CLARE E. CONNORS 7936
Attorney General
State of Hawaiʻi

STUART N. FUJIOKA 4223
RYAN W. ROYLO 6329
MELISSA J. KOLONIE 10209
CARTER K. SIU 7313
Deputy Attorneys General
235 S. Beretania Street, Room 304
Honolulu, Hawaiʻi 96813
Telephone: (808) 586-1255
Facsimile: (808) 586-1488

Email: Stuart.N.Fujioka@hawaii.gov
Ryan.W.Roylo@hawaii.gov
Melissa.J.Kolonie@hawaii.gov
Carter.K.Siu@hawaii.gov

Attorneys for Petitioner
DEPARTMENT OF EDUCATION,
STATE OF HAWAIʻI

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LAND USE COMMISSION

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAIʻI

In the Matter of the Petition of

DEPARTMENT OF EDUCATION,
STATE OF HAWAIʻI,

To Amend the Agricultural Land Use District Boundaries into the Urban Land Use District for Approximately 77.2 acres of land at Kihei, Maui, Hawaiʻi, Maui Tax Map Key Nos. 2-2-02: 81 and 83.

DOCKET NO. A11-794

SUPPLEMENTAL EXHIBITS TO PETITIONER DEPARTMENT OF EDUCATION, STATE OF HAWAII'S MOTION TO AMEND THE LAND USE COMMISSION'S FINDINGS OF FACT, CONCLUSIONS OF LAW AND DECISION AND ORDER FILED JULY 29, 2013; EXHIBITS "39"-"42"; CERTIFICATE OF SERVICE

SUPPLEMENTAL EXHIBITS TO PETITIONER DEPARTMENT OF EDUCATION, STATE OF HAWAII'S MOTION TO AMEND THE LAND USE COMMISSION'S FINDINGS OF FACT, CONCLUSIONS OF LAW AND DECISION AND ORDER FILED JULY 29, 2013

Through counsel and at the request of Land Use Commissioner Gary Y. Okuda, during a Land Use Commission meeting held on August 25, 2021 regarding the matter of Petitioner's Motion to Amend the Land Use Commission's Findings of Fact, Conclusions of Law and Decision and Order Filed July 29, 2013, Petitioner submits the following supplemental exhibits:

Exhibit 39	Report FHWA/TX-01/2136-2, "Pedestrian Crossing Guidelines for Texas," December 2000.
Exhibit 40	National Cooperative Highway Research Program Report 189, "Quantifying the Benefits of Separating Pedestrians and Vehicles," 1978.
Exhibit 41	National Cooperative Highway Research Program Report 240, "A Manual to Determine the Benefits of Separating Pedestrians and Vehicles," November 1981.
Exhibit 42	"Safe Routes to Kihei High School: Pedestrian Route Study," Walkable and Livable Communities Institute (WALC) 2014. (An excerpt was submitted as Exhibit 2 to the Motion.)

DATED: Honolulu, Hawai'i, August 31, 2021.

/s/ Stuart N. Fujioka
STUART N. FUJIOKA
RYAN W. ROYLO
MELISSA J. KOLONIE
CARTER K. SIU
Deputy Attorneys General
Attorneys for Petitioner

DEPARTMENT OF EDUCATION,
STATE OF HAWAI'I

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PEDESTRIAN CROSSING GUIDELINES FOR TEXAS	December 2000
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Research Project Title: Revising the Pedestrian Warrant for the Installation of a Traffic Signal

16. Abstract

The purpose of this document is to recommend guidance and criteria on the provision of safe and effective pedestrian crossings. The guidelines should be useful to engineers and planners responsible for planning, designing, operating, and maintaining pedestrian facilities in Texas.

The guidelines are intended to outline the numerous alternatives that are available to address pedestrian safety problems or public concerns at roadway crossings. The guidelines describe the following crossing treatments:

- Pedestrian Crossing Examples – examples of good and bad design at pedestrian crossings;
- Basic Pedestrian Crossing Signs and Markings;
- Innovative Pedestrian Crossing Signs, Markings, and Other Treatments;
- Traffic Calming Measures – used to control vehicle speeds near crossings;
- Proposed Revised Warrants for Traffic Signal Control;
- Grade Separation – guidance on providing pedestrian overpasses or underpasses;
- Special Conditions: School Crossings and Special Events; and
- Education and Enforcement Activities.

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EXHIBIT 39

PEDESTRIAN CROSSING GUIDELINES FOR TEXAS

by

Shawn M. Turner, P.E.
Assistant Research Engineer
Texas Transportation Institute

and

Paul J. Carlson, P.E.
Assistant Research Engineer
Texas Transportation Institute

Product 2136-2
Project Number 0-2136
Research Project Title: Revising the Pedestrian
Warrant for the Installation of a Traffic Signal

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

December 2000

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 the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation (TxDOT) or the Federal Highway Administration (FHWA). This report does not constitute a standard, specification, or regulation. Not intended for construction, bidding, or permit purposes. The engineers in charge of the project were Paul Carlson, P.E. #85402 and Shawn Turner, P.E. #82781.

ACKNOWLEDGMENTS

The authors wish to acknowledge the support and guidance of Rick Collins, project director, of TxDOT's Traffic Operations Division. Additionally, the authors acknowledge the members of the project monitoring committee:

- Charles Comparini, San Antonio District, TxDOT;
- Paul Douglas, Transportation Planning and Programming Division, TxDOT;
- David Gerard, City of Austin, Texas;
- James Bailey, Traffic Operations Division, TxDOT; and
- Karen Akins, Trans-Texas Alliance.

The authors also acknowledge the following persons for their respective contributions:

- Suzee Brooks – for providing input on public safety concerns,
- Herman Huang – for providing numerous pictures of pedestrian crossings, and
- Ivan Lorenz – for developing high-quality images and drawings for the guidelines.

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CHAPTER 1. INTRODUCTION

Purpose of the Guidelines

The purpose of this document is to recommend guidance and criteria on the provision of safe and effective pedestrian crossings. The guidelines should be useful to engineers and planners responsible for planning, designing, operating, and maintaining pedestrian facilities in Texas.

The guidelines are intended to outline the numerous alternatives that are available to address pedestrian safety problems or public concerns at roadway crossings. It is not the intent of the guidelines to recommend a specific pedestrian crossing treatment exclusive of conditions, nor to recommend specific design dimensions. General criteria and design dimensions used elsewhere may be provided with some treatments, but engineering judgement should be used in applying these criteria and designs.

Primary Design References and Other Resources

The guidelines are intended to supplement the following traffic engineering references:

- *TxDOT Highway Design Division's Operations and Procedures Manual*, 1994;
- *Manual on Uniform Traffic Control Devices* (MUTCD), 2000 edition;
- Americans with Disabilities Act Accessibility Guidelines (ADAAG) – available at http://www.access-board.gov/adaag/html/adaag.htm; and
- Texas Accessibility Standards (TAS) - available at http://www.license.state.tx.us/AB/tas/abtas.htm.

The guidelines are largely a compilation of best practices from pedestrian guidebooks and design manuals shown in Figure 1. Interested readers should refer to these guidebooks for additional or supporting information.

Design and Safety of Pedestrian Facilities, Report No. RP-026A, March 1998 (*1*). Available from the Institute of Transportation Engineers (ITE) on-line bookstore, http://www.ite.org, $38 ($30 ITE members).

Planning, Design, and Operation of Pedestrian Facilities, a guidebook currently under development in the National Cooperative Highway Research Program (NCHRP), expected publication in 2001.

Pedestrian Facilities Guidebook: Incorporating Pedestrians into Washington's Transportation System, September 1997 (*2*). Available from the Washington Department of Transportation, http://www.wsdot.wa.gov/hlrd/PDF/PedFacGB.pdf, no cost.

Pedestrian Crossing Control Manual, March 1998 (*3*). Available from the Transportation Association of Canada (TAC) on-line bookstore, http://www.tac-atc.ca, $75 Canadian ($49 Canadian TAC members).

1995 Oregon Bicycle and Pedestrian Plan, June 1995 (*4*). Available from the Oregon Department of Transportation, contact Michael Ronkin (michael.p.ronkin@odot.state.or.us) at (503) 986-3555.

Portland Pedestrian Design Guide, June 1998 (*5*). Available from the City of Portland, Oregon, contact the Pedestrian Transportation Program at (503) 823-7004.

Improving the Safety at Uncontrolled Pedestrian Crossings, an informational report currently under development by the Pedestrian and Bicycle Task Force, Institute of Transportation Engineers, expected publication in 2001.

Figure 1. Useful Pedestrian Crossing Guidebooks and References.

Organization of the Guidelines

The guidelines are organized as follows:

Chapter 2. Definitions, Texas State Law, and Pedestrian-Vehicle Crash Characteristics
This chapter defines terms, summarizes Texas State law as it relates to crosswalks and pedestrian right-of-way, and summarizes the characteristics of pedestrian-vehicle crashes.

Chapter 3. Pedestrian Crossing Treatments
This chapter describes the various treatments that can be used to provide safer and more effective pedestrian crossings. The chapter contains the following sections:

- Pedestrian Crossing Treatment Warrants;
- Pedestrian Crossing Examples;
- Basic Pedestrian Crossing Signs and Markings;
- Innovative Pedestrian Crossing Signs, Markings, and Other Treatments;
- Traffic Calming Measures;
- Proposed Revised Warrants for Traffic Signal Control;
- Grade Separation;
- Special Conditions: School Crossings and Special Events; and
- Education and Enforcement Activities.

Appendix – Texas State Law Pertaining to Pedestrian Crossings
The appendix contains the full text of state laws related to crosswalks.

CHAPTER 2. DEFINITIONS, TEXAS STATE LAW, AND PEDESTRIAN-VEHICLE CRASH CHARACTERISTICS

This chapter defines terms used throughout the guidelines and summarizes Texas State law as it relates to crosswalks and pedestrian right-of-way. The chapter concludes with a summary of the characteristics of pedestrian–motor vehicle crashes to illustrate the context and need for improved roadway designs that better accommodate pedestrian travel.

Definitions

Texas State law (Transportation Code of Texas, Sec. 541.302) defines a crosswalk as:

> “(A) the portion of a roadway, including an intersection, designated as a pedestrian crossing by surface markings, including lines; or
>
> (B) the portion of a roadway at an intersection that is within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or, in the absence of curbs, from the edges of the traversable roadway.”

The law defines a *marked crosswalk* as a pedestrian crossing that is designated by surface markings and an *unmarked crosswalk* as the extension of a sidewalk across intersecting roadways (Figure 2). Thus Texas State law recognizes both marked and unmarked crosswalks but makes no legal distinction between the two in assigning pedestrian right-of-way.

A *mid-block crossing* is a pedestrian crossing that is not located at a roadway intersection (Figure 2). If a mid-block crossing is not designated by a marked crosswalk, then pedestrians must yield the right-of-way to motorists (see following section).

An *uncontrolled location* is a roadway intersection or other mid-block crossing that is not controlled by either a traffic signal or a stop sign. Uncontrolled locations can be the most challenging places to provide a safe pedestrian crossing.

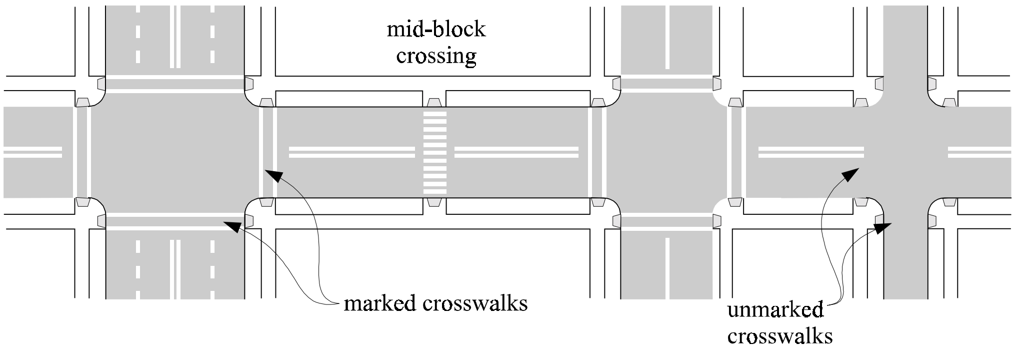


Figure 2. Illustration of Terms Used in Pedestrian Crossing Guidelines.

Texas Law Pertaining to Pedestrian Crossings

Texas State law (Transportation Code of Texas, Sec. 552.003) includes the following regulations regarding pedestrian crossings (see Appendix for full text of the statute):

- Vehicle operators must yield the right-of-way to pedestrians in a crosswalk if no traffic signal control is in place or in operation (Sec. 552.003(a)).
- A pedestrian may not suddenly proceed into the path of a vehicle so close that it is impossible for the vehicle operator to yield (Sec. 552.003(b)).
- A pedestrian must yield the right-of-way to vehicle operators when crossing the roadway at a place a) other than a marked or unmarked crosswalk at an intersection, or b) where a pedestrian tunnel or overhead pedestrian crossing has been provided (Sec. 552.005(a)).
- When traffic control signals are in operation at adjacent intersections, pedestrians may cross only in a marked crosswalk (Sec. 552.005(b)).
- Vehicle operators emerging from or entering an alley, building entrance, or private road or driveway must yield the right-of-way to a pedestrian approaching on a sidewalk extending across said alley, building entrance, or private road or driveway (Sec. 552.006(c)).

Characteristics and Types of Pedestrian–Motor Vehicle Crashes

To provide safer pedestrian crossings, it is important to understand the characteristics of pedestrian–motor vehicle crashes. Pedestrians are clearly over-represented in crash and fatality statistics. On average, pedestrians account for 14 percent of all motor vehicle–related fatalities in the United States *(6)*. More striking, however, is that pedestrian travel accounts for only 5 percent of all person-trips and less than 1 percent of all person-miles traveled *(7)*.

The following summary points are from a 1996 pedestrian/bicycle crash typing study ($5{,}000^{+}$ crashes) performed in the states of California, Florida, Maryland, Minnesota, North Carolina, and Utah *(8)*:

- **Young persons (under 25 years of age) were over-represented in pedestrian crashes.** The most common types of crashes involving young children (under 14 years of age) were a) pedestrian ran into intersection and/or motorist's view was blocked (7.2 percent of all crashes), and b) pedestrian mid-block dart out/dash (13.3 percent of all crashes).

- **Pedestrian crashes occurred most frequently during the late afternoon and early evening hours, a time when exposure was likely highest and visibility may have been a problem.** Contrasting this conclusion, however, was the finding that the majority of pedestrian crashes occurred during daylight conditions (61 percent of all crashes) and when the weather was clear (71 percent of all crashes).

- **A majority of the crashes occurred on two-lane, undivided roadways where the speed limit was 35 mph or less.** Nearly 42 percent of crashes occurred on local streets, with another 24 percent occurring on county routes.

- **Where traffic controls were present, pedestrian injuries were less severe (presumably due to lower vehicle speeds).** However, no traffic control was present in over 71 percent of all the crashes. Roadway medians were present in less than 3 percent of pedestrian crashes, and researchers associated the presence of a median with higher serious injury rates.

- **Forty-one percent of the crashes occurred at roadway intersections and an additional 8 percent at driveway or alley intersections.**

A local analysis of 1994 to 1996 pedestrian crash data from Travis County, Texas (city of Austin and environs), had different findings in regard to pedestrian crash locations. The Trans Texas Alliance found the following *(9)*:

- **More crashes in Travis county occurred while pedestrians were crossing at locations other than an intersection or crosswalk.** Only 23 percent of pedestrian crashes in Travis county occurred when the pedestrian was attempting to cross the street at an intersection or crosswalk, whereas 42 percent of the pedestrian crashes occurred while the pedestrian was crossing at locations other than an intersection or crosswalk.

- **Fatalities were much higher when pedestrian crashes occurred at locations other than an intersection or crosswalk (presumably due to speed of vehicle).** About 67 percent of all fatalities occurred at locations other than an intersection or crosswalk. This finding is consistent with a finding of the crash typing study summarized above.

These two sets of crash study findings lead to the following important points about providing safe pedestrian crossings:

- **Pedestrian crossings require good visibility for motorists to recognize pedestrians and yield the right-of-way.** Considerations for good visibility include adequate street lighting, removal of on-street parking in the vicinity of crossings, and curb extensions that place the waiting or crossing pedestrian in the motorists' field-of-view.

- **Good design calls for controlled vehicle speeds in the vicinity of pedestrian crossings.** Control of vehicle speeds is most often accomplished through good street design, traffic calming measures, or application of appropriate traffic control devices.

- **Pedestrian crossing design should encourage pedestrian use at designated crossing locations.** Driver expectancy is better met when pedestrians cross the roadway at designated locations. These designated crossing locations should be convenient for pedestrians and should not require undue or circuitous travel.

CHAPTER 3. PEDESTRIAN CROSSING TREATMENTS

This chapter describes the various treatments and alternatives that can provide safer and more effective pedestrian crossings. The chapter contains sections on each of the major types of pedestrian crossing treatments, and the sections are organized into a control hierarchy that moves from least restrictive to most restrictive. The chapter includes the following sections:

- Pedestrian Crossing Treatment Warrants;
- Pedestrian Crossing Examples;
- Basic Pedestrian Crossing Signs and Markings;
- Innovative Pedestrian Crossing Signs, Markings, and Other Treatments;
- Traffic Calming Measures;
- Proposed Revised Warrants for Traffic Signal Control;
- Grade Separation;
- Special Conditions: School Crossings and Special Events; and
- Education and Enforcement Activities.

Pedestrian Crossing Treatment Warrants

Quantitative criteria-based warrants are not provided here for the various pedestrian crossing treatments. The literature shows that "the use of strict engineering criteria, [when used to deal with emotional issues or perceived problems of pedestrian safety], often misses these concerns and leads to public frustration and political unrest" *(10)*. Instead, guidelines and qualitative criteria are given here to provide flexibility in addressing unique problems in local areas. Readers interested in using or applying pedestrian crossing treatment warrants should consult those warrants developed by the Transportation Association of Canada (see Figure 1 for contact information) or by the City of Boulder, Colorado.

Pedestrian Crossing Examples

One approach to creating or designing a safe and convenient pedestrian crossing is to first study good and bad examples. This chapter starts with examples that illustrate good and bad design at pedestrian crossings. All of the good examples contain one or more of the following attributes of a safe and convenient pedestrian crossing:

- **The street crossing task is made simple and convenient for pedestrians.** This approach includes elements such as 1) minimizing the crossing distance by using curb extensions, 2) providing median refuge islands so that pedestrians can cross one direction at a time, 3) adjusting signal timing patterns to minimize pedestrian conflicts with right- or left-turning vehicles, and 4) providing appropriate pushbuttons and walk signals at signalized intersections to indicate when pedestrians may cross.

- **The crossing location and any waiting or crossing pedestrian(s) have excellent visibility.** Advance visibility provides additional reaction time for motorists to recognize pedestrians and yield the right-of-way. Considerations for good visibility include adequate street lighting, removal of on-street parking in the vicinity of crossings, and curb extensions that place the waiting or crossing pedestrian in the drivers' field-of-view. Advance signing and innovative crosswalk marking can also be used to improve visibility of crosswalk locations.

- **Motor vehicle speeds are slowed or controlled in the vicinity of the pedestrian crossing.** Slower vehicle speeds provide more reaction time for the motorist and the pedestrian, as well as translating to less serious injuries if a pedestrian-vehicle crash occurs. A later section in this chapter describes how traffic calming measures can be used to slow or better control vehicle speeds.

- **Enforcement personnel use periodic enforcement (where and when necessary) to ensure that vehicle drivers yield the right-of-way to pedestrians.** Despite the fact that most states have laws that give the right-of-way to pedestrians in crosswalks, driver disregard for these laws is quite common. Periodic police enforcement can help pedestrians gain more respect from motorists.

- **Pedestrians are encouraged to use designated crossing locations and to obey applicable state and local traffic laws.** Pedestrian disregard for established laws can lead to resentment by motorists and eventual motorist disregard to pedestrian right-of-way.

Figure 3 provides an example of good pedestrian crossing design. All of the intersection corners have curb extensions that reduce the crossing distance and improve pedestrian visibility. The crosswalks are constructed of brick pavers that improve the visibility of the crossing. A wide, landscaped median island provides refuge for pedestrians crossing the four-lane arterial street.

Figure 3. Use of Curb Extensions, Textured Crosswalks, and Median Refuge Islands.
(Photo courtesy of Herman Huang,
University of North Carolina (UNC) Highway Safety Research Center)

Figure 4 provides another example of good pedestrian crossing design. Overhead pedestrian crossing signs and supplemental lighting provide better visibility to this crossing. A median refuge island permits pedestrians to cross one direction of traffic at a time. Ladder-style crosswalk markings lend additional visibility to the pedestrian crossing.

Figure 4. Use of Overhead Crossing Signs, Ladder-Style Crosswalk Markings, and Median Refuge Island.
(Photo courtesy of Herman Huang, UNC Highway Safety Research Center)

Figure 5 shows the application of in-roadway and sign-mounted flashing lights at a pedestrian crossing. This crossing connects a major city government building to its parking lot but has visibility problems because of the tree canopy over the street. Pedestrians can activate in-roadway flashing lights (not visible in this picture) and flashing beacons using a push button at the curb. These flashing lights and the flourescent yellow-green pedestrian crossing sign improve the visibility of pedestrians using the crosswalk. The median refuge island allows pedestrians to cross one direction of traffic at a time. The in-roadway lights at this location have also helped to increase the number of motorists yielding to pedestrians. Despite the increased yield compliance and the inclusion of in-roadway lights in the 2000 MUTCD, however, there has been some disagreement locally about whether this crossing represents good design.

Figure 5. Use of Pedestrian Activated In-Roadway Lights and Flashing Beacons, Flourescent Yellow-Green Sign, and Median Refuge Island.

Figure 6 provides an example of things to avoid when designing a pedestrian crossing. This crossing is located on a collector street approximately 200 feet prior to a stop-controlled intersection. Additionally, the crossing does not connect major pedestrian traffic generators—it serves only as an encouraged shortcut for pedestrian trips that would otherwise cross at the nearest intersection 200 feet away. Although generous Americans with Disabilities Act (ADA)-compliant ramps have been provided for the crossing, parked vehicles often make the ramps impossible to use. On-street parking in the vicinity of the crossing also reduces the visibility of pedestrians waiting or proceeding to cross the street.

Figure 6. Mid-Block Crosswalk Blocked by On-Street Parking and within 200 Feet of Stop-Controlled Intersection.

Figure 7 provides an example of a pedestrian crossing that engineers could improve with the addition of several basic design elements. This pedestrian crossing, located along a collector street, connects relatively new suburban development to a shared-use path, a middle school, and a neighborhood park. Although traffic volumes are relatively low at this time, the wide, straight, and flat nature of this street encourages high vehicle speeds (the street is currently posted at 35 mph). A median refuge island could be placed in the center two-way left turn lane to provide pedestrian refuge, and roadway narrowing in the vicinity of the median refuge island would help to control vehicle speeds. If vehicle speeds at this crossing are high and the pedestrian volumes are significant, a raised crosswalk could also be used to control vehicle speeds. If traffic volumes increase and young or elderly pedestrians have trouble finding adequate gaps, in-roadway flashing lights could be installed to encourage motorists to yield to pedestrians.

Figure 7. Mid-Block Marked Crosswalk on Straight, Wide Street with Inadequate Median Refuge.

Figure 8 provides another example of a pedestrian crossing that could be improved with the addition of several crossing treatments. The existing crossing location connects neighborhoods (left side of picture) to a neighborhood swimming pool and park (right side of picture). The crossing is on a four-lane arterial street with a center, two-way left turn lane. The visibility of the crossing could be substantially improved with high-visibility crosswalk markings and overhead signs. Pedestrian-activated (or passive detection) flashers could be used in addition to the overhead signing. A median refuge island could be placed in the center two-way left turn lane to provide pedestrian refuge.

Figure 8. Mid-Block Marked Crosswalk with Poor Visibility on Arterial Street.

Basic Pedestrian Crossing Signs and Markings

The 2000 MUTCD contains basic information on pedestrian crossing warning signs and crosswalk markings. Information is also provided on the application of pedestrian signal heads but is not included here. Figure 9 shows a basic pedestrian crossing, which typically consists of crosswalk markings and side or overhead-mounted pedestrian warning signs (in this figure, the side-mounted sign is partially obstructed by a disabled parking sign). Flashing beacons are sometimes provided with the pedestrian crosswalk signs. The following sections provide specific information on the location and designs of these signs and crosswalk markings.

Figure 9. Basic Pedestrian Crossing with Crosswalk Sign and Markings.

Crosswalk Markings

Texas law recognizes both marked and unmarked crosswalks but makes no legal distinction between the two in defining pedestrian right-of-way (see Figure 2 and discussion in Chapter 2). Crosswalks are marked to 1) indicate the preferred crossing path to pedestrians, and 2) alert motorists to the presence of pedestrian crossing locations. Figure 10 illustrates various types of crosswalk markings used in the U.S. and in Europe, and Figure 11 shows the crosswalk marking patterns in the 2000 MUTCD. The standard crosswalk marking consists of two parallel white lines, spaced between six and ten feet apart. Variations include the use of diagonal lines, longitudinal lines, and other marking patterns to increase visibility. The MUTCD (*11*) states that crosswalks:

SHALL

- have 6-inch minimum width markings consisting of solid white lines across the roadway.

SHOULD

- have 6-foot minimum crosswalk width,
- be used where substantial pedestrian and vehicle conflicts exist,
- be used at appropriate points of pedestrian concentration or where pedestrians could not otherwise recognize the proper place to cross (e.g., loading islands, mid-block pedestrian crossings),
- not be used indiscriminately,
- be installed based on an engineering study if located other than at a STOP sign or traffic signal, and
- have advance warning signs if installed mid-block where pedestrians are not expected, and allow for restriction of parking for adequate visibility.

MAY

- be marked with white diagonal or longitudinal lines (parallel to vehicle traffic) for added visibility,
- omit the transverse crosswalk lines when the extra markings are added, and
- use unique markings for diagonal crossings at signals when an appropriate exclusive pedestrian phase is used.

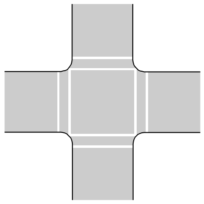
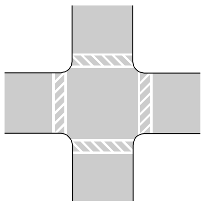
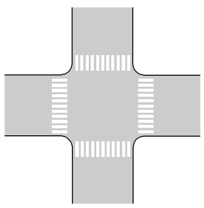
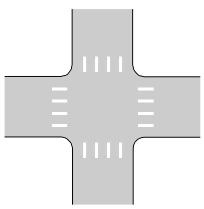
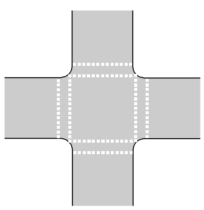
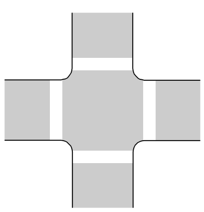
	Marking Pattern	*Advantages*	*Disadvantages*
	Horizontal Bars	Common practice at stop-controlled intersections, less expensive, easy to install and maintain	Not as visible as some other marking types; bars tend to wear faster than other types; not appropriate for mid-block locations
	Zebra	Highly visible	More maintenance required since wheel friction rubs off diagonal stripes; surface can be slippery
	Ladder Bar	Highly visible	Wider stripes rub off with wheel friction but can be placed to minimize this effect; surface can be slippery
	Piano	Highly visible and becoming more commonly used; easy to maintain since stripes can be placed outside the wheel friction areas	
	Dashed (European)	Captures attention because it is not a commonly used pattern	May not define space as well as some of the other choices
	Solid	Visible (but may not be as eye catching as other patterns); not commonly used	Expensive; more difficult to install and maintain; surface can be slippery

Figure 10. Advantages and Disadvantages of Various Crosswalk Marking Patterns (2).

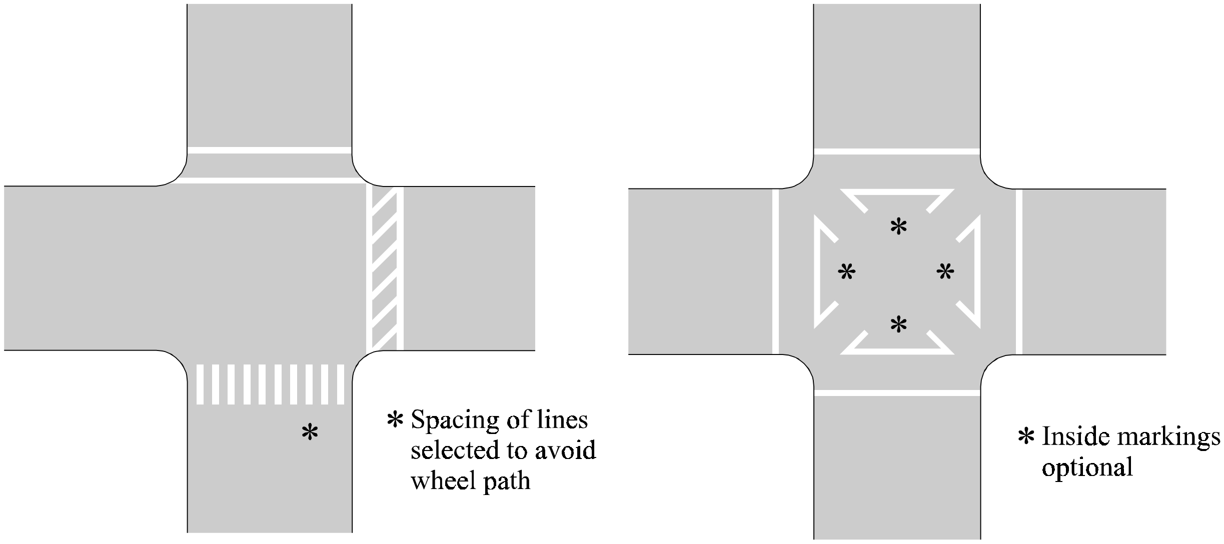


Figure 11. Crosswalk Marking Patterns in 2000 MUTCD (*11*).

There is considerable and ongoing debate about the safety and effectiveness of marked versus unmarked crosswalks at uncontrolled locations (i.e., no traffic signal or stop sign). Some engineers advocate the conservative use of crosswalk markings at uncontrolled locations because they believe that:

- there are no safety benefits from marking crosswalks, and in some cases, higher pedestrian crash risk can result at marked crosswalks (*12,13*);
- marked crosswalks provide pedestrians with a false sense of security, thus pedestrians may not use due caution when crossing in a marked crosswalk; and
- marked crosswalks are much less visible to motorists than to pedestrians, and even if they are visible, motorists typically disregard them.

Advocates for marked crosswalks assert that:

- marked crosswalks send an important message that the crosswalk area is a defined pedestrian crossing space that should not be intruded;
- because pedestrians have the legal right-of-way in marked or unmarked crosswalks, they should expect some degree of protection from motor vehicles and should be able to display a sense of security that motorists will obey the law; and

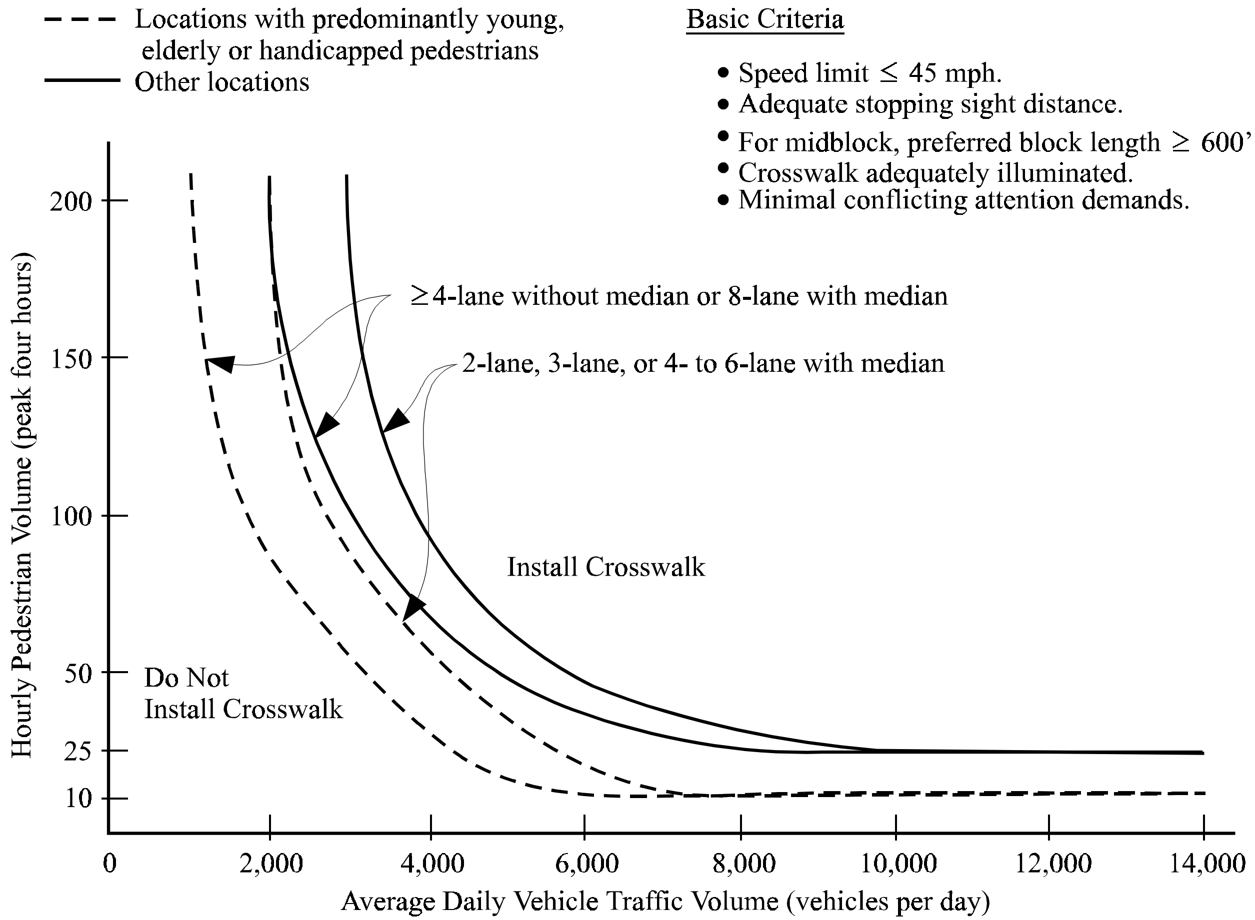
- poor safety records at marked crosswalks are indicative of motorist disregard for traffic laws and should be treated as such with higher levels of police enforcement.

The debate about marked versus unmarked crosswalks will likely continue for quite some time. The recommended philosophy at this time appears in the MUTCD, which says that "crosswalk markings should not be used indiscriminately." For marked crosswalks to be effective, they should be located and designed using sound engineering judgment and practice. The recommended engineering practice at this time relies on two sets of guidelines:

- Smith and Knoblauch guidelines (*14*), 1987 (Figure 12) and
- Zegeer, Stewart, and Huang guidelines (*15*), 2000 (Table 1).

In addition to these two sets of guidelines, the ITE Recommended Practice (*1*) is as follows:

> "Marked crosswalks are generally recommended under the following conditions:
>
> - signalized intersections with pedestrian signal indications or substantial pedestrian crossings;
>
> - where a marked crosswalk can concentrate or channelize multiple pedestrian crossings to a single location;
>
> - where there is a need to delineate the optimal crossing location when it is unclear because of confusing geometrics or traffic operations;
>
> - at approved school crossings or for crossings on recommended safe school routes;
>
> - at other locations with significant pedestrian crossings and pedestrian and vehicle conflicts."



1. If using only peak hour, pedestrian volume threshold must be increased by 1.5.
2. For streets with a median, use one-way (directional) average daily traffic volume.

Other notes: Minimum striping is 6" parallel lines. Consider bolder markings and/or supplementary advanced markings or signing at uncontrolled locations where speed limits exceed 35 mph.

Figure 12. Smith and Knoblauch Crosswalk Marking Guidelines (*14*).

Table 1. Draft Recommendations for Installing Marked Crosswalks and Other Needed Pedestrian Improvements at Uncontrolled Locations* (*15*).

Roadway Type	Vehicle ADT: ≤ 9,000			Vehicle ADT: 9,000 to 12,000			Vehicle ADT: 12,000 to 15,000			Vehicle ADT: > 15,000		
	Speed Limit**											
	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph
2-lane	C	C	P	C	C	P	C	C	N	C	P	N
3-lane	C	C	P	C	P	P	P	P	N	P	N	N
Multi-lane (4 or more lanes) with raised median	C	C	P	C	P	N	P	P	N	N	N	N
Multi-lane (4 or more lanes) without raised median	C	P	N	P	P	N	N	N	N	N	N	N

* These guidelines include intersection and mid-block locations with no traffic signals or stop sign on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations which could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, substantial volumes of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone will **not** make crossings safer, nor necessarily result in more vehicles stopping for pedestrians. Whether marked crosswalks are installed, it is important to consider other pedestrian facility enhancements, as needed, to improve the safety of the crossing (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic calming measures, curb extensions). **These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.**

C = **Candidate sites for marked crosswalks**. Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to show whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volumes, vehicle speeds, sight distance, vehicle mix, etc. may be needed at other sites. It is recommended that a minimum of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) exist at a location before placing a high priority on the installation of a marked crosswalk.

P = **Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements.** These locations should be closely monitored and enhanced with other pedestrian crossing improvements, if necessary, before adding a marked crosswalk.

N = **Marked crosswalks are not recommended, since pedestrian crash risk may be increased with marked crosswalks. Consider using other treatments, such as traffic signals with pedestrian signals to improve crossing safety for pedestrians.**

† The raised median or crossing island must be at least 4 ft. wide and 6 ft. long to adequately serve as a refuge area for pedestrians in accordance with MUTCD and American Association of State Highway and Transportation Officials (AASHTO) guidelines.

Pedestrian Crossing Signs

Previous editions of the MUTCD recommended that an advance warning sign (W11-2) be used in conjunction with a pedestrian crossing sign (W11-2a, showing the pedestrian figure in a crosswalk), which was to be placed immediately adjacent to the crossing. Because motorist comprehension of and distinction between these two pedestrian crossing signs was poor, the 2000 MUTCD recognizes a single pedestrian crossing sign (W11-2), shown here as Figure 13. When used in advance of the pedestrian crossing, the sign is intended to warn motorists of an upcoming pedestrian crossing. When the sign in Figure 13 is used at a pedestrian crossing, a diagonal downward pointing arrow plaque (W16-7) (Figure 14) is required only when the crossing location is not delineated by crosswalk pavement markings.

Figure 13. Pedestrian Ahead/ Crossing Sign (W11-2) (*11*).

Figure 14. Pedestrian Crossing Sign (W11-2) with Supplemental Plaque (W16-7) (*11*).

The 2000 MUTCD permits the use of flourescent yellow-green pedestrian and school crossing signs. However, engineers should use a single color scheme (either standard yellow or flourescent yellow-green) within a particular crossing area or zone.

Engineers in some areas have chosen to mount pedestrian crossing signs on an overhead mast arm to increase the visibility of the pedestrian crossing sign (Figure 15). Flashing beacons are sometimes used to increase the visibility of pedestrian crossing signs, although many engineers question their effectiveness. It has been suggested that flashing beacons will be most effective if they flash ONLY when pedestrians are present in the crosswalk or sidewalk area, although no definitive research could be found. Pedestrian-activated flashing beacons can be used, but the most effective operation can be accomplished by installing microwave, infrared, or other automatic pedestrian detectors (Figures 16 and 17) that prompt flashing operation only when pedestrians are present. More information on these pedestrian detection devices can be found at the FHWA-sponsored PedSmart web site (http://www.walkinginfo.org/pedsmart/).

Figure 15. Use of Overhead Mast Arm and Flashing Beacons for Pedestrian Crossing Sign.

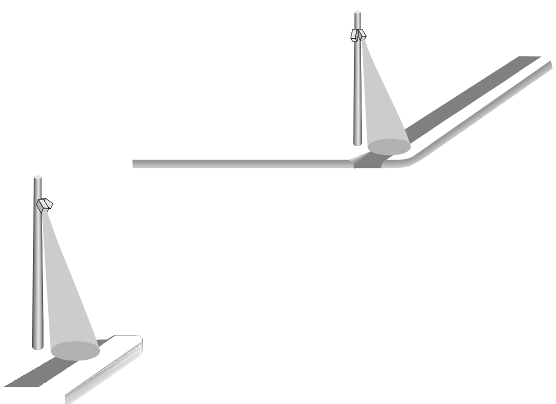


Figure 16. Passive Detection of Pedestrians at Intersection Corners.

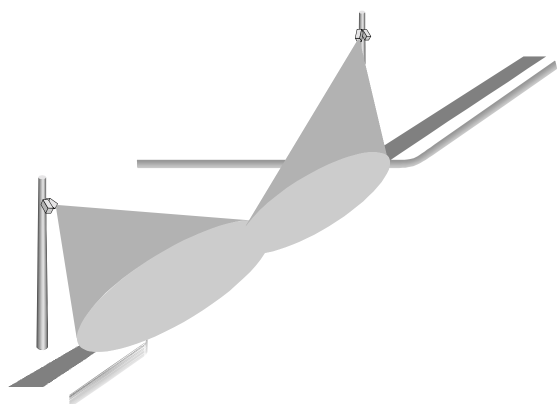


Figure 17. Passive Detection of Crossing Pedestrians in Crosswalk.

Innovative Pedestrian Crossing Signs, Markings, and Other Treatments

This section contains information on innovative signs, markings, and other engineering treatments that can be used at pedestrian crossings. Most of these innovative treatments are intended to improve the visibility of the crosswalk or warn motorists when pedestrians are present at the crossing area. Two of the treatments are intended to improve pedestrian awareness at the crossing location.

The 2000 MUTCD does not contain some of the traffic control devices in this section. Some of the devices, though, have been introduced in the 2000 MUTCD or are contained in other states' or countries' traffic control device manuals. Before using any traffic control device that is not included in the national MUTCD, the interested state or locality should submit a request for permission to experiment to FHWA's Office of Highway Safety (HHS-10), 400 Seventh Street SW, Washington, D.C. 20590. Guidelines for conducting an experiment can be found at the FHWA's Office of Highway Safety web site (http://www.ohs.fhwa.dot.gov/devices/1a_6.html).

In-Roadway Flashing Lights

California first introduced in-roadway flashing lights at pedestrian crosswalks in 1993, and these lights have since been implemented at numerous other locations in California, Washington State, Florida, Maryland, New York, and Texas. Although different vendors offer slightly different products, the basic component of most systems is roadway surface-mounted, amber lights that can flash either upon pedestrian activation or upon automatic pedestrian detection (Figures 18 and 19). The unit costs for systems bid in Kirkland, Washington, in early 1999 were between $15,000 and $18,000 (*16*).

As indicated by the growing pace of their implementation, these systems have been considered effective in terms of increased percentages of motorists yielding to pedestrians at crosswalks. California's Traffic Control Device Committee has recently endorsed in-roadway lighting for crosswalks. In-roadway lights have been added to Section 4L of the 2000 MUTCD. This new section includes both standards and guidance for the design and operation of in-roadway lights (if used). The standards include the following:

- in-roadway lights are installed parallel to the edge of the crosswalk;
- flashing operation is to be based upon pedestrian actuation (either active or passive);
- flashing operation will cease at a predetermined time after actuation, or with passive detection, once the pedestrian clears the crosswalk;
- installation of marked crosswalks requires applicable warning signs; and
- height of in-roadway lights is not to exceed 0.75 inch.

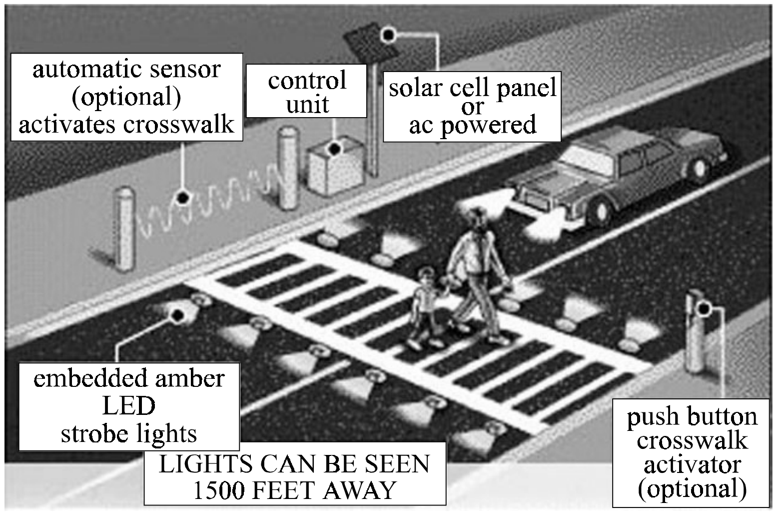


Figure 18. Schematic of In-Roadway Flashing Lights at a Pedestrian Crosswalk.
(Figure courtesy of Lightguard Systems, Inc.)

Figure 19. In-Roadway Flashing Lights at Pedestrian Crosswalk.
(Photo courtesy of Lightguard Systems, Inc.)

Supplemental Pedestrian Crossing Channelizing Devices (SPCCD)

The SPCCD is essentially a plastic safety cone that supports pedestrian crosswalk warning signs in the middle of the roadway for improved visibility to motorists (Figure 20). The device is now included in the New York State MUTCD, which specifies that the crosswalk sign can be used on the SPCCD or on a separate roadside sign (*17*). The SPCCD has been crash-tested by the New Jersey State Police and has been evaluated by the University of North Carolina's Highway Safety Research Center. In their evaluation (*18*), Huang and Cynecki found increased percentages of motorists yielding to pedestrians after installation of the SPCCD (69.8 percent yielding before vs. 81.2 percent yielding after).

