanes and pedestrians in the middle lane and on-site crosswalk. Traffic in this zone was heavy between 7:35 and 8:05 a.m. The queue backed up out of the site onto the local street and then onto the minor collector. The maximum queue contained approximately 20 cars on-site, seven cars on the local street, and eight cars on the minor collector (total length estimated as approximately 650 ft [198 m]). The queue would have been worse except that some vehicles created two off-site drop-off zones: (1) the right shoulder on northbound side of the minor collector – students walk across a grass median to the on-site crosswalk; and (2) the parking lot of a neighborhood amenities center located near the crosswalk across the minor collector.

The data collection counted 245 vehicles utilizing the parent loop during morning drop-off period. The service time sample revealed that, on average, a vehicle was able to enter and exit the site in 4 minutes, 11 seconds (low of 2 minutes, 34 seconds and high of 7 minutes, 4 seconds).

Afternoon Pick-Up Period

TTI staff arrived at the school at 2:15 p.m., approximately 45 minutes prior to the release of students. The same crossing guards were stationed at the on-site crosswalk beginning at 2:45 p.m. No orange traffic cones were placed within the parent pick-up zone; however, when school let out approximately 15 staff members were present in both the parent and bus zones to monitor and help organize pick-up operations.

Figure 7-22. Looking South at the Crosswalk across the Local Street into the Parent Zone Entrance.

Figure 7-23. Traffic Cones Placed in the Parent Zone during Morning Drop-Off Period.

Traffic in the parent loop was heavy between 2:40 and 3:10 p.m. The pick-up zone operated with the middle lane as the only through lane with the inside and outside lanes for loading. Similar to the morning drop-off period, many parents were observed parking along the northbound side of the minor collector or in the neighborhood amenities center parking lot. Some got out of their cars and walked to pick up their children and others waited for their children to come to them. Eleven full-size buses and four day care vans loaded students in the rear of the school. Most of the buses were released onto the local street at the same time and blocked the entrance to the parent loop temporarily as they waited to turn onto the minor collector (see Figure 7-24).

The data collection revealed that 98 vehicles utilized the parent loop during afternoon pick-up. The service time sample was much more variable than in the morning as many vehicles arrived on-site significantly before the school dismissal time. The average service time for the sample vehicles was 10 minutes, 33 seconds (low of 5 minutes, 25 seconds and high of 22 minutes, 2 seconds).

Figure 7-24. Queue Spilling Out of Parent Zone Entrance as Buses Wait to Turn onto the Minor Collector.

Other Observations

- Most of the on-site signing and marking was found to be in compliance with accepted MUTCD standards.
- The design of the parent loop was somewhat different than most schools observed because the entrance and exit driveways were located on different streets. This configuration seemed to operate well, even during the morning when the queue backed out of the site and onto the adjacent roadways.
- The use of cones to block off access to the faculty parking and middle lane during the morning drop-off period in the parent lanes worked well, especially with the two on-site crossing guards keeping vehicle and pedestrian movements safely separated.
- The neighborhood setting of this elementary school site promoted more pedestrian access to the school; however, the bike racks in the back of the school were empty at the start of school.

ELEMENTARY SCHOOL, CASE STUDY SITE 4

Background

Elementary school case study site 4 serves kindergarten through fifth grade students in a central Texas city. It currently has an existing student population of 551 students. There are 72 faculty and staff employed at the elementary school. According to the school, approximately 73 percent of students use the six buses serving the school, 23 percent of the students arrive by automobile, 3 percent walk, and 1 percent ride a bicycle to school. The normal school hours are from 8:00 a.m. to 3:00 p.m. Researchers conducted a traffic observation study at the school on May 20 and 21, 2002. The laptop computer technique (see Table 7-2) was used to determine how many and at what times cars entered and exited the school site.

Field Observations

All entrances and exits to the elementary school access a collector road (Figures 7-25 and 7-26). This road has four travel lanes with a center turn lane in the vicinity of the school grounds. The school speed zone is 35 mph (56 km/h), and the regulatory speed zone is 55 mph (89 km/h). There are three main driveways to this elementary school: Driveway 2 is the entrance to the parent drop-off zone, Driveway 1 is the exit to the parent drop-off zone, and Driveway 3 leads to the bus parking lot located next to the bus loading zone.

Parent Drop-Off/Pick-Up Zone

Driveway 2 provides access to the parent pick-up/drop-off zone and a parking lot. The driveway, wide enough for three lanes of traffic, diverges approximately 50 ft (15 m) into the campus (Figures 7-27 and 7-28). When entering the parking lot, parents continue along the right edge of the driveway to drop off their children. The drop-off zone consists of two lanes (Figure 7-29). The staff and visitors entering the parking lot use the left lane of the driveway (Figure 7-30). The driveway also connects to a turn-around lane. Two medians are present, one separating the drop-off zone from the parking and the other separating parking areas. Figure 7-31 shows the parking area that is furthest from the school building. A service roadway connects the two parking areas (Figure 7-32). When exiting the parking lot, cars enter the left-turn lane or the right-turn lane (Figure 7-33). The parking lot has 70 parking spaces for faculty members, the handicapped, and visitors.

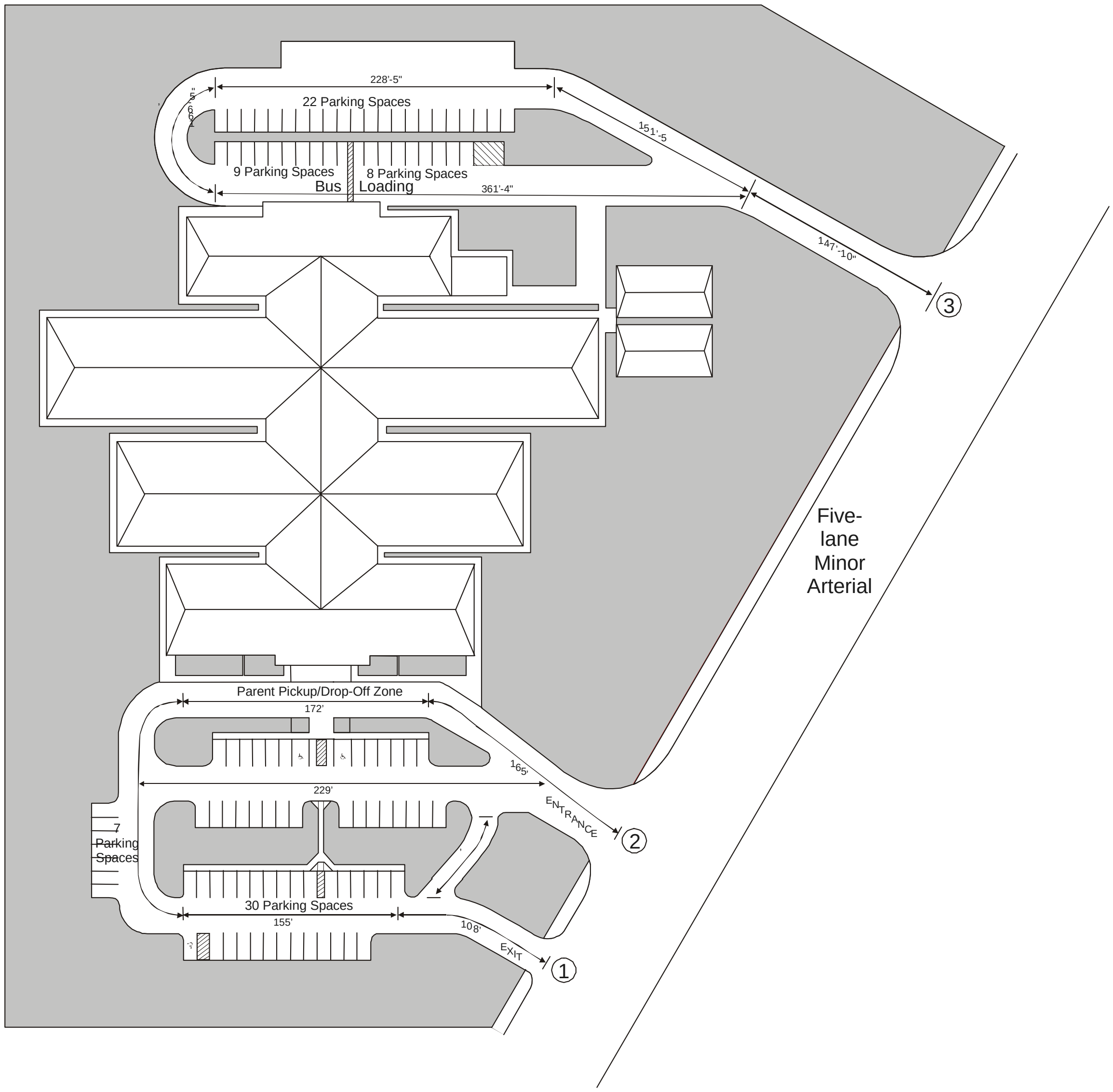


Figure 7-25. The Elementary School Case Study Site 4 School Layout.

Figure 7-26. Front View of the Elementary School.

Figure 7-27. Entrance Driveway to the Parent Drop-Off Zone.

Figure 7-28. Two Options near the Entrance of the Parent Drop-Off Zone: to the Right for Drop Off and to the Left for the Parking Lot.

Figure 7-29. The Parent Drop-Off Zone.

Figure 7-30. The Closest Parking Area to the School, near the Parent Drop-Off Zone.

Figure 7-31. The Farthest Parking Area to the School in the Parent Drop-Off Parking Zone.

Figure 7-32. The Turn Around in the Parent Drop-Off Parking Zone.

Figure 7-33. Exit to the Parent Drop-Off Zone, Driveway 1.

Morning Drop-Off Period. Parents drop their children off by the front entrance to the school building in the parent drop-off zone. The morning traffic in the faculty parking lot occurs between 7:20 and 8:02 a.m. Cars queue in the morning, with some cars waiting on the street. The worst congestion occurred between 7:40 and 7:56 a.m., with up to eight cars observed on the city street. In the morning, a high in queue lengths reached 20 cars. The traffic flow through the exit mostly ran smoothly. However, the queue length expanded from 7:50 to 8:04 a.m., reaching a length of 12 cars. Approximately 215 cars entered the parent drop-off zone to drop off children. Figure 7-34 shows the arrival/departure data in the parent drop-off zone for the morning drop-off period.

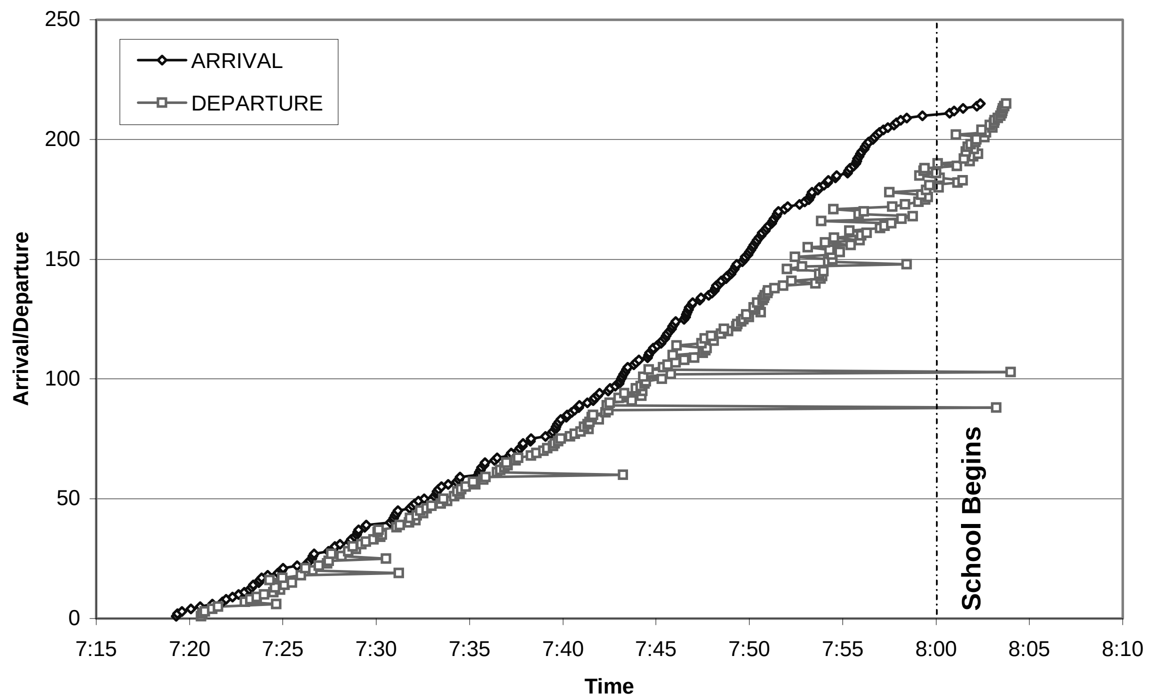


Figure 7-34. Parent Parking Lot Arrival/Departure Operations during the Morning Period.

Afternoon Pick-Up Period. In the afternoon, parents picked up their children in the same area of the parent drop-off zone. The afternoon traffic in the faculty parking lot occurred between 2:27 to 3:25 p.m. The principal stood outside, attempting to keep traffic running smoothly and assisting children across the parking lot. Some parents parked and walked in to pick up their children. The afternoon pick-up period reached a maximum queue length of 15 cars. There was an overflow of waiting cars, resulting in up to three cars queuing on the city street. Approximately 117 cars entered the parking lot to pick up children in the afternoon. Figure 7-35 represents the arrival/departure data for the afternoon pick-up period.

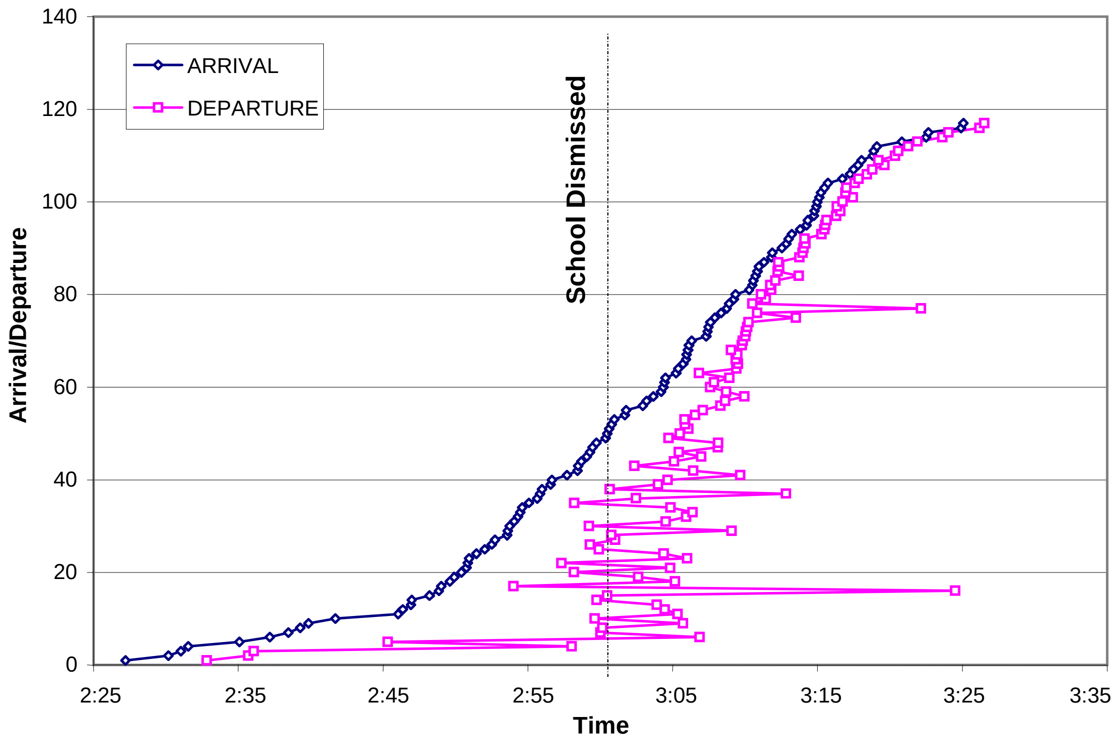


Figure 7-35. Parent Parking Lot Arrival/Departure Operations during the Afternoon Period.

Bus Drop-Off/Pick-Up Zone

Driveway 3 consists of a roadway between the bus parking lot and the local street (Figure 7-36). This particular elementary school has separated the bus loading operation from passenger car loading. The bus parking lot provides for both bus traffic and faculty parking. Six buses serve 420 passengers at this elementary. There are 57 parking spaces in the bus parking lot including faculty and handicapped spaces. Buses pass through the parking area (Figure 7-37) and then loop around (Figure 7-38) to the drop-off zone in this particular bus lot. The drop-off zone consists of one lane. Vehicles follow a slight curve which later straightens as they exit the bus/faculty parking lot. The parking lot exit consists of one lane. Small directional signs and pavement markings direct drivers.

Morning Drop-Off Period. The morning traffic in the bus parking lot occurs between 7:15 and 7:43 a.m. No queuing was observed. The buses remain in the parking lot for approximately 15 minutes, as buses are not allowed to let children exit the buses until 7:45 a.m. Figure 7-39 shows the arrival/departure data for the morning drop-off period in the bus parking lot. Approximately 18 faculty members were observed arriving during this time period. In the morning, faculty members supervised the bus unloading operation.

Figure 7-36. Entrance and Exit Driveway to the Bus Parking Lot.

Figure 7-37. Parking Area in the Bus Parking Lot.

Figure 7-38. Curve in Bus Parking Lot.

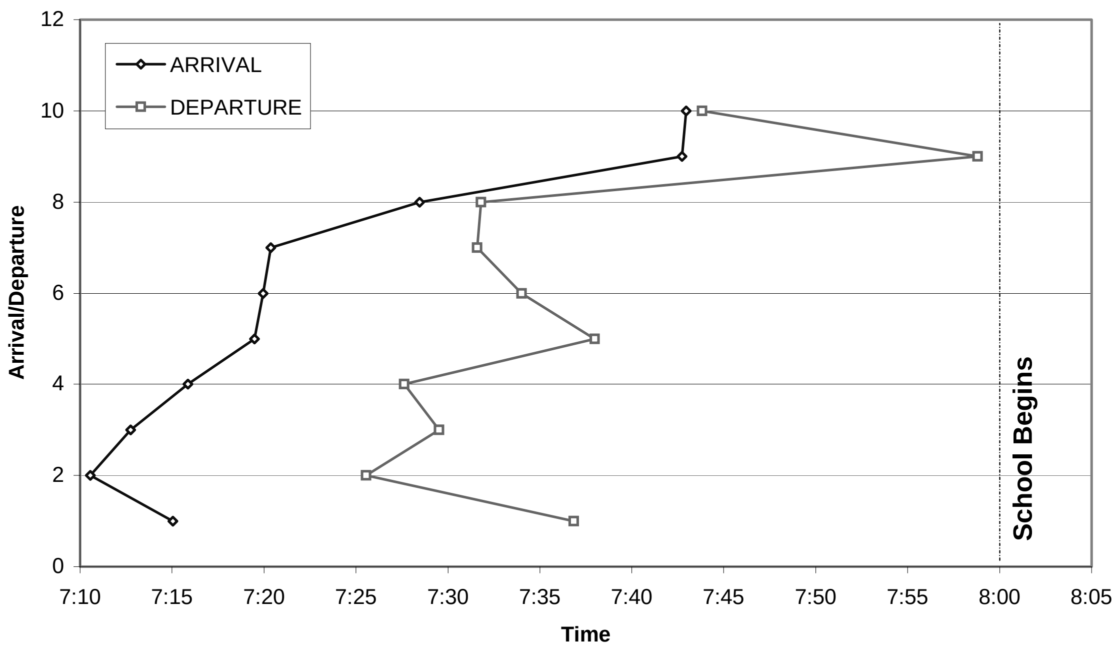


Figure 7-39. Bus Parking Lot Arrival/Departure Operations during the Morning Period.

Afternoon Pick-Up Period. The afternoon traffic in the bus parking lot occurs between 3:24 to 4:29 p.m. Once again, there is no congestion in this parking lot due to the low traffic volumes. Figure 7-40 shows the arrival/departure data for the afternoon pick-up in the bus parking lot. Faculty members supervised the loading operation. Researchers observed few faculty/staff members leaving at this time. A small number of parents were observed using the parking lot to pick up children.

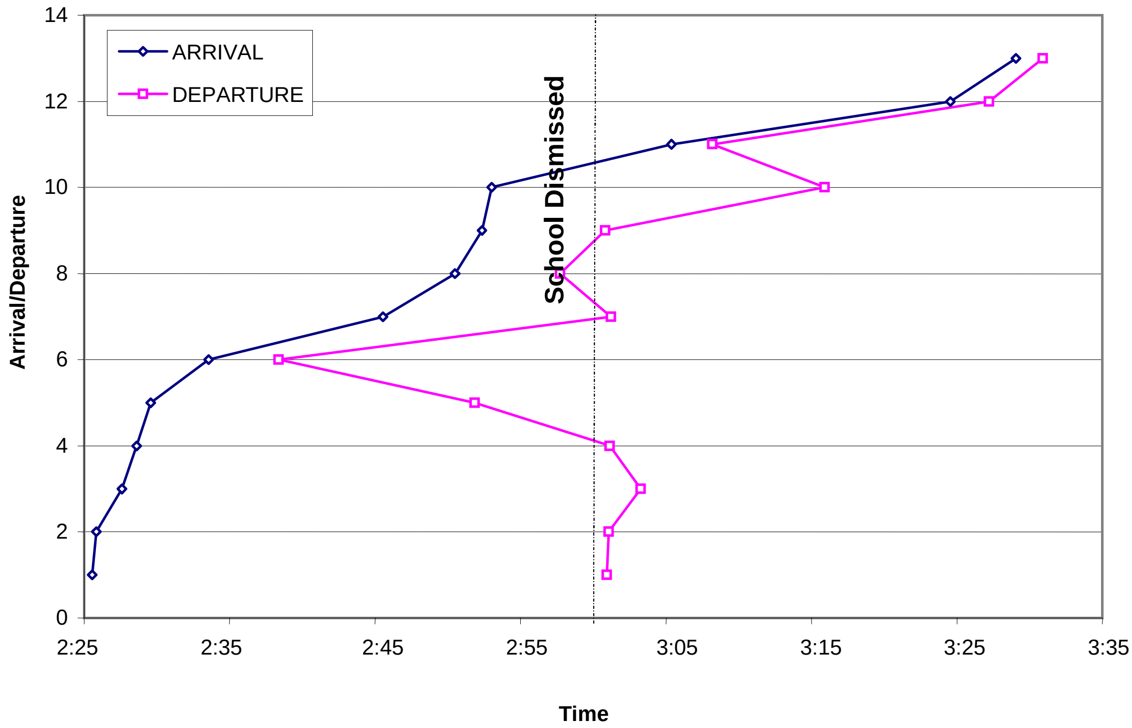


Figure 7-40. Bus Parking Lot Arrival/Departure Operations during the Afternoon Period.

Other Observations

A crosswalk was located down the road at a nearby intersection. There were approximately 10 children that used the crosswalk. There were 25 students that used their bikes to travel. Once on campus grounds, children are expected to walk bikes. One car dropped a child on the local street and never entered the parking lot.

ELEMENTARY SCHOOL, CASE STUDY SITE 5

Background

The elementary school case study site 5 is located on a four-lane urban arterial with a divided raised median. The roadway serves residential neighborhoods and is the primary east-west route between a loop and an Interstate highway. The elementary school is located in a large school district in a major urban area of Texas. This elementary school currently has an existing student population of 910 with a maximum of 1000 students. Ninety faculty and staff are employed at the school and arrive before the students. According to the school, approximately 85 percent of the students use the 13 buses serving the school. Fourteen percent of the students arrive by automobile, 1 percent walk, and no students ride a bicycle to school. The school hours are 7:45 a.m. to 2:45 p.m. Researchers conducted a traffic observation study on May 28, 2002, using the video technique (see Table 7-2).

Field Observations

Access to the elementary school is from two driveways, both located on the four-lane arterial (Figure 7-41). The western driveway, Driveway 1, is used for parent drop-off/pick-up and for accessing the administration and visitor parking lots. The eastern driveway, Driveway 2, is used for bus drop-off/pick-up and for accessing the employee parking lots. Driveway 2, which is signalized, is also used for parent drop-off in the morning after 7:30 a.m. Both driveways allow for all turning maneuvers.

The elementary school has two administration/visitor parking lots in front of the school and two employee parking lots at the rear of the school (Figure 7-41). A one-way roadway from the front to the rear of the school connects these two areas. The additional administration/visitor parking lot and one-way roadway were not included in the original school layout and were constructed later.

The school site has a parent drop-off/pick-up zone in front of the school and a bus drop-off/pick-up zone at the rear of the school (Figure 7-41). Parents can drop off students at the rear of the school only during the morning period after 7:30 a.m.

1 Driveway 1

2 Driveway 2

3 Administration and visitor parking

4 Administration and visitor parking not included in the original school site design

5 Employee parking

6 Parent drop-off/pick-up zone

7 Bus drop-off/pick-up zone, parent drop-off zone only during morning period after 7:30 a.m.

Figure 7-41. The Elementary School Case Study Site 5
(Base Aerial Photograph from GlobeXplorer (*45*)).

The road in front of the school is a four-lane urban arterial divided with a raised median. The section directly in front of the school is designated as a school zone and has a speed limit of 20 mph (32 km/h) during morning drop-off and afternoon pick-up periods. The regulatory speed on this road is 45 mph (73 km/h). Standard school zone signing exists on both directions of the road, including School Advance signs on both sides of the roadway and a School Speed Limit sign with flashing beacons and a When Flashing plaque on the right side of the roadway (Figure 7-42). In addition to these signs, a Signal Ahead sign is installed on both directions for the traffic signal at the intersection of the four-lane arterial and Driveway 2. The end of the school zone is designated by the 45 mph (73 km/h) speed limit signs.

Figure 7-42. Road Signing (Facing Northeast.)

Fully directional median openings with left-turn bays are provided at both school driveways. The left-turn bay length, including taper, is 500 ft (153 m) at Driveway 1 and 350 ft (107 m) at Driveway 2. Sidewalks are discontinuous along the section of roadway adjacent to the school.

Driveway 1 is the westernmost driveway serving the school and is located at a 120 ft (37 m) wide full median opening on the road. The driveway is aligned with a gated residential neighborhood driveway across the road. This driveway serves as the primary drop-off/pick-up zone and the administration and visitor parking lots. Figures 7-43 through 7-48 show the general layout and pavement markings and signing associated with Driveway 1 and the administration and visitor parking lots.

Figure 7-43. Driveway 1 (Facing North).

Figure 7-44. Driveway 1 (Facing West).

Figure 7-45. The Entrance to the East Administration/Visitor Parking Lot and Access to the Rear of the School and to Driveway 2 (Facing North).

Figure 7-46. The Entrance to the Parent Drop-Off/Pick-Up Zone, and Exit from the Drop-Off Zone and West Administration/Visitor Parking Lot (Facing Northwest).

Figure 7-47. Primary Parent Drop-Off/Pick-Up Zone (Facing Northwest).

Figure 7-48. The East Administration/Visitor Parking Lot and Path to the Rear of the School and Driveway 2 (Facing Southwest).

Driveway 2 is signalized at a full median opening on the road and is aligned with a driveway to a church. This driveway serves the bus drop-off/pick-up zone and the employee parking lots. Driveway 2 also serves for deliveries and access to a fire lane behind the school. A pedestrian crosswalk and a pedestrian signal are provided across the road; however, a crosswalk is not provided across either of the driveways at the intersection. Figures 7-49 through 7-54 show the general layout, pavement markings, and signing associated with Driveway 2; the bus drop-off/pick-up zone; and the employee parking lot.

Figure 7-49. Driveway 2 (Facing Northwest).

Figure 7-50. Driveway 2 (Facing Southwest).

Figure 7-51. The Employee Parking Lot and Entrance to the Bus Drop-Off/Pick-Up Zone (Facing Northwest).

Figure 7-52. The Employee Parking and Bus Drop-Off/Pick-Up Zone (Facing West).

Figure 7-53. The Entrance to the Employee Parking Lot and Driveway 2 from the Front of the School (Facing South).

Figure 7-54. Driveway 2 (Facing Southeast).

Morning Drop-Off Period

Classes at this particular elementary school start at 7:45 a.m., and students regularly arrive at approximately 7:10 a.m. Parents are allowed to drop off students at the primary parent drop-off zone in front of the school accessed by Driveway 1. Buses drop off students at the drop-off zone in the rear of the school accessed by Driveway 2. According to the school principal, parents are allowed to drop off students at the rear location after 7:30 a.m.; however, no sign states this operation.

During the observation study, one of the two lanes was used as the "drop-off" lane in the primary parent drop-off zone. The other lane was used as a "drive-through" lane. These lanes are indicated by pavement markings and separated by traffic cones. Teachers and students assisted in the parent drop-off zone. Teachers directed traffic and students assisted in opening doors of vehicles. With assistance from a teacher, students also controlled the crosswalk in the drop-off zone. These operations are depicted in Figure 7-55.

There were no significant queues entering the drop-off zone at Driveway 1; however, a queue of 10 vehicles developed exiting the site at Driveway 1 (Figure 7-56). Even though the intersection at Driveway 1 allows for all turning movements, most vehicles traveled to the traffic signal at Driveway 2 to turn left from the school to the road.

After 7:30 a.m., traffic entering and exiting Driveway 2 significantly increased. More parents dropped off students at the rear drop-off zone, where teachers and students assisted in the operations (Figure 7-57). Long queues developed exiting the school site at Driveway 2.

Vehicles queued from the traffic signal to the drop-off zone (Figure 7-58). The traffic at the school during the morning drop-off period lasted until 7:50 a.m.

Figure 7-55. The Front Drop-Off Zone during the Morning Period.

Figure 7-56. Driveway 1 Queue during the Morning Period.

Figure 7-57. Rear Drop-Off Zone Operations during the Morning Period.

Figure 7-58. Driveway 2 Queue during the Morning Period.

Afternoon Pick-Up Period

Classes at this elementary school let out at 2:45 p.m. A queue developed at Driveway 1 on the road at 2:30 p.m. and lasted until 2:50 p.m. (Figure 7-59). The queue on the road consisted of approximately 15 vehicles and disrupted traffic traveling westbound on the road. No significant queue was observed exiting the site.

Only buses were allowed at the rear pick-up zone (Figure 7-60). The buses were stationed on two lanes where students were loaded. A teacher wearing an orange safety vest observed loading operations and directed the buses to exit the site once all the students were loaded.

The only major pedestrian activity occurred during the afternoon pick-up period. After the buses exited the school site, college students escorted groups of students across the road to a day care facility at the church across the school site. The crossing took place at the pedestrian crosswalk/traffic signal at Driveway 2. An adult supervised the groups crossing the road and directed traffic with a stop sign paddle in addition to the protected pedestrian signal phase (Figure 7-61).

Figure 7-59. The Queue on the Road during the Afternoon Period.

Figure 7-60. Bus Loading Operations during the Afternoon Period.

Figure 7-61. Pedestrian Activity.

Other Observations

Researchers collected arrival and departure information at the school to determine the drop-off or pick-up period. Figure 7-62 presents morning operations at Driveway 1. Based on a sample size of 50 vehicles arriving between 7:29 and 7:46 a.m., the average service time was 1 minute, 38 seconds.

