Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-04/4286-2		

4. Title and Subtitle	5. Report Date
TRAFFIC OPERATIONS AND SAFETY AT SCHOOLS: RECOMMENDED GUIDELINES	October 2003 Resubmitted: January 2004
	6. Performing Organization Code
7. Author(s) Scott A. Cooner, Kay Fitzpatrick, Mark D. Wooldridge, and Garry L. Ford	8. Performing Organization Report No. Report 4286-2
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135	10. Work Unit No. (TRAIS) 11. Contract or Grant No. Project No. 0-4286
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Implementation Office P. O. Box 5080 Austin, Texas 78763-5080	13. Type of Report and Period Covered Research: September 2001 - August 2003 14. Sponsoring Agency Code

15. Supplementary Notes

Research performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.
Research Project Title: Operational and Safety Guidelines for Roadway Facilities around Schools

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 report contains the recommended school site planning guidelines for transportation-related elements such as site selection, general site requirements and design, bus operations, parent drop-off/pick-up zone, driveways, turn lanes, signing and marking, parking, and pedestrian and bicycle access. The research team based these guidelines on a comprehensive review of existing guidelines and the results of field studies at school sites in Texas. The report provides examples of good practices and also examples of practices to avoid for many of the more prominent guidelines. The guidelines are focused on transportation design, operations and safety within school sites – with a particular focus on the parent and bus drop-off/pick-up zones. The final chapter of the report contains a site plan review checklist that TxDOT engineers, field crews, architects, and school district personnel can use to coordinate efforts and make sure that school access is safe and efficient.

17. Key Words	18. Distribution Statement
School, Safety, Drop-off, Pick-up, Design Guidelines, School Bus, Site Plan	No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif.(of this report)	20. Security Classif.(of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	80	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

TRAFFIC OPERATIONS AND SAFETY AT SCHOOLS: RECOMMENDED GUIDELINES

by

Scott A. Cooner, P.E.
Associate 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

and

Garry L. Ford, P.E.
Assistant Research Engineer
Texas Transportation Institute

Report 4286-2
Project Number 0-4286
Research Project Title: Operational and Safety Guidelines for Roadway Facilities around Schools

Sponsored by the
Texas Department of Transportation
In Cooperation with the
U.S. Department of Transportation
Federal Highway Administration

October 2003
Resubmitted: January 2004

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

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration and/or Texas Department of Transportation. This report does not constitute a standard or regulation, and its contents are not intended for construction, bidding, or permit purposes. The use of names or specific products or manufacturers listed herein does not imply endorsement of those products or manufacturers. The engineers in charge of this project were Mr. Scott A. Cooner, P.E. #86225 (Texas), and Dr. Kay Fitzpatrick, P.E. #86762 (Texas).

ACKNOWLEDGMENTS

The research reported herein was performed by the Texas Transportation Institute (TTI) as part of a project titled *Operational and Safety Guidelines for Roadway Facilities around Schools* sponsored by the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). Mr. Scott A. Cooner, P.E. #86225 (Texas), and Dr. Kay Fitzpatrick, P.E. #86762 (Texas), served as co-research supervisors, Ms. Terry Sams, P.E. #58499 (Texas), (TxDOT Dallas District) served as project coordinator, and Mr. Linden Burgess (TxDOT Dallas District) served as project director.

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

- 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. Scott Young, City of Frisco.

The research team extends a special thanks to the school principals and other district administrators that allowed TTI researchers access to their campuses to observe and collect data.

TABLE OF CONTENTS

LIST OF FIGURES

Page

LIST OF FIGURES (continued)

Page

LIST OF TABLES

LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
AIA	American Institute of Architects
CEFPI	Council of Educational Facility Planners International
DOE	Department of Education
DOT	Department of Transportation
FHWA	Federal Highway Administration
FM	Farm to Market
ISD	Independent School District
ITE	Institute of Transportation Engineers
MPO	Metropolitan Planning Organization
MSTA	Municipal School and Transportation Assistance
MUTCD	Manual on Uniform Traffic Control Devices
NCSU	North Carolina State University
NHTSA	National Highway Traffic Safety Administration
NSC	National Safety Council
PTSI	Pupil Safety Transportation Institute
ROW	Right-of-Way
TCD	Traffic Control Device
TTI	Texas Transportation Institute
TxDOT	Texas Department of Transportation
WASHTO	Western Association of State Highway and Transportation Officials

CHAPTER 1. INTRODUCTION

BACKGROUND AND SIGNIFICANCE OF RESEARCH

This report contains the recommended school site planning guidelines for site selection, general site requirements and design, school bus-related design and operations, parent drop-off/pick-up zones, pedestrian and bicycle access, driveways, turn lanes, traffic control, signing and marking, and parking. The research team based these guidelines on a comprehensive review of existing guidelines and the results of field studies at school sites in Texas. The report documents the recommended guidelines and best practices for transportation operations and safety within school sites – focusing on the parent and bus drop-off/pick-up zones. The report also contains a site plan review checklist tool that TxDOT engineers and school district representatives can use to facilitate good site planning and design.

Precious Cargo Program

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 (Figure 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 conducted 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.

Figure 1. Precious Cargo Program Brochure.

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. The recommended guidelines and best practices documented in this report address the critical issues associated with safety and operational improvements around schools.

SUMMARY OF PRIMARY RESEARCH EFFORTS

Project 0-4286 consisted of four primary efforts:

1. review of existing guidelines;
2. interviews and surveys of school transportation stakeholders;
3. observational case studies at school sites; and
4. field studies at school sites.

The research team accomplished the review of existing guidelines primarily during the first-year project activities. Researchers used various sources including review of published papers and reports, Internet searches, and school safety marketing materials to obtain information on existing guidelines for transportation-related elements on school sites. The review of existing guidelines is contained in Report 4286-1 (*6*).

The research team conducted interviews and surveys with architecture firm representatives, school district personnel, consulting engineers, and state and municipal engineers with school site review responsibilities. The interviews and surveys were designed to gather information on existing policies, procedures, and processes for school site planning, design, and review. Detailed information on the interview and surveys can be found in Report 4286-1 (*6*).

Researchers performed observational case studies at 14 school campuses throughout Texas. These studies allowed the research team to gain an understanding of common problems at school sites and to refine data collection techniques and processes. Report 4286-1 provides information on general observations, data collected, site design and layout, and other items for each school studied (*6*).

During the second year, the research team conducted field studies at 20 school campuses throughout Texas. The field studies concentrated on design and operation of on-site parent drop-off/pick-up zones and bus loading zones at elementary school sites. Report 4286-3 documents the data analysis and findings of the year-two field studies (*7*).

REPORT ORGANIZATION

The research team divided this report into four chapters. Chapter 1 contains the background and significance of this research and the summary of the primary research efforts.

Chapter 2 (School Site Planning: Guidelines and Best Practices) provides the recommended guidelines for critical elements in the school site planning process. The guidelines concentrate on on-site transportation elements such as parent drop-off/pick-up zones. This chapter also provides examples of good practice and examples to avoid based on some of the design, operations, and safety practices observed at school sites in Texas.

Chapter 3 (School Site Plan Review Checklist) presents a checklist tool that can be used by TxDOT engineers and other interested stakeholders to review school site plans based on the guidelines contained in Chapter 2. The research team intends for this document to facilitate greater use of the existing Precious Cargo Program.

CHAPTER 2. SCHOOL SITE PLANNING: GUIDELINES AND BEST PRACTICES

This chapter contains the primary product of Project 0-4286 – the recommended school site planning guidelines and best practices. The research team developed these guidelines to provide a source for those interested in the safety and efficiency of student transportation at school sites. Researchers intend for the recommended guidelines to capture the mainstream guidance on how to design and operate roadway facilities within and around schools in order to improve safety and reduce local congestion.

The researchers based the recommended guidelines on a comprehensive review of existing guidelines, interview and survey results, and analysis of data collected at school campuses throughout Texas. The guidelines are relevant to all of the basic school types (elementary, middle, and high schools); however, are most applicable to elementary schools because of the amount of data collected at this school type during the project. The research team organized the recommended guidelines into nine different categories including:

- site selection;
- general site requirements and design;
- bus-related design and operations;
- parent drop-off/pick-up zones;
- bicycle/pedestrian;
- driveways;
- turn lanes;
- traffic control, signing, and pavement markings; and
- parking requirements and design.

The remainder of this chapter synthesizes the recommended guidelines for each of the nine categories listed above. Researchers placed the guidelines in tables, with the written guideline and the corresponding sources where the guideline was found. Some of the recommended guidelines are also supplemented with a best practices section. Guidelines in the tables that have a star next to them indicate that they have a best practices section. The best practices section uses information gathered during the field studies to illustrate the application of the guideline with an example to avoid and a good example.

CRITERIA AND GUIDELINES FOR SELECTION OF SCHOOL SITES

From a practical standpoint, the selection of a site for a new school dictates the resulting design and operations of the facility. Interviews with several independent school district (ISD) representatives regarding how future school sites are obtained and selected revealed the following:

- 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.

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

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 (CEFPI), a professional society composed primarily of school district personnel, architects, engineers, and contractors. Table 1 provides the CEFPI guidelines (*8*). Several agencies have also 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 pickup (*9*, *10*, *11*).

Table 1. Site Size Guidelines for New School Sites.

School Type	Number of acres (hectares) required CEFPI Guidelines[2] (*8*)
Elementary (K-6)	10[1] (4.05)
Middle (5-8)	20[1] (8.1)
Junior High (7-9)	20[1] (8.1)
Senior High (9-12)	30[1] (12.15)
Vocational Center	10[1] (4.05)

[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, Canada, ranged from 350 ft (106.75 m) for an elementary school to 600 ft (183 m) for secondary (i.e., middle, junior high, and senior high) school (*12*). 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 have also adopted general guidelines relating to frontage space including:

- provide ample frontage to allow for separate car and bus entrances and exits (*13*);

<u>Guideline 1</u>: School buildings should be set back on the site a sufficient distance from the adjacent roadways to ensure safe and adequate site storage for stacking of loading and unloading vehicles. (DESIGN)

- provide adequate frontage to avoid congestion at site entrances/exits; and
- 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. Building setback is an important consideration because the placement of the building significantly affects the traffic circulation and amount of on-site space for stacking of vehicles. One agency had a general guideline 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.

Best Practice for Application of Guideline 1

Figures 2 and 3 show examples of school sites located in the same ISD. Both schools are elementary schools that used the same prototype design for the school building.

Example to Avoid

The school site shown in Figure 2 was the first prototype elementary school built in the suburban ISD. In this case the architect placed the school building near the front of the site, set back approximately 150 feet from the adjacent two-lane roadway. This site regularly had the queue of vehicles in the front loop driveway spill back out onto the adjacent roadway during morning drop-off and afternoon pick-up operations, blocking through traffic.

Example of Good Practice

Based on this experience, the ISD built the next prototype elementary on a similar site but placed the building approximately 350 feet farther back on the site (see Figure 3 – school is located in middle of the aerial photograph). The increased setback distance provides more on-site stacking space and has resulted in better operations at the school.

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.

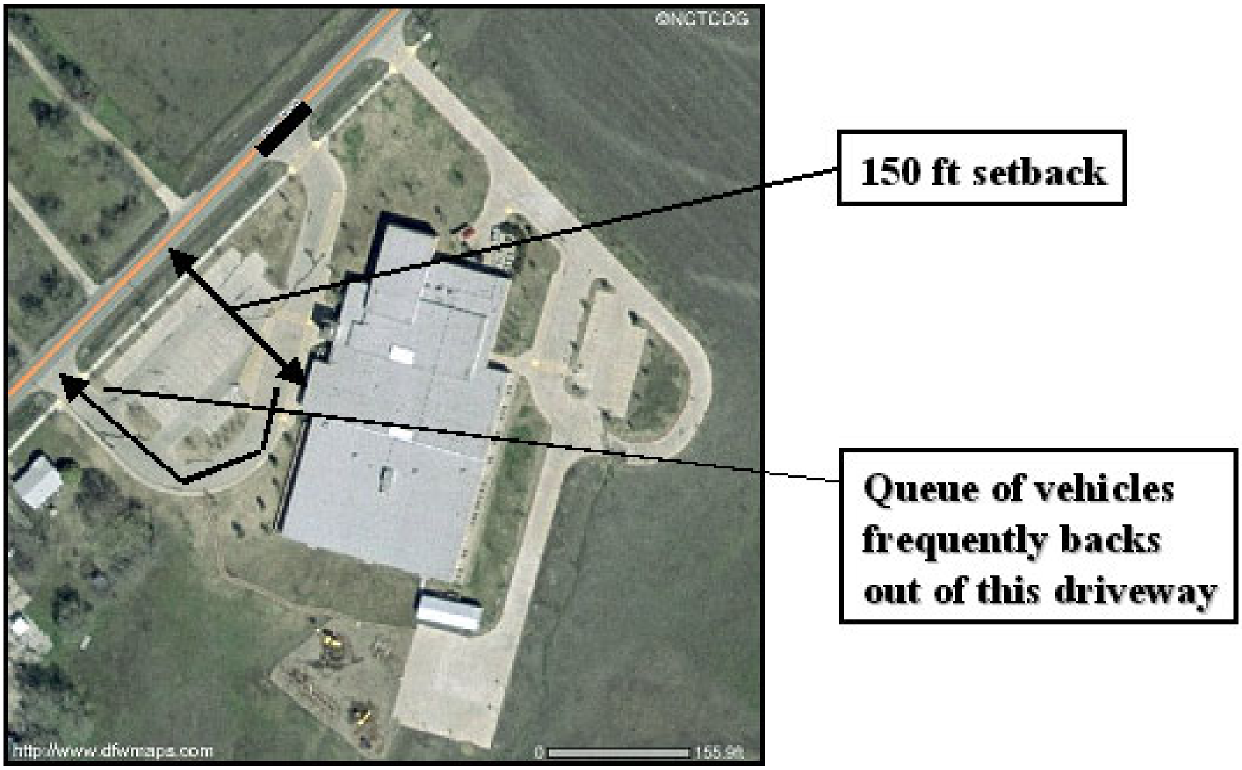

Figure 2. School Building Located near the Front of the Site – Frequent Spillback (*14*).

Figure 3. School Building Pushed Back on the Site – Better Operations (*14*).

Table 2 provides a listing of guidelines and their corresponding source(s) 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 (ITE) Michigan Section, and the New South Wales Road Authority (*15, 16, 17, 18, 19, 20*). Most of these guidelines relate to choosing elementary school sites as close as possible to the residential areas where students live and away from high-volume roadways.