Figure 20. Supplemental Pedestrian Crossing Channelizing Device used in New York State.
(Photo courtesy of Herman Huang, UNC Highway Safety Research Center)

New Signs and Markings Introduced in or Proposed for the 2000 MUTCD

The 2000 MUTCD introduces or had proposed several new traffic control devices that have applicability to pedestrian crossings:

- "YIELD HERE" signs,
- YIELD lines, and
- advanced warning marking for speed humps.

A review draft of the 2000 MUTCD had proposed "YIELD HERE" signs (Figures 21 and 22) for placement at pedestrian crossing locations. These signs were not included in the final published version of the 2000 MUTCD. It is not known at this time whether any locations have experimented with these signs.

Figure 21. First Version of YIELD HERE Sign (*11*).

Figure 22. Second Version of YIELD HERE Sign (*11*).

The FHWA added YIELD lines to the 2000 MUTCD (as an option) to indicate the point behind which vehicles are required to yield. YIELD lines consist of a row of isosceles triangles extending across approach lanes, with one point of the triangles pointing toward approaching vehicles (Figure 23). It is not known at this time whether any locations in the United States have experimented with these signs, although their use is prevalent in Sweden (Figure 24).

The FHWA also added advanced warning markings for speed humps to the 2000 MUTCD (Figure 25). These pavement markings also could be applied where speed humps are used with crosswalks (see Figure 26 for pavement markings for speed humps with crosswalks). Although the advance warning markings have not been proposed specifically for marked crosswalks, these markings could potentially be used as a supplemental device to warn motorists of an upcoming pedestrian crosswalk. The use of pavement markings to warn motorists in advance of a pedestrian crossing has also been used in European countries (see next section).

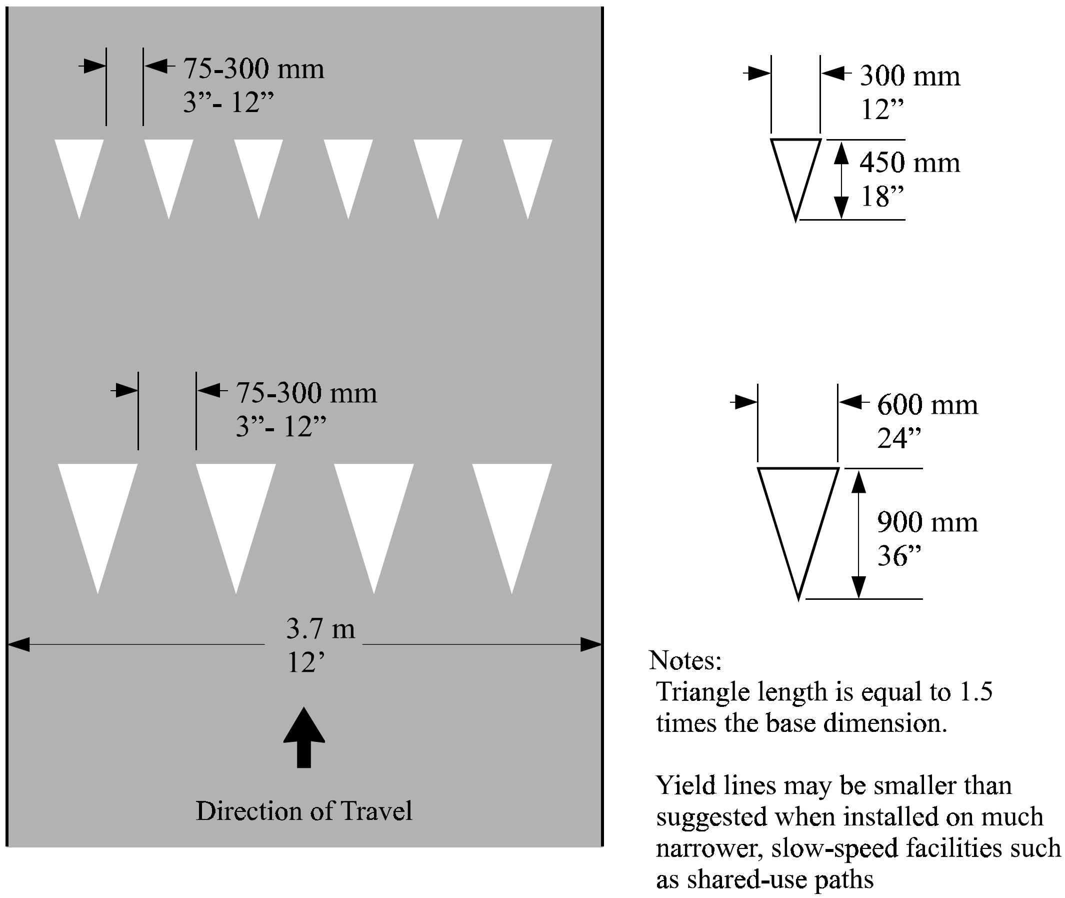


Figure 23. Optional YIELD Lines in 2000 MUTCD (*11*).

Figure 24. Use of YIELD Lines in Sweden (*19*).

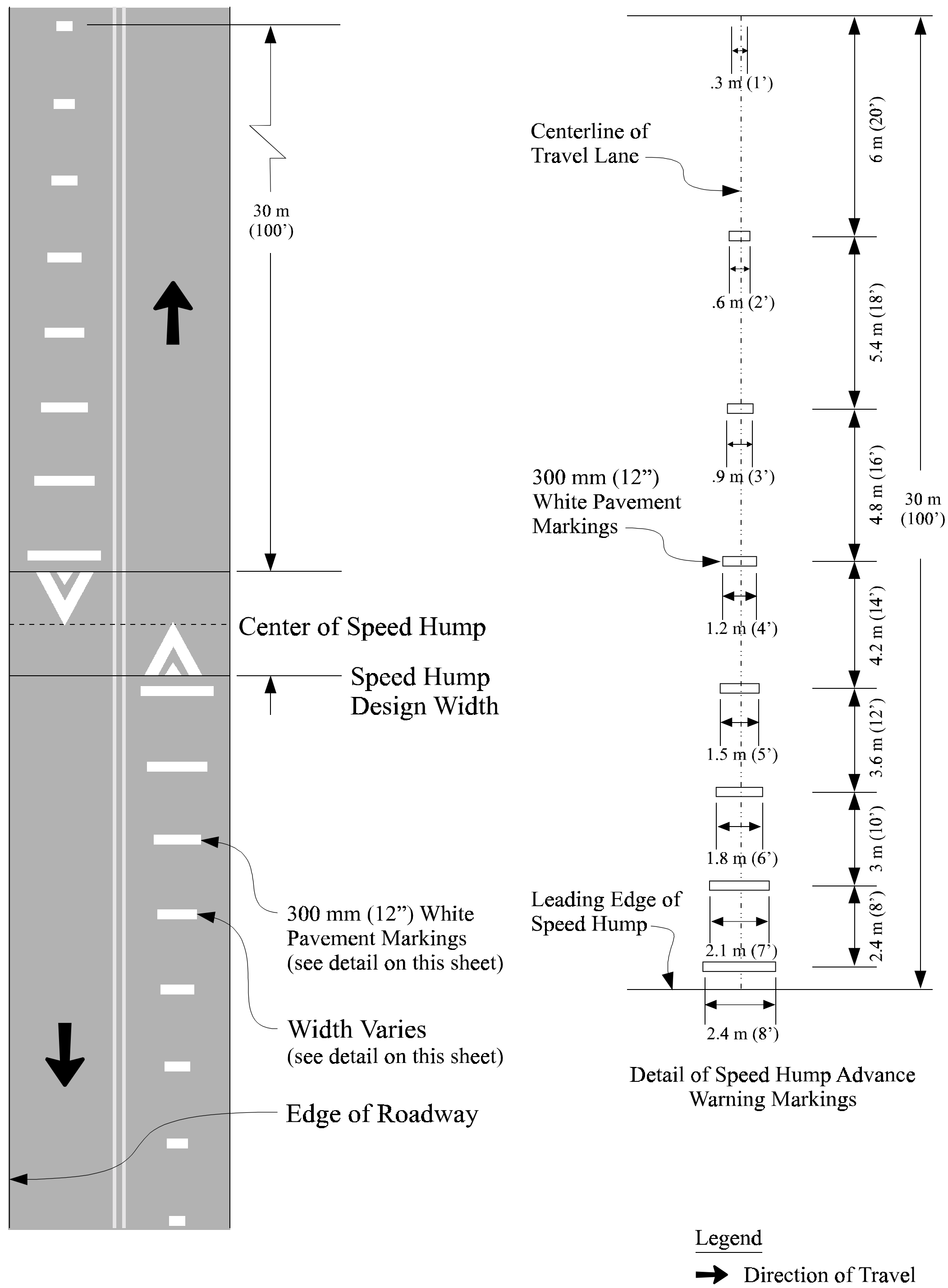


Figure 25. Optional Advanced Warning Markings for Speed Humps in 2000 MUTCD (*11*).

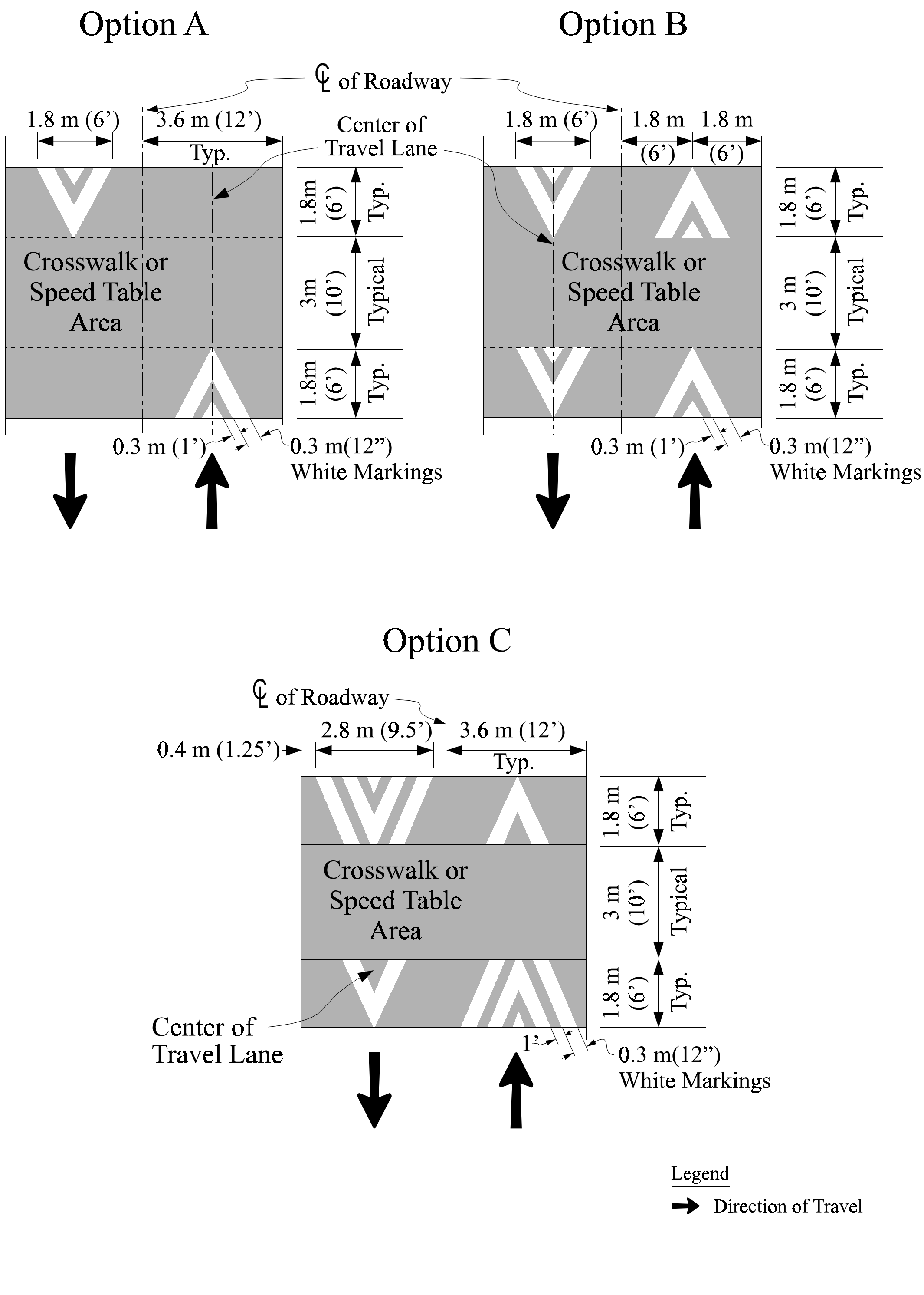


Figure 26. Optional Pavement Markings for Speed Humps with Crosswalks in 2000 MUTCD (*11*).

Devices to Increase Awareness of Pedestrians

There are two devices that have been used to increase pedestrian awareness at roadway crossings: animated eyes display and text pavement markings in crosswalks. The animated eyes display is an LED signal head that displays "searching" eyes in conjunction with the WALK/DON'T WALK symbols (Figure 27). The animated eyes are designed to "look" in the direction of oncoming traffic, thereby eliciting a response from pedestrians to check for oncoming traffic. The animated eyes display can also be used to elicit motorists to look for pedestrians, such as at blind corners or crosswalks. An animated eyes display has been installed and tested in St. Petersburg, Florida, where the device was found to be effective at reducing pedestrian-vehicle conflicts at intersections (*20*). The authors concluded that the animated eyes display is most appropriate in locations where it is important for motorists and pedestrians to look for potential threats.

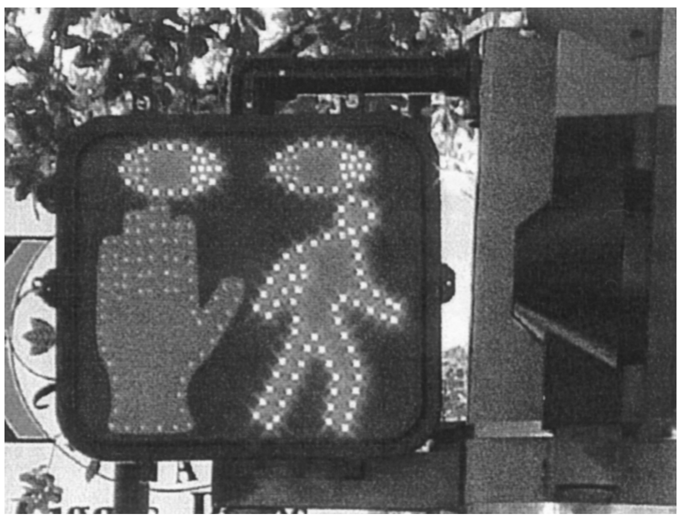


Figure 27. Animated Eyes Display with Pedestrian Signal Head (*20*).

Text pavement markings that include the text "LOOK LEFT" or "LOOK RIGHT" have been used in Europe to prompt pedestrians to check for oncoming vehicle traffic (Figure 28). Engineers in London use these text pavement markings because many tourists look in the incorrect direction when attempting to cross the street (*21*).

Figure 28. "LOOK RIGHT" Pavement Markings Used to Increase Awareness of Crossing Pedestrians – United Kingdom.
(Photo courtesy of Gene Hawkins, Texas Transportation Institute)

European Practices at Pedestrian Crossings

The United Kingdom (UK) has designated the following types of mid-block pedestrian crossings, all of which require motorists to yield to pedestrians (*21, 22*):

- **zebra crossing –** no signal control, only black and white pavement markings ("ladder bar" pattern);

- **pelican crossing –** pedestrian-activated push-button signal, pedestrian signal head indications, dashed pavement markings parallel to crosswalk;

- **puffin crossing –** pedestrian signal activated by push-button, infrared detector, or pressure-sensitive mat; "intelligent" pedestrian signal head indications that can shorten or extend pedestrian crossing time; dashed pavement markings parallel to crosswalk; and

- **toucan crossing –** a pedestrian crossing that is shared with bicyclists, as in "two can" use the crossing.

All of the pedestrian crossings include a zig-zag line located along the upstream edge of the pavement that is used to warn motorists of the crossing (Figure 29). The zebra crossing has been used since the 1950s for mid-block pedestrian crossings. Most engineers and traffic officials consider these crossings inappropriate on high-speed or high-volume roadways, as technical guidance recommends they not be installed on roads where the 85th percentile speed is above 35 mph. Flashing yellow lamps (belisha beacons, see Figures 29 and 30) are used to warn motorists of pedestrians in the crosswalk.

Figure 29. Use of Zig-Zag Lines and Belisha Beacons to Warn of Upcoming Pedestrian Crossing – United Kingdom (*19*).

Figure 30. Use of Belisha Beacons at Zebra Pedestrian Crossings – United Kingdom.
(Photo courtesy of Herman Huang, UNC Highway Safety Research Center)

In the past 10 years, many of the zebra crossings have been replaced by signal-controlled pelican crossings. Because of the fixed time signal cycle associated with pelican crossings, it is possible for motorists to experience unnecessary delay when no pedestrians are present. The UK added advanced pedestrian detection capabilities to create the puffin (Pedestrian User-Friendly INntersection crossing), which is capable of extending or shortening the pedestrian crossing time based upon the presence or absence of pedestrians in or near the crosswalk.

Traffic Calming Measures

Traffic calming is "the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users" (*23*). Traffic calming measures are used most commonly on local residential and collector streets to better control and manage vehicle speeds. Traffic calming can also be implemented on arterial streets; however, arterial streets will require a balance between improving safety (through traffic calming) and providing mobility.

The focus of this section is on traffic calming measures that can be applied at or near pedestrian crossings to reduce vehicle speeds. It should be noted that although spot traffic calming treatments have been somewhat successful, the most successful traffic calming has been areawide treatments. In these situations, neighborhood traffic calming plans are developed to proactively identify problems and traffic calming solutions.

The traffic calming measures most relevant at pedestrian crossings are:

- curb extensions (neckdowns and chokers),
- center island narrowing and median refuge islands,
- roadway narrowing, and
- raised crosswalks and intersections.

There are numerous other traffic calming measures that can be used in the vicinity of pedestrian crossings to control speeds, such as chicanes, traffic circles, speed humps, etc. Readers can find more information on these and other traffic calming measures in the following references:

- *Traffic Calming: State of the Practice*, ITE/FHWA, August 1999 (also available at ITE's Traffic Calming web site, http://www.ite.org/traffic/).

- *Handbook of Speed Management Techniques*, Report 1770-2, Texas Transportation Institute (TTI), September 1998 (*24*).

- *State of the Art: Residential Traffic Management*, Report FHWA/RD-80/092, Federal Highway Administration, December 1980 (*25*).

The following descriptions of traffic calming measures come primarily from the first two references, TTI Report 1770-2 and the ITE/FHWA State of the Practice report.

Curb Extensions

Curb extensions (also referred to as neckdowns [Figures 31 and 33] at intersections and chokers [Figures 32 and 34] at mid-block) narrow a street by extending the sidewalk or widening the planting/grass strip. Curb extensions have been shown to improve pedestrian safety by shortening the street crossing distance for pedestrians, thereby reducing their exposure to vehicle traffic. Pedestrians waiting to cross at curb extensions also have better visibility to motorists since they are closer to the edge of the travel lane (and not standing behind parked cars).

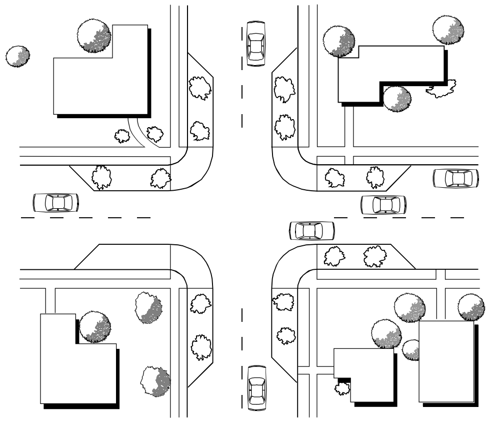


Figure 31. Plan View of Curb Extensions at Intersection (Neckdown) (*23*).

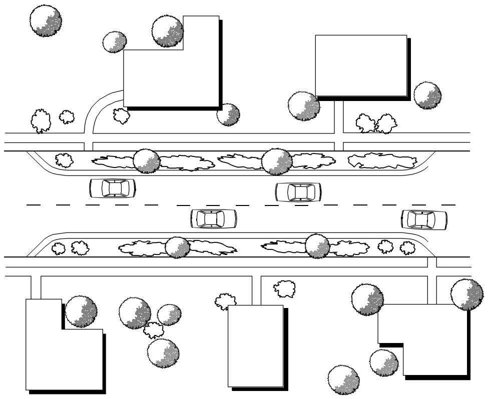


Figure 32. Plan View of Curb Extensions at Mid-Block (Choker) (*23*).

Figure 33. Curb Extension at an Intersection (Neckdown) – Bryan, Texas.

Figure 34. Curb Extension at a Mid-Block Crossing (Choker) with Textured Crosswalk and Landscaping – Westminster, Maryland (*24*).

Curb extensions are best applied:

- on local and collector streets or on main roads through small communities; and
- in conjunction with features such as textured or other high-visibility crosswalks, raised intersections, median refuge islands, or on-street parking.

Curb extensions are advantageous because they:

- reduce pedestrian crossing exposure,
- provide better visibility to crossing and waiting pedestrians,
- typically reduce vehicle speeds,
- do not slow emergency vehicles,
- provide opportunity for additional landscaping or "streetscaping," and
- can be used for transit stop and shelter.

Disadvantages of or other considerations for curb extensions are that they:

- may require parking removal,
- may require bicyclists to share a narrowed space with motor vehicles,

- may require additional drainage provisions, and
- may impede legitimate truck movements.

Median Refuge Islands and Center Island Narrowing

Median or pedestrian refuge islands are typically raised islands located along the centerline of a street (Figure 35). With center island narrowing, the travel lanes are narrowed at the median island location (Figure 36). Median islands should provide a pedestrian refuge area (6 to 8 feet or more) that permits pedestrians to cross streets one direction of traffic at a time if so desired. Median islands are often landscaped for visual enhancement yet still provide adequate visibility for motorists and pedestrians.

Figure 35. Use of Median Refuge Island on Eight-Lane Arterial Street – College Station, Texas.

Figure 36. Center Island Narrowing with Speed Cushions – Austin, Texas.

Median islands are best applied:

- on wide (four or more lanes) streets with moderate to high traffic volumes,
- at locations with a large proportion of pedestrians with slower-than-average crossing times, and
- at signalized intersections where it may be difficult to cross more than one direction of traffic during one pedestrian phase.

Advantages of median islands are that they:

- provide pedestrian refuge in median,
- permit pedestrians to cross one direction of traffic at a time,
- may reduce vehicle speeds because of narrower travel lanes,
- make pedestrian crossings more visible to motorists, and
- provide a location for landscaping and visual enhancement.

Disadvantages of or other considerations for median islands are that they:

- may reduce parking and driveway access,
- may create potential crash obstacle for motorists,
- are more expensive than at-grade islands, and
- may create problems for street sweeping or snow plowing.

Roadway Narrowing

Roadway (or lane) narrowing can be created by geometric features (curb modifications) or traffic control materials (pavement marking or buttons, see Figure 37) that effectively reduce the width of travel lanes. Roadway narrowing is typically done continuously along a roadway, thus it is differentiated from the location-specific narrowing used with curb extensions and median refuge islands. Narrow travel lanes (no less than 10 feet in width) have been shown to reduce vehicle speeds. The safety impacts of roadway narrowing have been mixed, as past research shows both increases and decreases in collision rates after roadway narrowing.

Figure 37. Roadway Narrowing Using Raised Pavement Markings – Arlington, Texas (*24*).

Roadway narrowing is best applied:

- on two- or four-lane roadways with wide cross-sections.

Advantages of roadway narrowing are that it:

- provides continuous, visual channelization;
- can be inexpensive to install and/or quickly implemented (depending upon technique);
- does not negatively affect emergency response times; and
- may provide space for on-street parking and/or landscaping.

Disadvantages of and other considerations for roadway narrowing are that it:

- may require regular maintenance of narrowing devices,
- may be unfriendly to bicyclists unless other bicycle provisions are made, and
- increases the cost of roadway resurfacing.

Raised Intersections and Crosswalks

Raised intersections (also referred to as intersection humps or plateaus) are flat, raised areas covering entire intersections (Figure 38). Similarly, raised crosswalks are flat, raised areas covering the surface area of a crosswalk (Figures 39 and 40). Raised intersections and crosswalks have ramps on all street approaches and are often paved with brick or other textured material. Raised intersections have been shown to reduce vehicle speeds in the vicinity of these intersections, as well as making the entire intersection area more pedestrian-friendly.

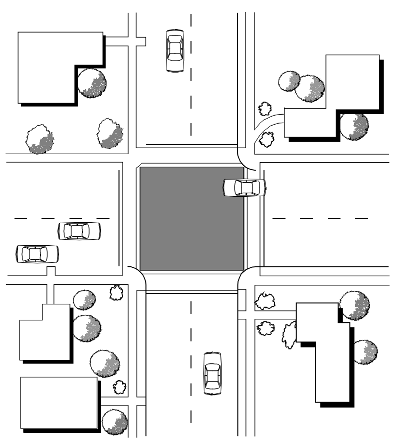


Figure 38. Plan View of Raised Intersection (*23*).

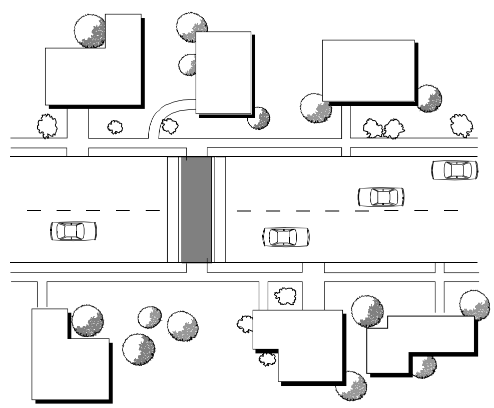


Figure 39. Plan View of Raised Crosswalk (*23*).

Figure 40. Raised Crosswalk Used Near High School Building – Ft. Worth, Texas.

Raised intersections and crosswalks are best applied:

- as part of an areawide traffic calming scheme involving both intersecting streets,
- in commercial business districts or densely developed urban areas, and
- in conjunction with curb extensions and textured crosswalks.

Advantages of raised intersections and crosswalks are that they:

- reduce vehicle speeds on intersection approaches/crosswalk,
- provide more pedestrian visibility at the intersection/crosswalk, and
- can be used on high or low volume streets.

Disadvantages of and other considerations for raised intersections and crosswalks are that they:

- slow emergency response vehicles to about 15 miles per hour,
- may require storm drainage modifications, and
- may require bollards or other edge delineation at the roadway/sidewalk interface.

Proposed Revised Warrants for Traffic Signal Control

As part of the research project that developed these pedestrian crossing guidelines, the TTI research team also developed proposed revised warrants for traffic signal control. The proposed revisions consist of the following major considerations:

- including pedestrians and bicyclists in all warrants that currently consider only vehicle traffic volumes on minor-street approaches;
- including a reduction factor based upon the presence of certain types of pedestrian trip generators; and
- changing the existing pedestrian warrant to a mid-block pedestrian crossing warrant, removing language about pedestrian crossing speeds, and adding a reduction factor for high-speed roadways or built-up areas.

A full discussion of these proposed warrants, as well as how the research team developed them, is provided in TTI Report 2136-1. Interested readers are encouraged to review this report.

Grade Separation

Grade separation of pedestrian and motor vehicle traffic is typically considered at crossings where the number of pedestrian–motor vehicle conflicts is high and/or the risk to crossing pedestrians is great. The following discussion of grade-separated pedestrian crossings was largely excerpted from the ITE Recommended Practice (*1*).

Several types of grade-separated crossings can be used (*1*):

- **pedestrian overpass/bridge –** a passageway for pedestrians (and sometimes other non-motorized users) above the grade of the roadway. An ADA-compliant ramp and stairs are used to provide the elevation necessary to cross the roadway, although in some cases the roadway is depressed and the pedestrian overpass remains at grade.
- **skywalk/skyway –** an elevated walkway (sometimes enclosed) that connects buildings at mid-block locations. A skywalk/skyway permits traveling between buildings without being exposed to inclement weather and is often used in central business districts or large corporate campuses in harsh climates (e.g., Minneapolis in winter or Houston in summer).
- **pedestrian tunnel/underpass –** a passageway for pedestrians below the grade of the roadway. As with an overpass/bridge, ADA-compliant ramps and/or stairs are used to effect the elevation change.

- **underground pedestrian network –** a network of pedestrian passageways below the grade of the roadway. A network of tunnels, like that of skywalks/skyways, is often used to connect several large buildings in a central business district or large corporate campus.

Past research has shown the effectiveness of grade-separated pedestrian crossings depends upon the perceived effort and time to use it. For example, Figure 41 defines a convenience measure, R, and compares it to the percentage of pedestrians likely to use a grade-separated crossing. The figure shows that 95 percent of pedestrians will likely use an underpass and 70 percent will likely use an overpass if the travel times at-grade and grade-separated are equal (i.e., R=1). Similarly, less than 5 percent would use either an overpass or an underpass if it takes 50 percent longer (R=1.5).

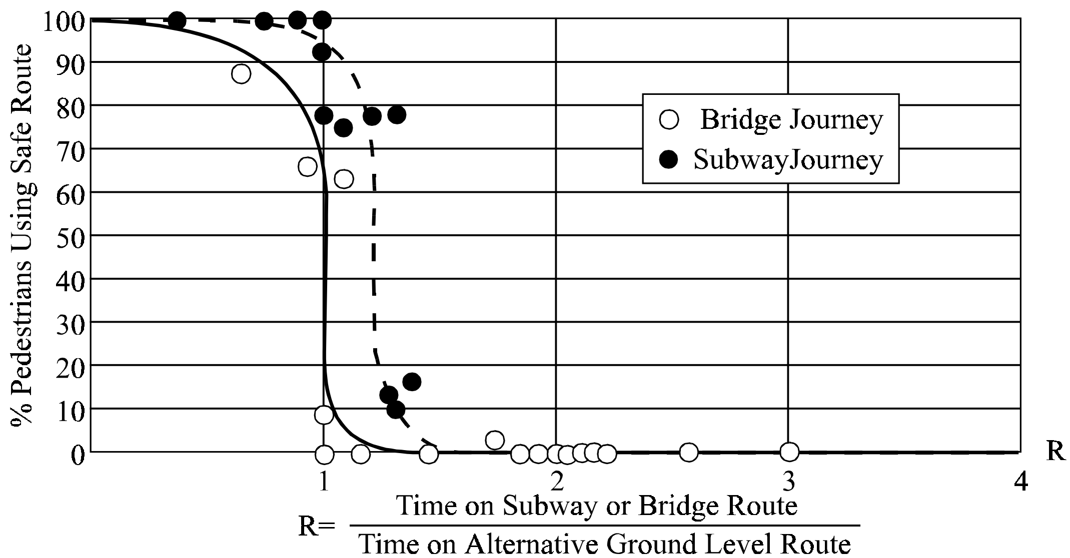


Figure 41. Pedestrian Use of Grade-Separated Crossings (*1*).

Other studies have shown that pedestrians use grade-separated crossings more often if the elevation change can be minimized or worked into the normal path of pedestrian movement. For example, circuitous ramps are often used for ADA compliance but provide a time-consuming approach for some pedestrians. Although more right-of-way may be required, the site topography at the approaches to the crossing may be able to be modified to better accomplish the elevation change without circuitous ramps.

Figure 42 shows an example of a grade-separated pedestrian crossing. This particular pedestrian overpass is located near Texas A&M University and crosses over a major arterial street and an active set of railroad tracks. The pedestrian overpass is used heavily during special events (e.g., football games, etc.) and during train passings, but only modestly during other times. Future plans at this location involve reconstructing the intersection to provide a pedestrian undercrossing that gradually slopes to below the grade of the surface street.

Figure 42. Pedestrian Bridge over Five-Lane Arterial Street and Active Railroad Tracks – College Station, Texas.

A 1988 synthesis by Zegeer and Zegeer (*26*) suggested that grade-separated pedestrian crossings are most beneficial under the following conditions:

- where there is moderate to high pedestrian demand to cross a freeway or expressway,
- where there is a large number of young children (i.e., particularly near schools) who must regularly cross a high-speed or high-volume roadway,
- on streets having high vehicle volumes and high pedestrian crossing volumes and where there is an extreme hazard for pedestrians (e.g., on wide streets with high-speed traffic and poor sight distance), and
- where one or more of the conditions stated above exists in conjunction with a well-defined pedestrian origin and destination (e.g., residential neighborhood across a busy street from a school, a parking structure affiliated with a university, or apartment complex near a shopping mall).

Axler suggested more specific warrants and other general considerations for grade-separated pedestrian crossings (*27*):

- The pedestrian hourly volume should be more than 300 in the four highest continuous hour periods if the vehicle speed is more than 40 mph and the proposed sites are in urban areas and not over or under a freeway. Otherwise, the pedestrian volume should be more than 100 pedestrians in the four highest continuous hour periods.

- Vehicle volume should be more than 10,000 in the same four-hour period used for the pedestrian volume warrant or have an ADT volume greater than 35,000 if vehicle speed is over 40 mph and the proposed site(s) are in urban areas. If these two conditions are not met, the vehicle volume should be more than 7,500 in the four hours or have an ADT greater than 25,000.

- The proposed site should be at least 600 feet from the nearest alternative “safe” crossing. A “safe” crossing is defined as a location where a traffic control device stops vehicles to create adequate gaps for pedestrians to cross. Another “safe” crossing is an existing overpass or underpass near the proposed facility.

- A physical barrier is desirable to prohibit at-grade crossing of the roadway as part of the overpass or underpass design plan.

- Artificial lighting should be provided to reduce potential crime against users of the underpasses or overpasses. It may be appropriate to light underpasses 24 hours a day and overpasses at night.

- Topography of the proposed site should be such as to minimize changes in elevation for users of overpasses and underpasses and to help ensure that construction costs are not excessive. Elevation change is a factor that affects the convenience of users.

- A specific need may exist for a grade-separated crossing based on the existing or proposed land use(s) adjoining the proposed development site that generates pedestrian trips. This land use should have a direct access to the grade-separated facility.

- Funding for construction of the underpass or overpass must be available prior to a commitment to construct it.

In addition to the traffic and pedestrian volume considered in these warrants, a benefit-cost analysis will likely be required for grade-separated pedestrian crossings. Readers interested in conducting a benefit-cost analysis are encouraged to consult NCHRP Report 189 (“Quantifying the Benefits of Separating Pedestrians and Vehicles,” 1978) and NCHRP Report 240 (“A Manual to Determine the Benefits of Separating Pedestrians and Vehicles,” 1981).

Special Conditions: School Crossings and Special Events

Pedestrian crossings at certain locations may require special attention beyond the basic engineering treatments described in the previous sections. Examples include pedestrian crossings near schools as well as near locations where special events are held (e.g., arenas, stadiums). These two special conditions are described below, with guidance provided for each.

As the crash statistics in an earlier section indicated, children under the age of 14 are the most over-represented age group in pedestrian–motor vehicle crashes. Additionally, the majority of motorists do not reduce vehicle speeds in school zones unless children, adult crossing guards, or enforcement personnel are clearly visible. In response to the special needs of school zones, ITE developed a Recommended Practice in 1984 entitled "School Trip Safety Program Guidelines." This Recommended Practice describes the steps that can be taken to develop a school trip safety program, including the following elements:

- a committee whose responsibility is to ensure the appropriate and uniform application of school crossing protection measures;

- designation of school routes, identification of route deficiencies and needed improvements, and implementation of route improvements; and

- determining the need for appropriate traffic control, such as school safety patrol, adult crossing guards, or school crossing traffic signals.

The FHWA also provides information and resources for addressing school-age pedestrian safety, in particular a brochure entitled "Pedestrian Safety for School-Age Children" (*28*). Several states have also developed separate chapters in their traffic manuals that deal with the issues of school area pedestrian safety (e.g., Caltrans example is available at http://www.dot.ca.gov/hq/traffops/signtech/signdel/chp10/chap10.htm).

Figure 43 shows the existing 2000 MUTCD traffic signal warrant for school crossings. The ITE Recommended Practice (*1*) suggests the following warrants for adult crossing guards (comparable to the American Automobile Association's [AAA's] Adult School Crossing Guards Manual):

1. At uncontrolled crossings where there is no alternate controlled crossing within 600 feet, and:

    a. In urban areas where the vehicular traffic volume exceeds 350 in each of any two daily hours during which 40 or more school children cross while going to or from school whenever the critical approach speed exceeds 40 mph, the warrants for rural areas should be applied.

b. In rural areas where the vehicular traffic volume exceeds 300 in each of any two daily hours during which 30 or more school children cross while going to or from school.

2. At stop sign–controlled intersection crossings:

   a. Where the vehicular traffic volume on undivided highways of four or more lanes exceeds 500 per hour during any period when the children are going to or from school.

3. At traffic signal–controlled intersection crossings:

   a. Where the number of vehicular turning movements through the school crosswalk exceeds 300 per hour while the children are still going to or from school.

   b. Where there are circumstances not normally present at a signalized intersection, such as crosswalks more than 80 feet long with no intermediate refuge, or an abnormally high proportion of heavy commercial vehicles.

Warrant 5, School Crossing (2000 MUTCD)

The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of school children at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the children are using the crossing is less than the number of minutes in the same period (see Section 7A.03) and there are a minimum of 20 students during the highest crossing hour.

Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.

The School Crossing signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 90 m (300 ft), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

Figure 43. 2000 MUTCD School Crossing Traffic Signal Warrant (*11*).

Because of the short duration and potentially high pedestrian volumes at special events near stadiums and arenas, the event's traffic management plan should give special consideration to pedestrian crossings. Traffic engineering treatments that are appropriate for modest pedestrian volumes throughout the day may not be well suited for pedestrian traffic at special events. Police or other uniformed officers are most often used in controlling and managing special event traffic. In cases where police traffic control is used, the relative priority of competing pedestrian and vehicle flows should be established and communicated to the directing officers in pre-event coordination meetings.

Figure 44 shows a pedestrian crossing that connects a community amphitheater (shown in left middle of picture) to a parking area across a three-lane collector street. The crosswalk is textured with brick pavers and a pedestrian crossing sign is present. However, police control and additional warning signs are used at this crossing when events are being held at the amphitheater. Pedestrians rarely use the crossing other than during special events, thus no crosswalk markings or other crossing treatments are provided here during non-event times.

Figure 44. Pedestrian Crossing Used Only During Special Events – College Station, Texas.

Education and Enforcement Activities

Engineering treatments may be entirely effective in addressing problems at some pedestrian crossings. In some locations, though, a balance of engineering, education, and enforcement efforts will be the most effective in improving pedestrian safety. This section summarizes several pedestrian education and enforcement programs that interested communities can use.

Pedestrian Safety Roadshow – Developed by FHWA, the purpose of the Roadshow is to assist communities in developing their own approach to identifying and solving the problems that affect pedestrian safety and walkability. It is a four-hour workshop to community officials (e.g. engineering, planning, enforcement, educators, health), concerned citizens (e.g. youth groups, senior groups), and local business leaders (e.g. builders/developers, insurance). The objectives are to increase the awareness of pedestrian safety and walkability concerns, provide participants with information about the elements that make a community safe and walkable, and channel their concern into a plan of action for addressing pedestrian concerns. More information on the Roadshow is available at http://www.ota.fhwa.dot.gov/walk.

Pedestrian Safety Roadmap and Resource Catalog – Another program developed by FHWA, the resource catalog has an extensive inventory of information on pedestrian safety education, including numerous educational brochures and pamphlets. The Resource Catalog can be found at http://www.ota.fhwa.dot.gov/walk/resource/psrdm4.htm.

Walkability Checklist – The Checklist can be used by community members or others to rate walking conditions and identify deficiencies in their neighborhood. The walkability checklist can be found by searching the National Highway Traffic Safety Administration (NHTSA) web site at http://www.nhtsa.dot.gov.

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APPENDIX – TEXAS STATE LAW PERTAINING TO PEDESTRIAN CROSSINGS

SUBTITLE C. RULES OF THE ROAD

CHAPTER 541. DEFINITIONS

Sec. 541.302. Traffic Areas.

In this subtitle:

. . .

(2) “Crosswalk” means:

(A) the portion of a roadway, including an intersection, designated as a pedestrian crossing by surface markings, including lines; or

(B) the portion of a roadway at an intersection that is within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or, in the absence of curbs, from the edges of the traversable roadway.

. . .

(13) “School crossing zone” means a reduced-speed zone designated on a street by a local authority to facilitate safe crossing of the street by children going to or leaving a public or private elementary or secondary school during the time the reduced speed limit applies.

(14) “School crosswalk” means a crosswalk designated on a street by a local authority to facilitate safe crossing of the street by children going to or leaving a public or private elementary or secondary school.

(16) “Sidewalk” means the portion of a street that is:

(A) between a curb or lateral line of a roadway and the adjacent property line; and

(B) intended for pedestrian use.

Acts 1995, 74th Leg., ch. 165, Sec. 1, eff. Sept. 1, 1995.

CHAPTER 552. PEDESTRIANS

Sec. 552.001. Traffic Control Signals.

(a) A traffic control signal displaying green, red, and yellow lights or lighted arrows applies to a pedestrian as provided by this section unless the pedestrian is otherwise directed by a special pedestrian control signal.

(b) A pedestrian facing a green signal may proceed across a roadway within a marked or unmarked crosswalk unless the sole green signal is a turn arrow.

(c) A pedestrian facing a steady red signal alone or a steady yellow signal may not enter a roadway.

Sec. 552.002. Pedestrian Right-of-Way if Control Signal Present.

(a) A pedestrian control signal displaying "Walk," "Don't Walk," or "Wait" applies to a pedestrian as provided by this section.

(b) A pedestrian facing a "Walk" signal may proceed across a roadway in the direction of the signal, and the operator of a vehicle shall yield the right-of-way to the pedestrian.

(c) A pedestrian may not start to cross a roadway in the direction of a "Don't Walk" signal or a "Wait" signal. A pedestrian who has partially crossed while the "Walk" signal is displayed shall proceed to a sidewalk or safety island while the "Don't Walk" signal or "Wait" signal is displayed.

Sec. 552.003. Pedestrian Right-of-Way at Crosswalk.

(a) The operator of a vehicle shall yield the right-of-way to a pedestrian crossing a roadway in a crosswalk if:
- (1) no traffic control signal is in place or in operation; and
- (2) the pedestrian is:
  - (A) on the half of the roadway in which the vehicle is traveling; or
  - (B) approaching so closely from the opposite half of the roadway as to be in danger.

(b) Notwithstanding Subsection (a), a pedestrian may not suddenly leave a curb or other place of safety and proceed into a crosswalk in the path of a vehicle so close that it is impossible for the vehicle operator to yield.

(c) The operator of a vehicle approaching from the rear of a vehicle that is stopped at a crosswalk to permit a pedestrian to cross a roadway may not pass the stopped vehicle.

Sec. 552.004. Pedestrian to Keep to Right.

A pedestrian shall proceed on the right half of a crosswalk if possible.

Sec. 552.005. Crossing at Point Other Than Crosswalk.

(a) A pedestrian shall yield the right-of-way to a vehicle on the highway if crossing a roadway at a place:

(1) other than in a marked crosswalk or in an unmarked crosswalk at an intersection; or

(2) where a pedestrian tunnel or overhead pedestrian crossing has been provided.

(b) Between adjacent intersections at which traffic control signals are in operation, a pedestrian may cross only in a marked crosswalk.

(c) A pedestrian may cross a roadway intersection diagonally only if and in the manner authorized by a traffic control device.

Sec. 552.006. Use of Sidewalk.

(a) A pedestrian may not walk along and on a roadway if an adjacent sidewalk is provided.

(b) If a sidewalk is not provided, a pedestrian walking along and on a highway shall if possible walk on:

(1) the left side of the roadway; or

(2) the shoulder of the highway facing oncoming traffic.

(c) The operator of a vehicle emerging from or entering an alley, building, or private road or driveway shall yield the right-of-way to a pedestrian approaching on a sidewalk extending across the alley, building entrance or exit, road, or driveway.

Sec. 552.007. Solicitation by Pedestrians.

(a) A person may not stand in a roadway to solicit a ride, contribution, employment, or business from an occupant of a vehicle, except that a person may stand in a roadway to solicit a charitable contribution if authorized to do so by the local authority having jurisdiction over the roadway.

(b) A person may not stand on or near a highway to solicit the watching or guarding of a vehicle parked or to be parked on the highway.

(c) In this section, “charitable contribution” means a contribution to an organization defined as charitable by the standards of the United States Internal Revenue Service.

Sec. 552.008. Drivers to Exercise Due Care.

Notwithstanding another provision of this chapter, the operator of a vehicle shall:
(1) exercise due care to avoid colliding with a pedestrian on a roadway;
(2) give warning by sounding the horn when necessary; and
(3) exercise proper precaution on observing a child or an obviously confused or incapacitated person on a roadway.

Sec. 552.009. Ordinances Relating to Pedestrians.

A local authority may by ordinance:

(1) require pedestrians to comply strictly with the directions of an official traffic control signal; and
(2) prohibit pedestrians from crossing a roadway in a business district or a designated highway except in a crosswalk.

Acts 1995, 74th Leg., ch. 165, Sec. 1, eff. Sept. 1, 1995

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM REPORT **189**

QUANTIFYING THE BENEFITS OF SEPARATING PEDESTRIANS AND VEHICLES

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

EXHIBIT 40

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM REPORT 189

QUANTIFYING THE BENEFITS OF SEPARATING PEDESTRIANS AND VEHICLES

RONALD R. BRAUN AND MARC F. RODDIN
STANFORD RESEARCH INSTITUTE
MENLO PARK, CALIFORNIA

RESEARCH SPONSORED BY THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS IN COOPERATION WITH THE FEDERAL HIGHWAY ADMINISTRATION

AREAS OF INTEREST:
- HIGHWAY SAFETY
- ROAD USER CHARACTERISTICS
- URBAN TRANSPORTATION SYSTEMS

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
WASHINGTON, D.C. 1978

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are responsibilities of the Academy and its Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the National Academy of Sciences, or the program sponsors.