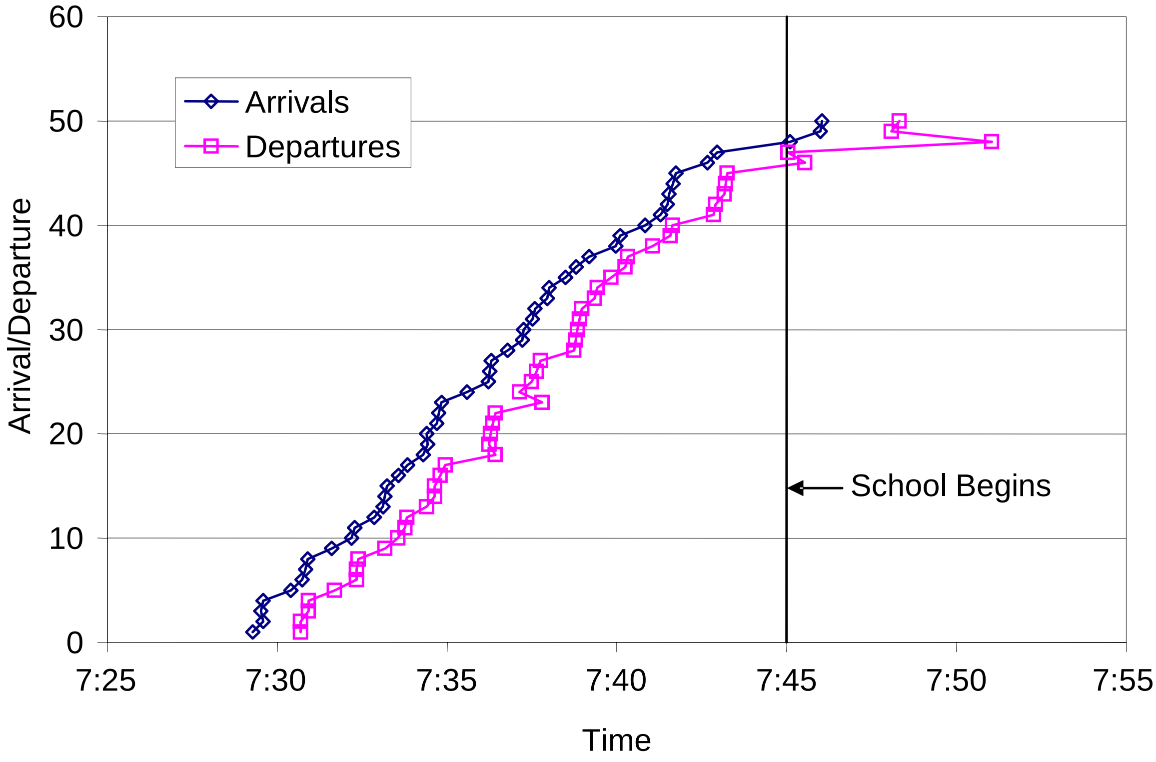


Figure 7-62. Driveway 1 Arrival/Departure Operations during the Morning Period.

Figure 7-63 presents afternoon operations at Driveway 1. Based on a sample size of 24 vehicles arriving between 2:44 and 2:52 p.m., the average service time was 3 minutes and 14 seconds.

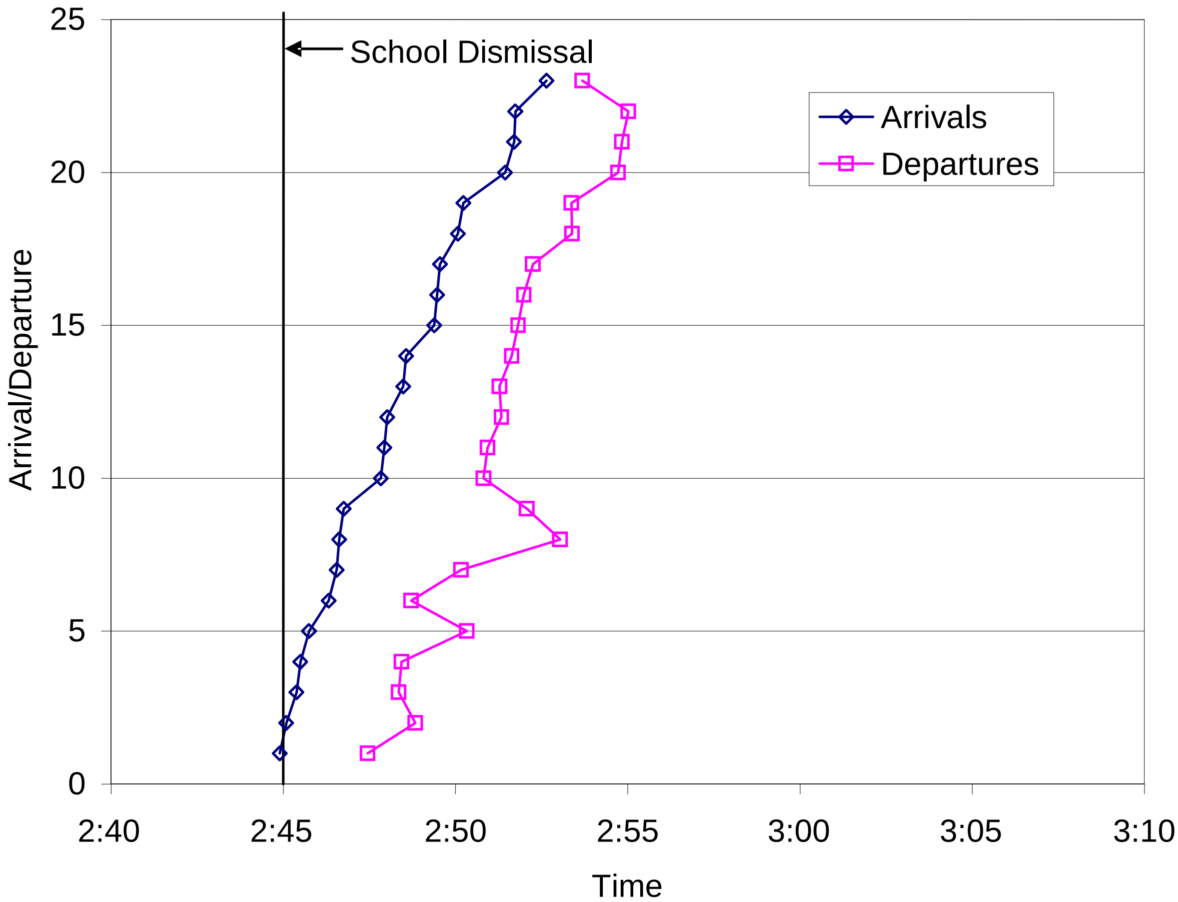


Figure 7-63. Driveway 1 Arrival/Departure Operations during the Afternoon Period.

ELEMENTARY SCHOOL, CASE STUDY SITE 6

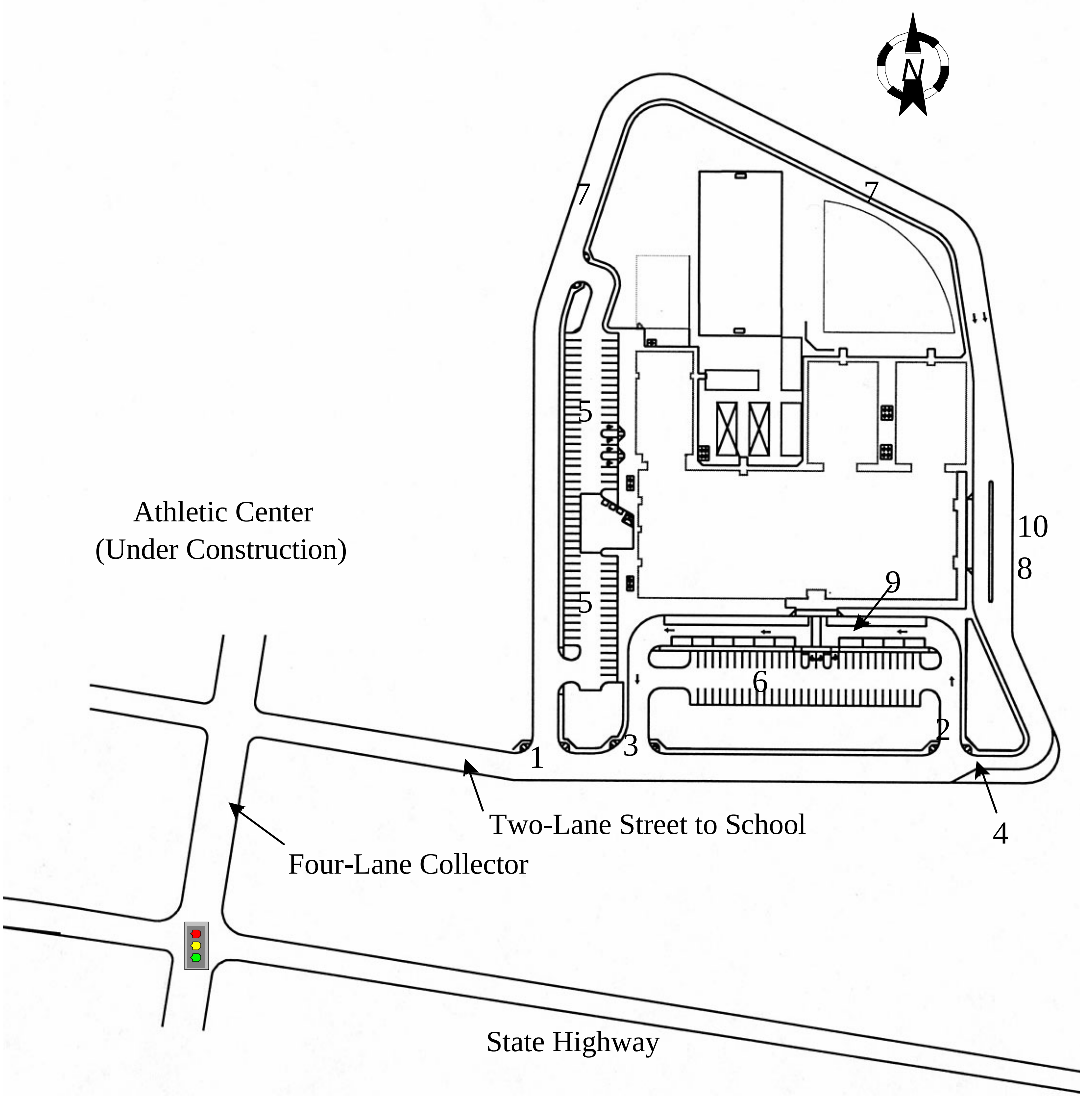
Background

Elementary school case study site 6 is located on a two-lane street that connects to a local drive which connects to a state highway. The local drive serves primarily as an entrance/exit roadway for the elementary school and Athletic Center north of the state highway. The local drive meets the state highway at a signalized intersection and serves residential neighborhoods south of the state highway. The state highway runs west to east and serves as the major roadway that connects two cities together.

This elementary school currently has an existing student population of 1090 which is in excess of its capacity of 900 students. One hundred and one faculty and staff are employed at the school and arrive before the students. According to the school, approximately 90 percent of the students use the 13 buses serving the school. Eight percent of the students arrive by automobile, 2 percent walk, and no students ride a bicycle to school. The school hours are between 7:45 a.m. to 2:45 p.m. Researchers conducted a traffic observation study on May 20, 2002, using the video technique (see Table 7-2).

Field Observations

Vehicles access the elementary school by traveling north on the local drive from the state highway, then east on the street. Four driveways connect this elementary school with the street (Figure 7-64). The western driveway, Driveway 1, is a two-way driveway used for entrance into the drop-off/pick-up zone east of the school, as well as for entrance to and exit from the employee parking lot, located west of the school. Driveway 2 is an entrance-only driveway accessing the drop-off/pick-up zone and visitor parking lot in front (south) of the school. Driveway 3 is an exit-only driveway and serves exiting vehicles from the facilities in front of the school. The easternmost driveway, Driveway 4, is an exit-only driveway, serving the exiting vehicles from the drop-off/pick-up zone east of the school.



1 Driveway 1
2 Driveway 2
3 Driveway 3
4 Driveway 4
5 Administration/employee parking
6 Visitor parking
7 Service road connecting Driveways 1 & 4
8 Bus drop-off zone
9 Bus pick-up zone
10 Parent drop-off/pick-up zone

Figure 7-64. The Elementary School Case Study Site 6 Layout.

The state highway is a five-lane urban arterial with a continuous two-way left-turn lane (TWLTL). The section of highway near the school and at the local drive intersection is designated as a school zone. The school zone speed limit is 30 mph (48 km/h) during morning drop-off and afternoon pick-up periods and 45 mph (73 km/h) during normal operations. A School Bus Entrance warning sign and a School Speed Limit sign with flashing beacons are located on both approaches of the state highway to the school area (Figure 7-65). In addition to these signs, a Fire Truck warning sign with flashing beacons is installed on both directions of the approach to the local drive intersection. The end of the school zone is designated by a 45 mph (73 km/h) speed limit sign.

Figure 7-65. State Highway (Facing West).

The local drive is a four-lane collector street, as well as the entrance to the elementary school and school district Athletic Center north of the state highway. The local drive is divided by a raised median and currently ends at the two-lane street, 225 ft (69 m) north of the state highway (Figure 7-66). The Athletic Center and adjacent parking lots/roadways were under construction at the time of the data collection; however, once complete, a stop-controlled four-leg intersection will be in place at the local drive and the street (Figure 7-67). The street is a two-lane, 33 ft (10 m) wide roadway that currently only travels east of the local drive and terminates at the elementary school (Figure 7-68).

Figure 7-66. The Local Drive (Facing South).

Figure 7-67. Street (Facing East).

Figure 7-68. End of Two-Lane Street (Facing East).

Driveway 1 is a two-way driveway that provides an entrance and exit to the employee parking lot. Driveway 1 also leads to a two-lane, one-way service road which surrounds the school and accesses the drop-off/pick-up zone located at the east side of the school. White pavement markings and a 15 mph (24 km/h) speed limit sign exist for the service road. Figures 7-69 through 7-72 show the general layout, pavement markings, and signing associated with Driveway 1; the employee parking lot; and the surrounding service road.

Figure 7-69. Driveway 1 (Facing North).

Figure 7-70. Employee Parking Lot (Facing Northeast).

Figure 7-71. The One-Way Service Road Surrounding the School from Driveway 1 to Driveway 4 (Facing North).

Figure 7-72. Employee Parking Lot Entrance/Exit (Facing Northwest).

Driveway 2 is a 24 ft (7 m) wide, one-way driveway entering the front area of the school. This driveway routes school traffic to a pick-up zone or to the visitor parking lot. Traffic entering the school site from Driveway 2 exits through Driveway 3. Driveway 3 is an exit-only driveway controlled by Stop signs located on both sides. Figures 7-73 through 7-78 show the general layout, pavement markings, and signing associated with Driveways 2 and 3.

Figure 7-73. Driveway 2 (Facing North).

Figure 7-74. Driveway 2 (Facing South).

Figure 7-75. Visitor Parking and Pick-Up Zone.

Figure 7-76. Drop-Off/Pick-Up Zone in Front of School (Facing West).

Figure 7-77. Driveway 3 (Facing South).

Figure 7-78. Driveway 3 (Facing West).

Driveway 4 is a one-way, exit-only driveway utilized by vehicles dropping off or picking up students on the east side of the school. This driveway is the only exit for the service road surrounding the school. The drop-off/pick-up zone, pictured in Figure 7-79, consists of two lanes separated by a striped median. Driveway 4 is striped as two lanes as it transitions into the street (Figure 7-80). Vehicles that exit the school on Driveway 4 and to the street must yield to vehicles turning into Driveway 2 (Figure 7-80).

Figure 7-79. Driveway 4 and Eastside Drop-Off/Pick-Up Zone (Facing North).

Figure 7-80. Driveway 4 (Facing Southwest).

Morning Drop-Off Period

Classes at this particular elementary school started at 7:45 a.m. and students regularly arrived at the school at approximately 7:10 a.m. Students were dropped off at the eastside drop-off zone by parents. Traveling around the service road, parents and buses used Driveway 1 to drop off students at the eastside zone. These vehicles exited the area via Driveway 4. Parents also dropped off students in the visitor parking lot located in front of the school accessed by Driveway 2. Parents used the 24 ft (7.3 m) roadway in the parking lot as a two-lane drop-off zone and exited through Driveway 3. Teachers assisted the drop-off operations in the visitor parking lot during the morning period. The pick-up zone located in the front of the school and adjacent to the visitor parking lot was coned off during the entire morning operations. This area was restricted until buses arrived in the afternoon (Figure 7-81).

There were no significant queues entering the school driveways during the morning period; however, a queue of approximately 12 vehicles developed exiting the site at the signalized intersection of the state highway and the local drive. The traffic at the school during the morning drop-off period lasted until 7:55 a.m.

Afternoon Pick-Up Period

Classes at this elementary school let out at 2:45 p.m. During the afternoon period, buses used two lanes in the front pick-up zone accessed by Driveway 2 to load students. At 2:40 p.m., a queue of buses developed from the pick-up zone and spilled back into the street by two buses (Figure 7-81). During this time, parents waited for students in the parking lot roadway, blocking individual parking spaces. A few vehicles circled through the visitor parking lot when it was full; however, no queue developed on the street. Only parents utilized the eastside pick-up zone accessed by Driveway 1 and the surrounding service road.

At 2:45 p.m., students were let out of school and loading operations began. The first groups of buses departed at 2:50 p.m., after which the queuing at the school site started to dissipate. Teachers assisted in the bus loading operations. They were also stationed at the crosswalk which crossed the front pick-up zone, connecting the school to the visitor parking lot. Not including the initial queue waiting for school to let out, a queue of 16 vehicles further developed, exiting the site at the signalized intersection of the state highway and the local drive (Figure 7-82). During the morning and afternoon periods, there was no major pedestrian or bicycle activity.

Figure 7-81. Bus Queue during Afternoon Operations.

Figure 7-82. Queue at State Highway and the Local Drive from the Elementary School during Afternoon Operations.

Other Observations

Arrival and departure information were collected at both drop-off/pick-up zones to determine average service time. Morning operations for the eastside drop-off zone by parents and serviced by Driveways 1 and 4 are presented in Figure 7-83. Based on a sample size of 50 vehicles arriving between 7:32 and 7:45 a.m., the average service time for passenger cars entering Driveway 1 and exiting Driveway 4 was 1 minute and 58 seconds.

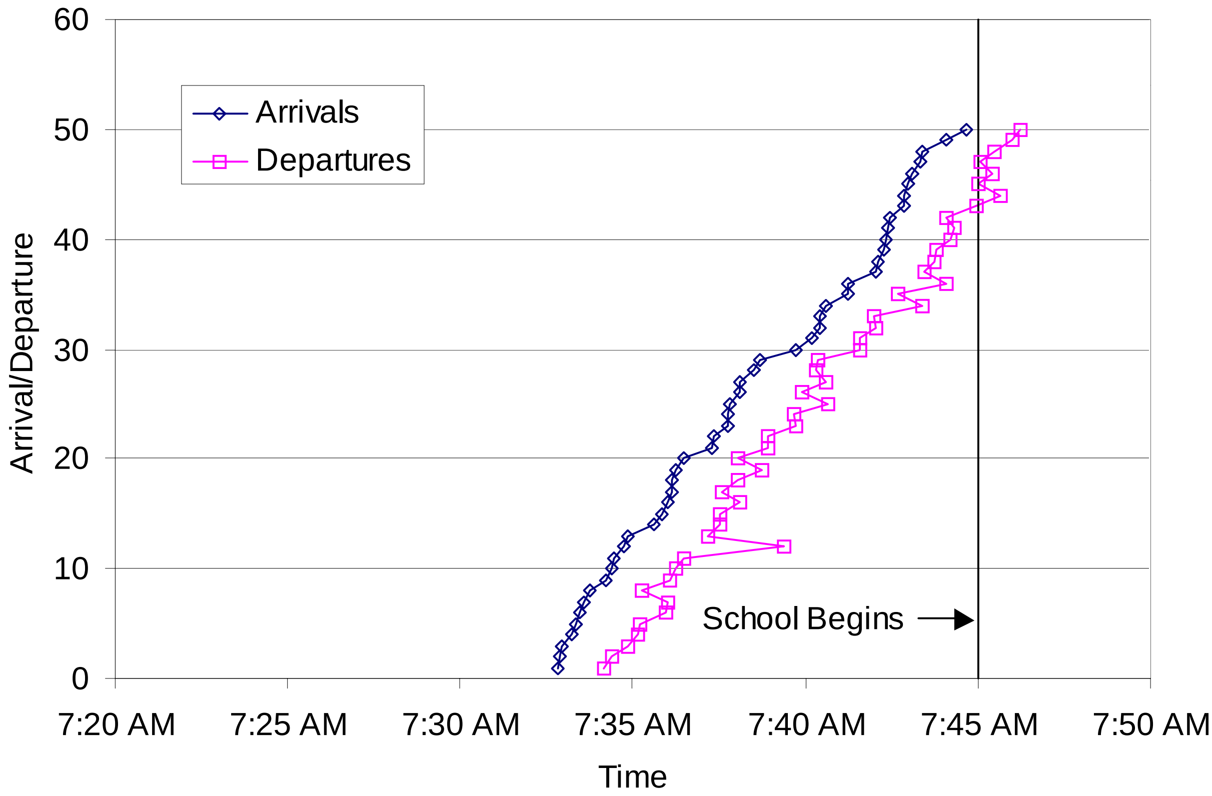


Figure 7-83. Driveway 1 to Driveway 4 Arrival/Departure Operations during the Morning Period.

Morning data for the parent drop-off periods in the visitor parking lot are presented in Figure 7-84. Based on a sample size of 49 vehicles between 7:22 and 7:44 a.m., the average service time entering Driveway 2 and exiting Driveway 3 was 3 minutes and 29 seconds. In some cases, parents parked and walked their children to school.

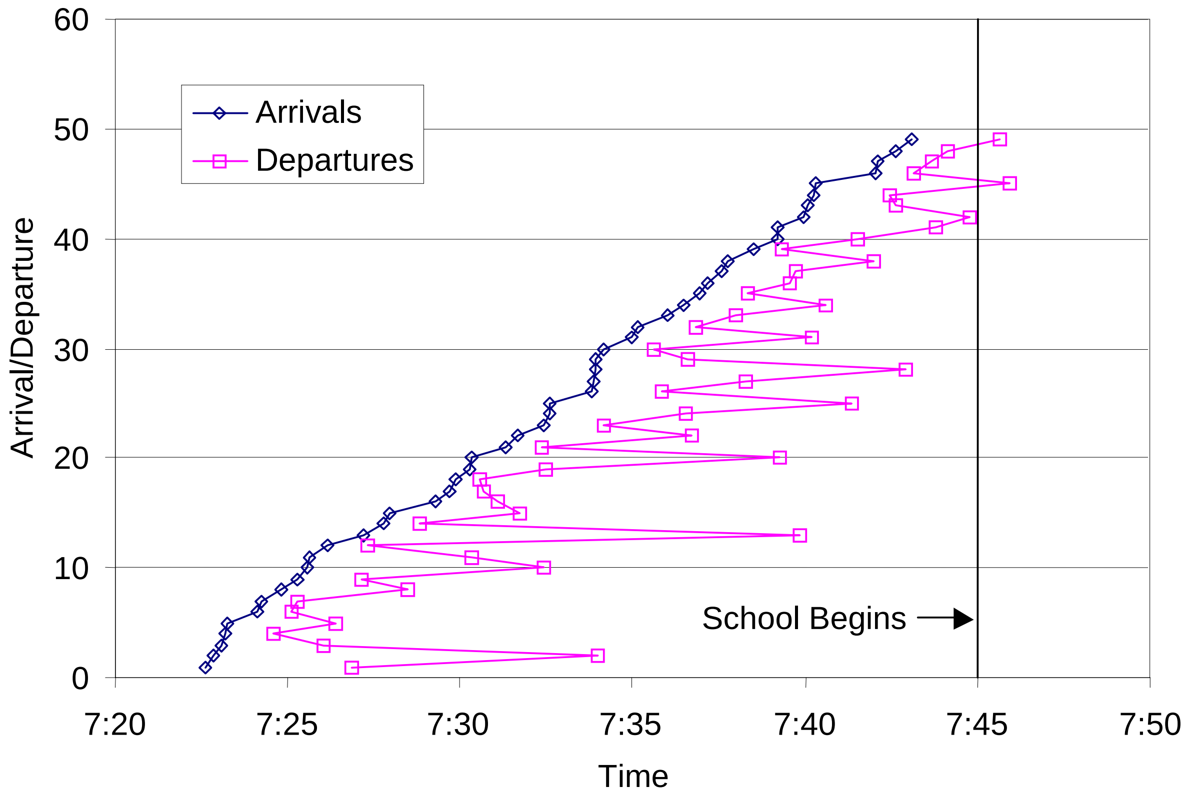


Figure 7-84. Driveway 2 to Driveway 3 Arrival/Departure Operations during the Morning Period.

Afternoon operations for the eastside pick-up zone accessed by Driveway 1 are presented in Figure 7-85. Based on a sample size of 20 vehicles arriving between 2:38 and 2:52 p.m., the average service time was 2 minutes and 58 seconds.

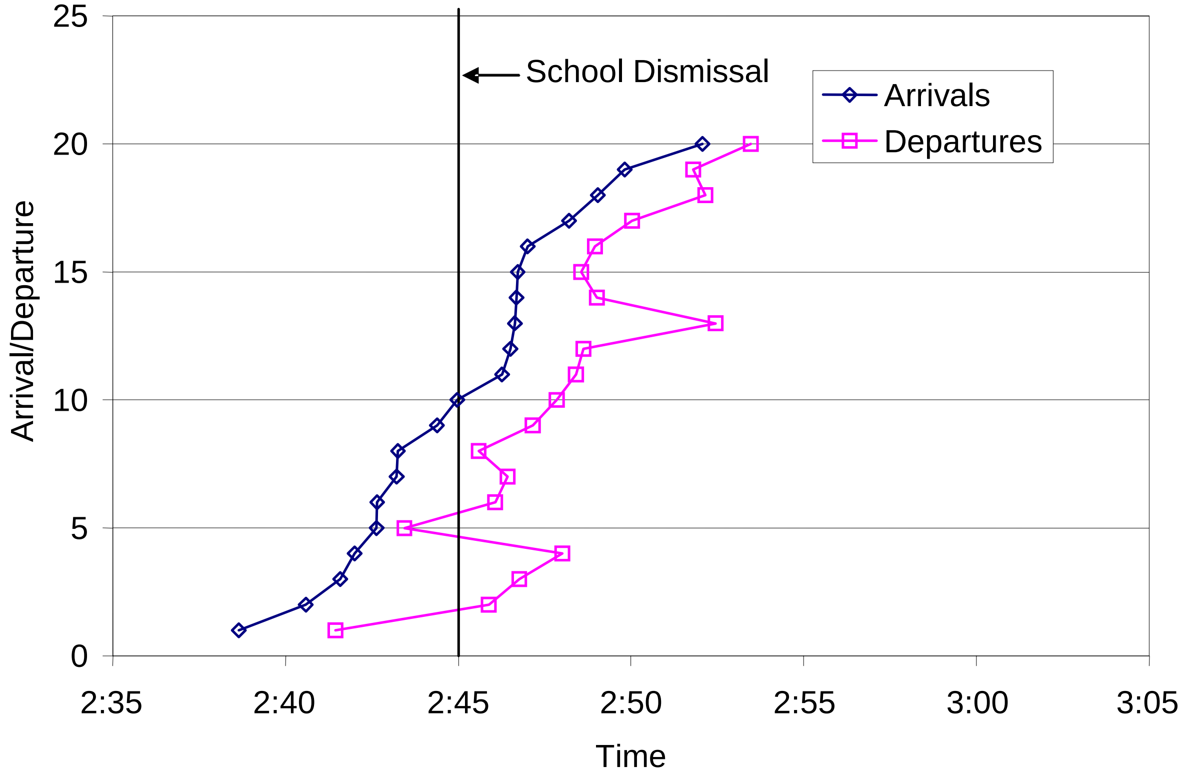


Figure 7-85. Driveway 1 to Driveway 4 Arrival/Departure Operations during the Afternoon Period.

Afternoon data for the parent pick-up periods in the visitor parking lot are presented in Figure 7-86. Based on a sample size of 24 vehicles between 2:35 and 2:54 p.m., the average service time entering Driveway 2 and exiting Driveway 3 was 4 minutes and 2 seconds.

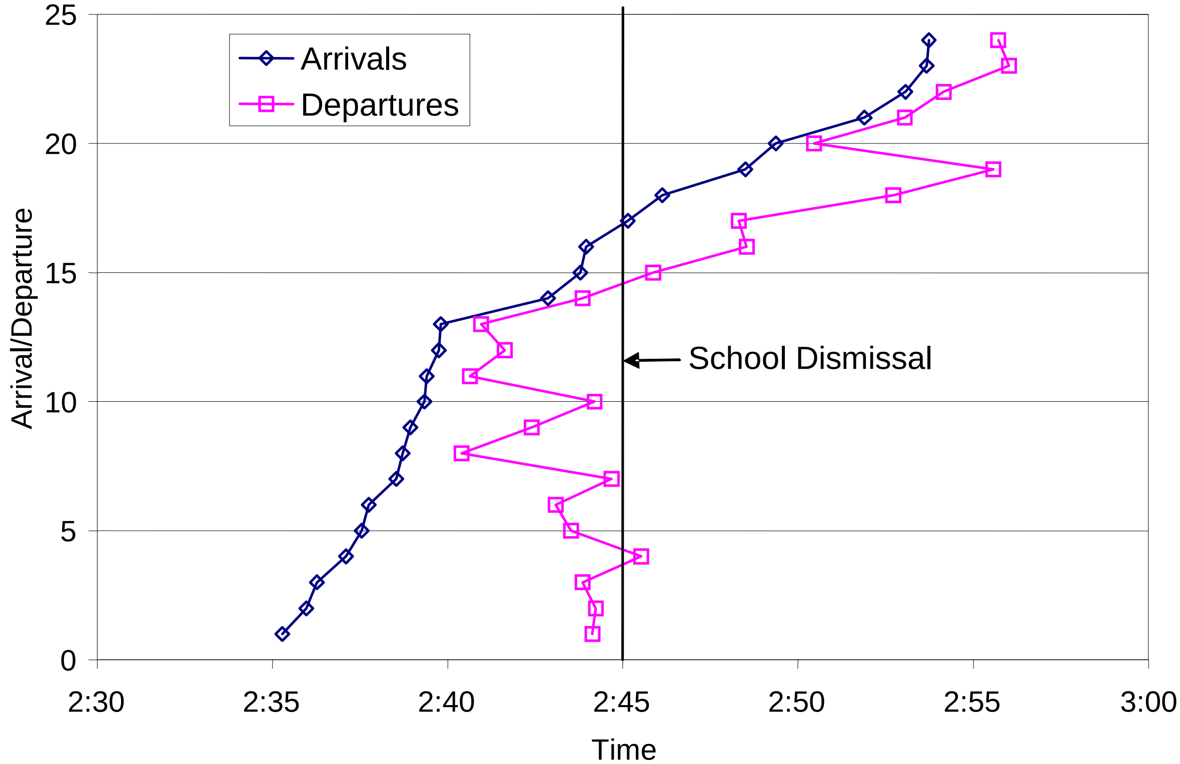


Figure 7-86. Driveway 2 to Driveway 3 Arrival/Departure Operations during the Afternoon Period.

ELEMENTARY SCHOOL, CASE STUDY SITE 7

Background

Elementary school case study site 7 serves first through fifth grade students with an existing student population of 400 students. There are 50 faculty and staff employed at the elementary school. According to the school, the distribution of modes is: 27 percent of students use the five buses serving the school, 45 percent of the students arrive by automobile, 18 percent walk, and 9 percent ride a bicycle to school. The normal school hours are from 8:00 a.m. to 3:00 p.m. Using the laptop computer technique (see Table 7-2), researchers conducted a traffic observation study on May 21 and 22, 2002.

Field Observations

The school speed zone is 20 mph (32 km/h), and the regulatory speed limit is 30 mph (48 km/h) on the street by the school. There are three main driveways to this elementary school (Figure 7-87). Figure 7-88 illustrates the parking lots in relation to the school. The entrance to the parent drop-off zone is directly accessed by the street. The exits to the parent drop-off zone and the bus parking lot are accessed by the main drive. The entrance and exit used for parent drop-off also provide access to a small visitor and faculty parking lot. The entrance and exit used by buses also provide access to the larger faculty parking lot.

Figure 7-87. Aerial View of the Elementary School (*47*).