Table 3 records the existing guidelines and their corresponding source(s) specific to secondary (i.e., middle, junior high, and high) school facilities. In contrast to the elementary school guidelines, the secondary school guidelines promote access from high-volume roadways (e.g., arterials) to accommodate school-generated traffic. Table 4 lists general (i.e., not specific for school type) guidelines for school site location and accessibility.

Table 2. Site Location and Accessibility Guidelines for Elementary School Facilities.

Guideline	Source(s)
Should be situated centrally to a neighborhood, abutting and having access to a collector street.	Region of York–Canada (*15*)
Access to major collectors akin to minor arterials should be avoided due to the volume of traffic.	Region of York–Canada (*15*)
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 (*15*)
Avoid high-volume traffic flow near elementary school entrances and exits.	Douglas County–Colorado (*16*)
Avoid elementary school site along local streets opposite residential driveways.	Douglas County–Colorado (*16*)
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 (*18*), ITE Michigan Section (*17*), Arizona DOT (*21*)
Should not be located on arterial or major collector roads.	City of Mississauga–Canada (*12*), City of Phoenix–Arizona (*22*)
Provide bussing for elementary students who cross busy major streets or use major streets as school attendance or bussing boundaries.	City of Phoenix–Arizona (*22*)

Table 3. Site Location and Accessibility Guidelines for Secondary School Facilities.

Guideline	Source(s)
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 (*15*)
Justify a traffic signal (where vehicle volumes warrant) during peak periods at schools with access from an arterial.	Douglas County–Colorado (*16*)
Consider pedestrian travel desire lines when locating schools near commercial centers.	City of Mississauga–Canada (*12*)
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 (*21*)

Guideline 2: Avoid locations with direct access to high-speed roadways. (DESIGN)

Best Practice for Application of Guideline 2

It is desirable to locate school sites with appropriate accessibility from the adjacent roadway network based on the type of school. One of the prominent site selection criteria found in numerous sources was to avoid locations with direct access to high-speed roadways (e.g., trunk highways and frontage roads). This criterion is consistent with promotional materials for the TxDOT Precious Cargo Program.

Example to Avoid

Figure 4 provides a picture of a bad example of following Guideline 2. In this case, a school district planned a new school for a site located on a high-speed two-lane roadway with no turning lanes. This is a typical example of a situation that is becoming more common in Texas, particularly in suburbs located on the fringe of rapidly growing metropolitan areas. The right panel of the picture shows a vehicle passing a truck adjacent to a school driveway – not a desirable condition.

Table 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 *(15)*, New South Wales–Australia *(18)*
★ Provide access from more than one direction to the immediate vicinity of the site, and provide access to the site from at least two adjacent streets.	Douglas County–Colorado *(16)*
★ 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 *(23)*, New South Wales–Australia *(18)*
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 (NSC) *(24)*, City of Mississauga–Canada *(12)*, North Carolina Department of Education (DOE) *(9)*, Minnesota DOE *(25)*
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 *(12)*, Minnesota DOE *(25)*
Avoid locating school sites abutting each other on the same road frontage: separate with parks or other land uses.	City of Mississauga–Canada *(12)*
Accessible at reasonable cost to public roads that are adequate to accommodate the added traffic generated by the school.	North Carolina DOE *(9)*, Minnesota DOE *(25)*
Be adjacent to or readily accessible to modes of transport useful to students and staff: school buses, vehicles, public transit, bicycles, and/or pedestrians.	North Carolina DOE *(9)*
Not be too close to congested traffic arteries or highways that are noisy and will cause delays or special hazards.	North Carolina DOE *(9)*
Students approaching on foot should not have to cross main traffic arteries.	North Carolina DOE *(9)*
Site is located to efficiently and safely serve the school population.	Massachusetts DOE *(26)*
Locate site near bus routes to limit student travel time, whenever possible.	Minnesota DOE *(25)*

★ Guidelines with this star symbol also have a best practice section

<u>Guideline 3</u>: Provide access from more than one direction to the immediate vicinity of the site, and provide access to the site from at least two adjacent streets. (DESIGN)

Figure 4. School Site Located on High-Speed Roadway without Turn Lanes.

Best Practice for Application of Guideline 3

The majority of schools where researchers collected data during this project had access driveways from only one adjacent roadway. As stated in Guideline 3, it is desirable to provide access to the school site from at least two adjacent streets. Having access from more than one street has several potential benefits including: easier separation of parent and bus operations, better driveway spacing, and greater dispersion of traffic into and out of the site.

Example to Avoid

Figure 5 shows an aerial of an elementary school site where the access driveway is provided from a local street. The site is located on a corner lot; however, it only has access from the roadway on the eastern side of the lot. No access driveways are provided from the roadway on the southwestern portion of the picture.

Example of Good Practices

Figure 6 shows an elementary school site where access is provided from a minor collector street and a local street. This site layout is the default standard for this school district for elementary schools. Having access driveways from two adjacent streets allows this site to function well operationally.

Figure 5. Elementary Site with Access from One Adjacent Roadway (*14*).

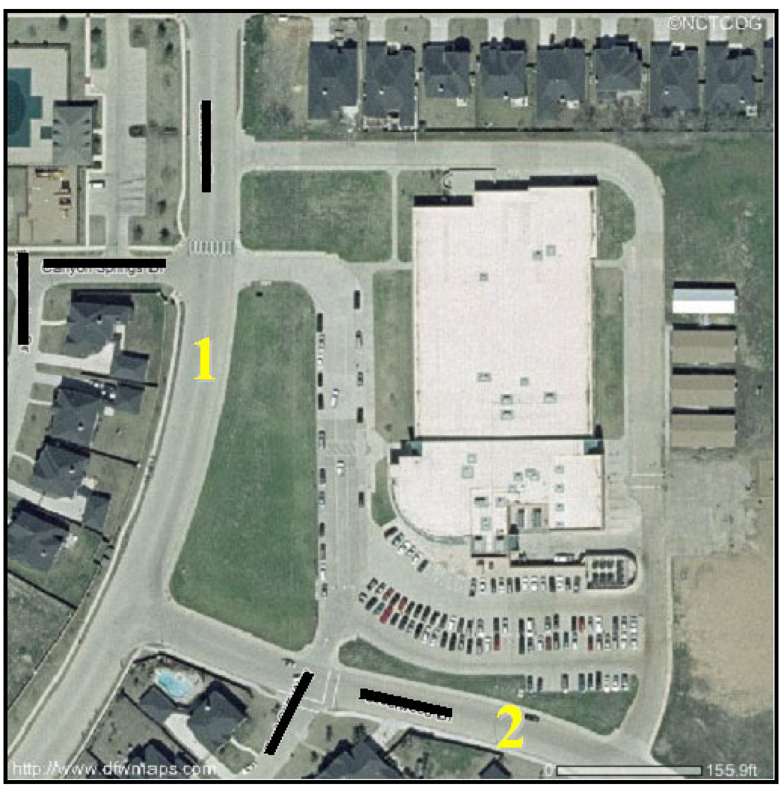

Figure 6. Elementary School Site with Access from Two Adjacent Roadways (*14*).

<u>Guideline 4</u>: School site should be situated where the road alignment provides good visibility. (DESIGN)

Best Practice for Application of Guideline 4

The provision of adequate sight distance near school exits and entrances is important for safe and efficient traffic operations. If the school site is located on a tangent section of roadway that is relatively flat then sight distance is typically not going to be an issue. If the site is located along a road with horizontal and/or vertical curvature then good visibility might pose a problem. There are several other sight distance and visibility-related guidelines similar to Guideline 4 that should also be applied to enhance safety. These guidelines include:

- All roads within the school site should be graded with a maximum grade of 5 percent to avoid configurations that could impair a motorist's vision.
- The location of drives, buildings, equipment, landscaping, and school sign that typically marks the main entrance must permit adequate sight distances for drivers and pedestrians.

Example of Good Practice

Figure 7 shows views from both directions from a school driveway where adequate sight distance was provided. Most of the field study sites had good sight distance from driveways.

Figure 7. Good Example of School Driveway with Good Sight Distance in Both Directions.

Example to Avoid

One of the schools included in the observational case studies had undesirable sight distance in the vicinity of the entrance-only driveway. Figure 8 provides a picture of the entrance driveway with a sharp curve located approximately 150 feet upstream (dump truck just coming into view). This situation becomes a safety issue when the queue of vehicles in the parent drop-off zone backs up out of this driveway and vehicles on the adjacent roadway encounter stopped traffic just after rounding the sharp curve.

<u>Guideline 5</u>: The physical routes provided for the basic modes (buses, cars, pedestrians, and bicycles) of the traffic pattern should be separated as much as possible from each other. (DESIGN)

Figure 8. Site with Driveway Located near Horizontal Curve – Inadequate Sight Distance.

GENERAL SITE REQUIREMENTS AND DESIGN GUIDELINES

The second category of guidelines is related to general site requirements and design. The guidelines tend to fall into one of the following topic areas: (1) separation of transport modes; (2) service, delivery, and maintenance issues; (3) emergency access issues; (4) weather protection; or (5) general site design and layout. Table 5 provides the guidelines for the first four topic areas in the previous list and also provides the source(s). Table 6 provides guidelines and corresponding source(s) for the fifth topic area, the general site design and layout category. The research team also reviewed two ITE publications that contained general guidelines for school sites that are not listed in either table but provide useful information:

- *Survey of Traffic Circulation and Safety at School Sites* (*27*); and
- *A Survey of Establishing Reduced Speed School Zones* (*28*).

Best Practice for Application of Guideline 5

In the research team's opinion, perhaps the most universal guideline involving design and operations at schools is summarized in Guideline 5 above. Almost every source, whether from architecture, transportation, or educational professions, had some guidance on providing for separation of the basic modes of travel for students within the school site. Providing for physical separation of the basic modes is both a design issue (e.g., layout of separate driveways, loading areas, etc.) and an operations issue (e.g., enforcement of bus-only zones, supervision of crosswalks, etc.).

Table 5. School Site Requirements and Design Guidelines–Sorted into Specific Categories.

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–Florida (29), Wake County–North Carolina (30), South Carolina DOE (13) and DOT (31), School Bus Fleet (32, 33, 34), Douglas County–Colorado (16), New South Wales–Australia (18), NSC (24), ITE Michigan Section (17), City of Mississauga–Canada (12), North Carolina DOE (9), California DOE (10), Kentucky DOE (35), Minnesota DOE (25) and DOT (23), Missouri DOT (36), Arizona DOT (21)
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 length delivery trucks and a 50 ft (15.25 m) radius turnabout.	Miami-Dade County–Florida (29), North Carolina DOE (bullet #1 only) (9)
Provide dumpster area with enclosure and/or concrete-filled bollards.	Kentucky DOE (35)
Flush ribbon curbed turnouts from roadways and parking areas shall be provided to allow for maintenance without climbing over raised curbing.	Seminole County–Florida (37)
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 (35)
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 (17)
It is recommended that where parking lots or driveways do not lie contiguous to the school, consideration should be given to the use of high-strength sidewalks, 15 ft (4.575 m) wide, with radii that accommodate an emergency vehicle.	ITE Michigan Section (17), Arizona DOT (21)
Provide adequate site lighting at night: at all driveway intersections and bus loop for emergency vehicle access.	Kentucky DOE (35)
Plans for roads and loading areas should accommodate emergency vehicles–must have access at all times.	NSC (24)
Weather Protection	
★ All primary building entrances for students shall be weather protected by overhead cover or soffit.	Wake County–North Carolina (30), North Carolina DOE (9), Miami-Dade County–Florida (29)

★ Guidelines with this star symbol also have a best practice section

Example of Good Practice

Most of the sites included in the field studies had good separation of the basic arrival modes. Figure 9 is an aerial photo of an elementary school site that shows a good example of separation of parent vehicles, school buses, and pedestrians/bicyclists. The basic design of this school site provided for good separation; however, an operational change from the original layout improved the function of the site from the perspective of separating the basic modes of the traffic pattern.

The school principal made the operational change from the original layout because the queue in the loop driveway in front of the school was frequently stacking out onto the adjacent roadway. The operational change involved closing this loop driveway to parent traffic and making it a pedestrian/bicycle-only zone. The driveway on the south side of the school, labeled with the number 1 in Figure 9, was then opened to be the parent drop-off/pick-up zone. This site had a higher than average percentage, with just over 20 percent of students, arriving by walking or cycling, which is at least partly attributable to the system of sidewalks, bicycle racks, and the creation of the pedestrian-bicycle only zone. The driveway labeled with the number 2 in Figure 9 serves as the entrance and exit for all of the school buses into the site.

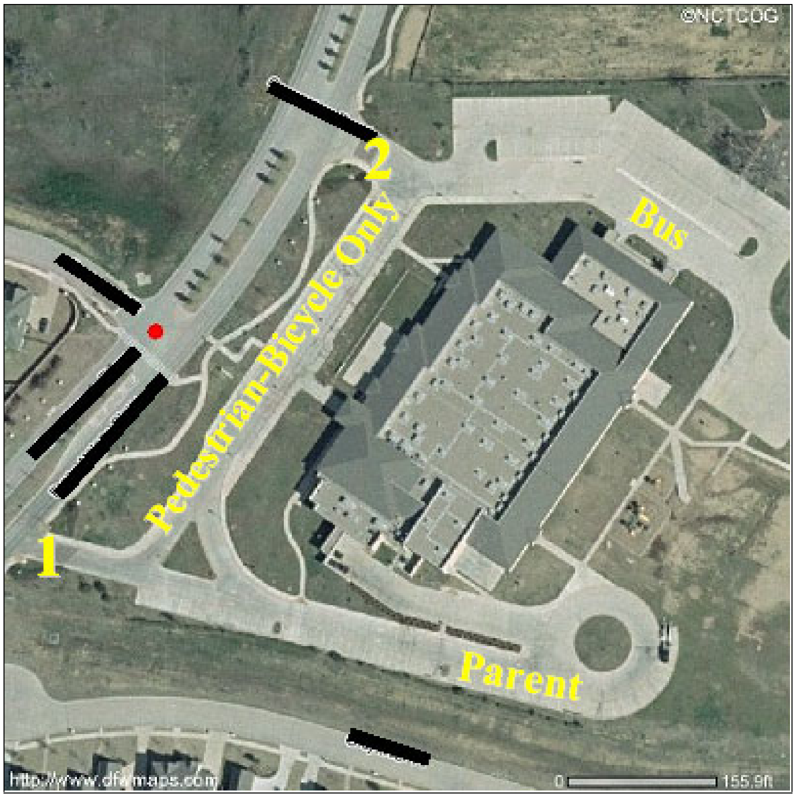

Figure 9. School with Good Physical Separation of Basic Modes of Traffic Pattern (*14*).