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FOREWORD

By Staff
Transportation
Research Board

This report contains a comprehensive methodology for evaluating the social, environmental, and economic impacts of proposals for pedestrian facilities and will be of special interest to urban and transportation planners, and traffic safety specialists in state and local governments. Measurement techniques were developed for 36 variables that quantify all significant direct and indirect benefits of facilities separating pedestrians and vehicles. The methodology can be used to evaluate alternative facilities being considered for a single site or to establish warrants or priorities for a number of pedestrian facilities. The report is organized in easily identifiable elements to serve the needs of both practitioners and researchers. Practitioners will find the user's guide particularly helpful. It describes applications of the methodology and presents step-by-step instructions to use the measurement techniques recommended for each of the 36 facility evaluation variables. Researchers will find that this research builds firmly on previously established plan evaluation methodologies. Because the benefits of a pedestrian separation are influenced strongly by facility design, structural engineers and architects will find the report to be of interest. The research described in this report is related to the Federal Highway Administration's FCP Project 1-E, "Safety of Pedestrians and Abutting Property Occupants." More specifically, the research is closely related to and enhances the results of the work reported in FHWA's Research and Development Report No. 75-7, "A Comparison of Costs and Benefits of Facilities for Pedestrians."

In recent decades, the pedestrian has not been given adequate consideration in the decisions for person mobility. Increasing concern for the environment, safety, energy, community cohesion, and health have contributed to a social awareness of the pedestrian. In determining use of space, an inherent conflict exists between vehicles and pedestrians. This research has been directed to the need of identifying and measuring benefits of separating pedestrians and vehicular traffic.

The Stanford Research Institute approach to the problem, after evaluating the state of the art, was to identify benefits of separating pedestrians and vehicles and affected population groups. Hundreds of individual parameters were examined as candidates for describing benefits. At the same time, an intensive effort was begun to develop measurement techniques to quantify benefits. A goal in the development of the measurement techniques was to go one level deeper in precision than had been previously attempted by others. The results from these tasks were then incorporated into a comprehensive evaluation methodology that could be used to assess individual and alternative proposals for pedestrian separation facilities.

The methodology selected and described in this report is a scoring, rating, or matrix method, in which all relevant attributes of a pedestrian facility are assigned unitless scores over a designated range (through specified objective measurement techniques) and the scores are weighted and summed to a total. If it is a necessity to convert unitless scores to dollar values, guidance is given. The developed method thus combines subjective values that reflect community preferences with objective measurements for each variable under consideration. Possibly the greatest advantage of the recommended methodology is that it allows and encourages the use of many benefit measures usually excluded from conventional economic analysis. By reflecting community needs and values that are not easily quantified, use of the methodology may provide adequate justification for projects not defendable previously by economic analysis alone.

CONTENTS

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The research reported herein was performed under NCHRP Project 20-10 by Stanford Research Institute, Menlo Park, Calif. Ronald L. Braun, Operations Analyst, and Marc F. Roddin, Transportation Analyst, were co-principal investigators responsible for performance of all of the research.

Dr. Joseph E. Armstrong and David A. Curry, Senior Policy Analysts, helped develop the evaluation methodology as well as quantification and description of some of the variables. Both performed extensive reviews of the draft material. Other persons who provided inputs to the measurement techniques were Kristin M. Clark, Research Analyst; Cynthia A. Kroll, Operations Analyst; Marilyn Duffey-Armstrong (formerly Bagley), Operations Analyst; Eleanor L. Myers, Research Analyst; and Edward P. Meko II, Transportation Economist. Judith Roberts (formerly Higgins), Transportation Analyst, worked on the benefits of separation and affected groups.

William A. Blandin, Traffic Design Engineer, Seattle (Wash.) Department of Engineering, provided sources of information for evaluating pedestrian facilities in Seattle. Lorne L. Smith, Chairman, Pedestrian Mall Authority of Ottawa (Ont.), provided valuable information and insights to the design and operation of the Sparks Street Mall. Jeannine M. Kahan, Director of Transportation Planning, Office of Downtown Brooklyn Development (now Transportation Supervisor, City of Belmont, Calif.), and her successor, Nazir A. Mir, Transportation Planner, provided plans and information sources on the proposed Fulton Mall.

QUANTIFYINC THE BENEFITS OF SEPARATING PEDESTRIANS AND VEHICLES

SUMMARY

A comprehensive methodology for evaluating the social, environmental, and economic benefits of proposals for facilities separating pedestrians and vehicles was developed and demonstrated during the course of NCHRP Project 20-10. This report presents the analyses undertaken as a part of the project, and the findings and recommendations of the researchers.

In the past, evaluation methods for pedestrian facilities, like those of other transportation projects, were based largely on a comparison of economic benefits and design, construction, and maintenance costs. Today, however, increased awareness of the automobile's responsibility for depletion of natural resources and spreading concern for health, safety, the quality of life, and the environment are providing the basis for a pedestrian renaissance—a return to pedestrian scale in the planning and design of facilities for people.

Accompanying the need for pedestrianization is the need for an evaluation methodology that can systematically measure the many diverse impacts of planned pedestrian facilities. The objective of this research was to identify and develop techniques for quantifying all of the significant direct and indirect benefits associated with the separation of pedestrians and vehicles, and to develop a methodology for relating these benefits to the evaluation of proposals for separation. Key research findings are summarized in the following.

Identification of Benefits and Affected Population Groups

The SRI project staff conducted an extensive review of transportation literature and articles selected from relevant social, environmental, health, and economic research areas, and held numerous discussions with experts in those areas. The objectives and results were to:

- Identify and characterize the population groups that are directly or indirectly affected by pedestrian-vehicular separation. Impacted pedestrian groups examined include: elderly, handicapped, children, persons under the influence of alcohol, shoppers, workers on break, persons conducting business, commuters, tourists, and strollers. Other affected groups include: joggers, bicyclists, motor vehicle operators and passengers, property owners, business persons, neighborhood residents, taxpayers, special interest groups (such as environmentalists), and political representatives at all levels of government.
- Identify and describe all significant direct and indirect benefits of separating pedestrians and vehicle traffic. A three-level hierarchy of items was developed by a lengthy iterative process that continued throughout the project. The benefits are listed in four major categories (see Fig. 1), as follows:

1. *Transportation*—includes the transportation impacts on actual and potential users of all transportation facilities within the evaluation area (pedestrians, motorists, transit riders, and others).

2. *Safety/Environment/Health*—includes the safety and health impacts caused by the construction and use of the facilities under study on all persons within the evaluation area (both users and nonusers), as well as the impact of this subset of factors on the physical environment.

3. *Residential/Business*—includes the impacts on interpersonal relationships, property, and attitudes of those persons within the evaluation area, also the impacts on industrial and commercial properties, and transactions within the evaluation area, as a result of the facilities under study.

4. *Government/Institutional*—includes the impacts of the facility under study on government and community-wide services and activities within the evaluation area.

At the second level are groups such as pedestrians, motor vehicles, and other community transportation. The third-level items, called "variables," are the major focus of benefit measurements. For example, the variables for the pedestrians group are travel time (1.1.1), ease of walking (1.1.2), convenience (1.1.3), and special provisions (1.1.4). A scoring procedure has been developed for each of the 36 variables identified during this project. These measurement techniques are presented in Appendix A and sample applications are given in Appendix B.

Suggested Evaluated Methodology

The research objective was to develop a comprehensive evaluation methodology that could be used to assess individual and alternative proposals for pedestrian separation facilities. The method developed is a unitless scoring system that combines subjective values reflecting community preferences with objective measurements for each of the 36 variables. Measured variable scores are weighted by preference or relative importance multipliers before the resulting relative benefit values for each variable are incorporated into a total score for each facility. This combination provides much more than just a "score" for a proposed facility, because the weighted variable scores provide considerable insight both on the values of the decision-makers, and on the attributes of the facilities themselves. This added information suupports a careful comparison of alternative proposals by identifying the important differences between alternatives. Chapter Two contains a detailed description of the characteristics of the evaluation methodology developed during this research.

Because many of the variables are subjective in nature (e.g., comfort, attractiveness, noise), the measurement of benefits is performed using a unitless scale of positive and negative values (+10 to −10) for each variable. Positive values correspond to desirable characteristics; negative values indicate undesirable characteristics. Zero values indicate either "does not apply" or "indifference" (neither good nor bad).

Unitless scoring reduces the need for assigning dollar values to the many noneconomic impacts of pedestrian facilities (and many other public projects). Such scoring is particularly appropriate to the stated project objective because comparison of alternatives can be performed by comparing unitless scores and costs without the need for calculating benefits in dollars. Guidance is also provided for obtaining benefit values in dollars, if required, to allow comparison of pedestrian facilities with other public projects.

The difficulties associated with the development of community preferences have been partially alleviated by provision of suggested weights for each variable. The researchers devoted considerable effort to discussions with planners, analysts, designers, evaluators, decision-makers, and pedestrians to obtain information about their needs and desires, their likes and their dislikes concerning pedestrian environments. A questionnaire (App. C) was also distributed to a similar but larger group of planners and decision-makers to obtain their relative preference values for each of the evaluation variables.

Different sets of weights may be appropriate for different types of pedestrian facilities, depending on the major purpose of the facility. The safety/movement type includes those facilities where severe pedestrian/vehicle conflicts occur or where high pedestrian volumes result in congestion, and the primary intent is to provide safe unimpeded pedestrian movement. The social/commercial type includes planned activity pedestrianization where the major purpose is to provide a safe and enjoyable place for pedestrians to move leisurely and linger, or to shop. Overpasses and pedestrian transit ways are examples of the first type; malls and small urban parks are examples of the second type.

When the questionnaire was distributed, respondents were requested to identify which type of facility they were considering, or if both types were being considered together (combined facilities). Comparison of the questionnaire returns indicated that few significant differences existed between combined facilities and safety/movement facilities. Thus, a single set of weights (or community preferences) can be developed for either safety or combined facilities.

However, the questionnaire responses for social/commercial-oriented facilities were significantly different from both safety only and the combined weights. Discussions with other planners indicated similar differences. Thus, a special set of weights may be appropriate when social/commercial objectives are the primary basis for pedestrian facilities in a community. The researchers have developed two sets of suggested weights for evaluators to use as a starting point in developing their own weights (presented in Chapter Three).

Measurement Techniques

The original research plan was to identify the best state-of-the-art techniques available for measuring the social, economic, and environmental impacts of transportation projects; to identify the deficiencies in applying these techniques to pedestrian facilities; and to improve on them as much as needed. Careful examination of relevant literature revealed that no measurement techniques were available for many of the impacts the research was intended to cover. Thus, what was anticipated to be a moderate effort in this area became the major focus of the research. The results of the extensive research and development effort on measurement techniques are given in Appendix A.

As the focal point of this research project, great care was taken in the selection of evaluation variables and in the development of specific measurement techniques for each variable. The key criteria for inclusion were:

- Did the item represent a potentially significant impact of separate pedestrian facilities?
- Was the item well enough defined so it would not be included more than once (double counted) in the measurement process?

In addition to informal discussions on possible measurement techniques with specialists in each of the impact areas, two general review meetings were held with an aesthetics expert, an environmental planner, an urban planner, a noise expert, a transportation economist, and several transportation planners. These meetings were structured to critically review the grouping, order, and content of the individual impact items under consideration. The first general meeting was held before the measurement techniques were fully developed. The second was held after their development to reassess the original selection and consider information added by the field evaluations.

A scoring system for each of the selected 36 variables was developed by using several basic techniques. They include selection of values from tables, simple formulas, summed table values, separately scored components, weighted formulas, and qualitative scoring (each described in Chapter Two).

Several important criteria were used to guide the selection of a measurement type for each variable or component. The first was to choose the measurement type that provided the most precise degree of quantification consistent with the data and information available for the item under consideration. The second criterion was a deliberate attempt to measure at least one level deeper in precision than had been previously attempted by others. This criterion was adopted to encourage serious consideration by evaluators and others on the meaning and importance of all of the variables. It resulted in inclusion of hundreds of individual parameters as components or characteristics of the 36 measurement variables. The third criterion was an attempt to estimate the relative importance of components within variables, especially where the literature or discussions between the researchers and others indicated probable unequal weighting.

Since many of the measurement techniques developed during this research extend beyond the usual level of quantification for the selected variables, changes based on experience and future research will be required. Users of this research are encouraged to make changes to specific measurement techniques whenever such changes seem appropriate. When somewhat different values seem more appropriate to particular groups of evaluators or decision-makers, they should be used. A primary objective in the development of measurement techniques has been to develop a flexible, quantitative framework for examining and evaluating the many potential impacts of pedestrian facilities. Thus, the basic techniques can be used even if specific values for individual variables or components change over time.

Testing the Developed Techniques

Two existing and two planned facilities were chosen as test sites to provide a more complete testing of the developed techniques than had been scheduled originally. Two small-scale facilities were analyzed—a planned overpass at a hazardous intersection (Rainier Ave. and Empire Way) and a bridge closure to motor vehicles (20th Ave. N.E./Ravenna Park), both in Seattle, Wash. The successful Sparks Street Mall in Ottawa, Ont., and the proposed Fulton Mall in New York City's Borough of Brooklyn were chosen to test the application of the methodology to large-scale facilities.

The site selection procedure and data collection techniques used are described in Chapter Two. Detailed field test data for each of the four sites are given in Appendix B. The conduct of the field tests demonstrated the practical use of the developed measurement techniques. In addition, the tests provided valuable insights that suggested several significant revisions to both the measurement techniques and the over-all evaluation methodology.

Conclusion

The over-all methodology and the extensive range of measured parameters provide a broad perspective on the design and use of pedestrian facilities. Possibly the greatest advantage of the suggested methodology is that it makes possible and encourages the use of many benefit measures usually excluded from conventional economic analysis. By reflecting social needs and values that are not easily quantified, the use of the method may provide adequate justification for projects previously not defendable using only economic analysis. Thus, the general direction of the methodology is to increase the number of impacts considered by the decision-maker, while making the decision task easier by use of explicit rather than implied evaluation factors.

CHAPTER ONE

INTRODUCTION AND RESEARCH APPROACH

NEED FOR PEDESTRIAN/VEHICULAR SEPARATION

Concern for Pedestrians

Transportation considerations are an integral part of space planning and utilization. The range of these considerations is from the location of cities conveniently near access modes, such as rivers and highways, to the floor plan of a home that is organized around the expected traffic flow of the occupants.

Ancient and medieval planners took transportation factors into account by providing extensive pedestrian facilities within their cities because the primary transportation mode was walking. Some planners even separated pedestrian and vehicular traffic by decree, or provided barriers or grade separation. Many cities were provided with central pedestrian plazas to complement the important buildings located around the perimeter. These plazas provided a marketplace, a meeting and recreational place, and a safe haven from vehicular traffic. Pedestrian comfort was also accommodated by medieval planners through galleries, canopies, and other protective features used to shield pedestrians from the sun and inclement weather.

Gradually increasing volumes and speed of vehicular transportation have resulted in a complete reversal of those planning objectives. Pedestrians have been thrust into the background as ever-increasing vehicular demands continue. Vehicular transportation advanced in speed and flexibility too quickly to be concerned with its liabilities.

Today, however, an opportunity exists to restore the balance betwen vehicles and pedestrians within the transportation system. A significant number of coincident factors combine to refocus our attention on the feasibility of separating pedestrians and vehicles. Among these factors are:

1. *Transportation.* Increased understanding of the transportation needs of the elderly and the handicapped has led to examination of the need for better pedestrian facilities. The need for separation comes largely from transportation and safety aspects of the inherent conflict between vehicles and pedestrians. When conflict occurs, the vehicle driver is generally only aware of time and space, whereas the pedestrian is usually vividly aware of time, space, distance, comfort, and safety. The transportation needs of pedestrians are being recognized by a large number of cities and counties for the first time with the formulation of comprehensive pedestrian plans and bikeway systems. Many medium-size cities now have a full-time pedestrian/bicycle person on their planning staffs.

2. *Safety.* Reduction of the pedestrian accident toll, which amounted to 19 percent of all motor vehicle fatalities and 17 percent of all motor vehicle disabling injuries in 1974 (*Accident Facts,* 1975), is a national problem that is now treated at the local level with varying degrees of concern and results. There are also significant differences in pedestrian and traffic laws and in signing practices that result in confusion and accidents for a mobile population. Pedestrian-vehicle separation is obviously a way of eliminating the accident problem by eliminating conflicts.

3. *Social.* An increased awareness of the value of walking as a method of transportation is engendered by a wide variety of social factors. Indeed, the Office of the Secretary of the U.S. Department of Transportation is sponsoring research on incentives for nonmotorized utilitarian travel in urban areas. This is to be based on interviews with bicyclists, pedestrians, motorists, planners, policy-makers, and researchers, as well as an inventory of existing physical facilities and social programs in several cities. Attempts are being made to remedy the frustration to pedestrians

who are inconvenienced or prevented from performing their usual activities. Other social factors leading to increases in walking patterns are (1) a desire to slow down the pace of life; (2) emphasis on the "body beautiful" and the health and exercise effects of walking; and (3) the lessons brought home by the "energy crises" that motor vehicle transportation demands can be reduced, better managed, or directed to alternate modes.

4. *Environmental.* Concern for environmental factors is an integral aspect of many of the problems facing modern man. Motor vehicles are the worst offenders in causing the poor air quality in our largest cities, with resultant harmful effects on man and his world. A possible effect of increasing the availability of useful pedestrian facilities will be a reduction in vehicle-miles traveled, especially in crowded urban areas. Even without a reduction in vehicle-miles traveled, a reduction in atmospheric pollutants can be achieved as a result of separate pedestrian facilities by a decrease in vehicle travel times due to fewer stops or increased average speeds. Another environmental factor is the depletion of nonreplaceable resources, such as fossil fuels. Replacement of vehicle use by walking is very helpful environmentally because short trips are the least efficient operating mode for automobiles.

5. *Health.* Several health factors are associated with separated pedestrian and vehicle facilities. The factors vary in significance depending on (1) the distance between vehicles and pedestrians, (2) whether the separation is horizontal or vertical (allowing pollutants to act on pedestrians above the roadway), and (3) the degree of isolation (e.g., one or the other in ventilated enclosures). These health factors include low-level carbon monoxide poisoning, noise and vibration that affect some individuals, physiological difficulty for elderly persons in obtaining medical services without adequate pedestrian facilities, exposure to inclement weather (including water splashed by vehicles), plus the effects of accidents involving vehicles. The exericse of walking not only contributes to general physical health, but has become both a preventive and remedial treatment for heart attacks.

6. *Economic.* The uneasy mix of vehicles and pedestrians on unseparated facilities provides only one assumed benefit; i.e., lower first cost in property acquisition and construction costs. Provision of safe, convenient facilities for pedestrians can reduce accident costs, reduce vehicle operation costs, increase retail sales adjacent to such facilities, and increase participation in community activities.

Characterization of Pedestrian Facilities

Pedestrian Networks

Pedestrian activity can be characterized as the nonmechanical movement of a person on a path from one activity location to another activity location. Each activity location can be considered as a terminator and originator of movement. It is obvious that literally any point could be such a location (e.g., "I will meet you at the middle of the block.").

To preserve the useful distinction between activity locations and paths, locations are used herein to refer to easily recognizable features such as homes; buildings (offices, stores, restaurants, museums, and the like); transit stops; parking areas; collection and distribution features (elevators, stairs, ramps, escalators, etc.); and distinct pathway intersections. As implied by the foregoing, the size or capacity of a location may vary depending on the intended application.

Pathways are subject to greater variation. They range from well-defined (a sidewalk) to directionless (such as a pedestrian mall or plaza), with many types between (the edge of the roadway or a trodden path through a field). The primary concern of this study is those pathways (also pedways or walkways) that incur construction or maintenance costs.

Consideration of pedestrian-vehicle separation suggests two basic types of pedestrian pathways:

- Pedestrian-exclusive—where vehicles are not normally allowed.
- Mixed—where vehicels are allowed to intersect or parallel the pedestrian pathway in the same time period, creating conflict opportunities.

The preceding section on the need for pedestrian-exclusive facilities described the types of factors to be considered in evaluation of these facilities. The following description identifies some of the features that a well-designed pedestrian facility should provide to the user of the facility.

Pedestrian paths should offer the pedestrian directness that will avoid time loss or greater distance. The paths should provide continuity of movement and possess adequate capacity. Vertical change requirements should be minimized. Protection against wind, rain, cold, heat, and pollution will enhance utilization, as will provision of security against criminal threat. Separation of pedestrians and vehicles will eliminate conflicts and provide safe pedestrian routes if access by pedestrians to vehicle pathways is prevented. The pathways should provide directional orientation and adequate accessibility. Finally, the pathway should offer a pleasing environment to stimulate pedestrian interest and psychologically reduce the negative effects of trip distance and duration.

In summary, pedestrian-exclusive systems can provide the benefits described in the previous section, plus advantages to vehicular traffic by the elimination of competition for time and space inherent in the mixed system. On the other hand, the mixed system may be characterized as a time-and-space conflict in the minds of vehicle operators; and a time, space, distance, comfort, and safety conflict in the minds of pedestrians.

Pedestrian-Exclusive Facility Types

A pedestrian-exclusive system may be composed of three types of separation features relative to vehicle location:

- Vertical or grade separation.
- Horizontal separation.
- Temporal separation.

Any or all of these features may be present in a pedestrian network, although the first two are frequently used for new pedestrian facilities, whereas temporal separation is commonly used with existing systems (e.g., intersection signalization and part-time "street-malls").

Vertical separation is frequently described as above-grade, at-grade, or below-grade, depending on pedestrian location with respect to ground level. This characterization is useful because of its cost implications and for feature identification. The advantages of at-grade pedestrian locations with below-grade vehicles are similar to those for pedestrian above-grade vertical separations in the discussions that follow, whereas overhead vehicle pathways result in a situation somewhat similar to below-grade pedestrian facilities by creating a tunnel effect for the at-grade pedestrians.

Some general advantages of below-grade systems are: protection is provided from sun and inclement weather, a free-form grid pattern may be used, the urban landscape is not obstructed, incremental expansion is possible, they can be linked to existing underground systems, direct linkage is possible between major activity centers, and vehicular circulation is improved.

The disadvantages of below-grade systems are: high construction costs, the requirements for change in grade and numerous entry points, adverse effects on orientation and coherence because of (a) loss of visual contact with the city and (b) imposition of an artificially created environment, and impeded emergency servicing.

Above-grade elements support pedestrian movement above the level of vehicular traffic. They may be characterized as:

- Independent—structurally self-supporting.
- Integral exterior—structurally integral with a building, but exterior to the building itself.
- Integral interior—structurally integral with a building or group of buildings in a development.

Above-grade systems can provide direct, convenient paths for pedestrians; a visually pleasing vantage point; elevated direct linkage between major activity centers; possible incremental expansion; more compact and efficient arrangement of retailing space; and improved vehicular circulation. Some general disadvantages of above-grade systems are: high construction costs, requirements for change in grade and numerous entry points, possible decrease in retail activity at the street level, additional visual clutter, and impeded emergency servicing.

Horizontal separations can be characterized as parallel (adjacent to vehicular movement) or displaced (physically separated from roadways by significant distances or other structures). Examples of parallel separations are sidewalks, arcades, and partial malls (sometimes with limited traffic). Examples of displaced separations are full malls and displaced grids (e.g., pathways between buildings) exclusive of vehicular traffic.

Parallel horizontal separation may provide a buffer zone with reduced potential for conflict and accident. However, such separations may reduce the street width available to vehicles, may increase vehicle congestion on surrounding streets, do not solve the problem of conflict at intersections, may not affect pedestrian exposure to weather, and may reduce retail store space.

Displaced horizontal separations, which are a better solution from the pedestrian viewpoint, can be developed in stages, allow a wide range of activities, and can be integrated with existing parks, malls, and plazas to create a system of urban open space. They also stimulate retail activity in immediate areas; provide freedom from noise and fumes; and may provide shelter. They also require total cooperation of property owners and other retail interests. Disadvantages of displaced horizontal separations are typified by high development, operating, and maintenance costs; comprehensive preplanning; increased traffic volumes on surrounding streets; and reduced retail activity on nearby streets.

NEED FOR COMPREHENSIVE EVALUATION METHODOLOGY

To view the state of the art of evaluation methodologies for pedestrian facilities from a broader perspective than would be possible otherwise, it is compared with a capsule history of highway project evaluations. Since about 1920, data and methodologies have been available for rational comparison of alternative highway location and design proposals on the basis of savings to users (travel time, accident avoidance, and operating cost savings to motor vehicle operators) compared with the highway construction, maintenance, and operating costs. Most highway evaluations performed at that time, however, were done by academics and researchers—not by highway decision-makers or their staffs. All too many highway projects were selected and constructed using engineering and travel demand inputs only, with merely a casual glance in the direction of economics. Over the last 25 or 30 years, most major intercity and urban highways have been completed; new investments are in reconstruction and improvement rather than in new facilities.

Decisions to implement such highway improvements have been subject to increasing public scrutiny and hostility, which has been facilitated by recent legislation, including the Clean Air Act, the National Environmental Policy Act, and the Federal-Aid Highway Act. In addition, the Federal-Aid Highway Act of 1973 made available funds for development and improvement of pedestrian walkways and bikeways located on or in conjunction with highway rights-of-way. These funds can be used to finance the federal share of the cost of constructing pedestrian walkways. No motorized vehicle would be permitted on these walkways except for maintenance purposes. Also under the provisions of that Act, the Federal Highway Administration can authorize states to use their regularly apportioned federal-aid highway funds for construction of pedestrian walkways outside the normal federal-aid highway rights-of-way and for planning and construction of auto-restricted zones in central business districts.

The Clean Air Act legislated air quality standards and emission controls. Its indirect source regulations apply to motor-vehicle-oriented facilities which do not themselves pollute, but which attract automobiles (e.g., athletic arenas, shopping centers, parking lots). The National Environmental Policy Act requires public disclosure of the impacts from federally funded projects; this requirement is usually satisfied with preparation of an environmental statement. Section 136(b) of the Federal-Aid Highway Act of 1970 requires transportation planning agencies receiving federal funds to develop an Action Plan that thoroughly considers all possible social, economic, and environmental effects of alternative courses of action throughout the entire project development process. This plan must be introduced into the study process as early as is feasible.

To satisfy the needs of these legislative requirements to ameliorate the adverse ecological and social impacts of new highway projects, particularly in dense urban areas, one viable alternative is installation of pedestrian-oriented facilities. This is one part of a move to achieve higher densities of land use and a decreased dependence on the automobile for personal intracity travel. Major shifts from automobiles to transit, bicycle, and pedestrian modes will result in less noise and air pollution, as reported in environmental impact statements. Ironically, though, in their rush to construct new pedestrian facilities in cities, many planners have neglected to assess the total impacts of these proposals. Instead, they assumed that any transportation facility designed primarily for pedestrians must be good because it will attract people away from other more polluting modes.

There is need for a systematic method of analyzing all of the impacts of a pedestrian-oriented facility. Analogous to the decisions made during the 1930s and 1940s to proceed with specific highway projects without an assessment of all of the project's outcomes, pedestrian facilities—such as malls and overpasses—are being proposed with little or no background study on pedestrian travel demand and travel time, motor vehicle costs, accident frequency, vandalism, retail sales, or a host of other variables.

In the event that more facilities have been proposed than can be funded or alternative proposals have been suggested for the same location, a choice must be made; this decision should be based on a rational determination of the impacts of the planned projects. In particular, the methodology should highlight all of the critical issues associated with the project, so that an informed decision may be made by the body politic.

OBJECTIVE AND SCOPE

The objective of this research has been to identify and develop techniques for quantifying all of the benefits associated with separation of pedestrians and vehicles, and to develop a methodology for relating these benefits to the evaluation of proposals for separation. The scope includes identification of the direct and indirect benefits of separation by: (1) considering transportation, safety, social, economic, environmental, and health factors; (2) identifying specific population segments in the community likely to benefit from or be affected by pedestrian-vehicular separation; (3) adopting or developing techniques for measurement of these impacts qualitatively, quantitatively, or in dollar values for use in evaluation and design of proposals for separation; (4) testing the developed techniques on two planned and two existing pedestrian facilities; and (5) providing suitable documentation for effective use of the results of this research.

RESEARCH APPROACH

The research plan for the project consisted of five tasks, as follows:

1. Perform a literature search and review current practice.
2. Identify benefits of separation and affected population groups.
3. Develop measurement techniques to quantify benefits.
4. Develop cost-benefit techniques for evaluation of proposals for separation.
5. Test developed techniques.

This section briefly describes each of these tasks.

The comprehensive search and review of the literature on pedestrian and interacting vehicle factors included economic, behavioral, social, safety, environmental, and health impacts. An active document search effort was maintained throughout the project to ensure that the most recent relevant information was obtained. Also included in Task 1 was an examination of the procedures used by highway engineers, transportation economists, urban planners, and others who perform analyses for the evaluation of pedestrian facilities. The results of a search for this information made clear the need for the project being undertaken. Rapidly rising construction costs, combined with very limited methods for evaluating the benefits of pedestrian facilities, have made it difficult to justify many desired facilities, particularly high-cost structures such as overpasses.

Two specific objectives were established for Task 2. The first major objective was to identify and characterize the population segments that are directly or indirectly affected by pedestrian-vehicular separation. The first section in Chapter Two describes the results of the research findings on affected population groups. The second major objective of this task was to identify and describe all significant direct and indirect benefits of separating pedestrians and vehicle traffic. The impact areas examined included transportation, safety, social, environmental, health, and economics. An iterative development and refinement of benefit items to be measured resulted in categorization and arrangement of items as shown in Figure 1.

The original plan for Task 3 was to identify the best state-of-the-art techniques available for measuring the social, economic, and environmental impacts of proposed pedestrian separation; to identify the deficiencies in using these techniques; and to improve on these techniques as much as needed. Careful examination of relevant literature revealed that very few measurement techniques were available for many of the impacts that the research was intended to cover. Thus, what was anticipated to be a moderate research effort in this area became the major focus of effort for the entire project. The results of this extensive research and development effort on measurement techniques are given in Appendix A.

1. TRANSPORTATION

   1.1 Pedestrian

      1.1.1 Travel Time
      1.1.2 Ease of Walking
      1.1.3 Convenience (Access and Availability)
      1.1.4 Special Provisions for Various Groups

   1.2 Motor Vehicles

      1.2.1 Motor Vehicle Travel Costs
      1.2.2 Use of Automobiles
      1.2.3 Signal/Signing Needs Adjacent to Facility

   1.3 Other Community Transportation

      1.3.1 Adaptability to Future Transportation Development Plans
      1.3.2 Impact on Use of Existing Transportation Systems

2. SAFETY/ENVIRONMENT/HEALTH

   2.1 Safety

      2.1.1 Societal Cost of Accidents
      2.1.2 Accident Threat Concern
      2.1.3 Crime Concern
      2.1.4 Emergency Access/Medical and Fire Facilities

   2.2 Attractiveness of Surroundings

      2.2.1 Pedestrian–Oriented Environment
      2.2.2 Litter Control
      2.2.3 Density
      2.2.4 Climate Control and Weather Protection

   2.3 Environment/Health

      2.3.1 Effects of Air Pollution
      2.3.2 Noise Impacts of Motor Vehicles
      2.3.3 Health Effects of Walking (exercise, fatigue, etc.)
      2.3.4 Conservation of Resources

3. RESIDENTIAL/BUSINESS

   3.1 Residential Neighborhoods

      3.1.1 Residential Dislocation
      3.1.2 Community Pride, Cohesiveness, and Social Interaction
      3.1.3 Aesthetic Impact, and Compatibility with Neighborhood

   3.2 Commercial/Industrial Districts

      3.2.1 Gross Retail Sales
      3.2.2 Displacement or Renovation Required or Encouraged by Facility
      3.2.3 Ease of Deliveries and Employee Commuting
      3.2.4 Attractiveness of Area to Business

4. GOVERNMENT AND INSTITUTIONS

   4.1 Transportation and Land–Use Planning Process

      4.1.1 Public Participation in the Planning Process
      4.1.2 Conformance with Requirements and Regulations

   4.2 Economic Impacts

      4.2.1 Net Change in Tax Receipts and Other Revenue
      4.2.2 Resulting Changes in Employment
      4.2.3 Change in the Cost of Providing Community Services

   4.3 Community Impacts

      4.3.1 Community Activities
      4.3.2 Adaptability to Future Urban Development Plans
      4.3.3 Construction Period

Figure 1. Pedestrian facility evaluation variables.

The primary criteria for development of measurement techniques were ease of understanding and use by planners, designers, engineers, decision-makers, and concerned citizen groups. Although a unitless scoring system was devised for all variables under study to allow use of a broadly based evaluation, a methodology for computing dollar value benefits was also developed where appropriate. A discussion of how measurement procedures were developed is given in Chapter Two. Instructions on the use of the measurement techniques are contained in Chapter Three.

The objective of Task 4 was to develop a comprehensive evaluation methodology that could be used to assess individuals and alternative proposals for pedestrian separation facilities. The method developed combines subjective values that reflect community preferences with the objective measurement techniques developed in Task 3. This combination provides much more than just a "score" for a proposed facility, because its components provide considerable insight on the values of the decision-makers, and on the attributes of the facilities themselves. This added information supports a careful comparison of alternative proposals by identifying the important differences between alternatives. Chapter Two contains a detailed description of the characteristics of the evaluation methodology developed during this research.

The project team devoted considerable effort to discussions with planners, analysts, designers, evaluators, decision-makers, and citizens to obtain information on their needs and desires, their likes and dislikes, on the subject of pedestrian facilities. A questionnaire (App. C) was also distributed to pedestrian facility planners and decision-makers to provide the researchers with data on the relative preferences or values associated with the 36 selected evaluation variables. This questionnaire and its results are discussed in Chapter Two.

The purpose of Task 5 was to thoroughly test the evaluation procedures being developed at actual pedestrian facility locations. Two existing and two planned facilities were chosen as test sites to provide a more complete testing of the developed techniques than had been originally scheduled. Two small facilities, a planned overpass at a hazardous intersection (Rainier Ave. and Empire Way) and a bridge closure (20th Ave. N.E./Ravenna Park) to motor vehicles, both in Seattle, Wash., were analyzed. The successful Sparks Street Mall in Ottawa, Ont., and the proposed Fulton Mall in New York City's Borough of Brooklyn were chosen to test application of the methodology to large-scale facilities. The site selection procedure and the data collection techniques used are described in Chapter Two. Detailed field test data for each of the four sites are given in Appendix B. The form of the data is keyed to the measurement techniques developed in Task 3, and thus serves as an illustration of how evaluation data might be assembled by the users of this report.

ORGANIZATION OF THE REPORT

This final report has been organized to serve two major objectives. The first is to report on the research conducted, the need for the research, and the objectives and procedures followed. These are described in Chapter One. The research results, as detailed in Chapter Two, are intended for the investigator who is interested in knowing how the research was conducted and how the various factors interrelate. Chapter Four contains a summary of the conclusions reached and suggestions for further research.

The second major objective is to provide a user guide to the results of this study. Chapter Three describes potential applications of the techniques developed and presents step-by-step instructions for their use. Appendix A is an integral part of the user instructions, and Appendix B provides four sample applications of the developed methodology and techniques. The material in Appendix C may be of interest to either type of reader.

CHAPTER TWO

FINDINGS

POPULATION GROUPS AFFECTED BY PEDESTRIAN FACILITIES

A major research objective was to identify and characterize the population groups that are directly or indirectly affected by pedestrian-vehicular separation. Examination of the needs of these diverse groups was used to ensure adequate consideration of benefits during the research. This section describes the most significant characteristics of the groups identified.

Captive Pedestrians

Along with the handicapped and the poor, the elderly are particularly vulnerable to the disadvantages of pedestrianism, because alternative modes of transportation frequently are unavailable to them. It has been estimated (Raynes, 1974) that transit-dependent persons comprise 26 percent of the urban populace. Thus, although exact data are not available on the sizes of each of these pedestrian groups relative to the total of all pedestrians, it is estimated that these persons constitute a large fraction of the total. Such "captive pedestrians" are more dependent on walking than are other groups for a variety of trip purposes—shopping, attending schools and churches or places of employment, visiting friends and relatives, and traveling to social and recreational facilities.

Accessibility, travel time, and expanded social contacts are among the principal impacts of pedestrian facilities on elderly pedestrians. In a study of elderly pedestrians in San Antonio, Tex., Carp (1971) concluded that "generally, places to which the most people walked involved basic physical subsistence needs . . . and basic psychological needs." Trips tended to be short. She found that all one-way pedestrian trips reported to her were less than 30 min in length, with most being shorter than 15 min. A major disadvantage of walking cited by her respondents was that many places to which they needed to go were simply too far away.

Elderly people in the San Antonio study admitted to a host of fears having to do with walking. These included fear of attack, an accident, a fall, an inability to complete crossing the street before the light changed, and fear of becoming lost. Responses elicited during interviews led the author to conclude that these people had a strong concept of territoriality. "They felt strongly that vehicles should not invade pedestrian territories; and they, as pedestrians, did not go willingly into automobile territory or onto private property." An interesting result of the study, supported by a follow-up study in San Francisco, Calif., (Carp, 1972), is that those people who walked the most were found to be the most negative in their evaluation of walking as a means of transportation.

Persons over 65 account for almost 25 percent of all pedestrian fatalities (*Accident Facts,* 1975). In a study of the physiological factors associated with elderly pedestrian accidents, Yaksich (1965) found the following factors to be most significant:

- Impaired hearing.
- Less accurate depth perception.
- Decreased lateral field of vision.
- Slower perception and reaction.
- Decreased learning capacity.

Increased susceptibility to injury and decreased ability to survive injury may account in part for a higher incidence of death resulting from injury for elderly pedestrians (Haddon et al., 1961, pp. 242-243).

Handicapped persons have many of the same desires for accessibility and social contacts that elderly pedestrians do. In a case study of blind and deaf individuals in Washington, D.C., it was found that work and shopping trips were the most important walking trips made, followed by recreation trips (Roberts, 1972). The individuals expressed concern for better design of facilities to meet their needs, with more attention to directions and signs. Thus, comfort and convenience were seen as important impacts. In contrast to the study of elderly pedestrians mentioned earlier, "walking was evaluated as a pleasant activity by all groups; they emphasized the desire to do more walking to additional destinations if pedestrian conditions were improved" (Roberts, 1972).

The elderly and the handicapped are usually given special consideration when pedestrian accommodations are designed because these groups are expected to be major users of a facility when completed. Also, the amenities (such as benches) implemented for those specific groups can readily be used by others. Features of pedestrian plans that affect safety, accessibility, travel time, and pedestrian orientation of the environment are likely to benefit all pedestrians, but their perceived importance may be expected to differ for different groups. Solutions geared to one group's needs, however, may not always benefit others. For example, installation of special pavement guidestrips for blind persons do not aid other pedestrians and are of benefit only to specially trained blind persons (Herms et al., 1975).

Frequent Accident Victims

Accident reduction is likely to be an important beneficial result of separating pedestrians and vehicles. National Safety Council statistics for 1974 indicate that only 10 percent of rural highway deaths are pedestrians, but 36 percent of all urban motor vehicle fatalities are pedestrians. In 1975, about 300,000 pedestrians were involved in accidents with automobiles, resulting in 8,119 pedestrian deaths (NHTSA, 1976). The incidence of involvement of children and elderly persons in pedestrian accidents is considerably out of proportion to their relative numbers in the population at large (Wiener, 1969) perhaps due in part to their greater dependence on walking. An analysis of accident records nationwide for 1974 reveals that 25 percent of pedestrian fatalities were children under 14 years of age (*Accident Facts,* 1975).

Studies conducted by S. Sandels at the Institute for Child Development Psychology, University of Stockholm, suggest that developmental factors may play a large role in inhibiting a child's safe conduct in traffic. Among factors cited are: (1) misunderstandings and misconceptions of children regarding traffic rules and the physics of stopping an automobile; (2) lack of experience and limited judgment in traffic; (3) limited visibility because of a child's small size; (4) limited powers of concentration; (5) tendency of a child to be playful and impulsive (van der Does, 1975).

Alcohol plays a serious enough role in accident causation to warrant possible consideration of "intoxicated persons" as a separate group. In a Virginia study, alcohol was claimed as an important contributing factor because "39 percent of adult pedestrians killed were known to have been drinking" (Yu, 1971) at the time of the accident. The classic study by Haddon et al. (1961, pp. 655-678) found that 42 percent of the fatally injured adults in Manhattan had blood alcohol concentrations of 0.10 percent or higher, compared with 8 percent of a very carefully selected control group. This study also provides insight to many other aspects of pedestrian fatalities.

Efforts at reducing pedestrian accidents through stricter enforcement of pedestrian traffic laws have been largely ineffective. Attitude seems to play a crucial role. A study of the responses of elderly pedestrians to a campaign of enforcement of pedestrian traffic rules revealed that illegal crossings following the campaign reverted to their pre-campaign level, except when a police officer was present

(Wiener, 1969). In another study, a comparison was made of the number of unsafe acts observed relative to the total number of pedestrians at a Brooklyn, N.Y., intersection, both before and after installation of pedestrian traffic signals. No significant difference in pedestrian behavior was noted. According to the authors, "assuming that changes in safety behavior are a valid criterion for evaluating the effectiveness of a method designed to reduce accidents and that the safety behavior observed was a representative sample, it may be concluded that pedestrian traffic signals are not an effective method for reducing pedestrian accidents" (Flieg and Duffy, 1967).

Because incorrect actions of pedestrians and drivers, combined with poorly designed pathways, are frequently the cause of pedestrian accidents, it has been commonly assumed that education, law enforcement, and pedestrian and vehicle traffic controls, if properly used, can prevent these accidents. On-going FHWA and NHTSA pedestrian safety research programs have quantified specific types of pedestrian accidents and have examined selective countermeasures to these types. Examples are elimination of parked vehicles to enhance driver/pedestrian visibility, one-way streets to reduce attention-demanding conflicts, and greater use of illumination and retroreflective materials. Further insight on control of pedestrian accidents can be obtained from the papers by Baker (1975), Neutra and McFarland (1972), and Snyder and Knoblaugh (1971), which note that an important accident countermeasure for separate pedestrian and vehicle pathways is prevention of pedestrian access to vehicle pathways by means of effective physical barriers that ensure conflct elimination.

Other Pedestrians

Other sizable groups of pedestrians, including shoppers, people out for a meal, and persons conducting business (personal or company), are affected by the quality of pedestrian facilities provided for them, particularly if accessibility and travel time are involved. Downtowns abound with these types of pedestrians, especially around the noon hour. One planner has noted that although downtown shopping trips outnumber business trips, "the average business-walking trip is longer than the average shopping trip, so that the total distance walked for business is about the same as the distance walked for shopping" (Morris, 1967). He adds that knowledge of the purpose and length of pedestrian trips will permit installation of pedestrian amenities at appropriate intervals to meet the walker's needs. The tendency of shoppers to make more than one stop per trip underscores an accessibility factor because there is "a close correlation between the convenience—the mutual accessibility—of stores and the interaction of shopping between them." For many shoppers, the level of comfort and convenience available may sometimes mean the difference between making a trip or not.

Although most individuals use other modes of transportation to commute to their places of employment, all must become pedestrians for at least part of the trip. Travel time and accessibility are important impacts to communters, particularly at terminals and transfer points.

In parts of many cities, tourists are a notable subgroup of pedestrians. Indeed, cities such as Boston have identified and posted signs to signify pedestrian routes that connect various points of interest. With interest in seeing the sights, including cultural and historic points, route choices for tourists may be more strongly guided by aesthetic considerations than those of most residents. Although safety and travel time impacts are important, the fact that the trip is not made out of necessity causes greater emphasis to be placed on the comfort and attractiveness of the immediate surroundings. This is likely to be true as well for the stroller, the casual walker who is out for relaxation or exericse, perhaps with no particular destination in mind, and to a certain extent for the jogger.

Other Affected Groups

Bicyclists tend to straddle the line separating pedestrians from motor vehicles. Although they are legally subject to most of the laws governing motor vehicle operations, there is often an overlap into pedestrian territory, particularly for the young rider. For example, a bicyclist approaching a pedestrian overpass can easily dismount and become a pedestrian guiding a bicycle, provided ramps, rather than stairs, are provided for access. In other circumstances, however, bicyclists and pedestrians are likely to interfere with one another. Where facilities are to be shared, sufficient width should be provided to allow for a difference of speeds. Where separation is desired, signs or other deterrents may be needed to restrict entry.

Vehicle operators are often most directly impacted by a program for separation of pedestrians and vehicles, particularly if the plan calls for establishment of auto-free zones. In many instances, the impacts are beneficial. Construction of an overcrossing imposes no new restrictions to motorists and usually will improve traffic operations. A reduction in accidents and travel time often results, and decreases in stop-and-go driving usually lower the costs of operating vehicles. Even the establishment of auto-free zones may reduce vehicle costs, in spite of slightly longer travel distances, by concentrating pedestrians in the zone and reducing conflicts on adjacent arterials.

Property owners and residents of neighborhoods in which pedestrian facilities are under consideration will be concerned with a number of other potential impacts. Community cohesion may be a principal concern. Reduction of the barrier effects of a freeway through construction of an overpass, for example, will usually be viewed favorably by nearby residents. In some cases, construction of a facility will mean relocation of a number of residences or businesses. Residents will also be impacted by changes in the surrounding environment, including air pollution, water pollution, changes in noise levels, and by aesthetic considerations. Where a facility is financed locally, taxpayers and property owners may be the same individuals. Where financing is derived from a wider tax base, the majority of taxpayers will tend to be less impacted by the immediate physical and social impacts of a facility, but will share the property owners' concerns for the economic impacts. This group is directly affected by the negative impacts of construction and maintenance costs.

Other special interest groups may be strongly concerned with the impacts of a potential facility, even where the effects on them may be neither direct nor immediate. Thus, environmentalists might seek to minimize negative impacts of air, water, and noise pollution, land use, resource depletion, or ecosystem changes to the community at large. Business groups might well be impacted by changes in land use and economic development resulting from a pedestrian facility, perhaps focusing on a longer time frame than certain other groups.

Political representatives of federal, state, and local governments may, in a sense, feel any or all of these impacts. Which impacts are most important will depend on the immediate circumstances, but one might expect that economic and cost consideration would usually be among them. In addition, environmental concerns, particularly relating to regional goals, might be of great concern. Although the day-to-day impacts on travel time and vehicle operating costs may be less of an issue, expectation of a sizable decrease in accidents could be quite important to policy-makers.