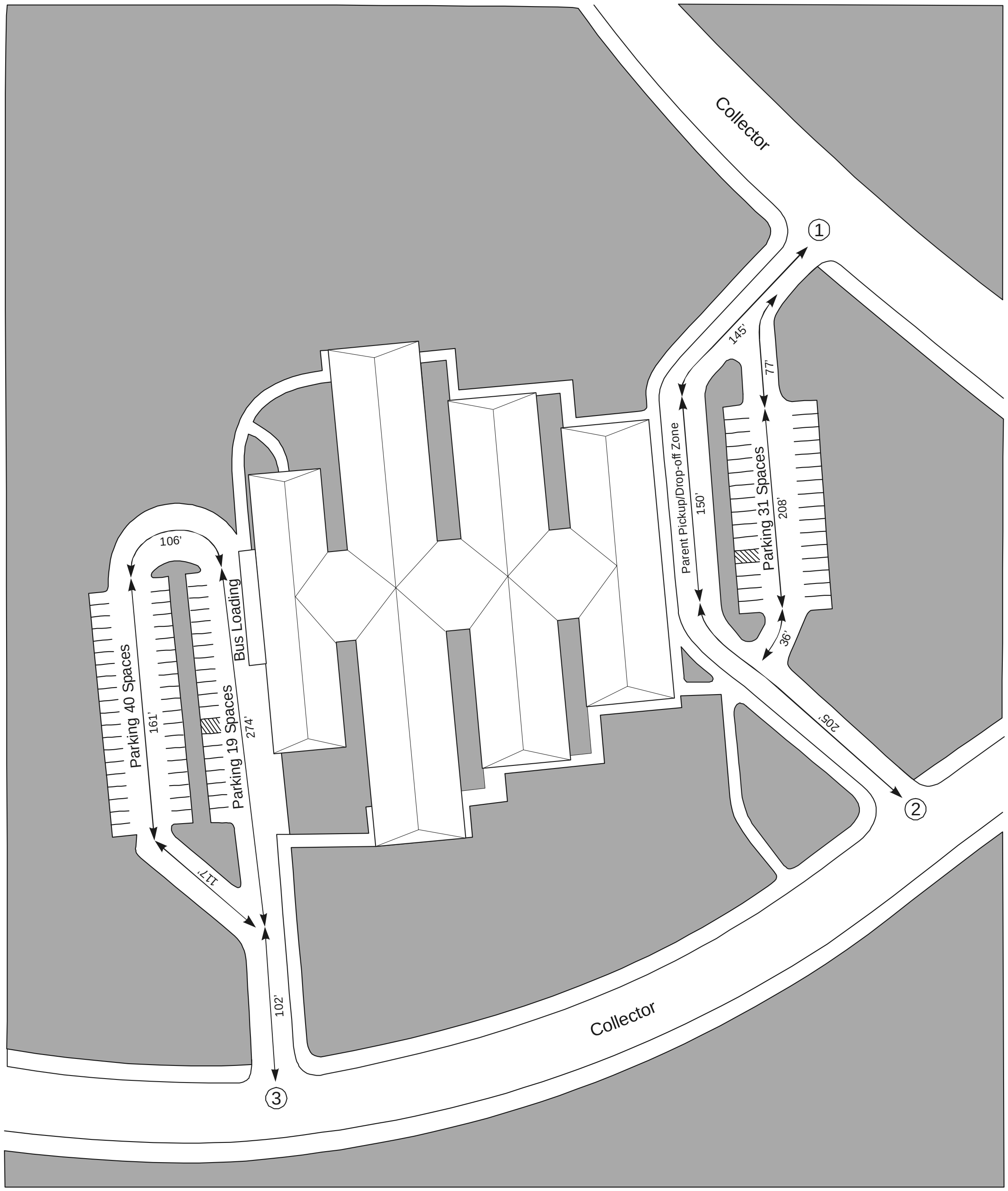


Figure 7-88. The Elementary School Case Study Site 7 Layout.

Parent Drop-Off/Pick-Up Parking Lot

The parent drop-off parking lot, located in front of the school building, contains a drop-off zone and a parking area. The entrance driveway is wide and short, which results in traffic queuing on the street (Figure 7-88). When entering the parking lot, drivers are given the choice to proceed to the drop-off area or turn left to the parking area (Figure 7-89). The parent drop-off area contains one lane. The parking area exit merges with traffic from the drop-off zone exit before exiting the campus (Figure 7-90). The exit forms two lanes: one lane for the traffic to turn left and one lane for the traffic to turn right (Figure 7-91). The parent drop-off parking lot has 31 parking spaces for the handicapped, faculty members, and visitors.

Figure 7-89. The Entrance Driveway to the Parent Drop-Off Zone.

Figure 7-90. Exit Area of the Parking Area That Leads to the Exit Driveway in the Parent Drop-Off Zone.

Figure 7-91. Exit Driveway of the Parent Drop-Off Zone and Parking Lot.

Morning Drop-Off Period. Parents drop off their children by the entrance to the school building (Figure 7-92). Faculty members oversee the unloading of children. Orange cones divert traffic into the primary drop-off zone to prevent parents from dropping off children in the parking area. The morning traffic in the parent drop-off zone occurs between 7:17 and 8:01 a.m. In the morning, the traffic queued on to the street. The queue length on the street reached a maximum of 10 cars. Figure 7-93 represents the arrival and departure operations in the parent drop-off zone for the morning period. Approximately 145 cars passed through the drop-off zone in the morning.

Figure 7-92. Entrance to the Drop-Off Zone in Parent Drop-Off Parking Lot.

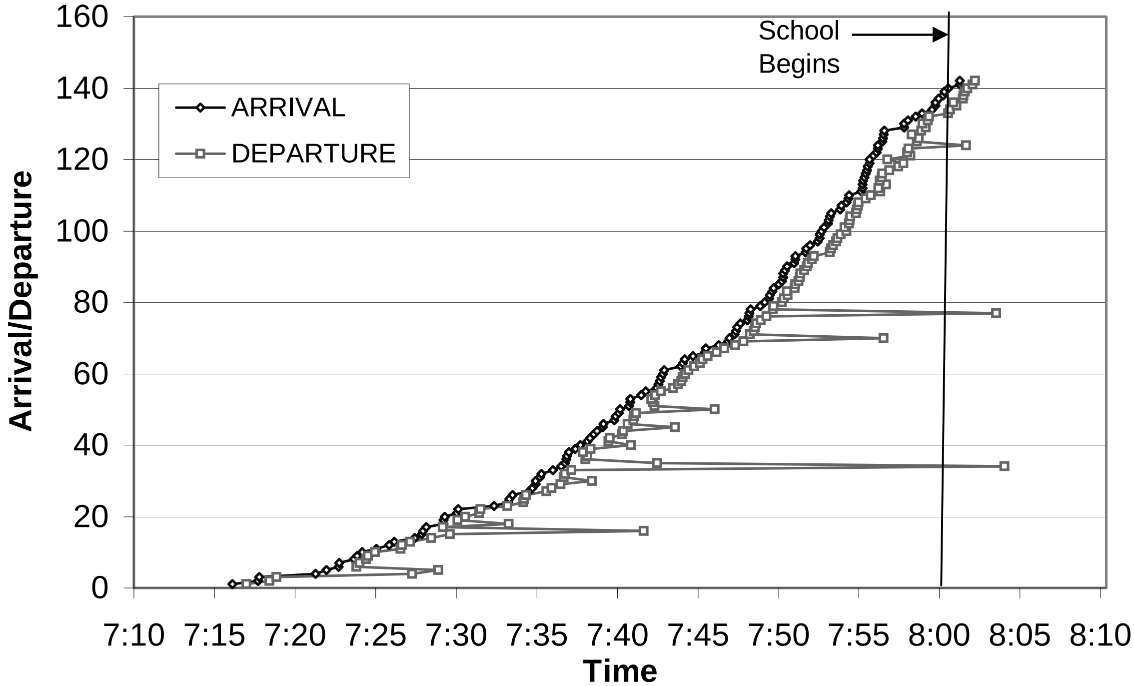


Figure 7-93. Arrival and Departure Operations for the Morning Period in the Parent Drop-Off Zone.

Afternoon Pick-Up Period. Parents pick up their children in the same area of the parent drop-off parking lot as in the morning (Figure 7-92). Faculty members are stationed outside with the students until their parents arrive to pick them up. Orange cones divert traffic into the primary drop-off/pick-up zone to prevent parents from picking up children in the parking area. The afternoon traffic began to queue up in the parent drop-off parking lot at 2:40 p.m. The queue length turning left into the pick-up zone reached a peak of seven cars, while the queue length turning right reached a peak of two cars. In the afternoon, approximately 50 cars drove through the parent drop-off parking lot. Figure 7-94 shows the arrival and departure operations for the afternoon pick-up period in the parent drop-off parking lot.

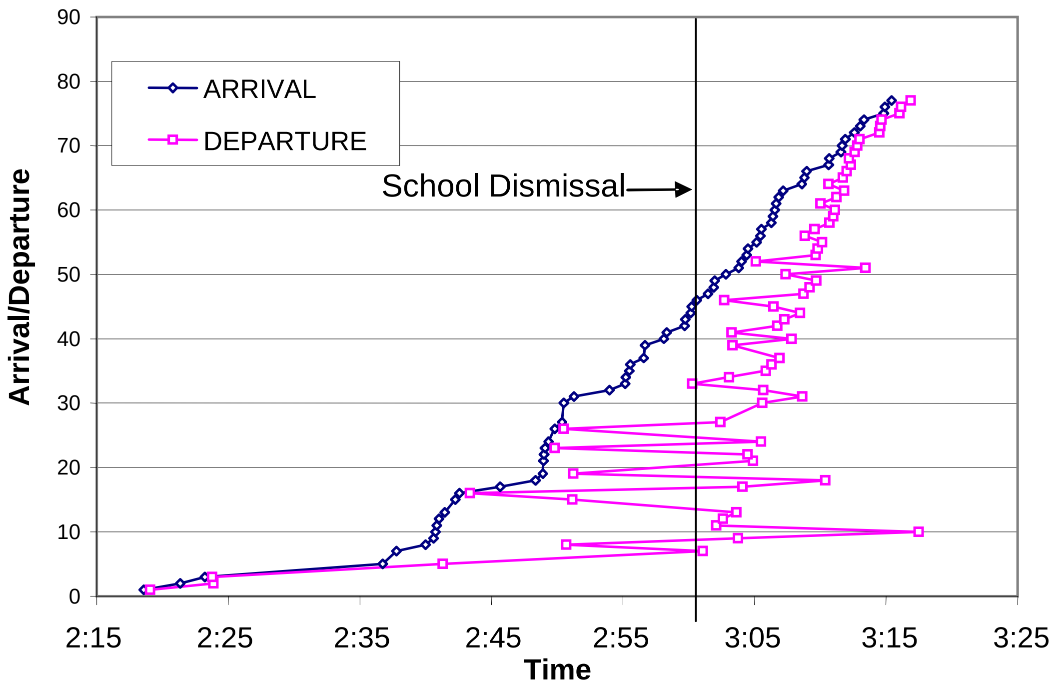


Figure 7-94. Arrival and Departure Operations in the Parent Drop-Off Zone during the Afternoon Pick-Up Period.

Bus/Faculty Parking Lot

Driveway 3 to the elementary school consists of the entrance and exit to the bus/faculty parking lot (Figure 7-95). The bus/faculty parking lot contains both bus movement and faculty parking. Neither line nor any type of marking separates the entrance lane and exit lane. After entering the parking lot, the buses continue forward and park in the bus-loading zone. A yellow painted curb that has BUS LOADING ZONE stenciling marks the bus-loading zone (Figure 7-96). The bus drop-off zone contains two lanes. The faculty either park opposite the bus-loading zone or continue further into the parking lot to park (Figure 7-97). Five buses serve the elementary school. The bus/faculty parking lot contains 60 parking spaces for faculty, visitors, and the handicapped.

Figure 7-95. The Entrance/Exit to the Bus/Faculty Parking Lot.

Figure 7-96. Bus-Loading Zone in Bus/Faculty Parking Lot.

Figure 7-97. The Faculty/Bus Parking Lot.

Morning Drop-Off Period. The morning traffic in the bus/faculty parking lot occurs between 7:20 and 7:45 a.m. Researchers observed four buses entering and exiting the parking lot. A few faculty members entered the parking lot at this time. Figure 7-98 shows the arrival and departure operations for the bus/faculty parking lot in the morning period. In the morning, faculty members stationed outside by the bus-loading zone oversee the unloading operation.

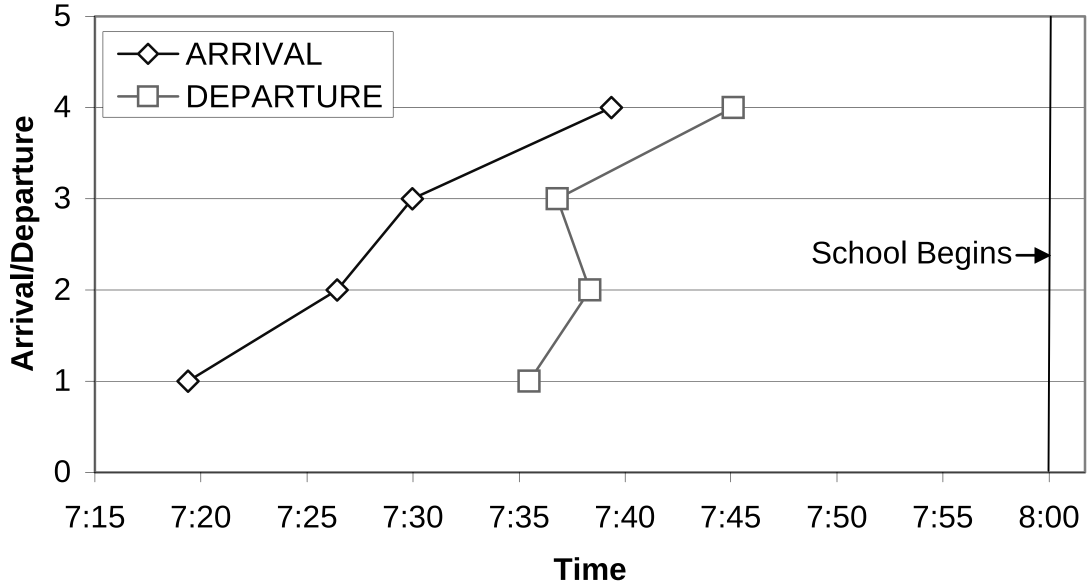


Figure 7-98. Arrival and Departure Operations for the Morning Drop-Off Period in the Bus/Faculty Parking Lot.

Afternoon Pick-Up Period. The afternoon traffic in the bus/faculty parking lot occurs between 2:30 and 3:00 p.m. Researchers observed four buses entering and exiting the parking lot at this time. Figure 7-99 represents the arrival and departure operations for the afternoon pick-up period in the bus/faculty parking lot. Some faculty members leave at this time as well. A few teachers and faculty members stand outside by the bus-loading zone to make sure the children get on the correct bus and oversee the loading operation.

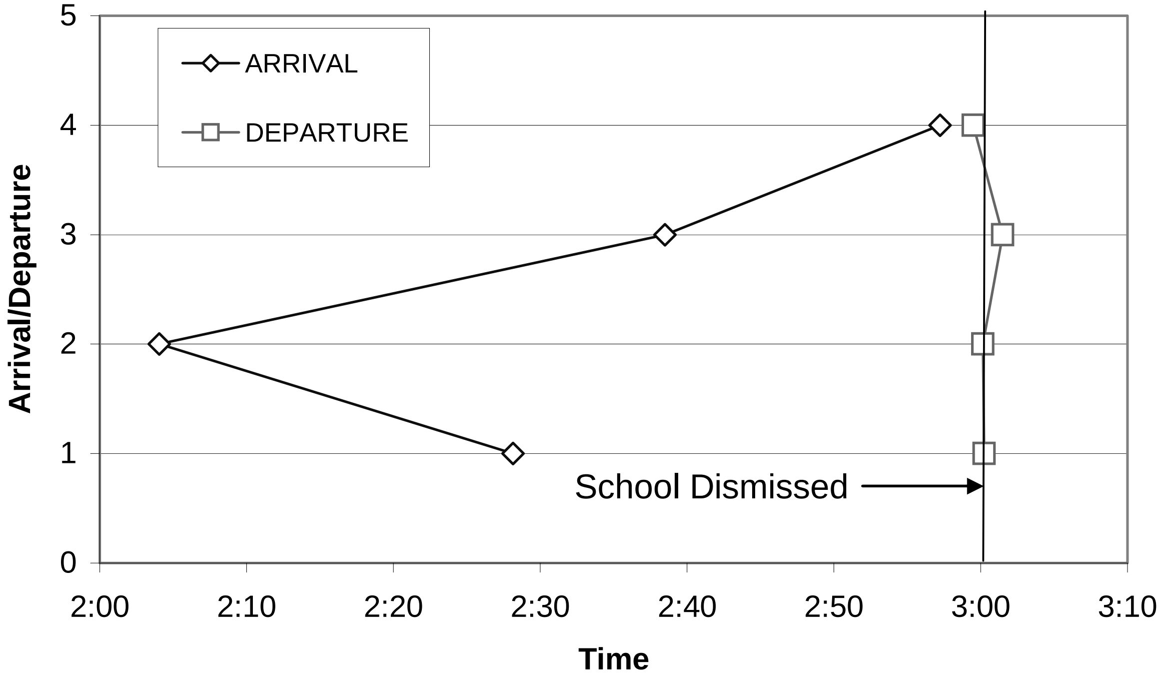


Figure 7-99. Arrival and Departure Operations for the Afternoon Pick-Up Period in the Bus Parking Lot.

Other Observations

During the afternoon pick-up period, some of the parents park on the approach to the pick-up zone and wait for their children to come out. There is only one crosswalk area, which is located on the main drive. The main drive has no lane markings and is four lanes, reducing to two lanes after passing the entrance to the parking lot.

MIDDLE SCHOOL, CASE STUDY SITE 1

Background

A middle school and an intermediate school are located on a state highway that passes through a major urban area in Texas. These two schools share the same school site and are primarily served by one driveway north of the school site, off of the state highway. The schools are also served by a secondary, bus-only driveway located on a local road south of the school site. The local road connects back to the state highway east and west of the school site.

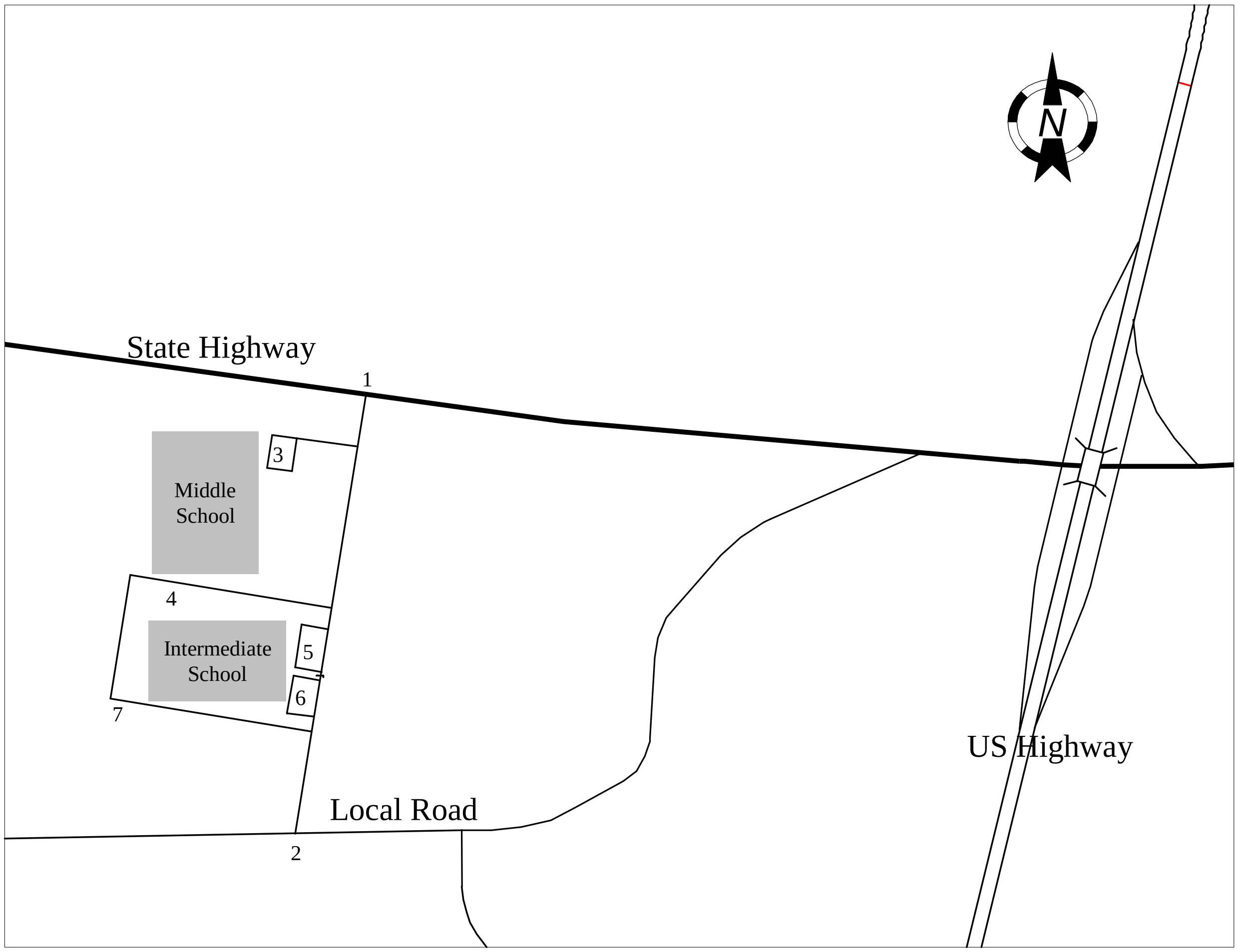
The middle school currently has an existing student population of 600 with a maximum of 800 students. Eighty faculty and staff are employed at the school and arrive before the students. The school did not provide arrival and departure mode choice of the students. The school hours are 8:30 a.m. to 3:30 p.m.

The intermediate school currently has an existing student population of 750 with a maximum of 800 students. Sixty faculty and staff are employed at the school and arrive before the students. According to the school, approximately 75 percent of the students use the 24 buses serving both schools. The remainder of the students arrive by automobile, and no students walk or bike to school. The intermediate school hours are between 7:45 a.m. to 3:00 p.m. Researchers conducted a traffic observation study during the afternoon period on May 16, 2002, using the video data collection technique (see Table 7-2). Due to inclement weather, observation study for the morning period was conducted on May 23, 2002.

Field Observations

The state highway directly accesses the two schools through the primary driveway, Driveway 1 (Figure 7-100). Driveway 1 is used mostly for parents and the schools' staff; however, researchers observed a few buses utilizing this driveway to access the school site. Driveway 1 leads to a three-leg intersection, 180 ft (55 m) south of the state highway. The intersection marks the westbound entrance to the middle school's parent drop-off/pick-up zone and the administration/visitor parking lot. The roadway also continues south to the middle school's transportation facilities (bus drop-off/pick-up zone and employee parking lot) and to the intermediate school. South of the school and off of the local road, the secondary driveway, Driveway 2, is used exclusively by buses; when the buses are not actively servicing the schools, this driveway is closed.

The middle school has a parent drop-off/pick-up zone and employee/visitor parking lot in front of the school. The bus drop-off/pick-up zone is located at the south side of the school. The intermediate school has a parent drop-off/pick-up zone in front of the school and a bus drop-off/pick-up zone adjacent to, but separated from, the parent area. The school has one administration/visitor parking lot in the front of the school and one employee parking lot at the rear of the school. An additional roadway surrounds the intermediate school and provides access to Driveway 2, the middle school drop-off/pick-up zone, and the intermediate school employee parking lot.



1 Driveway 1 (primary access)
2 Driveway 2 (bus access only)
3 Middle School parent drop-off/pick-up zone and employee/visitor parking
4 Middle School bus drop-off/pick-up zone
5 Intermediate School parent drop-off/pick-up zone and visitor parking
6 Intermediate School bus drop-off/pick-up zone
7 Intermediate School employee parking and service road

Figure 7-100. The Site Map to the Two Schools.

The state highway is a three-lane highway with a continuous two-way left-turn lane. The section of roadway directly in front of the school is designated as a school zone with a speed limit of 35 mph (56 km/h) during morning drop-off and afternoon pick-up periods. The regulatory speed of this section of the state highway is 45 mph (72 km/h). Standard school zone signing exists on both directions of the state highway, including School Advance signs and School Speed Limit signs with flashing beacons (Figure 7-101). The end of the school zone is designated by 45 mph (72 km/h) speed limit signs. In addition to school signing, a guide sign indicating the school names and location was placed on both directions of the state highway, just before the schools' primary driveway, Driveway 1. A right-turn bay was provided on the eastbound state highway at Driveway 1. The right-turn bay length, including taper, is 180 ft (55 m).

Figure 7-101. State Highway Approaching the School Sites (Facing West).

Driveway 1 serves as the primary entrance to the two schools. The driveway is 35 ft (11 m) wide and is stop-controlled approaching the state highway. Two speed limit signs are installed on both sides of the roadway leading into the school site. Driveway 1 leads to a three-leg intersection 120 ft (37 m) south of the state highway. To the south, Driveway 1 continues to the intermediate school and to the middle school's bus drop-off/pick-up zone. The entrance to the middle school parent drop-off/pick-up zone and employee/visitor parking lot is to the west. The southbound approach from the state highway is free-flow (no control), while the northbound and eastbound approaches are stop-controlled. Figures 7-102 through 7-104 show the general layout, pavement markings, and signing associated with Driveway 1 and the state highway intersection. Figures 7-105 and 7-106 show the layout of the intersection just south of the state highway and Driveway 1 intersection.

Figure 7-102. Driveway 1 (Facing South).

Figure 7-103. Driveway 1 (Facing East).

Figure 7-104. Driveway 1 (Facing North).

Figure 7-105. Intersection at the Entrance to the School Sites (Facing Northeast).

Figure 7-106. Intersection at the Entrance to the School Sites (Facing North).

Figure 7-107. Roadway Leading to the Middle School Parent Drop-Off/Pick-Up Zone and the Employee/Visitor Parking Lot (Facing West).

The roadway located to the west of the intersection at the entrance of the school site provides access to the middle school parent drop-off/pick-up zone and employee/visitor parking lot (see

Figure 7-107). The eastbound approach to the intersection is stop-controlled. Figures 7-108 through 7-111 show the general layout, pavement markings, and signing associated with roadway.

Figure 7-108. The Middle School Employee/Visitor Parking Lot and Parent Drop-Off/Pick-Up Zone (Facing West).

Figure 7-109. The Middle School Parent Drop-Off/Pick-Up Zone (Facing South).

Figure 7-110. Roadway Leaving the Middle School Parent Drop-Off/Pick-Up Zone and the Employee/Visitor Parking Lot (Facing East).

Figure 7-111. Roadway Leading to the Middle School Bus Drop-Off/Pick-Up Zone and the Intermediate School Facilities (Facing South).

The middle school bus drop-off/pick-up zone and the intermediate school facilities are located off the roadway, continuing south from the entrance intersection (Figure 7-112). The primary roadway leading to the middle school bus drop-off/pick-up zone is located 815 ft (249 m) south of the intersection and to the west. Figures 7-113 and 7-114 show the middle school bus facility.

Figure 7-112. Roadway Leading to the Middle School Bus Drop-Off/Pick-Up Zone and Road Surrounding the Intermediate School (Facing West).

Figure 7-113. The Middle School Bus Drop-Off/Pick-Up Zone (Facing West).

Figure 7-114. The Intermediate School Parent Drop-Off/Pick-Up Zone and Administration/Visitor Parking Lot (Facing South).

The roadway to the middle school bus drop-off/pick-up zone also leads to the roadway surrounding the intermediate school. The surrounding roadway accesses the intermediate school employee parking lot and bus drop-off/pick-up zone. The roadway also allows for buses to traverse from the primary driveway, Driveway 1, to secondary school site driveway, Driveway 2.

The main roadway from the state highway leads past the middle school to the intermediate school parent drop-off/pick-up zone and administration/visitor parking lot, located at the front (and east) of the school. A gate separating the parent and bus drop-off/pick-up zones closes the main roadway. Figures 7-115 through 7-117 show the general layout, pavement markings, and signing associated with the intermediate school facilities.

Figure 7-115. The Intermediate School Parent Drop-Off/Pick-Up Zone (Facing South).

Figure 7-116. Gate Closing the Main School Site Roadway and the Intermediate School Bus Drop-Off/Pick-Up Zone (Facing South).

Figure 7-117. The Intermediate School Bus Drop-Off/Pick-Up Zone (Facing Northwest).

The majority of buses servicing the schools enter and exit the school grounds through Driveway 2, which is located at the local road and south of the school site. This driveway is used exclusively for bus operations and is gated closed when buses are not actively servicing the schools.

Morning Drop-Off Period, Intermediate School

Classes at the intermediate school started at 7:45 a.m.; students began arriving at the school at approximately 7:20 a.m. Parents dropped students off at the parent drop-off/pick-up zone in front of the school accessed by Driveway 1. Buses utilized the bus drop-off/pick-up zone adjacent to the parent drop-off/pick-up zone accessible by Driveway 2. There were no significant queues entering the drop-off zone at Driveway 1; however, a queue of approximately 12 vehicles developed entering the site from westbound state highway (Figure 7-118). A queue of approximately eight vehicles developed exiting the site through the main driveway (Figure 7-119).

After 7:30 a.m., traffic entering and exiting Driveway 1 significantly increased. The traffic at the school during the morning drop-off period lasted until 7:45 a.m. The vehicles exiting Driveway 1 at this time encountered more activity at the three-leg intersection state highway. This coincided with the beginning of the morning period for the middle school (Figure 7-120).

Figure 7-118. The Intermediate School Vehicles Queue as They Gain Entry onto School Site from State Highway.

Figure 7-119. The Intermediate School Main Driveway Queue during the Morning Period.

Figure 7-120. The Intermediate School End of Morning Period Coinciding with Beginning of Morning Period for Middle School.

Afternoon Pick-Up Period, Intermediate School

Classes at the intermediate school let out at 3:00 p.m. No significant queue developed on the state highway or exiting the site. As observed during the morning period, buses entering through Driveway 2 picked up students at the bus pick-up/drop-off zone adjacent to the parent pick-up/drop-off zone. Students boarded onto the buses stationed on two lanes. When the buses were loaded, they exited the school site through Driveway 2 onto the local road. The local road connected back to the state highway at two points – east and west of the main driveway – on the north side of the school site. No major pedestrian activity occurred during the afternoon pick-up period.

Other Observations, Intermediate School

Researchers collected arrival and departure information at the intermediate school to determine the drop-off and pick-up service time. Figure 7-121 presents the morning operations at Driveway 1. Based on a sample size of 50 vehicles arriving between 7:29 and 7:38 a.m., the average service time was 2 minutes and 21 seconds.