Examples to Avoid

Figure 10 shows photographs of a junior high school site with a design that should be avoided. This site actually has some physical separation of modes in place — bus and parent zones are separated via a raised median and have separate entrance driveways. The layout at this site has the bus zone adjacent to the school entrance with the parent zone separated via a raised concrete median. While these loading zones are physically separated, students dropped-off in the parent zone have to cross the bus zone driveway in order to access the school entrance. This layout promotes pedestrian/bus conflicts. The other element of this site that did not work well and violates the guideline of trying to separate modes is that parent vehicles and buses utilize the same exit driveway. This created unnecessary on-site congestion, particularly in the afternoon when buses and parent vehicles are trying to exit at the same time.

Figure 10. Site with a Layout to Avoid – Bus and Parent Zones Adjacent to Each Other.

Researchers visited several sites where the layout had good separation; however, parent or staff vehicles circumvented traffic control devices (e.g., bus-zone only signs, do not enter signs, no parking signs, etc.) or the school staff did not enforce procedures, which caused vehicles, buses, and pedestrians to be unnecessarily mixed while on-site. Several schools had loading zones signed as bus-only but did not enforce it and allowed parent cars to use the zone (see Figure 11).

Figure 11. Site Where Parents Use the Bus-Only Loading Zone.

<u>Guideline 6</u>: All primary building entrances for students shall be weather protected by overhead cover or soffit. (DESIGN)

Best Practice for Application of Guideline 6

Several sources included a guideline related to providing covered walkways or soffits near school entrances to provide protection for students during rain and other types of inclement weather. Guideline 6 has relevance from a transportation perspective because it is intuitive that sites with weather protection operate better during rainy weather than those without, particularly during afternoon pick-up.

Example of Good Practice

Figure 12 provides a picture of a school site with a covered walkway that runs along the entire length of the parent drop-off/pick-up zone. The covered walkway is approximately 10 feet wide between the columns and has a lot of space available for storage of waiting students. This design is a good example of fulfillment of Guideline 6. Researchers performed field studies at several school sites with some weather protection, particularly newer facilities constructed within the last five years.

Figure 12. Covered Walkway Adjacent to the Parent Loading Zone.

Guideline 7: The school site and proposed plans should be reviewed by the proper road agency. (PLANNING and DESIGN)

Best Practice for Application of Guideline 7

Coordination between school district representatives and transportation agencies is critical to planning for safe and efficient access to and from school sites. This process is particularly critical when a new school is being constructed. Several sources had something similar to Guideline 7, which advocates that plans for a proposed school site need to be reviewed by the appropriate roadway agencies. The TxDOT Precious Cargo Program is essentially designed to foster coordination between school districts and TxDOT representatives during the planning stages for new school sites, particularly when they are going to be located on state-maintained roadways.

Table 6. General School Site Requirements and Design Guidelines.

Guideline	Source(s)
Utilize all potential drop-off zones to reduce congestion.	Katz, Okitsu, & Associates–California (*38*)
Avoid transit stops, vending/mailboxes, or on-street parking between drop-off entrance and exits along the school frontage.	Miami-Dade County–Florida (*39*), City of Mississauga–Canada (*12*)
Orient and locate playfields, parking, service drives, drop-off zones, and bus zones to reduce the cost of connecting elements without requiring pedestrians to cross vehicular traffic lanes.	Miami-Dade County–Florida (*29*)
Provide a paved standing area for 25% of the student population next to the main student entry area.	Miami-Dade County–Florida (*29*)
Provide adequate on-site parking and loading/unloading space designed for all modes of transportation.	New South Wales–Australia (*18*), South Carolina DOT (*31*), Arizona DOT (*21*)
Whenever possible, roads should not be constructed that completely encircle a school. Areas that students must cross for outside activities should be free of all vehicular traffic.	NSC (*24*), North Carolina DOE (*9*), Little Institute for School Facilities Research (*8*), California DOE (*10*)
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 on-site roads.	NSC (*24*), ITE Michigan Section (*17*)
Internal two-way roadways to two-lane one-way roadways on a school site should have a minimum width of 26 ft (7.93 m) face-to-face of curb, or 24 ft (7.32 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 (*17*), Missouri DOT (*36*)
The location of drives, buildings, equipment, and landscaping must permit adequate sight distances for drivers and pedestrians.	NSC (*24*), ITE Michigan Section (*17*), School Bus Fleet (*34*)
★ The site and proposed plans should be reviewed by the proper road agency.	ITE Michigan Section (*17*), Precious Cargo–Texas (*1*), Oregon DOT (*40*)
Buildings should be parallel to the street and have parking located at the side or rear of the property.	City of Mississauga–Canada (*12*)
Provide at least a 50 ft (15.25 m) tangent between reverse curves.	California DOE (*10*), NSC (*24*)
Avoid excess paving or concrete curbing.	Kentucky DOE (*35*)
Check contours for drainage away from the building.	Kentucky DOE (*35*)

★ Guidelines with this star symbol also have a best practice section

Example of Good Practices

There have been numerous success stories and awards associated with the TxDOT Precious Cargo Program. More than 160 schools in over 50 school districts statewide have seen traffic safety improvements around their schools or future school sites as a result of the Precious Cargo Program. Table 7 provides the mailing addresses and telephone numbers to contact each of the 25 TxDOT districts regarding participation in the Precious Cargo Program. The following list provides some examples of the types of benefits and partnerships schools have experienced from participation in the TxDOT Precious Cargo Program:

- necessary labor and equipment for construction of turn lanes supplied by TxDOT while the ISD provided the funding;
- received recommendations for traffic improvements based on review of 15 schools included in a district-wide bond campaign;
- installation of traffic signals based on early coordination that allowed for TxDOT funding to be programmed; and
- changes to circulation patterns to improve safety and congestion on adjacent roadways.

Table 7. List of Precious Cargo Contact Information for Each TxDOT District.

District	Mailing Address	Telephone Number
Abilene	P.O. Box 150 Abilene, TX 79604-0150	(915) 676-6800
Amarillo	P.O. Box 2708 Amarillo, TX 79105-2708	(806) 356-3200
Atlanta	P.O. Box 1210 Atlanta, TX 75551-1210	(903) 796-2851
Austin	P.O. Drawer 15426 Austin, TX 78761-5426	(512) 832-7000
Beaumont	8350 Eastex Fwy. Beaumont, TX 77708	(409) 892-7311
Brownwood	P.O. Box 1549 Brownwood, TX 76804-1549	(915) 646-2591
Bryan	1300 N. Texas Ave. Bryan, TX 77803-2760	(979) 778-2165
Childress	P.O. Box 900 Childress, TX 79201-0900	(940) 937-7100
Corpus Christi	P.O. Box 9907 Corpus Christi, TX 78469-9907	(361) 808-2300
Dallas	P.O. Box 133067 Dallas, TX 75313-3067	(214) 320-6100
El Paso	13301 Gateway West El Paso, TX 79928-5410	(915) 790-4200
Fort Worth	P.O. Box 6868 Fort Worth, TX 76115-0868	(817) 370-6500
Houston	P.O. Box 1386 Houston, TX 77251-1386	(713) 802-5000
Laredo	1817 Bob Bullock Loop Laredo, TX 78043	(956) 712-7400
Lubbock	P.O. Box 771 Lubbock, TX 79408-0771	(806) 745-4411
Lufkin	1805 N. Timberland Dr. Lufkin, TX 75901	(936) 634-4433
Odessa	3901 E. U.S. 80 Odessa, TX 79761	(915) 332-0501
Paris	P.O. Box 250 Paris, TX 75461-0250	(903) 737-9300
Pharr	P.O. Drawer EE Pharr, TX 78577-1231	(956) 702-6100
San Angelo	P.O. Box 61550 San Angelo, TX 76906-1550	(915) 944-1501
San Antonio	P.O. Box 29928 San Antonio, TX 78229-0928	(210) 615-1110
Tyler	2709 W. Front St. Tyler, TX 75702	(903) 510-9100
Waco	100 South Loop Dr. Waco, TX 76704	(254) 867-2700
Wichita Falls	P.O. Box 660 Wichita Falls, TX 76307-0660	(940) 720-7700
Yoakum	P.O. Box 757 Yoakum, TX 77995-0757	(361) 293-4300

SCHOOL 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), dedicated to school bus-related issues (41). The review of existing guidelines produced a significant number of bus-related design and operations guidelines. Table 8 lists these guidelines. Researchers found some differences when it came to recommended guidelines for the width and number of lanes for on-site bus facilities.

Table 8. Bus-Related Design and Operations Guidelines.

Guideline	Source(s)
Drop-off area design does not require backward movement by buses.	Katz, Okitsu, & Assoc.–California (38), Miami-Dade County–Florida (39), South Carolina DOE (13), Wake County–North Carolina (30), North Carolina DOE (9), Douglas County– Colorado (16), Missouri DOT (36), Minnesota DOT (23), Arizona DOT (25), NSC (24)
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–Florida (39), South Carolina DOE (13), Region of York–Canada (15), School Bus Fleet (33), New South Wales–Australia (18), NSC (24), ITE Michigan Section (17), North Carolina DOE (9), California DOE (10), Missouri DOT (36), Minnesota DOT (23), Arizona DOT (25)
Maximize fronting curb space as loading zone – have enough space to stage all buses on a daily basis.	Katz, Okitsu, & Associates–California (38), Missouri DOT (36), Minnesota DOT (23)
The school bus loading zone may be located further from the school entrance.	City of Edmonton–Canada (42), School Bus Fleet (33)
Each parking stall for a full-size bus shall be a minimum of 15 ft (4.575 m) wide.	South Carolina DOE (13), Wake County–North Carolina (30)
Required drop-off and pick-up areas for schools 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 (no more than 12 spaces required).	City of Henderson–Nevada (43)
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 (15), School Bus Fleet (33)
★ Single-file right wheel to the curb is the preferred staging method for buses.	School Bus Fleet (33), ITE Michigan Section (17), Arizona DOT (25)
Locate the bus area so that buses exit upstream of automobiles and gain priority, thereby reducing delay.	Douglas County–Colorado (16)
Avoid crosswalks at entry to and exit from bus zone.	Douglas County–Colorado (16)
Curbing, with suitable drainage, is recommended on all roads utilized by school buses within the site.	NSC (24)
Attention should be given in planning bus parking, loading, and unloading zones to encourage diagonal parking (minimum of 60 ft [18.3 m] paved surface).	NSC (24), California DOE (10)
The type of pavement and base should conform to the local state highway department specification for buses.	NSC (24)
Provide buses only/no entry signs at ends of bus loop.	Kentucky DOE (35)
★ Consider two outbound lanes if possible, one for left turning buses and one for right turns.	Minnesota DOT (23)

★ Guidelines with this star symbol also have a best practice section

<u>Guideline 8</u>: Single-file right wheel to the curb is the preferred staging method for buses. (DESIGN and OPERATIONS)

Best Practice for Application of Guideline 8

Guideline 8 refers to the preferred staging method for school buses while loading or unloading students at school sites. The preferred method of staging buses is single-file right wheel to the curb because students are not required to pass between buses.
Figure **13** shows the different staging methods for buses for loading and unloading students at school sites. The bus-loading zone needs to be designed for the expected number of buses to accommodate Guideline 8.

Example of Good Practice

Many schools where researchers performed field studies staged buses in a single-file right wheel to the curb formation. Figure 14 provides a picture of a site where two of the buses were staged in a single-file formation adjacent to the curb for afternoon loading.

Examples to Avoid

The research team observed several sites where the preferred staging method was not employed. The most likely reason for using other staging methods, such as multiple-lane parallel, was lack of space to accommodate the number of buses serving the school campus. In the opinion of the research team that, if possible, staging methods such as the one shown in Figure 15 should be avoided to minimize the risks of conflicts with buses and students in the loading zone area.

GUIDELINES FOR THE DESIGN AND OPERATION OF PARENT ZONES

The topic of design and operation of parent drop-off/pick-up zones at schools has not received considerable attention until recently. Researchers believe that parent drop-off and pick-up zones are often overlooked in school design, but are very important. The provision of adequate zones minimizes illegal standing or parking near schools and helps prevent problems such as blocking bus driveways and flow on adjacent roadways *(44)*. The research team did find some information for guidelines and recommended practices that is provided in Table 9. Several studies, performed in the states of North and South Carolina, have given significant consideration to design and operation of parent drop-off/pick-up zones.