DESCRIPTION OF EVALUATION METHODOLOGY

State of the Art

The preceding sections clearly indicate a growing need for pedestrian facilities and for evaluation methods to assist in their design and selection. Earlier work has been done by others in two important areas: criteria or warrants for installation and cost/benefit analysis.

The City of Seattle, Wash., in a study of pedestrian overpasses (van Gelder, 1970), established a point scoring system and applied it to a large number of intersections in the city as potential sites for grade-separated pedestrian crossings. Thirty sites were examined in detail using the scoring system developed. Seven factors were assessed, as follows:

Volume factors:	
Pedestrian volume crossing	40%
Vehicle volume crossed; vehicle velocity; street width	
Accidents:	15%
Pedestrian accident experience	
Vision and miscellaneous:	45%
Clear sight distance	
Pedestrian age	
Adaptability of the crossing to the terrain	
Pedestrian and vehicle delay and convenience	

A priority weighting system was devised to "limit the emotional bias and unsubstantiated opinions which are always a factor in such determinations." The weights of the selected evaluation factors were limited by percentages as indicated. Quantitative guidelines were also developed to aid in determination of values for each factor. The process was considered to have "significant value as a screening process and as a guide to a general priority ranking for administrative decision."

The New Jersey Department of Transportation (Batz et al., 1975) has developed a similar but extended system to account for variations found among different types of sites. Two measurement systems were developed, one for sites with existing pedestrian activity (e.g., intersections) and another for those with no pedestrian activity either because pedestrians are forbidden (freeway crossings) or because of physical features such as a center barrier. A weighted point scoring system was used for each type of site, as follows:

Locations with existing pedestrian activity:

Factor	Points Avail.
Pedestrian and vehicle volume with peak-hour delay factor	80
Sight distance, desirable gap distance, or pedestrian signal timing	50
School crossing	30
Distance to nearest alternate crossing	30
Engineering judgment	10
All	200

Locations with no pedestrian activity:

Factor	Points Avail.
Trip generation	70
Distance to nearest alternate legal crossing	70
Engineering judgment	60
All	200

This procedure includes a more extensive quantitative system for evaluation of points to be awarded in each factor group listed. One of the system's authors (R. L. Hollinger) also coauthored a report (Reilly et al., 1974) describing a methodology for evaluating transportation alternatives using cost-utility analysis.

Scott and Kagan (1973)* performed the first major work attempting to compare costs and benefits of facilities for pedestrians. They developed a detailed description of facility types and provided a good treatment of construction costs by component for different types of facilities. However, benefit calculations were restricted to the following costable benefit factors:

Reduced cost of vehicular delay time.
Reduced cost of vehicular operation.
Reduced cost of pedestrian injury and fatality.
Reduced cost of vehicular accidents of pedestrian causation.
Reduced cost of alternative crossing controls.
Reduced cost of pedestrian roadside delay.
Reduced cost of alternative transportation modes.
Reduced cost of pedestrian trip time.

Improved linkage of neighborhood and other land uses.

Their report contains an excellent summarization of many factors involved in consideration of pedestrian facilities, such as pedestrian travel demand and typical walking distances.

Each of these earlier efforts provided valuable information to the present research effort and the broad-based evaluation methodology developed incorporates and extends the most useful aspects found in each.

* A summary of this report was prepared by Prokopy (1974).

Selection of the Evaluation Approach

The proper evaluation of pedestrian facilities requires identification and comparison of all relevant attributes of such facilities, along with the preferences of affected interest groups for such attributes. In addition, the evaluation methodology must be reasonably easy to learn and to apply to a variety of facility types.

Evaluation of alternatives having multiple outcomes or results for diverse interest groups has been the subject of research in several disciplines over the past ten years. Table 1 lists the techniques that are major contenders for the conduct of such evaluations, in approximate order of increasing difficulty and sophistication. Each approach varies in the amount of data that users are required to generate for the analysis. Table 1 also provides comments on the applicability of each method to evaluation of pedestrian facilities.

Briefly, the first two methods (economic and cost-effectiveness analysis) do not provide a single final number that can be used for evaluation of alternatives that will result in a large number of different impacts. The last two methods (decision analysis and game theory) are overly sophisticated, in the researchers' view, for comparison of reasonably similar and standard types of alternatives where risk attitudes, uncertainty, or controversies among different interest groups are unlikely to play a major role in the analysis. Three other highly technical approaches—logit models of observed behavior to obtain scalar values, principal components analysis, and linear programming evaluation techniques—were considered and rejected because the data requirements for applying such approaches far exceed the data available for pedestrian facilities.

The approach selected and described in this report is a scoring, rating, or matrix method, in which all relevant attributes of a pedestrian facility are assigned unitless scores over a designated range (through specified measurement techniques) and the scores are weighted and summed to a total. The procedure is intended to facilitate identification of attributes to which the score is sensitive, improvement of weak design features where advisable, and discussion or bargaining among interest groups as to desirable levels of quality for different attributes. In addition to measurement

TABLE 1

RANGE OF POTENTIAL METHODS FOR EVALUATING PEDESTRIAN FACILITIES

Method	Comments
1. Economic analysis (including engineering economy and benefit-cost analysis), covering only results readily valued in dollars. (Grant and Ireson, 1970; Andersen et al., 1975).	This approach is too limited because many important effects are not readily valued in dollars; however, see comment on method 4 below.
2. Cost-effectiveness analysis, entailing the measurement or description of all significant outcomes, followed by an analysis of trade-offs among alternatives and a judgmental decision in cases where one alternative is not dominant for all outcomes and interest groups. (Manheim et al., 1975; Hovey, 1968).	While cost-effectiveness analysis has been useful in extending the range of attributes that are measured, it is weak in resolving multi-attribute, multi-interest group issues unless, as indicated, one alternative is clearly preferable to the others for all outcomes and interest groups.
3. Scoring, rating, or "matrix" schemes, in which project objectives are defined, criteria and measurement scales are developed and applied, and results are weighted by relative importance (Hill, 1968; Jessiman et al., 1967; Nash et al., 1975; Miller, 1969).	Scoring methods, when carefully applied with reasonably complete, linear, and independent criteria, can can produce useful and consistent results, though the resulting scores are often not intuitively meaningful.
4. Decision analysis; all significant outcomes valued in dollars; value trade-offs, time preference, uncertainties, and risk attitude all explicitly considered; minimal definition of goals as "targets," but relative values are defined for different outcomes (Raiffa, 1969; Howard, 1968).	Essentially a scoring method utilizing dollar values, but augmented by superior modeling capability (e.g., decision trees) and ability to consider uncertainties and risk attitudes. Tends to be expensive and to require considerable training or technical assistance to apply, including the same care in selection of criteria as method 3.
5. Game theory: adds consideration of bargaining strategies and threats, hence is a more general or "rational" approach for multi-interest group issues (Spinetto, 1975).	While sound in theory, the game theoretical approach has not yet been widely applied and entails intensive orientation efforts for users plus consulting assistance to apply the mathematics. Could only be feasible for very costly and controversial facilities.

scores for each attribute, the total score produced can also be a useful guide to decisions among alternatives.

The unifying feature of a scoring approach to project evaluation is that all of the variable scores are weighted by individual preferences or values of persons affected by the project being evaluated. Its main advantage over purely economic approaches is that nonmarket effects are considered along with values and preferences that are revealed in the marketplace. It is also possible, if scores are linear and additive, to convert the scores into dollar equivalents and thereby conduct the evaluation as an economic analysis. Guidelines for these procedures are provided for such steps if desired by the user.

In designing the scoring approach for this study, the researchers paid close attention to past criticisms of scoring methods, and in particular incorporated the following features to make the approach internally consistent and acceptably rigorous:

- The 36 outcome variables included in the analysis are reasonably independent, to minimize double counting, and together describe all features of pedestrian facilities believed to be significant.
- Variables are grouped into categories by affected interest groups (pedestrians, motorists, other travelers, the environment, the community, businesses, and government) to facilitate analysis of trade-offs between groups.
- Measurement scales have been devised for all variables, even those usually considered intangible or qualitative, over a standard range of +10 to −10, corresponding to the highest and the lowest reasonable values, respectively, for each variable. The resulting variable scores can be weighted by preference or relative importance multipliers before the resulting relative benefit values for each variable are incorporated into a total score for each facility. For example, if variable 1 is weighted twice variable 2, it implies that each point for variable 1 is twice as valuable as each point for variable 2.
- Two levels of descriptors below the variable level—first "components" and then "characteristics"—are used to allow appropriately detailed measurements of most variables. Scores for these levels are combined in various ways (described in the section on measurement techniques later in this chapter) to comprise the +10 to −10 range for a given variable. In most cases, the actual data item to be evaluated is so specifically defined that the allocation of points is essentially a factual determination. A few variables require the evaluator to assign a point score based on subjective judgment and descriptive guidance provided with the measurement techniques (App. A).

Some criticisms of scoring methods that require further comment are as follows:

Criticism. The practice of adding scores does not accommodate nonlinearities in different outcomes.

Comments. Careful definition of a standard scale from +10 to −10 in which the ends of the scale are selected as extreme but still reasonable values minimizes nonlinearities. For example, the selected rating scale does not include the possibility of 30 percent grades on pedestrian ramps, which would certainly be a nonlinear and extremely negative point. Also, even the +10 to −10 scale is nonlinear for some variables, although this was avoided as much as possible in assigning scale values.

Criticism. No general significance can be attached to weights that are developed with a particular project in mind, so comparison of different types of projects is questionable.

Comments. The rating scheme is probably best suited and least controversial for the simple evaluation problem of comparing mutually exclusive alternatives, such as overpasses versus underpasses for a given location. Nevertheless, assuming that the points allowed for different categories of outcomes are of equivalent scale after weighting, it follows that diverse types of facilities can be compared. For example, if a set of mid-block overpasses is being compared with a new pedestrian mall, the greater number of items that can be rated favorably for the mall might accord it (if both facilities are well designed) a higher rating than the overpasses. Hence, at the same price, the mall should be preferred to the overpass, or should be built first.

Criticism. Scoring all attributes of an alternative, rather than just outcome variables, interferes with developing an understanding of how decision variables (those controlled by the high-level decision-maker, such as project cost) and state variables (those outside his control, such as weather) interact to produce the outcome variables.

Comments. The scoring of all attributes of pedestrian facilities is not suggested, only their outcomes, although many of the outcomes are a function of decision variables for the design of the pedestrian facility—such as climate control, surface texture, facility capability, and public participation in the planning process.

Criticism. Different interest groups will have different weights for different variables and facilities, and such weights cannot be well determined in advance.

Comments. Results of a questionnaire (described in Chapter Three) have been used to identify general weights for facility types that emphasize goals of either safety or sociability. In addition, decision-makers are encouraged to specify their own weights for particular facilities, utilizing questionnaires or other public participation techniques to help define the weights.

There is a strong rationale for adding or modifying weights for variables *after* quantification (or measurement) of the variables for a given type of facility. Nash et al. (1975) state:

> Relative importance weights attached to various objectives in matrix evaluation methods indicate the rate at which the community . . . is prepared to trade gains and losses on one objective with gains and losses on another [based on the magnitude of measurements] . . . persons weighting relative objectives must have available to them detailed information on project consequences.

It is therefore recommended that several existing or proposed facilities within each community actually be evaluated before a final set of weights for the categories and variables is selected for the community. The discussion of suggested weights (in Chapter Three) derived from questionnaire returns is intended to assist in selecting an initial set of weights to serve as a basis for community discussion or for preliminary evaluation of a limited number of facilities. An important point is that zero weighting values may be used to reflect decision-maker opinion, or to reduce evaluation complexity. For example, a quick evaluation of a pedestrian safety countermeasure might use zero weights for social or institutional impacts.

Described next are: (1) the complete evalaution process that the suggested scoring method supports, and (2) how to treat costable variables separately if that is desired. The measurement techniques for all 36 variables are presented in Appendix A, and details of their use are presented in Chapter Three.

Suggested Evaluation Process

Although the steps of an evaluation process can be varied in depth or sequence to suit the needs of a particular facility, a complete process might contain the nine steps shown in Figure 2. Of these steps, the major concern of this report has been in defining steps 5 and 6, development of criteria and measurement techniques and their application for pedestrian facilities in general. Conduct of the other seven steps is by now well-documented for studies of other transportation modes, particularly in Andersen et al. (1975), Manheim (1975), Thomas (1968), and Winfrey (1971); the recent consensus of each step is summarized in the following.

Step 1. Identify Goals for Accommodating Pedestrians

This step entails definition of pedestrian facility goals for a community. Such goals might begin with general policy statements regarding pedestrian safety and access, but should preferably be translated into tentative long-range plans—or alternative possibilities—for each type of facility that is needed.

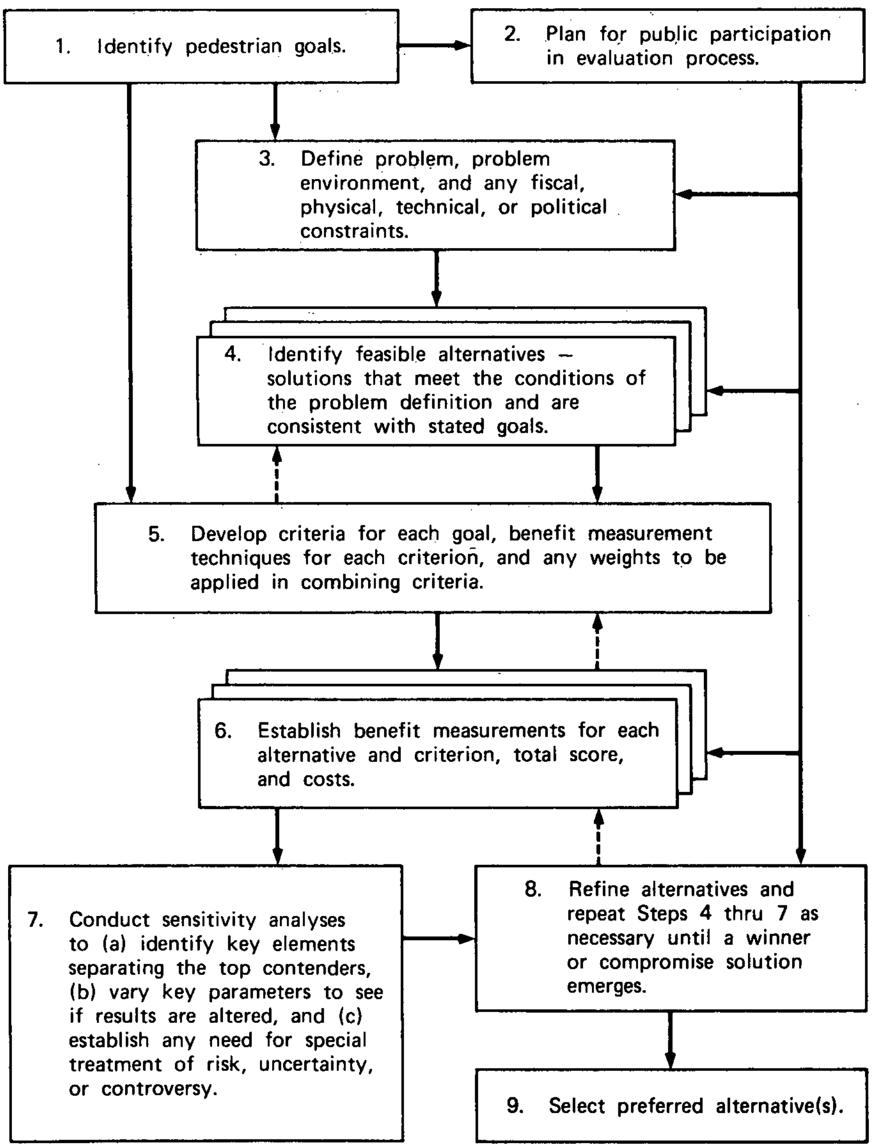

Figure 2. Suggested evaluation process.

Step 2. Plan for Public Participation

The need for involving affected interest groups in government decisions has been well established in recent years, especially for decisions on transportation facilities that represent long-term investment with a broad variety of public impacts. Therefore, a variable for rating public participation has been included in the planning process (4.1.1). The discussion for this variable should be consulted in connection with Step 2 of the evaluation process. When the plan for public transportation is in operation it can, as shown in Figure 2, become an input to subsequent tasks. Public involvement in the evaluation of projects is frequently criticized as producing imperfect renderings of consumer preferences and taxpayer willingness to pay because of the nonrepresentative process by which the public participates and because of conflicting personal interests. In response, the variable measurement scales and the weighting system have been selected and designed to facilitate explicit identification of conflicting goals and preferences. Hopefully, this will assist in the resolution of conflicts by concentrating on results rather than differences.

Step 3. Define the Problem

The nature of the existing pedestrian problem, its environment, and any fiscal, physical, technical, or political constraints that affect the selection of a solution should next be described. Consideration should be given, for example, to the possibility that the problem could be solved more economically through means other than pedestrian facilities, or that the cost of proposed facilities is beyond available funds.

These three initial steps—identification of goals, the plan for public participation, and definition of the problem—should be closely linked. Many communities already have routine approaches to all three steps for pedestrian safety facilities. In cases such as a major pedestrian mall or auto-restricted zone, it may be advisable to give more detailed attention to identifying the relevant interest groups and their goals, the mode of public transportation, and problem definition. If further information is needed, Manheim's guidelines for these steps (Manheim et al., 1975, pp. 15-77) are quite complete and illustrated with case studies.

Step 4. Facility Planning and Design

After the pedestrian-vehicle conflict problem has been identified and solution goals have been established, plans may be drafted for a facility to remedy the problem. Two sources (Eckmann et al., 1975, and Barrett, 1972) describe the pedestrian planning process in detail. The following discussion draws liberally from both of these references, especially the first, which is the Institute for Public Administration's study of pedestrian needs and accommodations.

The suggested tasks for the design process are as follows:

1. Determine the configuration of existing land uses and delineate the boundaries of the study area. Pedestrian traffic generators (parking lots, transit stops. etc.) and pedestrian attractors (stores, offices, homes) should be identified on the land-use map.

2. Perform a pedestrian origin/destination (O/D) study. This is done by specifying all possible movements between the generators and attractors, including walking from one transportation mode to another; eliminating spurious and unimportant movements from the list; estimating hourly flow based on observations, building populations, or standard trip generation rates; and drawing desire lines for various classes of pedestrians during the peak hours for those groups.

3. Perform traffic counts to establish the validity of the network found through the O/D study and to establish the actual number of walkers on the street.

The result of these three tasks should be a clear and accurate picture of the existing walking pattern, by user type, and how it relates to the land uses of any given place.

4. Track individuals within the area to observe their behavior and to determine where comfort and discomfort are extreme.

5. Use observation to examine areas of overlap, dense use, and special use. In fact, all parts of the pedestrian system should be subjected to some direct evaluation by observation. These observations should be recorded on a map to show problems and opportunities (by user group, when appropriate).

6. Project a reasonable future showing future land-use patterns and population projections by type. The analysis of pedestrian users and land uses can aid in projecting the effect future changes will have on the distribution of walkers. Thus, future pedestrian patterns can be mapped by user type, whose needs can be assumed to be similar to those of present users of similar type.

7. Use questionnaires, workshops, or other means to elicit subjective views of future needs and goals. This information should also be gathered and used in categories by user types.

8. Generate a series of alternative designs that make specific proposals of pedestrian improvements for each pedestrian group.

These proposals should be keyed to the map of the existing and future pedestrian pattern. Although responding to special problems and opportunities, the design recommendations should be keyed primarily to the comfort factors of the users of the street. When following these steps, it is important to remember that the planning process is an iterative one. Thus, steps may be repeated or performed in different orders as more data become available. Further specific guidelines for special situations are given in the following.

In areas of high use by elderly pedestrians, benches should be placed where the elderly can rest and socialize. Ramps should be provided to eliminate the inconvenience and hazard of curbs. Traffic lights should be timed to allow slow walkers sufficient time to cross. About 35 sec for 50 ft of roadbed is recommended.

Over the long term, construction of housing for the elderly within a one-block walking distance of parks, libraries, and inexpensive shopping areas should be encouraged. This would accommodate social/recreational and shopping trips, which are the most common purposes of walks by the elderly. Construction of housing for the elderly in exclusively residential areas will force them to take uncomfortably long walks or use vehicular travel to reach locations that are comfortable to them.

In areas used by children, such as the neighborhoods of playgrounds and schools, pedestrian routes should offer many shortcuts, which children prefer, and should minimize conflict with traffic and traffic controls. Children are the most impatient of all pedestrians, and they are also the most curious and observant. Thus, playground equipment and educational kiosks along their walking paths should attract their attention and occupy their enthusiasm.

In areas of intense shopping activity, a broad network of path options should be provided over a minimum area of five square blocks, including the zone of greatest pedestrian shopping trip density, to accommodate the average walking trip length of shoppers. Path options are important for shoppers who walk spontaneous and meandering routes.

In areas of intense office employment, especially between these areas and nearby residential neighborhoods, long, direct, unobstructed routes should be designed for pedestrian travel to work. Pedestrians will walk lengthy routes to appreciate unobstructed and uncrowded paths.

Over the long term, residential and employment areas should be developed within walking distance of each other. Many people prefer to walk to work, even over long distances, because it is convenient, economical, and healthful.

Step 5. Select Benefit Criteria, Weights, and Measurement Techniques

As the focal point of this research, great care was taken in selection of the 36 evaluation variables (Fig. 1) and in development of specific measurement techniques for each variable. The selection procedure began with development of lists containing hundreds of potential variables identified during a literature review and discussions with many researchers and planners concerned with pedestrian transportation. The project team also devoted considerable effort to discussions with planners, analysts, designers, evaluators, decision-makers, and citizens to obtain information on their needs and desires, their likes and dislikes, on the subject of pedestrian facilities. A questionnaire (App. C) was distributed to pedestrian facility planners and decision-makers to provide the researchers with data on the relative preferences or values associated with the 36 selected evaluation variables. This questionnaire and its results are discussed later in this chapter.

Items on the lists were grouped and ordered in a long iterative procedure that ended only after the collection and evaluation of test data from actual pedestrian facilities. Many informal discussions at these field sites helped shape the final list. In addition, two general review meetings were held with an aesthetics expert, an environmental planner, an urban planner, a noise expert, a transportation economist, and several transportation planners. These meetings were structured to critically review the grouping, order, and content of the individual impact items under consideration. The first general meeting was held before the measurement techniques were fully developed. The second was held after their development to reassess the original selection and to consider information added by the newly developed measurement techniques.

The evaluation variables were arranged in a five-level hierarchy of items. At the top level are four major categories: transportation; safety/environment/health; residential/business; and government and institutions. At the second level are groups such as pedestrians, motor vehicles, and other community transportation. The third-level variables are the heart of the evaluation methodology. As an example, the variables for the group pedestrians (1.1) are: travel time (1.1.1), ease of walking (1.1.2), convenience (1.1.3), and special provisions (1.1.4). In the evaluation methodology, a means for scoring is developed for each of the 36 variables identified during this research. Fourth- and fifth-level terms, components, and characteristics were also selected for those variables that include many subvariable factors. For example, the variable climate control and weather protection (2.2.4) is measured with the use of four component scores: heating, air conditioning, ventilation, and protection. Protection is in turn scored by considering such characteristics as exposure to sunlight, winds, precipitation, and so on.

The key question for including a variable was: "What items will or could significantly affect, or be affected by, a separated pedestrian facility?" The next important criterion in the variable selection process was to avoid "double counting" by including a single variable in several categories or groups (usually under different names or descriptions). This was managed by carefully defining each variable selected for consideration. Examples of these definitions are given in Appendix C. Similar, but less serious, problems occurred at the component and characteristic levels, and these were resolved by limiting the impact of a component such as lighting to the purpose of the variables under consideration. Thus the item "lighting" was functionally subdivided into its accident prevention, crime prevention, sign illumination, and aesthetic characteristics, and each characteristic was incorporated into only one variable to prevent duplication.

A complete description of how user-selected preferences for the 36 variables are established and combined with objective measurements for each variable is presented in Chapter Three under "Instructions to Users." A discussion on development of measurement techniques for the variables is presented in the next section of this chapter.

The developed method thus combines subjective values that reflect community preferences with objective measurements for each variable under consideration in the evaluation of pedestrian-oriented facilities. This combination provides much more than just a "score" for a proposed facility, because its components provide considerable insight on the values of the decision-makers, and on the attributes of the facilities themselves. This added information supports a careful comparison of alternative proposals by identifying the important differences between alternatives.

A feedback arrow is shown between Steps 5 and 4 in Figure 2 to indicate that the criteria of Step 5 should affect the detailed design of alternatives in Step 4.

Step 6: Establish Outcome Measurements

Outcome measurements are determined using Appendix A, which is a self-contained workbook presenting the measurement technique to be used for each of the 36 evaluation variables. The feedback arrow shown between Steps 6 and 5 in Figure 2 indicates that the results of applying the measurement techniques may suggest modifications to the criteria being used or to the detailed design of an alternative. An example would be obtaining a large negative value (such as −9) for any variable such as accident cost (2.1.1) or noise (2.3.2).

The primary criteria for development of measurement techniques were ease of understanding and use by planners, designers, engineers, decision-makers, and concerned citizen groups. Although a unitless scoring system was devised for all variables under study to allow use of a broadly based evaluation, a methodology for computing dollar value benefits was also developed where appropriate.

Step 7: Conduct Sensitivity Analysis

Sensitivity analysis is carried out in three parts; the first is observation of those variables for which low scores are obtained and the proportion of the total difference between alternatives (or between an acceptable and unacceptable total score) that is caused by each such variable. This information is used to consider methods and costs for upgrading less attractive facilities (see Step 8).

The second part of the sensitivity analysis is to let the key parameters for the study vary over their possible ranges of values (presuming that the most likely values have been used so far) and see whether the results of the analysis are altered. Examples of such parameters are the future level of pedestrian and highway traffic and the prospective growth of retail trade within the service area of the pedestrian facility. The failure of some malls to improve retail trade as expected is a case in point. If the uncertainties in such variables would cause a change in the rank order of total scores for the alternatives or in the number of attractive versus unattractive alternatives, there may be a case for repeating the analysis in a probabilistic mode. This would require assignment of probabilities to different ranges or values of the state variables to which the results of the analysis are sensitive; for such procedures, refer to the literature on decision analysis (Howard, 1968; Raiffa, 1968).

The third part of the sensitivity analysis is to consider whether serious disagreements may take place over the proper weights to use for different criteria. This may be likely among persons who are individually affected very favorably or unfavorably by one or more impacts or design features of the facility, and would accordingly wish to weight such impacts more heavily. The resolution of such disagreements is an individual matter. Although a majority voting rule can usually resolve a particular issue, it may leave a disgruntled minority unsatisfied. If the support of that minority is essential or desirable for a particular facility, compromise solutions (including design modifications) could be further explored.

Step 8: Refine Alternatives

The eighth step in the evaluation requires choices among the following options:

- Refine one or more alternatives as suggested by results of the first part of the sensitivity analysis in Step 7, and repeat Steps 6 and 7.
- Expand the evalaution to consider risk or uncertainty, or to improve the method of conflict resolution (the need for which is also identified in Step 7).
- Proceed with Step 9, selection of the most acceptable alternative(s).

Two key evaluation process issues are the total time and effort required to get to this point in the analysis, and how much additional effort (if any) is warranted to refine the analysis further. There are no fixed rules for such issues, but the following general guidelines may be of assistance:

- Corporations often consider a budget of up to 1 percent of the cost of the completed project acceptable for evaluation efforts supporting a decision to go ahead with the project or not. Such a budget would be exclusive of facility design costs.
- The researchers' experience in working with Step 5—probably the most time-consuming technical step in the evaluation process for the case studies—suggests a range of 2 working days for a simple project, such as an intersection overpass, to 30 working days for a conversion of a major street to a pedestrian mall. These estimates assume the availability of certain existing data, such as vehicle volumes, and accident histories. They also assume that the evaluator is experienced with such pedestrian facilities.
- Requirements for public participation and interaction, if extensive, could be very time-consuming and are not included in the foregoing estimates.

Step 9: Select Preferred Alternative(s)

The last step in the evaluation process is the first step in the implementation process—a commitment of financial and other resources to the preferred alternative or alternatives. This is listed as a separate step because the formal process of selecting alternatives entails two important considerations:

- Economy study constants for summation of costable data.
- Decision rules for project selection.

Economy Study Constants

For those impacts of a pedestrian facility that are measurable in dollars *or* for the case where all criteria ratings are translated into dollar equivalents, it may be desirable to compare the cost of a facility with its dollar benefits, discounted to present value, over its economic life. Other sources (Andersen et al., 1975; Grant and Ireson, 1970; Winfrey and Zellner, 1971) provide detailed guidance for selection of economy study constants and the conduct of economy studies. The following is a synopsis of current thinking on these matters (chiefly from Andersen et al., 1975):

- *Analysis period and residual value.* An analysis period of about 25 years is suggested for pedestrian-oriented structures. An even longer economic lifetime is likely, but traffic and other projections are not normally available beyond 25 years. Residual value should be based on the remaining economic life, but a rule of thumb could be the full cost of land plus 50 percent of the cost of structures.
- *Discount rate and risk.* The discount rate for present-value calculations should represent the real opportunity cost of capital to the taxpayer, estimated at about 4 percent, if future benefits and costs are calculated in constant dollars. If future benefits and costs are adjusted for expected price increases, the expected average rate of inflation should be added to the 4 percent. (To obtain the sum of two interest rates, add their product to their sum. For example, the sum of 4 percent and 5 percent would be $4\% \times 5\% + 9\% = 9.2$ percent. Thus, the real rate of return that would total 10 percent (the minimum rate currently required by the Office of Management and Budget for most Federal Government investments) with a 5 percent rate of inflation is approximately 4.76 percent.) A risk premium of up to 1 percent is sometimes added to allow for uncertainty, but it is preferable to treat risk and uncertainty explicitly by estimating a range of benefit or cost estimates (Grant and Ireson, 1970, Ch. 14; Howard, 1968).
- *Calculation of benefits for induced travel.* For facilities where a different level of pedestrian or vehicle traffic is estimated than in the base case or "do-nothing" alternative, the average of traffic with and without the facility should be used in calculating total benefits. This approach yields the "consumers' surplus" for the facility, a concept explained in Andersen et al. (1975).
- *Value of travel time.* The value of travel time savings for motorists and pedestrians is usually included in economy studies and is based on their demonstrated willingness to pay for such savings. Suggested current values for motorists are provided in Section 1.2.1.2 of Appendix A, and values for pedestrian travel time savings are provided later in this chapter under "Treatment of Costable Variables."
- *Choice of study years.* In cases where only the criteria rating scheme is used for comparison of alternatives, a single future year can be chosen for comparison of all variables. This should probably be about ten years after the facility is completed, to account for its full effect on pedestrian travel and other impacts. In cases where costable benefits are being calculated, it is recommended that two study years be used, one early in the period (such as the first full year of operation) and one later, probably year 10 or 15. Present-worth factors can then be used to find the equivalent value of the total stream of benefits.

Decision Rules for Project Selection

The usual rule for economic efficiency in cases where all costs and benefits are measured in dollars is to select the project or set of projects that yields the greatest net present value, which is defined as the difference between the present value of the benefits received from the projects and the costs of implementing the projects. Where there is a budget constraint of total project construction costs, this decision rule amounts to maximizing the present value of benefits for the available budget. Then if there are several independent projects to choose from, selection of projects in the order of declining benefit-cost ratios will obtain the set that maximizes present value (see Andersen et al., 1975, for a full discussion of using benefit-cost ratios for project selection, and Grant and Ireson, 1970, for guidelines on using the internal rate of return for project selection in a consistent manner).

In cases where all costs and benefits are not measured in dollars, such as the proposed scoring approach to pedestrian facility evaluation, decision rules are not so readily formulated, and eventually depend on some translation of points into dollar equivalents. For the purpose of illustration, consider a cost-effectiveness approach in which the cost and the score (as a proxy for effectiveness) of each facility is compared. Assume first a set of alternatives—A, B, C, and D—that score and cost as follows:

Alternative	Score	Cost ($1,000)	Points/ $1,000
A	100	150	0.7
B	100	100	1.0
C	150	100	1.5
D	200	200	1.0

Figure 3 shows the same data graphically.

It is clear that alternative B is preferable to A because it costs less and achieves the same score; and C is preferable to B because it achieves a higher score for the same cost. But what of D? Alternative D has a point-per-$1,000 ratio equal to that of B, but when D is compared to C, the added score is 50 points and the added cost is $100,000. This gives an incremental (or marginal) ratio for D to C of only 0.5 points per $1,000. So, incrementally, D offers less benefits per dollar than A, B, or C. Thus, C is the most preferable alternative.

To describe a project selection procedure, one must first be able to establish an acceptable score per $1,000. This is called an "acceptable level." Whatever this level is, *it has*

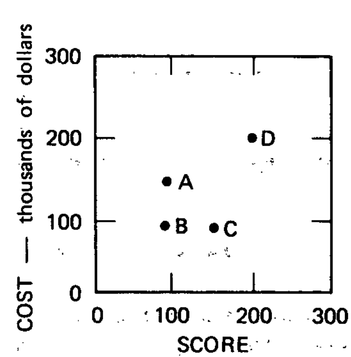

Figure 3. Cost-effectiveness of four sample alternatives.

the effect of setting a dollar equivalence to the score, because only projects with a higher score per $1,000 would be judged worth constructing. Based on experience with past projects, there may turn out to be different levels for different facility types, which would indicate the degree of preference for each project type relative to other types. In the case of projects A, B, C, and D in the foregoing example, if the minimum acceptable score was 0.8 points per $1,000 and the projects were independent, projects B, C, and D would be acceptable within a budget of $400,000 or more.

If the projects were mutually exclusive (alternatives for the same site), project C should be chosen because it dominates A and B, and the incremental score/dollar ratio of D compared with C is only 0.5 points per $1,000. Select non-mutually exclusive projects within a budget limitation in order of their score/dollar ratios until either the available budget is exhausted or the lowest acceptable score per $1,000 is reached. Note that an alternative to this cost-effectiveness approach to project selection is to simply apply the score/dollar ratio to project scores and conduct the selection process as an economic analysis directed to maximizing net present value.

DISCUSSION OF MEASUREMENT TECHNIQUES

As the focal point of this research, great care was taken in selection of evaluation variables and in development of specific measurement techniques for each variable. It soon became apparent that well-developed measurement techniques appropriate to pedestrian facilities were not available for most of the selected variables. Thus, what had been planned as a moderate effort to choose and adapt appropriate techniques became a major development effort.

The previous section described the choice of a unitless scoring system for variable measurements. A scoring technique was developed for each variable ranging from +10 to −10. The maximum positive (desirable) score is +10, a neutral or does-not-apply score is 0, and the largest negative (undesirable) score is −10. Several basic techniques were used to develop a scoring system for each of the selected 36 variables. These basic techniques are described in the following and illustrated with examples from Appendix A.

Types of Measurement Techniques Used

Selection of Value from Table

When this technique is used, the score for the variable is obtained by performing some measurement or observation and looking in a table for the corresponding score. For example, pedestrian density (2.2.3) is scored by determining the average amount of space available for each pedestrian, then looking up the corresponding score in Table 2. In this case, a practical guide is also given for determining the amount of space per pedestrian. An area can be marked off or may already be available (e.g., concrete pavement separators). Then the number of pedestrians per block can be observed—the sample box given is about 8 ft (2.5 m) square—and the corresponding values obtained.

TABLE 2
PEDESTRIAN DENSITY AND LEVEL OF SERVICE

Number of Persons per 7'10" Square Box	Amount of Space (Square feet* per person)	Level of Service	Score
6 or more	10 or less	Measurable delay numerous conflicts	-10
5	12	Crowded	-6
4	15		-4
3	20	Constrained	0
2	30		4
1	60	Impeded	7
1/2	120		9
1/3	180	Free flow	10
Fewer than 1/23	1400 or more	Empty	6

*To convert square feet to square meters, multiply by 0.0929.

Simple Formula

This scoring technique is illustrated by noise impacts of motor vehicles (2.3.2). In this case both a formula (Eq. 1) and a corresponding graphic scale (Fig. 4) are given for value selection. The appropriate score value is selected after a series of sound readings have been taken and averaged for the facility under evaluation (or estimated for proposed facilities).

This example also illustrates an important measurement feature, the setting of practical end points. Sound levels below 40 db(A) are not often encountered. Because values below this level would not be of added worth to users, a maximum score of +10 is used for all values less than or equal to 40 db(A). Sound levels above 90 db(A) make speech unintelligible and are actually hazardous to health. Therefore, the most undesirable score (—10) is assigned for any sound level greater than or equal to 90 db(A). Assignment of practical end points has three valuable characteristics:

- The resulting smaller range of values allows greater sensitivity in the scoring of different facilities.
- More uniform scoring is frequently made possible because unusual characteristics often appear at the ends of a scale rather than in the middle.
- The occurrence of values beyond the suggested end points alerts the evaluator to unusual conditions that may require special consideration on the part of planners or decision-makers (this situation is noted where appropriate in Appendix A).

Summed Table Values

Figure 5 illustrates the scoring technique used for accident threat concern (2.1.2). This variable appears in the measurement techniques in addition to an accident variable (2.1.1) because utilization of a pedestrian facility is affected both by its actual accident history and by the apparent or perceived threat of accidents. Scoring for this variable is done by checking or circling the value that applies for each component listed in the left-hand column. The value se-

90 db(A)	77.5 db(A)	65 db(A)	52.5 db(A)	40 db(A)
-10	-5	0	+5	+10

Any noise level over 90 db(A) scores -10
Any noise level under 40 db(A) scores +10

$$\text{Total NOISE SCORE} = -10 + \left[(90 - \text{observed or estimated noise level}) \times 0.4\right]$$

= ________

Figure 4. Noise level scoring.

		Positive		Average		Negative	
Vehicles	Traffic Volume	Low	2	Med	0	High	2
	Traffic Speed	Low	2	Med	0	High	2
	Turning Conflicts	Few	1	Mod	0	Many	1
	One-way Traffic	Yes	1	No	0		--
	Vehicle Mix		--	Mixed	0	High % Trucks Buses	1
Setting	Crosswalks	Marked	1		--	Unmarked	1
	Signalization	Veh and Ped	1	Veh Only	0	None	1
	Sight Distance	Good	1	Mod	0	Poor	1
	Lighting	Good	1	Mod	0	Poor	1

Sum the column values: Positive = ____ Average = 0 Negative = ____

Total ACCIDENT THREAT SCORE is Positive Sum - Negative Sum = ________

Figure 5. Accident threat concern scoring.

lected may be positive, average, or negative. After a value is selected for each component, the positive and negative columns are each added as indicated. The total score is obtained by subtracting the negative sum from the positive sum.

Another measurement feature is illustrated by this example. Note that the components "traffic volume" and "traffic speed" are more heavily weighted (two times more) than any other component. This feature is used to indicate the relative importance of each component when some have a greater effect than others. In this example, up to 40 percent of the sum of the positive points (or negative points) can be contributed by the two named components, whereas the other seven combined can contribute only 60 percent of the respective sums. This weighting indicates the relatively strong effects of vehicle volume and speed on fear of accidents.

Separately Scored Components

Some variables, such as ease of walking (1.1.2), have components with enough special characteristics that each component is separately measured. The scoring range for each component is established separately, then they are combined to produce a total score for the variable being evaluated. The following indicates the individual range of values possible for each of the five components that together are used to score ease of walking:

Component	Scoring Range
Walking surface	−2 to 2
Grade changes	−4 to 2
Continuity	−1 to 2
Signing	−1 to 2
Lighting	−2 to 2
Total EASE OF WALKING SCORE	−10 to 10

Similar to the previous example, different component scores indicate the relative weight of each of the components within the variable.

Weighted Formula

Complex variables such as societal cost of accidents (2.1.1) and travel time (1.1.1) make use of a type of formula that can be adjusted (or weighted) to comparatively measure several facilities. The formula effectively lowers the possible scoring range for each facility proportionately to the magnitude of a selected scaling parameter. For example,

$$\text{Total COST OF ACCIDENT SCORE} = \frac{\left(\begin{array}{c}\text{Present}\\ \text{number of}\\ \text{crossings}\end{array} \times \begin{array}{c}\text{Present}\\ \text{NI rate}\end{array}\right) - \left(\begin{array}{c}\text{Proposed}\\ \text{number of}\\ \text{crossings}\end{array} \times \begin{array}{c}\text{Proposed}\\ \text{NI rate}\end{array}\right) \times 10}{\begin{array}{c}\text{Maximum of above products}\\ \text{for all facilities being compared}\end{array}} = \underline{\qquad}. \quad (2)$$

is used to score the cost of accidents.

In Eq. 2, the numerator represents the difference between the number of accidents before the proposed facility (present), and after the proposed facility (proposed). The number of accidents for each case is obtained by multiplying the number of crossings by the NI rate (net accident involvement rate), computed by using Figure A-9. The feature being illustrated, however, is the denominator. By selecting the maximum number of accidents (either present or proposed), and dividing the difference in accidents for each individual site by this one number, the individual scores will be proportional to the number of accidents for each facility. For example, if Site A had a reduction of 10 accidents and Site B had a reduction of 5 accidents, the scoring for Site B would be only one-half of the score for Site A. If the denominator were 20, the score for A would be +5 and the score for B would be +2.5 (or rounded to +3). This type of formulation is required for some key variables to maintain a level of comparability for the scores of several facilities.

Qualitative Scoring

Some of the variables under consideration in this project were simply too subjective to devise reasonable quantitative measures. For such variables, discussion and some general guidelines are given in Appendix A. The evaluator is then required to assign a value based on judgment and the guidelines given, as illustrated in Figure 6 for adaptability to future urban development plans (4.3.2).

Criteria for Measurement Technique Selection

Several important criteria were used to guide selection of a measurement type for each variable or component. The first was to choose the measurement type that provided the most precise degree of quantification consistent with the data and information available for the item under consideration. The examples given previously indicate the approximate degree of quantification that could be used in a practical measurement technique for each of the sample variables. The second criterion was a deliberate attempt to measure at least one level deeper in precision than had been previously attempted by others. This criterion was adopted to encourage serious consideration by evaluators and others into the meaning and possible importance of all of the variables. The third criterion was an attempt to estimate the relative importance of components within variables, especially where the literature or discussions between the researchers and others indicated probable unequal weighting between components.

Many of the measurement techniques developed during this research extend beyond the usual level of quantification for the selected variables. Thus, use of the developed measurement techniques and future research will verify some of the observations and will also require changes in others. Users of the results of this research are encouraged to make changes to specific measurement techniques whenever such changes seem appropriate. When somewhat different values seem more appropriate to particular groups of evaluators or decision-makers, they should be used. The researchers' primary objective in development of measurement tech-

-10	-5	0	+5	+10
Requires significant modifications to existing land use and development to accommodate the facility		No significant effect on short- or long-term land use and development plans		Enhances desired land use and growth patterns

FUTURE URBAN PLANS SCORE selected = __________.

Figure 6. Urban plan scoring.

niques has been to develop a flexible, quantitative framework for examining and evaluating the many potential impacts of pedestrian facilities. Thus, the techniques will remain useful even if specific values for individual variables or components change over time.

Treatment of Costable Variables

Five of the 36 evaluation variables are costable; each of these first is expressed in dollar units and then scaled to the standard +10 to −10 range. The first of these, and sometimes the largest in absolute magnitude, is motor vehicle travel costs (1.2.1). Vehicle operating and ownership costs are combined with parking costs, and a dollar equivalent of travel time is also included. Total motor vehicle travel costs are transformed to the unitless +10 to −10 scale based on the change from the existing situation.

Two variables in the retail sector, gross retail sales (3.2.1) and displacement or renovation costs (3.2.2), are computed in dollars. Gross retail sales are translated to the unitless +10 to −10 scale based on their average annual percentage increase; displacement and renovation costs are transformed by expressing them as a fraction of the change in gross sales.

The last two costable variables, tax receipts and other revenue (4.2.1) and cost of providing community services (4.3.2), are in the public sector. These are transformed to the unitless scale by dividing by the existing total city budget for the previous year.

Value of Pedestrian Travel Time

Two other variables, pedestrian travel time (1.1.1) and societal costs of accidents (2.1.1) are frequently translated into dollar costs in transportation studies, but this assignment requires judgments to be made of the value to society of an individual's time and the value of reducing accidents, particularly fatalities and serious injuries. This assignment of value is not required by the methodology, but the procedure for imputing values to each of these variables is described subsequently for use by those who desire it.

By the same means that value can be established for savings in automobile travel time (by observing drivers' and passengers' willingness to pay for time savings by using a faster toll road), pedestrian travel may be evaluated by willingness to pay transit fares to save time. However, there are other factors involved in the pedestrian's decision to take transit, particularly comfort and a chance to sit down while traveling. Nevertheless, a few attempts have been made to quantify the value of pedestrian travel time based on willingness to pay transit fares and other models.

Contemporary investigators have concluded that motor vehicle travel time savings for commute trips should be valued at approximately one-half the prevailing wage rate. Thomas (1968) used 0.5 of the hourly wage rate, Ellis (1972) used 0.5, and Webster (1974) used 0.55. Thomas and Thompson (1971) have shown that the value of travel time varies significantly with the magnitude of time saved per trip. Updated values of their findings presented in Andersen et al. (1975) indicate values of 6.4 percent of the wage rate for time savings of less than 5 min, 32.2 percent between 5 and 15 min, and 52.3 percent over 15 min.

A higher value should be assigned to the travel time of pedestrians than that of passenger car occupants. This is because the motorist is in a climate-controlled environment, physically protected and psychologically insulated from the outside. The pedestrian, on the other hand, pays a higher price for travel because of being rained upon, splashed on, exposed to cold, threatened by accidents, and possibly suffering an invasion of his psychological buffer zone. The pedestrian is frequently a purchaser. All of the face-to-face business transacted in a city, except for a limited number of drive-in facilities, is conducted by pedestrians. Because he makes shorter trips than the motorist, a given delay will account for a larger fraction of his total trip, and thus causes more inconvenience. His time is at a different level of perception from that of the motorist and, therefore, has been valued by researchers at two or three times the rate for motorists. The values derived by various investigators are as follows:

Investigator	Ratio of Pedestrian Travel Time Value to Motorist Travel Time Value
Quarmby (1967)	2 to 3
Lisco (1968)	2.8
Ellis (1972)	2
Pushkarev and Zupan (1975)	3.2
Dawson * (1975)	2

* From personal correspondence.