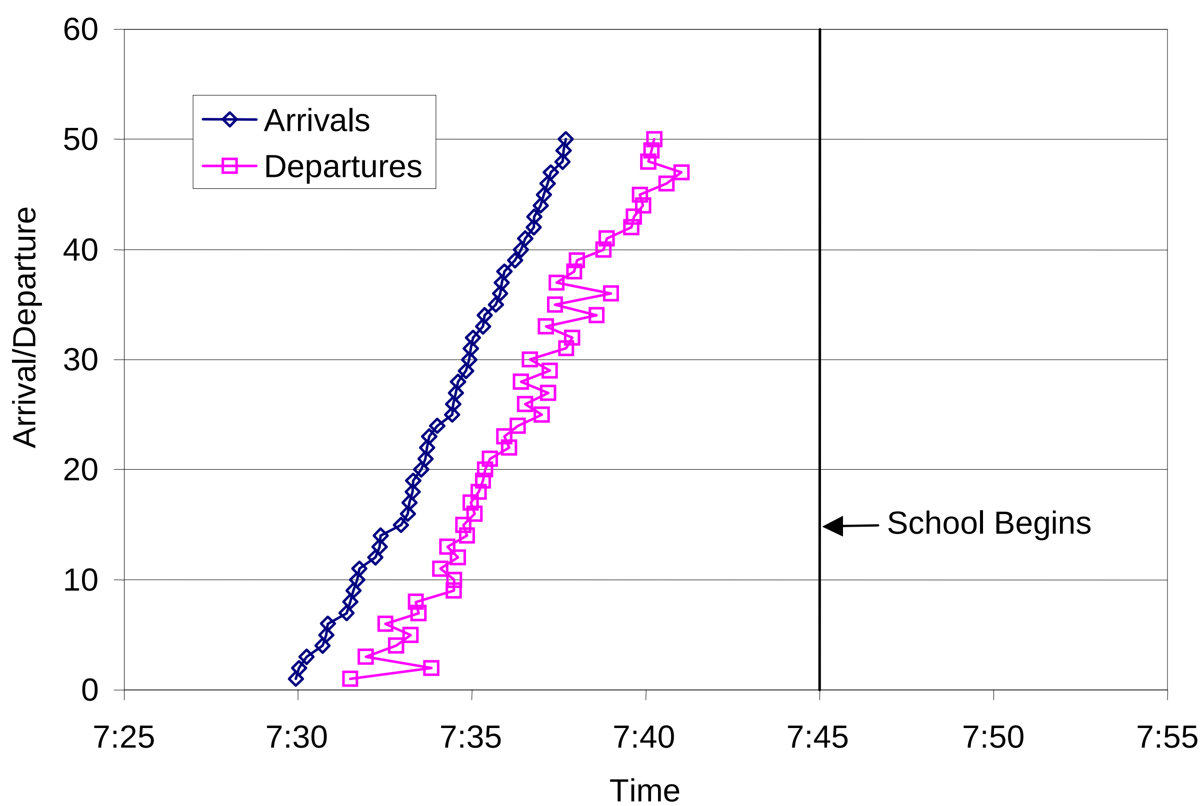


Figure 7-121. Intermediate School Driveway 1 Arrival/Departure Operations during the Morning Period.

Figure 7-122 presents afternoon operations at Driveway 1. Based on a sample size of 50 vehicles arriving between 2:52 and 3:08 p.m., the average service time was 3 minutes and 24 seconds.

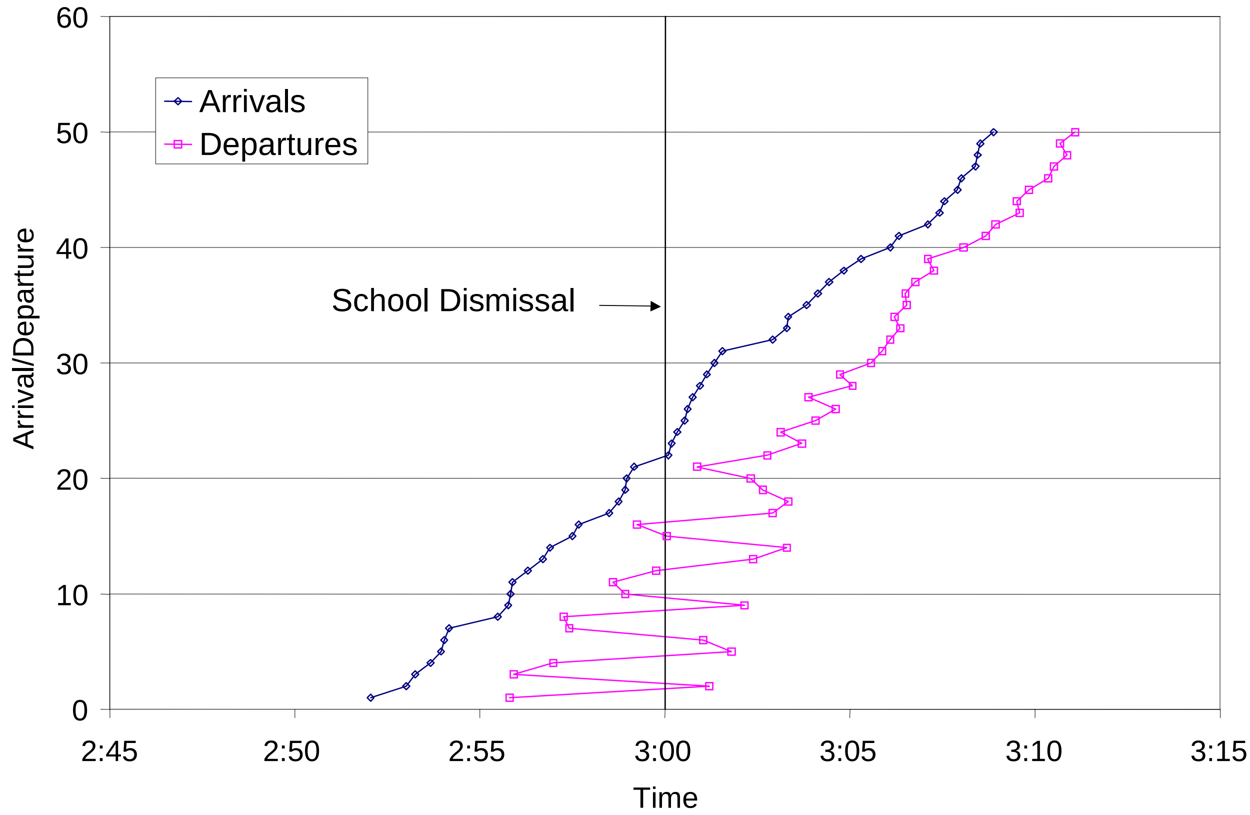


Figure 7-122. Intermediate School Driveway 1 Arrival/Departure Operations during the Afternoon Period.

Morning Drop-Off Period, Middle School

Classes at the middle school start at 8:30 a.m.; students began arriving at the school at approximately 7:50 a.m. Parents dropped students off at the parent drop-off/pick-up zone in front of the school by entering the westbound entrance into the middle school at the three-leg intersection on Driveway 1. Buses dropped students off at the bus drop-off/pick-up zone on the south side of the school.

A queue entering the parent drop-off/pick-up zone developed at the entrance to the middle school driveway and spilled back onto the state highway. The queue on the state highway consisted of approximately 15 vehicles and was stored in the TWLTL. The queue affected operations for parents arriving late to drop off students at the intermediate school (Figure 7-123).

After 7:50 a.m., traffic entering and exiting the main driveway significantly increased. Parents dropped students off at the parent drop-off/pick-up zone where teachers assisted in the operations (Figure 7-109). Long queues developed exiting the school site at Driveway 1. Vehicles began to queue at the exit to the middle school driveway and extended half way back to the drop-off zone (Figure 7-120). The traffic at the school during the morning drop-off period lasted until 8:35 a.m.

Figure 7-123. The Middle School Queue Entering the School Site.

Afternoon Pick-Up Period, Middle School

Classes at the middle school let out at 3:30 p.m. A small queue from the intermediate school was still present at the exit of Driveway 1, and consequently contributed to developing the queue exiting the middle school driveway. The queue exiting the middle school driveway began at 2:50 p.m. and lasted until 3:45 p.m. The queue from the westbound approach on the state highway consisted of approximately 12 vehicles and was contained in the TWLTL. As a result of the TWLTL, traffic traveling westbound on the state highway was minimally affected. The queue exiting the site through the main driveway was contained entirely within the school grounds. Parents desiring to travel west on the state highway encountered some difficulty traversing the eastbound lane. This difficulty could be attributed to limited sight distance created by the 12-vehicle queue stored in the TWLTL along with small gaps between vehicles traveling east on the state highway.

Only buses were allowed at the rear pick-up zone (Figure 7-100). They gained entry to the bus drop-off/pick-up zone through Driveway 2 via the local road. The buses were stationed on a single lane where students were loaded. Once the buses were loaded, they exited the school site through Driveway 2. Once on the local road, the buses could gain access to the state highway. No major pedestrian activity occurred during the afternoon pick-up period.

Other Observations, Middle School

Researchers collected arrival and departure information at the school to determine the drop-off or pick-up service time. Figure 7-124 presents morning operations at the middle school driveway. Based on a sample size of 50 vehicles arriving between 8:01 and 8:10 a.m., the average service time was 3 minutes and 28 seconds.

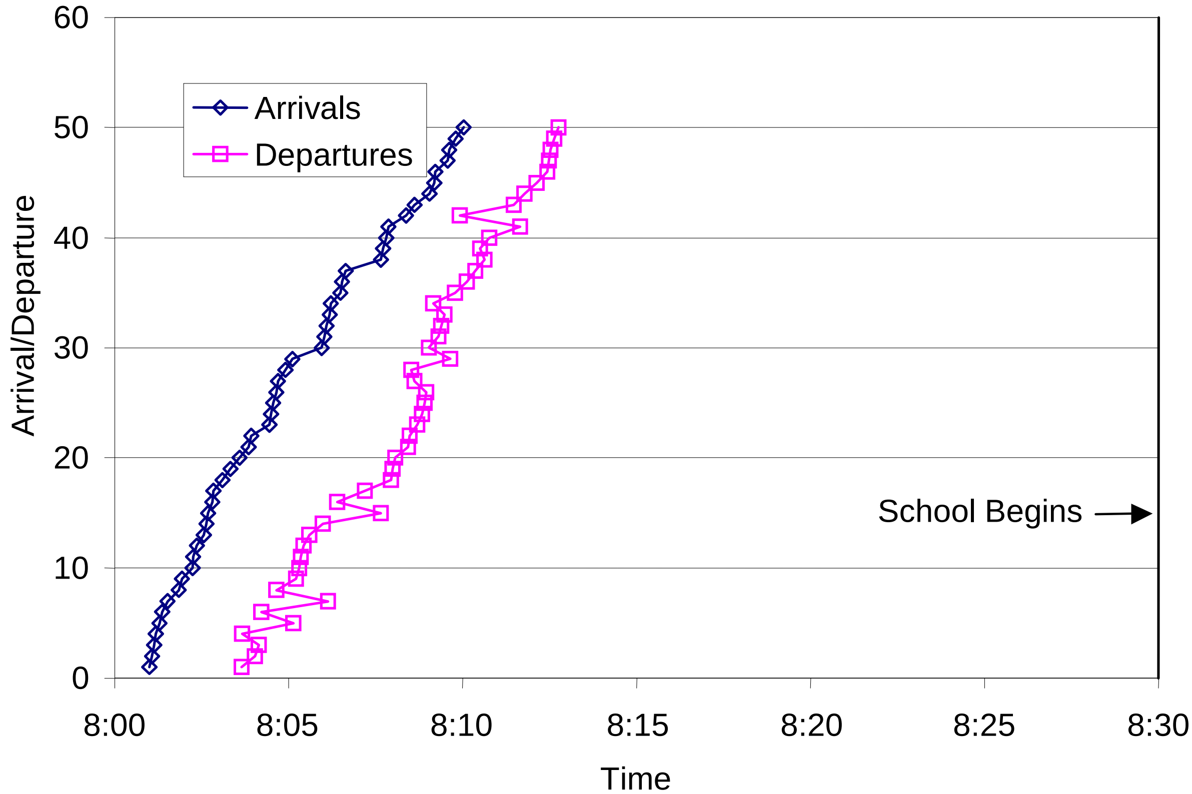


Figure 7-124. The Middle School Driveway Arrival/Departure Operations during the Morning Period.

Figure 7-125 presents afternoon operations at the middle school driveway. Based on a sample size of 50 vehicles arriving between 3:37 and 3:53 p.m., the average service time was 6 minutes and 55 seconds.

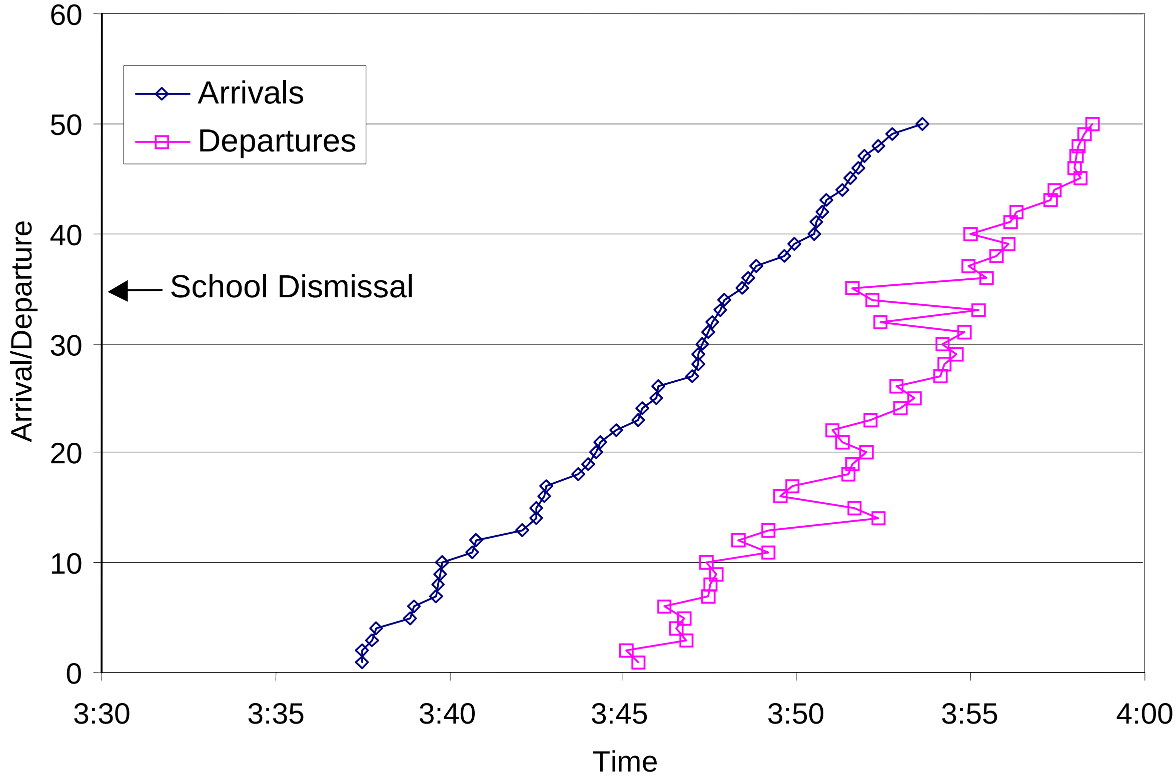


Figure 7-125. The Middle School Driveway Arrival/Departure Operations during the Afternoon Period.

MIDDLE SCHOOL, CASE STUDY SITE 2

Background

Middle school case study site 2 is located on a four-lane urban collector roadway that runs through a major urban area in Texas. The roadway has a divided raised median or a two-way left-turn lane in the vicinity of the school. There is currently an existing student population of 1225 with a maximum of 1300 students at this middle school. One hundred faculty and staff are employed at the school and arrive before the students. According to the school, approximately 75 percent of the students use the 19 buses serving the school. Approximately 20 percent of the students arrive by automobile, 5 percent walk, and less than 1 percent bicycle to school. The school hours are between 8:30 a.m. to 3:30 p.m.

Researchers conducted a traffic observation study on May 17 and 24, 2002, using the video data collection technique (see Table 7-2). Rain showers during the morning period on May 17 prevented TTI staff from collecting data during the morning drop-off period that same day. At 2:30 p.m., one video camera was set up across the school campus focusing on the primary driveway accessing the parent drop-off/pick-up zone at the school. TTI returned to the school site on May 24, 2002, to complete the morning traffic observation, including videotaping, recording vehicle information, and taking digital photographs.

Field Observations

Two driveways are the access points between the urban collector and the middle school (see Figure 7-126). The eastern driveway, Driveway 1, is used for parent drop-off/pick-up and for accessing the administration/visitor parking lot. The western driveway, Driveway 2, is used for bus drop-off/pick-up and for accessing the employee parking lot. A roadway exists behind the school and serves as an emergency fire lane.

1 Driveway 1

2 Driveway 2

3 Parent drop-off/pick-up zone

4 Bus drop-off/pick-up zone

5 Administration and visitor parking

6 Employee parking

7 Emergency fire road

Figure 7-126. The Middle School Case Study Site 2 Layout (Base Aerial Photograph from GlobeXplorer (*45*)).

The road is a four-lane urban collector divided by a raised median. The raised median becomes a TWLTL in front of the school and between driveways. The section of roadway directly in front of the school is designated as a school zone and has a speed limit of 20 mph (32km/h) during morning drop-off and afternoon pick-up periods. The regulatory speed of the road is 40 mph (64 km/h). Standard school zone signing exists on both directions of the road, including School Advance signs on both sides of the roadway and a School Speed Limit sign with flashing beacons and a When Flashing plaque on the right side of the roadway. The end of the school zone is designated by 40 mph (64 km/h) speed limit signs. Nine No Parking This Side In This Block signs are displayed on both sides (five on the school side) of the road (Figure 7-127).

Figure 7-127. Parking Restriction Signing (Facing Northeast).

A 420 ft (128 m) TWLTL is located on the collector in front of the school between Driveway 1 and Driveway 2. The TWLTL allows for turning movements from the driveways and is marked with the standard pavement markings. A left-turn bay is provided on the section of raised median-separated road to the east of Driveway 1. The left-turn bay length, including taper, is 185 ft (56 m) and a Keep Right symbol sign is located in the median. A sidewalk exists on the school side of the road and is continuous to residential neighborhoods to the east of the school.

Driveway 1 is the eastern-most driveway and serves the parent drop-off/pick-up zone and the administration/visitor parking lot. Figures 7-128 through 7-133 show the general layout, pavement markings, and signing associated with Driveway 1, the administration/visitor parking lot, and the parent drop-off/pick-up zone.

Driveway 1 is a two-way driveway that splits between a parking lot and a one-way road traveling around the parking area and through the drop-off/pick-up zone. Traffic cones were placed in the administration/visitor parking lot entrance to restrict vehicles exiting the parking area to enter the one-way entrance upstream of the drop-off zone (7-130), preventing vehicles from traveling the wrong way.

Figure 7-128. Driveway 1 (Facing Southeast).

Figure 7-129. Driveway 1 (Facing Northeast).

Figure 7-130. Driveway 1 Entrance to the Administration/Visitor Parking Lot and the Parent Drop-Off/Pick-Up Zone (Facing Southwest).

Figure 7-131. Parent Drop-Off/Pick-Up Zone (Facing Northeast).

Figure 7-132. Administration/Visitor Parking Lot (Facing South).

Figure 7-133. Driveway 1 (Facing North).

Driveway 2 serves the bus drop-off/pick-up zone and the employee parking lot. Driveway 2 also serves for deliveries and access to the cafeteria and an emergency fire lane roadway behind the school. Figures 7-134 through 7-139 show the general layout, pavement markings, and signing associated with Driveway 2, the bus drop-off/pick-up zone, and the employee parking lot.

Figure 7-134. Driveway 2 (Facing Southeast).

Figure 7-135. Driveway 2 (Facing Northeast).

Figure 7-136. Access to the Cafeteria with the Employee Parking Lot and Bus Drop-Off/Pick-Up Zone in the Background (Facing South).

Figure 7-137. Employee Parking Lot (Facing Southwest).

Figure 7-138. Bus Drop-Off/Pick-Up Zone (Facing Southeast).


Figure 7-139. Driveway 2 (Facing Northwest).

Morning Drop-Off Period

Classes at this middle school started at 8:30 a.m. and students regularly arrived at the school at approximately 7:30 a.m. From 7:30 to 8:10 a.m., students were dropped off at the drop-off zone in front of the school accessed by Driveway 1. At 8:10 a.m., traffic to the school and on the road in front of the school significantly increased and vehicles entering into the drop-off zone started to queue onto the road. The queue was primarily caused by the vehicles waiting to turn left from Driveway 1 onto the road (Figure 7-140). At this time, students were also being dropped off onto the sidewalk in front of the school. Queuing developed on the curb lane of eastbound traffic on the road and extended upstream by approximately 20 vehicles, or 400 ft (122 m) from Driveway 1 and across Driveway 2. The significant queuing and congestion lasted until 8:30 a.m.

Some of the unsafe traffic operations observed at Driveway 1 during the morning drop-off period include:

- Some vehicles that dropped off students onto the sidewalk made U-turn movements across the second lane of traffic (Figure 7-141).
- Left-turning vehicles pulled out in front of through traffic due to limited sight distance (due to the vehicle queued on the eastbound curb lane), slow speeds of the through traffic (school zone speed limit of 20 mph [32 km/h]), and/or through traffic (from both directions) stopped for the left-turning vehicles.
- Left-turning vehicles from Driveway 1 and U-turning vehicles from the eastbound traffic on the road's curb lane queued onto the TWLTL (Figure 7-142).
- Left-turning vehicles from westbound traffic on the road to Driveway 1 queued across all lanes of eastbound traffic on the road (Figure 7-142).

Figure 7-140. Driveway 1 Queue during the Morning Period.

Figure 7-141. Queue in the TWLTL during the Morning Period.

Figure 7-142. Driveway 1 Blockage of Through Traffic during the Morning Period.

Buses used Driveway 2 to drop off students in the bus drop-off zone in the western part of the school. Only a few parents used this driveway to drop off students at the driveway location. Two operational problems associated with Driveway 2 were observed due to the queuing upstream of Driveway 2 on eastbound traffic on the road. In some cases, buses traveling on the outside lane of eastbound traffic on the road took a right turn across traffic queued in the curb lane. Additionally, vehicles desiring access to Driveway 1, or the sidewalk in front of the school, queued across and blocked Driveway 2.

Afternoon Pick-Up Period

Classes at this particular middle school let out at 3:30 p.m. A queue developed at Driveway 1 on the road at 3:15 p.m. and lasted until 3:45 p.m. (Figure 7-143). The queue on eastbound traffic on the road extended past the school zone (approximately 40 vehicles or 900 ft (275 m) upstream of Driveway 1) and disrupted others traveling in the same direction. The same unsafe problems associated with Driveway 1 during the morning operations existed during the afternoon operations. During the afternoon period, vehicles parked on the road in front of the school for a longer period of time (waiting for students), increasing the disruption of through vehicles headed eastbound on the road. Additionally, vehicles queued downstream of Driveway 1 caused problems for right-turning vehicles exiting the school site at Driveway 1.

Figure 7-143. Queue on Access Road during the Afternoon Period.

Only buses are allowed at the bus pick-up zone accessed by Driveway 2. At the pick-up zone, buses were stationed on two lanes where students were loaded (Figure 7-138). During the afternoon period, vehicles queued on the roadway (a designated fire lane) associated with Driveway 2. This caused problems when buses were exiting and entering Driveway 2 at the same time.

The problem of buses taking a right turn across traffic queued in the curb lane was more prevalent during the afternoon period (Figure 7-144). Buses exited the school using Driveway 2, and most of the buses departed the school at the same time. During this operation, through vehicles on the road stopped to let groups of buses turn left. It was observed that buses would accept this courteous, but potentially inappropriate, operation (Figure 7-145).

Figure 7-144. A Bus Turning Right into Driveway 2 across Queued Traffic.

Figure 7-145. A Through Vehicle Stopping for Left-Turn Bus Traffic.

The major pedestrian activity was when students were dropped off or picked up on the road. Students would wait along the sidewalk to be picked up or cross Driveway 1 or 2 to be picked up or walk home. The only pedestrian marking was placed across the parent drop-off/pick-up zone from the school to the administration/visitor parking lot (Figure 7-146). A bike rack was placed in front of the school in the same area (Figure 7-147).

Figure 7-146. The Crosswalk from School to Administration/Visitor Parking Lot.

Figure 7-147. The Bike Rack in Front of School.

Other Observations

Researchers determined arrival and departure information at the school to determine the drop-off or pick-up service time. Figure 7-148 presents morning operations at Driveway 1. Based on a sample size of 50 vehicles arriving between 8:13 and 8:25 a.m., the average service time was 2 minutes and 57 seconds.

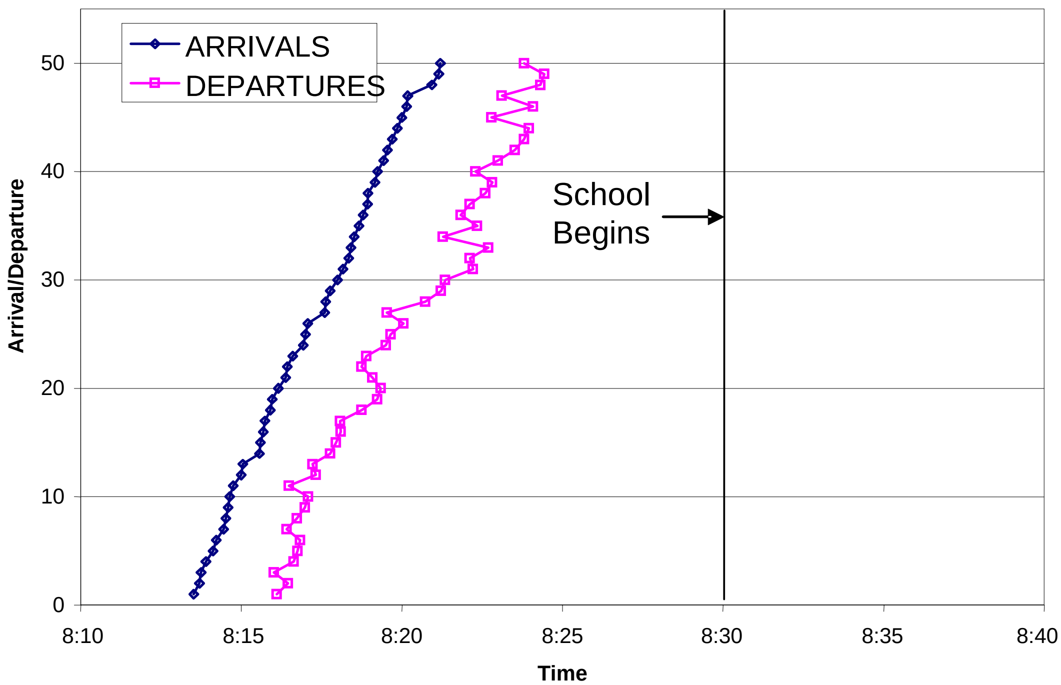


Figure 7-148. Driveway 1 Arrival/Departure Operations during the Morning Period.

Figure 7-149 presents afternoon operations at Driveway 1. Based on a sample size of 50 vehicles arriving between 3:33 and 3:50 p.m., the average service time was 3 minutes and 37 seconds.

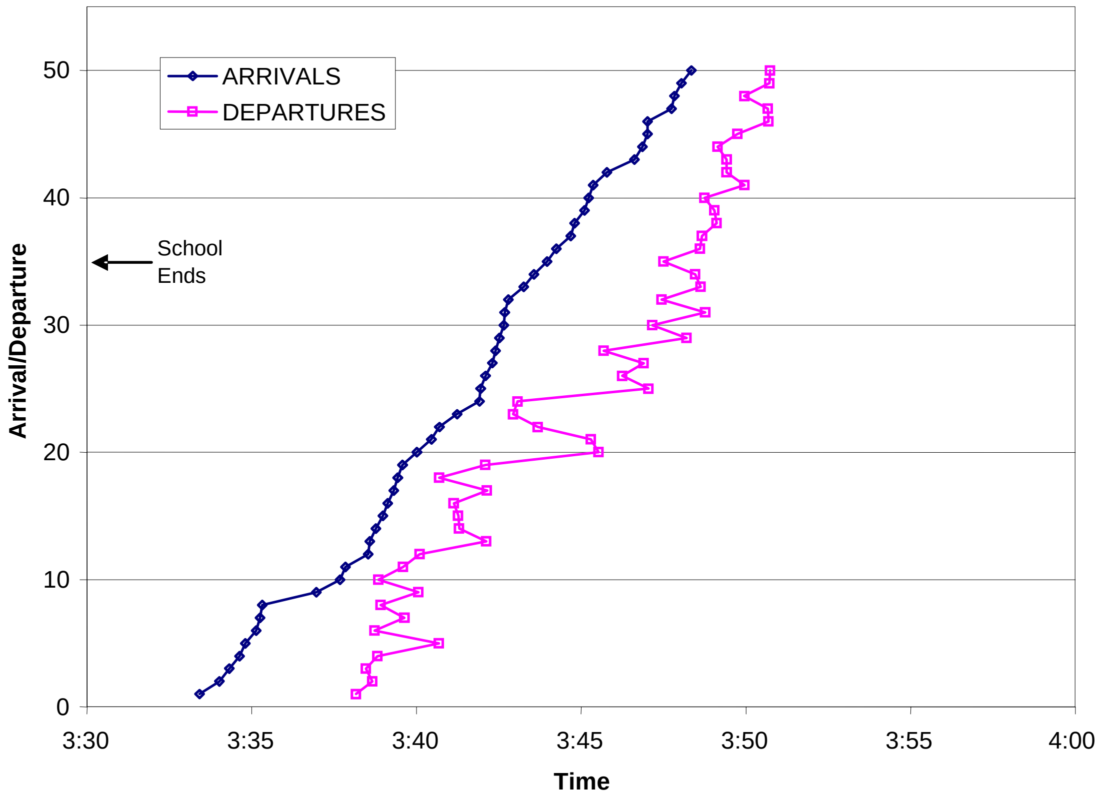


Figure 7-149. Driveway 1 Arrival/Departure Operations during the Afternoon Period.

MIDDLE SCHOOL, CASE STUDY SITE 3

Background

Middle school case study site 3 serves seventh and eighth grades and currently has an existing student population of 650 students. Sixty-six faculty and staff are employed at the school. According to the school, approximately 35 percent of students use the 14 buses serving the school. Thirty percent of the students arrive by automobile, and the remainder either walk or ride a bicycle to school. The normal school hours are from 8:25 a.m. to 3:30 p.m. Researchers conducted a traffic observation study at this middle school on May 15, 16, and 23, 2002, using the laptop computer data collection technique (see Table 7-2).

Field Observations

The entrance to this intermediate school faces a five-lane arterial with a center turn lane. Figure 7-150 shows an aerial view of the school; Figure 7-151 shows a drawing. The school speed zone is 25 mph (40 km/h) and the regulatory speed limit is 40 mph (64 km/h) on the road in front of the school. There are four main driveways to this middle school that provide access from the arterial. Driveway 1 is used by the buses and by the staff. Driveways 2 and 3 are used for the entrance and exit to the semicircle in front of the school. Driveway 4, which extends all the way down the west side of the school building, is used as an entrance and exit for parent pick-up and drop-off.

Figure 7-150. Aerial View of the Middle School Case Study Site 3 (*47*).