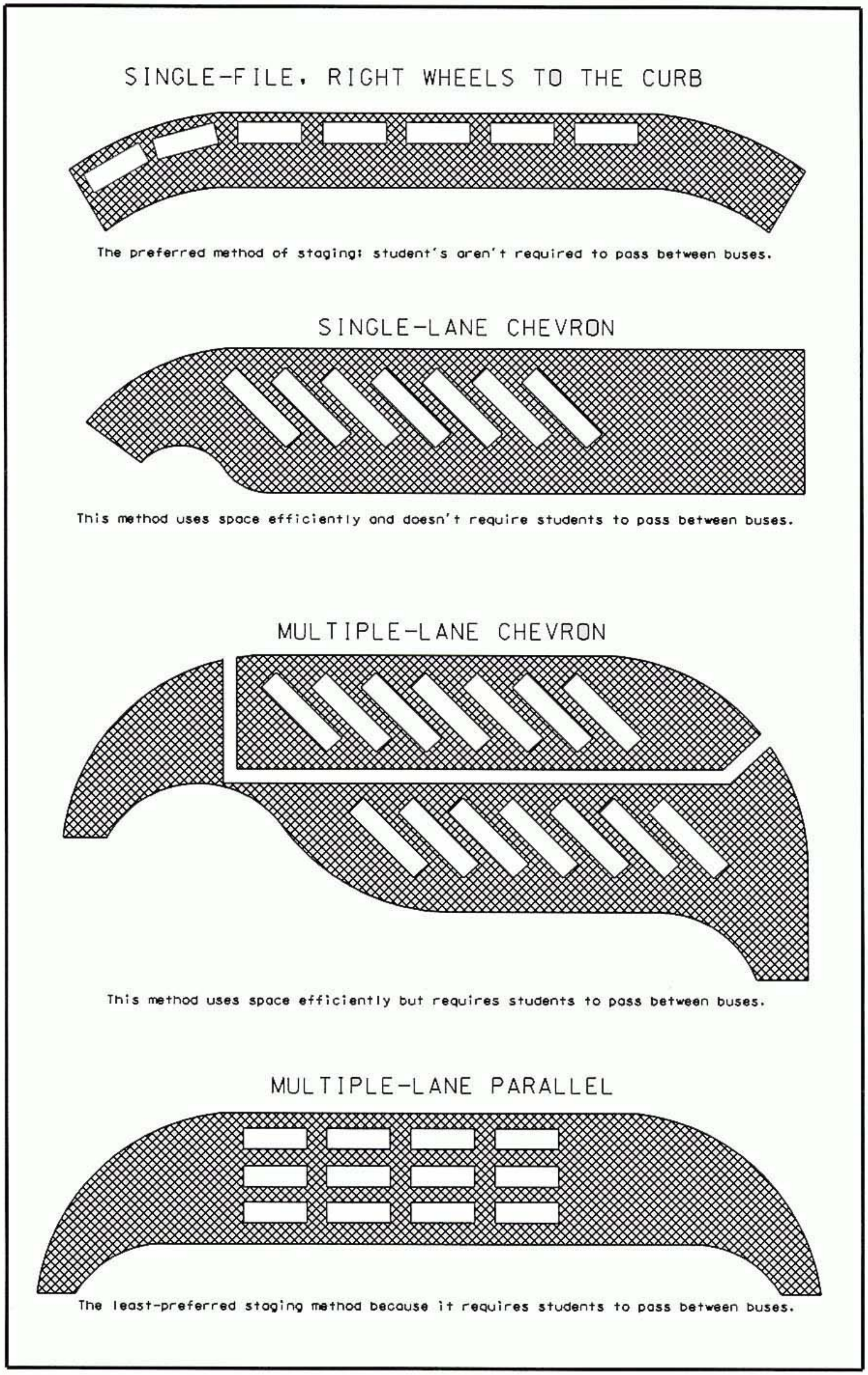

Figure 13. Methods to Stage Buses at School Sites (33).

Figure 14. School Buses Staged in Preferred Method – Single-File Right Wheel to the Curb.

**Figure 15. Buses Staged in Multiple Columns –
Avoid if Possible to Reduce Potential Conflicts.**

Table 9. 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–California (38), Miami-Dade County–Florida (39), South Carolina DOE (13), Wake County–North Carolina (30), Arizona DOT (25), Douglas County–Colorado (16), North Carolina DOE (9), Missouri DOT (36), Minnesota DOT (23)
★ 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–Florida (39), South Carolina DOE (13), Region of York–Canada (15), ITE Michigan Section (17), North Carolina DOE (9), California DOE (10), Missouri DOT (36), Minnesota DOT (23), Arizona DOT (25)
★ Maximize fronting curb space as loading zone – provide an adequate driveway for lining up cars on site.	Katz, Okitsu, & Associates–California (38), North Carolina DOE (9), Safe School Design Guidelines (45), South Carolina DOT (31), 4286 Research
★ 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 (18), Minnesota DOT (23), North Carolina DOT (46)
Prior to designing and laying out roads and parking, architects should consult with school administrators on: (1) number of cars dropping/picking up students; and (2) type of schedule (staggered or single opening time).	NSC (24), Arizona DOT (25)
Required drop-off and pick-up areas for schools (public or private) shall include at least: (1) 5 auto or (2) one auto space for every 50 students, whichever results in the greater number (no more than 12 spaces required).	City of Henderson–Nevada (43)
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 (12)
★ Do not load or unload students where they have to cross a vehicular path before entering the building.	North Carolina DOE (9)
★ Short-term parking spaces should be identified past the student loading area and near the building entrance.	North Carolina State University (47)
★ Parent loading should occur in designated zones to minimize pedestrian/vehicle conflicts.	4286 Research
★ Student safety patrols and loading supervisors should be well trained and wear reflective safety vests.	4286 Research, North Carolina State University (47)
★ Traffic cones and other channelizing devices can be used to minimize pedestrian/vehicles conflicts.	4286 Research

★ Guidelines with this star symbol also have a best practice section

North Carolina Guidelines for Managing School Carpool Traffic

Some of the most comprehensive studies on the design and operation of drop-off/pick-up zones have occurred in the State of North Carolina. Researchers at the North Carolina State University (NCSU) collected data at 20 elementary schools on the loading process and associated queuing. Based on these studies, NCSU developed a *Best Practice for Managing School Carpool Traffic Schematic* (*47*). Figure 16 replicates this schematic and the corresponding guidelines. NCSU also produced a web-based school carpool decision support tool that provides procedural recommendations based on the common problems during school drop-off/pick-up times (*48*). For example, if the problem is that parent's vehicles are spilling back out of the site onto adjacent roads, implementation of a dual queue lane is recommended for the purpose of increasing storage capacity.

The North Carolina DOT also has the Municipal School and Transportation Assistance (MSTA) group dedicated to addressing safety concerns and traffic operations on school campuses and the surrounding state roadways (*49*). The MSTA, based on data collected at numerous schools throughout the state, has developed a design tool called the *School Traffic Calculator* (*46*). This tool estimates the morning and afternoon traffic loads and the corresponding maximum queue lengths that can be used to size the drop-off/pick-up zone.

South Carolina Guidelines for On-Site Stacking Length

The South Carolina DOT also has a dedicated unit for handling school-related transportation issues. This unit recently published a document entitled *Guidelines for School Transportation Design* (*31*). This document contains information, provided in Table 10, regarding recommended on-site stacking lengths ranging from 800 to 1500 ft (244 to 458 m) depending on the school type and student population.

Table 10. South Carolina DOT Recommendations for On-Site Stacking Length (*31*).

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.		

It should be noted that many of the school sites in South Carolina utilize a single two-way driveway (i.e., driveway serves as the entrance and exit) for the parent zone in order to increase the stacking length. This type of design is not as prominent in Texas schools where most sites have separate entrance and exit points, which can decrease the available stacking space.

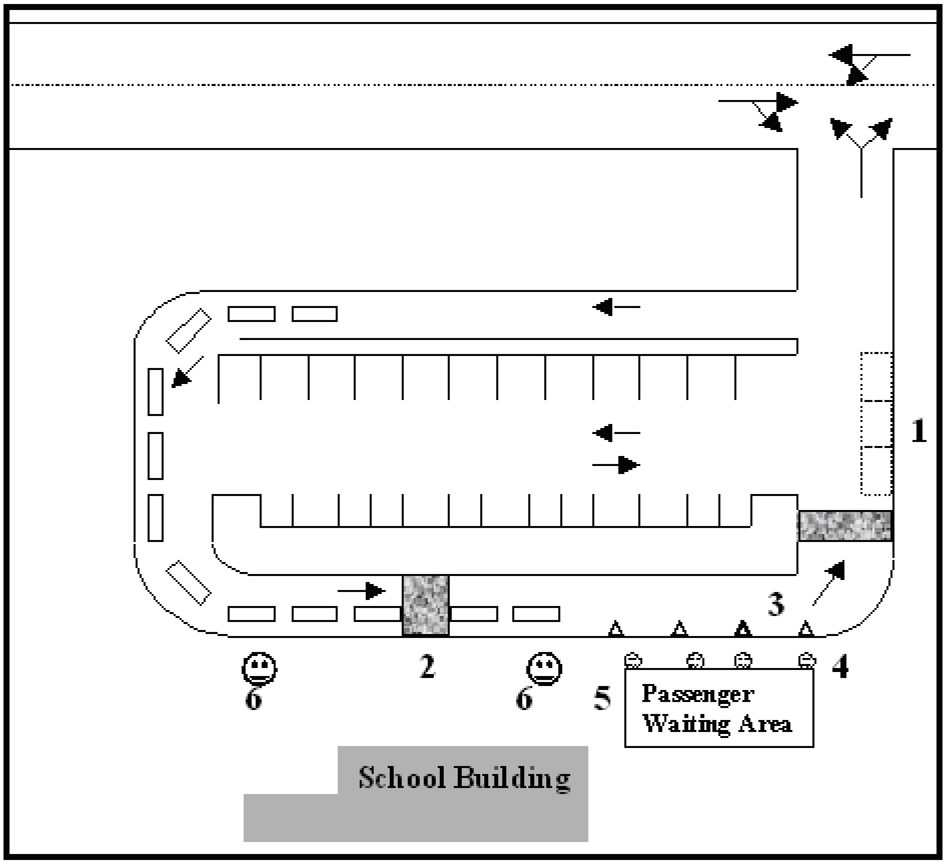

Figure 16. Best Practice for Managing School Carpool Traffic Schematic *(47)*.

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.

<u>Guideline 9</u>: Provide an adequate driveway for stacking cars on site. (DESIGN)

The research team found several examples of guidelines similar in nature to Guideline 9. Having adequate on-site stacking length to accommodate parent vehicles during the morning drop-off and afternoon pick-up operations is important. One of the primary focuses of the field studies during the 4286 project was to examine geometric design and operational practices in parent drop-off/pick-up zones. Researchers concentrated on collecting sufficient data at elementary schools in Texas to be able to validate the existing South Carolina (*31*) and North Carolina (*46*) guidelines for on-site stacking length.

The data collected during the 4286 field studies validated the *School Traffic Calculator* (*46*). It is good practice to use the afternoon pick-up data to predict the maximum queue of vehicles. The maximum queue length is then used to design and appropriate size the length needed in the parent driveway for lining up cars on site. The analysis of the average, maximum, and 95^{th} percentile queue data at Texas schools did not produce any statistically significant models based on a regression analysis. The data did show that the observed maximum queue lengths were often well below the recommended on-site stacking lengths given in Table 10 and those predicted by the *School Traffic Calculator* (*46*).

It appears the South Carolina and North Carolina recommended on-site stacking lengths were more conservative compared to the Texas data. Based on this finding, the research team feels that the recommended on-site stacking lengths for Texas schools can be decreased and will still be able to meet the objective of Guideline 9 – providing an adequate driveway for stacking cars on site. Even though no statistically significant models were developed based on queue length, the research team had sufficient data to formulate recommended on-site stacking lengths for Texas elementary and middle schools. Based on the data from this project, researchers recommend the on-site stacking lengths for high schools contained in Table 10 for Texas because no new field data were collected at Texas high schools (*7*). Table 11 provides the recommended on-site stacking lengths for Texas schools.

Table 11. Recommended Parent Drop-off/Pick-up Zone On-Site Stacking Length for Texas.

School Type	Student Population	Loop Drive Stacking Length (linear feet) (m)
Elementary	Less than 500 500 or more	400 – 750 (122 – 229) 750 – 1500 (229 – 458)
Middle	Less than 600 600 or more	500 – 800 (153 – 244) 800 – 1600 (244 – 488)
High (*31*)	400 – 800 800 – 2500	800 – 1200 (244 – 366) 1200 – 1500 (366 – 458)
<u>Note:</u> For high school populations greater than 2500 students, consider two separate student pick-up/drop-off loops.		

Best Practice for Application of Guideline 9

Providing adequate on-site stacking length is important to the safety and operations of traffic within and around the school site.

Examples to Avoid

During the case studies and field studies, the research team observed many sites that did not provide adequate on-site stacking length. The inadequate on-site space to accommodate the queue led to spillback on adjacent roadways. Figure 17 shows an intermediate school site where the both lanes of the northbound direction of the adjacent roadway were blocked by the queue of vehicles that backed up out of the parent drop-off/pick-up zone driveway. Figure 18 shows another example of queue spillback at an elementary school site.

Figure 17. Example of Queue Spillback from the School Site.

Figure 18. Another Example of Queue Spillback from the School Site.

<u>Guideline 10</u>: Students should be loaded and unloaded on the right side directly to the curb/sidewalk. (DESIGN and OPERATIONS)

Best Practice for Application of Guideline 10

The practice of loading and unloading students on the right side of vehicles directly to the curb/sidewalk is a prominent guideline found in numerous sources. If practiced, it is intuitive that pedestrian/vehicle conflicts in the parent drop-off/pick-up zone would be minimized because students would not be walking through driveways exposed to traffic.

Examples of Good Practice

Researchers observed several schools, particularly the elementary schools, with well-organized and efficient operations in the parent drop-off/pick-up zone. Figure 19 shows a good example of Guideline 10 where students were loaded directly from the vehicles to the curb/sidewalk.

Figure 19. Good Examples of Students Loaded Directly from Vehicles to Curb/Sidewalk.

Examples to Avoid

During the field studies, researchers encountered several examples to avoid where students were not loaded directly from vehicles to the curb/sidewalk in the parent drop-off/pick-up zone. Researchers observed most of these examples during the afternoon pick-up period when vehicles would park along the far curb of the loading zone, forcing students to have to cross the driveway

<u>Guideline 11</u>: Short-term parking spaces should be identified past the student loading area and near the building entrance. (DESIGN and OPERATIONS)

to enter the vehicles. This type of situation also violates the guideline that indicates that students should not have to cross a vehicle path before entering the building or after exiting the building. Figure 20 shows some pictures with examples to left-side loading, which increases the potential for pedestrian/vehicle conflicts.

Figure 20. Examples to Avoid – Students Loaded on Left Side Away from Curb.

Best Practice for Application of Guideline 11

The review of existing guidelines for the relative placement of short-term or visitor parking spaces at schools produced several different results. Several sources indicated that visitor parking should be combined with the parent drop-off driveway located near the main entrance and offices *(9, 45)*. The *Best Practice for Managing School Carpool Traffic Schematic* indicates that short-term parking spaces should be identified past the student loading area and near the building entrance *(47)*. This source further recommends that 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 (see Figure 16). The findings from the 4286 field studies support Guideline 11 because placing the visitor spaces past the student loading area keeps the loading area clear of parked vehicles and results in safer and more efficient operations.

<u>Guideline 12</u>: Parent loading should occur in designated zones to minimize pedestrian/vehicle conflicts. (OPERATIONS)

Best Practice for Application of Guideline 12

One of the major aspects of the field studies was evaluation of pedestrian/vehicle conflicts in the parent drop-off/pick-up zones. The research team collected and classified pedestrian/vehicle conflicts that were observed during the morning and afternoon operations. These data were analyzed and led to the development of Guideline 12, which indicates that parent loading should occur in designated zones to minimize pedestrian/vehicle conflicts. Researchers also recommend supervision of morning drop-off and afternoon pick-up by school staff members, particularly at middle schools. The conflict data suggested that school type was a significant variable and that middle school sites had more conflicts than elementary sites. The majority of the elementary school campuses seemed to provide adequate supervision; however, several of the middle schools had little staff supervision of traffic and children, especially during morning drop-off.