The elderly, handicapped, young, and poor—because they often do not own automobiles—are likely to be overrepresented among pedestrians in suburban and rural locations. These people are often not employed; thus, they probably assign a lower value than average to their time. Hence, a lower value of time could be used for locations other than central business districts. It is also more appropriate to express pedestrian travel time as a value per minute (than per hour as for passenger car time) because pedestrian trips are usually shorter. Even though the time saved is small compared to the total trip time, it is still perceptible to the pedestrian.

The low values associated with small travel time savings for motorists are related to the variability in motor vehicle travel time for a given trip, which is a function of traffic congestion, time of arrival at traffic lights, presence of law enforcement officers, weather, and the time required to find a parking space. Pedestrians, on the other hand, are more in control of their total travel time, inasmuch as stops for rest, sightseeing, shopping, or conversation are usually discretionary. Only delays due to conflicts with vehicles and other pedestrians are usually beyond the control of the pedestrian. Informal observation by project team members shows that pedestrians are acutely aware of and quite irritated by even small delays, such as turning vehicles or escalator queues. Additional evidence is provided by the design guidelines for new elevator installations in office buildings, which frequently specify average waits of no more than 30 sec and average travel times of no more than 60 to 90 sec (Strakosch, 1967) at a considerable cost expense per elevator. Thus, even small changes in pedestrian travel time, particularly those caused by delays rather than changes in walking distance, should be appropriately valued in the methodology.

Considering all of the foregoing, and making the assumptions listed in the following, acceptable values have been developed for pedestrian travel time. The assumptions are as follows:

- The average wage rate is \$6.00 per hour for pedestrians in a busy central business district (CBD) and \$4.50 per hour for other pedestrians. Webster (1974) used \$5.10. Although the national average wage rate for all private production and nonsupervisory nonagricultural workers was \$4.49 in June 1975, a substantial fraction of pedestrians in the average CBD hold supervisory or professional positions at higher wage rates.
- Automobile travel time is valued at one-half the prevailing average wage rate, and pedestrian travel time is valued at 2½ times the value for an automobile traveler, or 1¼ times the wage rate.
- The value to an employer of his employees' time is 1½ times the wage rate. This takes into account fringe benefits, training costs, and profit or overhead.
- Delays of up to 5 min are valued at twice the average wage rate.
- Leisure travel and the time of limited-mobility groups is valued at ½ the normal rate.
- Children under the age of 16 have a zero value of travel time, except when the travel decision is made by the parents, in which case other trip characteristics (such as safety) may be more important than travel time.

When calculations are performed using the listed assumptions, the guidelines given in Table 3 are obtained. The reader is, of course, free to use other values, particularly to reflect the local economic conditions.

The total cost of pedestrian travel time is obtained by using the data summarized in Appendix A, Sec. 1.1.1.5. The total travel time (in minutes) for each pedestrian group is multiplied by the corresponding values from Table 3, producing travel time costs for the existing situation and for a proposed facility.

TABLE 3

VALUES OF PEDESTRIAN TRAVEL TIME

Type of Pedestrian (or Trip)	Value of Time (per minute): Central Business Districts	Value of Time (per minute): Other Locations
Commuters, workers on lunch break, or unknown mix	12¢	9¢
People in the course of their work	15¢	11¢
Delays (such as stop lights)	20¢	15¢
Other: Leisure trips, personal business, handicapped, retired, or students	6¢	6¢
Elementary school children	0	0

Societal Cost of Accidents

The approach taken to the evaluation of accident costs is to estimate the total societal costs resulting, directly or indirectly, from motor vehicle accidents involving pedestrians. The monetary values presented here are based on the NHTSA study, "Societal Costs of Motor Vehicle Accidents" (U.S. DOT, 1972). When values from this study are updated to 1975 using a 6 percent cost increase per year, the average societal cost of a fatality is estimated at \$239,000; the average cost of a nonfatal injury (average of disabling and nondisabling) is estimated at \$8,700. These values include medical costs (doctors, medication, special services), legal and court costs, hospital costs, loss of income, employer losses, losses to others, funeral cost (for fatalities), cost of community services, pain and suffering, losses in assets, and inurance administration costs.

Pedestrian accident statistics (from *Accident Facts,* 1975) show that in 1974 there were 8,700 pedestrian fatalities out of an estimated 300,000 pedestrian accidents (about 3 percent). The same source lists 120,000 nonfatal pedestrian injuries (40 percent) that were disabling beyond the day of the accident. However, this does not include nondisabling injuries. It is estimated that some personal injury results from almost all reported pedestrian/vehicle accidents. This conclusion is consistent with an intuitive observation on the probable result of an impact between a 150-lb (70 kg) person and a 4,000-lb (1,800 kg) vehicle. This estimate is also supported by other data in *Accident Facts* (1975) where 40 percent of the injuries in all types of accidents are classed as disabling, and 60 percent of the injuries are classed as nondisabling. Thus, the values given in Table 4 are used in estimating the dollar cost of pedestrian accidents.

By combining the previously developed figures with an estimated probability of a pedestrian accident per person crossing in urban areas of 5×10^{-7} (Prokopy, 1974), an estimated societal pedestrian accident cost of \$0.0078 per person crossing is obtained. This combination provides an estimate of accident costs at an existing or planned pedestrian facility based on the number of pedestrians crossing vehicle lanes. But it also should be noted that complete vehicle/pedestrian separation will result in no such crossings, which will reduce the accident cost for such a facility to zero. Planners who are proposing facilities in an area with reliable historic accident experience data can use the previous data and scale it by the estimated number of pedestrian crossings in the proposed facility divided by the estimated number of pedestrian crossings during the corresponding accident data collection period.

TABLE 4

ACCIDENT FREQUENCY AND COST, BY SEVERITY

Accident Severity	Frequency of Severity per Accident	Cost per Accident by Severity
Fatality	3 per 100	\$239,000
Disabling injury	40 per 100	\$ 8,700
Nondisabling injury	57 per 100	
All	100 per 100	\$ 15,600

A technique was developed to modify the basic pedestrian accident risk figure per crossing (5×10^{-7}) by considering several pedestrian, vehicle, environmental, and traffic control factors. The relative accident risk per crossing for each facility (or each crossing point within the facility if necessary) is developed using Figure 7. For each crossing to be analyzed (one representative crossing may be evaluated if several similar crossings are involved), check off the boxes that apply, then sum the results (using the formula below the table) under both present and planned conditions, obtaining net involvement rates (NI rate) for both situations.

After estimating the present and proposed number of pedestrian crossings per year, the following formulas can be used to obtain a dollar cost figure for each site alternative. Eq. 3 can be used if reliable historic accident data are not available, and Eq. 4 or Eq. 5 can be used if such data are available.

$$\begin{aligned}\text{Annual cost} &= \frac{\text{Est. no. of}}{\text{annual accidents}} \times \$15{,}600 \\ &= \text{Accident risk per crossing} \times \text{Proposed no. of crossings} \times \$15{,}600 \\ &= 5 \times 10^{-7} \times \text{Proposed NI rate} \times \text{Proposed no. of crossings} \\ &\quad \times \$15{,}600 \qquad (3)\end{aligned}$$

or

$$\begin{aligned}\text{Annual cost} &= \text{Historic accident risk per crossing} \times \text{Proposed NI rate} \\ &\quad \times \text{Proposed no. of crossings} \times \$15{,}600 \\ &= \frac{\text{Historic no. of accidents}}{\text{Historic no. of crossings} \times \text{Historic NI rate}} \times \text{Proposed NI rate} \\ &\quad \times \text{Proposed no. of crossings} \times \$15{,}600 \qquad (4)\end{aligned}$$

$$\begin{aligned}&= \text{Historic no. of accidents} \times \frac{\text{Proposed NI rate}}{\text{Historic NI rate}} \times \frac{\text{Proposed no. of crossings}}{\text{Historic no. of crossings}} \\ &\quad \times \$15{,}600 \qquad (5)\end{aligned}$$

The estimated accident cost saving of a proposed pedestrian facility equals the present accident cost minus the estimated accident cost of the proposed facility.

DESCRIPTION OF FIELD TEST AND SITE EVALUATIONS

To ensure that the methodology could be applied to real-life situations, the research approach called for testing the methodology at both existing and proposed pedestrian-vehicle separation facilities. Early in the study, for the purpose of sharing preliminary plans and findings, the re-

	Number of:	Rate Decreases				Average		Rate Increases			
PEDESTRIAN	Elderly (⩾65)	Few	10	5%	5	10%	0	20%	20	⩾30%	40
	Very Young (⩽10)	Few	10	1%	5	2%	0	4%	20	⩾8%	40
	Alcohol Involved	None	10	Few	5	Mod	0	Mod-High	20	High	40
	Illegal Crossings	None	5	Few	3	Mod	0	Mod-High	10	High	20
VEHICLE	Average Vehicle Volume	Low	5	Mod-Low	3	Mod	0	Mod-High	5	High	20
	Average Vehicle Speed (mph) (kph)	<15 (<25)	5	15-24 (25-39)	3	25-30 (40-49)	0	31-40 (50-65)	10	>40 (>65)	20
	Turning Conflicts	None	5	Few	3	Mod	0	Freq.	5	Many	10
	One-way Traffic		–	Yes	3		–	No	5		–
ENVIRONMENT	Sight Distance	Good	4	Fairly Good	2	Fair	0	Poor	5	Bad	10
	Crossings After Dark (Good Light)	Few	4	Mod-	2	Mod	0		–		
	Crossings After Dark (Poor Light)		–		–	Few	0	Mod	10	Many	20
	Weather	Mild	4	Mod-Mild	2	Mod	0	Mod-Severe	3	Severe	5
CONTROL	Signalization (Presence)			Ped & Veh	10	Veh Only	0	None	20		
	Police Enforcement (Ped Laws)			Heavy	3	Mod	0	Light	3		
	Active Public Education			Yes	2		–	No	2		

Sum the colums as indicated and divide each sum by 100: Decreases ___/100 = ___ Increases ___/100 = ___

Net Involvement Rate is Increase Rate - Decrease Rate _______ + 1 = _______

Figure 7. Accident involvement rate adjustment.

searchers contacted planners who were proposing pedestrian facilities. After a first draft of the measurement techniques was prepared, field trips were made to four sites to apply the techniques. Observations made during these field trips were the basis for substantial modifications to the measurement techniques. Indeed, Sparks Street in Ottawa was the first personal experience the researchers had with a successful mall; it was reassuring to evaluate favorably all of the important features of the mall, based on criteria developed from reading papers and articles on the subject.

Two planned and two existing pedestrian facilities, representing widely different types, were selected for testing the evaluation methodology:

- A pedestrian overpass under construction at Rainier Avenue South and Empire Way South in Seattle, Wash.
- 20th Avenue N.E./Ravenna Park Bridge (Seattle) closure to motor vehicles.
- Sparks Street Mall, Ottawa, Ont.
- Proposed Fulton Mall, Brooklyn, N.Y.

The sites selected for testing range in complexity from the 20th Avenue N.E. Bridge and the Rainier and Empire overpass, which are relatively simple facilities, to the Fulton Mall and the Sparks Street Mall. Thus, the evaluation methodology received a thorough testing over a broad application range with these four facilities. The diversity of these facilities was an important reason for selecting them as examples. Another reason was that the local planners were actively involved with their specific facilities and eager to work with the researchers.

A sound meter, tape measure, camera and film, four tally registers, and notebooks were the only equipment needed for the field studies. Slightly more than one week was required in each city to collect the necessary data. Table 5 outlines the typical field evaluation procedure conducted at each site.

The actual results of applying the methodology to these four sites are given in Appendix B as four separate case studies presented in the chronological order in which the field tests were performed. In each case study, a brief description of the facility site is given followed by the score for each of the 36 evaluation variables (and their com-

TABLE 5

TYPICAL FIELD TEST PROCEDURE

Initial interview with facility planner or manager to:
- Review objectives of the research
- Identify current status of the facility or plan
- Discuss data requirements
- Request introduction or referral to other key personnel.

Field observation
- Thorough familiarization with the site.
- Pedestrian and vehicular traffic counts.
- Detailed inventory of structures, pedestrian and vehicular pathways, street furniture, and so on.
- Application of the measurement techniques.
- Refinement of the measurement techniques based on these observations.

Additional interviews with facility planner or manager as necessary.

Additional field observations as necessary.

Contacts initiated with other municipal agencies for obtaining additional data elements.

Discussions with local merchants.

Final interview with facility planner or manager.

ponents, if applicable), with a discussion of how the score was arrived at and any other relevant comments. For the sake of brevity, most of the worksheets are not reproduced in this section except for a summary score sheet. Therefore, in following the discussion of variables that are evaluated with the use of checklists, it may be helpful to refer to the appropriate scoring worksheet in Appendix A.

Two important results are illustrated by the case studies presented in Appendix B. The first is that evaluations can be performed with little special equipment and with a reasonable number of evaluator man-hours. The second is that the evaluation method has been demonstrated to be applicable to a broad range of pedestrian-oriented facilities in diverse community settings.

DESCRIPTION OF QUESTIONNAIRE AND RESULTS

Purpose of Questionnaire

Probably the most serious difficulty in use of a weighted scoring system is development of an appropriate set of weights for each facility type. This can be a time-consuming process with many complications, especially when a combination of costable, intangible, and qualitative variables is being considered.

Because the difficulties in development of subjective weights were recognized, a questionnaire was devised to (1) determine the practicality of a weighting system and (2) assist in development of guidelines for value estimation. The questionnaire results are presented for the reader to use as a starting point for development of representative weights for his own community.

TABLE 6

SUMMARY OF QUESTIONNAIRE RESULTS

Variable List	Safety/Movement Facilities: 7 State Agencies	Safety/Movement Facilities: 3 Urban Agencies	Social/Commercial Facilities: 3 Urban Agencies	Safety and Social Facilities: 5 State Agencies	Safety and Social Facilities: 9 Urban Agencies	All (12) State Agencies	All (15) Urban Agencies	Combined (27) State and Urban Agencies
TRANSPORTATION	25.7%	36.5%	21.9%	30.9%	29.3%	27.0%	29.3%	28.2%
Pedestrians								
(1.1.1)* Travel Time	2.9%	4.7%	1.6%	3.6%	3.3%	2.1%	3.2%	2.7%
(1.1.2) Ease of Walking	2.8	3.6	4.4	2.7	3.0	2.8	3.4	3.1
(1.1.3) Convenience (Access and Availability)	2.7	3.2	5.9	3.8	3.3	3.2	3.8	3.5
(1.1.4) Special Provision for Various Groups	2.2	2.7	2.4	2.8	3.0	2.5	2.8	2.7
Motor Vehicles								
(1.2.1) Motor Vehicle Travel Cost	8.5	5.4	0.4	6.5	5.5	7.7	4.5	6.0
(1.2.2) Use of Automobiles	2.2	3.5	0.8	3.2	2.4	2.6	2.3	2.4
(1.2.3) Signal/Signaling Needs Adjacent to Facility	1.4	3.0	1.3	2.1	2.0	1.7	2.1	1.9
Other Community Transportation								
(1.3.1) Adaptability to Future Transportation Development Plans	1.8	4.4	2.1	3.5	3.3	2.5	3.3	2.9
(1.3.2) Impact on Use of Other Transportation Systems	1.2	6.0	3.0	2.7	3.5	1.9	3.9	3.0

	SAFETY/ENVIRONMENT/HEALTH	54.6%	30.2%	24.9%	47.9%	38.9%	52.3%	34.4%	42.6%
	Safety								
(2.1.1)	Societal Cost of Accidents	23.0%	5.8%	0.3%	17.4%	6.9%	20.7%	5.3%	12.3%
(2.1.2)	Accident Threat Concern	11.7	4.5	1.1	5.6	6.3	9.2	4.9	6.9
(2.1.3)	Crime Concern	3.6	3.2	2.1	4.2	2.3	3.9	2.4	3.1
(2.1.4)	Emergency Access/Medical and Fire Facilities	4.1	2.1	2.5	5.4	3.6	4.7	3.1	3.8
	Attractiveness of Surroundings								
(2.2.1)	Pedestrian Oriented Environment	5.3	2.9	9.6	2.0	4.7	4.0	5.3	4.8
(2.2.2)	Litter Control	0.5	1.3	1.9	1.1	1.1	0.8	1.3	1.1
(2.2.3)	Density	1.3	2.1	1.1	2.1	1.4	1.7	1.5	1.5
(2.2.4)	Climate Control and Weather Protection	0.8	1.3	2.8	1.8	1.9	1.2	2.0	1.6
	Environment/Health								
(2.3.1)*	Property Damage Effects of Air Pollution	0.7	0.9	0.7	0.9	1.3	0.8	1.1	1.0
	Health, Psychological and Other Effects of Air Pollution	1.0	1.7	0.7	2.6	2.3	1.7	1.9	1.8
(2.3.2)	Noise Impacts of Motor Vehicles	1.0	1.5	0.5	2.1	1.8	1.5	1.5	1.5
(2.3.3)	Health Effects of Walking (Exercise, Fatigue)	1.0	1.2	0.8	1.9	2.8	1.4	2.1	1.8
(2.3.4)	Conservation of Resources	0.6	1.7	0.8	0.8	2.5	0.7	2.0	1.4
	RESIDENTIAL/BUSINESS	12.1%	14.9%	27.6%	9.9%	19.9%	11.4%	20.4%	16.3%
	Residential Neighborhoods								
(3.1.1)	Residential Dislocation	1.4%	4.7%	0.8%	1.5%	2.9%	1.5%	2.8%	2.2%
(3.1.2)	Community Pride, Cohesiveness and Social Interaction	2.7	2.3	7.9	1.3	4.9	2.1	5.0	3.7
(3.1.3)	Aesthetic Impact, Compatibility with Neighborhood	2.9	2.5	6.1	2.0	2.8	2.6	3.4	3.0
	Commercial/Industrial Districts								
(3.2.2)	Displacement, Replacement, or Renovation	1.2	1.8	2.0	1.6	1.6	1.4	1.7	1.6
(3.2.1)	Profit After Taxes	0.5	0.9	2.2	1.1	2.6	0.8	2.2	1.5
(3.2.3)	Ease of Deliveries and Employee Commuting	1.3	1.6	3.3	1.1	2.1	1.2	2.2	1.8
(3.2.4)	Attractiveness of Area to Business	2.1	1.1	5.3	1.3	3.0	1.8	3.1	2.5
	GOVERNMENT/INSTITUTIONAL	7.6%	18.4%	25.6%	11.3%	11.9%	9.3%	15.9%	12.9%
	Planning Process								
(4.1.1)	Transportation and Land Use Planning Process	1.1%	3.8%	2.9%	2.8%	2.7%	1.8%	3.0%	2.5%
(4.1.2)	Conformance with Requirements and Regulations	0.7	2.0	2.0	2.1	2.9	1.3	2.5	2.0
	Indirect Impacts								
(4.2.1)	Net Change in Tax Receipts and Other Revenue	0.6	2.0	4.2	1.0	1.1	0.8	1.9	1.4
(4.2.2)	Resulting Changes in Employment	0.2	2.0	2.8	0.7	0.9	0.4	11.5	1.0
	Community Impacts								
(4.3.1)	Community Activities	2.6	1.7	6.5	2.0	2.0	2.4	2.8	2.6
(4.2.3)*	Change in Cost of Providing Community Services	1.1	3.0	3.0	1.3	1.3	1.2	2.0	1.6
(4.3.2)	Adaptability to Future Urban Development Plans	1.3	3.9	4.2	1.4	1.0	1.4	2.2	1.8
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

*Identifies final variable number assigned in Appendix A.

Results

Review of responses to a preliminary version of the questionnaire and discussions with respondents led the researchers to conclude that the weights developed by respondents varied by facility objective. Two types of pedestrian facility were designated by major purpose. The safety/movement type includes those facilities where severe pedestrian/vehicle conflicts occur or where high pedestrian volumes result in congestion, and the primary intent is to provide safe, unimpeded, pedestrian movement. The social/commercial type includes diverse pedestrian-oriented activities where the major purpose is to provide a safe and enjoyable place for pedestrians to move leisurely and linger, or to shop. Overpasses and pedestrian transit corridors are examples of the first type; malls and small urban parks are examples of the second type.

Questionnaires were sent to (a) 13 state highway or transportation agencies, (b) planning departments or other agencies of 93 city governments (65 of which were known to have pedestrian malls), and (c) 18 other individuals with whom the research team had made contacts. Respondents were requested to identify which type of facility they were considering, or if both types were being considered together. From the 27 completed questionnaires, 10 respondents chose the safety/movement type, 3 chose the social/commercial orientation, and 14 indicated that both types were considered together (combined facilities).

Responses were grouped first by the three facility types then by type of respondent, either as state agencies or as urban agencies (mostly city planners). The results are presented in Table 6, in which Col. 1 lists the 36 variables, by categories and by groups, described in the questionnaire. Because slight modifications were made after the questionnaire was distributed, the current variable number (as in Fig. 1 and App. A) is given for each questionnaire variable.

Cols. 2 through 6 give the average weight for each variable by facility type and respondent type, as well as the sum of the weights within each major category (such as transportation). Cols. 7, 8, and 9 give the average of all state responses, the average of all urban responses, and the average of all responses, respectively.

Comparison of the weight averages by facility type (both state and local values combined) indicated that few significant differences existed between combined facilities and safety/movement-only facilities. Thus it appears that no differentiation need be made between safety facilities and all types of facilities combined when developing a set of weights for community use. However, the questionnaire responses for social/commercial-oriented facilities were significantly different from both safety-only and combined weights. Discussions with other planners indicated similar differences. Thus, when social/commercial objectives are the primary basis for pedestrian facilities, a somewhat different set of weights may be appropriate.

The researchers have developed suggested weights for evaluators to use as a starting point in developing their own weights. Figure 12 gives suggested weights for combined or safety/movement-only facilities; Figure 13 gives suggested weights for social/commercial facilities. The values in Table 6 and Figures 12 and 13 are presented to provide a perspective on the variations and similarities among sets of weights developed for different pedestrian facility objectives.

CHAPTER THREE

INTERPRETATION, APPRAISAL, APPLICATIONS

POTENTIAL APPLICATIONS OF TECHNIQUES DEVELOPED

The primary objective of this research was to provide a comprehensive methodology for evaluating the social, environmental, and economic benefits of pedestrian facility proposals. Benefits and disbenefits are quantified by a set of measurement techniques developed for the 36 variables presented in Appendix A. The over-all evaluation methodology combines analytic measurements of the 36 variables and explicitly stated subjective values (weights) of decision-makers on the relative importance of each variable.

Because many of the variables are subjective in nature (e.g., comfort, attractiveness, noise), the calculation of benefits is performed using a unitless scale of positive and negative values (+10 to −10) for each variable. Positive values correspond to desirable characteristics; negative values indicate undesirable characteristics. Zero values indicate either "does not apply" or "indifference" (neither good nor bad).

Unitless scoring allows comparison of alternatives without the need for assigning dollar values to the many non-economic impacts of pedestrian facilities (and many other public projects). Guidance is also provided for obtaining benefit values in dollars, if required, to allow comparison of pedestrian facilities with other budget expenditures. The primary basic use of the methodology is for evaluation and comparison of proposals for pedestrian facilities, according to the objectives of this research. This application is described in detail in the section "Instructions to Users." Another use of the scoring system is to evaluate existing pedestrian problem locations on a comparative basis. This could be used to indicate the need for improvements on a priority basis. The scoring system may also be used as a design evaluation tool to encourage alterations that will increase the benefits obtained from pedestrian facilities.

Explicit weighting of the relative importance of each variable requires a formalization of preference values for the community. This determination may be made by the decision-maker alone, or may be the result of extensive public participation. Once developed, the explicit use of such weights provides consistent evaluation criteria. These preference weights may be applicable to other public projects as well.

Possibly the greatest advantage of the suggested methodology is that it allows and encourages use of many benefit measures usually excluded from conventional economic analysis. By reflecting community needs and values that are not easily quantified, use of the method may provide adequate justification for projects not defendable previously by economic analysis alone. Thus, objective benefit measurements, coupled with the explicit identification of relative importance values, produce a method that may aid in "preserving and fostering an urban environment drawn to human scale, with values, services, and facilities that respond fully to the needs of various groups that make up the urban community" (OECD, 1969).

INSTRUCTIONS TO USERS

Transportation projects, including pedestrian facilities, should be evaluated as early in the planning and design process as is practical, so that shortcomings can be detected and steps taken to remedy them. The evaluation may then be repeated throughout the planning process as often as new plans are proposed or major changes are made to existing plans. The evaluation procedure may also be used as an aid to the design process by purposely designing facilities that will score high values.

Figure 8 is a flow chart of the steps to be performed for a pedestrian facility evaluation. The diamonds are decision points that allow the user the option of taking shortcuts within the over-all procedure if time or available resources are limited.

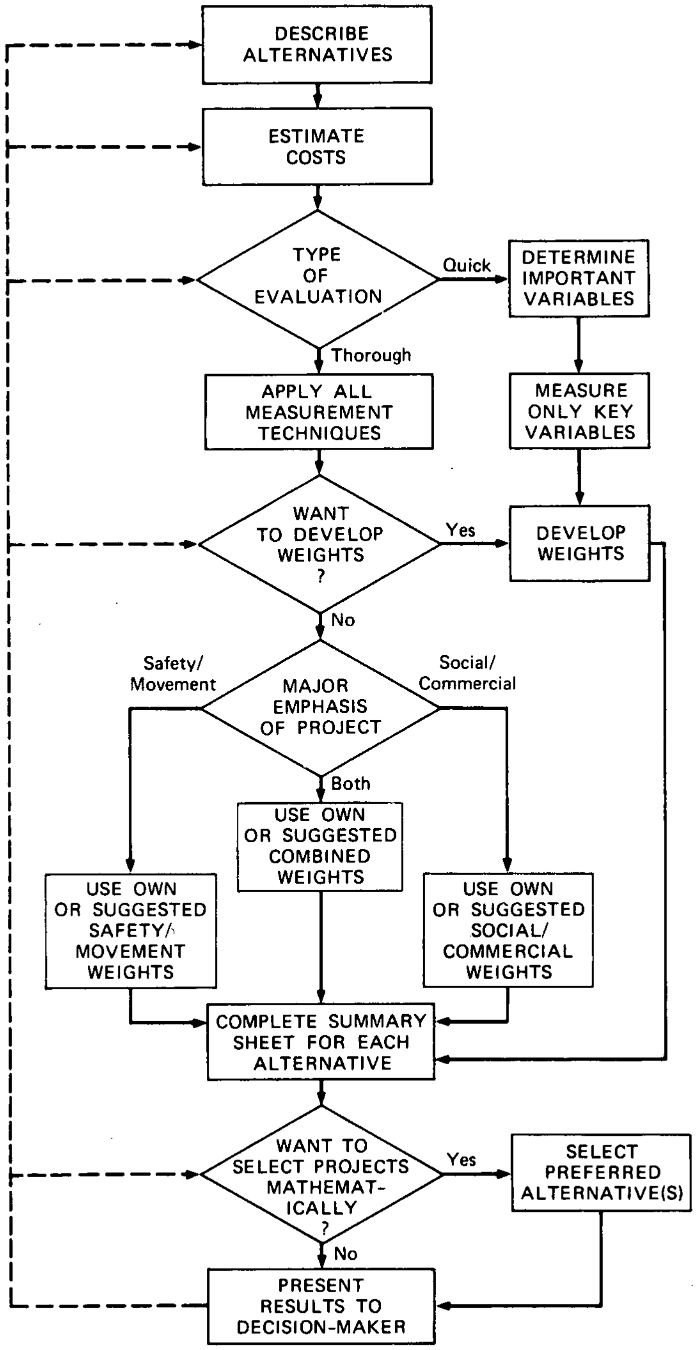

Figure 8. Pedestrian facility evaluation methodology.

Describe Alternatives

The first step of the process is to describe all of the alternative facilities being considered as potential solutions to an existing pedestrian problem. If the study is concerned with only one or a few problem locations or proposed projects, several alternatives representing a range of solutions should be considered and fully described for the evaluation. Location of the proposed facility, its proposed configuration, projected use levels, user profiles, operation characteristics, and any modifications to existing laws or regulations should be specified.

If an entire city-, region-, or statewide plan for pedestrian transportation is being prepared, the specific project alternatives may not always be defined in as much detail as for a single location. In this case, the locations of proposed improvements may be more important than the improvements themselves.

Estimate Costs

An integral component of the process for identifying project alternatives is to estimate costs for the different pedestrian facilities being considered. Table 7 gives all of the major cost categories for implementation and operation of pedestrian-oriented facilities. Make the best estimates

TABLE 7

MAJOR COST COMPONENTS OF PEDESTRIAN FACILITIES

1. Design and architect costs

2. Financing costs and legal fees

3. Site preparation
   - Real estate acquisition
   - Demolition
   - Drainage
   - Grading
   - Utilities relocation
   - Foundation

4. Construction
   - Height, width, and length of facility
   - Length of span (if any)
   - Method of support
   - Enclosures (if any)
   - Materials
   - Construction method used

5. Finishing touches
   - Walkway paving, curbs
   - Lighting
   - Street furniture
   - Amenities
   - Landscaping

6. Operation and maintenance
   - Cleaning
   - Gardening
   - Maintenance and repairs
   - Lighting
   - Security
   - Taxes

possible for the costs associated with each category for the facilities being evaluated. Because the primary purpose of the evaluation in most cases is to compare alternatives, the accuracy of the total cost estimate is not as important as the differences in costs for the various alternatives. This should give encouragement to the planner who is uncertain about the magnitudes of individual cost components. The same observation holds for the benefits determination process: differences between alternatives are more important than the actual score for a particular project proposal. However, if a more detailed cost estimation procedure is desired at this stage in the evaluation process, the reader is directed to Chapter V, "Facility Costs," of *A Manual for Planning Pedestrian Facilities* (Prokopy, 1974), which describes a step-by-step costing approach that is tailored for each particular type of facility.

Assess Benefits

The next step of the methodology is to assess the benefits of the proposed facility. This procedure has been the focal point of the research, and as such will require the greatest effort on the part of the user. However, it is an operation that was previously unavailable, and its existence now will allow more informed public decision-making with complete specification of the impacts of various alternatives.

A total of 36 variables completely specify all primary and secondary impacts of a major facility. However, for quick assessments or for evaluations of very simple facilities, not all of these variables are needed. Therefore, before evaluating any benefits look through the variables discussed in Appendix A and simply cross out those it is not desired to include in this particular analysis. (This is equivalent to assignment of zero benefit to the variables that are eliminated.)

Next apply the instructions for measuring impacts given in Appendix A to all of the variables that remain. Appendix A has been designed to be completely self-contained, so this action is a matter of following the instructions given there, although it may be rather time consuming. Each variable is scored on a uniform +10 to −10 scale. If for any reason it appears that a variable would not apply to a particular facility being evaluated, score zero for that variable.

A project summary sheet (Fig. 9) should be prepared for each alternative under consideration. Record the score for each variable in the "variable score" column on the project summary sheet.

Assign Weights

After the benefits for each proposed alternative have been quantified by using the measurement techniques in Appendix A and properly recorded on the project summary worksheet, it is time to develop weights that reflect the relative priorities of the different impacts. These may be determined directly by the decision-maker (or his representative) based on inputs from groups affected by the facility; or may be selected from the suggested weights developed during this project on the basis of observations, discussions, the researchers' judgment, and the results of a questionnaire distributed to state and local pedestrian facility planners (described in Ch. Two and App. C). These suggested priorities assign a positive weight to every variable, so if some of the variables were eliminated from the analysis in the previous step and the suggested weights are used without modification, it will not be possible for a facility to achieve a perfect score. This can be remedied by proportionately reallocating to other variables the weights of variables that have been eliminated.

Once a set of weights has been developed or selected by the decision-maker, that set can and should be used for all similar projects. The weights need only be revised occasionally to reflect changes in the preferences of the community, decision-makers, or office-holders. This will produce comparable scores for all proposals evaluated. If the weights are changed significantly, resulting scores cannot be directly compared but must be adjusted by the ratio of the differing weights.

Name of Project ______________

Cost initial$ ______ annual $ ______

Total Score

		Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1 Travel Time			
	1.1.2 Ease of Walking			
	1.1.3 Convenience			
	1.1.4 Special Provisions			
1.2 Motor Vehicle Transportation	1.2.1 Vehicle Travel Costs			
	1.2.2 Use of Automobiles			
	1.2.3 Signal/Signing Needs			
1.3 Other Community Transportation	1.3.1 Future Transportation Plans			
	1.3.2 Existing Transportation			
2.1 Safety	2.1.1 Cost of Accidents			
	2.1.2 Accident Threat			
	2.1.3 Crime Concern			
	2.1.4 Emergency			
2.2 Attractiveness of Surroundings	2.2.1 Pedestrian Oriented Environment			
	2.2.2 Litter Control			
	2.2.3 Density			
	2.2.4 Climate Control & Weather Protection			
2. 3 Environment/ Health	2.3.1 Air Pollution			
	2.3.2 Noise			
	2.3.3 Health			
	2.3.4 Conservation			
3.1 Residential Neighborhoods	3.1.1 Residential Dislocation			
	3.1.2 Community Pride & Inter-action			
	3.1.3 Aesthetics & Compatibility			
3.2 Commercial/ Industrial Districts	3.2.1 Retail Sales			
	3.2.2 Displacement or Renovation			
	3.2.3 Deliveries & Commuting			
	3.2.4 Attractiveness to Business			
4.1 Planning Process	4.1.1 Public Participation			
	4.1.2 Requirements & Regulations			
4.2 Economic Impacts	4.2.1 Tax Receipts			
	4.2.2 Employment			
	4.2.3 Community Services			
4.3 Community Impacts	4.3.1 Community Activities			
	4.3.2 Future Urban Plans			
	4.3.3 Construction			

Figure 9. Project summary sheet.

Direct Determination

The purpose of developing a set of weights is to incorporate the decision-maker's perception of the relative importance of changes in degree of impact of the evaluation variables used in the methodology. The procedure is to assign a separate set of values expressed in percentages for each of the three levels of impacts (categories, groups, and variables), the sum of each level being 100 percent. When the percentage values assigned to the three levels for a particular variable are multiplied together, the resulting product indicates the relative importance of that factor in the total evaluation process. For example, if values of 20 percent, 40 percent, and 30 percent are assigned to the headings transportation (category), pedestrians (group), and travel time (variable), respectively, by multiplying ($0.2 \times 0.4 \times 0.3 = 0.024$), a value of 2.4 percent is obtained as the relative weight of the variable "travel time" (1.1.1).

The following procedure is suggested to assist the reader in developing a set of relative values:

1. Refer to Figure 10, which is a worksheet for use in assigning a set of values as previously described.
2. Review Appendix A and the results of the measurements to become familiar with the categories and descriptions of the variables as listed on the worksheet (Fig. 10).
3. Rank order (1, 2, 3, etc.) each of the three levels of impacts. First rank order the major categories, then the groups within each major category, and finally each subset of individual variables. This may be easier than attempting to assign actual values on the first attempt.
4. Repeat Step 3, refining the rank ordering into percentages. This is shown in Figure 11, a sample completed worksheet. Zero is a legitimate percentage value to use at any level (e.g., signal/signing needs adjacent to facility in Fig. 11). Zeroes should also be assigned to the variables that were previously eliminated from the evaluation.
5. Review the assigned weights and revise them if desired. Check the arithmetic to see that each sum adds to 100 percent.
6. Multiply the three level weights together to determine and compare the resulting relative weight of each individual factor. Round the percentages to the nearest tenth (e.g., $25\% \times 35\% \times 30\% = 0.02625$ is rounded to 2.6%).
7. If desired, it is possible to allow different constituencies to express their individual preferences. Have a representative of each group indicate its preferences on a copy of Figure 10. These multiple results may then be used in one of three ways:
   (a) If equal importance is applied to each of the groups completing the worksheet, simply take the average weight for each variable from the last column of the worksheets prepared by the groups as the composite weight.
   (b) If some groups are more important, vocal, or influential than others, assign weights (adding up to 100%) indicating the relative importance of the groups. Then take the weighted average for each variable from the last column of the completed worksheets as the composite weight.
   (c) If the different groups have completely different sets of values, a composite weighting would not reflect the variance. For example, if values assigned to safety were 40 percent and 2 percent, the average (21 percent) is a compromise that does not indicate how much safety is valued by the first group or how little it is valued by the other. In these cases, it is not necessary to combine the community's preferences at this point. Instead, perform a separate evaluation of the alternatives for each group. Each evaluation would use the same objective measurements, but the weights will be different. Present the objective measurements, each group's subjective weights, and final score for the proposed project alternatives (a) to the community and to the decision-maker or (b) to the community and allow the decision-maker to achieve a compromise based on public meetings, private meetings, and his own judgment.
8. Transfer the results from the last column of the weight assignment worksheet (Fig. 10) to the second column of the project summary sheet (Fig. 9).

Use of Suggested Weights

If a quick evaluation is being made, it is possible to apply a set of weights developed by the researchers, rather than the reader. One advantage of these standard weights (other than the obvious savings of time and effort) is that evaluations performed in different cities or states will be directly comparable. Even if the reader is developing weights to represent community preference, an examination of the suggested weights might provide insights, particularly on the difference in emphasis between facility types.

Two types of pedestrian facilities have been identified based on their major purpose. The *safety/movement* type includes those facilities where severe pedestrian/vehicle conflicts occur or where high pedestrian volumes result in congestion, and the primary intent is to provide safe unimpeded pedestrian movement. The *social/commercial* type includes planned activity pedestrianization where the major purpose is to provide a safe and enjoyable place for pedestrians to move leisurely and stop. Overpasses are examples of the first type; malls are examples of the second type.

Suggested weights for safety or movement facilities are shown in Figure 12. Figure 13 shows the recommended weights for social or commercial facilities. If the evaluation combines both project types, the weights given in Figure 12 are used. Transfer the weights from the final column of the appropriate figure to the second column of the project summary worksheet (Fig. 9).

Summary Step

At this point in the evaluation, the project summary sheet (Fig. 9) should have the first two columns (variable score and variable weighting) completed. The sheet should also indicate the name of the project and the initial construction and annual operating costs for each alternative considered. The third column (weighted score) is completed by multiplying the objective measurement score for each variable (first column) by the weight (second column) in percent (not decimal form). The total weighted score of the benefits for a pedestrian facility is simply the sum of all the individual weighted scores. Use of percent values as indi-

Types of Facilities Being Evaluated

- ☐ Safety/Movement Only
- ☐ Social/Commercial Only
- ☐ Both Types Together

Rank Order | Percent-Ages | Levels of Impacts | Weight of Each Variable

___/___% I. Transportation

___/___% Pedestrians

- ___/___% Travel Time ______%
- ___/___% Ease of Walking ______
- ___/___% Convenience (Access and Availability) ______
- ___/___% Special Provision for Various Groups ______

(100%)

___/___% Motor Vehicles

- ___/___% Motor Vehicle Travel Costs ______
- ___/___% Use of Automobiles ______
- ___/___% Signal/Signing Needs Adjacent to Facility ______

(100%)

___/___% Other Community Transportation

- ___/___% Adaptability to Future Transportation Development Plans ______
- ___/___% Impact on Use of Other Transportation Systems ______

(100%) (100%)

___/___% II. Safety/Environment/Health

___/___% Safety

- ___/___% Societal Cost of Accidents ______
- ___/___% Accident Threat Concern ______
- ___/___% Crime ______
- ___/___% Emergency Access/Medical and Fire Facilities ______

(100%)

___/___% Attractiveness of Surroundings

- ___/___% Pedestrian Oriented Environment ______
- ___/___% Litter Control ______
- ___/___% Density ______
- ___/___% Climate Control and Weather Protection ______

(100%)

___/___% Environment/Health

- ___/___% Effects of Air Pollution ______
- ___/___% Noise Impacts of Motor Vehicles ______
- ___/___% Health Effects of Walking (exercise, fatigue, etc.) ______
- ___/___% Conservation of Resources ______

(100%) (100%)

___/___% III. Residential/Business

___/___% Residential Neighborhoods

- ___/___% Residential Dislocation ______
- ___/___% Community Pride, Cohesiveness, and Social Interaction ______
- ___/___% Aesthetic Impact, Compatibility with Neighborhood ______

(100%)

___/___% Commercial/Industrial Districts

- ___/___% Gross Retail Sales ______
- ___/___% Displacement or Renovation ______
- ___/___% Ease of Deliveries and Employee Commuting ______
- ___/___% Attractiveness of Area to Business ______

3 (100%) (100%)

___/___% IV. Government/Institutional

___/___% Transportation and Land Use Planning Process

- ___/___% Public Participation in the Planning Process ______
- ___/___% Conformance with Requirements and Regulations ______

(100%)

___/___% Economic Impacts

- ___/___% Net Change in Tax Receipts and Other Revenue ______
- ___/___% Resulting Changes in Employment ______
- ___/___% Change in Cost of Providing Community Services ______

(100%)

___/___% Community Impacts

- ___/___% Community Activities ______
- ___/___% Adaptability to Future Urban Development Plans ______
- ___/___% Construction Period ______

(100%) (100%) (100%) (100%)

Figure 10. Worksheet.

Types of Facilities Being Evaluated

- ☐ Safety/Movement Only
- ☐ Social/Commercial Only
- ☐ Both Types Together

Rank Order	Percent-Ages			Levels of Impacts	Weight of Each Variable
2	20%	I.		Transportation	
		1 /40%		Pedestrians	
			1 /30%	Travel Time	2.4%
			4 /20%	Ease of Walking	1.6
			3 /20%	Convenience (Access and Availability)	1.6
			2 /30%	Special Provision for Various Groups	2.4
			(100%)		
		2 /40%		Motor Vehicles	
			1 /90%	Motor Vehicle Travel Costs	7.2
			2 /10%	Use of Automobiles	.8
			3 /0%	Signal/Signing Needs Adjacent to Facility	0
			(100%)		
		3 /20%		Other Community Transportation	
			1 /80%	Adaptability to Future Transportation Development Plans	3.2
			2 /20%	Impact on Use of Other Transportation Systems	.8
		(100%)	(100%)		
1	60%	II.		Safety/Environment/Health	
		1 /80%		Safety	
			1 /70%	Societal Cost of Accidents	33.6
			2 /10%	Accident Threat Concern	4.8
			3 /10%	Crime	4.8
			4 /10%	Emergency Access/Medical and Fire Facilities	4.8
			(100%)		
		3 /10%		Attractiveness of Surroundings	
			2 /30%	Pedestrian Oriented Environment	1.8
			4 /10%	Litter Control	.6
			1 /40%	Density	2.4
			3 /20%	Climate Control and Weather Protection	1.2
			(100%)		
		2 /10%		Environment/Health	
			1 /40%	Effects of Air Pollution	2.4
			3 /30%	Noise Impacts of Motor Vehicles	1.8
			2 /20%	Health Effects of Walking (exercise, fatigue, etc.)	1.2
			4 /10%	Conservation of Resources	.6
		(100%)	(100%)		
3	10%	III.		Residential/Business	
		1 /50%		Residential Neighborhoods	
			2 /20%	Residential Dislocation	1.0
			3 /30%	Community Pride, Cohesiveness, and Social Interaction	1.5
			1 /50%	Aesthetic Impact, Compatibility with Neighborhood	2.5
			(100%)		
		2 /50%		Commercial/Industrial Districts	
			1 /50%	Gross Retail Sales	2.5
			2 /20%	Displacement or Renovation	1.0
			4 /10%	Ease of Deliveries and Employee Commuting	.5
			3 /20%	Attractiveness of Area to Business	1.0
	3	(100%)	(100%)		
4	10%	IV.		Government/Institutional	
		2 /20%		Transportation and Land Use Planning Process	
			1 /60%	Public Participation in the Planning Process	1.2
			2 /40%	Conformance with Requirements and Regulations	.8
			(100%)		
		3 /10%		Economic Impacts	
			1 /50%	Net Change in Tax Receipts and Other Revenue	.5
			3 /20%	Resulting Changes in Employment	.2
			2 /30%	Change in Cost of Providing Community Services	.3
			(100%)		
		1 /70%		Community Impacts	
			1 /60%	Community Activities	4.2
			3 /20%	Adaptability to Future Urban Development Plans	1.4
			2 /20%	Construction Period	1.4
(100%)		(100%)	(100%)		(100%)

Figure 11. Sample completed worksheet.

Name of Project ______________

Cost initial$ ______ annual $ ______

Total Score

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time		2.5 %	
	1.1.2	Ease of Walking		3.0	
	1.1.3	Convenience		3.5	
	1.1.4	Special Provisions		2.5	
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs		6.0	
	1.2.2	Use of Automobiles		2.5	
	1.2.3	Signal/Signing Needs		2.0	
1.3 Other Community Transportation	1.3.1	Future Transportation Plans		3.0	
	1.3.2	Existing Transportation		3.0	
2.1 Safety	2.1.1	Cost of Accidents		12.0	
	2.1.2	Accident Threat		7.0	
	2.1.3	Crime Concern		3.0	
	2.1.4	Emergency		3.5	
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment		5.0	
	2.2.2	Litter Control		1.0	
	2.2.3	Density		1.5	
	2.2.4	Climate Control & Weather Protection		1.5	
2.3 Environment/ Health	2.3.1	Air Pollution		3.0	
	2.3.2	Noise		1.5	
	2.3.3	Health		1.5	
	2.3.4	Conservation		1.5	
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation		2.0	
	3.1.2	Community Pride & Inter-action		3.5	
	3.1.3	Aesthetics & Compatibility		3.0	
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales		1.5	
	3.2.2	Displacement or Renovation		1.5	
	3.2.3	Deliveries & Commuting		2.0	
	3.2.4	Attractiveness to Business		2.5	
4.1 Planning Process	4.1.1	Public Participation		2.5	
	4.1.2	Requirements & Regulations		2.0	
4.2 Economic Impacts	4.2.1	Tax Receipts		1.5	
	4.2.2	Employment		1.0	
	4.2.3	Community Services		1.5	
4.3 Community Impacts	4.3.1	Community Activities		2.5	
	4.3.2	Future Urban Plans		2.0	
	4.3.3	Construction		1.0	

Figure 12. Suggested safety/movement or combined weights.