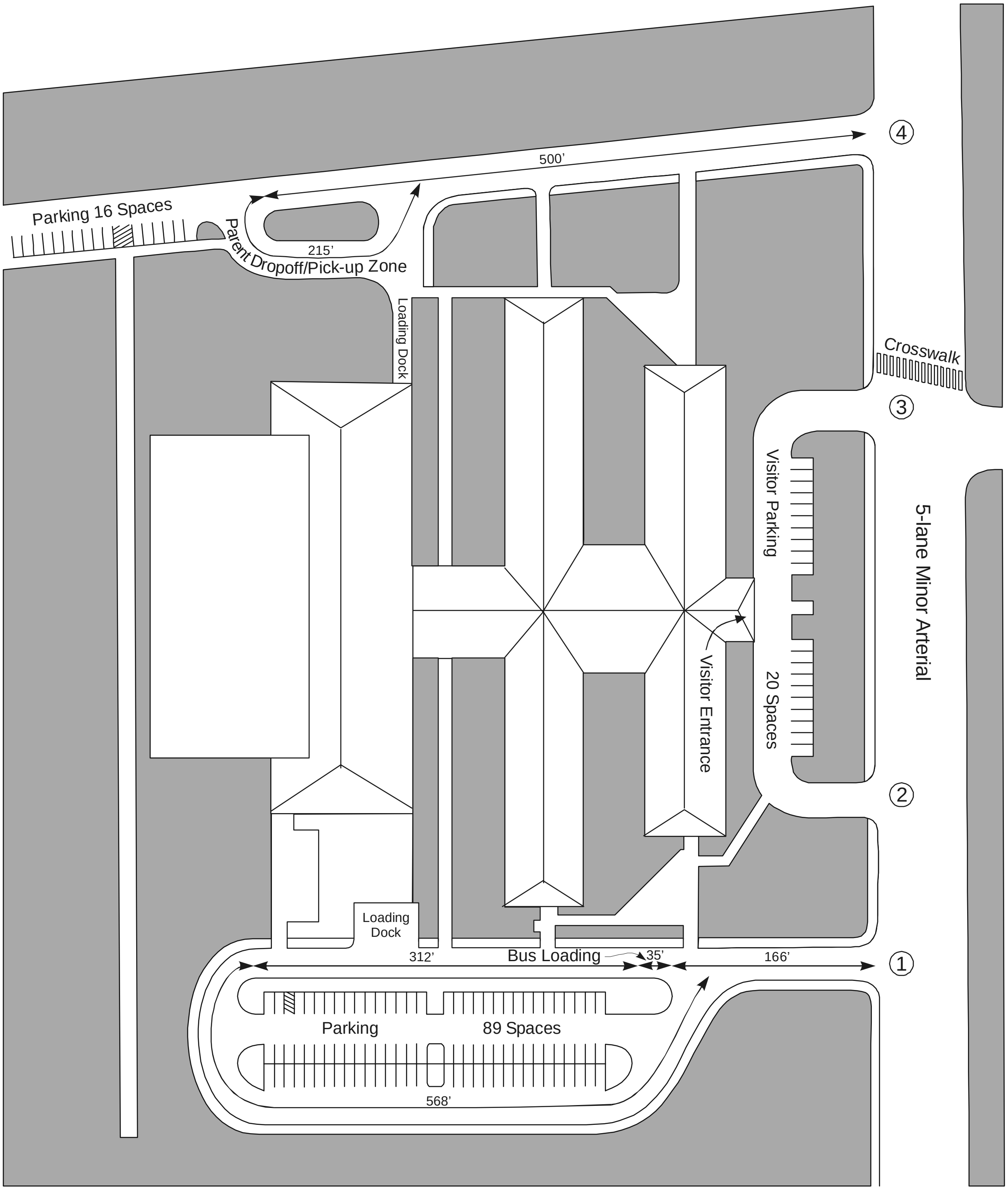


Figure 7-151. The Middle School Case Study Site 3 Layout.

Bus-Loading Zone

The bus loading zone is accessed by Driveway 1, used for both entrance and exit (Figure 7-152). The driveway has one very wide entrance lane and one exit lane. When entering the parking lot, buses continue forward and stop at the bus-loading zone. Figure 7-153 shows the bus-loading zone. After the buses load/unload, they loop around the parking lot to the driveway. When the faculty and staff members enter this driveway to access their parking lot, they turn left from the entrance driveway to enter the parking lot. The parking lot has two medians; one median separates the bus-loading zone from parking, and the other median divides the parking lot (Figure 7-154).

Figure 7-152. Entrance and Exit Driveway to the Bus/Faculty Parking Lot.

Figure 7-153. The Bus Drop-Off Zone.

Figure 7-154. A View of the Bus/Faculty Parking Lot.

Morning Drop-Off Period. During the morning drop-off period, buses and faculty entered around the same time. The 14 buses that serve this middle school arrived between 7:46 and 8:09 a.m. Figure 7-155 shows the bus arrival/departure data for the morning drop-off period. A few faculty members stood outside to assist the children. Several students were dropped off from private automobiles in the parking lot, though cars were supposed to utilize another drop-off location. Approximately 62 cars entered this parking lot during the study period.

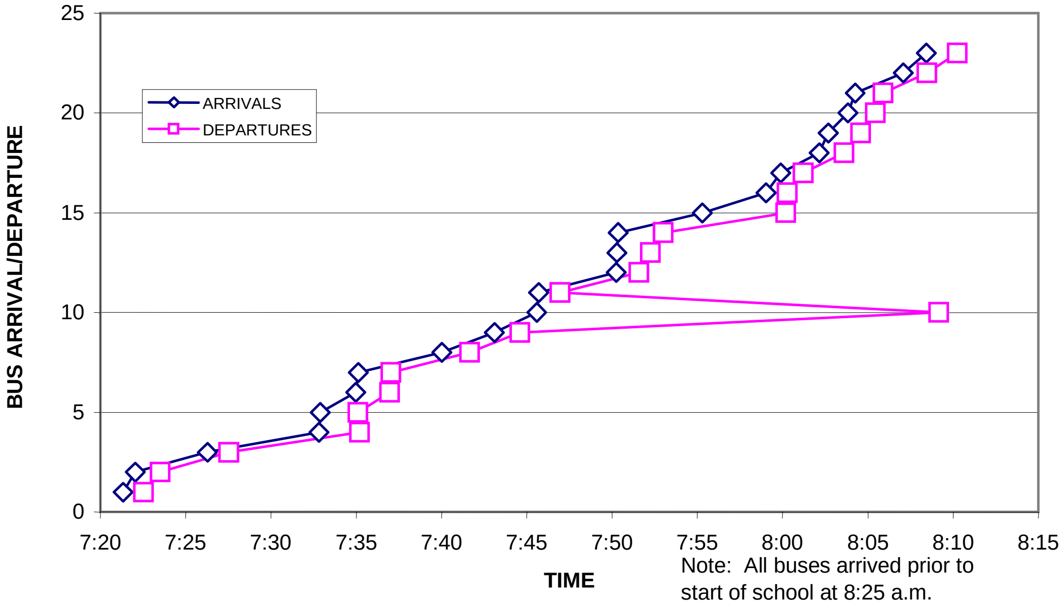


Figure 7-155. Arrival/Departure Operations at Bus/Faculty Parking Lot Drop-Off Zone during the Morning Period.

Afternoon Pick-Up Period. In the afternoon, the traffic is very light through this parking lot. Faculty members are stationed outside with the students until the buses come to pick the children up. The traffic in this lot is heavy from 3:06 to 4:00 p.m. (see Figure 7-156). Fourteen buses picked up students in the afternoon, while 11 cars were observed entering and exiting in the afternoon.

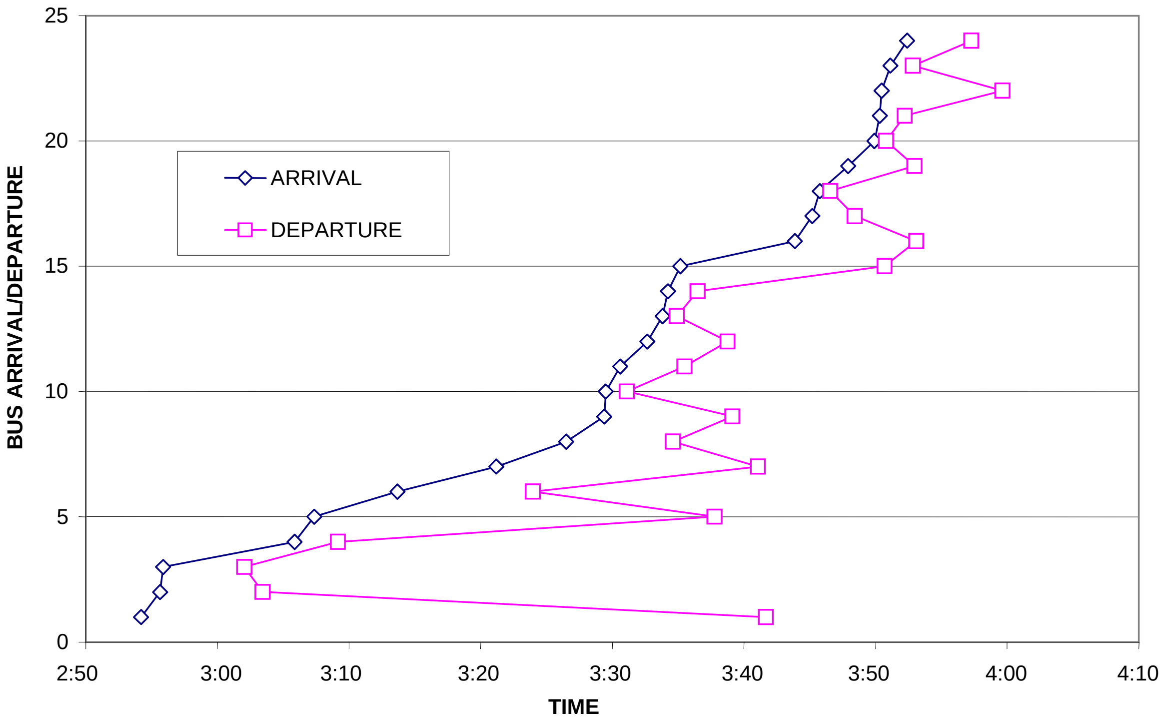


Figure 7-156. Arrival/Departure Operations at Bus/Faculty Parking Lot Pick-Up Zone during the Afternoon Period.

Visitor Semicircle

Driveways 2 and 3 in front of the school are the entrance and exit driveways to the semicircle (see Figures 7-157 through 7-159). Figure 7-159 shows the exit from the visitor semicircle. The circle consists of one lane for through traffic (Figures 7-151 and 7-158). Twenty parking spaces for faculty, visitors, and the handicapped comprise the parking lot. Parents are requested not to drive through this circle to drop off/pick up children (none were observed).

Figure 7-157. Entrance Driveway to the Visitor Semicircle.

Figure 7-158. A View of the Through Lane and Parking Area in the Visitor Semicircle.

Figure 7-159. The Exit to the Visitor Semicircle, Driveway 2.

A few passenger cars and buses used this semicircle for pick-up in the afternoon. Two buses and 22 passenger cars were observed using the pick-up point. Figure 7-160 shows the arrival/departure data in the visitor semicircle for afternoon pick-up. No supervision was provided.

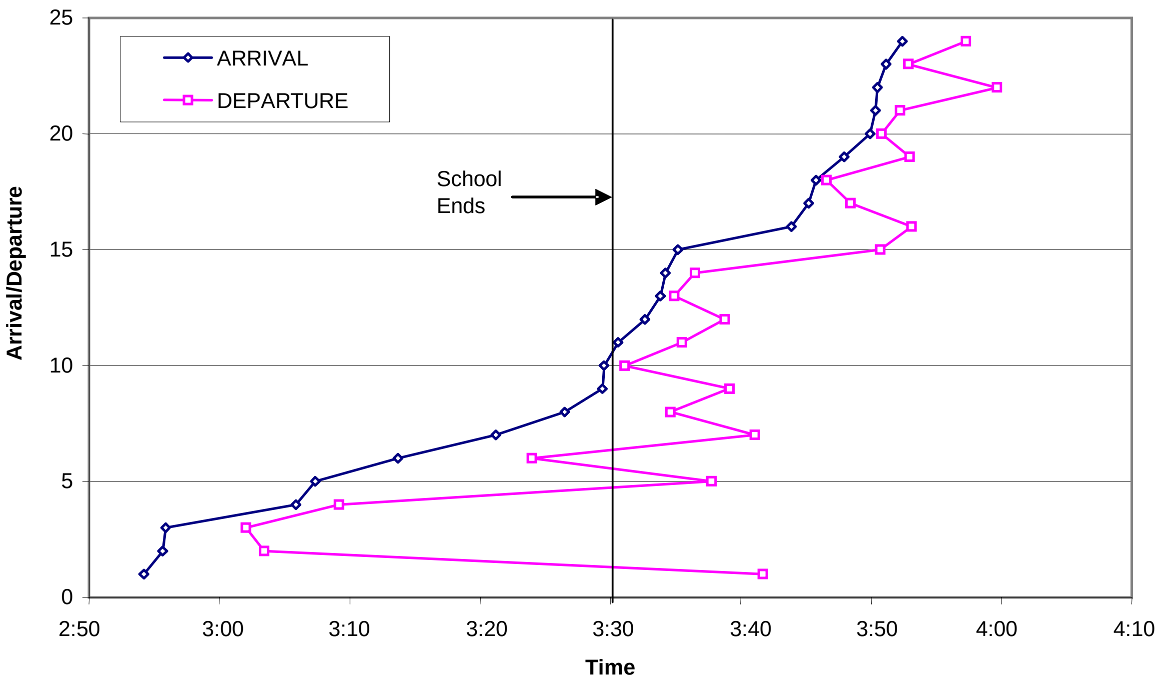


Figure 7-160. Arrival/Departure Data for the Afternoon Pick-Up in the Visitor Semicircle.

Parent Drop-Off/Pick-Up Zone

Driveway 4 provides access to the parent drop-off zone and a small parking lot (Figure 7-161). At the end of a long entrance lane, drivers are faced with the option of continuing forward to park or turning left to enter the drop-off loop (Figure 7-162). The parking area is very small and contains 16 parking spaces, including one handicapped space. Drivers must enter the small, two-lane wide drop-off loop to exit the parking lot (Figure 7-163). After exiting the loop, drivers proceed to the parking lot; the lot exit offers a lane for drivers to turn left and a lane for drivers to turn right (Figure 7-164). Limited sight distance at the marked stop position causes drivers to move forward until they can see oncoming traffic.

Figure 7-161. Entrance and Exit Driveway to the Drop-Off Parking Lot.

Figure 7-162. Arrows Illustrating the Options of Continuing to the Drop-Off Loop or Parking Area.

Figure 7-163. Two Lanes in the Drop-Off Zone Created by Yellow Center Stripe.

Figure 7-164. Two Exit Lanes for the Drop-Off Parking Lot, Driveway 4.

Morning Drop-Off Period. Most students are dropped off at the loop in the back of the school. Traffic increased in this parking lot between 7:40 and 8:11 a.m. Approximately 140 cars entered and exited this parking lot to drop off children in the morning. The average amount of time the cars were in the queue was 2 minutes and 44 seconds. The peak queue length left 12 cars on the road in both turn lanes accessing the parking lot. The queue lasted for a maximum of approximately 15 minutes. Figure 7-165 shows the arrival/departure data in the drop-off parking lot for the morning drop-off period. Teachers and staff members supervise the drop-off operation.

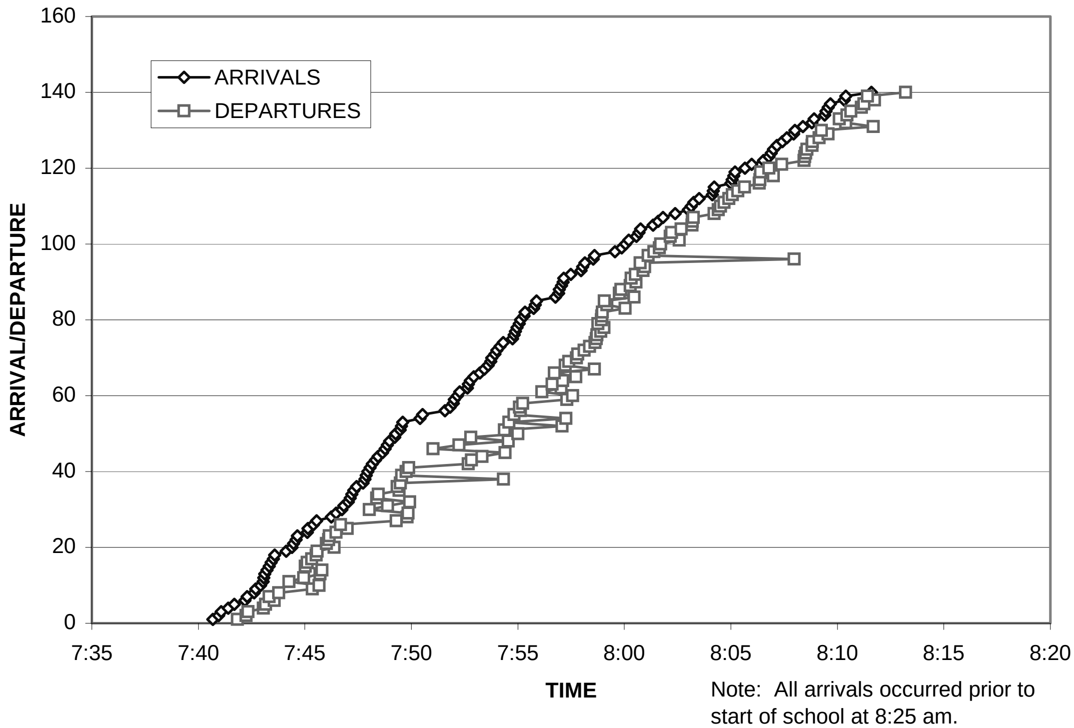


Figure 7-165. Arrival/Departure Operations in the Parent Parking Lot Drop-Off Zone during the Morning Period.

Afternoon Pick-Up Period. Students are usually picked up in the loop in the drop-off parking lot. Heavy traffic occurred from 3:34 to 4:02 p.m. Researchers observed 98 cars using the parking lot to pick up children from school. Figure 7-166 shows the arrival/departure data for the afternoon pick-up period in the parent drop-off parking lot. Teachers and staff members supervised the loading operation.

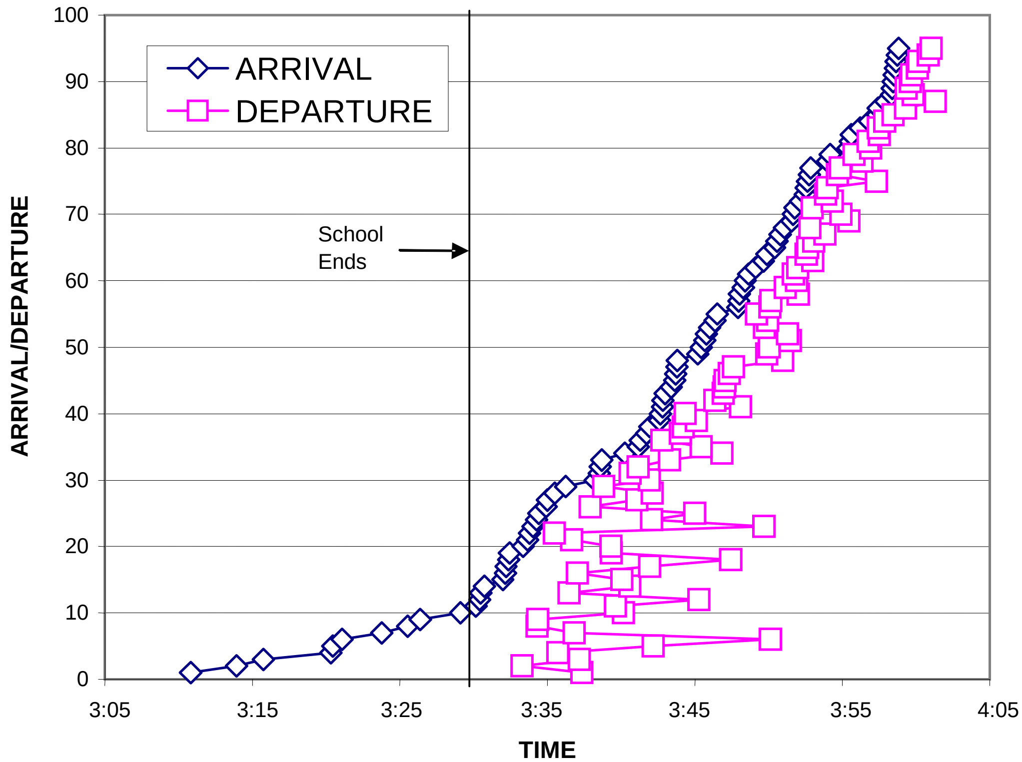


Figure 7-166. Arrival/Departure Operations at the Parent Drop-Off Parking Lot during the Afternoon Period.

Other Observations

An intersection with a residential street is located between the driveways to the school. There is a crosswalk at this intersection with a crossing guard. A large number of pedestrians use this crosswalk, including a few bicyclists walking their bicycles. Parents were observed stopping on the road in front of the school so their children could exit without entering the queues.

MIDDLE SCHOOL, CASE STUDY SITE 4

Background

Middle school case study site 4 serves fifth and sixth grade students and has an existing student population of 585 students. Fifty-two faculty and staff are employed at the school who arrive before and at the same time as the students. According to the school, approximately 41 percent of students use the 16 buses serving the school, 46 percent of the students arrive by automobile, 6 percent walk, and 7 percent ride a bicycle to school. The normal school hours are from 8:30 a.m. to 3:35 p.m. Researchers conducted a traffic observation study on May 13 and 14, 2002, using the laptop computer technique (see Table 7-2).

Field Observations

The entrances and exits to this middle school intersect a collector street (Figure 7-167). The collector has two lanes with a two-way left-turn lane in the center. It also has bike lanes and sidewalks on both sides. The school speed zone is 25 mph (40 km/h) and the regulatory speed limit is 45 mph (72 km/h). As shown in Figure 7-167, four main school driveways directly access this road: the entrance and exit to the faculty parking lot (Driveways 3 and 4), and the entrance and exit to the bus parking lot (Driveways 1 and 2). The site has one morning drop-off zone (west side of school) and three afternoon pick-up zones. The students are assigned pick-up zones based on their grades. The school added pick-up zones 2 and 3 when the line of cars at Parent Pick-Up Zone 1 consistently queued onto the collector road in front of the school.

The faculty parking lot located on the west side of the school building has entrance and exit Driveways 4 and 3, separated by a small median (Figure 7-168). The parent drop-off/pick-up zone is accessed from a roadway that circulates through the faculty parking lot. The drop-off/pick-up zone is separated by a median from the parking lot. After parents pass through the parking area, a loop leads them to the drop-off zone. The drop-off zone is a long straight path. When exiting the parking lot, cars form two lanes, one lane to turn left or proceed straight, and a lane to turn right. The faculty parking lot has 102 parking spaces.

The two additional driveways that provide access to this middle school are the entrance Driveway 2 and exit Driveway 1 to the bus and visitor parking lot (see Figure 7-167). The parking lot has both bus and passenger car traffic. A white line that begins at the entrance to the bus parking lot separates into a buses-only lane and a lane for passenger cars and Parent Pick-Up Zone 2 (Figures 7-169 and 7-170). There are 16 buses that serve this middle school. Twenty parking spaces for the faculty, visitors, and the handicapped comprise the bus parking lot. Figure 7-170 shows the drop-off/pick-up zone in the parking lot.

The exit to Parent Pick-Up Zone 2 is located at the end of the dividing line in the bus parking lot. The exit connects to a service road that leads to the back of the school and to Parent Pick-Up Zone 3 (Figure 7-171). Figure 7-172 shows the exit to the bus parking lot when facing the collector in front of the school. No traffic markings are provided to indicate turn movements.

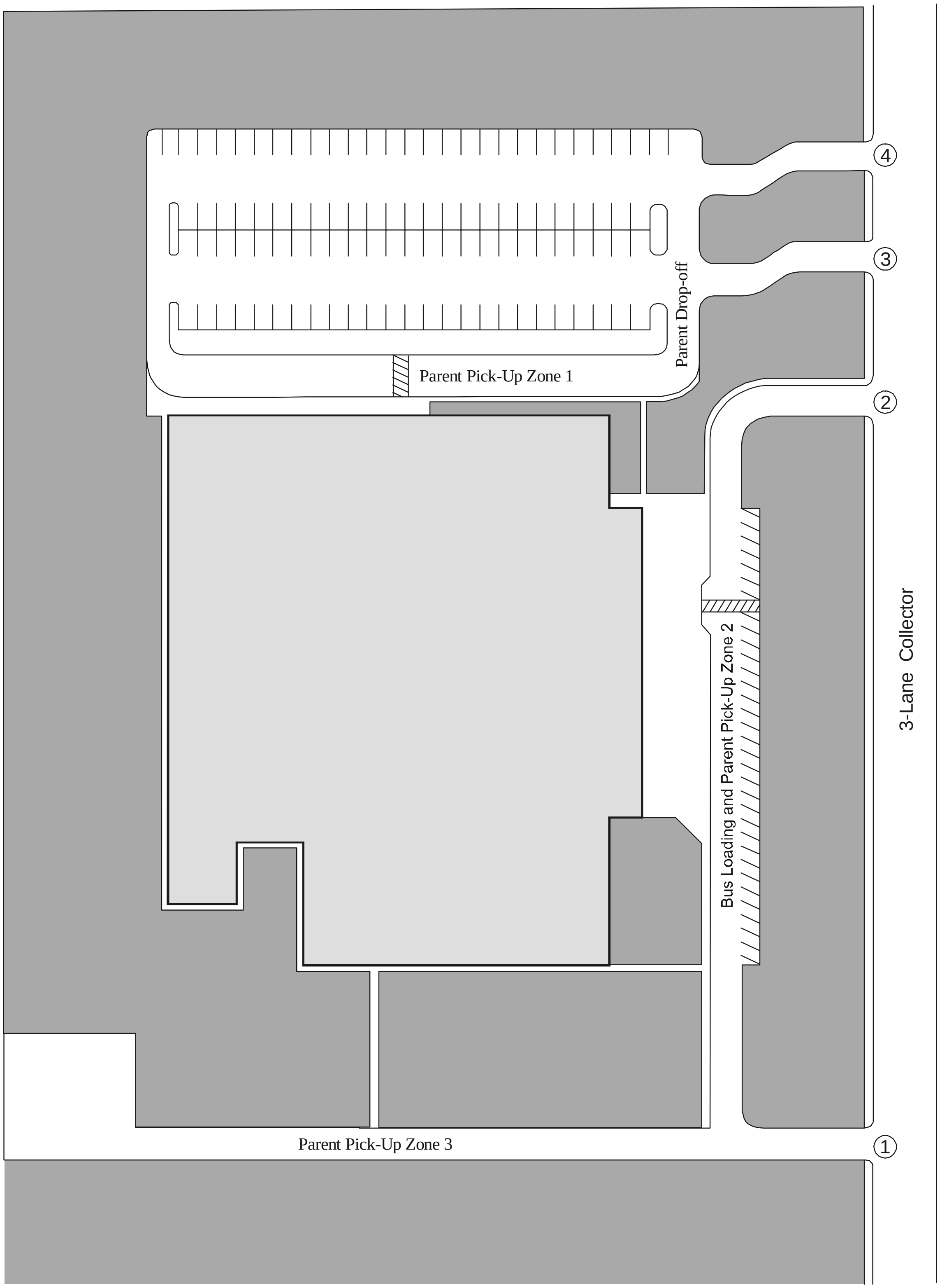


Figure 7-167. Middle School Case Study Site 4 School Layout.

Figure 7-168. Entrance (Driveway 4, Right) and Exit (Driveway 3, Left) to the Faculty Parking Lot and Parent Drop-Off Zone.

Figure 7-169. Entrance to the Bus and Visitor Parking Lot, Driveway 2.

Figure 7-170. Drop-Off Zone in the Bus and Visitor Parking Lot.

Figure 7-171. Service Road to Back of School and Parent Pick-Up Zone 3.

Figure 7-172. The Exit to the Bus Parking Lot and Service Road at Driveway 1, Facing the Street.

Morning Drop-Off Period

Most of the parents drop their children by the curved section of the curb in the faculty parking lot, allowing the children to enter the front of the building from the side (Figure 7-173). No faculty supervision was observed during the drop-off period. Some of the faculty members come to school at the same time as the students, using a crosswalk to cross the parent queue. The morning traffic in the faculty parking lot largely occurs between 7:30 and 8:30 a.m. The arrival/departure data for the morning drop-off period at the parent drop-off zone in the faculty parking lot are illustrated in Figure 7-174. In the morning, the traffic entering the faculty parking lot never queued onto the street, but exiting traffic would queue into the parking lot. Approximately 200 cars passed through the faculty parking lot during the morning drop-off period.

Figure 7-173. Drop-Off Zone in the Faculty Parking Lot at the Middle School.

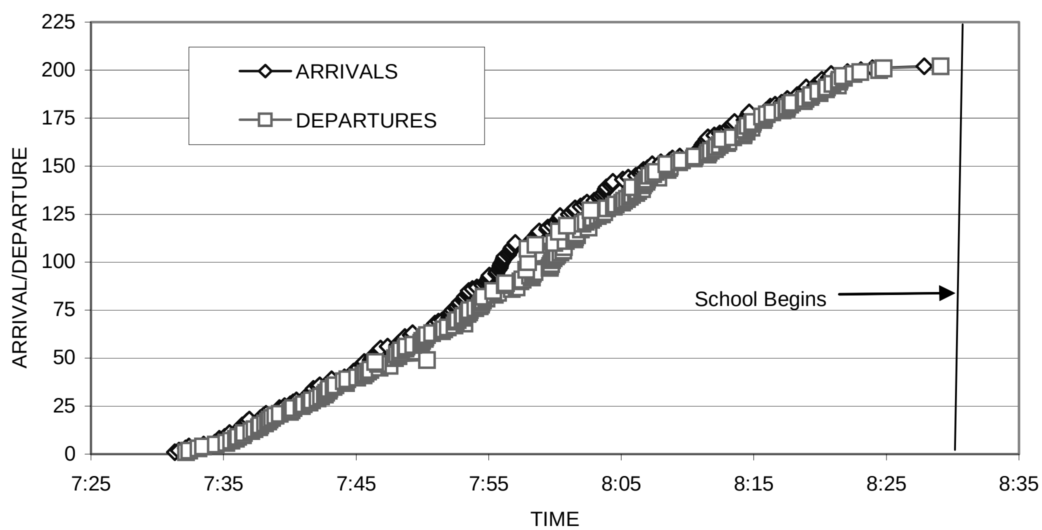


Figure 7-174. Arrival/Departure Operations at the Parent Drop-Off Zone in the Faculty Parking Lot during the Morning Period.

Afternoon Pick-Up Period at Parent Pick-Up Zone 1

Parents generally utilized the overhang segment located near the side door when they picked up their children at the Parent Pick-Up Zone 1 location (Figure 7-175). Faculty members were stationed outside with the students until the parents came to pick the children up, while other faculty members left at the same time as the children. The afternoon traffic in the faculty parking lot occurred between 3:05 and 3:55 p.m. (school is dismissed at 3:35 p.m.). In the afternoon, the cars began queuing shortly after 3 p.m. Figure 7-176 shows the arrival/departure data in the faculty parking lot for the afternoon pick-up period at Parent Pick-Up Zone 1. In the afternoon, approximately 80 cars passed through the faculty parking lot.

Figure 7-175. Pick-Up Zone in Faculty Parking Lot at Middle School.

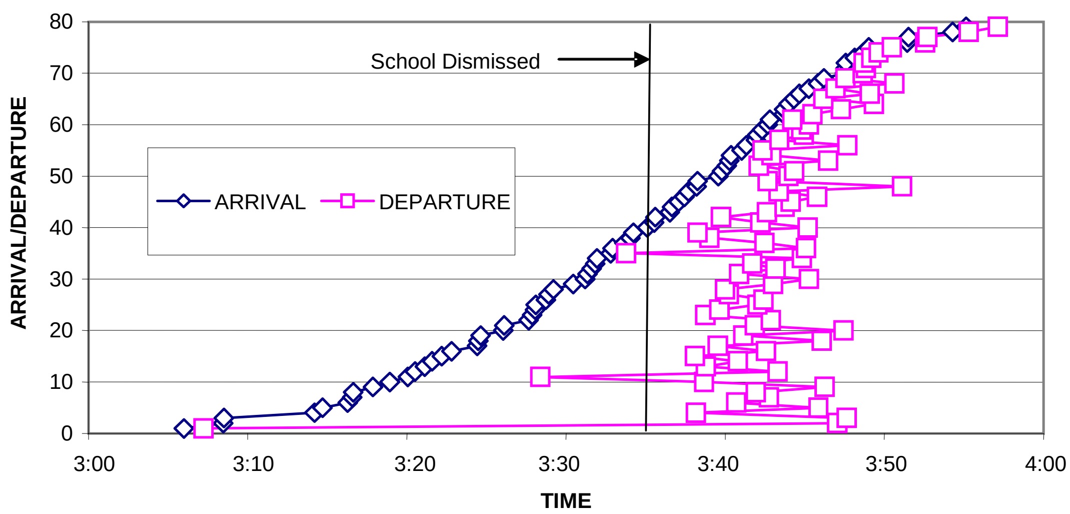


Figure 7-176. Arrival/Departure Operations at Parent Pick-Up Zone 1 in the Faculty Parking Lot during the Afternoon Period.

Morning Drop-Off Period for Buses

The morning traffic in the bus parking lot occurs between 7:35 to 8:30 a.m. The bus-loading zone is open to buses only, but sometimes parents use the zone to drop-off children (see Figure 7-177). The bus-loading zone processed approximately 85 buses and cars in the morning drop-off period. Faculty members were present to oversee the drop-off.