Examples to Avoid

Researchers observed several violations of Guideline 12 at school sites. Several of the common scenarios for loading in non-designated areas are described in the list below:

- <u>Scenario 1</u>: loading occurs in a parking lot (typically occurs when the designated parent zone is congested and the parking layout is conducive to a parent cutting through and bypassing the queue) – see Figure 21. This type of loading is undesirable because children can be difficult to see when they emerge from rows of parked vehicles.
- <u>Scenario 2</u>: loading occurs across an adjacent street – see Figure 22. This type of loading is undesirable because parents and students often jaywalk across the street and the vehicles are often parked in no parking zones.
- <u>Scenario 3</u>: loading occurs on the same side as the school on an adjacent street – see Figure 23. This type of loading is undesirable because the vehicles may block through traffic and are a potential safety hazard.

Figure 21. Student Being Loaded in Parking Lot Instead of Designated Area.

Guideline 13: Student safety patrols and loading supervisors should be well trained and wear reflective safety vests. (PLANNING and OPERATIONS)

Figure 22. Student Being Loaded across the Adjacent Street Instead of Designated Area.

Figure 23. Students Being Loaded Off-Site along Right-of-Way of the Adjacent Street.

Best Practice for Application of Guideline 13

Student safety patrols can be an effective tool for assisting children in and out of vehicles and helping the loading process in the parent drop-off/pick-up zone to be more efficient. The student safety patrols are more commonly utilized at elementary school campuses and often consist of children from the highest grade level at the school. Teachers, staff, and parent volunteers also often supervise loading operations, direct traffic, and assist children in and out of vehicles.

Researchers developed Guideline 13 based on the experience gained during the field studies. Members of the data collection team for each field study wore reflective safety vests to be visible to parents. Principals often commented that parents were on their best behavior during the field studies because of all the 'official' looking persons wearing the safety vests. It is important that members of student safety patrols and other adult loading supervisors are well trained and wear some type of reflective safety vests to enhance their visibility and give them an official look. Other equipment, besides vests, that can be helpful in creating a safe and efficient parent drop-off/pick-up zone are traffic control devices such as STOP paddles, whistles, and bullhorns.

Examples of Good Practice

During the field studies, researchers did not observe many of the student safety patrol and/or loading zone supervisor personnel wearing reflective safety vests. Figure 24 shows a picture of two appropriate reflective safety vests. Researchers observed more of the student safety patrol and loading zone supervisor personnel using other equipment such as STOP paddles to help direct traffic in the parent drop-off/pick-up zone. Figure 25 is a picture of a student safety patrol with a STOP sign mounted on the end of a pole (notice they are not wearing a reflective safety vest).

Figure 24. Reflective Safety Vests Enhance Visibility.

Figure 25. Safety Patroller with STOP Pole Supervising Crosswalk in the Loading Zone.

<u>Guideline 14</u>: Traffic cones and other channelizing devices can be used to minimize pedestrian/vehicles conflicts. (DESIGN and OPERATIONS)

Examples to Avoid

Researchers observed several sites where Guideline 13 was partially followed. Figure 26 shows a student safety patroller opening a door during morning drop-off. The list below provides an assessment of practices to avoid and those that were good for the type of situation in Figure 26:

- orange reflective safety vests were worn by each of the patrollers (GOOD);
- adult loading supervisor did not have a safety vest (AVOID); and
- patroller had to walk from the curb across a lane that was used for through traffic in order to open the vehicle door (AVOID).

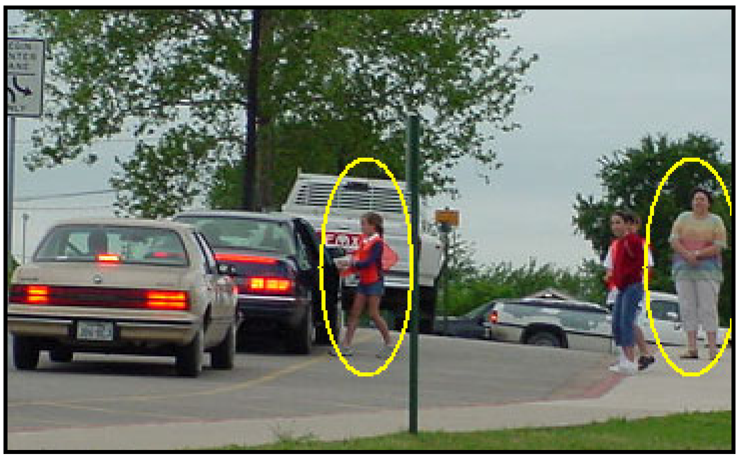

Figure 26. Student Safety Patrol at Elementary School.

Best Practice for Application of Guideline 14

The actual physical design of the school site plays a large role in dictating traffic circulation at the site. In addition to physical layout and geometric elements (e.g., driveway width – number of lanes) many schools utilize traffic cones and other channelizing devices to control on-site traffic patterns. Researchers observed several innovative practices, primarily placement of traffic cones, that schools used for traffic control and access restriction *(6)*. The conflict studies during the field studies found that as the number of lanes in the parent zone increased the pedestrian/vehicle conflicts also increased *(7)*. This finding led to the development of Guideline 14, which indicates that traffic cones or other channelizing devices (e.g., gates, barrels, etc.) can be used to minimize pedestrian/vehicle conflicts in the parent zone and throughout the entire site.

Examples of Good Practice

Researchers observed several examples of good practices of Guideline 14 at school sites. Several of the common good practices are described in the list below:

- Channelizing practice 1: placement of cones to create a single-lane queue in the parent drop-off/pick-up zone (see Figure 27). This practice is desirable because it minimizes the potential for pedestrian/vehicles conflicts; however, it can only be used practically if there is enough capacity to process the queue efficiently using only one through lane.
- Channelizing practice 2: placement of cones in the middle lane (labeled as 2) of a three-lane loading zone to create a median area that acts like a second curb lane (see Figure 28). This practice is generally not favored because children have to cross an active driveway lane. The desirable part is that vehicles can unload students in two lines – one from the curb adjacent to the entrance (lane 1) and one from the far lane (lane 3), which creates additional on-site stacking space. However, this type of solution can improve operations and safety if well supervised (e.g., use a loading supervisor and have students unloaded in the far lane walk to the on-site crosswalk before crossing the curbside lane).
- Channelizing practice 3: placement of cones to restrict vehicles, typically parent vehicles, from accessing a zone designated for other uses (e.g., parking, bus loading, etc.). Figure 29 and Figure 30 show pictures of several examples of this practice. This practice is desirable because it is a relatively easy way to restrict traffic flow and circulation.

Figure 27. Placement of Traffic Cones to Create a Single-Lane Queue.

Figure 28. Placement of Traffic Cones to Create a Dual-Lane Queue.

Figure 29. Traffic Cones Placed to Reinforce Turn Restrictions from Exit Driveway.

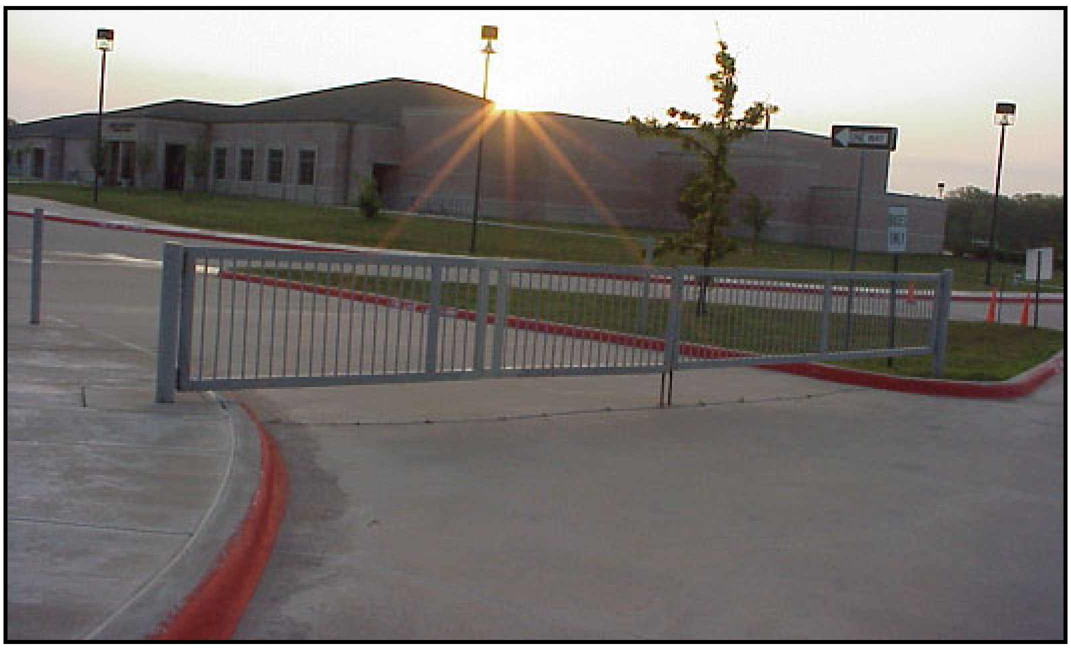

Figure 30. Traffic Gate to Restrict Access from Parent Zone to a Pedestrian/Bicycle Zone.

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 is a program oriented toward pedestrian and cyclist safety and has grown internationally. Table 12 describes the most prominent bicycle and pedestrian guidelines reviewed by the research team.

Guideline 15: Provide safe crosswalks with crossing guards. (OPERATIONS)

Table 12. Pedestrian and Bicycle Guidelines for School Sites.

Guideline	Source(s)
★ Provide safe crosswalks with crossing guards (use adult crossing guard/safety officer at nearby intersections with sizable traffic volume).	Katz, Okitsu, & Associates–California (38), Miami-Dade County–Florida (39)
Pedestrian and vehicle conflicts should be minimized (do not mix them together).	Miami-Dade County–Florida (39), City of Mississauga–Canada (12), North Carolina DOE (9), Missouri DOT (36)
★ There should be standard and well-maintained sidewalks and/or a designated safe path leading to the school.	Miami-Dade County–Florida (39), South Carolina DOE (13), Douglas County–Colorado (16), ITE Michigan Section (17), Arizona DOT (21)
Develop safe walk/bike routes/maps leading to school.	Too many to list
Pedestrians from student parking areas shall not be allowed to cross school drives to reach the school building.	South Carolina DOE (13), North Carolina DOE (9)
★ Facilities should be provided for bicycle access and storage.	Wake County–North Carolina (30), City of Mississauga–Canada (12)
Except at pick-up locations, sidewalks shall be kept a minimum of 5 ft (1.525 m) away from roadways.	Seminole County–Florida (37)
Student pedestrian traffic should not be mixed with vehicle traffic.	School Bus Fleet (33)
No pedestrian crosswalks should cross through a loading area.	School Bus Fleet (33), NSC (24), California DOE (10), Missouri DOT (36)
Students approaching buildings on foot should not have to cross main traffic arteries.	North Carolina DOE (9)
Use two adult crossing guards at wide street crossings.	City of Phoenix-Arizona (22)
★ Create wider paved student queuing areas at major crossings and paint sidewalk 'stand-back lines' to show where to stand while waiting.	City of Phoenix-Arizona (22)

★ Guidelines with this star symbol also have a best practice section

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* (50),
- *Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas* (51), and
- *Recommendations to Reduce Pedestrian Collisions* (52).

Best Practice for Application of Guideline 15

Many studies and programs, including Safe Routes to School, are currently geared to promoting safety for pedestrians, bicycles, and other non-motorized modes of getting to and from school. There are several key benefits typically cited by these studies and programs: (1) lowered vehicle demand and (2) exercise for the children. One of the good ways to encourage pedestrian and bicycle access is to provide safe crosswalks with crossing guards (Guideline 15). Some cities, notably the City of Phoenix, Arizona, have the guideline that two crossing guards be used at wide street crossings (see Figure 31).

Figure 31. Two Adult Crossing Guards for Wide Streets.

Example to Avoid

Researchers observed several practices that violated Guideline 15. Figure 32 shows an example of a situation where a crosswalk is not available to cross an adjacent street, which causes a parent and child to jaywalk across the roadway to their neighborhood across the street.

Figure 32. Jaywalking across Street Adjacent to the School Site – No Marked Crosswalk.

The need for adequate supervision of crosswalks is not reserved for those across streets adjacent to the site. It is also important to consider on-site crosswalks, particularly those across entrance driveways where vehicles may turn in conflict with pedestrians or bicyclists.

Guideline 16: There should be well-maintained sidewalks leading to the school. (DESIGN, PLANNING and OPERATIONS)

Best Practice for Application of Guideline 16

Sidewalks and designated paths leading to schools promote safe access to non-motorized modes of travel. Many sources advocate that there should be well-maintained sidewalks and/or a designated safe path for students to use to get to and from school. Provision of pedestrian amenities such as sidewalks is especially important for access to elementary school sites.

The TxDOT *Roadway Design Manual* offers some guidance on design criteria for sidewalks (6 to 8 ft [1830 to 2440 mm], 5 ft [1525 mm] minimum) and borders (20 ft [6100 mm] for arterials and collectors, 15 foot [4575 mm] minimum) (*53*). The manual states that sidewalks are "applicable for commercial areas, school routes, or other areas with concentrated pedestrian traffic," which supports Guideline 16. The manual also discusses buffers in Section 2. It states:

> **Sidewalk Location.** For better pedestrian comfort, especially adjacent to high-speed traffic, it is desirable to provide a buffer space between the traveled way and the sidewalk. For curb and gutter sections, a buffer space of 3 ft [915 mm] or greater between the back of the curb and the sidewalk is desirable. For rural sections without curb and gutter, sidewalks should be placed between the ditch and right-of-way line if practical (*53*).
>
> **Sidewalk Width.** Sidewalks should be wide enough to accommodate the volume and type of pedestrian traffic expected in the area. The minimum clear sidewalk width is 5 ft [1525 mm]. Where a sidewalk is placed immediately adjacent to the curb, a sidewalk width of 6 ft [1830 mm] is desirable to allow additional space for street and highway hardware and allow for the proximity of moving traffic. Sidewalk widths of 8 ft [2440 mm] or more may be appropriate in commercial areas, along school routes, and other areas with concentrated pedestrian traffic (*53*).