Name of Project ____________

Cost initial$______ annual $______

Total Score

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time		1.5%	
	1.1.2	Ease of Walking		2.5	
	1.1.3	Convenience		3.5	
	1.1.4	Special Provisions		3.0	
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs		0.5	
	1.2.2	Use of Automobiles		1.0	
	1.2.3	Signal/Signing Needs		1.5	
1.3 Other Community Transportation	1.3.1	Future Transportation Plans		1.5	
	1.3.2	Existing Transportation		3.0	
2.1 Safety	2.1.1	Cost of Accidents		3.0	
	2.1.2	Accident Threat		2.0	
	2.1.3	Crime Concern		3.0	
	2.1.4	Emergency		3.0	
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment		10.0	
	2.2.2	Litter Control		2.0	
	2.2.3	Density		2.0	
	2.2.4	Climate Control & Weather Protection		2.0	
2.3 Environment/ Health	2.3.1	Air Pollution		4.0	
	2.3.2	Noise		2.5	
	2.3.3	Health		2.5	
	2.3.4	Conservation		2.0	
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation		2.0	
	3.1.2	Community Pride & Inter-action		6.0	
	3.1.3	Aesthetics & Compatibility		4.0	
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales		2.5	
	3.2.2	Displacement or Renovation		2.5	
	3.2.3	Deliveries & Commuting		2.5	
	3.2.4	Attractiveness to Business		4.5	
4.1 Planning Process	4.1.1	Public Participation		3.5	
	4.1.2	Requirements & Regulations		1.0	
4.2 Economic Impacts	4.2.1	Tax Receipts		3.5	
	4.2.2	Employment		2.0	
	4.2.3	Community Services		1.0	
4.3 Community Impacts	4.3.1	Community Activities		5.0	
	4.3.2	Future Urban Plans		2.5	
	4.3.3	Construction		1.5	

Figure 13. Suggested social/commercial weights.

Name of Project SPARKS STREET MALL

Cost initial $1,500,000 annual $34,800

+391 Total Score

Category	No.	Variable	Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time	+1	1.5 %	2
	1.1.2	Ease of Walking	+7	2.5	18
	1.1.3	Convenience	+4	3.5	14
	1.1.4	Special Provisions	0	3.0	0
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs	+1	0.5	1
	1.2.2	Use of Automobiles	+1	1.0	1
	1.2.3	Signal/Signing Needs	0	1.5	0
1.3 Other Community Transportation	1.3.1	Future Transportation Plans	+5	1.5	8
	1.3.2	Existing Transportation	0	3.0	0
2.1 Safety	2.1.1	Cost of Accidents	+6	3.0	18
	2.1.2	Accident Threat	+8	2.0	16
	2.1.3	Crime Concern	+8	3.0	24
	2.1.4	Emergency	+6	3.0	18
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment	+7	10.0	70
	2.2.2	Litter Control	0	2.0	0
	2.2.3	Density	-4	2.0	-8
	2.2.4	Climate Control & Weather Protection	-6	2.0	-12
2.3 Environment/ Health	2.3.1	Air Pollution	+5	4.0	20
	2.3.2	Noise	+4	2.5	10
	2.3.3	Health	+4	2.5	10
	2.3.4	Conservation	+10	2.0	20
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation	0	2.0	0
	3.1.2	Community Pride & Inter-action	+4	6.0	24
	3.1.3	Aesthetics & Compatibility	0	4.0	0
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales	+4	2.5	10
	3.2.2	Displacement or Renovation	+1	2.5	3
	3.2.3	Deliveries & Commuting	-5	2.5	-13
	3.2.4	Attractiveness to Business	+6	4.5	27
4.1 Planning Process	4.1.1	Public Participation	+6	3.5	21
	4.1.2	Requirements & Regulations	+10	1.0	10
4.2 Economic Impacts	4.2.1	Tax Receipts	0	3.5	0
	4.2.2	Employment	+2	2.0	4
	4.2.3	Community Services	0	1.0	0
4.3 Community Impacts	4.3.1	Community Activities	+10	5.0	50
	4.3.2	Future Urban Plans	+10	2.5	25
	4.3.3	Construction	0	1.5	0

Figure 14. Sample project summary sheet for the Sparks Street Mall.

cated will result in a "total score" for the facility between +1000 and −1000, which is more suitable for comparing projects than the +10 to −10 scale appropriate for measuring individual benefit variables.

This completes the project evaluation. A completed project summary sheet for each proposed alternative summarizes all of the important information about the impacts of the project. Priorities for a small set of alternatives or a single go/no-go decision may be made directly. If a large number of alternatives is being investigated or a budget allocation programming is being performed, the reader may wish to follow the discussion of "Decision Rules for Project Selection" (Ch. Two).

Figure 14 is a sample project summary sheet for the Sparks Street Mall. Summary sheets for the other three case studies are included in Appendix B.

Conversion to Dollar Values (Optional)

If it becomes desirable to estimate a dollar value for all benefits (for example, to compare with other types of public projects), the following procedure can be used. Record the computed dollar values from Appendix A before conversion to unitless scoring for motor vehicle travel costs (1.2.1), gross retail sales (3.2.1), renovation costs (3.2.2), tax receipts and other revenue (4.2.1), and cost of providing community services (4.3.2). Then use the sections "Value of Pedestrian Travel Time" and "Societal Cost of Accidents" in Chapter Two to compute dollar value estimates for those two variables (1.1.1 and 2.1.1, respectively).

The remaining 29 variables are not readily quantified in dollars, but proxy dollar values can be established by deriving a value per point from the costable variables. For example, if motor vehicle travel costs (1.2.1) scored +10 points, and was weighted at 15 percent, the weighted score would be 150 points (10 points × 15%). If the dollar value was $15,000, each weighted scoring point would be estimated at $100. This procedure should be followed for all seven of the costable variables and an average point value should be computed to apply to the noncostable variables. For example, if the average point value was $100, and if accident threat concern (2.1.2) scored +5 points and was weighted at 6 percent, its weighted score would be 30 points (5 points × 6%), and its proxy dollar value would be $3,000 ($100 × 30 weighted points). A total project dollar benefit value can then be obtained for this example by adding the products of the average point value times the weighted scoring point for each noncostable variable to the dollar values of the seven costable variables identified in the previous paragraph.

An alternative approach is to calculate the average point value of similar types of pedestrian facilities, either approved for construction or already constructed, using their total cost as a rough measure of their benefits. (Such costs should be escalated to current price levels in the case of completed facilities.) A point value obtained this way would provide a lower bound on what the community has demonstrated it is willing to pay per point for such facilities. Higher values for benefit point can be used if benefits are judged by the community to have exceeded costs for completed projects.

CHAPTER FOUR

CONCLUSIONS AND SUGGESTED RESEARCH

CONCLUSIONS

The primary objective of this research, the development of a comprehensive methodology for evaluating the social, environmental, and economic impacts of proposals for pedestrian facilities, has been achieved. Measurement techniques were developed for 36 variables that quantify all significant direct and indirect benefits and disbenefits of facilities separating pedestrians and vehicles. Hundreds of individual parameters are examined as components or characteristics of the 36 measurement variables in Appendix A. The over-all methodology combines analytic measurement of these variables with weights selected by the decision-maker on the relative importance of each variable. The result is a comprehensive and consistent, yet flexible and responsive tool for traffic engineers, planners, developers, architects, evaluators, political decision-makers, lobbyists, and community civic groups.

The over-all methodology and the extensive range of measured parameters provide a broad perspective on the design of pedestrian facilities. The inclusion and quantification of many subjective variables reflect the presence of needs and desires within the community that are usually excluded from conventional economic analyses. Thus, even though the methodology increases the number of impacts considered by the decision-maker, it makes the decision task easier by the use of explicit rather than implied evaluation factors.

SUGGESTIONS FOR FUTURE RESEARCH

Further Refinement of the Measurement Techniques

This research has attempted to develop a comprehensive methodology that evaluates all primary and secondary impacts of a wide variety of pedestrian-oriented facilities. The variables and their components were developed in their present form by the research team from minimal existing information in many cases. Inasmuch as the techniques have been tested only at four locations and only by the researchers responsible for their development, further refinement of the measurement techniques will undoubtedly occur when they are employed in future applications. Development and extension of this research should occur during the first few years that the methodology is used in the design and evaluation phases of a variety of projects that separate pedestrians from vehicles. It certainly would be desirable to collect all of these experiences at some future time.

It is believed that further refinement of the measurement structure, the addition or deletion of variable characteristics and components, the technique for evaluating each component characteristic, the internal weighting of the various components, and the phrasing of the narrative and graphics could be embarked upon as a separate research study for almost any of the 36 evaluation variables. Some variables deserve a higher priority in this reevaluation and reformulation process than others, based on the current state of measurement techniques and the consequent uncertainties that are encountered in formulating them. These priorities are discussed in the following paragraphs.

For most of the 36 variables, the important components that characterize the particular impact have been identified, but the four case studies were insufficient to perfect the relative weightings given to the various components. The implicit weights for each variable were determined as best estimates, based on reading the literature, discussions with facility planners and designers, the four case studies, and personal experience as pedestrians. In some cases, though, assignment of a particular set of weights was not justified, and all of the characteristics were assembled into a checklist, implicitly assigning them all equal weight. The following seven variables should be examined more thoroughly in an effort to develop more precise internal weights of their components:

- 1.1.2 Ease of walking.
- 1.1.4 Special provision for various groups.
- 2.2.1 Pedestrian-oriented environment.
- 2.2.3 Health effects of walking.
- 3.1.2 Community pride, cohesiveness, and social interaction.
- 3.1.3 Aesthetic impact, and compatibility with neighborhood.
- 3.3.4 Attractiveness of area to business.

In view of the experience gained in the conduct of this project, six additional variables are believed to be candidates for more comprehensive study and reformulation. These variables deserve more concentrated attention than was possible in this study because little previous research had been done in their particular domain. These six variables are described as follows:

1. Impact on use of existing transportation systems (1.3.2) provides the user with a chart for recording changes in the type of use and required modifications to existing transportation modes, but the analyst must use his own judgment to convert the entries on this table to a final score. The impacts of proposed pedestrian facilities on other transportation systems are poorly understood. In anticipation of ever-increasing emphasis on energy conservation, on efforts to decrease urban air, water, and noise pollution, and on citizen demands for less congestion, an effective and comprehensive evaluation of these multiple impacts is expected to become increasingly important to the urban planner.
2. For societal cost of accidents (2.1.1), greater accuracy is needed in predicting the frequency of pedestrian accidents, basing the predictions on facility design, use, and environmental characteristics. Also, an effort should be made to predict the severity of injuries and the probability of a fatal pedestrian accident, given these same parameters.
3. Additionally, research is needed to more accurately predict the occurrence and effects of criminal incidents (crime, 2.1.3), given information about the design and operation of the pedestrian facility and information about social content of the surrounding community.
4. A major component of the litter control (2.2.2) variable is the cleanliness index developed by the Urban Institute to evaluate street and alley litter conditions. This work should be extended to produce photographs illustrating the levels of cleanliness of pedestrian facilities (such as malls and overpasses).
5. For residential dislocation (3.1.1), further research should be directed to better understanding the social and psychological impacts to individuals who are relocated, and how social assistance may be designed to meet these needs.
6. Finally, a better means is needed for predicting and measuring how a pedestrian facility affects the level of community activities (4.3.1).

Further study on any one of the 13 variables mentioned is believed to be a candidate subject for university research, and particularly well suited for dissertation or thesis topics.

Extensions of the Research Project

In addition to refinement of the particular measurement techniques previously mentioned, further research to extend the presented methodology would prove helpful to pedestrian facility planners and evaluators. These specific research topics are identified in the following.

First, this research report could be supplemented with the use of a well-designed visual display using sophisticated graphics techniques. A narrated slide show or a moving picture might be the best format. The presentation could convey the information presented in this report rapidly and effectively to decision-makers, community groups, and planners.

An objective of this research was to identify comprehensive primary and secondary impacts of a wide range of pedestrian facilities to planners and members of the community alike. Thirty-six variables have been chosen to completely describe all of the benefits and disbenefits of a complex facility such as a large mall or an extensive auto-free zone. However, fewer variables chosen from the 36 are required to adequately describe the impacts of simpler facilities. The researchers have attempted to provide a widely useful methodology by suggesting that different weights be used for what are designated as "safety/movement" and "social/commercial" types of facilities. However, this is a compromise; although a unified and comprehensive evaluation methodology is desirable for citywide or regional budget allocation, methodologies designed for evaluating specific facility types might be more useful in situations where only certain types of facilities are being considered for given applications.

Thus, the second suggestion for extending the study would be to write several handbooks, each of which would describe an evaluation methodology tailored for a specific type of facility.

These two suggested extensions to the research could be performed with a relatively modest budget because they involve presenting, in different formats, research that has already been completed.

The third suggested extension to the present research is more in the nature of a follow-on project; its purpose would be to develop a broad set of pedestrian facility design concepts and selection criteria related to facility purpose and stakeholder interests. Facilities intentionally designed to achieve a high rating are likely to be well received in the community. With generally accepted pedestrian design criteria, cost savings would be realized in materials, assembly, and construction if modular, multipurpose components would be developed to meet variable needs. The need is for a system that will help to optimize tradeoffs. Additionally, model ordinances and building codes could be developed for use by cities desiring to guarantee that future public works and private developments would be planned with the pedestrian user in mind.

A related extension of the research would be to use the evaluation methodology as a basis for developing warrants for pedestrian facilities. Not all of the measurement techniques would be needed for this application because many of them are more applicable to evaluating proposed changes, rather than quantification of existing problems.

Other Related Research Topics

Other suggestions for research in areas related to this project, but not direct extensions of this study, are described in the following.

The current research project was undertaken because pedestrians and motor vehicles usually cannot safely or comfortably coexist on land that is intensively used for transportation or other commercial purposes. An increasingly attractive alternative to separating pedestrian and motor vehicle traffic is to eliminate one of them, within carefully defined borders. One solution that is growing more socially acceptable and environmentally sound is to restrict the operation of motor vehicles in central cities. The means for accomplishing this have been researched extensively and rough estimates made of the impacts of such actions. However, no definitive study has been made on comparative costs to a city and its residents of supporting and operating an urban transport system centered around the automobile. The results of this study might prove to be very enlightening, for if the results show from a broad social perspective that the automobile is more expensive to maintain and operate than the alternatives, cities would be able to more completely compute the financial and other advantages that would accrue by eliminating automobiles from congested city centers.

An objective of this research project has been to assess a comprehensive range of social, economic, and environmental impacts of proposed pedestrian facilities and to organize these impacts in a fashion that enables decision-makers to act with full knowledge of the implications of the various alternatives. Further research directed toward developing a rational decision-making strategy for local governments and others might bring the process further into the public eye. If more knowledge were available on how decisions may be guided by informed public inputs, community civic associations could learn to make themselves more effective, and presumably everyone would benefit as a result.

One final suggested research project is the development of an effective pedestrian counter. The researchers have heard suggestions for this research at professional society meetings for some time, but the need became clear when pedestrians were counted by researchers holding a tally register in each hand. The solution is certainly not straightforward, yet we believe that technological solutions are probably feasible for the perfection of a fast and accurate counter through a directed research project.

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APPENDIX A

MEASUREMENT TECHNIQUES FOR EVALUATING PEDESTRIAN FACILITY VARIABLES

INTRODUCTION

This workbook presents measurement techniques for evaluating each of the 36 variables identified during the research for NCHRP Project 20-10. The Pedestrian Facility Evaluation Index, serving as both an index and an outline, lists the impacts of pedestrian facilities in four major categories: Transportation, Safety/Environment/Health, Residential/Business, and Government and Institutions. These categories are subdivided into groups of impacts, such as pedestrians, motor vehicles, and other community transportation. The groups consist of individual impacts called variables, which are the major focus of benefit measurements. For example, the variables for the group "pedestrians" are travel time (1.1.1), ease of walking (1.1.2), convenience (1.1.3), and special provisions (1.1.4).

A scoring procedure has been developed for each of the 36 variables listed. Benefit values are determined using a unitless scale of positive and negative values (+10 to −10) for each variable. Positive values correspond to desirable

characteristics, and negative values indicate undesirable characteristics. Zero values indicate either "does not apply" or "indifference" (neither good nor bad). Large negative values usually indicate a serious deficiency in the design of a proposed facility which may cause its rejection or suggest possible modifications to improve it.

Many of the variables are composed of parameters called components, which are sometimes subdivided into characteristics. For example, the variable "climate control and weather protection" (2.2.4) is measured with the use of four component scores: heating, air conditioning, ventilation, and protection. Protection is in turn scored by considering such characteristics as exposure to sunlight, wind, precipitation, and so forth.

Great care was taken in selection and definition of the evaluation variables and in development of specific measurement techniques for each. Critical review meetings were held with a group of SRI specialists to ensure inclusion and logical arrangement of all significant impacts of pedestrian facilities, and to ensure that no items were included more than once (double counted) in the measurement process. Multiple use of components and characteristics (such as lighting) is limited in each appearance to a specific role, such as crime prevention.

Users of this research are encouraged to make changes to specific measurement techniques whenever such changes seem appropriate. When particular groups of evaluators or decision-makers feel that somewhat different values are more appropriate, they should be used. A primary objective to the development of these measurement techniques has been to develop a flexible, quantitative framework for examining and evaluating the many potential impacts of pedestrian facilities. Thus, the basic techniques can be used even if specific values for individual variables or components change over time.

1. TRANSPORTATION

Economic costs have traditionally dominated the planning, evaluation, and selection of transportation projects, not because the intangibles were viewed as unimportant, but rather because the means for measuring them were not generally accepted. Today, there is still no generally accepted procedure for assessing traveler- and travel-related impacts of transportation projects, but there is a definite trend and an established need for the inclusion of these factors in the analysis. A suggested solution to fill this need is provided with the nine variables described in the following. Only one of these variables (1.2.1, motor vehicle travel costs) is an economic cost; the eight remaining factors are more intangible, such as pedestrian comfort and convenience.

1.1 Pedestrians

None of the four variables, travel time, ease of walking, convenience, and special provisions, described for the evaluation of pedestrian transportation are costable in dollars, although they can all be evaluated objectively. Pedestrian travel time (1.1.1) can be expressed in dollars, as is done for motor vehicle travel time, but the objective is to evaluate all variables on a unitless +10 to −10 scale. For the convenience of those performing other types of analyses, for which a dollar assignment to pedestrian travel time might be useful, a discussion of unit pedestrian travel time values has been included in Section 2.

1.1.1 Travel Time

This variable is concerned with the computation of total pedestrian travel time for a particular facility. It may be computed according to

$$\text{Total travel time} = \text{No. of pedestrians} \times \left(\frac{\text{Route length}}{\text{Walking speed}} + \text{Signal delay}\right) \quad \text{(A-1)}$$

The following sections describe procedures for evaluating the components of Eq. A-1.

1.1.1.1 Number of Pedestrians and Route Length. Both of these variables are inherent to the planning and design process for pedestrian facilities, described as Step 4 of the suggested evaluation process (Fig. 2) described in Chapter Two.

Route length may be determined from plans for the facility (such as engineering drawings or blueprints) as part of Step 4. In general, pedestrian routes will be less than 3,000 ft (915 m) in length. To avoid circuitous routing, walking distance should be equal to no more than approximately 1.4 times the straightline distance from origin to destination, and preferably less than 1.2 times (Vuchic and Kikuchi, 1974). If pedestrians have alternate routes to choose from, determine average route length based on the proportion of pedestrians who do (or are expected to) use the various routes.

1.1.1.2 Walking Speed. Average unimpeded pedestrian speed is about 295 ft per min (1.50 m/sec).* This is the value given by Oeding (1963), the upper end of the range given by Lövemark (1972), and is in excellent agreement with Hoel (1968) and Claxton (1974). This is an average value for general applications, when there are no impedances to flow. For commuters in busy downtown areas, 267 ft per min (Fruin, 1971) is a better value, whereas 320 ft per min (Navin and Wheeler, 1969; agrees with Hankin and Wright, 1958) is more appropriate for students. The researchers measured pedestrian travel speeds of 270 to 300 ft per min in downtown Ottawa, Ont., and 244 to 258 ft per min in downtown Brooklyn, N.Y. (slower because of high pedestrian density).

When there is a concentration of pedestrians in an area, naturally, these speeds will be reduced. The speed is reduced by an amount directly proportional to the density of the pedestrians according to Eq. A-2, but this correction only becomes significant at high densities (such as one pedestrian per 10 sq ft):

$$\text{Adjusted speed} = \text{Speed} - B \times \text{Pedestrian density} \quad \text{(A-2)}$$

Values for B, which when divided by the initial speed equals the theoretical maximum space allocation per pedestrian at

* To convert the other travel speeds in this discussion from ft per min to m/sec, multiply by 0.00508.

the point when congestion causes everyone to halt, are as follows (Pushkarev and Zupan, 1975a):

Type of Flow	Initial Speed (ft/min)	B (ft^3/min)
Downtown commuters	267	722
Mixed traffic	295	835
Students	320	1,280

For example, if a downtown mall had a total area of 500,000 sq ft and 1,000 commuters were walking through it,

$$\text{Adjusted speed} = \text{Speed} - B \times \text{Density}$$
$$= 295 \frac{\text{ft}}{\text{min}} - 835 \frac{\text{ft}^3}{\text{min}} \times \frac{1{,}000}{500{,}000 \text{ ft}^2}$$
$$= 293 \frac{\text{ft}}{\text{min}}$$

only a minor correction.

In addition to density, walking speed reductions of up to 25 percent may occur for extreme age or grades. However, no corrections are necessary for ages less than 65 years or for grades of up to 5 pecent (Fruin, 1971). Also, pedestrians walk about 10 percent faster in subfreezing weather than they do in 65- to 75-F (18 C to 24 C) temperatures, according to Hoel (1968), so when examining wintertime use of facilities in cold-weather climates, increase the assumed walking speed by 10 percent.

1.1.1.3 Signal Delay. Pedestrian delay at signalized intersections can be determined from a simple calculation based on signal timing measurements. It is assumed from experience that pedestrians arrive at random times and that they will begin to cross at any time during the green phase. If fraction, F, of the pedestrians wait when they arrive at a red, amber, or flashing DON'T WALK signal, the mean delay is given by

$$D = \frac{F\,(R + A)^2}{2(G + R + A)} \qquad \text{(A-3)}$$

in which

- D = average delay per pedestrian;
- F = the fraction of pedestrians who obey the signal;
- R = the duration of the red or DON'T WALK signal;
- A = the duration of the amber or flashing DON'T WALK signal; and
- G = the duration of the green or WALK signal.

Of course, for a pedestrian-actuated signal, parameters for pedestrian delay must be established based on the particular characteristics of the traffic control device.

Calculation of the delay most likely to be incurred by pedestrians at crossings without signals or signs has been made by Joyce et al. (1975), based on empirical measurements made in the London Borough of Hammersmith and the Royal Boroughs of Kensington and Chelsea, both in the United Kingdom. The formula that assumes that the pedestrian will cross the street directly in one movement rather than cross halfway and wait, is

$$D = 6.7 \times 10^{-6}\,(Q)^2 + 0.3 \qquad \text{(A-4)}$$

in which D is the delay most likely to be incurred, in seconds, and Q is the total hourly vehicle flow in both directions. Eq. A-4 is not valid for vehicle flows greater than 1,600 per hour or for mean delays greater than 18 sec, at which points more site-specific relationships must be developed based on vehicle mix and speeds, street width, and pedestrian population.

1.1.1.4 Total Travel Time. Once the route length and walking speed for the types of pedestrians expected to use the pedestrian facility have been determined, distance should be divided by speed to obtain the travel time for each trip across the facility. This time per trip should then be multiplied by the number of pedestrians expected to use the facility to obtain total time. Symbolically, for each grouping of pedestrians:

$$\text{Time per trip} = \text{Route length} \div \text{Walking speed} \qquad \text{(A-5)}$$

$$\text{Total time} = \text{No. of pedestrian trips} \times \text{Time per trip} \qquad \text{(A-6)}$$

1.1.1.5 Unit Pedestrian Travel Time Savings. This information may be recorded on the following chart. Weighting the travel times for the four groups shown is recommended, based on each group's mean wage rate. The value of time for people who are walking in the course of their work should be valued at 1.5 times the value for commuters and workers on lunch break because of the money expended by their employers for salary, payroll taxes, and overhead or profit. Similarly, other pedestrians, particularly those on leisure trips, personal business, or persons who are not employed have a time value about one-half of that for commuters, because pedestrian travel time savings cannot be readily converted into employment for them. The value of time for elementary school children is very low (one-tenth of that for commuters, unless their travel decision is made by a parent, in which case it might be higher) because they have very little money but lots of free time.

	BEFORE	AFTER
Number of commuters or workers on lunch break	______	______
Travel time per person	______	______
Total travel time	______	______
Number of people walking in the course of their work	______	______
Travel time per person	______	______
Total travel time	______	______
Multiply by 1.5	______	______
Number of elementary school children	______	______
Travel time per child	______	______
Total travel time	______	______
Multiply by 0.1	______	______
Number of other pedestrians	______	______
Travel time per person	______	______
Total travel time	______	______
Multiply by 0.5	______	______
Total travel time in equivalent minutes	______	______

Weighting commuters' time by 1, the travel time of people walking in the course of their work by 1.5, elementary school children's time by 0.1, and other pedestrian time by 0.5 will result in a total travel time in "equivalent" minutes, equivalent to the specified amount of travel time for commuters or those workers on their lunch break.

A unitless score for travel time is obtained by using Eq. A-7 and the values of total travel time in equivalent minutes determined using the foregoing chart:

$$\text{Total TRAVEL TIME SCORE} = \frac{\left(\begin{array}{c}\text{Total travel}\\ \text{time before}\end{array}\right) - \left(\begin{array}{c}\text{Total travel}\\ \text{time after}\end{array}\right)}{\text{Maximum of above terms}} \times 10 = \_\_\_\_\_\_ \qquad \text{(A-7)}$$

If this evaluation is being used to compare a number of sites, the maximum value indicated should be the largest term for all sites under consideration.

1.1.2 Ease of Walking

Ease of walking may be described in terms of five components: condition of the walking surface, grade changes, path continuity, signing, and lighting. Techniques for measuring these components are described in the following sections. The range in number of points assigned to each is given in the following, which may also be used to summarize the scores of the different sections:

	Scoring Range	Score
Walking surface	−2 to +2	
Grade changes	−4 to +2	
Continuity	−1 to +2	
Signing	−1 to +2	
Lighting	−2 to +2	
Total EASE OF WALKING SCORE	−10 to +10	

1.1.2.1 Walking Surface. Check off the appropriate boxes in response to the following questions:

	YES	SOMEWHAT	NO
Is the walking surface esthetically appealing? Consider color, texture, and sound.	1/2	0	-1/2
Is the surface comfortable to walk on, even for someone who is wearing high-heel shoes or sandals? A comfortable walking surface is neither too hard nor too soft. Considering comfort only, dry soil is ideal. Concrete is too hard, whereas sand is too soft.	1/2	0	-1/2
Is the pavement free of severe cracks or holes?	1/2	0	-1/2
Is the surface slip-proof, especially when wet or freezing?	1/2	0	-1/2

WALKING SURFACE SCORE is the sum of values in boxes checked = ______.

1.1.2.2 Grade Changes. These scales assume bidirectional flows, hence both upgrades and downgrades. If the facility allows pedestrian flow in only one direction (e.g., a bus unloading area), an upgrade should result in a more negative score and a downgrade should result in a less negative score. Fruin (1971, p. 41) provides data on how slope affects free-flow walking speed, which was used to help determine scores for the steepness of slope. Cantilli (1972) supplies information on requirements for escalators, based on distances of activity areas below surface level.

Steepness of Slope

Grade (%)	Points
5 or less	1
10	0.5
15	−0.5
20	−1.5
25	−2.0

For slopes less than 25 ft (7.6 meters) in length, score 1 point. If a slope greater than 25 percent is planned, serious consideration should be given to redesigning the facility.

STEEPNESS SCORE selected = ______

Vertical Distance to Climb Without Mechanical (Elevator or Escalator) Assistance

Distance (ft)*	Points
0	1
25	0
50	−1
75	−1.5
100 or more	−2

* To convert feet to meters, multiply by 0.3048.

Vertical score selected = ______

COMBINED GRADE SCORE is Steepness score + Vertical score = ______.

1.1.2.3 Continuity. Check off the appropriate boxes in response to the following questions:

	YES	SOMEWHAT	NO
Are there continuous, unbroken, unambiguous pedestrian paths?	1	1/2	0
Are there small jogs or slight bends in the path, but not enough to make the route highly irregular?	1	1/2	0
Is there an absence of obstacles to the flow of pedestrians?	1	1/2	0

CONTINUITY SCORE is the sum of values in boxes checked ______ - 1 = ______.

1.1.2.4 Signing. Check off the appropriate boxes in response to the following questions:

	YES	NO	UNNECESSARY
Are directions to important destinations given or maps of the area provided?	1	0	1
Is there proper signing for safety?	1	0	1
Are any rules or other important information conveyed if necessary?	1	0	1
Are the signs simple and easy to understand?	1	0	1
Can they be understood by persons who cannot read English?	1	0	1
Can they be read by persons with poor eyesight or colorblindness?	1	0	1
Are signs located at likely points of confusion or indecision?	1	0	1
Is there a clear, unobstructed view of each sign?	1	0	1
Are the signs illuminated properly, free of glare?	1	0	1

Signing Point Score is sum of value in boxes checked = ________

Total SIGNING SCORE is Point Score ______ ÷ 3 ______ - 1 = ______

1.1.2.5 Lighting. Lighting effectiveness can be measured in terms of the amount of illumination, the type of lighting, and the height of the lamps.

Level of Illumination.—Now that energy conservation is generally accepted as a desirable public policy, lighting standards may be lowered accordingly, if they continue to satisfy safety and comfort criteria. Thus, existing standards or rules of thumb should not be accepted without question, and reevaluation may be warranted.

The illumination level may be measured with a small hand-held light meter. Also, when making test measurements, it was found that the ambient light in a city (until around midnight in the case of Ottawa) can add 5 ft-c * or more to each reading, so it is best to perform these measurements very late at night (for outdoor facilities), after most of the city has gone to sleep. The measurements should be made about 5 ft (1.5 m) above the ground at representative pedestrian locations. Try to measure an average location, taking into consideration the placement of lights, rather than use an average of the measurements taken. The level of illumination can be translated into a point value according to the following:

* To convert foot-candles to lumen per square meter (lux) multiply by 10.764.

Level of Illum. (ft-c) *	Points
15 or more	0
10 or more	−0.5
5 or more	−1.5
2 or more	−2.0
less than 2	−2.5

* To convert foot-candles to lumen per square meter (lux) multiply by 10.764.

Level score selected = ______

Type of Lighting.—Certain types of lighting (such as incandescent) are soft to the eye, whereas others (such as sodium or strontium vapor) are very harsh. Fluorescent and neon lights fall somewhere between. Scores are assigned to these differing degrees of harshness or softness as follows:

Type of Lighting	Points
Soft: incandescent	0
Medium: neon or fluorescent	−0.5
Harsh: sodium or strontium vapor	−1

Type score selected = ______

Height of Lamps.—Highways are wide and must accommodate tall vehicles, so that lights are located on poles 40 ft (12 m) high. This height is unnecessary and undesirable for pedestrian activity areas, for which 10- or 12-ft (3 m) pole heights are more suitable.

Height of Lamps	Points
Lighting is on a pedestrian scale	0
Lighting is automobile oriented	−0.5

Height score selected = ______

Combined Lighting Score.—COMBINED LIGHTING SCORE is Level score + Type score + Height score = ______, + 2 = ______.

1.1.3 Convenience (Availability and Access)

This variable is measured by considering the availability of the facility to its users and the variety of activities that it makes more accessble to pedestrians (or bicyclists).

1.1.3.1 Time Facility Is Open for Use.

Situation	Points
Open at all times that facility is required	0
Open part-time for special purposes; e.g., lunch hours, school hours, daytime, peak travel hours, weekends	−2
Open part-time only for reasons indirectly related to the facility, such as when major stores are open or when there is (or is not) heavy traffic	−6
Open only rarely, randomly, or irregularly	−10

TIME SCORE selected = ______.

1.1.3.2 Accessibility. Does the facility make pedestrian (or bicycle) travel more convenient to:

Transit	☐
Parking	☐
Transportation terminals	☐
Bike routes	☐
School or education centers	☐
Recreational, historical, or cultural facilities	☐
Medical facilities	☐
Places of worship	☐
Retail stores	☐
Residential areas	☐

ACCESSIBILITY SCORE is number of boxes checked = ________

1.1.3.3 Total Convenience Score.
Total Convenience score is Time score + Accessibility score = ______.

1.1.4 Special Provisions for Various Groups

Special provisions to accommodate special groups of pedestrians (children, elderly, visually or mobility handicapped, bicyclists, joggers, strollers) usually benefit all pedestrians by making it easier for them to walk. Thus, signs that are intelligible to children or visible to partially sighted persons are included under signing (1.1.2.4). Improved signs benefit all pedestrians, just as benches for the elderly can be used by any tired pedestrian, and thus are included in pedestrian-oriented environment (2.2.1). Only those provisions that were not included elsewhere are included here. The following questions are self-explanatory; check off the appropriate items. Spencer (1975) furnishes an excellent set of design criteria for accommodating physically handicapped pedestrians.

	YES	NO	NOT APPLICABLE
Is maximum curb or step height 6 inches* or less?	1	0	1
Are ramped curb cuts provided?	1	0	1
Are all walkways at least 5 feet† wide?	1	0	
Are there any interior areas that are not accessible by at least one nonrevolving door, easy to open, at least 32 inches wide?	0	1	1
Are there any grade changes greater than 15 feet for which ramps or elevators are not provided?	0	1	
Are there any pedestrian-activated crossing signal buttons located more than 40 inches above the ground?	0	1	1
Is there any public telephone with at least 27 inches clearance underneath, but the dial a maximum of 48 inches from the ground?	1	0	
Is there a drinking fountain whose top is no more than 33 inches above the ground?	1	0	
Are changes in pavement texture provided to assist blind pedestrians through difficult crossings?	1	0	1
Are there angular corners, rather than rounded, to allow for better directional orientation?	1	0	1
Are other aids provided for the blind (e.g., sound devices, braille signs, chains, guides)?	1	0	1
Are crossing signals audible?	3	0	3
Are bicycle racks or storage areas for bicycles provided?	3	0	
Is a right-of-way provided for bicycles, separate from that of pedestrians?	3	0	
Is there a dirt, wood chip, or other soft path available for joggers? Jogging on hard surfaces can cause "shin splints" and damaged arches, commonly known as flat feet, according to Hodges (1975).	3	0	
Are there any locations appropriate for placement of handrails, where they are not provided?	0	1	1
Do sewers or gratings hinder access for vehicles with narrow wheels or persons with narrow shoes?	0	1	

Point Score is sum of values in boxes checked = ________

Total SPECIAL PROVISIONS SCORE is Point Score × 0.8 = ________,

- 10 = ________.

*To convert inches to centimeter, multiply by 2.540.
†To convert feet to meters, multiply by 0.305.

1.2 Motor Vehicles

An important economic impact of a pedestrian facility is the increase or decrease in costs of automobile transportation resulting from changes in traffic flow and routes. Just as in Section 1.1, where increase in accumulated pedestrian delay is considered a disbenefit, that portion of vehicle delay, vehicle operating and ownership costs, and changes in the likelihood of accidents caused by the pedestrian facility are considered in the following.

The four sections following provide guidance on the computation of motor vehicle operating costs, travel time for motor vehicle occupants, parking costs, and vehicle ownership, respectively. These may be computed on either a daily or an annual basis (or any other period convenient to the analyst, as long as all calculations are performed for the same period). If daily costs are to be computed, select a typical working day as the standard.

The following description of a procedure for evaluating motor vehicle travel costs is the longest of all variable descriptions. That does not imply that this variable is more important than any of the others; it simply reflects the fact that the computation has more steps and involves more highly developed data than are available for other variables.

1.2.1 Motor Vehicle Travel Costs

1.2.1.1 Motor Vehicle Operating Costs. This section is largely extracted from the final report for NCHRP Project 2-12, "User Benefit Analysis for Highway and Bus Transit Improvements" (Andersen et al., 1975), where more complete information can be found.

Motor vehicle operating costs, as the sum of basic section costs, accident costs, and delay costs, are given by

$$\mathrm{HU} = (B + A) \times L + D \qquad \text{(A-8)}$$

in which HU is the unit highway user cost for a given section of highway, in dollars per 1,000 vehicles. Highway user costs herein are all expressed in dollars per 1,000 vehicles or vehicle-miles. To convert to cents per vehicle or vehicle-mile, multiply by 0.10, inasmuch as $\$1/1{,}000\ \text{veh} = 0.1¢/\text{veh}$. To convert to cost per kilometer, multiply by 0.621. B represents basic section costs, consisting of the unit cost (time value and vehicle running costs) associated with vehicle flow and the basic geometrics (grades and curves) of the analysis section; A represents unit accident costs in the analysis section; L represents analysis section length, in miles (preferably to the nearest hundredth); D represents additional unit time and running costs caused by delays at intersections, traffic signals, stop signs, or other traffic control devices.

The nomographs in Figures A-1 through A-3 enable direct calculation of B, basic section costs, for three types of highways as a function of either the ratio of traffic volume over highway capacity ratio or the average running speed. Examples illustrating the use of these nomographs are provided on the figures themselves. The nomographs are entered at the lower left, either with volume/capacity ratios (estimated by the analyst for the representative hour of operation of the analysis section) or with average running speed. The analysis proceeds to determination of travel time (the inverse of running speed) portrayed on the left-hand scale of the lower left-hand graph; tangent running costs, and added running costs due to curves. Added running costs due to speed change cycles are then derived by entering the upper left-hand graph with the v/c ratio from the lower left-hand graph. The indicated costs of speed changes are minor except for level of service F (queuing) conditions.

Data on vehicle flows should be available to the analyst from traffic records and projections. In calculating the v/c ratio, the capacity of the section under study is the relevant denominator. Because of different roadway widths, traffic mixes, and other conditions, different sections of the same facility may have significantly different capacities. The *Highway Capacity Manual* (1965) should be consulted in estimating section capacities.

If the volume and capacity of a road section are known, average running speed can be estimated directly for different highway design speeds from the lower left-hand chart of Figures A-1 through A-3.

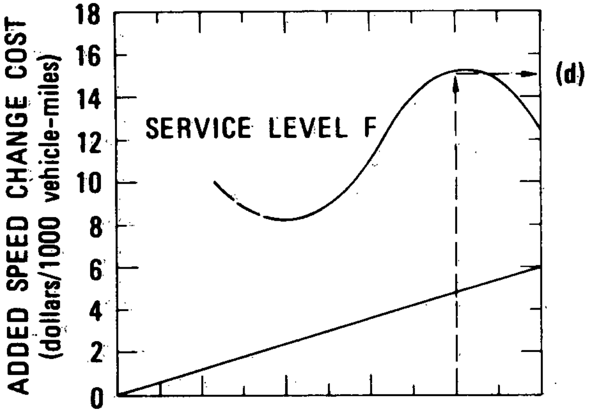
Where more locally valid speed-flow relationships are available, the analyst is urged to use them in place of the lower left-hand chart in Figures A-1 through A-3 to determine average speed. Alternatively, the practice of sending out an observation car to drift with the traffic stream—trying to pass an equal number of cars to those that pass the test vehicle, for example—is useful for obtaining average running speeds of existing highways. However, traffic speed in future years must be derived from the traffic volumes that are forecast for those years, which may have no current counterpart.

Intersection Delay Costs D.—Intersection delay is caused by slowing down and speeding up from a stop caused at an intersection, pedestrian crosswalk, or by a traffic signal, and from idling while stopped. Such costs, symbolized by D, are calculated on a per 1,000-vehicle basis, and should be added to previous estimates of basic section costs.

Intersection delay costs depend primarily on the type and configuration of the traffic control devices employed, the level of traffic on the section, and the speed at which the stop or signal is approached. Figures A-4 and A-5 facilitate calculation of stopping and idling costs as functions of these factors. Examples provided on the figures illustrate their use. Approximate adjustment factors are also provided to account for trucks in the traffic stream.

Figures A-4 and A-5 require data on the following parameters of the signalization and traffic of the intersection under study:

- Green-to-cycle time ratio, λ. The ratio of effective green time of the signal to the cycle length of the signal, both expressed in the same unit of time (usually seconds). In terms of the *Highway Capacity Manual* (HCM), effective green time is the actual green time of the signal. If the HCM is not used, effective green time is defined as the total available for vehicular movement. (If it is assumed that the part of the yellow interval used for vehicular movement and the time lost while the queue gets in motion are equal, both methods of defining effective green time are equivalent.) The cycle length of a signal is the total time taken for



EXAMPLE

GIVEN:

Vehicle Type: Passenger Car
Facility: Multi-Lane Highway
Design Speed: 50 mph
Service Level F? Yes
v/c Ratio: 0.8
Grade: Level
Curvature: None

*Assumed hourly value of time per vehicle.

SOLUTION:

Average Running Speed = 20 mph	
(a) Time: 50 hrs x $3.00*	$150
(b) Tangent Running Cost	70
(c) Added Running Cost Due to Curves	0
(d) Added Running Cost Due to Speed Changes	15
Total Basic Section Costs per 1,000 Vehicle Miles (B)	$235

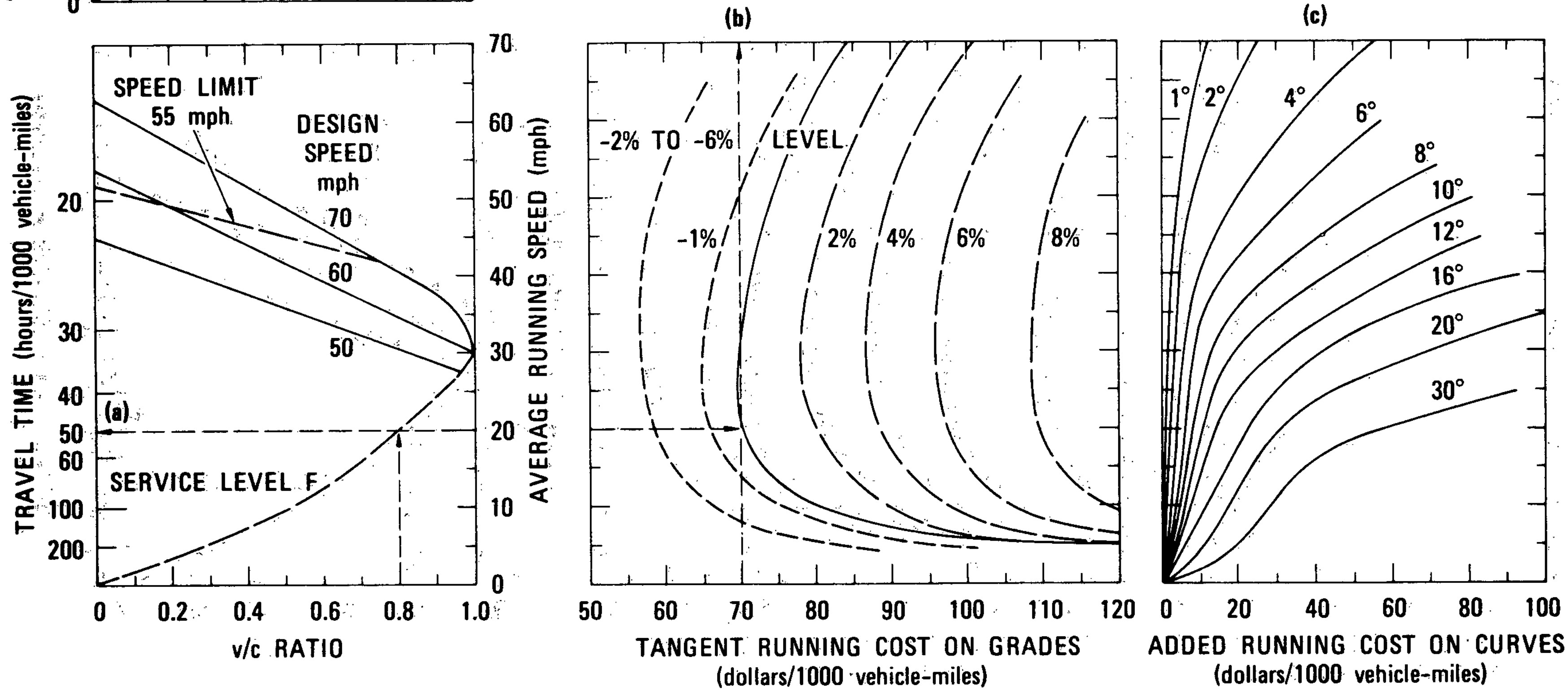
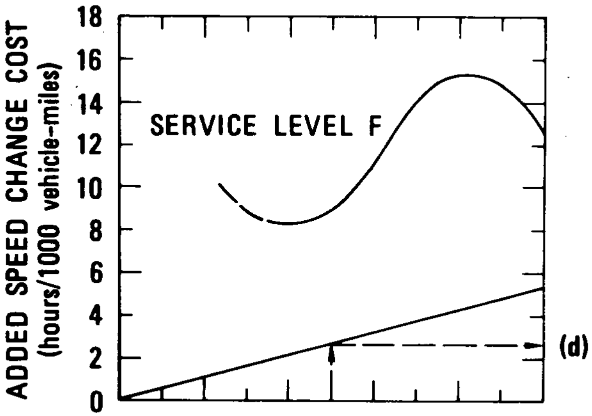


Figure A-1. Basic section costs, B, for passenger cars of multilane highways.