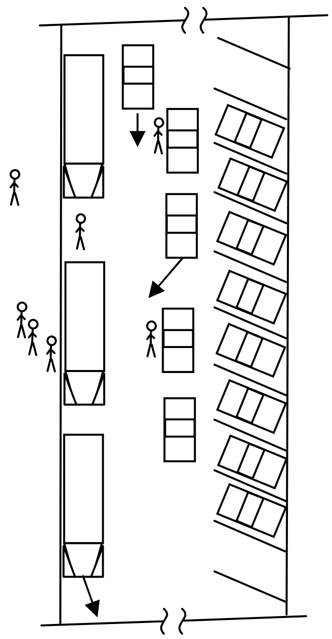


Figure 7-177. Pick-Up Operations at Bus Loading and Parent Pick-Up Zone 2.

Afternoon Pick-Up Period at Parent Pick-Up Zones 1 and 2

The afternoon traffic in the bus and visitor parking lot occurs between 2:55 to 4:00 p.m. Seventy cars and buses used the Parent Pick-Up Zones 2 and 3 for loading students (see arrival/departure data in Figure 7-178). Figure 7-177 shows a sketch of pick-up operations in the bus loading and Parent Pick-Up Zone 2. Because of concerns over the extensive queues that developed when only Parent Pick-Up Zone 1 was allowed, this zone was opened for use by parents. Supervision by faculty members was present, but the potential for conflicts remains high.

As shown in Figure 7-177, buses queue along the curb for loading and private automobiles queue along the left side of the roadway behind the parked vehicles. To gain access to their parents' cars, students walk through the line of buses and across the open lane. This open lane provides the only way for vehicles to leave the queuing area. Because students depart randomly, parents leave the queue when their child arrives at their vehicle. The only avenue for departure is to use the open lane through the middle of the loading zone. This lane also provides the only legal way of accessing Parent Pick-Up Zone 3 (seen in Figure 7-171).

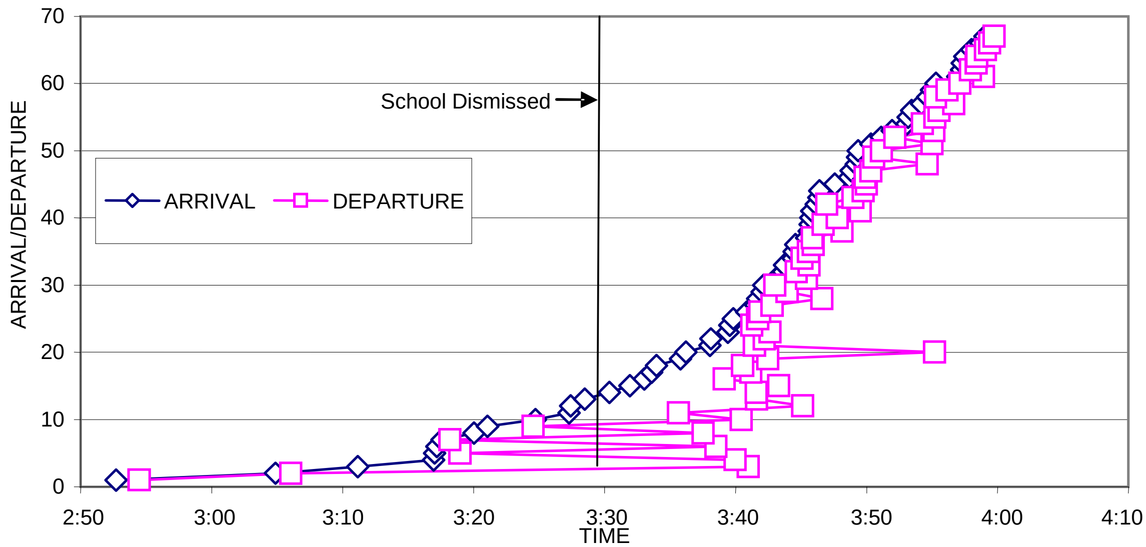


Figure 7-178. Arrival/Departure Operations at Parent Pick-Up Zones 1 and 2 during the Afternoon Period.

As shown in Figure 7-179, the legal entry for Parent Pick-Up Zone 3 is through the bus-loading zone. A number of vehicles enter through the exit (provided with a Do Not Enter sign), however, because of the congestion in the bus loading and Parent Pick-Up Zone 2.

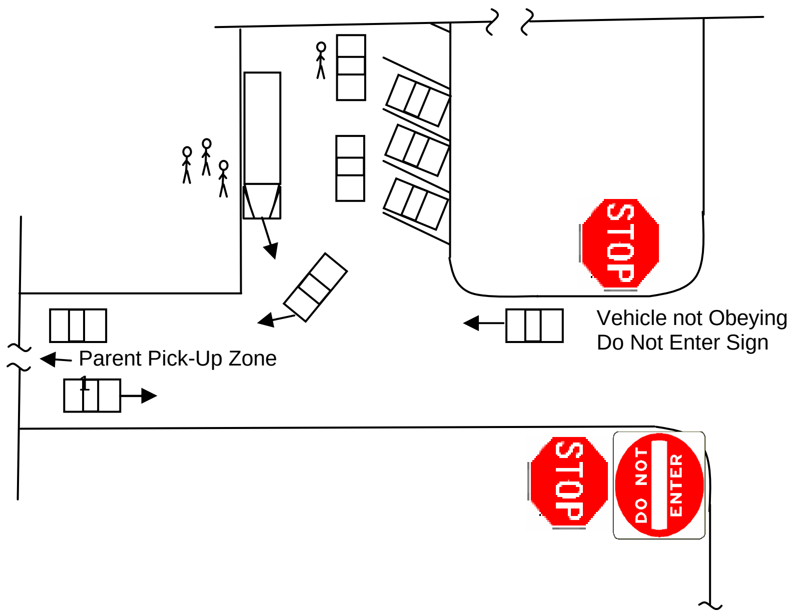


Figure 7-179. Entrance to Pick-Up Zone 1 and Departure Operations at Service Road.

The mixing of bus-loading operations and parent pick-up zones creates an increased opportunity for conflict between pedestrians and vehicles and also between vehicles. The use of marked exits as entrances could also lead to an increased risk of conflict.

MIDDLE SCHOOL, CASE STUDY SITE 5

Background

Middle school case study site 5 was conducted at a junior high school campus located on the suburban fringe. Eight hundred and forty students were enrolled at this campus during the 2001-02 school year. According to a school principal, the school design can accommodate a maximum of 1000 students. Ninety faculty and staff are employed at the school and arrive before the students. The school principal indicated that approximately 42 percent of students use the nine regular and three special education buses serving the school. Fifty-six percent of the students arrive by automobile, 2 percent walk, and no students ride bicycles to school. The normal school hours are from 8:15 a.m. to 3:30 p.m.

TTI staff conducted a traffic observation study on Thursday, May 2, 2002, with clear weather conditions using the manual data collection technique (see Table 7-2).

Field Observations

Three driveways provide access to the school site from a local collector-type roadway (Figure 7-180 – north at top). Driveway 1, the westernmost driveway, is the entrance to the bus-only drop-off/pick-up zone. Driveway 2 is the entrance to the parent drop-off/pick-up zone and all on-site parking. Driveway 3 is the exit for all site traffic (vehicle and bus). At this time, there is no direct access between the school site and the FM roadway that runs north/south on the western side of the school site.

The primary faculty parking lot sits to the north of the school building within the parent loop (Figure 7-180). A two-way roadway from the front to the rear of the school site connects to an auxiliary parking lot adjacent to the gymnasium. Service vehicles also use this roadway to connect to a loading bay on the east side of the school.

The bus-only drop-off/pick-up zone sits directly in front of the school building, with a one-way traffic flow in the counterclockwise direction. The parent drop-off/pick-up zone is adjacent to the bus zone and is separated by a raised concrete median. This zone also operates as one-way in the counterclockwise direction.

A traffic signal controls the intersection on the northwest side of the school site. This signal has been in operation since the opening of the school in August of 1997. The FM roadway is a two-lane undivided rural arterial. The section of the FM roadway adjacent to the school site is designated as a school zone with a speed limit of 45 mph (72 km/h) during morning drop-off and afternoon pick-up periods (Figure 7-181). The normal speed on this facility is 60 mph (96 km/h). The roadway on the north side of the school site is a two-lane undivided local collector roadway with a normal speed limit of 30 mph (48 km/h) (no reduced speed school zone).

At the signalized intersection there are four turn bays: (1) westbound left-turn; (2) northbound right-turn; (3) northbound left-turn; and (4) southbound left-turn. Each of the turn bays is 150 ft (45.75 m) in length, including taper.

1	Driveway 1 – entrance to bus loading zone
2	Driveway 2 – entrance to parent drop-off/pick-up and parking
3	Driveway 3 – exit for all site traffic (vehicle and bus)
4	Bus loading zone
5	Primary parent drop-off/pick-up zone
6	Faculty and visitor parking lot
7	Auxiliary parking lot (located next to gymnasium)
8	Fire lane/emergency vehicle access for the rear of the school

Figure 7-180. Middle School Case Study Site 5 Aerial Photograph (Base Aerial Photograph Is from GlobeXplorer (*45*)).

Figure 7-181. Looking South along FM Roadway at Signalized Intersection Near the Middle School Site.

Morning Drop-Off Period

TTI staff arrived at the school at 7:15 a.m., approximately one hour prior to the beginning of school. Figure 7-182 shows vehicles in both the bus and parent loading zones which are separated by a raised median. The entrance driveways to these zones are separated; however, both use the same exit from the site onto the local collector. Figure 7-183 illustrates the school site plan labeled with pertinent features. The parent zone operates as two lanes with most vehicles unloading students directly onto the raised median (students then cross the bus lane using an on-site crosswalk). All of the morning buses had dropped off their passengers by 7:40 a.m. so they had left the site prior to the majority of the parent drop-off zone traffic.

Figure 7-182. View of Bus and Parent Loading Zones.

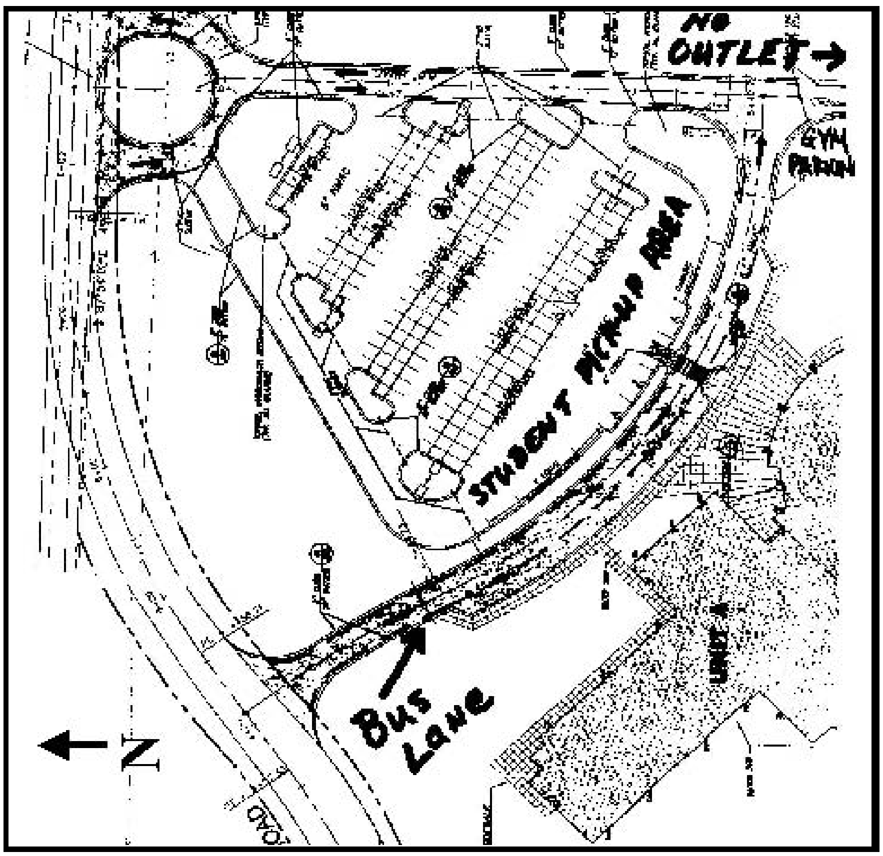


Figure 7-183. Middle School Site Layout.

Traffic in the parent loop was congested between 8:00 and 8:15 a.m. (school begins at 8:15 a.m.). The queue of vehicles in the drop-off zone never backed out of the site entrance (Driveway 2). The maximum queue occurred at 8:08 a.m. with more than 40 cars in queue on-site waiting to exit. A vehicle waiting to turn left from the local collector into the parent entrance blocked exiting traffic, creating this queue. When the designated drop-off zone became congested, parents began to use the faculty parking lot to unload their children (Figure 7-184). This situation presented a safety hazard as children walked between parked cars and then across the parent zone at various points. The data collection revealed that 383 vehicles utilized the parent loop during morning drop-off period. The service time sample revealed that, on average, a vehicle was able to enter and exit the site in 2 minutes, 31 seconds (low of 1 minute and high of 6 minutes, 27 seconds).

Afternoon Pick-Up Period

TTI staff arrived at the school at 2:45 p.m., approximately 45 minutes prior to student dismissal. There was one staff person supervising the loading of buses and an assistant principal supervised traffic and pedestrians in the parent and faculty parking zone. Heavy traffic in the parent loop grew between 3:25 and 3:55 p.m. The on-site congestion was significantly worse than in the morning. The queue consistently backed out of the pick-up zone and out of the site onto the local collector on several occasions. TTI staff again observed the same problem with students walking through the faculty parking to their parent's vehicle. Ten to 15 parents utilized the north side of the local collector as the pick-up zone for their children (Figure 7-185). This area has No Parking signs posted, and no crosswalk connects here from the school site. Several parents also utilized the south side of the local collector for pick-up, never entering the site. School staff has informed parents that student pick-up should only occur within the designated zone; however, without adequate monitoring or police enforcement, the staff experiences difficulty forcing parents to comply.

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Figure 7-184. Student Being Loaded in the First Row of the Faculty Parking Lot.

Figure 7-185. Parents Lined Up across Local Collector in No Parking Zone for Afternoon Pick-Up Period.

When the pick-up zone became congested, parents also met their children in the auxiliary parking lot located on the east side of the school at the back of the site. This allowed them to avoid the delay of waiting in line in the designated pick-up zone.

In the bus loading zone, seven full-size buses and two mini-buses were queued up waiting to be loaded when school let out. These buses left the campus at approximately 3:40 p.m. as a group, creating congestion as they attempted to leave the site. Another three buses entered the zone about 5 minutes later, loaded, then left the site by 3:50 p.m.

The data collection revealed that 195 vehicles utilized the parent loop during afternoon pick-up. The service time sample was much more variable than in the morning as many vehicles arrived significantly earlier on-site than the school dismissal time. The average service time was 12 minutes, 31 seconds (low of 5 minutes, 58 seconds and high of 19 minutes, 17 seconds).

Other Observations

- The location of the teacher parking lot within the parent loop created many opportunities for vehicle and pedestrian conflicts.

- The poor separation (less than 50 ft [15.25 m]) of the entrance and exit driveways to the site created some congestion; however, having only a very small amount of westbound traffic entering the site from the local collector roadway helped reduce the potential size of this problem.

- The presence of an actuated traffic signal at the intersection of the FM and local collector roadways minimized the off-site congestion. All the movements at this intersection have left-turn bays that, in most cases, adequately stored queued vehicles to leave through lanes unobstructed.

- Having the bus lane and parent lanes adjacent to each other and having to use the same exit contributed to on-site congestion and vehicle/pedestrian conflicts.

HIGH SCHOOL, CASE STUDY SITE 1

Background

High school case study site 1 is located on a state highway and an FM road in a rural area in Texas. Both roads have two lanes. The high school currently has an existing student population of 1900. The maximum number of students that it can accommodate was unavailable. One hundred eighty-seven faculty and staff are employed at the school and arrive before the students. The high school hours are from 8:30 a.m. to 3:30 p.m. Researchers conducted a traffic observation study on May 10, 2002, using the video data collection technique (see Table 7-2).

Field Observations

The state highway directly accesses the high school with one driveway (Driveway 1), and the FM road accesses the school with two driveways (Driveway 2 and 3). Figure 7-186 shows the layout of the high school site, and Figure 7-187 shows the eastbound approach to the school on the state highway. Driveways 1 and 2 converge at a three-leg intersection, 1400 ft (427 m) south of the state highway. The intersection marks the entrance to a school roadway leading to the parent drop-off/pick-up zone and the student/administration/visitor parking lots. Driveway 3, located southeast of the school and off of the FM road, is used primarily by buses to access the bus drop-off/pick-up zone.

The state highway is a two-lane rural highway that traverses rolling terrain in Texas. The section of roadway directly in front of the school is designated as a school zone and has a speed limit of 35 mph (56 km/h) during morning drop-off and afternoon pick-up periods. The regulatory speed of this section of the state highway is 50 mph (49 km/h). Standard school zone signing exists on both directions of the state highway, including School Advance signs and School Speed Limit signs with flashing beacons (Figure 7-187). The end of the school zone is designated by 50 mph Speed Limit signs. A right-turn bay is on the state highway going eastbound at Driveway 1. A left-turn bay is also on the state highway going eastbound at Driveway 1 to access the residential area immediately across from the school site.

The main driveway, Driveway 1, serves as one of the primary entrances to the high school for vehicles traveling east on the state highway. Left turns into Driveway 1 are prohibited. The driveway is 25 ft (7.6 m) wide and is stop controlled approaching the state highway. Two speed limit signs are installed on both sides of the roadway leading into the school site. Figures 7-188 through 7-192 show the general layout, pavement markings, and signing associated with Driveway 1 and the three-leg intersection south of the state highway.

1 Driveway 1

2 Driveway 2

3 Driveway 3 (bus access only)

4 Parent drop-off/pick-up zone

5 Bus drop-off/pick-up zone

6 Employee/visitor parking

7 Employee/student parking

8 Student parking lot (not shown in figure)

Figure 7-186. Layout of High School Case Study Site 1 (Base Aerial Photograph Is from Terraserver (*47*)).

Figure 7-187. Eastbound Approach to the High School (Facing East).

Figure 7-188. Driveway 1 (Facing South).

Figure 7-189. Driveway 1 (Facing West).

Figure 7-190. Driveway 1 (Facing East).

Figure 7-191. Driveway 1 (Facing North).

Figure 7-192. Driveway 1 at Three-Leg Intersection (Facing South).

Driveway 2 is located on the FM road and serves as a second entrance into the high school for westbound vehicles entering the school site from the state highway. Driveway 2 is stop-controlled at the FM road. Driveway 2 converges with Driveway 1 at the three-leg intersection that leads to the parent drop-off/pick-up zone and the student/administration/visitor parking lots. The eastbound and westbound approaches to the three-leg intersection from the state highway are free-flow (no control), while the southbound approach from Driveway 1 is stop-controlled. Figures 7-193 through 7-195 show the general layout, pavement markings, and signing associated with Driveway 2 and the three-leg intersection south of the state highway.

Figure 7-193. Driveway 2 (Facing West).

Figure 7-194. Driveway 2 Leading to the School Site and the Three-Leg Intersection (Facing West).

Figure 7-195. Three-Leg Intersection (Facing Northwest).

Driveway 3 is located on the FM road and serves primarily as a bus and service driveway into the high school. The approach to the FM road is stop-controlled. The driveway leads to the rear of the school where the bus drop-off/pick-up zone is located. Figures 7-196 through 7-199 show the general layout, pavement markings, and signing associated with Driveway 3 and the roadway/bus zone at the rear of the school.

Figure 7-196. Driveway 3 (Facing West).

Figure 7-197. Driveway 3 (Facing East).

Figure 7-198. Service Roadway at the Rear of the School (Facing East).

Figure 7-199. Bus Drop-Off/Pick-Up Zone (Facing East).

The roadway served by Driveways 1 and 2 directly accesses the parent drop-off/pick-up zone and student/employee/visitor parking lot. Figures 7-200 through 7-204 show the general layout, pavement markings, and signing associated with the roadway, the parent drop-off/pick-up zone and the student/employee/visitor parking lot.

Figure 7-200. Three-Leg Intersection at the Entrance to the School (Facing Northeast).

Figure 7-201. Roadway Leading to the Parent Drop-Off/Pick-Up Zone and Parking Lots (Facing Southwest).

Figure 7-202. Roadway Leading to the Parent Drop-Off/Pick-Up Zone and Parking Lots (Facing South).

Figure 7-203. Parent Drop-Off/Pick-Up Zone and Employee Parking Lot (Facing South).

Figure 7-204. The Student/Employee/Visitor Parking Lots (Facing East).

The high school bus drop-off/pick-up zone (Figure 7-199) is located off the bus/service roadway. The bus/service roadway leading to the high school bus drop-off/pick-up zone is located 3000 ft (915 m) west of the entrance to Driveway 3 and the FM road.

Morning Drop-Off Period

Classes at the high school started at 8:30 a.m., and students regularly arrived at the school at approximately 7:45 a.m. Parents dropped off students at the parent drop-off/pick-up zone in front of the school accessed by the school roadway. Buses utilized the bus/service roadway to the drop-off/pick-up zone, accessed by Driveway 3. At the parent drop-off/pick-up zone, one of two lanes was used as the “drop-off” lane while the other lane was used as a “drive through” lane. These lanes were not indicated by pavement markings. It appeared that the majority of students drive themselves to the school site.

After 8:10 a.m., traffic entering and exiting Driveway 1 significantly increased. The traffic at the school during the morning drop-off period lasted until 8:35 a.m. The only significant queue observed was that of the vehicles entering the parent drop-off zone and the student/employee/visitor parking lot. The queue originated at the school roadway and extended back onto Driveway 1 and 2. There was no queue on the state highway, and time did not allow for observations to be made along the FM road during the morning period.

Afternoon Pick-Up Period

Classes at the high school let out at 3:30 p.m. School staff indicated that a large number of students disregarded the No Left Turn restriction at Driveway 1 (Figure 7-205). As a result of this, school police blocked off access to Driveway 1 from 3:25 to 3:45 p.m. The driveway was blocked off with a golf cart at the three-leg intersection located in front of the school. During this time, parents and students used Driveway 2 as the primary exit. Buses and some students used Driveway 3 as an exit.

Figure 7-205. Student Disregarding the No Left Turn Restriction at Driveway 1.

Almost all the passenger vehicles and buses exiting the school at Driveway 2 would turn left and travel north along the FM road to access the state highway. The eastbound and westbound approaches from the state highway are free-flow and have a flashing yellow indication at the intersection. The approaches on the FM road are stop-controlled and have a flashing red indication at the intersection. Cross Traffic Does Not Stop supplemental signs are located below each Stop sign. A queue would develop at the state highway/FM intersection and would result in cars waiting both on the FM road (see Figures 7-206 and 7-207) and on Driveway 2 (see Figure 7-208). The queue at one point during the study period was estimated to be approximately 3500 ft (1068 km).

Figure 7-206. Queue on Northbound Approach of the FM Road (Facing South).

Figure 7-207. Queue on Northbound Approach of the FM Road (Facing North).

Figure 7-208. Queue along Driveway 2 during Afternoon Period.

Vehicles northbound on the FM road encountered difficulty crossing and turning west on to the state highway during the afternoon period. These vehicles consequently queued approximately 1700 ft (519 km) towards Driveway 2. During this period, researchers observed various inappropriate movements to bypass the queued vehicles. These include passing on a double yellow line (see Figure 7-209), queuing over a marked median (see Figure 7-206), and using the gravel shoulder (see Figure 7-210). Some vehicles also traveled through (north) the intersection, turned around in a vacant driveway, traveled south to the intersection, and took a right turn to go west on the state highway (see Figures 7-211 and 7-212).

Figure 7-209. Vehicle Making an Unsafe Maneuver on the FM Road When Northbound.

Figure 7-210. Buses Using the Gravel Shoulder on the State Highway to Bypass the Queue Length on the FM Road Created by Northbound Traffic.

Figure 7-211. Vehicles Making a U-Turn after Traveling North through the State Highway Intersection to Gain Quicker Access to the State Highway Heading Westbound.

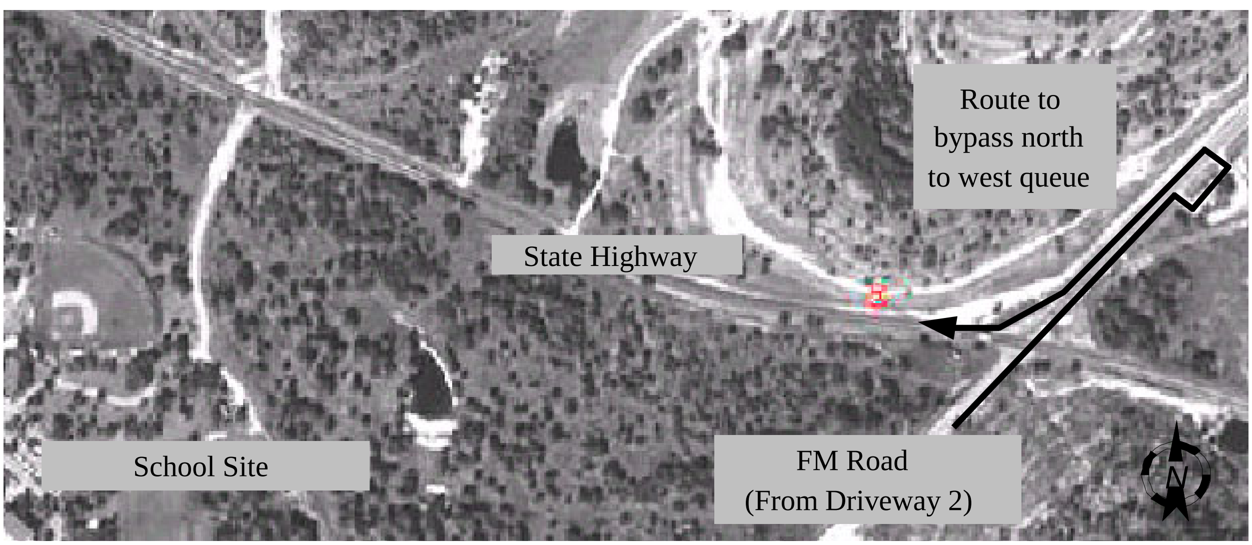

Figure 7-212. Alternative Route to Bypass the Northbound FM Road Queue and the State Highway Intersection (Base Aerial Photograph Is from Terraserver (*47*)).

Other Observations

Researchers collected arrival and departure information at the school to determine the drop-off or pick-up service time. Figure 7-213 presents morning operations at the three-leg intersection accessed by Driveways 1 and 2. Based on a sample size of 50 vehicles arriving between 7:29 and 7:38 a.m., the average service time was 2 minutes and 50 seconds.

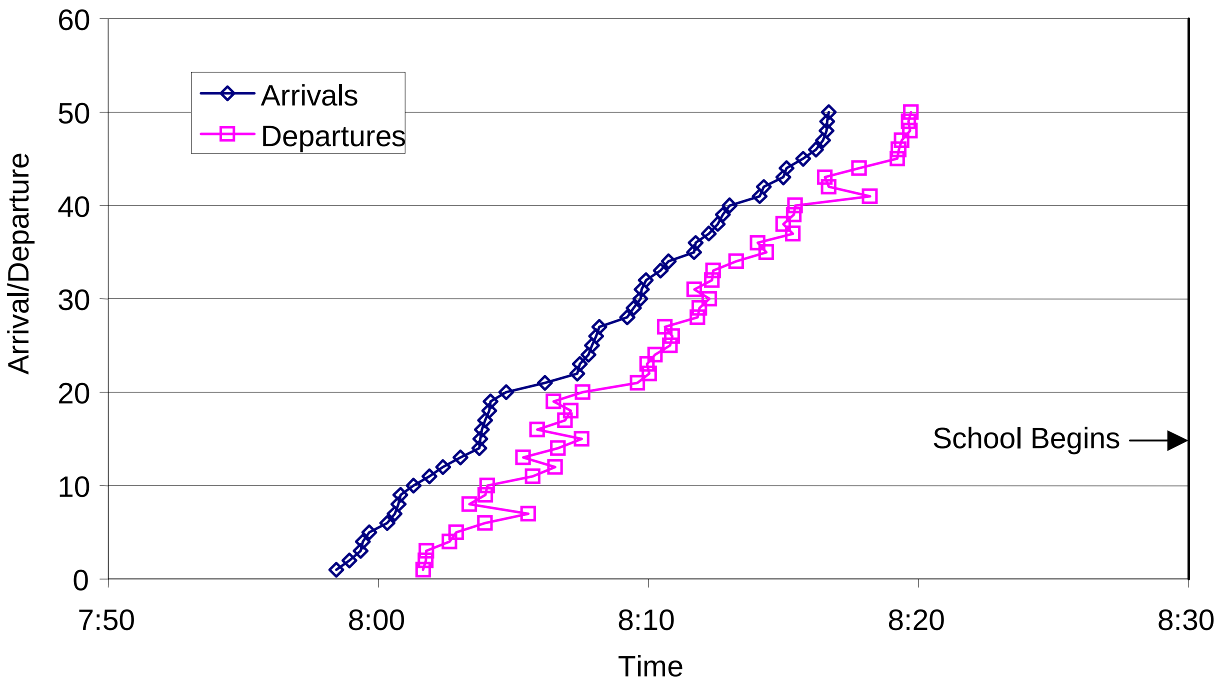

Figure 7-213. The High School Roadway Arrival/Departure Operations during the Morning Period.

Figure 7-214 presents afternoon operations from Driveways 1 and 2. Based on a sample size of 27 vehicles arriving between 2:52 and 3:08 p.m., the average service time was 6 minutes and 42 seconds.

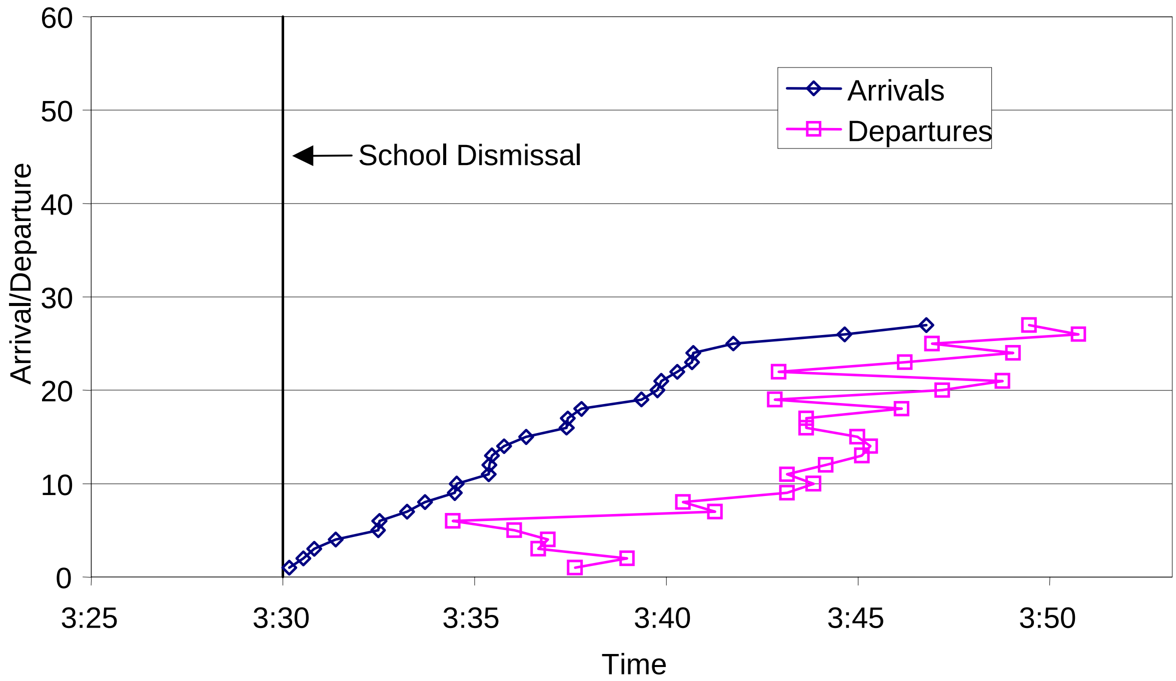

Figure 7-214. Driveway 1 Arrival/Departure Operations during the Afternoon Period.