Example of Good Practice

Figure 33 is a picture of well-maintained sidewalks on both sides of a street near a school site. These sidewalks were designed with the recommended 3-foot buffer from the adjacent roadway.

Example to Avoid

Researchers performed studies at several campuses that were located on two-lane high-speed roadways. These sites typically did not have sidewalks and less than 1 percent of their total enrollment walked or biked to and from school. Figure 34 shows a picture of an elementary school site located along a farm to market (FM) roadway with a typical posted speed limit of 55 miles per hour (mph) – 35 mph during school hours. There are no sidewalks at this site and virtually all of the access to the site by students is by parent vehicles or school buses.

<u>Guideline 17</u>: Create wider paved student queuing areas at major crossings and paint sidewalk "stand-back lines" to show where to stand while waiting. (DESIGN)

Figure 33. Roadway near School with Well-Maintained Sidewalks on Both Sides of Street.

Figure 34. School Site Located on Two-Lane High-Speed Roadway – No Sidewalks.

Best Practice for Application of Guideline 17

In 2001, the City of Phoenix Transportation Department formed a School Safety Task Force. This group developed approximately 20 recommended actions based on their review of safety and operations issues around schools. One of the recommended actions was to create wider student queuing areas at major crossings and paint sidewalk "stand-back lines" (Figure 35) to delineate where students should stand while waiting at crosswalks. Figure 36 shows a picture taken at a crossing in Phoenix before a student queuing area was installed. Figure 37 shows the same crossing after the wider student queuing area was installed. The benefit of having the students farther from the adjacent roadway is evident based on the before and after pictures.

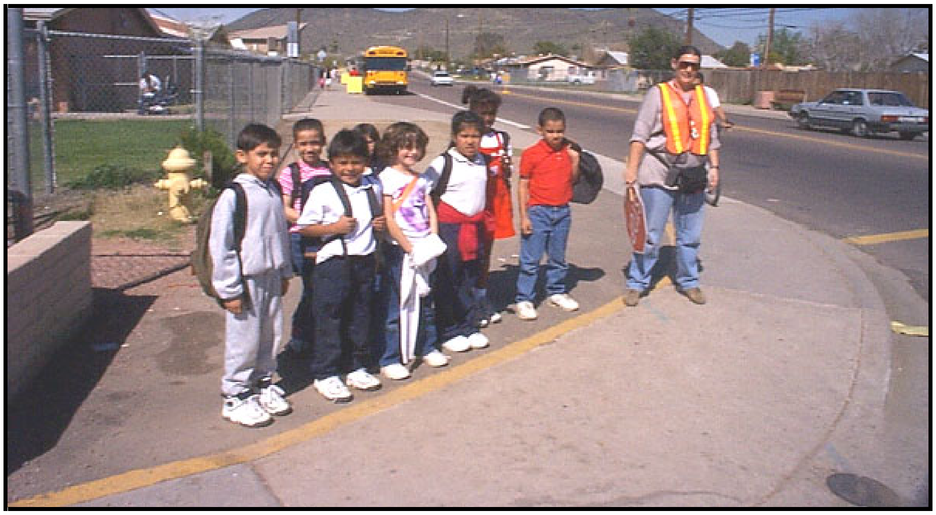

Figure 35. Stand-Back Line at Major Crossing.

Figure 36. Students on Sidewalk at Crossing before Installation of Paved Queuing Area.

Figure 37. Students Waiting in New Queuing Area Away from Crossing.

Guideline 18: Facilities should be provided for bicycle access and storage. (DESIGN)

Best Practice for Application of Guideline 18

Guideline 18 relates to the provision of facilities for bicycle access and storage at school sites. Bicycle access facilities include bicycle lanes (Figure 38), shared lanes (produced by providing a wider lane for the inside travel lane), and in some cases trails on separate right-of-way (ROW). In addition, access needs to be provided between the roadway or trail and the bike storage facility. For most schools, bicyclists are required to walk their bike once on the school site. Bike storage facilities range from bicycle racks (Figure 39) to concrete pads with fencing (Figure 40).

Figure 38. Bicycle Lane in Front of Middle School Site.

Figure 39. Example of Typical Rack for Bicycle Storage.

Figure 40. Fenced Concrete Pad Adjacent to School Building for Bicycle Storage.

GUIDELINES FOR SCHOOL ACCESS DRIVEWAYS

Researchers examined guidelines related to school access driveways. The guidelines fell into one of the following topic areas: (1) number; (2) spacing; (3) location; or (4) layout and design.

Guidelines for Number of School Access Driveways

The research team gathered information on existing guidelines related to the number of driveways to adequately service the school. Most of the guidelines were found in local and state access management manuals. Several of the guidelines were not specific to the number of school driveways, just the number of driveways in general to serve general land uses. Table 13 provides information on the guidelines specific to school sites for the number of school access driveways.

Spacing Guidelines for School Access Driveways

Researchers collected information on existing guidelines for the spacing of school driveways. Most were found in local and state manuals. Almost all the guidelines treated schools the same as other land uses for driveway spacing. Table 13 gives information on guidelines for driveway spacing for schools. Six hundred feet was cited by two sources as the ideal spacing to allow for adequate left-turn lane development (Figure 41). TxDOT has a draft Access Management Manual that addresses intersection/driveway spacing *(54)*. The manual refers to spacing between driveways as connection spacing. The draft manual is online at the TxDOT website *(54)*.

Location Guidelines for School Access Driveways

The research team found several existing design guidelines for how far school access driveways must be offset from the nearest intersection. As with driveway frequency and spacing, most of the existing guidelines were collected from local and state access manuals. Secondary sources were the AASHTO *Policy on Geometric Design* *(55)*, DOT design manuals, and the *Manual on Uniform Traffic Control Devices* (MUTCD) *(56)*. The following list gives a range of guidelines for the minimum offset distance for school access driveways from adjacent intersections:

<u>Guideline 19</u>: School driveways should conform to TxDOT design and access management guidelines for number, spacing, location, and layout. (DESIGN)

- New Hampshire DOT – 100 ft (30.5 m),
- South Carolina DOT – 75 to 100 ft (22.875 to 30.5 m), and
- New York DOT – 2W + 15 ft (4.575 m); where W is the width of the nearby intersection.

Some agencies 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.

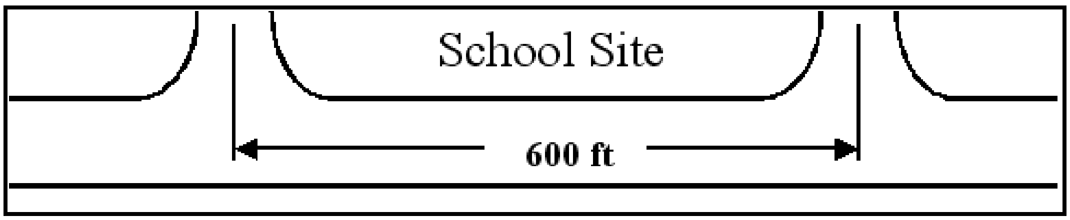

Figure 41. Ideal Spacing of School Driveways for Adequate Left-Turn Lane Development.

Guidelines for the Layout and Design of School Access Driveways

Researchers uncovered existing guidelines for the layout and design of school access driveways. These guidelines included recommended values for minimum turning radius and lane widths for driveways. Several sources were cited including access management/driveway manuals, AASHTO *Policy on Geometric Design* (*55*), and DOT design manuals. Table 13 provides four specific values for the driveway designs. The South Carolina DOT has guidelines for the layout and design for two-way car (Figure 42) and two-way bus (Figure 43) school driveways.

One source had a guideline that driveway intersection angles should be between 75 and 90 degrees because skewed driveway and street intersections can cause problems (*34*). Furthermore, several sources advocated that it is often desirable for exit driveways to have two outbound lanes (Figure 44), one for left-turning vehicles and one for right turners (*34*, *23*). This 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 13 also provides the guidelines for relative placement of driveways at school sites and their corresponding source.

As previously mentioned, TxDOT has a draft Access Management Manual that addresses driveway-related issues (*54*). Guideline 19 indicates that school driveways, particularly those with access to state-maintained roadways, should conform to TxDOT design and access management guidelines for number, spacing, location, and layout. The draft manual is online at the TxDOT website (*54*).

Table 13. Driveway-Related Guidelines for School Sites.

Guidelines for the Number of Driveways		Source
No more than 3 for any parcel (assuming minimum spacing is met).		New Hampshire DOT–Survey Response
Typically allow for 2 entrances – one for bus traffic and the other for student, teacher, and parent drop-off/parking.		Delaware DOT–Survey Response
Minimum of 2 – one for buses and one for parent drop-off.		Maryland DOT–Survey Response
Discourage all direct access for schools but the Colorado State Highway Access Code controls if there are driveways permitted.		Colorado DOT–Survey Response
• 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 *(31)*
Guidelines for the Spacing of Driveways		**Source**
Use rule of thumb of 10 times operating speed as a minimum spacing.		Virginia DOT–Survey Response
300 to 400 ft (91.5 to 122 m) is desirable.		Delaware DOT–Survey Response
600 ft (183 m) – distance required to accommodate the installation of a properly designed left-turn lane.		Minnesota DOT *(23)* South Carolina DOT *(31)*
Guidelines for the Layout and Design of Driveways		
Minimum Radius (ft)	**Recommended Lane Width (ft)**	**Source**
50 (15.25 m)	12 (3.66 m)	Mississippi DOT–Survey Response
50 (15.25 m)	12 (3.66 m)	Maryland DOT–Survey Response
35 (10.675 m)	16 (4.88 m)	Delaware DOT–Survey Response
25 car / 40 bus	12 with 18 throat entrance	South Carolina DOT *(31)*
30 car / 50 bus	12 + increased on curves	Missouri DOT *(36)*
Guidelines for the Relative Placement of Driveways		**Source**
Locate the bus area so that buses exit upstream of automobiles and gain priority, thereby reducing delay.		Douglas County–Colorado *(16)*
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.		Minnesota DOT *(23)*
Driveways should not be located too close to nearby intersections. Doing so will create offset or dogleg intersections with other streets or high-volume driveways. Offset intersections can create erratic patterns and detract from drivers' abilities to look out for pedestrians.		School Bus Fleet *(34)*

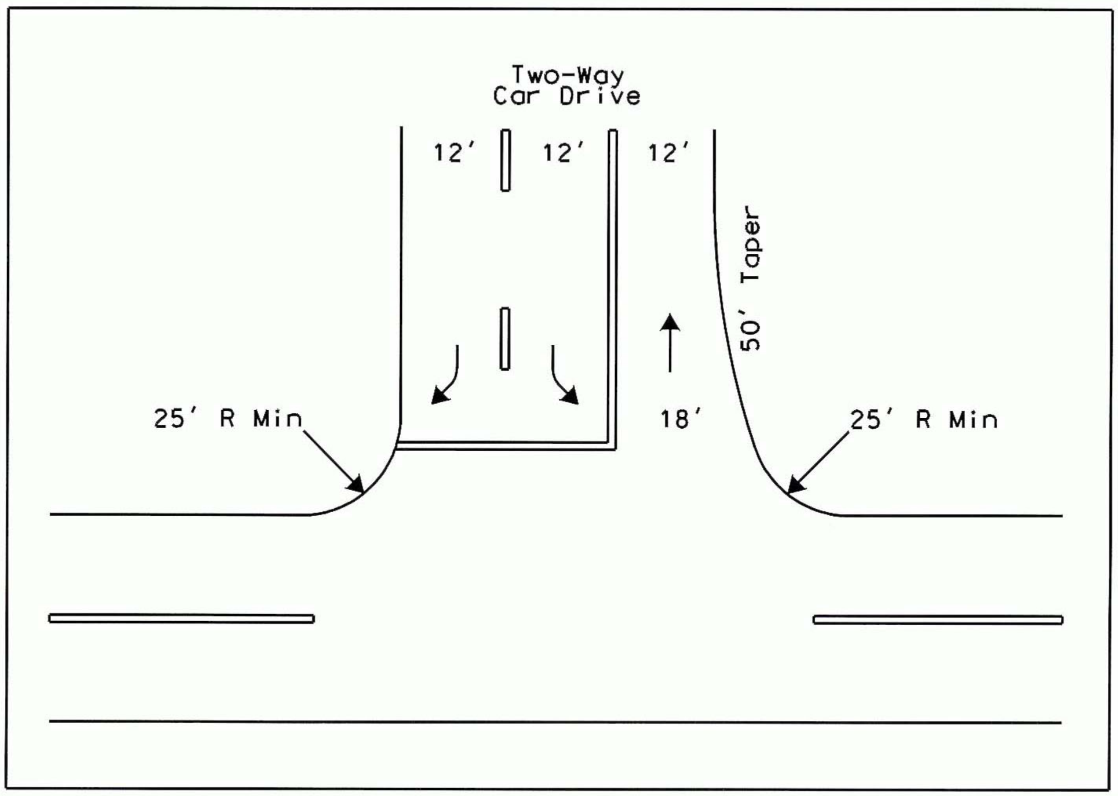

Figure 42. South Carolina DOT Layout and Design for Two-Way Car Driveway (*31*).