EXAMPLE

GIVEN:

Vehicle Type: Passenger Car

Facility: Two-Lane Highway

Design Speed: 40 mph

Service Level F? No

v/c Ratio: 0.5

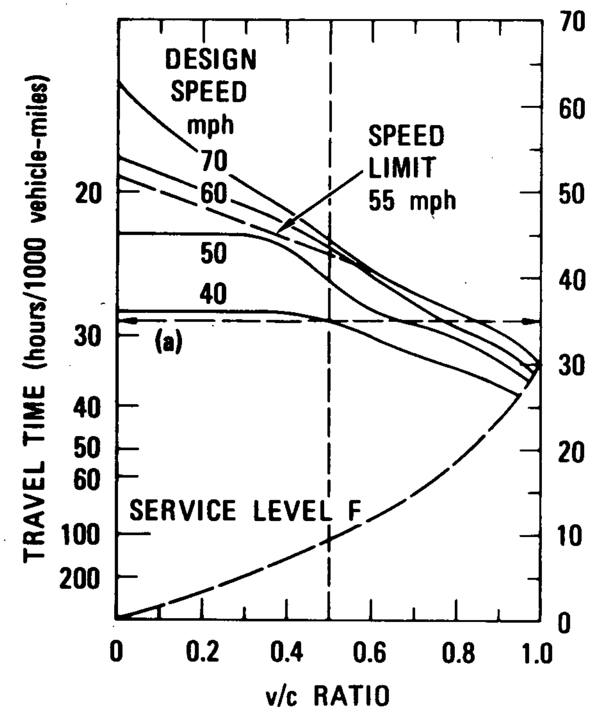
Grade: -1%

Curvature: 16°

*Assumed hourly value of time per vehicle.

SOLUTION:

Average Running Speed = 35 mph	
(a) Time: 28.6 hrs x $3.00*	$85.80
(b) Tangent Running Cost	65
(c) Added Running Cost Due to Curves	60
(d) Added Running Cost Due to Speed Changes:	2.60
Total Basic Section Costs per 1,000 Vehicle Miles (B)	$213.40



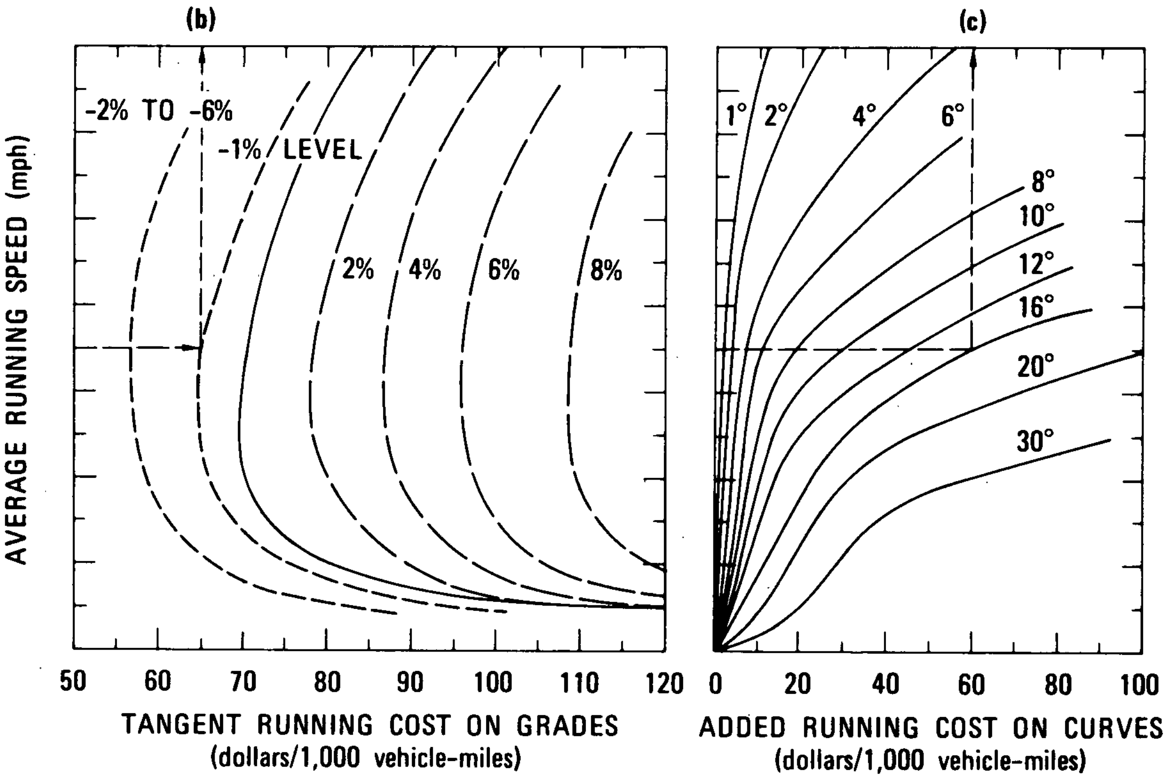
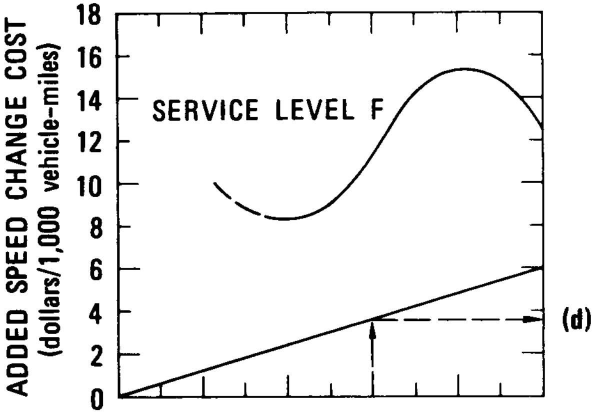


Figure A-2. Basic section costs, B, *for passenger cars on 2-lane highways.*



EXAMPLE

GIVEN:
Vehicle Type: Passenger Car
Facility: Arterial
Speed Limit: 45 mph
Service Level F? No
v/c Ratio: 0.6
Grade: -4%
Curvature: None

*Assumed hourly of time per vehicle.

SOLUTION:
Average Running Speed = 40 mph

(a) Time: 25 hrs x \$3.00*	\$75
(b) Tangent Running Cost	57
(c) Added Running Cost Due to Curves	0
(d) Added Running Cost Due to Speed Changes	3.60
Total Basic Section Costs per 1,000 Vehicle Miles (B)	\$135.60

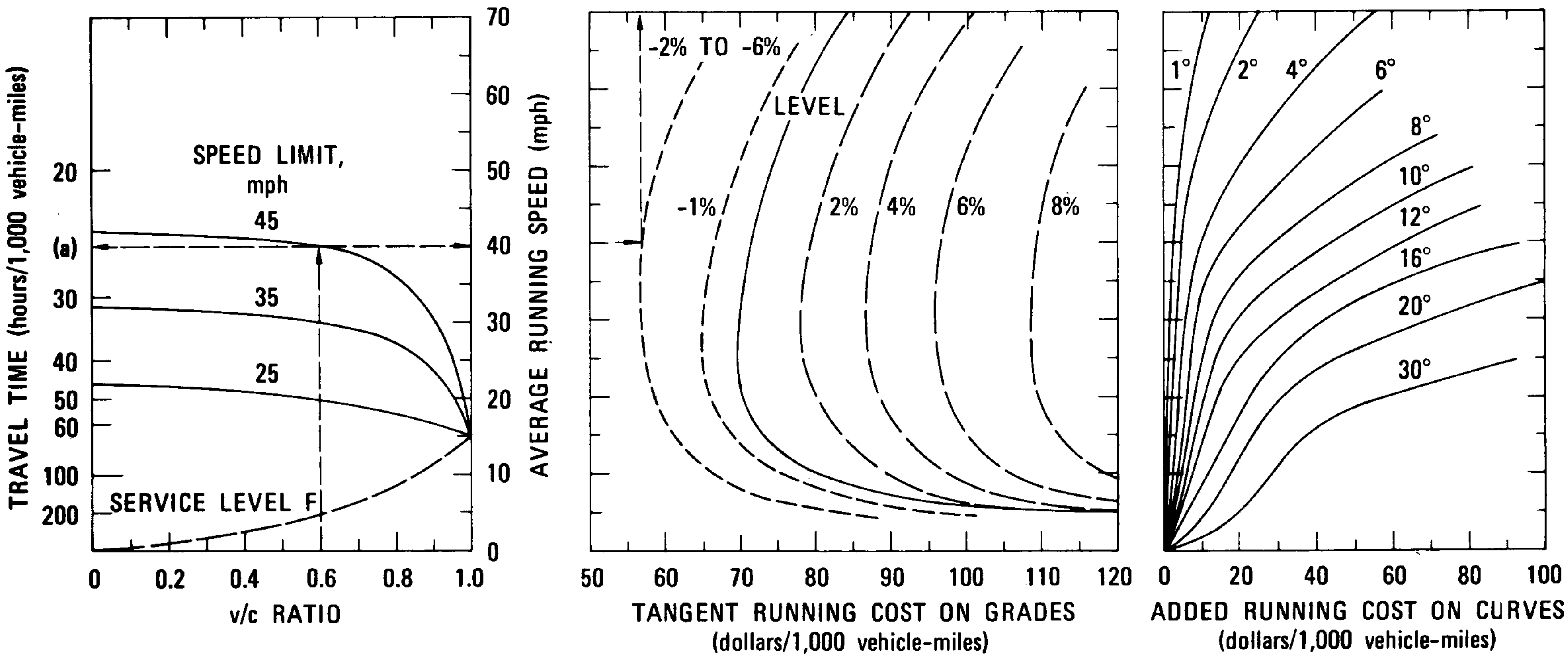


Figure A-3. Basic section costs, B, for passenger cars on arterials.

EXAMPLE

GIVEN:

Volume: 480 vehicles/hr
Saturation Flow: 1,600 vehicles/hr
Signal Cycle Time: 60 sec
Effective Green Time: 30 sec
Intersection Approach Speed: 30 mph
5% Single Unit Trucks
5% 3-S2 Combination Trucks

SOLUTION:

$\lambda = 30/60 = 0.5$
Capacity of Approach = 0.5 x 1600 = 800
$\chi = 480/800 = 0.6$
(a) Average Stops per Vehicle (per Signal): 0.71
(b) Stopping Delay per Signal: 2.5 hrs
(c) Cost of Stopping: $10.30

Time Cost: 2.5 x \$3.00* x 1.35†	\$10.13
Running Cost: \$10.30 x 1.42†	14.63
Total Cost Due to Stopping per 1,000 vehicles per Signal (excludes idling):	\$24.76

*Assumed hourly value of time per passenger car.
†Adjustment factors for trucks in traffic stream.

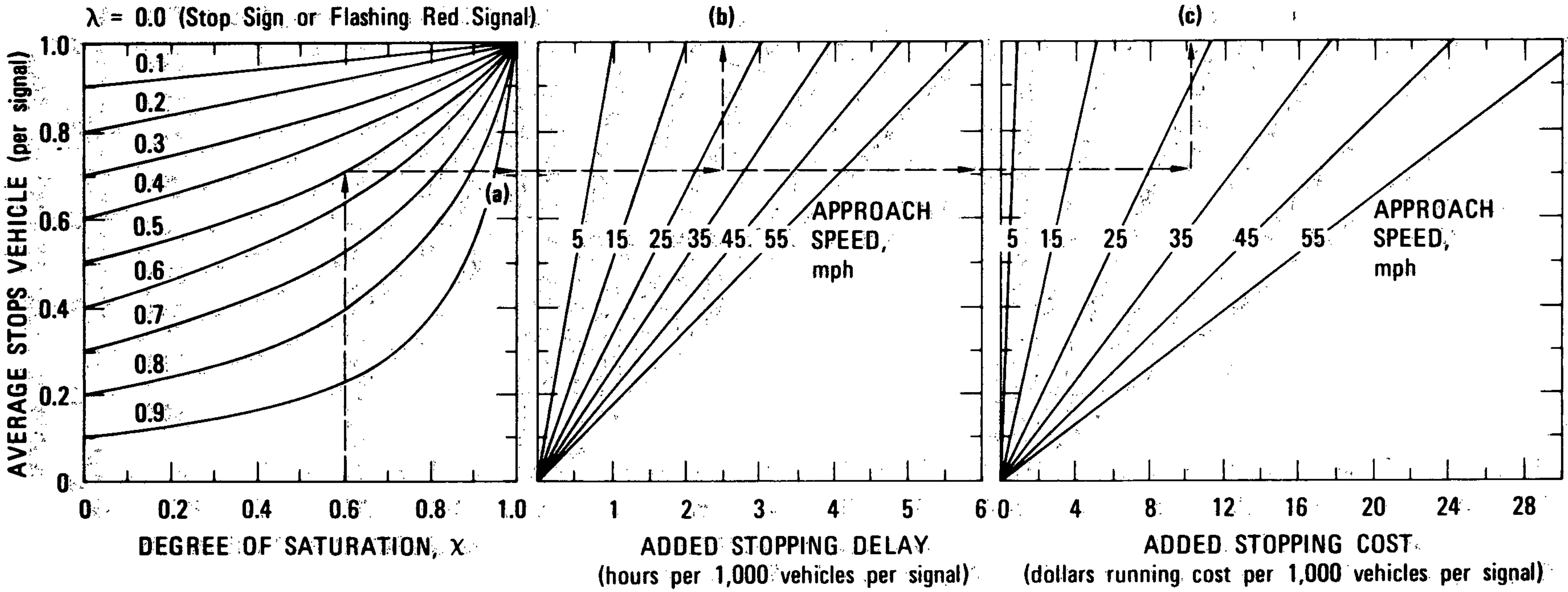
ADJUSTMENT FACTORS FOR PERCENT TRUCKS IN TRAFFIC STREAM

TIME COST

APPROACH SPEED (mph)	SINGLE UNIT TRUCKS (percent)	3 S-2 COMBINATION DIESEL TRUCKS (percent in traffic stream)				
		0	5	10	20	100
5-20	0	1.00	1.15	1.30	1.61	4.03
	5	1.07	1.22	1.37	1.67	–
	10	1.13	1.28	1.43	1.74	–
	20	1.26	1.41	1.57	1.87	–
	100	2.31	–	–	–	–
21-40	0	1.00	1.25	1.51	2.01	6.05
	5	1.10	1.35	1.60	2.11	–
	10	1.20	1.45	1.70	2.21	–
	20	1.40	1.65	1.90	2.41	–
	100	2.99	–	–	–	–
41-60	0	1.00	1.41	1.82	2.63	9.17
	5	1.11	1.56	1.93	2.74	–
	10	1.22	1.61	2.04	2.85	–
	20	1.44	1.85	2.26	3.07	–
	100	3.20	–	–	–	–

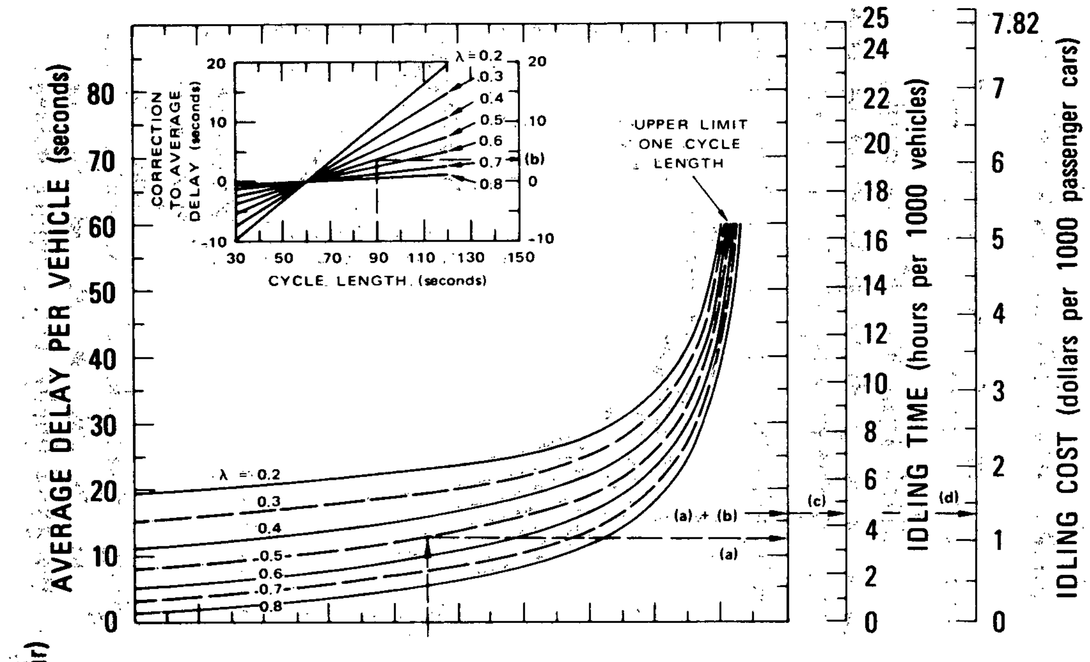
RUNNING COST

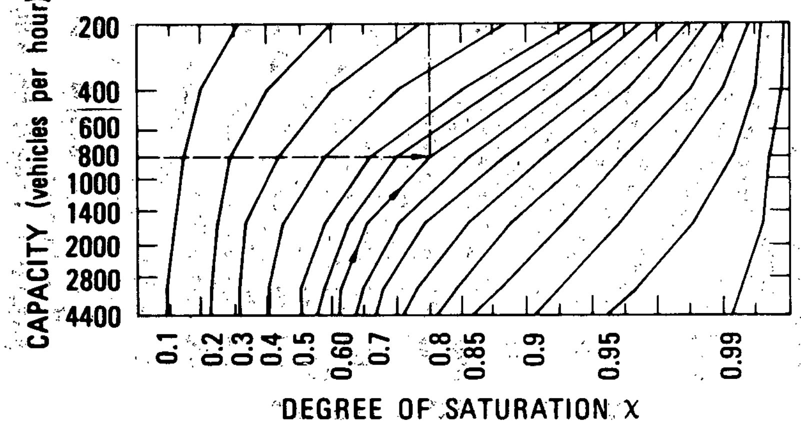
APPROACH SPEED (mph)	SINGLE UNIT TRUCKS (percent)	3 S-2 COMBINATION DIESEL TRUCKS (percent in traffic stream)				
		0	5	10	20	100
5-20	0	1.00	1.35	1.70	2.40	8.02
	5	1.08	1.43	1.78	2.49	–
	10	1.16	1.51	1.86	2.57	–
	20	1.32	1.68	2.03	2.73	–
	100	2.62	–	–	–	–
21-40	0	1.00	1.35	1.71	2.41	8.07
	5	1.07	1.42	1.78	2.48	–
	10	1.14	1.49	1.84	2.55	–
	20	1.27	1.63	1.98	2.69	–
	100	2.37	–	–	–	–
41-60	0	1.00	1.35	1.70	2.39	7.96
	5	1.06	1.41	1.76	2.45	–
	10	1.12	1.47	1.82	2.51	–
	20	1.24	1.59	1.94	2.63	–
	100	2.21	–	–	–	–



NOTE: Where X = v/λs = v/capacity   s = saturation flow   v = volume   λ = green to cycle time ratio

Figure A-4. Costs caused by stopping at intersection (excludes idling).





ADJUSTMENT FACTORS FOR PERCENT TRUCKS IN TRAFFIC STREAM

IDLING TIME FACTOR		3-S2 COMBINATION TRUCKS (percent)				
		0	5	10	20	100
SINGLE UNIT TRUCKS (percent)	0	1.00	1.08	1.17	1.33	2.67
	5	1.07	$\boxed{1.15}$	1.23	1.40	–
	10	1.13	1.22	1.30	1.47	–
	20	1.27	1.35	1.43	1.60	–
	100	2.33	–	–	–	–

IDLING COST FACTOR		3-S2 COMBINATION TRUCKS (percent)				
		0	5	10	20	100
SINGLE UNIT TRUCKS (percent)	0	1.00	0.98	0.96	0.92	0.62
	5	0.99	$\boxed{0.98}$	0.96	0.92	–
	10	0.99	0.97	0.95	0.91	–
	20	0.98	0.96	0.94	0.90	–
	100	0.89	–	–	–	–

EXAMPLE

GIVEN:

X = 0.6

Capacity = 800

λ = 0.5

Cycle Length: 90 seconds

5% Single Unit Trucks

5% 3-S2 Combination Trucks

SOLUTION: Average Delay per Vehicle: (a) + (b) = 16.2 sec

(c) Idling Hours: 4.5 hrs

(d) Idling Cost: $1.40

Total Delay: 4.5 hrs x $3.00* x 1.15†	$15.53
Total Idling Cost: $1.40 x 0.98†	1.38
Total Cost Due to Idling per 1000 Vehicles (per signal)	$16.91

*Assumed hourly value of time per passenger car.

†Adjustment factors for percent trucks in traffic stream.

NOTE: Where: X = v/λs = v/capacity s = saturation flow v = demand volume λ = green to cycle time ratio

Figure A-5. Costs caused by idling at intersection.

display of all of the several indications provided by the signal.

For a pedestrian-activated signal, λ is modified as reported by Ferlis and Kagan (1974) according to

$$\lambda_p = \frac{t_b + (1/\lambda)\exp(-\lambda t_b + \lambda t_a)}{P + t_b + (1/\lambda)\exp(-\lambda t_b + \lambda t_a)} \tag{A-9}$$

in which

λ_p = effective green-to-cycle time ratio for a pedestrian-actuated signal;
t_b = minimum vehicular green time, in sec;
t_a = minimum lag between actuation and signal response, in sec;
P = pedestrian volume, in pedestrians per sec.

- Saturation flow, s. In terms of the HCM, saturation flow is the approach volume in vehicles per hour of green time that is found for the intersection when the load factor is 1.0 and the appropriate adjustment factors are applied. In the absence of HCM solutions, recommended values for saturation flow are 1,700 to 1,800 veh/hr times the number of approach lanes.
- Capacity, c. Where the HCM is used, capacity is the service volume of the approach at a load factor of 1.0. It is also equal to the saturation flow times the green-to-cycle time ratio.
- Degree of saturation, X. The ratio of the volume of traffic approaching the intersection (usually in veh/hr) to the capacity of the intersection (usually in veh/hr).
- Approach speed. Also termed "midblock speed," this is the average running speed at which the signalized intersection is approached by the vehicle running stream.

For an unsignalized (zebra) crossing, where the pedestrian has the right-of-way over passing vehicles and the drivers are expected to wait until all pedestrians have crossed the road, the average delay to vehicles can be computed from Eq. A-10, as reported by Pillai (1975), based on a regression analysis of field data and simulation:

$$d = c\,K\,T^2/60 \tag{A-10}$$

in which

d = average delay to vehicles due to pedestrians stopping them;
c = varies between 0.7 and 1.0 for $K \leq 4$; 0.85 is good to use for a first cut;
K = the number of times vehicles are stopped by pedestrians in 1 min
$= 0.18\sqrt{P\,V} - 0.58$;
P = flow of pedestrians per minute in both directions;
V = flow of vehicles per minute in both directions;
T = the duration of crossing for a group of pedestrians
$= t + 0.78\left(\frac{P + 4.54}{4}\right) - 0.58$; and
t = average pedestrian crossing time, in sec;

To determine the maximum pedestrian and vehicle flow that can exist without any delay to vehicles, set K (the number of tiems vehicles are stopped by pedestrians in one minute) = 0. This would require:

$$P\,V \leq 10.38 \tag{A-11}$$

In other words, if the product of the vehicle and pedestrian flows is less than 10.38 (e.g., an average of 10.38 veh/min and 1 pedestrian per minute), there will not be any delay to vehicles.

1.2.1.2 Travel Time for Motor Vehicle Occupants. Unlike pedestrians, the majority of automobile drivers and other motor vehicle occupants do not perceive small time savings (or losses) of less than 5 min. Because motorists tend to be making longer trips than pedestrians, there is more variation in the travel time of a specific trip (because of traffic congestion and delays caused by signals). Motorists are also in a relatively comfortable environment, protected from the elements. Hence, time savings for motorists will be valued at a rate that depends on the amount of time saved. The following values for motor vehicle travel time are from the final report of NCHRP Project 2-12 (Andersen et al., 1975):

	Value of Time per Traveler ($)		% of Avg. Family Income
	(hr)	(min)	
For low time savings (0-5 min):			
Average trips	0.21	0.0035	2.8
Work trips	0.48	0.008	6.4
For medium time savings (5-15 min):			
Average trips	1.80	0.03	24.2
Work trips	2.40	0.04	32.2

The percent of average hourly family income figures assume 2,080 working hours a year for the $15,500 average family income of the $14,000 to $17,000 range, or $7.45 per hour, almost 50 percent higher than the assumed average pedestrian wage rate of $5.00 per hour, reflecting the cost of automobile ownership and use. These percentages can be used to adjust time value factors proportionately when average family incomes are outside the $14,000 to $17,000 range.

The per-person time values given can be converted to average values per vehicle through multiplying by the vehicle occupancy factor. Representative factors are as follows, but such values may vary considerably from place to place and over time:

Trip Type	Adults per Vehicle
Work	1.22
Social-recreational	1.98
Personal business	1.64
Average	1.56

The product of travel time value per vehicle occupant and the occupancy of adults per vehicle gives the value of travel time per vehicle-hour. The travel time for highway sections is determined from Figures A-1, A-2, or A-3, depending on the type of road. To this is added deceleration time for stopping at intersections ("stopping delay" in Fig. A-4) and idling time from Figure A-5. Total travel time is then multiplied by the value of travel time per vehicle-hour to give the total value of time saved or delayed for motor vehicle occupants.

1.2.1.3 Parking Costs. Changes in the availability, demand, and hence the cost of parking, should be evaluated. This should be done through use of a field inventory if the data do not already exist in the files of the local transportation or land-use planning agency. Figure A-6 provides a suitable format for the data to be collected.

1.2.1.4 Vehicle Ownership. Savings in automobile ownership can be realized only if a pedestrian/bicycle facility shortens the travel distance significantly (e.g., a freeway crossing where none existed before), greatly improves the walking environment, facilitates the use of transit, or restricts the use of automobiles. This will tend to occur only in multiple-car families when one of the vehicles is used only for a routine trip, such as commuting to work. If any dollar savings in automobile ownership are anticipated, these should be computed and combined with vehicle operating costs (see Sec. 1.2.1.5).

Ownership costs include not only the original cost of the vehicle, as depreciated over its lifetime, but also insurance, registration, garaging, finance charges on automobile loans, and interest foregone by having capital invested in the vehicle rather than in savings. As a rough approximation, assume that these ownership costs average about $1,000 per year for each automobile. This is equivalent to $4 per average working day if there are 250 work days per year. Multiply the estimated change (if any) in number of motor vehicles owned by the cost per vehicle for the analysis period to obtain total ownership savings.

1.2.1.5 Total Motor Vehicle Travel Cost. At this point, combine the motor vehicle cost components computed in the preceding four sections. Assemble these data on the worksheet of Figure A-7. Scoring for this variable is based on the totals of Figure A-7 and is computed according to

$$\begin{array}{c}\text{Total VEHICLE}\\ \text{TRAVEL COST SCORE}\end{array} = \frac{\text{Present cost} - \text{Cost for alt. } i}{\text{Max. of above costs}} \times 10 \tag{A-12}$$

If this evaluation is being used to compare a number of sites, the denominator of Eq. A-12 should be the maximum cost for all alternatives under consideration, including the status quo.

1.2.2 Use of Automobiles

In contrast to section 1.2.1, which takes into account the operation costs and travel time for motor vehicle trips, this variable simply considers the number of trips made by automobile, or the mode split between automobiles and pedestrians and transit. Estimates of the number of trips taken by automobile should be made at the same time that pedestrian and traffic volumes are forecast.

The score for this variable is computed according to

$$\text{Score} = 40 \times \left(\frac{M_a}{M_b} - 1\right) \tag{A-13}$$

The mode split after initial operation of a pedestrian fa-

Type of Parking Facility	Number of Spaces In Study Area	Hourly Charge Per Space	Average Stay	Turnover Per Day	Daily Revenues Per Space	Total Daily Revenue	Total Annual Revenue
On Street							
Off-Street, Lots							
Off-Street, Enclosed							

Total Number of Spaces ______

Total Cost ______

Figure A-6. Parking cost calculation work sheet.

Cost Component	Existing Situation	Alternative A	Alternative B
1. Motor Vehicle Operating Costs 2. Travel Time for Motor Vehicle Occupants 3. Parking Costs 4. Vehicle Ownership			
Total Motor Vehicle Travel Cost			

Figure A-7. Motor vehicle travel cost summation.

cility, M_a, is equal to the number of trips taken by foot, bicycle, or transit during a specified period (day, month, or year) divided by the total number of trips, including those made by automobile. Similarly, M_b is the mode split of the existing situation; i.e., before there is a facility. If Eq. A-13 produces a score greater than +10 or smaller than −10, use +10 or −10 as the rating. The formula is based on a change in mode split of 25 percent from the status quo accounting for a maximum score; smaller changes are scaled proportionately. Peak-period, off-peak weekday, evening, and weekend trips are all weighted equally, although the evaluator may choose to ocnsider peak-period trips only for this analysis.

Total USE OF AUTOMOBILES SCORE = ______.

1.2.3 Signal/Signing Needs Adjacent to Facility

The cost of signals and signs at and within the facility itself will be included for the total cost for the entire project. However, there might be a need for signs or signals adjacent to the facility:

- For detours or rerouting when a street is closed to motor vehicles.
- To direct pedestrians and bicyclists to the facility.
- To indicate changes in the location of bus stops or routes.

Assign a value between −10 and +10 to the signing requirements, based on these sample guidelines:

−10 Dangerous situation; significant confusion at 3 or more locations.
−5 Clear need for additional major signing.
0 Additional signs useful, but not essential.
+5 Need indicated only for small, routine signs, such as bus stops or route designators.
+7 Minor problem only at one or two locations.
+10 No problem; no need for additional signs.

SIGNAL/SIGNING NEEDS SCORE selected = ____.

1.3 Other Community Transportation

It is important to remember that pedestrian facilities are only one part of the city's and, possibly, the region's transportation system. These two variables consider the impact of the pedestrian facility on the larger transportation and urban environment in which it is situated.

1.3.1 Adaptability to Future Transportation Development Plans

As a part of the over-all planning process, expected future transit and highway developments should be considered to determine if they are likely to have a measurable effect on the facility. For example, plans for a pedestrian crossing over a highway would certainly be changed if at a future date the highway were to be abandoned, relocated, or widened. Similarly, the design for a pedestrian tunnel would be different if plans existed for an underground rapid transit route crossing it.

This factor is intended to provide a judgmental rating for the adaptability of the proposed pedestrian facility to the present and planned transportation system. Based on all the information that is known concerning private and public growth plans for the future of the area, evaluate the adaptability of the pedestrian facility to future transportation and urban development plans on a scale from +10 to −10, as follows:

-10	-5	0	+5	+10
Requires significant modification to city or regional transportation plans to accommodate the facility		No significant effect on current or planned citywide or regional transportation system		Enhances planned future transportation system

FUTURE TRANSPORTATION PLANS SCORE selected = ________.

1.3.2 Impact on Use of Existing Transportation Systems

Pedestrian and vehicle separation facilities may well have impacts on other transportation systems in the community. For example, vehicle or pedestrian rerouting might inconvenience bicyclists who had been accustomed to riding on uncongested routes. Transit lines might have to be rerouted, and buses might become overloaded in the vicinity of the pedestrian facility. Pupils' use of school buses might decline if the children can now cross a freeway safely or walk a shorter distance.

Figure A-8 is intended to be used as a worksheet to specify the extent and magnitude of the impacts. Place a check in each box that corresponds to an expected impact on the indicated mode. If the impact is major, use two checks. Add up the total number of checks on the bottom line.

2. SAFETY/ENVIRONMENT/HEALTH

2.1 Safety

2.1.1 Societal Cost of Accidents

The total societal cost of motor vehicle accidents involving pedestrians is a function of the number of accidents, their severity, and many direct and indirect costs such as medical and hospital, legal, income loss, pain and suffering, and insurance administration costs. This section provides a technique for estimating the relative risk of accident occurrence based on past experience of pedestrian, vehicle, environmental, and traffic control components. By multiplying the accident risk by the number of pedestrian exposures (in terms of pedestrian crossings of vehicle roadways), an estimate can be made of the number of accidents.

Dollar value estimates for total societal costs can be developed using the data from this section and the techniques and cost data given in Chapter Two. The rest of this section describes how relative accident risk is estimated and then used to determine a unitless accident score for alternative pedestrian facilities.

The accident risk per crossing for each facility (or each crossing point affected by the facility if necessary) is estimated using the accident involvement rate adjustment (Fig. A-9). For each crossing to be analyzed (one representative crossing may be evaluated if several similar crossings are involved), check off the boxes that apply, then sum

Transportation Systems	Change in Type of Use	Increase in Use	Noticeable Decline in Use	Modifications Required	Others
Bikeways					
Transit					
School buses					
Terminals					
Bus					
Railroad					
Airport					
Ferry					
Total					

Based upon the entries above, indicate on the scale below the degree of impact of the pedestrian facility on other community transport systems.

-10	-5	0	5	10
Very negative		Neutral impact		Very good

EXISTING TRANSPORTATION SCORE selected = ____.

Figure A-8. Impacts on other transportation systems.

	Number of:	Rate Decreases				Average		Rate Increases			
PEDESTRIAN	Elderly (⩾65)	Few	10	5%	5	10%	0	20%	20	⩾30%	40
	Very Young (⩽10)	Few	10	1%	5	2%	0	4%	20	⩾8%	40
	Alcohol Involved	None	10	Few	5	Mod	0	Mod-High	20	High	40
	Illegal Crossings	None	5	Few	3	Mod	0	Mod-High	10	High	20
VEHICLE	Average Vehicle Volume	Low	5	Mod-Low	3	Mod	0	Mod-High	5	High	20
	Average Vehicle Speed (mph) (kph)	<15 (<25)	5	15-24 (25-39)	3	25-30 (40-49)	0	31-40 (50-65)	10	>40 (>65)	20
	Turning Conflicts	None	5	Few	3	Mod	0	Freq.	5	Many	10
	One-way Traffic		–	Yes	3		–	No	5		–
ENVIRONMENT	Sight Distance	Good	4	Fairly Good	2	Fair	0	Poor	5	Bad	10
	Crossings After Dark (Good Light)	Few	4	Mod-	2	Mod	0		–		
	Crossings After Dark (Poor Light)		–		–	Few	0	Mod	10	Many	20
	Weather	Mild	4	Mod-Mild	2	Mod	0	Mod-Severe	3	Severe	5
CONTROL	Signalization (Presence)			Ped & Veh	10	Veh Only	0	None	20		
	Police Enforcement (Ped Laws)			Heavy	3	Mod	0	Light	3		
	Active Public Education			Yes	2		–	No	2		

Sum the colums as indicated and divide each sum by 100: Decreases ____/100 = ____ Increases ____/100 = ____

Net Involvement Rate is Increase Rate - Decrease Rate ______ + 1 = ______

Figure A-9. Accident involvement rate adjustment.

the results for both present and planned conditions using the formula below the table to obtain net involvement rates (NI rate) for both situations.

Scoring Pedestrian Accident Costs.—Unitless scoring for pedestrian accident costs is accomplished by computing a comparative crossing risk for each situation by multiplying the annual number of crossings by the NI rate (limited to a maximum of 2.0) for that situation and comparing by use of

$$\begin{array}{c}\text{Total}\\ \text{COST OF}\\ \text{ACCIDENT}\\ \text{SCORE}\end{array} = \frac{\left(\begin{array}{c}\text{Present}\\ \text{no. of}\\ \text{crossings}\end{array} \times \begin{array}{c}\text{Present}\\ \text{NI rate}\end{array}\right) - \left(\begin{array}{c}\text{Proposed}\\ \text{no. of}\\ \text{crossings}\end{array} \times \begin{array}{c}\text{Proposed}\\ \text{NI rate}\end{array}\right)}{\begin{array}{c}\text{Max. of above products}\\ \text{for all facilities being compared}\end{array}} \times 10 = \underline{\qquad}. \tag{A-14}$$

If this evaluation is being used to compare a number of sites, the maximum value indicated should be the maximum comparative crossing risk of all sites under consideration.

In Eq. A-14, the numerator represents the difference between the number of accidents before the proposed facility (present), and after the proposed facility. The number of accidents for each case is obtained by multiplying the number of crossings by the NI rate, computed using Figure A-7. The denominator is obtained by selecting the maximum number of accidents (either present or proposed), and dividing the difference in accidents for each individual site by this one number; the individual scores will be proportional to the number of accidents for each facility. For example, if Site A had a reduction of 10 accidents and Site B had a reduction of 5 accidents, the scoring for Site B would be only one-half of the score for Site A. If the denominator were 20, the score for A would be +5 and the score for B would be +2.5 (or rounded to +3). This formulation is used to maintain a level of comparability for the scores of several facilities.

If only the present situation is being compared for a number of sites, Eq. A-15 below should be used for each site. This will provide a relative accident risk index (from 0 to —22.5 for comparing potential pedestrian improvement sites).

$$\begin{array}{c}\text{Relative}\\ \text{accident}\\ \text{risk index}\end{array} = \frac{\begin{array}{c}\text{Present}\\ \text{no. of}\\ \text{crossings}\end{array} \times \left(\begin{array}{c}\text{Present}\\ \text{NI rate}\end{array} - 0.2\right)}{\begin{array}{c}\text{Max. no. of crossings at}\\ \text{any site}\end{array}} \times (-10) = \underline{\qquad}. \tag{A-15}$$

Example of Use of Eq. A-14.—Assume a four-block area of a street in a retail area closed lengthwise but with cross streets left open to motor vehicles. The street crossing locations are all similar; their before (present) and after (proposed) net accident involvement rates are 1.45 and 0.85, respectively. The present and estimated future number of person crossings are 12,500 per day and 14,500 per day, respectively.

$$\begin{array}{c}\text{Total}\\ \text{COST OF}\\ \text{ACCIDENTS}\\ \text{SCORE}\end{array} = \frac{(12{,}500 \times 1.45) - (14{,}500 \times 0.85)}{\text{Max. of above products}} \times 10$$

$$= \frac{18{,}125 - 12{,}325}{18{,}125} \times 10 = +3.2 \text{ (or } +3\text{)}.$$

2.1.2 Accident Threat Concern

This variable estimates the degree of anxiety caused by the perceived nature of conflicts between pedestrians and vehicles at conflict locations within the proposed facility or site. For all facilities where some degree of pedestrian/vehicle conflict exists, Figure A-10 is used. Appropriate values are checked, and sums computed as indicated. If separation between pedestrians and vehicles is complete, the score is +10.

2.1.3 Crime Concern

The variable components to be considered here are those that affect the perception of crime by both pedestrians and nearby residents and business persons. It is extremely difficult to predict the number and types of actual crime incidences that will be induced or averted by any particular facility. Wide variations in the physical settings of different facilities, the necessity to incorporate previous crime patterns near the facility location, and lack of specific research in this area all contribute to these difficulties. Facilities that encourage large increases in the number of users may experience crime increases, particularly so-called "petty" crimes (such as vandalism and pickpocketing). However, reasonable enforcement levels can maintain or attain low crime rates in the area of pedestrian facilities if proper consideration of this variable is taken in the planning and design of the facility.

Fear of crime by the users and nonusers of the proposed facility can be estimated using the values of Figure A-11. Check the appropriate values and sum them to rate both the present and proposed facilities.

2.1.4 Emergency Access/Medical and Fire Facilities

Several components must be considered in assessing the ability of the facility to allow emergency access and to support the treatment of both personal health and physical property damage. The most important of these is the adequate availability of access for emergency vehicles, a major design requirement for large-scale pedestrian facilities. Considerations must include adequate numbers of entrances and exits, ample turning radii and sufficient height clearances for various types of emergency vehicles. In many cases this access will be required to obtain the necessary construction permits for the facility. Figure A-12 is used to measure the degree to which a facility supports emergency services.

2.2 Attractiveness of Surroundings

The pleasantness of surroundings for a pedestrian may be measured in terms of pedestrian orientation of the environment, litter control, pedestrian density, and climate control

		Positive		Average		Negative	
Vehicles	Traffic Volume	Low	2	Med	0	High	2
	Traffic Speed	Low	2	Med	0	High	2
	Turning Conflicts	Few	1	Mod	0	Many	1
	One-way Traffic	Yes	1	No	0		--
	Vehicle Mix		--	Mixed	0	High % Trucks Buses	1
Setting	Crosswalks	Marked	1		--	Unmarked	1
	Signalization	Veh and Ped	1	Veh Only	0	None	1
	Sight Distance	Good	1	Mod	0	Poor	1
	Lighting	Good	1	Mod	0	Poor	1

Sum the column values: Positive = ____ Average = 0 Negative = ____

Total ACCIDENT THREAT SCORE is Positive Sum - Negative Sum = ________

Figure A-10. Accident threat concern scoring.

	Positive		Average		Negative			
Frequency of Visible Police Patrols	High	4	Mod	0	Low	4		
Pedestrian Density	High	4	Mod	0	Low	2	Very Low	4
Lighting	Good	3	Mod	0	Poor	4		
Visual Connection with Environment	View Outside	1	No View, Spacious	0	Narrow, Stark	2		
Line of Sight	Long	1	Mod	0	Short	1		
Communications	Pull Boxes, No Coin Voice	1	Coin Voice	0	None	1		
Community Awareness Programs	Active	1	None	0				
Vehicle Volume	Low	1	Mod	0	High	.5		
Idlers (drunks, panhandlers, teenagers)	Very Few	2	Few	0	Med	1	Many	2
Clutter (confusion, distaste)	Little	1	Some	0	Much	.5		
Litter	None	1	Some	0	Much	1		

Sum the column values: Positive = ____ Average = 0 Negative = ________.

Total CRIME CONCERN SCORE is Positive Sum + Negative Sum = ________ , ÷ 2 = ________.

Figure A-11. Crime concern scoring.

and weather protection. The surroundings are much more important for pedestrian transportation than for other modes because the pedestrian interacts directly with his environment. Measurement techniques for these variables are described in the following sections.

2.2.1 *Pedestrian-Oriented Environment*

Check off the boxes in the following that describe the facility being evaluated. For further commentary on planning attractive pedestrian environments, the reader is directed to Antoniou (1971), Benepe (1965), Morris and Zisman (1962), Nelson (1974), and Owen (1969).

Positive Impacts

Amenities

- Small park or plaza ☐
- Water fountain, artificial waterfall, or splashing water ☐

The Arts

- Theater (open or enclosed) ☐
- Mural(s) or other graphic art ☐
- Sculpture ☐
- Strolling musicians and performers ☐
- Street artists, handcrafts ☐
- Tasteful, unobtrusive background music in selected areas ☐

Buildings

- Interesting architecture; creative entrances ☐
- Renovation, restoration, or good paint job ☐

Communications

- Attractive mailboxes ☐
- Attractive telephones ☐
- Clock or sundial ☐

Exhibits

- Exhibits, displays or demonstrations ☐
- Monument or statue ☐

Nature

- Trees ☐
- Gardens ☐
- Floral exhibits, with seasonal variety ☐
- Songbirds ☐

Outdoor Eating

- Sidewalk cafes ☐
- Food pushcarts ☐

Physical Comfort

- Long, deep (30-inch), wooden benches ☐
- Steps or ledges on which to sit ☐
- Drinking fountains ☐
- Leaning posts (walls, pillars, flagpoles) ☐

Retail Outlets

- Street vendors (flowers, sundries) ☐
- Colorful or interesting shop fronts ☐
- Bookstore(s) ☐
- Newsstand ☐

POSITIVE IMPACT SCORE is sum of boxes checked = ______

Negative Impacts

- Caged pedestrian overpasses ☐
- Utility poles and wires ☐
- Automobile intrusion, extensive curb parking, parking lots, or garages ☐
- Long, monotonous frontages (such as factory or warehouse walls) ☐
- Vacant lots or buildings ☐
- Billboards or distasteful advertising ☐
- Long sections of tall (higher than 6 feet, 1.8 meters) fences ☐
- Narrow walkway ☐
- Noise ☐
- Motor vehicles or industrial odors ☐

NEGATIVE IMPACT SCORE is sum of boxes checked ____ × 2 = ____

Total PEDESTRIAN ENVIRONMENT SCORE is Positive Impact Score - Negative Impact Score = ____, ÷ 2 = ____, -5 = ____.

2.2.2 Litter Control

Auto-free zones are more expensive to keep clean than equal areas of conventional city streets, partly because wind generated by moving traffic causes dust and litter to be deposited at the edges of the road, where it can be swept up by a street cleaning truck. Also, pedestrians in vehicle-free zones have more time to indulge in litter-producing activities, such as eating and smoking, so more litter is generated (Dalley, 1973). Further, less energy intensive but more costly manual sweeping methods often have to be used to clean malls instead of or in addition to the mechanized process. Thus, it is particularly important to carefully evaluate the litter potential of pedestrian separation facilities because a "clean" atmosphere encourages a "do-not-litter" attitude.

The Urban Institute, in *How Clean Is Our City?* (Blair and Schwartz, 1972) defined four levels of cleanliness for streets and alleys, based on 400 photographs of scenes representative of the range of litter conditions in the District of Columbia. These photographs were judged independently by 19 persons, and those on which there was complete or nearly complete agreement were selected as reference standards. These photographs, which constitute Exhibits 4 and 5 (pp. 20-23) of *How Clean Is Our City?* are shown in Figures A-13 and A-14 to facilitate the evaluation of cleanliness of pedestrian facilities.