HIGH SCHOOL, CASE STUDY SITE 2

Background

High school case study site 2 is located on a farm to market road that passes through a major urban area in Texas. The farm to market road is a four-lane arterial with left- and right-turn bays and a two-way left-turn lane (TWLTL) directly in front of the school. The high school is located approximately 1 mile (1.6 km) north of a loop road.

The high school currently has an existing student population of 3100 with a maximum of 3400 students. Two hundred faculty and staff are employed at the school and arrive before the students. According to the school, approximately 50 percent of the students use the 51 buses serving the school. Approximately 50 percent of the students arrive by automobile, less than 1 percent walk, and no one rides a bicycle to school. The school hours are between 7:50 a.m. and 4:00 p.m. Researchers conducted a traffic observation study on May 8, 2002, at the high school using the video data collection technique (see Table 7-2).

Field Observations

The farm to market road directly accesses the high school with five driveways (Figure 7-215). The western-most driveway, Driveway 1, is used by buses to access the bus drop-off/pick-up zone and by delivery vehicles. Driveway 2 is an entrance-only driveway, serving the employee and student parking lots. Driveway 3 is located at a signalized intersection across from a residential neighborhood street and serves a two-way entrance into the employee and student parking lots. Driveway 4 is an entrance-only driveway serving the parent drop-off/pick-up zone and another student parking lot. The eastern-most driveway, Driveway 5, is an exit-only driveway that serves the parent drop-off/pick-up zone and a student parking lot. Driveways 2 through 5 serve all parking lots and the parent drop-off/pick-up zone.

① Driveway 1
② Driveway 2
③ Driveway 3
④ Driveway 4
⑤ Driveway 5
⑥ Parent drop-off/pick-up zone
⑦ Bus drop-off/pick-up zone
⑧ Student and employee parking lot
⑨ Student parking lot
⑩ Student and visitor parking lot

Figure 7-215. The High School Case Study Site 2 Layout (Base Aerial Photograph Is from GlobeXplorer (*45*)).

The farm to market road is a two-lane urban arterial that widens in front of the school for left- and right-turn bays and a TWLTL. The FM road has a speed limit of 50 mph (81 km/h) with a school zone speed limit of 35 mph (56 km/h) in front of the high school during the morning and afternoon periods. A fluorescent yellow School Advance sign and Speed Limit plaque with flashing beacons display the 35 mph (56 km/h) speed limit (Figure 7-216) on both approaches to the school. In addition to these signs, a Signal Ahead sign is installed on both FM roads approaches to the signalized intersection at the FM road and Driveway 3. The signalized intersection includes pedestrian signals and crosswalks. Figures 7-217 through 7-219 present the general layout of the roadway and signalized intersection on the FM road. The nearest intersections to the high school on the FM road are with another FM road, 0.5 mile (0.8 km) to the northwest, and another local road, 1 mile (1.6 km) to the southeast. Both of these intersections have traffic signals.

Figure 7-216. The FM Road Approach to the High School (Facing Northwest).

Figure 7-217. The FM Road Approach to the High School and Driveway 3 Intersection (Facing Northwest).

Figure 7-218. The FM Road Approach to the High School (Facing Southeast).

Figure 7-219. The FM Road and Driveway 3 Intersection (Facing Southeast).

Driveway 1 serves the bus drop-off/pick-up zone and deliveries. The 27 ft (8.2 m), two-way driveway is signed for buses and deliveries. Figures 7-220 through 7-223 show Driveway 1 and the bus drop-off/pick-zone.

Figure 7-220. Driveway 1 (Facing Southwest).

Figure 7-221. Entrance to the Bus Drop-Off/Pick-Up Zone from Driveway 1 (Facing Southwest).

Figure 7-222. Bus Drop-Off/Pick-Up Zone (Facing Southeast).

Figure 7-223. Driveway 1 (Facing Northeast).

Driveway 2 is a one-way, entrance-only driveway accessing the employee and student parking lots. Driveway 2 and the employee and student parking lots are presented in Figures 7-224 through 7-228.

Figure 7-224. Driveway 2 (Facing Southwest).

Figure 7-225. Employee Parking Lot (Facing West).

Figure 7-226. Employee and Student Parking Lot (Facing Southwest).

Figure 7-227. Student Parking Lots (Facing South).

Figure 7-228. Driveway 2 (Facing Northeast).

Driveway 3 is a four-lane, two-way driveway that serves the student and employee parking lot. A traffic signal controls access to and from Driveway 3, which is aligned with a road that leads to a residential neighborhood. Figures 7-229 and 7-230 show the general layout, pavement markings, and traffic signal/signing associated with Driveway 3.

Figure 7-229. Driveway 3 (Facing Southwest).

Figure 7-230. Driveway 3 (Facing Northeast).

Driveways 4 and 5 serve the parent drop-off/pick-up zone, visitor parking, and student parking lot. Driveway 4 is an entrance-only driveway; Driveway 5 is an exit-only driveway. Figures 7-231 through 7-237 show the general layout and pavement markings associated with Driveways 4 and 5, the parent drop-off zone, and the visitor/student parking lot.

Figure 7-231. Driveway 4 (Facing Southwest).

Figure 7-232. Driveway 4 (Facing Southeast).

Figure 7-233 Driveway 4 (Facing Northeast).

Figure 7-234. Parent Drop-Off/Pick-Up Zone (Facing Southeast).

Figure 7-235. Parent Drop-Off/Pick-Up Zone and Visitor/Student Parking Lot (Facing Southwest).

Figure 7-236. Driveway 5 (Facing Northeast).

Figure 7-237. Driveway 5 (Facing Southwest).

Morning Drop-Off Period

Classes started at this high school at 7:50 a.m. Students started arriving at the school site at approximately 7:00 a.m. Buses dropped off students using Driveway 1; in some cases, researchers observed that school buses would allow vehicles to turn left in front of them, disregarding normal traffic control (Figure 7-238). Parents dropped off students entering Driveway 4 and exiting Driveway 5. Significant queues developed entering and exiting the parent drop-off zone and student/visitor parking lots at 7:25. Though a left-turn bay into Driveway 4 exists, the left turners spilled back into the main lane. The overflow resulted in a queue over .75 mile (1.2 km) southeast of the school, from where the majority of vehicles entering the school site are coming. No queue developed at Driveways 2 and 3, as the main roadway was blocked by traffic turning into Driveway 4. The school site traffic on the FM road cleared at 7:50 a.m. Figures 7-239 and 7-240 show the morning operations associated with Driveway 4 and the parent drop-off zone.

Figure 7-238. School Bus Allowing Another School Bus to Turn Left, Disregarding Traffic Control.

Figure 7-239. Morning Queue at Driveway 4.

Figure 7-240. Morning Operations at the Parent Drop-Off Zone.

Afternoon Pick-Up Period

Classes at the high school end at 4:00 p.m. Parents picking up students from the school queued on-site before school let out. Once school ended, significant queues developed for vehicles exiting the school site. At approximately 4:10 p.m., a queue developed from the traffic signal on the FM road and the local road, located 1 mile (1.6 km) southeast of the school, to the school site. At this time, buses departed the bus pick-up zone and added to the queue. The queuing did not subside until approximately 4:35 p.m. Figures 7-241 through 7-243 show the queuing associated with the afternoon period.

Figure 7-241. Afternoon Queue at Driveway 3.

Figure 7-242. Afternoon Queue on the FM Road.

Figure 7-243. Afternoon Queue on Driveway 5.

Other Observations

Arrival and departure information were collected at the school to determine the drop-off or pick-up service time. Morning operations of the parent drop-off/pick-up zone (Driveway 4 to Driveway 5) are presented in Figure 7-244. Based on a sample size of 50 vehicles arriving between 7:16 and 7:45 a.m., the average service time was 6 minutes and 30 seconds.

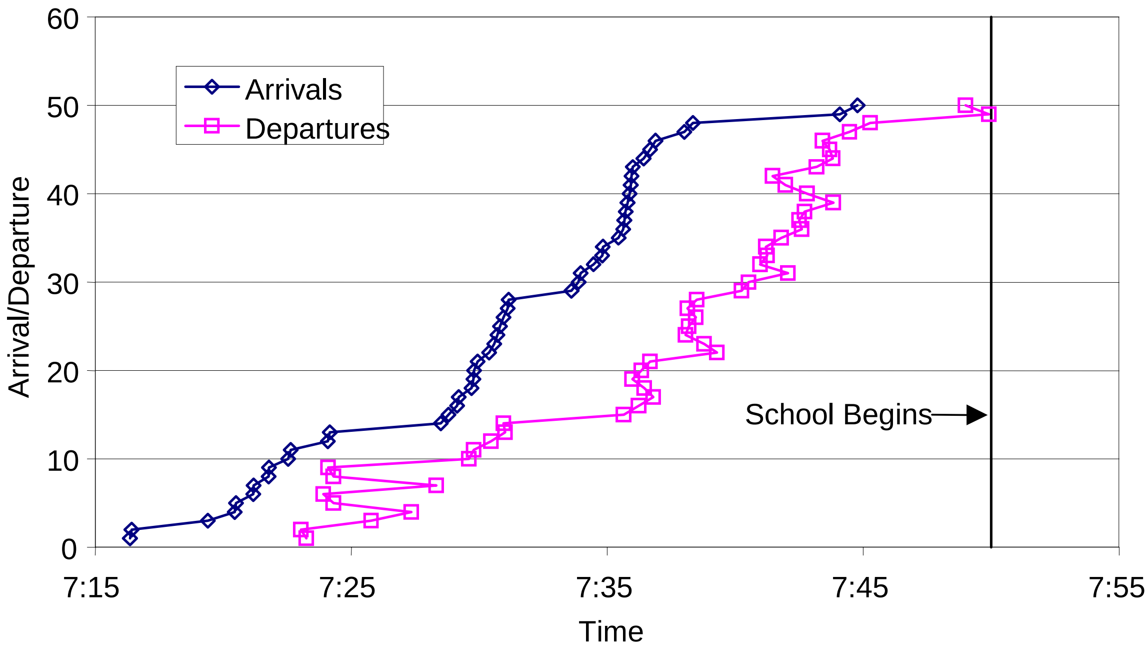

Figure 7-244. The High School Arrival/Departure Operations during the Morning Period.

Afternoon operations for the parent drop-off/pick-up zone are presented in 7-245. Based on a sample size of 50 vehicles arriving between 4:03 and 4:20 p.m., the average service time was 11 minutes and 41 seconds.

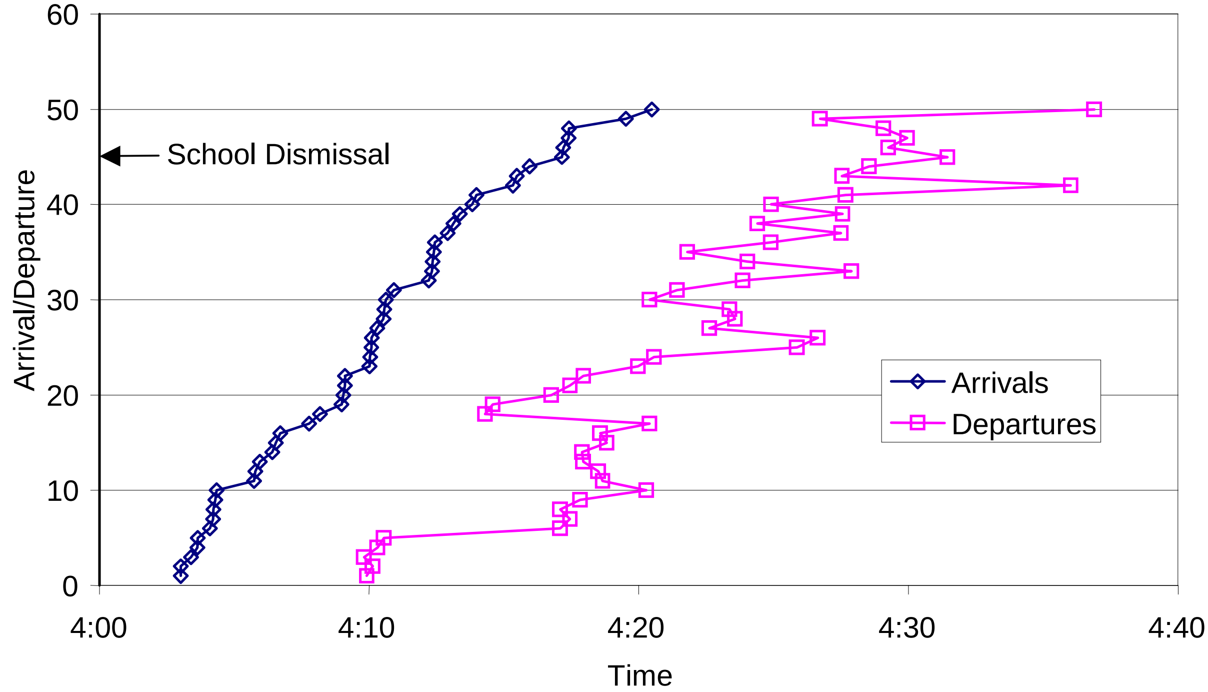

Figure 7-245. The High School Arrival/Departure Operations during the Afternoon Period.

CHAPTER 8. REVIEW OF EXISTING GUIDELINES

The overall goal of the TxDOT Research Project 0-4286 is to develop guidelines and good examples for the design and operation of roadway facilities within and around schools in order to improve safety and reduce local congestion. The research team used a variety of methods including review of published documents, Internet searches, survey instruments, and direct correspondence to obtain information on existing guidelines for transportation-related elements at schools. Researchers organized the guidelines review into nine different categories including:

- site selection criteria;
- general site requirements and design;
- bus design and operations;
- parent drop-off/pick-up zones;
- bicycle/pedestrian;
- driveways;
- turn lanes;
- traffic control, pavement markings, and signing; and
- parking requirements and design.

The following sections will provide more specific information on the existing guidelines in each of the categories.

SITE SELECTION CRITERIA AND GUIDELINES

From a practical standpoint, the selection of a site for a new school dictates the resulting design and operations of the facility. The research team's review of site selection criteria and guidelines produced information in the following categories:

- site size and frontage space,
- building setback requirements, and
- location and accessibility.

Site Size

The overall size of a school site is important to the design and layout of the necessary facilities (buildings, roadways, parking lots, recreational areas, etc.). Several agencies have existing guidelines indicating the number of acres required based on the type of school being built. The most used guidelines are those published by the Council of Educational Facility Planners International, a professional society composed primarily of school district personnel, architects, engineers, and contractors. Table 8-1 provides a range of the guidelines based on the CEFPI (*48*) and two additional sources (*49, 50*).

Several agencies also have adopted other general guidelines for site size including:

- preference for rectangular shape (length to width ratio does not exceed 2:1) and
- adequate land for parking of buses and queuing space for parent pick-up (*51*, *52*, *53*).

Table 8-1. Site Size Guidelines for New School Sites.

School Type	Number of acres (hectares) required		
	City of Mississauga	**CEFPI[2]**	**Minnesota Guide**
Elementary (K-6)	8 (3.24)	10[1] (4.05)	10 to 15[1] (4.05 to 6.075)
Middle (5-8)	17 (6.885)	20[1] (8.1)	25 to 35[1] (10.125 to 14.175)
Junior High (7-9)	17 (6.885)	20[1] (8.1)	25 to 35[1] (10.125 to 14.175)
Senior High (9-12)	17 (6.885)	30[1] (12.15)	60[1] (24.3)
Vocational Center	N/A	10[1] (4.05)	N/A

[1] Plus 1 acre (0.405 ha) per 100 students on maximum projected enrollment
[2] Where a school district intends to build two schools on a single site, it is permissible to reduce the total combined acreage by 15% based on the following groupings (elementary/middle, middle/junior high, junior high/senior high, or senior high/vocational center)

Closely related to the overall size of the site is the amount of frontage space (width). Only a few agencies had existing guidelines for the required frontage space based on the school type. The City of Mississauga ranged from 350 ft (107 m) for an elementary school to 600 ft (183 m) for secondary (i.e., middle, junior high, and senior high) school. The amount of frontage space is important to the transportation operations and design (primarily on-site queuing space/stacking length) of the site. Several other agencies also have adopted general guidelines relating to frontage space including:

- There shall be ample frontage to allow for separate car and bus entrances and exits (*54*).
- Provide adequate frontage to avoid congestion at site entrances/exits.
- Provide adequate frontage to provide safe access from roads or streets.

Building Setback Requirements

The review of existing guidelines for building setback requirements showed that no agencies had specific values for how far back from the roadway the school building needed to be placed. One agency had a general policy that school buildings be set back on the site a sufficient distance from the adjacent roadways to ensure safe and adequate site storage or stacking of loading and unloading vehicles.

Location and Accessibility

Another area of concern in the site selection process for schools is the location and accessibility of the site in relation to the nearby land uses and the adjacent roadway network. In the review of existing guidelines, a number of organizations had transportation-related guidelines for site location and accessibility. Some of the guidelines were specific to the type of school facility (i.e., elementary vs. secondary), while others were more general in nature.

Table 8-2 provides a listing of guidelines and their corresponding source(s) that are specific to elementary school facilities. The four primary sources of these guidelines were two Canadian agencies (Region of York and City of Mississauga); Douglas County, Colorado; the Institute of Transportation Engineers Michigan Section (Traffic Engineering Around Schools Committee); and the Traffic Authority of New South Wales (*8*, *55*, *56*, *57*, *58*). Table 8-3 records the existing guidelines and their corresponding source(s) specifically related to secondary school facilities. Table 8-4 lists general (i.e., not specific for school type) guidelines for school site location and accessibility.

Table 8-2. Site Location and Accessibility Guidelines for Elementary School Facilities.

GUIDELINE	Source(s)
Site should be situated centrally to a neighborhood, abutting and having access to a collector street.	Region of York (Canada)
Access to major collectors akin to minor arterials should be avoided due to the volume of traffic.	Region of York (Canada)
Access should be via the collector street and ideally a main driveway should align with a street (i.e., 4th leg of a T intersection) with stop control on all approaches.	Region of York (Canada)
Avoid high volume traffic flow near elementary school entrances and exits.	Douglas County (CO)
Avoid elementary school site along local streets opposite residential driveways.	Douglas County (CO)
Elementary school sites should desirably be located as close as possible to the residential areas with provision for safe pedestrian and bicycle accessibility. This will minimize walking distances and also reduce traffic congestion.	New South Wales (Australia)
Site should not be located on arterial or major collector roads.	City of Mississauga (Canada), City of Phoenix (AZ) (*59*)
Sites for schools which serve younger children should be located as close as possible to the subdivisions in which the students reside in an effort to reduce the major street crossings, walking distance, and traffic congestion.	Institute of Transportation Engineers (ITE) Michigan Section, Arizona DOT (*60*)
Provide bussing for elementary students who cross busy major streets or use major streets as school attendance or bussing boundaries.	City of Phoenix (AZ)

Table 8-3. Site Location and Accessibility Guidelines for Secondary School Facilities.

GUIDELINE	Source(s)
Site should be located centrally to the catchment area close to the intersection of an arterial and a continuous collector street, with access provided from the collector. The access should be located far enough from the intersection (preferably signalized) so as not to impact operations.	Region of York (Canada)
Justify a traffic signal (where vehicle volumes warrant) during peak periods at schools with access from an arterial.	Douglas County (CO)
Consider pedestrian travel desire lines when locating schools near commercial centers.	City of Mississauga (Canada)
A high school site should be readily accessible from a street system capable of handling school generated traffic, and the use of local residential streets for primary access should be avoided.	Arizona DOT

Table 8-4. General Guidelines for School Site Location and Accessibility.

GUIDELINE	Source(s)
School site should be situated where the road alignment provides good visibility.	Region of York (Canada), New South Wales (Australia)
Provide access from more than one direction to the immediate vicinity of the site, and provide access to the school site from at least two adjacent streets.	Douglas County (CO)
School entrances should not be placed on trunk highways (major roads). Locations should be chosen on roadways with the lowest speed limit and/or lowest average daily traffic.	Minnesota DOT (*61*), New South Wales (Australia)
High density traffic flow near school exits and entrances due to the proximity of highways, periodic commercial traffic or high commuter traffic from industrial plants should be avoided.	National Safety Council (*62*), City of Mississauga (Canada), North Carolina DOT, Minnesota DOT
Locate schools adjacent to other community facilities where there is potential for shared use parking (e.g., parks, churches, etc): coordinate with the operation and layout of adjacent uses.	City of Mississauga (Canada), Minnesota DOT
Avoid locating school sites abutting each other on the same road frontage: separate with parks or other land uses.	City of Mississauga (Canada)
Provide accessibility at reasonable cost to public roads that are adequate to accommodate the added traffic generated by the school.	North Carolina DOT, Minnesota DOT
Locate schools adjacent to or readily accessible to modes of transport useful to students and staff: school buses, private vehicles, public transportation, bicycles, and/or pedestrians.	North Carolina DOT
Do not be too close to congested traffic arteries or highways that are noisy and will cause delays or special hazards.	North Carolina DOT
Students approaching buildings on foot should not have to cross main traffic arteries.	North Carolina DOT
Locate site to efficiently and safely serve the school population.	Massachusetts DOE (*63*)
Locate site near bus routes to limit travel time for students, whenever possible.	Minnesota DOT

GENERAL SITE REQUIREMENTS AND DESIGN

The second category of guidelines was related to general site requirements and design. The guidelines tended to fall into one of the following topic areas:

- separation of transport modes;
- service, delivery, and maintenance issues;
- emergency access issues;
- weather protection; and
- general site design and layout.

Table 8-5 provides the guidelines for the first four topic areas in the previous list and also provides the source(s).

Table 8-5. General Site Requirements and Design Guidelines (Part I).

Guideline	Source(s)
Separation of Transport Modes	
The physical routes provided for the basic components (buses, cars, pedestrians/bicycles, and service vehicles) of the traffic pattern should be separated as much as possible from each other.	Miami-Dade County (FL) Public School District (*64*), Wake County (NC) Public School System (*65*), South Carolina DOE and DOT (*9*), School Bus Fleet (*66*, *10*, *67*), Douglas County (CO), New South Wales (Australia), National Safety Council, ITE, City of Mississauga (Canada), North Carolina, California, and Kentucky DOEs (*68*), Minnesota DOE and DOT, Missouri DOT (*69*), Arizona DOT
Service, Delivery, and Maintenance Issues	
An independent service drive, 2 lanes wide, shall access a fenced service yard with a loading zone. 1. Locate the service yard next to the kitchen. 2. The service yard shall contain parking for kitchen personnel and maintenance vehicles. 3. Provide a loading zone for 2 maximum allowable length tractor trailer delivery trucks and a 50 ft (15.25 m) radius turn-about.	Miami-Dade County Public School District (*64*), North Carolina State Board of Education (item #1 only) (*51*)
Provide a dumpster area with enclosure and/or concrete-filled bollards.	Kentucky DOE
Flush ribbon curbed turnouts from roadways and parking areas shall be provided to allow for maintenance without climbing over raised curbing.	Seminole County (FL) Public Schools (*70*)

Table 8-5. General Site Requirements and Design Guidelines (Part I) (continued).

Guideline	Source(s)
Locate site utilities and physical plant components to avoid conflict with student and vehicular traffic, future growth of play areas, building expansion, etc.	Kentucky DOE
Emergency Access Issues	
It is recommended that all roadways, with the exception of loading zones, on school properties be signed 'No Parking or Standing, Fire Lane'.	ITE Michigan Section
It is recommended that where parking lots or driveways do not lie contiguous to the school buildings, consideration should be given to the use of high-strength sidewalks, 15 ft (4.575 m) wide, with radii that would accommodate an emergency vehicle.	ITE Michigan Section, Arizona DOT
Provide adequate site lighting for nighttime hours: around building at each exterior door for security, and at all driveway intersections and bus loop for safe emergency vehicle access.	Kentucky DOE
Plans for roads and loading areas should accommodate emergency vehicles, which must have access to the school at all times.	National Safety Council
Weather Protection	
All primary building entrances for students shall be weather protected by overhead cover or soffit.	Wake County (NC) Public Schools, North Carolina DOE, Miami-Dade County Public Schools

Table 8-6 provides guidelines and corresponding source(s) for the fifth topic area, the general site design and layout category. The research team also reviewed several sources that contained general guidelines for school sites that are not listed in Table 8-6:

- *Survey of Traffic Circulation and Safety at School Sites* (*71*),
- *A Survey of Establishing Reduced Speed School Zones* (*72*), and
- *School Safety Program Guidelines* (*11*).

Table 8-6. General Site Requirements and Design Guidelines (Part II).

Guideline	Source(s)
Utilize all potential drop-off zones to reduce congestion at the main access area.	Katz, Okitsu & Associates (CA) (73)
Avoid transit stops, newspaper vending boxes, mailboxes, or on-street parking between drop-off zone entrance and exit points along the school frontage.	Miami-Dade County (FL) Metropolitan Planning Organization (74), City of Mississauga (Canada)
Orient and locate playfields, parking, service drives, drop-off zones, and bus loading zones to reduce the cost of connecting elements without requiring pedestrians to cross vehicular traffic lanes.	Miami-Dade County (FL) Public School District
Provide a paved standing area for 25% of the student population next to the main student entry area.	Miami-Dade County (FL) Public School District
Provide adequate on-site parking and loading/unloading space designed for all modes of transportation.	New South Wales (Australia), South Carolina DOT, Arizona DOT
Whenever possible, roads should not be constructed that completely encircle a school. Areas that students must cross to engage in outside activities should be free of all vehicular traffic.	National Safety Council, North Carolina DOE, Little Institute for School Facilities Research, California DOE
All roads within the school site should be graded to avoid configurations that could impair a motorist's vision. It is suggested that a maximum 5% grade be allowed for roads on school sites.	National Safety Council, ITE Michigan Section
Internal two-way roadways to two-lane one-way roadways on a school site should have a minimum width of 26 ft (7.9 m) face-to-face of curb, or 24 ft (7.3 m) edge-to-edge for an uncurbed facility. Consideration of wider pavement widths should be made when the roadway is curvilinear in design.	ITE Michigan Section, Missouri DOT
The location of drives, buildings, equipment, and landscaping must permit adequate sight distances for drivers and pedestrians alike.	National Safety Council, ITE Michigan Section, School Bus Fleet (67)
The site and proposed plans should be reviewed by the proper road agency.	ITE Michigan Section, Precious Cargo (TX) (4), Oregon DOT (75)
Buildings should be parallel to the street and have parking located at the side or rear of the property.	City of Mississauga (Canada)
At least a 50 ft (15.3 m) tangent section is provided between reverse curves.	California DOE, National Safety Council
Avoid excess paving or concrete curbing.	Kentucky DOE
Check contours for drainage away from the building.	Kentucky DOE

BUS-RELATED DESIGN AND OPERATIONS GUIDELINES

The subject areas of bus operations, safety planning, and facilities design have all received considerable research in the past. There are a number of prominent groups and organizations, such as the Pupil Transportation Safety Institute (PTSI) (*76*), dedicated to school bus-related transportation issues. The review of existing guidelines produced a significant number of bus-related design and operations guidelines. Table 8-7 lists the guidelines.

Table 8-7. Bus-Related Design and Operations Guidelines.

Guideline	Source(s)
Drop-off area design does not require backward movement by buses.	Katz, Okitsu & Associates (CA), Miami-Dade County (FL) MPO, South Carolina DOE, Wake County (NC) Public School System, Douglas County (CO), National Safety Council, North Carolina DOE, Missouri DOT, Minnesota DOT, Arizona DOT
Bus drop-off areas should be one-way in a counterclockwise direction to assure the loading/unloading of students occurs from the right-hand side of the vehicle adjacent to the building (children should never have to walk between buses).	Miami-Dade County (FL) MPO, South Carolina DOE, Region of York (Canada), School Bus Fleet (*67*), New South Wales (Australia), National Safety Council, ITE Michigan Section, North Carolina DOE, California DOE, Missouri DOT, Minnesota DOT, Arizona DOT
Maximize fronting curb space as loading zone. – provide enough space to stage all buses on a daily basis.	Katz, Okitsu & Associates (CA), Missouri DOT, Minnesota DOT
The school bus loading zone may be located further from the school entrance (students walking to and from the bus will be in groups that are more visible to drivers).	City of Edmonton (Canada) (*77*), School Bus Fleet (*67*)
Each parking stall for a full-size bus shall be a minimum of 15 ft (4.6 m) wide. Smaller spaces may be provided for mini-buses used to transport students.	South Carolina DOE, Wake County (NC) Public School System
Required drop-off and pick-up areas for schools (public or private) shall include at least: (1) 5 school bus spaces or (2) 2 school bus spaces for every 50 students, whichever results in the greater number of spaces (no more than 12 spaces required).	City of Henderson (NV) – see Figure 8-1 (*78*).
On-site bus loading zones shall have two lanes – one for travel and one for stopping. The facility should be sized for the expected number of buses.	Region of York (Canada), Miami-Dade County (FL) Public School District, School Bus Fleet (*66*)
Single-file right wheel to the curb is the preferred staging method for buses.	School Bus Fleet (*67*), ITE Michigan Section, Arizona DOT

Table 8-7. Bus-Related Design and Operations Guidelines (continued).

Guideline	Source(s)
Locate the bus area so that buses exit upstream of automobiles and gain priority, thereby reducing delay.	Douglas County (CO)
Avoid crosswalks at entry to and exit from the bus zone.	Douglas County (CO)
Curbing, with suitable drainage, is recommended on all roads utilized by school buses within the site.	National Safety Council
Attention should be given in planning school bus parking, loading and unloading zones to encourage diagonal parking (minimum of 60 ft [18.3 m] paved surface).	National Safety Council, California DOE
The type of pavement and base should conform to the local state highway department specification for buses.	National Safety Council
Provide buses only and no entry signage at appropriate ends of the bus loop.	Kentucky DOE
Consider two outbound lanes if possible, one for left-turning buses and one for right turns.	Minnesota DOT

Researchers found some discrepancy when it came to recommended guidelines for the width and number of lanes for on-site bus facilities.

DESIGN AND OPERATION OF PARENT DROP-OFF/PICK-UP ZONES

Arizona noted that the topic of design and operation of parent drop-off/pick-up zones at schools has not received considerable attention. Parent pick-up and drop-off zones are often overlooked in school design, but are very important. Students deserve a safe space to be dropped off and picked up. The provision of adequate drop-off zones minimizes illegal standing or parking near schools and helps prevent problems such as blocking school buses and driveways (*60*). The research team did find some information for guidelines and recommended practices that is provided in Table 8-8. Figure 8-1 illustrates an example of drop-off/pick-up zone design guidelines.

Researchers surveyed members of the American Association of State Highway and Transportation Officials Highway Subcommittee on Traffic Engineering regarding school access issues (*79*). The appendix contains the survey document that was distributed to one representative of each state DOT. The research team received 32 completed surveys representing 28 different state DOTs. One of the survey questions asked respondents to describe any design criteria and/or guidelines for on-site stacking length (i.e., the distance in the loop drive/parent drop-off/pick-up zone to accommodate loading and unloading of students). Only one respondent, the South Carolina DOT (*9*), had a specific guideline for on-site stacking length ranging from 800 to 1500 ft (244 to 458 m) depending on school type and student population. Several respondents indicated that they used general criteria from the *Manual on Uniform Traffic Control Devices* (*37*), AASHTO (14), and other sources.

Table 8-8. Guidelines for Design and Operation of Parent Drop-Off/Pick-Up Zones.