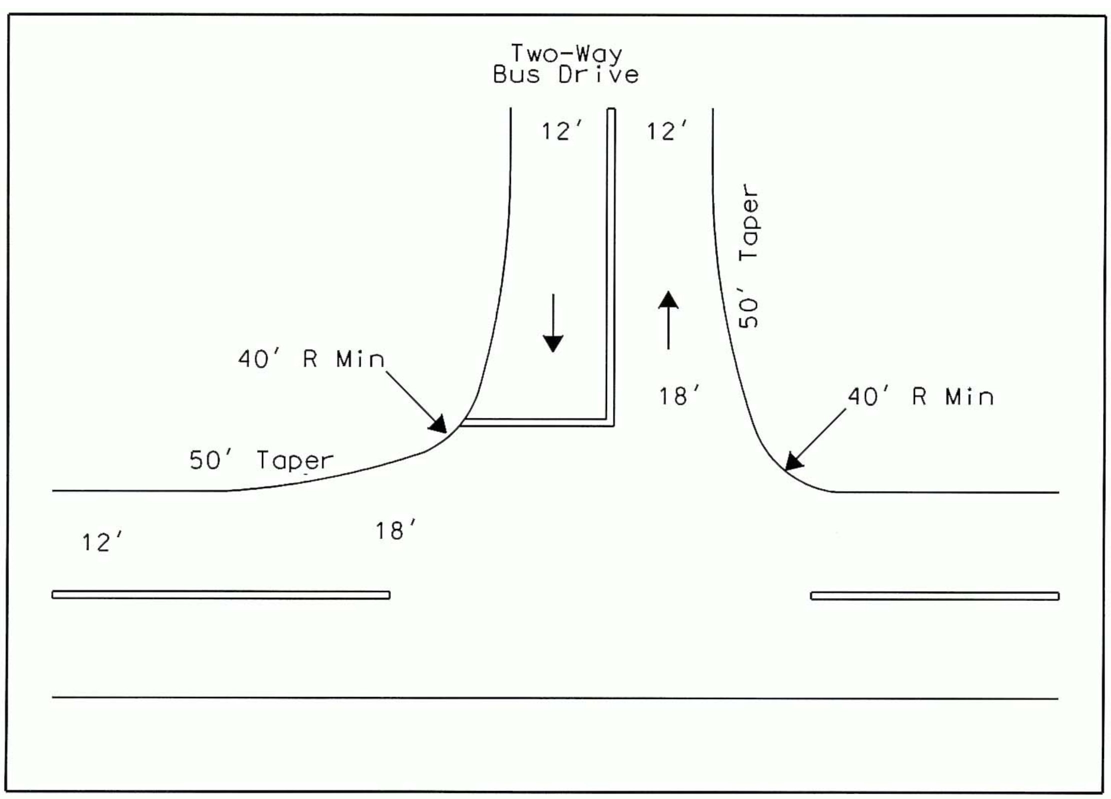

Figure 43. South Carolina DOT Layout and Design for Two-Way Bus Driveway (*31*).

<u>Guideline 20</u>: Utilize the existing Texas Department of Transportation design guidelines for left- and right-turn lanes and apply these to school sites. (DESIGN)

Figure 44. School Exit Driveway with Two Lanes for Left and Right Turn Movements.

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. The research team gathered information on existing design criteria or guidelines for the installation of turn lanes/bays at new and/or existing school sites. The majority of those with guidelines 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 of DOT representatives cited the AASHTO *Policy on Geometric Design of Streets and Highways* (55) – also known as the Green Book – as a primary source for their turning lane criteria. One agency indicated that they use the AASHTO turn lane criteria in Table 9-75 of the Green Book; 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 they require a traffic impact study, which 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 (152.5 to 183 m) as the distance needed to develop an adequate left-turn lane. Most of the warrants for turn lanes were based primarily on volume and speed as criteria.

Best Practice for Application of Guideline 20

The guidelines contained in the TxDOT *Roadway Design Manual* should be used for the design of left- and right-turn lanes to school sites *(53)*. Installation of turn lanes is particularly important to consider when school sites are located on high-speed roadways where separation of turning movements from through traffic provides operational and safety benefits. School sites generate fairly substantial peaks of traffic during relatively short time periods – average of 30 minutes in the morning and 30 minutes in the afternoon. These peaks must be considered in the design and layout of turn lanes to school sites.

The research team observed several common problems related to turn lanes at school sites. The first problem was that no turn lanes were present and the associated queuing caused safety and operational problems. Figure 45 shows a situation where right-turn traffic into the school driveway is using an unpaved shoulder as the de facto right-turn lane so that through traffic is not blocked on the adjacent roadway. The second problem was that turn lanes did not have adequate length to accommodate the vehicles arriving to turn into the school site. Figure 46 shows an example of the second problem where the left-turn lane is experiencing spillback onto the through lane because of the high traffic demand and the inadequate length. Figure 47 shows a newly installed two-way left-turn lane in front of an elementary school.

Figure 45. Traffic Queue on Unpaved Shoulder – Right-Turn Lane Might Be Warranted.

Figure 46. Queue in Left-Turn Lane Starting to Spillback and Block Through Lane.

<u>Guideline 21</u>: All site and regulatory signage and markings within school sites shall comply with the Texas Manual on Uniform Traffic Control Devices. (DESIGN)

Figure 47. Newly Installed Left-Turn Lane in Front of an Elementary School.

TRAFFIC CONTROL, MARKING, AND SIGNING GUIDELINES

In the review of existing guidelines for traffic control, markings, and signing for school sites, the research team concentrated on guidelines and recommended practices dealing with on-site issues at schools. As noted in the case studies, the research team observed a wide variety of traffic control, markings, and signing at the school sites in Texas.

Table 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 *(56)*. Another agency requires the installation of truck exclusion signs around the school area.

Best Practice for Application of Guideline 21

The MUTCD is thought of in the traffic engineering profession as the definitive source for guidance on signing, pavement marking, and traffic control. Guideline 21 advocates that all site and regulatory signage and markings within school sites shall comply with the Texas MUTCD *(57)*. If traffic control devices, signs, and pavement markings with school sites comply with the Texas MUTCD, it is more likely that drivers, pedestrians, and bicyclists will operate in a uniform manner consistent with off-site operations.

Table 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–Florida *(39)*
Install truck exclusion signs around the school area.	Miami-Dade County–Florida *(39)*
★ All site and regulatory signage and markings shall comply with the Texas Manual on Uniform Traffic Control Devices (TMUTCD).	Seminole County–Florida *(37)*, ITE Michigan Section *(17)*, School Bus Fleet *(34)*
Curbs (flush ribbon or raised) at bus and vehicle drop-off/pick-up locations shall be painted yellow.	Seminole County–Florida *(37)*
Sign height from the ground is a minimum of 7 ft (2.135 m) for a single sign and 5 ft (1.525 m) for a double sign.	School Bus Fleet *(33)*
Justify a traffic signal (where vehicle volumes warrant) during the peak periods at secondary school access to or from an arterial.	Douglas County–Colorado *(16)*
All curbside parking should be prohibited in advance of school pedestrian crossings, at driveways, and at school building entrances.	New South Wales–Australia *(18)*, ITE Michigan Section *(17)*
Where necessary, traffic control devices should be provided to assist school traffic in entering the regular traffic flow.	NSC *(24)*
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 *(17)*
Provide 'Buses Only' and 'No Entry' signage at ends of the bus loop.	Kentucky DOE *(35)*
Paint SCHOOL pavement stencil on each high-speed crossing approach.	City of Phoenix–Arizona *(22)*

★ Guidelines with this star symbol also have a best practice section

Example to Avoid

The research team observed several common violations of Texas MUTCD guidelines related to signs and pavement markings at school sites. Some of the common violations included:

- Use of yellow paint for pavement markings and directional arrows – Figure 48 provides an example of yellow crosswalk pavement markings at an elementary school.
- Signs mounted below standard levels – Figure 49 shows a sign mounted below the 5-foot minimum (person next to sign is approximately 6 feet tall).
- Signs with inconsistent text color – Figure 50 shows a SCHOOL BUS ONLY sign that uses green paint for the text instead of the black.
- Non-standard signs – Figure 51 shows a picture of a standard DO NOT ENTER sign on one side and a non-standard DO NOT ENTER sign on the other.

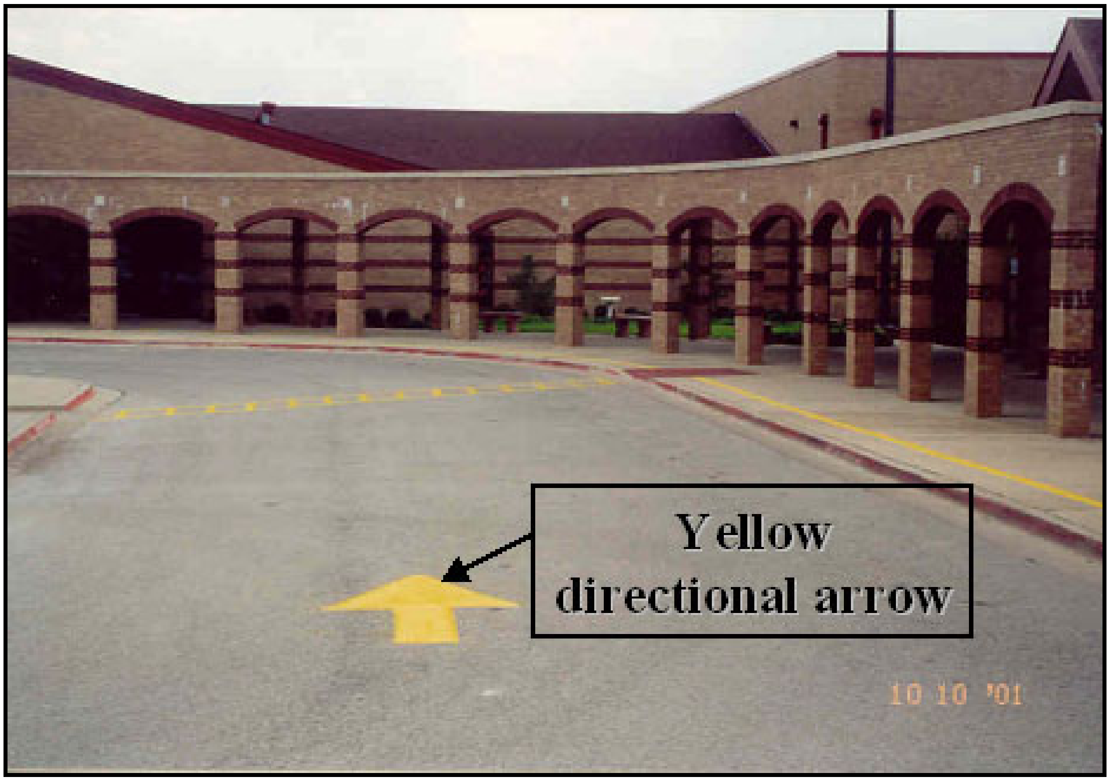

Figure 48. Example of Yellow Markings for On-Site Crosswalk at Elementary School.

Figure 49. Sign on Elementary Site Mounted Several Feet below the Standard Height.

Figure 50. Sign at Elementary Site with Non-Standard Font Color and Message.

Figure 51. Example of Non-Standard Sign at Elementary School Site.

GUIDELINES FOR PARKING DESIGN AND LAYOUT AT SCHOOL SITES

The research team identified only a few sources with existing guidelines for school parking facilities. Table 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 driveway, 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 schools. 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 (*16*). A similar guideline indicated that 2.25 spaces should be provided for each teacher station (this includes spaces for staff and visitors) (*10*). 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 (*10*).

As indicated in the interviews conducted with school district personnel and architects, many utilize local requirements, typically from a municipality, for the parking requirements at schools. The local requirements for total number of spaces often vary based on school type (i.e., high vs. middle vs. elementary schools). Most school architects also use standard graphics software packages for the actual design of parking spaces (angled, parallel, or conventional) and lots.

Table 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 *(13)*, Miami-Dade County–Florida *(39)*, Douglas County–Colorado *(16)*, New South Wales–Australia *(18)*, ITE Michigan Section *(17)*, North Carolina DOE *(9)*
Peninsula and detached islands in parking areas shall have 6 inch (15.2 cm) raised curbing.	Seminole County–Florida *(37)*
When the island area exceeds 1000 ft^2 (93 m^2), the curb shall taper down to a flush ribbon curb for 6 ft (1.83 m) in length at a location that is inaccessible to vehicles yet allows for mower access to the island.	Seminole County–Florida *(37)*
Staff parking areas can be located with less concern for accessibility than other areas because staff members generally arrive before and leave after students and are generally more experienced in traffic.	School Bus Fleet *(33)*
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.	NSC *(24)*, North Carolina DOE *(9)*
Short-term parking spaces should be identified past the student loading area and near the building entrance. Installing 'Visitor Parking' signs can identify these spaces.	North Carolina State University *(47)*
Prior to designing and laying out parking lots, architects should consult with school administration on the total number of pupils and staff.	NSC *(24)*
There should be one stall for each staff member and an additional 10% of that for visitor parking.	ITE Michigan Section *(17)*
Buildings should be parallel to the street and have parking located at the side or rear of the property.	City of Mississauga–Canada *(12)*
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 *(9)*
Provide an adequate turning radius (45 ft [13.725 m] minimum outside and 26 ft [7.93 m] minimum inside) within parking lots.	North Carolina DOE *(9)*
Combine visitor parking with the parent drop-off driveway located near the main entrance and administrative office.	North Carolina DOE *(9)*
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 *(9)*
Provide 2.25 parking spaces for each teacher station (this includes space for staff members and visitors).	California DOE *(10)*
Many school districts provide student lots with a minimum parking capacity calculated on 50 percent of the school enrollment.	California DOE *(10)*
Locate kitchen/custodial staff parking at service/kitchen area.	Kentucky DOE *(35)*

CHAPTER 3. SCHOOL SITE PLAN REVIEW CHECKLIST

This chapter presents a checklist tool that TxDOT engineers and other interested stakeholders can use to review school site plans based on the guidelines contained in Chapter 2. Researchers intend for this checklist to facilitate greater use of the existing Precious Cargo Program, which encourages early cooperation and planning between TxDOT, school districts, architects, and other stakeholders.

TYPES OF SITE PLAN REVIEW

There are two basic types of site plan review performed as part of the TxDOT Precious Cargo Program:

1. existing school campus with traffic flow problems or other safety issues within or around the school site; or
2. new school campus.

The research team developed questionnaires to facilitate planning between TxDOT and school district representatives for both types of site plan review. Appendix A provides the questionnaire to use when the review is of an existing school campus. The questionnaire to use for a new school campus is in Appendix B.

SITE PLAN REVIEW CHECKLIST

Table 16 provides the site plan review checklist. The research team based this checklist on the 21 guidelines in Chapter 2 contained in text boxes. TxDOT engineers and other interested stakeholders can use this checklist and other guidelines contained in Chapter 2 to review site plans for existing or new school sites.

Table 16. Site Plan Review Checklist.

Guideline #	Review Question	Answer		Comments
		Yes	No	
1	Is the building setback a sufficient distance to provide adequate site storage?			
2	Is the school site located on a high-speed roadway? (if yes, please comment)			
3	Is access provided from more than one direction to the immediate vicinity of the site (i.e., from at least two adjacent streets)?			
4	Is the school site situated where the road alignment provides good visibility?			
5	Are the physical routes provided for the basic modes (buses, cars, pedestrians, and bicycles) separated from each other on the site?			
6	Does overhead cover or soffit protect all primary building entrances for students?			
7	Has the school site and proposed plans been reviewed by the proper road agency?			
8	Are school buses going to be staged single-file right wheel to the curb in the loading zone?			
9	Is there adequate driveway stacking length for lining up cars on site – see Table 11?			
10	Are students loaded and unloaded on the right side directly to the curb/sidewalk in the bus and parent loading zones?			
11	Are the short-term parking spaces located past the student loading area and near the building entrance?			
12	Is parent loading occurring only in designated zones? (if not, please note non-designated zones in comments section)			
13	Are the student safety patrols and loading supervisors well trained and outfitted with reflective safety vests?			
14	Are traffic cones or other channelizing devices used within the site to minimize pedestrian/vehicle conflicts?			
15	Are safe crosswalks with crossing guards provided on-site and off-site to minimize pedestrian/vehicle conflicts?			
16	Are there standard and well-maintained sidewalks and/or a designated safe path leading to the school?			
17	Are there wider paved student queuing areas at major crossings and “stand-back lines” to show where to stand while waiting?			
18	Are facilities for bicycle access and storage provided at this campus?			
19	Do the school driveways conform to TxDOT design and access management guidelines for number, spacing, location, and layout?			
20	Does this school site have existing or planned left- or right-turn lanes? Do they meet existing TxDOT design guidelines?			
21	Do all site and regulatory signs and markings within the site comply with the Manual on Uniform Traffic Control Devices?			

REFERENCES

1. Agencies Work Together Toward School Safety. *Texas Transportation Researcher*, Volume 35, Number 4, 1999.
2. Safety Matters: Precious Cargo Brings Communities and TxDOT Together. *Texas Transportation Researcher*, Volume 37, No. 3, 2001.
3. Plano Resident Shines as a Point of Light: Selected as Nation's Volunteer of the Day. Points of Light Award National Press Release, Washington, D.C., March 2002.
4. Precious Cargo Program Progress Report. Texas Department of Transportation, January 2002.
5. Wisconsin State Legislature: 2001 Assembly Bill 436.
6. Cooner, S., K. Fitzpatrick, M. Wooldridge, and G. Ford. *Traffic Operations and Safety at Schools: Review of Existing Guidelines*, Research Report 4286-1, Texas Transportation Institute, Texas A&M University System, October 2002.
7. Cooner, S., K. Fitzpatrick, M. Wooldridge, and G. Ford. *Traffic Operations and Safety at Schools: Overview of Project Activities and Findings*, Research Report 4286-3, Texas Transportation Institute, Texas A&M University System, November 2003.
8. Hubler, G. *The School Design Primer: A How-To Manual for the 21st Century*. The Little Institute for School Facilities Research, North Carolina, 1996. http://www.edfacilities.org/pubs/li/little.html. Accessed August 29, 2003.
9. *The School Site Planner: Land for Learning*. North Carolina State Board of Education, Raleigh, June 1998. http://www.schoolclearinghouse.org/pubs/schsite.pdf. Accessed August 29, 2003.
10. *Guide to School Site Analysis and Development: 2000 Edition*. California Department of Education, Sacramento, 2000. http://www.cde.ca.gov/facilities/field/publications/schoolsiteanalysis2000.pdf. Accessed August 29, 2003.
11. *Resources for School Facilities Planning*. California Department of Education, Sacramento, 2000. http://www.cde.ca.gov/facilities/field/publications/schsiteselandapp2000.pdf. Accessed August 29, 2003.
12. *Urban Design Guidelines for School Sites*. City of Mississauga, Canada, Planning and Building Department, 1998.
13. *Planning and Construction Guide*. South Carolina State Department of Education, Office of School Facilities, 1983. http://www.sde.state.sc.us/offices/sf/. Accessed August 29, 2003.
14. North Central Texas Council of Governments. DFW Maps Home Page – 2001 Aerial Photos. http://www.dfwmaps.com/. Accessed August 29, 2003.
15. *Safety and Traffic Circulation at School Sites Guidelines Study*. Region of York, Transportation and Public Works Department, Canada, 1999.
16. *School Site Access Guidelines*. Prepared by Carter and Burgess, Inc. for Douglas County, Colorado, May 1997.
17. Michigan Section Committee on Traffic Engineering Around Schools. *Traffic Safety Planning on School Sites*, ITE Journal, August 1978, pp. 22-29.
18. *Interim Guidelines for the Planning and Design of School Traffic and Pedestrian Facilities*. Roads and Traffic Authority of New South Wales, Australia. January 2002.

19. *Interim Guidelines for the Planning and Design of School Bus Routes and Bus Stops*. Roads and Traffic Authority of New South Wales, Australia. January 2002.
20. *A Practical Guide to Addressing Road Safety Issues Around Schools*. Roads and Traffic Authority of New South Wales, Australia. http://www.rta.nsw.gov.au/roadsafety/downloads/schoosafetaprac_dl1.html. Accessed August 29, 2003.
21. *School Safety Program Guidelines*. Arizona Department of Transportation, January 1983, in *Selected Readings on Home-to-School Transportation Topics, I Can't Get There from Here Conference,* University of Florida Department of Urban and Regional Planning and the Florida Department of Transportation Pedestrian/Bicycle Program, November 30 – December 4, 1992.
22. City of Phoenix (Arizona). Phoenix School Safety Task Force Recommendations, 2001.
23. *Best Practices in School Zones*. Minnesota Department of Transportation, Office of Traffic Engineering, February 2000.
24. *Planning School Sites for School Bus Safety*. National Safety Council, Motor Transportation Division, School Transportation Section, March 1998. http://www.nsc.org/mem/motor/busplans.htm. Accessed August 29, 2003.
25. *Guide for Planning School Construction Projects in Minnesota*. Minnesota Department of Children, Families, and Learning, May 1999. http://education.state.mn.us/content/003023.pdf Accessed August 29, 2003.
26. *School Construction Regulations*. Massachusetts Department of Education – Laws and Regulations. http://www.doe.mass.edu/. Accessed August 29, 2003.
27. *Survey of Traffic Circulation and Safety at School Sites*, Prepared by the Institute of Transportation Engineer's Transportation Safety Council Committee TSC-4S-08, October 1998. http://safety.fhwa.dot.gov/fourthlevel/pdf/SchoolSurvey.pdf. Accessed August 29, 2003.
28. *A Survey of Establishing Reduced Speed School Zones*, Prepared by the Institute of Transportation Engineer's Transportation Safety Council Committee TSC-4S-06, 2000.
29. Miami-Dade County Public School District. General Considerations Design Criteria. http://facil.dade.k12.fl.us/facplan/. Accessed August 29, 2003.
30. Wake County (North Carolina) Public School System Design Guidelines, March 1999.
31. *Guidelines for School Transportation Design*. South Carolina Department of Transportation, School Operation Section, 2001. http://www.dot.state.sc.us/doing/trafficengineering.html. Accessed August 29, 2003.
32. Laue, K. *Six Steps to Improved School Site Safety*, School Bus Fleet, April 2001. http://www.schoolbusfleet.com/. Accessed August 29, 2003.
33. Matthews, J. *Make Bus Safety a Priority When Designing School Sites,* School Bus Fleet, February 1996, pp. 42-45. http://www.schoolbusfleet.com/. Accessed August 29, 2003.
34. Gattis, J. L. *Create a Safe Traffic Stream around School Sites*. School Bus Fleet, April/May 1999. http://www.schoolbusfleet.com/. Accessed August 29, 2003.
35. *Facility Programming and Construction Criteria Planning Guide*. Kentucky Department of Education, Division of Facilities Management, Construction Branch. http://www.kde.state.ky.us/KDE/Administrative+Resources/Facilities/default.htm. Accessed August 29, 2003.

36. *School Transportation and Traffic Safety: Guidebook for Local Agencies*. Missouri Highway and Transportation Department, December 1996.
37. Seminole County (Florida) Public Schools. Facilities Planning Department Design Guidelines, 2001. http://www.scps.k12.fl.us/facilities/_doc/designmanual5_2001.pdf. August 29, 2003.
38. Carmel del Mar Elementary School Traffic Study (California). Katz, Okitsu, and Associates. January 31, 2002.
39. *School Zone Traffic Congestion Study*. Prepared by David Plummer and Associates for the Miami-Dade County (Florida) Metropolitan Planning Organization, January 2002.
40. *A Guide to School Area Safety*. Oregon Department of Transportation, Traffic Management Section, January 2000. http://www.odot.state.or.us/traffic/PDF/General/SchoolSafetyGuide.pdf. Accessed August 29, 2003.
41. *School Safety Planning: for Vehicle and Pedestrian Traffic*. Pupil Transportation Safety Institute, Syracuse, New York, 1996.
42. *Traffic Safety at Schools*. City of Edmonton, Transportation and Streets Department, Canada, September 2001.
43. City of Henderson (Nevada). Parking Design Standards.
44. *Traffic Safety for School Areas*. Arizona Department of Transportation, Traffic Group, July 1995.
45. *Florida Safe School Design Guidelines*. A Research Report for the Florida Department of Education by the Florida Center for Community Design and Research, University of South Florida, July 1993.
46. *The MSTA School Traffic Calculator*. Municipal School and Transportation Assistance, North Carolina Department of Transportation, 2002. http://www.doh.dot.state.nc.us/preconstruct/traffic/congestion/CM/msta/docs/School_Calculator_2002.xls. Accessed August 29, 2003.
47. *Best Practices for Managing School Campus Carpool Traffic – Fact Sheet*. The Institute for Transportation Research and Education, North Carolina State University, School Transportation Group, August 2002. http://www.itre.ncsu.edu/STG/news1.htm#02aug1. Accessed August 29, 2003.
48. *Carpool Decision Tree – Carpool Recommendations*. The Institute for Transportation Research and Education, North Carolina State University, School Transportation Group, September 2002. http://www.itre.ncsu.edu/STG/news1.htm#02sept1. Accessed August 29, 2003.
49. *Municipal School and Transportation Assistance*. North Carolina Department of Transportation Web Site. http://www.doh.dot.state.nc.us/preconstruct/traffic/congestion/CM/msta/. Accessed August 29, 2003.
50. *A Guidebook for Student Pedestrian Safety*. Prepared by KLS Associates, Inc. for the Washington State Department of Transportation and the Washington State Traffic Safety Commission, August 1996.

51. Smith, S. A., K. Opiela, and L. Impett. *Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas*, National Cooperative Highway Research Program Report 294A, Transportation Research Board, National Research Council, Washington, D.C., June 1987.
52. *Recommendations to Reduce Pedestrian Collisions*. Washington Quality Initiative's Pedestrian Safety Improvement Team, December 1999.
53. Texas Department of Transportation, *Roadway Design Manual*. Revised April 2002. http://manuals.dot.state.tx.us:80/docs/coldesig/forms/rdw.pdf. Accessed August 29, 2003.
54. Texas Department of Transportation, *Draft Access Management Manual*. Draft June 2003. http://manuals.dot.state.tx.us/dynaweb/. Accessed August 29, 2003.
55. American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets.* American Association of State Highway and Transportation Officials, Washington, D.C., 2001.
56. *Manual on Uniform Traffic Control Devices*. U.S. Department of Transportation, Federal Highway Administration, U.S. Government Printing Office, Washington, D.C., 1988.
57. *Texas Manual on Uniform Traffic Control Devices for Streets and Highways*. Texas Department of Transportation. 2003. http://mutcd.fhwa.dot.gov/kno-millennium.htm. Accessed February 4, 2003.

APPENDIX A
EXISTING SCHOOL CAMPUS QUESTIONNAIRE

EXISTING SCHOOL CAMPUS SITE PLAN REVIEW COORDINATION FORM

School Name: ______________________________________

School District: ____________________________ **County**: ________________________

Provide a current site plan or aerial photograph of the campus with all driveways, parking lots and student loading zones clearly labeled.

School Type (check one): ☐ Elementary ☐ Intermediate ☐ Middle ☐ High

School hours: _______ AM to _______ PM

Student population: _______ Existing _______ Maximum

Number of faculty/staff: _______ Is parking a concern? .... ☐ Yes ☐ No

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

How many buses serve the school? _______ Estimated number of passengers? _______

Do students walk or bike to and from school? ☐ Yes ☐ No – If yes, estimate how many? _____

How many parent vehicles access the school site? _______ AM drop-off _______ PM pick-up

Describe the existing traffic pattern for the parent/student-loading zone: (attach diagram if necessary)

____

____

____

Please check the box of each problem that needs to be specifically addressed during this review:

Problem Description	Yes	No
May need a reduced speed school zone		
May need a marked crosswalk		
May need a traffic signal		
May need left- or right-turn lanes into the site from adjacent roadway(s)		
The unloading of students from parents' cars is slow & disorganized during morning drop-off		
The loading of students to parents' cars is slow & disorganized during afternoon pick-up		
Vehicles are spilling out of the school site onto adjacent roadway(s) during morning drop-off		
Vehicles are spilling out of the school site onto adjacent roadway(s) during afternoon pick-up		
Pedestrians are walking thru active traffic lanes during drop-off or pick-up times		
Other (please describe):		

APPENDIX B
NEW SCHOOL CAMPUS QUESTIONNAIRE

NEW SCHOOL CAMPUS SITE PLAN REVIEW COORDINATION FORM

School Name: ____

School District: ______________________________ **County**: __________________________

Site plan prepared by: ________________________ **Dated**: ___________________________

Provide a copy of the proposed site plan of the new campus.

School Type (check one): ☐ Elementary ☐ Intermediate ☐ Middle ☐ High

Proposed school hours: _______ AM to _______ PM

Student population: _______ Expected _______ Design capacity of school

Number of faculty/staff: _______ Will they arrive at the same time as students?... ☐ Yes ☐ No

How many buses will serve the school? _______ Estimated number of passengers? _______

Do you expect students to walk or bike to and from school? ☐ Yes ☐ No – If yes, estimate how many? _______

Estimated number of students arriving by personal automobile? _______

Describe the traffic pattern for the parent/student-loading zone: (attach diagram if necessary)

____

____

____

On the site plan identify the following:

_____ The number of levels, or stories, of each building.

_____ Main entrances including handicapped entrances and parking spaces.

_____ Parking lots, providing as much detail as possible (number of parking spaces, islands, handicapped spaces, visitor, faculty and staff, bus spaces, and delivery points).

_____ Student loading zone(s) (parents and buses) including their proposed traffic pattern.

_____ All main driveway connections to adjacent roadways – initial and proposed.