Guideline	Source(s)
Drop-off area design does not require backward movement by vehicles.	Katz, Okitsu & Associates (CA), Miami-Dade County (FL) MPO, South Carolina DOE, Wake County (NC) Public School System, Douglas County (CO), North Carolina DOE, Missouri DOT, Minnesota DOT, Arizona DOT
Parent drop-off/pick-up zones should be one-way in a counterclockwise direction where students are loaded and unloaded directly to the curb/sidewalk.	Miami-Dade County (FL) MPO, South Carolina DOE, Region of York (Canada), ITE Michigan Section, North Carolina DOE, California DOE, Missouri DOT, Minnesota DOT, Arizona DOT
Maximize fronting curb space as loading zone – provide an adequate driveway for lining up cars on site.	Florida Safe School Design Guidelines (*80*), Katz, Okitsu & Associates (CA), North Carolina DOE
The length of the car pick-up zone can be determined by estimating the maximum number of cars likely to arrive at any one time.	New South Wales (Australia), Minnesota DOT
Prior to designing and laying out roads and parking lots, architects should consult with school administration on: 1. number of cars dropping off and picking up students and 2. type of schedule (staggered or single opening and closing times).	National Safety Council, Arizona DOT
Required drop-off and pick-up areas for schools (public or private) shall include at least: 1. 5 auto, or 2. 1 auto space for every 50 students, whichever results in the greater number (no more than 12 spaces required).	City of Henderson (NV) – see Figure 8-1.
Drop-off areas should be at side entrances where site size/frontage permits so that the amount of pavement in front of schools at the street edge is reduced.	City of Mississauga (Canada)
Do not load or unload students where they have to cross a vehicular path before entering the building.	North Carolina DOE
Combine visitor parking with the parent drop-off driveway located near the main entrance and offices.	North Carolina DOE, Safe School Design Guidelines

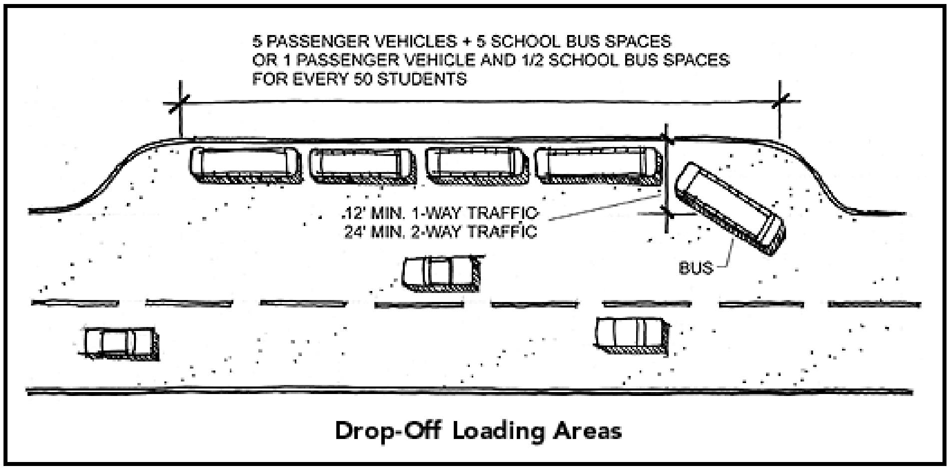

Figure 8-1. City of Henderson (Nevada) Drop-Off Loading Area Design Guidelines (*78*).

BICYCLE AND PEDESTRIAN GUIDELINES FOR SCHOOLS

A number of comprehensive studies and programs have been dedicated to bicycle and pedestrian issues for schools. The Safe Routes to School, a program oriented towards pedestrian and cyclist safety, has grown internationally. In order to save space, the research team will only document and review some of the more prominent guidelines in this subsection. Table 8-9 describes the most prevalent bicycle and pedestrian guidelines.

Table 8-9. Pedestrian and Bicycle Guidelines for School Sites.

GUIDELINE	Source(s)
Safe crosswalks with crossing guards (use adult cross guard/safety officer at intersections near school where there is a sizable traffic volume).	Katz, Okitsu & Associates, Miami-Dade County (FL) MPO
Pedestrian and vehicle conflicts should be minimized (do not mix them together).	Miami-Dade County (FL) MPO, City of Mississauga (Canada), North Carolina DOE, Missouri DOT
There should be standard and well-maintained sidewalks and/or a designated safe path leading to the school.	Miami-Dade County (FL) MPO, South Carolina DOE, Douglas County (CO), ITE Michigan Section, Arizona DOT
Develop safe walk/bike routes/maps leading to school.	Several
Pedestrians from student parking areas shall not be allowed to cross school drives to reach the school building.	South Carolina DOE, North Carolina DOE
Facilities should be provided for bicycle access and storage.	Wake County (NC) Public School System, City of Mississauga (Canada)
Except at pick-up locations, sidewalks shall be kept a minimum of 5 ft (1.5 m) away from roadways.	Seminole County (FL) Public Schools
Student pedestrian traffic should not be mixed with vehicle traffic.	School Bus Fleet (*67*)

Table 8-9. Pedestrian and Bicycle Guidelines for School Sites (continued).

GUIDELINE	Source(s)
No pedestrian crosswalks should cross through a loading area.	School Bus Fleet (*67*), National Safety Council, California DOE, Missouri DOT
Students approaching buildings on foot should not have to cross main traffic arteries.	North Carolina DOE
Use two adult crossing guards at wide street crossings.	City of Phoenix (AZ)
Create wider paved student queuing areas at major school crossings and paint "stand-back lines" on the sidewalk to show children where to stand while waiting to cross.	City of Phoenix (AZ)

The research team also found several other sources with valuable information on planning and designing student pedestrian facilities including:

- *A Guidebook for Student Pedestrian Safety* (*81*),
- *Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas* (*82*), and
- *Recommendations to Reduce Pedestrian Collisions* (*83*).

GUIDELINES FOR SCHOOL ACCESS DRIVEWAYS

The research team examined sources for guidelines related to school access driveways. The guidelines for driveways tended to fall into one of the following topic areas:

- number – recommendations related to the number of driveways to adequately service the school;
- spacing – recommendations for the desirable distance between driveways with access to the school site;
- location – recommendations for the minimum offset distance from the nearest intersection; and
- layout and design – recommendations for the minimum corner radii for bus and/or vehicle access and the design (width) of the driveways.

One of the questions on the AASHTO survey concerned existing design criteria/guidelines for number, spacing, location, and layout of school driveways. Approximately 44 percent of the survey respondents (14 of 32) indicated that they have existing design guidelines for the number of driveways to service school sites. Of those with existing guidelines, most cited access management guidelines and manuals as the primary source. Six of the state DOT representatives indicated that they treat school sites the same as all other land uses in terms of the number of driveways for site access. Table 8-10 provides information on the five state DOT respondents that have guidelines specific to school sites.

Table 8-10. Guidelines for the Number of Driveways for Servicing School Sites.

Guideline	Source
No more than 3 for any parcel (assuming that minimum spacing is met).	New Hampshire DOT
Typically allow for 2 entrances – one for bus traffic and the other for student, teacher, parent drop-off/parking.	Delaware DOT
Minimum of 2 – one for buses and one for parent drop-off.	Maryland State Highway Administration
Discourage all direct access for schools but the Colorado State Highway Access Code controls if there are driveways permitted.	Colorado DOT
• Elementary – 2 or 3 depending on if there is all-day kindergarten • Middle – 2 • High – 3 or 4 depending on student population	South Carolina DOT

Over half of the survey respondents (18 of 32) specified that they have existing design guidelines for the spacing of driveways that access school sites. Of those with existing guidelines, most cited access management guidelines and manuals as the primary source. Almost all DOT representatives indicated that they treat school sites the same as all other land uses in terms of the driveway spacing. Table 8-11 provides information on the four state DOT respondents that provided their specific guidelines for driveway spacing for school sites.

Table 8-11. Guidelines for the Spacing of Driveways at School Sites.

Guideline	Source
Use rule of thumb of 10 times the operating speed as a minimum spacing	Virginia DOT
300 to 400 ft (91.5 to 122 m) is desirable	Delaware DOT
600 ft (183 m) – distance required to accommodate the installation of a properly designed left-turn lane	Minnesota DOT South Carolina DOT

Almost 70 percent of the survey respondents (22 of 32) stated that they have existing design guidelines for how far driveways must be offset from the nearest intersection. As with driveway frequency and spacing, most agencies cited access management guidelines and manuals as the primary source for this information. Secondary sources for this type of guideline were the AASHTO *Policy on Geometric Design* (*14*), DOT Design Manuals, and the *Manual on Uniform Traffic Control Devices* (*37*). Only three respondents provided specific information on the minimum offset distance (most others just cited their access management manuals and/or regulations):

- New Hampshire DOT – 100 ft (30.5 m);
- South Carolina DOT – 75 to 100 ft (23 to 30.5 m); and
- New York DOT – 2W + 15 ft (4.6 m); where W is the width of the nearby intersection.

Several respondents indicated that queuing and operational analyses are performed on a case-by-case basis to determine the necessary offset distance for a driveway from the nearest intersection.

Over 70 percent (23 of 32) indicated that they have existing design guidelines for minimum turning radius and lane widths for driveways off of state-maintained facilities. Several sources were cited including access management/driveway manuals, AASHTO *Policy on Geometric Design* (*14*), and DOT Design Manuals. Four respondents supplied specific values for the driveway designs (Table 8-12).

Table 8-12. Guidelines for Layout and Design of Driveways at School Sites.

Guideline		Source(s)
Minimum Radius ft (m)	**Recommended Lane Width ft (m)**	
50 (15.3)	12 (3.7)	Mississippi DOT
50 (15.3)	12 (3.7)	Maryland DOT
35 (10.7)	16 (4.9)	Delaware DOT
25 car / 40 bus	12 (3.7) with 18 (5.5) throat entrance (see Figure 8-2)	South Carolina DOT
30 car / 50 bus	12 (3.7) + increased on curves	Missouri DOT

One source had a guideline that driveway intersection angles should be between 75 and 90 degrees because skewed driveway and street intersections (those not at right angles) can cause problems (*67*). Furthermore, several sources advocated that it is often desirable for exit driveways to have two lanes, one for left-turning vehicles and one for right turners (*61*, *67*). This design helps reduce congestion, because the right-turning cars and/or buses can proceed while the left turners are waiting for the traffic from the right to clear.

Several agencies also had recommended practices for the relative placement of school access driveways. Table 8-13 provides the guidelines for relative placement of driveways at school sites and their corresponding source.

Table 8-13. Guidelines for the Relative Placement of School Access Driveways.

Guideline	Source
Locate the bus area so that buses exit upstream of automobiles and gain priority thereby reducing delay	Douglas County (CO)
The one-way driveway into the school should be located at the far left side from the direction where the majority of traffic is coming from such as a city. In addition, the through roadway serving the one-way into the school should have a left- and right-turn lane. In this situation, the left-turn traffic only has to yield to the opposing through traffic lane and the right-turn lane. The majority of those exiting the school area will be turning right creating only one vehicle conflict. It might be difficult to obtain this optimum design	Minnesota DOT
Driveways should not be located too close to nearby street intersections. Doing so will create offset or dogleg intersections with other streets or high-volume driveways. Offset intersections can create erratic traffic patterns and detract from drivers' abilities to look out for pedestrians	School Bus Fleet (*67*)

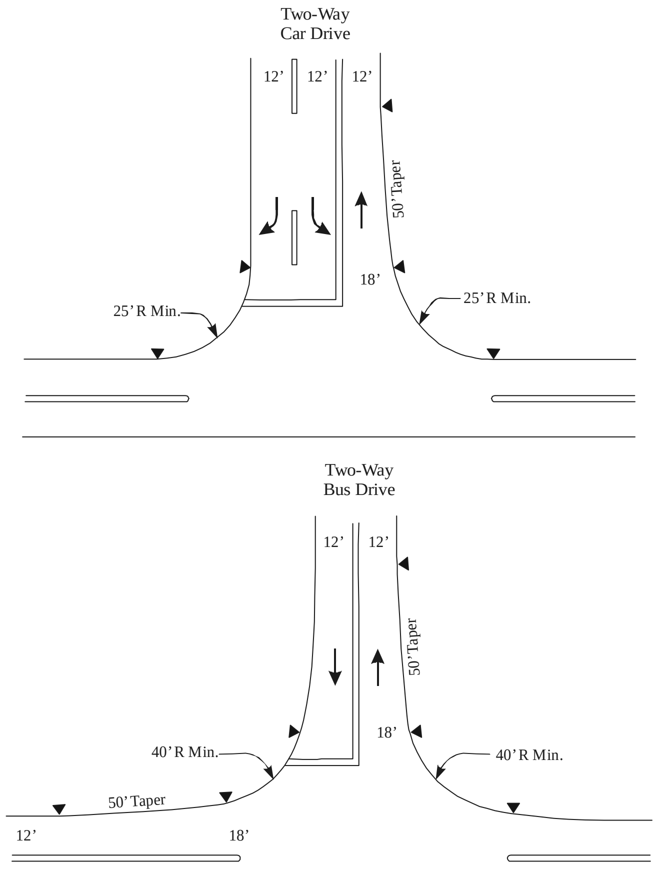

Figure 8-2. South Carolina DOT Driveway Lane Width and Corner Radii Guidelines (*9*).

GUIDELINES FOR TURNING LANES FOR SCHOOL SITES

Many agencies have existing guidelines for the installation and design of turn lanes for access to adjacent sites. One of the questions in the survey of members of the AASHTO Subcommittee dealt with existing design criteria or guidelines for the installation of turn lanes/bays at new and/or existing school sites.

Over 70 percent (23 of 32) of the survey respondents indicated that they have existing guidelines for when turn lanes are warranted and their required design. The majority of those with guidelines (15 of 23) cited a state manual (access management, design, and/or driveway) as a primary source for their turning lane criteria. One state customarily installs turn lanes with a minimum length of 300 ft (91.5 m) at all school driveways, and another recommends construction of turn lanes at most new school sites statewide.

Another group (9 of 23) cited the AASHTO *Policy on Geometric Design of Highways and Streets* (*14*) as a primary source for their turning lane criteria. One agency indicated that they use the AASHTO turn lane criteria in Table 9-75; however, they reduce the advancing volume by 50 percent when dealing with school site issues. Another agency routinely installs turn lanes at all school driveways and uses the AASHTO design criteria.

Three agencies with existing guidelines indicated that a traffic impact study is required and dictates when turn lanes are installed. One of these agencies also requires the school district to fund and construct the turn lane(s) if they are warranted.

In summary, many of the guidelines for required length and taper of left-turn lanes converged on 500 to 600 ft (153 to 183 m) as the distance needed to develop an adequate left-turn lane. Most of the warrants for whether a turn lane is warranted were based primarily on volume; however, some also used speed as a criterion.

TRAFFIC CONTROL, PAVEMENT MARKINGS, AND SIGNING FOR SCHOOL SITES

In the review of existing guidelines for traffic control, markings, and signing for school sites, the research team concentrated guidelines and recommended practices dealing with on-site issues at schools. As noted in the case studies (see Chapter 7), the research team observed a wide variety of traffic control, markings, and signing at the school sites in Texas.

Table 8-14 lists the on-site guidelines for traffic control, markings, and signing for school sites. The majority of the existing guidelines related to signing issues. Two sources have a guideline that all school site and regulatory signage comply with the *MUTCD* (*37*). Another agency requires the installation of truck exclusion signs around the school area.

PARKING REQUIREMENTS AND DESIGN AT SCHOOL SITES

The research team identified only a few sources with existing guidelines for design of school parking facilities. Table 8-15 lists the guidelines and associated sources for parking requirements and design at school sites. The most prominent guideline from the identified sources was that parking areas for students, staff, and visitors should be separated from loading zones. There were several guidelines that seemed to conflict with each other. The most obvious conflict was that one guideline suggested that all parking areas be separate and not part of any on-site roadway whereas another advocated that visitor parking be combined with the parent drop-off driveway.

The research team also found several guidelines for parking requirements (i.e., size and/or number of spaces) at school sites. One guideline was general and suggested that there should be one parking stall for each staff member and an additional 10 percent of that total for visitor parking (*8*). A similar guideline indicated that 2.25 spaces should be provided for each teacher station (this includes spaces for staff and visitors) (*52*). One agency has a guideline for parking at high schools that suggests that a parking capacity for student lots be calculated based on a minimum of 50 percent of the student enrollment (*52*).

As indicated in the interviews conducted with school district personnel and architects, many utilize local requirements, typically from a municipality, for the parking facilities requirements at schools. The local requirements for total number of spaces sometimes vary based on school type (i.e., elementary versus middle versus high schools). Most school architects also use standard graphics software packages for the actual design of parking spaces (type-angled, parallel, or conventional) and lots.

Table 8-14. Traffic Control, Markings, and Signing Guidelines for School Sites.

Guideline	Source(s)
Restrict turning movements during school beginning/ ending periods to reduce congestion/conflicts.	Miami-Dade County (FL) MPO
Install truck exclusion signs around the school area.	Miami-Dade County (FL) MPO
All site and regulatory signage and markings shall comply with the Manual on Uniform Traffic Control Devices.	Seminole County (FL) Public Schools, ITE Michigan Section, School Bus Fleet (*67*)
Curbs (flush ribbon or raised) at bus and vehicle drop-off/pick-up locations shall be painted yellow.	Seminole County (FL) Public Schools
Sign height from the ground is a minimum of 7 ft (2.1 m) for a single sign and 5 ft (1.5 m) for a double sign.	School Bus Fleet (*67*)
Justify a traffic signal (where vehicle volumes warrant) during the peak periods at secondary school access to or from an arterial.	Douglas County (CO)
All curbside parking should be prohibited in advance of school pedestrian crossings, at driveway areas, and at school gates/building entrances.	New South Wales (Australia), ITE Michigan Section
Where necessary, traffic control devices should be provided to assist school traffic in entering the regular traffic flow.	National Safety Council
It is recommended that all roadways, with the exception of loading and unloading zones, on school properties be signed 'No Parking or Standing, Fire Lane.'	ITE Michigan Section
Provide 'Buses Only' and 'No Entry' signage at appropriate ends of the bus loop.	Kentucky DOE
Paint SCHOOL pavement stencil on each high-speed approach to a school crossing.	City of Phoenix (AZ)

Table 8-15. Parking Requirements and Design Guidelines for School Sites.

Guideline	Source(s)
Separate parking areas (student, staff, visitors, and buses) from student loading/unloading areas.	South Carolina DOE, Miami-Dade County (FL) Public School District, Douglas County (CO), New South Wales (Australia), ITE Michigan Section, North Carolina DOE
Parking areas shall be separate and not part of the road system on the school site.	Miami-Dade County (FL) Public School District
Peninsula and detached islands in parking areas shall have a 6 inch (15.2 cm) raised curbing.	Seminole County (FL) Public Schools
Islands in parking areas shall have 6 inch (15.2 cm) raised curb perimeters. When the island area exceeds 1000SF (93 m^2), the curb shall taper down to a flush ribbon curb for 6 ft (1.8 m) in length at a location that is inaccessible to vehicles yet allows for mower access onto the island.	Seminole County (FL) Public Schools
Staff parking areas can be located with less concern for accessibility than other areas because staff members generally arrive before and leave after the students and are generally more experienced in handling traffic.	School Bus Fleet (*67*)
In the construction of parking areas, it might be advantageous if only the visitor parking spaces were close to the school. Care should be exercised in the placement of these areas to preclude the visitor from crossing the school bus traffic pattern.	National Safety Council, North Carolina DOE
Prior to designing and laying out parking lots, architects should consult with the school administration on that total number of pupils and school personnel.	National Safety Council
There should be one stall for each staff member and an additional 10% of that for visitor parking.	ITE Michigan Section
Buildings should be parallel to the street and have parking located at the side or rear of the property.	City of Mississauga (Canada)
Avoid parking cars parallel to curbs. This can cause traffic congestion and create a serious safety problem if students should step into traffic.	North Carolina DOE
Provide an adequate turning radius (45 ft [13.7 m] minimum outside and 26 ft [7.9 m] minimum inside) within parking lots.	North Carolina DOE

Table 8-15. Parking Requirements and Design Guidelines for School Sites (continued).

Guideline	Source(s)
Combine visitor parking with the parent drop-off driveway located near the main entrance and administrative office.	North Carolina DOE
Avoid driveways that allow parents to take short-cuts through parking lots to drop-off or pick-up students. This type of parking layout encourages students to cross vehicular paths.	North Carolina DOE
Provide 2.25 parking spaces for each teacher station (this includes space for staff members and visitors).	California DOE
Many school districts provide students lots with a minimum parking capacity calculated on 50% of the school enrollment.	California DOE
Locate kitchen/custodial staff parking at service/kitchen area.	Kentucky DOE

A study of six elementary schools in Oklahoma developed a model for peak vehicle accumulation and the associated parking demand (*84*). The model uses the following assumptions and objectives:

- About 4 percent of the students are absent.
- The fair-weather a.m. and p.m. peak traffic periods are regular occurrences, and because they regularly happen, the design as a minimum should accommodate these periods.
- At most locations, the p.m. peak is larger and of more concern than the a.m. peak period.
- Traffic accumulations will usually be larger in p.m. inclement weather than in p.m. mild weather. Even if accommodating only the mild weather traffic accumulation demand, the designer should determine if inclement weather traffic conditions will cause an unacceptable problem.

The study authors concluded that the school traffic problem is not only one of not enough parking; there is too much demand for vehicle space.

CHAPTER 9. FIRST-YEAR CONCLUSIONS AND FUTURE ACTIVITIES

The research team performed a state-of-the-practice literature review and conducted interviews and surveys of architects, school district personnel, consulting engineers, state DOT engineers, and municipal staff in order to gain an understanding of the myriad of issues with the design and operation of transportation-elements within and around K-12 school campuses. The interviews and surveys also provided suggestions regarding a potential symposium that is scheduled for the second year of this research project. In order to gain a practical understanding of the transportation challenges at a school, researchers also completed observational studies at 14 school sites in Texas. Finally, the research team performed a thorough review of existing guidelines for transportation-related elements at schools.

This chapter is organized into two primary sections:

- Key Findings and Conclusions: this section documents the key findings and conclusions based on the first-year research activities; and
- Future Activities: this section briefly describes the planned activities for the second year of the research.

KEY FINDINGS AND CONCLUSIONS

State-of-the-Practice Literature Review

- Much of the state-of-the-practice on design and operations issues around schools was found in non-traditional sources such as Internet sites for the various state DOTs and state and local school sources.
- Several state DOTs (North Carolina and South Carolina) have dedicated units for review of school site plans and school-related transportation issues.
- A recently completed Transportation Research Board (TRB) study indicated that school buses are the safest form for getting children to and from school.

Architect Interviews and Surveys

- There were a number of resources cited by the interview and survey participants used for the planning and design of K-12 educational facilities; however, most of these do not provide any substantial guidance on transportation-related issues.
- Only three of the 10 architects surveyed indicated an awareness/familiarity with the TxDOT Precious Cargo Program; however, half of the architects had at least one school site plan reviewed by a TxDOT representative prior to construction of a new school campus.
- The majority of architects surveyed (70 percent) stated that the most challenging problem with traffic access and circulation at educational facilities relates to separating vehicle, bus, and pedestrian traffic. One respondent indicated that working with TxDOT was the most challenging because reviewers were inconsistent in their comments and required actions.

- The three most important issues to the architect participants for a symposium were:
    1. coordination between designers, schools, and state and city transportation departments;
    2. design and operation of drop-off/pick-up zones; and
    3. retrofit options (design and operations) for schools with existing transportation problems.

School District Interviews and Surveys

- The State of Texas has led in the development and renovation of school campuses. Between 1992 and 2000, no state has spent more money (over 19 billion) on construction of K-12 school facilities than Texas.
- Within the range of site access issues, separation of traffic types (vehicles, school buses, day care vans, and pedestrians) was the highest rated problem area at all campus types (i.e., elementary, middle/junior, and high schools).
- Slightly more than half (56 percent) of the interview and survey participants indicated an awareness/familiarity with the TxDOT Precious Cargo Program; however, only 40 percent had at least one school site plan reviewed by a TxDOT representative prior to construction of a new school campus.
- Demographics (i.e., location of existing and future students) is the most important factor in the selection of future land parcels for development of new school campuses.
- The three most important issues to the school district personnel for a symposium were:
    1. design and operation of drop-off/pick-up zones;
    2. retrofit options (design and operations) for schools with existing transportation problems; and
    3. traffic impact analysis (volumes, modal estimation) and Safe Routes to School (recently passed Matthew Brown Act in the Texas legislature).

Consulting Engineers Interviews

- The integration of traffic circulation with the school building's location and orientation is very important, but consulting engineers are typically brought in late into the design process if at all. Engineers may be called upon after construction to devise solutions to access and circulation problems.
- Design guidelines for drop-off/pick-up zones are sketches or other in-house sources; no written guidelines are used.
- The three most important issues to the consulting engineers for a symposium were:
    1. coordination between designers, schools, and state and city transportation departments;
    2. design and operation of drop-off/pick-up zones; and
    3. Safe Routes to School (recently passed Matthew Brown Act in the Texas legislature).

TxDOT and Municipal Surveys

- Several TxDOT respondents indicated that they need to be involved very early in the school site planning process. Several respondents commented on the need for guidelines for traffic and pedestrian designs in and around schools.
- Approximately half of the TxDOT respondents had reviewed a school site plan in the previous six months.

Observation Studies at School Campuses

- The preferred data collection methodology is for TTI personnel to use travel time software on a laptop or handheld computers.
- At almost all sites, the average service time (i.e., amount of time spent on-site in the main parent drop-off/pick-up zone) was significantly more variable for afternoon pick-up operations as opposed to the morning drop-off period.
- There were a wide variety of design, operations, and traffic control/markings practices at the school sites studied.
- Some of the schools used pro-active practices such as placement of traffic cones, use of gates and/or other barriers, and use of student and staff for on-site traffic control to improve the safety and flow of traffic within their campus.
- In general, schools that had separation of the basic traffic types appeared to have less safety conflicts than those where separation was not present.

Review of Existing Guidelines

- To obtain information on existing guidelines for transportation-related elements at schools, the research team used a variety of methods including review of published documents, Internet searches, survey instruments, and direct correspondence.
- Several agencies provided general site requirements and design for separation of transport modes; service, delivery, and maintenance issues; emergency access issues; weather protection; and general site design and layout.
- The review of existing guidelines produced a significant number of bus-related design and operations guidelines.
- General information on parent drop-off/pick-up zones is included in several sources; however, specific guidance is limited. South Carolina DOT has a specific guideline for on-site stacking length ranging from 800 to 1500 ft (244 to 458 m) depending on school type and student population.
- A number of studies and programs have been dedicated to bicycle and pedestrian issues for schools (generally under the Safe Routes to School umbrella).
- About half of the department of transportation respondents to a survey indicated they have existing design guidelines for the number and spacing of driveways. Over 70 percent indicated that they have existing guidelines for when turn lanes are to be installed. Several indicated that they treat schools the same as other land uses in determining number and spacing of driveways and turn lanes.

FUTURE ACTIVITIES

The second year of the research project will include the following activities:

- conduct school issue symposium,
- conduct field studies,
- develop recommended guidelines, and
- document research findings.

Following is an overview of these activities.

Conduct School Issue Symposium

A minimum of one school issue symposium is planned for the second year of the project. Findings from the surveys and interviews will have a major impact on how the symposium will be structured. For example, a better attendance is expected if the symposium is scheduled to occur just prior to or following another professional society meeting that involves school officials. The symposium is tentatively planned for the Dallas/Ft. Worth metroplex; however, the final meeting site and date of the symposium will be a function of the location and dates of the professional society meeting that can best complement the symposium. Topics being considered for the symposium include:

- coordination between stakeholders,
- design of school sites (drop-off/pick-up zones, parking lots, etc.),
- Safe Routes to School,
- traffic operations,
- improvements for existing transportation problems, and
- other topics as developed.

Conduct Field Studies

Apparent needs for school transportation research appear to be broadly split by type of school: secondary and primary. Because of the different nature of the problems evidenced in the case studies performed and in the literature, the research activities planned for year two of this research project are centered on two primary efforts:

- secondary schools: parking needs and trip generation; and
- primary schools: queuing studies.

Information regarding data available from other sources and ongoing research projects (primarily in the North Carolina and South Carolina Departments of Transportation) will be incorporated where appropriate to extend the data collected in this project.

Secondary Schools

Secondary schools frequently have a major impact on the transportation infrastructure in their area. Because secondary schools tend to be much larger than primary schools and frequently depend primarily on personal automobiles for student transportation it would be desirable if school districts and transportation officials had a better idea of the number of trips being generated by the schools and the subsequent parking needs at those facilities. Studies contemplated include:

- parking needs,
- trips generated, and
- simulations of the effects of incorporating various entry turn treatments into school facilities.

A subsidiary effort to be undertaken at secondary schools is to review their queuing performance:

- queue demand rates,
- queue service rates, and
- pedestrian and vehicle conflicts.

Primary Schools

Primary schools tend to be smaller in size, although their typical location on minor roadways may still lead to substantial impacts on the local transportation infrastructure. Queuing issues appear to be most critical at primary schools, with substantial queues developing at both pick-up and drop-off times at most schools. Operational strategies vary substantially among schools, with some schools providing aggressive supervision, multiple queue lanes, etc. Examinations of queuing performance and practice will build on the data collected during the year one case studies and include:

- queue demand rates,
- queue service rates, and
- pedestrian and vehicle conflicts.

A subsidiary effort to be undertaken at principally middle schools will be:

- trip generation, and
- parking needs.

Develop Recommended Guidelines

Based on the findings and lessons learned during the field studies, review of existing guidelines, and symposium, the research team will develop recommended guidelines for the design of roadway facilities around schools. The guidelines will be oriented towards the broad range of stakeholders for school issues in order to facilitate their overall understanding and usefulness.

Document Research Findings

The final task of the project will be to document the findings from the research.

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APPENDIX: SURVEY INSTRUMENT
SCHOOL TRANSPORTATION ACCESS ISSUES

Name	
State DOT	

① Please rank the following issues at school sites located on or near state-maintained roadways from most problematic (#1) to least problematic (#10):

Issue	**Rank**
Pedestrian access to the school site (crosswalks, sidewalks, etc.)	
Bicycle access to the school site	
Provision of turn bays from adjacent roadways into the school site	
Installation and operation of reduced speed school zones	
Traffic congestion (queue spillback) during morning drop-off and afternoon pick-up due to inadequate on-site loading zones	
Driveway placement and design issues (corner clearance, separation distance, etc.)	
Selection of poor sites for traffic access	
Lack of coordination and planning with the school district and their architects	
Separation of bus and vehicle access and loading zones	
Provision of traffic signals to promote "safe" access to the school site	

② Does your DOT have a formal program to review and/or approve site plans for new K-12 schools that are located on or near state-maintained roadways? If yes, please describe.

③ What resources do DOT staff use when reviewing a proposed or existing school site plan?

Resource	Yes	No
Manual on Uniform Traffic Control Devices		
DOT Roadway Design Manual		
Engineering Judgment		
Other (please describe):		

④ Does your DOT have any authority over the approval of the school site plan before access is provided to a state-maintained roadway? If yes, please describe.

⑤ Does your DOT have an existing or planned program dedicated to funding school-related transportation safety and access improvements? If yes, please describe.

⑥ Please describe any design criteria and/or guidelines that your DOT utilizes for the following transportation-related elements at new and/or existing school sites:

Element Description	Design Criteria/Guidelines
On-site stacking length: recommendations for the distance in the loop drive/parent drop-off/pick-up zone to accommodate loading and unloading of students	
Number of school driveways: recommendations for number of driveways to adequately service the school - possibly by school type – elementary, middle, or high schools	
Spacing of school driveways: recommendations for the desirable distance between driveways with access to the school site	
Driveway location: recommendations for the minimum offset distance from nearest intersection	
Driveway layout: recommendations for the minimum corner radii for bus and/or vehicle access, lane widths, etc.	
Installation of turn lanes and/or bays: recommendations for when they are warranted, required length and taper, etc.	

⑦ Please write any other comments or suggestions related to transportation in and around schools:

PLEASE RETURN THE SURVEY BY JULY 31ST IN ONE OF THE FOLLOWING WAYS:

(1) E-MAIL ATTACHMENT to s-cooner@tamu.edu

(2) FAX: (817) 461-1239 Attn: Scott Cooner

(3) MAIL: Scott Cooner
Texas Transportation Institute
110 N. Davis Drive, Suite 101
Arlington, TX 76013-1877

Thirty-two DOT representatives from twenty-eight states responded to this survey.