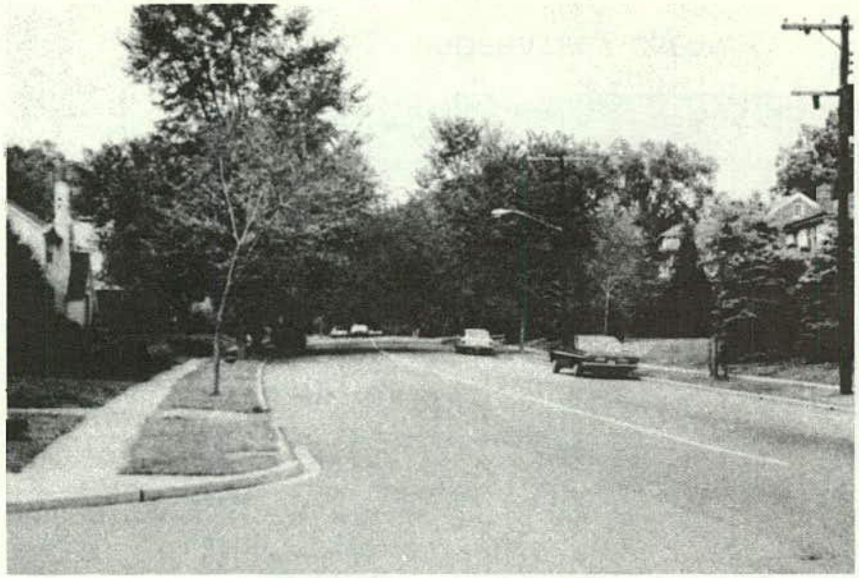
Points have been assigned to the different conditions, focusing on the conditions between 1.5 and 2.5 (midway between conditions 1 and 2, and 2 and 3, respectively) as

	Positive		Average		Negative			
Emergency Vehicle Access	Good	3	Partial	0	Poor, None	4		
Other Traffic	None	2	Little	0	Mod	1	Heavy	2
Pedestrian Density	High	1	Mod	0	Low	1		
Lighting	Good	1	Mod	0	Poor	1		
Communications	Pull Boxes, No Coin Voice	1	Coin Voice	0	None	2		
Medical Aid Stations	Yes	1	No	0				
Fire Extinguishers	Yes	1	No	0				

Sum the column values: Positive = ____ Average = 0 Negative = ____

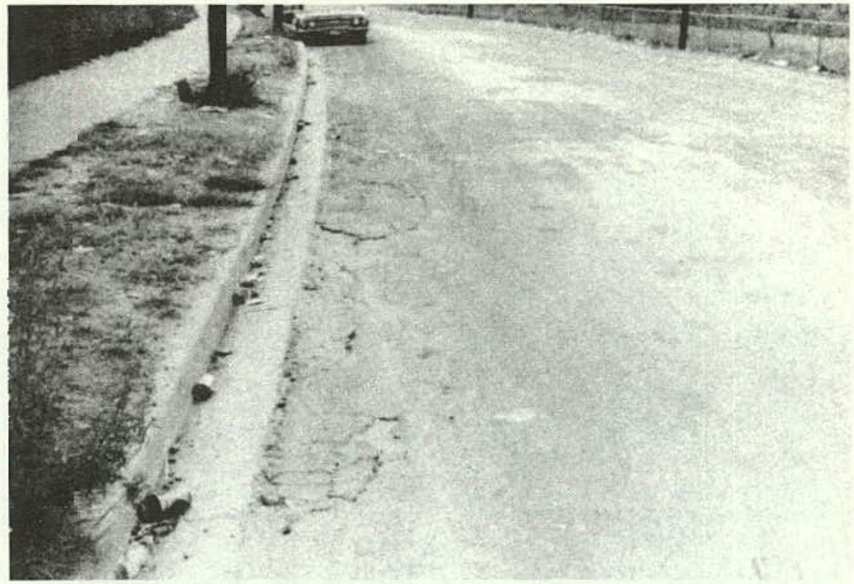
Total EMERGENCY SCORE = Positive Sum - Negative Sum = ________.

Figure A-12. Emergency scoring.



CONDITION 1: CLEAN

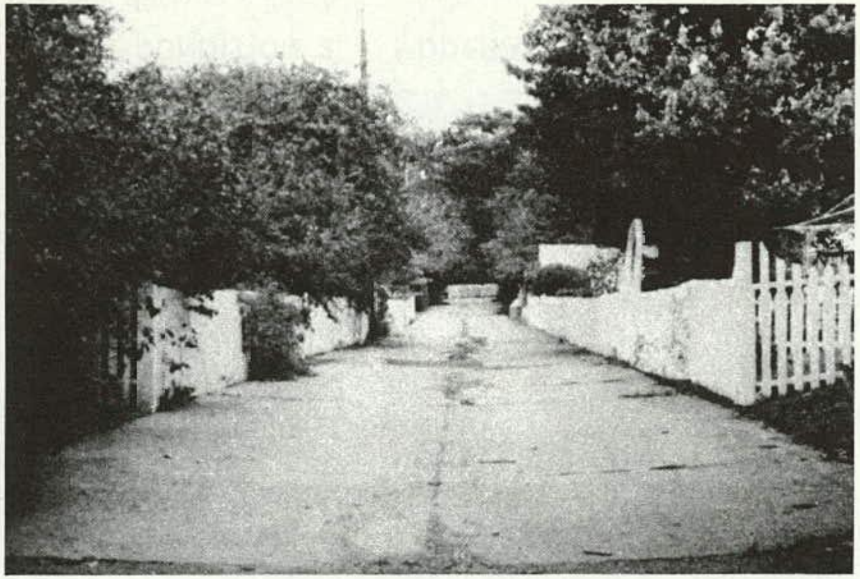
CONDITION 2: MODERATELY CLEAN



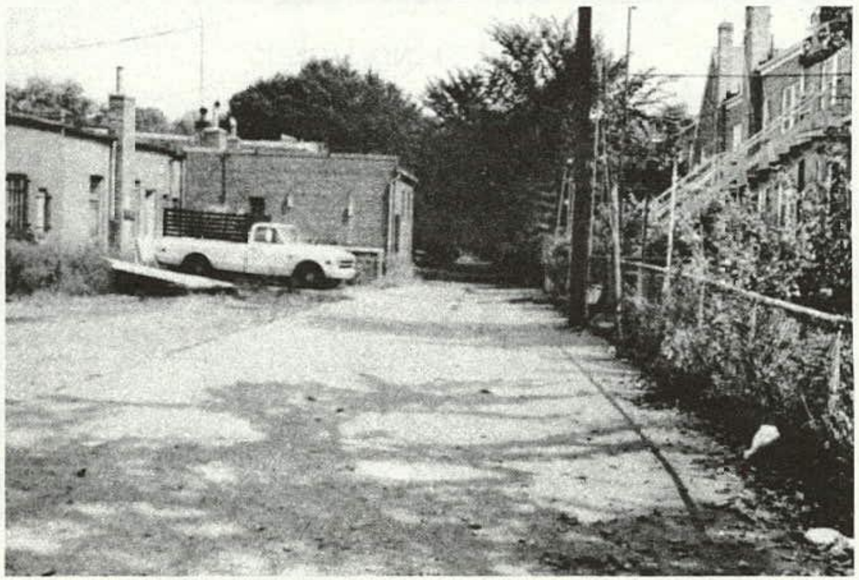
CONDITION 3: MODERATELY LITTERED

CONDITION 4: HEAVILY LITTERED

Figuer A-13. Examples of street litter conditions.



CONDITION 1: CLEAN



CONDITION 2: MODERATELY CLEAN

CONDITION 3: MODERATELY LITTERED

CONDITION 4: HEAVILY LITTERED

Figure A-14. Examples of alley litter conditions.

the most critical, highest cost-effectiveness range. The scoring procedure is as follows:

	Condition	Points
1.	Clean: free of unsightly dirt and litter	0
1.5	Almost clean: probably the most efficient goal for cities to aspire to meet	−1
2.	Moderately clean: slight accumulations of dirt and litter	−4
2.5	Littered	−7
3.	Moderately littered: significant accumulations of dirt and litter	−8
4.	Heavily littered: heavy accumulation of litter and rubbish in and near street (or promenade)	−10

LITTER CONDITION SCORE selected = _______.

Chewing gum that has been discarded on a walking surface sticks to it, captures dirt, melts, and eventually hardens into a black circle that is impossible to remove by almost any other means than steam cleaning. If this condition exists on the facility being evaluated, subtract 1 or 2 from the score selected, depending on the amount of gum residue present.

In addition to an index of the accumulation of litter present on a particular pedestrian facility, placement and collection of litter from trash baskets is important. It is frustrating for a pedestrian who does not want to litter to be unable to find a trash basket when one is needed. An equally bad situation is when the trash cans are filled to the brim, and anything left on top is likely to fall off or blow away. The following scale provides an indicator of the effectiveness of trash receptacle placement.

Situation	Points
No trash baskets	0
Trash baskets emptied very rarely	1
Some trash baskets but they are not sufficient, are unattractive, or are infrequently collected	5
Adequate placement of trash baskets but they are not necessarily attractive	8
Adequate placement of attractive or innovative trash baskets	10

Control Condition Score selected = _______

Total LITTER CONTROL SCORE is Litter condition + Control condition = _______.

2.2.3 Density

Smaller densities are usually preferable to greater densities, because the pedestrian may walk at the speed and direction he desires, not having to worry about conflicts with others. Also, at low densities, a person may stop to look into a store window without fear of having someone walk into him from behind. However, beyond a certain point, approximately 1,200 to 1,400 sq ft (111 to 130 m^2) per person, a mall will appear empty and hence less desirable than a mall full of activity. This reversal of the density curve was best expressed by Morris (1967): "It is better to have too many people for the walkway than to have a broad expanse of concrete with no pedestrians." At high densities, however, crowding occurs, causing conflicts, frustration, delay, speed and direction changes, and perhaps even claustrophobia in some. As considered here, density pertains only to inputs on the pedestrians' level of comfort; the delaying effect of density is covered under pedestrian travel time (1.1.1). Walking speed changes caused by density are only significant at very high densities anyway, those that give zero points on the scale presented later herein.

Pedestrian density will vary considerably throughout the day, usually reaching a peak during the lunch or heaviest shopping hours, and will probably reach zero from 2 to 4 a.m. To determine representative density for a pedestrian facility, it is appropriate to borrow a technique from highway planning and evaluate the 30th highest hour for the year (Wohl and Martin, 1967, Sec. 6.2). Unfortunately, pedestrian counts are much more expensive to take than freeway vehicle counts, because the state of the art for pedestrian counters is very primitive, whereas vehicle counters are quite sophisticated. Thus, observers are almost always required to count pedestrians, whereas they are needed only for counting turning vehicles at intersections. Hence, for lack of complete pedestrian traffic data, an educated guess will have to be made as to when the 30th highest hour occurs. Local merchants may be able to provide a good approximation, or pedestrian volume can be adequately estimated as follows. If the observer knows (or thinks) that the heaviest volumes occur during the weekday lunch hours, that fall is the busiest season and October the biggest month, the 30th highest hour could be a weekday lunchtime in late September, November, or December.

It is simple to measure pedestrian density when there are boxes of known area in the pavement. The ordinary boxes on sidewalks formed by the gaps allowed for concrete expansion and contraction are fine. On Sparks Street, these boxes are 7 ft 10 in. on a side, or 60.84 sq ft (5.65 m^2) in area, rounded to 60 sq ft for convenience. If there are no expansion joints, boxes can be drawn on the surface with chalk. To determine average densities, establish an appropriate grouping of between 4 and 40 boxes, depending on the pedestrian density and speed, pedway geometry, and the position of the observer. Then count the number of people within the group of boxes at various times. Multiply the area of each box by the number of boxes and divide by the number of pedestrians in the boxes to determine the amount of space per person.

On a large mall where people are traveling in all directions, density can vary tremendously from one minute to the next. This is because people often travel in groups, and if the group is walking slowly, pedestrians become stuck behind it, temporarily increasing the density, which will only fall again after the group passes. Thus, density must be observed continuously over a certain time period (probably at least 15 min) to be meaningful. Determine the typical maximum density for the time observed; i.e., the density level reached at least three times during a 15-min observation period.

Fruin (1971) derived levels of pedestrian service for design of terminal facilities for the Port Authority of New York and New Jersey. These have been expanded by Pushkarev and Zupan (1975b) into standards for crowding and impeded flow in pedestrian facilities. This work has been used as a starting point, but new criteria were developed by the researchers based on observations of pedestrian flow, crowding, and conflicts on the Sparks Street Mall. One major difference is that in transportation terminals pedestrian flow is often directed to and from the vehicles, whereas on a mall pedestrians walk in all directions. People also walk much faster in transportation terminals than on malls.

The 10-point allocation system developed during this process is recommended for evaluating pedestrian densities. The number of pedestrians per 7 ft 10 in. (2.4 m) square box provides an insight as to how the scores were developed and can be applied.

No. of Persons per 7′10″ Square Box	Amount of Space (sq ft)* per Person	Level of Service	Score
6 or more	10 or less	Measurable delay, numerous conflicts	−10
5	12	Crowded	−6
4	15		−4
3	20	Constrained	0
2	30		4
1	60	Impeded	7
½	120		9
⅓	130	Free flow	10
1/23 or less	1400 or more	Empty	6

* To convert square feet to square meters, multiply by 0.0929.

DENSITY SCORE selected = ________

One can see from the point system that discomfort due to density is gradual between 180 and 30 sq ft (16.7 and 2.8 m^2) per person, and then rises rapidly until 10 sq ft (0.9 m^2) per person, the critical point, is reached. At 1,400 or more sq ft (130 m^2) per person the area appears empty, and much of the pleasure of being around other people is lost.

2.2.4 *Climate Control and Weather Protection*

This item considers heating, cooling, ventilation, and protection from the elements. Inasmuch as outdoor facilities are rarely artificially heated or cooled, higher scores will occur on this variable for climate-controlled indoor facilities. Even indoor facilities that are not climate controlled provide some protection from the elements. For a discussion of traveler comfort with various heating, air conditioning, and ventilation conditions, see Cantilli (1972). However, increased attention has been given to energy conservation since the time of Cantilli's research, and the ratings presented in the following place the optimum temperature in winter 4 F (2.2 C) lower than that in his thesis.

• Heating. In winter, to what temperature is the facility heated?

Temperature	Points
78 F (26 C) or warmer	2
73 F (23 C)	4
68 F (20 C)	5
63 F (17 C)	4
58 F (14 C)	2
53 F (12 C), or unheated	0

HEATING SCORE selected = ________.

• Air Conditioning. In summer, to what temperature is the facility cooled?

Temperature	Points
57 F (14 C) or colder	0
62 F (17 C)	2
67 F (19 C)	4
72 F (22 C)	5
77 F (25 C)	4
82 F (28 C)	2
87 F (31 C) or warmer	0
No artificial cooling	0

AIR CONDITIONING SCORE selected = ________.

• *Ventilation.*

Ventilation Rate or Condition	Points
Outdoor facility	5
2 Ft^3 fresh air/min/ft^2 floor space	5
1½ Ft^3 fresh air/min/ft^2 floor space	4
1 Ft^3 fresh air/min/ft^2 floor space	2
½ Ft^3 fresh air/min/ft^2 floor space	0
No artificial ventilation	0

VENTILATION SCORE selected = ________.

• *Protection.* Are pedestrians protected from

	YES	NO
Direct sun?	1	0
Gusts of wind?	1	0
Precipitation?	1	0
Blown rain coming in at a slant?	1	0
Snowdrifts or puddles?	1	0

PROTECTION SCORE is sum of values in boxes checked = ______.

Total CLIMATE AND WEATHER SCORE is Heating Score + Air Conditioning Score + Ventilation Score + Protection Score = ________, -10 = ________.

2.3 Environment/Health

2.3.1 Effects of Air Pollution

Pollution results from the introduction of wastes into the environment in greater concentrations than can be absorbed over a given period of time. Motor vehicles contribute significantly to a number of major air pollutants. Because pedestrian facilities are structured around a basically nonpolluting mode of transportation (walking), they present opportunities to reduce motor vehicle pollution by decreasing the number of vehicle-miles traveled, and also by reducing or eliminating time and space conflicts between pedestrians and vehicles, thereby improving traffic flow. Such results would also reduce the consumption of fuel and oil and the wear on brake linings.

The pollutants generated by motor vehicles and considered here for their effects on humans and on property are:

- Carbon monoxide (CO)—resulting from incomplete combustion and injurious to human health at concentrations generated by heavy traffic volumes.
- Hydrocarbons (HC)—actually a group of organic gases such as ethylene, some of which pose serious threats to plant, animal, and human health in sufficient concentrations, as well as participating in the "smog" reaction with resultant eye and lung irritation and visibility restrictions.
- Nitrogen oxides (NO_x)—formed by high-temperature or high-pressure combustion processes and participate in photochemical reactions resulting in smog formation.
- Sulfur dioxide (SO_2) and sulfuric acid (formed when SO_2 comes in contact with water)—are very toxic materials highly injurious to human health (especially to persons with respiratory problems), plant life, and property.
- Particulate matter—dust, soot, asbestos from brake linings, tire rubber, and others that can cause damage to humans, plants, buildings, and other personal property.

Damage to property includes damage to plant life, buildings, clothing, and other personal property. The results of air pollution damage to property are more frequent replacement and renovation rates such as replanting, cleaning, and refinishing. Due to the complex nature of pollution damage effects, and the greater concentration of past research on danger to humans, considerably less is known about the specific impacts of pollution on property as described. However, the range of air pollutant concentrations that affect human health and psychology is generally coincident with the range of pollutant concentrations that affect property. Thus, the need for a relative scale value can be met by a single score for both property damage and human impacts.

The effects of air pollution result from the subject experiencing the ambient air quality, which is determined by: the number of, and distance from, air pollutant sources; the specific types and amounts of pollutants emitted; the physiographic characteristics of the area; and complex meteorological conditions. Analysis of these interacting characteristics to determine the air pollutant actually experienced by a person or an item of property is possible but not within the scope of the evaluation required here. Furthermore, even if the ambient concentrations experienced were accurately predicted, threshold reactions, synergistic effects, and varying responses of different individuals and materials to the same pollutants would make the effects analysis too complex for the evaluation of pedestrian facilities. Thus, to provide a practical evaluation technique, it was decided to assume a one-to-one relationship between motor vehicle emissions and health and property damage.

The user should be aware that this evaluation is very general. It cannot be used in place of an expert evaluation of the specific site and project plan to accurately determine the change in air pollution levels or their resulting effects. However, it does provide a reasonable method to allow an approximate comparison of alternate pedestrian facilities.

Determination of Pollutant Level Changes.

1. Define the area over which motor vehicle traffic will be significantly affected (the project area). A very small project area will not take all changes into account, whereas a very large area will make the resulting pollutant emissions seem insignificant. The area should be defined in terms of miles of roadway. This evaluation can be done separately for each road or section of road involved, with separate scores, for each section of road, added to or subtracted from the total score. Separate sections can be evaluated individually and their scores averaged if desired.
2. Determine the annual average traffic volume for each project area road segment and express it in terms of vehicle-miles traveled (VMT) per day. Estimate the comparable values for each project alternative.
3. Determine average speed for each area road segment. The average speed takes stop lights and the like into account, as well as the speed limit (see Sec. 1.2.1.1 for a discussion of speed determination). Again, if different road sections have different average speeds, the evaluation can be done separately and the scores averaged. This separate consideration might be beneficial in cases where some type of vehicle traffic impediment (such as a STOP sign) is removed on one street.
4. Determine the present (no project) emission level for each of the five pollutants by multiplying the daily VMT by the emission factors given in Table A-1 * for the project year and adjusted by the speed correction factors given in Figure A-15.†
5. Determine the future (with project) emissions for each of the five pollutants in the same manner. Emission factors for the same year should be used so that improvements in emission controls are not counted as project benefits.
6. Separately add the weighted emissions for the present case and the future case to get a weighted sum for each in the same units. The weighting factors to be used are: $CO = 1$; $HC = 125$; $SO_x = 15.3$; $NO_x = 22.4$; particulates $= 21.5$. These factors are derived (Walther, 1972) from the national ambient air quality standards that were

* Supplement No. 2 for "Compilation of Air Pollutant Emission Factors," 2nd Ed. U.S. Environmental Protection Agency, Research Triangle Park, N.C. (Sept. 1973) Table 3.1.1-1, p. 3.1.1-6.

† Ibid., Figure 3.1.1-1, p. 3.1.1-7.

TABLE A-1

AVERAGE EMISSION FACTORS FOR HIGHWAY VEHICLES BASED ON NATIONWIDE STATISTICS

	Carbon monoxide		Hydrocarbons				Nitrogen oxides (NO_x as NO_2)		Particulates				Sulfur oxides (SO_2)	
			Exhaust		Crankcase and evaporation				Exhaust		Tire wear			
Year	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km
1965	89	55	9.2	5.7	5.8	3.6	4.8	3.0	0.38	0.24	0.20	0.12	0.20	0.12
1970	78	48	7.8	4.8	3.9	2.4	5.3	3.3	0.38	0.24	0.20	0.12	0.20	0.12
1971	74	46	7.2	4.5	3.5	2.2	5.4	3.4	0.38	0.24	0.20	0.12	0.20	0.12
1972	68	42	6.6	4.1	2.9	1.8	5.4	3.4	0.38	0.24	0.20	0.12	0.20	0.12
1973	62	39	6.1	3.8	2.4	1.5	5.4	3.4	0.38	0.24	0.20	0.12	0.20	0.12
1974	56	35	5.5	3.4	2.0	1.2	5.2	3.2	0.38	0.24	0.20	0.12	0.20	0.12
1975	50	31	5.0	3.1	1.5	0.93	5.0	3.1	0.38	0.24	0.20	0.12	0.20	0.12
1976	44	27	4.3	2.7	1.3	0.81	4.8	3.0	0.38	0.24	0.20	0.12	0.20	0.12
1977	37	23	3.7	2.3	1.0	0.62	4.3	2.7	0.38	0.24	0.20	0.12	0.20	0.12
1978	31	19	3.2	2.0	0.83	0.52	3.8	2.4	0.38	0.24	0.20	0.12	0.20	0.12
1979	27	17	2.7	1.7	0.67	0.42	3.4	2.1	0.38	0.24	0.20	0.12	0.20	0.12
1980	23	14	2.4	1.5	0.53	0.33	3.1	1.9	0.38	0.24	0.20	0.12	0.20	0.12
1990	12	7.5	1.3	0.81	0.38	0.24	1.8	1.1	0.38	0.24	0.20	0.12	0.20	0.12

NOTE: This table reflects interim standards promulgated by the EPA Administrator on April 11, 1973, and in July 1973.

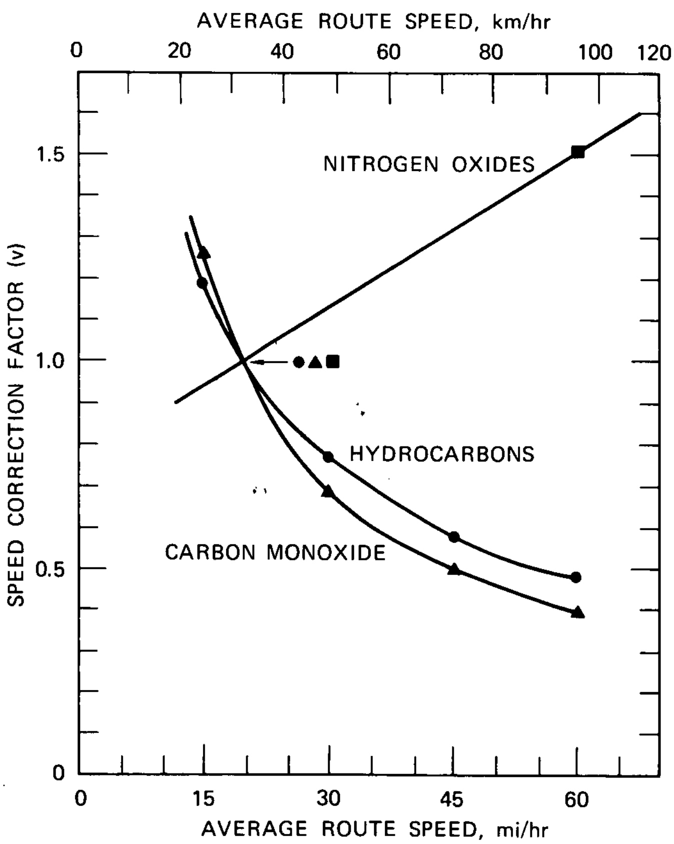


Figure A-15. Average speed correction factors for all model years. (Curves developed from test of pre-1968 (uncontrolled) vehicles. Recent tests indicate their approximate applicability to controlled vehicles, including those equipped with catalytic devices.)

promulgated to prevent health and welfare damages. Thus, the assumption is that a person (or a plant or property) can experience 125 units of concentration of carbon monoxide and get the same relative level of damage as one unit concentration of hydrocarbons.

7. Calculate the percent change in total emissions of project situation from no-project situation by using

$$(E_{\text{project}} - E_{\text{present}})/E_{\text{present}} \qquad \text{(A-16)}$$

8. Obtain the final score from Figure A-16.

Sample Application.

Present (no project)

1. Wrongway Avenue: ½ mi
   Easy Street: ¼ mi
   Roundabout Drive: ⅔ mi
   Total = 1 5/12 mi
2. Wrongway Ave.: 10,000 v/day × ½ mi = 5,000 veh-mi/day
   Easy St.: 2,000 v/day × ¼ mi = 500 veh-mi/day
   Roundabout Dr.: 1,500 v/day × ⅔ mi = 1,000 veh-mi/day
   Total = 6,500 veh-mi/day
3. Average speed over all streets = 30 mph.
4. CO = 50 g/mi × 6,500 veh-mi/day × 0.7
   = 227,500.00 g/day
   HC = (5.0 + 1.5 g/mi) × 6,500 mi/day × 0.75
   = 31,687.50 g/day
   SO_x = 0.20 g/mi × 6,500 mi/day
   = 1,300.00 g/day
   NO_x = 5.0 g/mi × 6,500 mi/day × 1.1
   = 35,750.00 g/day
   Part. = (0.38 + 0.20 g/mi) × 6,500 mi/day
   = 3,770.00 g/day

5. Does not apply; only the present case is being considered.
6. $(1 \times CO) + (125 \times HC) + (15.3 \times SO_x) + (22.4 \times NO_x) + (21.5 \times Part.) = (227{,}500) + 125(31{,}687.5) + 15.3(1{,}300 \times 22.4(35{,}750) + 21.5(3{,}770) = 5{,}090{,}183$ effect equiv. g/day $= E_{present}$

Future (with project). Possibly a pedestrian overpass replacing a mid-block pedestrian crossing on Wrongway Avenue. This attracts traffic off Easy Street and Roundabout Drive, and also increases average speed because of the stop eliminated.

1. Wrongway Avenue: ½ mi
   Easy Street: ¼ mi
   Roundabout Drive: ⅔ mi
   Total = $1\frac{5}{12}$ mi
2. Wrongway Ave.: 12,000 v/day × ½ mi = 6,000 veh-mi/day
   East St.: 1,000 v/day × ¼ mi = 250 veh-mi/day
   Roundabout Dr.: 500 v/day × ⅔ mi = 333 veh-mi/day
   Total = 6,583 veh-mi/day
3. Average speed over all streets = 33 mph.
4. Does not apply; this is a planned project.
5. CO = 50 g/mi × 6,583 mi/day × 0.63 = 207,364.50 g/day
   HC = 6.5 g/mi × 6,583 mi/day × 0.70 = 29,952.65 g/day
   SO_x = 0.20 g/mi × 6,583 mi/day = 1,316.60 g/day
   NO_x = 5.0 g/mi × 6,583 mi/day × 1.20 = 39,498.00 g/day
   Part. = 0.58 g/mi × 6,583 mi/day = 3,818.14 g/day
6. $(1 \times CO) + (125 \times HC) + (15.3 \times SO_x) + (22.4 \times NO_x) + (21.5 \times Part.) = (207{,}364.5) + 125(29{,}952.65) + 15.3(1{,}316.6) + 22.4(39{,}498) + 21.5(3{,}818.14) = 4{,}938{,}435$ effect equiv. g/day $= E_{project}$
7. $\frac{E_{project} - E_{present}}{E_{present}} = \frac{4{,}938{,}435 - 5{,}090{,}183}{5{,}090{,}183}$ $= -3$ percent (i.e., 3 percent lower emissions).
8. From Figure A-16, a −3 percent emissions change gives a score of +5 for effects of air pollution.

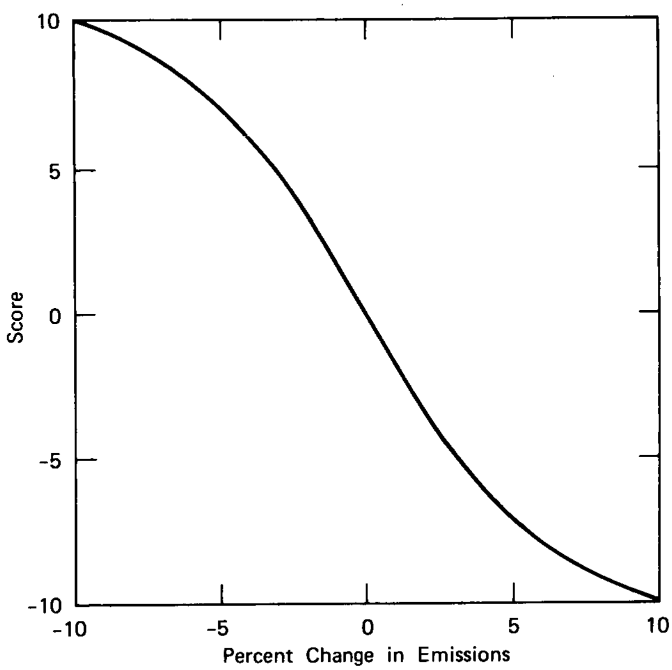


Figure A-16. Scoring graph for air pollution effects on human health and property.

2.3.2 *Noise Impacts of Motor Vehicles*

When pedestrians were asked what displeased them about their walking environment (Eckman et al., 1975), 26 percent expressed displeasure with noise, 14 percent with dirt or litter, and 11 percent with air pollution. Noise may be simply defined as any sound that is undesired by the recipient. The major function of the human auditory system is to select information-bearing components in a sound wave. Thus, the masking of speech is the most important effect of noise on man (Kryter, 1972).

Speech masking is not the only effect, however. Various sound levels are capable of producing annoyance, sleep disturbance, and declines in property value near noise sources. More seriously, noise can produce hearing losses, vasoconstrictive effects in the circulatory system, muscular tension, sweating, metabolic change, nausea, headaches, drowsiness, and respiratory irregularities.

Aspects of noise considered when measurement is made are the magnitude of the noise, the frequency distribution, and the variation and duration over time. The most commonly used measurement scale is the A-weighted decibel scale, db(A), which measures sound level in a way that emphasizes frequencies in a manner similar to human auditory systems. It was developed largely for use in measurement of motor vehicle noise (Berry et al., 1974).

Although hearing losses begin at 85 db(A) with prolonged exposure to such noise levels over several years and serious losses begin at 90 db(A) over a similar period (Dickerson et al., 1970), motor vehicle traffic noise seldom offers such physical danger to pedestrians. What it does do is annoy, cause discomfort, and interfere with speech. Heavy trucks and buses produce sound levels as high as 85 db(A) on city streets, as observed during this research. Figure A-17 shows comparative sound levels from a range of noise sources (Berry et al., 1974, Fig. 5-3, p. 214).

Because dangerous sound levels are seldom encountered by pedestrians, a scaling system to measure the impact of noise for pedestrian facilities can be restricted to the meaningful levels of sound usually encountered. Some general

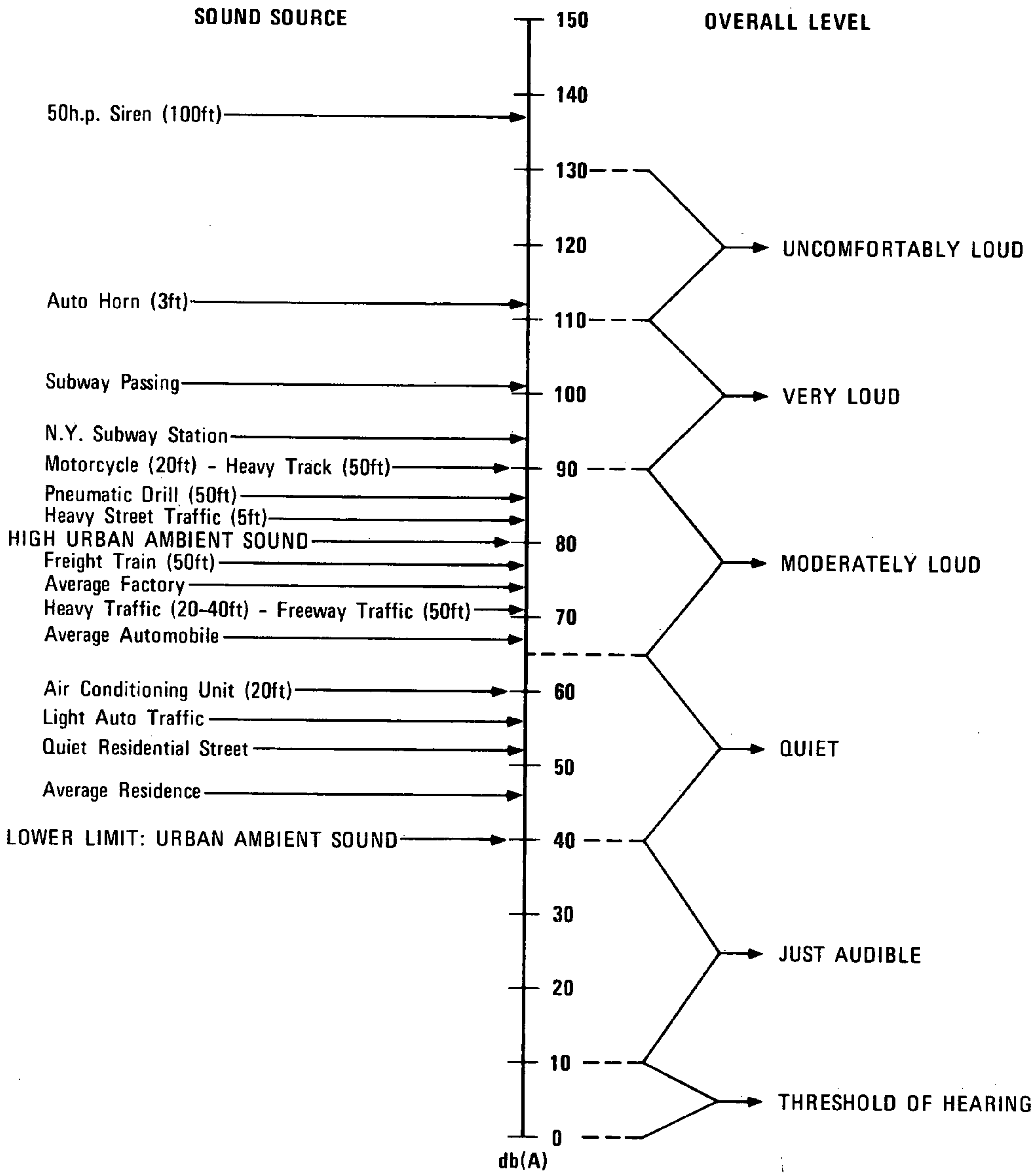


Figure A-17. Comparison of sound sources and noise levels.

values that may be encountered in typical types of pedestrian facilities are as follows:

70 db(A)	An open overpass over heavy traffic.
65 db(A)	A busy sidewalk on a commercial street allowing all types of vehicles with 70- to 85-db(A) peaks.
60 db(A)	An enclosed overpass over heavy traffic or a busy mall with buses and delivery traffic (with 70- to 85-db(A) peaks from those vehicles).
55 db(A)	An open overpass over light traffic or a busy mall with no vehicle traffic and light background noise.
50 db(A)	A quiet residential street.

The selected sound range for scaling pedestrian facilities is from 40 db(A) (a practical minimum) to 90 db(A) (a reasonable maximum). The upper value is exceeded by some subway-generated noises and other special noises, but speech is generally impossible beyond that level, so it is a practical upper bound for pedestrian facility evaluation.

Sound level measurements in decibels using the A scale should be taken at a sufficient number of points to obtain a representative noise level for an existing facility. Estimates of the noise level for proposed facilities can be made by taking sound measurements from comparable facilities, or examining Figure A-17 and the preceding list to select a reasonable value for the proposed facility. The following scale or formula (Eq. A-17) can then be used to evaluate the change in noise levels:

90 db(A)	77.5 db(A)	65 db(A)	52.5 db(A)	40 db(A)
-10	-5	0	+5	+10

Any noise level over 90 db(A) scores -10
Any noise level under 40 db(A) scores +10

$$\text{Total NOISE SCORE} = -10 + \left[(90 - \text{observed or estimated noise level}) \times 0.4\right]$$

$$= \underline{\qquad\qquad} \tag{A-17}$$

2.3.3 Health Effects of Walking (Exercise, Fatigue)

The primary anticipated health benefits of walking, jogging, running, or bicycling are improvements in physical health because of the physiological effects of exercise. Because our society has become quite sedentary, our major health concern is toward coronary heart disease (CHD) and its prevention or control. The classical concept is that over-all energy expenditure reduces the incidence of CHD; and the more exercise, the lower the risk.

Unfortunately, medical evidence being developed by current research strongly suggests that exercise must be vigorous, must be of significant duration (20 to 40 min) and must be regular (three or more times per week) to be effective in lowering the risk of CHD. Vigorous activity is usually defined relative to kilocalories consumed per minute; the required minimum threshold is about 6 to 7 kcal per min. This is comparable to walking briskly at 4 to 5 mph (6.4 to 8 kph). Jogging, running, bicycling, tennis, and swimming all generally exceed the minimum threshold, usually substantially; for example, running at 10 mph (16 kph) consumes 18 to 20 kcal/min. But ordinary walking, less than 4 mph (6.4 kph), is not sufficiently vigorous.

The medical point of view toward exericse is typified by the following statement from a report based on a study of middle- and upper-level British civil servants that showed a significant relationship between vigorous leisure-time activity and reduction in CHD (Morris et al., 1973): "Habitual vigorous exercise during leisure-time reduces the incidence of CHD in middle age among male sedentary workers. Vigorous activities which are normal for such men are sufficient. Training of the heart and cardiovascular system is one of the mechanisms of protection against common risk factors and the disease."

In spite of the fact that ordinary walking is not sufficiently vigorous to be effective in preventing CHD, such exercise has other benefits. These include caloric expenditure assisting in weight control, muscle tone development, reduced blood pressure, and reduction of psychological stress in many pedestrian environments. There is also a generally brighter mental outlook induced by attractive and comfortable pedestrian facilities. Against these must be weighed the possible disbenefits of induced fatigue (particularly the elderly), exposure to air pollution (particularly CO), and psychological stress if vehicles or excessive noise are present. Assessing the impact of a pedestrian facility on human health is therefore expressed in terms of those subelements that contribute (or detract) from the physical and mental well-being of its users.

Check the boxes in Figure A-18 that apply to a given pedestrian facility to determine its score.

2.3.4 Conservation of Resources

Precise identification of all resources involved in construction, maintenance, and use of a pedestrian facility would be an extremely time-consuming process unnecessary for the intent of this methodology. The scoring system presented is devised primarily to distinguish between alternatives, and a checklist of resources utilized relative to their scarcity is the indicator to be used.

Five major categories of resources were considered; the most significant elements in each category relative to pedestrian facilities were identified. They are:

- Energy resources (direct)—crude oil and related products; natural gas; hydropower; coal.
- Manufactured materials (indirect energy use)—metals and metal products; lumber and wood products.
- Natural resources (nonenergy)—water supply; soil quality, stability, and contour.
- Human resources—labor.
- Private and public services—sanitary services, communication services (transportation services are considered separately in Sections 1.1 to 1.3).

An estimate of the use should be made for each major resource category relative to the reviewer's concept of "ordinary" use of the resource in general pedestrian facilities. If very little use of a resource is made, check the box labeled "low" for that resource. If the amount of a resource category used seems significantly higher than comparable pedestrian facilities, check the box labeled "high." Otherwise check the box labeled "mod" (for moderate). The internal weights of resource categories below indicate the relative availability, renewability, or reusability of the resources considered.

	Positive		Negative
Direct energy	Low 4	Mod 0	High 4
Manufactured materials	Low 3	Mod 0	High 3
Natural resources	Low 1	Mod 0	High 1
Human labor	Low 1	Mod 0	High 1
Services	Low 1	Mod 0	High 1

Sum the columns: Positive = ____ Negative = ____

Total CONSERVATION SCORE is Positive Sum - Negative Sum

= ________.

3. RESIDENTIAL/BUSINESS

3.1 Residential Neighborhoods

3.1.1 Residential Dislocation

This variable deals subjectively with the out-of-pocket costs and inconvenience to households (property owners and renters) incurred as a result of implementing a pedes-

	Positive		Average		Negative	
Volume of vehicle traffic within 100 ft (30 m) of pedestrians	None	2	Light	0	Mod	1
					Heavy	3
Clear lanes for rapid walkers or joggers	Yes	1	No	0		--
Bicycle paths through or around facility	Yes	1	No	0		--
Improved access to tennis courts, swimming, other physical activity centers	Yes	1	No	0		--
Benches, ledges, and the like, available for rest stops	Yes	1		--	No	1
Adverse weather protection available (prevent exposure, physical discomfort)	Yes	1	No	0		--
Crime rate in area	Low	1	Mod	0	High	2
Aesthetically pleasing environment (conducive to mental health)	Good	1	Mod	0	Poor	2
Noise levels (psychological discomfort)	Low	1	Mod	0	High	2

Sum the columns as indicated: Positive = ______ Negative = ______

Total HEALTH SCORE is Positive Sum - Negative Sum = ________.

Figure A-18. Health effects scoring.

trian facility. The score for this variable will usually be negative or zero unless special circumstances are present. The out-of-pocket costs considered include:

- Movement of household goods and furnishings.
- Temporary living expenses (housing, food, transportation).
- Residence renovation in new location to establish a comparable living environment.
- Cleanup and repair of residence at present location if movement is not required (stimulated pride of ownership).
- Property adjustments (such as fences) if property boundaries are changed by facility.

Inconvenience to those required to move includes time lost due to the movement and loss of access to friends, neighbors, schools, shopping, and neighborhood activities. Special circumstances that could offset some of these costs (for disbenefits) might be a reimbursement policy that compensates beyond the actual out-of-pocket costs, or the availability of significantly better living quarters at comparable costs for those forced to move.

The final score for this factor is obtained by considering the number of households impacted, the costable and non-costable components previously listed, the reimbursement policy, and any special circumstances as follows. A household index is selected from the following:

No. of Households Impacted	Index Value
0	0
1-2	1
3-5	2
6-10	3
11-20	4
21+	5

1. Household index value selected = ______.

A reimbursement index is obtained using the following:

Costable Impact Types	Reimbursement Policy 0%	50%	100%
Movement of goods	4	2	0
Temporary living expenses	3	1.5	0
Residence renovation (moved to)	1	0.5	0
Residence renovation (stay)	1	0.5	0
Property adjustment (stay)	1	0.5	0

2. Reimbursement index is sum of values in boxes checked = ______ .

A special circumstances index should be selected to range in value from 0 (no special circumstances) to 10 (exceptional social and reimbursement policies).

Points (0-5) for social policy such as housing = ______.

Points (0-5) for excess reimbursement policy = ______.

3. Circumstances index is sum of values chosen = ______.

The final score for residential dislocation is obtained by

$$\text{Total RESIDENTIAL DISLOCATION SCORE} = \text{Circumstances index} - \frac{\text{Reimbursement index} \times \text{Household index}}{10} - \text{Household index} \quad \text{(A-18)}$$

The following descriptors are used to illustrate the scoring method: 15 households impacted; 50% reimbursement policy for household goods movement and living expenses; no reimbursement for other costs (renovation, etc.); good housing program to assist homeowners in finding reasonable dwellings (also at moderate cost for low-income families); household index = 4; reimbursement index = 6.5; circumstances index = 5.

$$\text{Total score} = 5 - \frac{6.5 \times 4}{10} - 4 = -1.6 \text{ (or rounded to } -2).$$

3.1.2 Community Pride, Cohesiveness, and Social Interaction

This variable considers the impacts of proposed pedestrian facilities on neighborhood and community attitudes and personal relationships among residents. These impacts are difficult to assess, in part because of the wide diversity of neighborhood types. A frequent assumption in the past has been a relative homogeneity of neighborhoods; however, in recent years this has been seriously challenged (Lehmann et al., 1974); Warren and Warren, 1975).

Variations of values and interactions within and between neighborhoods strongly suggest survey or interview techniques to adequately assess the impacts of proposed facilities (Kaplan et al., 1972; Ryan et al., 1972). These techniques provide data that cannot be efficiently obtained in any other way, but care must be taken to minimize measurement errors in such data (Lehmann et al., 1974). Detailed attitudes about the proposed project, attitudes toward the community, and the nature of friendship and social interaction patterns can all be examined, as well as attitudes toward alternative proposals.

Probably the most important assessment to be made in evaluating community impact is what degree of adaptation in behavior will be required as a result of the facility. The scoring system presented here is designed to assist in identifying the types of changes that may be caused by a pedestrian facility, and the degree of desirability of such changes.

The researcher should feel free to reassess the relative magnitude of individual changes by modifying the internal weights of each component. These weight modifications should be scaled to keep within the range of +10 to −10.

A total score for this variable is obtained using Figure A-19. The type of impact is assessed and checked for a list of variable components, then the rating columns are summed. The total score is the sum of the favorable points minus the sum of the points for unfavorable outcome.

	Rating		
Component	Favorable or Improved	No Change	Unfavorable or Decline
Interest expressed in project	1	0	1
Access to neighbors and friends	1	0	1
The pedestrian facility as a meeting place	1	0	1
Neighborhood communications (e.g., bulletin boards)	1	0	1
Access to community facilities (e.g., shopping, theaters)	1	0	1
Links to rest of community	1	0	1
Activities planned (e.g., block parties)	1	0	1
Protection of privacy	1	0	1
Fewer motor vehicles	1	0	1
Bicycle/jogging paths	1	0	1

Sum the columns as indicated: Favorable = ____ Unfavorable = ____

Total COMMUNITY PRIDE AND INTERACTION SCORE is

Favorable Sum - Unfavorable Sum = __________.

Figure A-19. Neighborhood/community impacts.

3.1.3 Aesthetic Impact, Compatibility with Neighborhood

This variable is used to assess the blending of a proposed pedestrian facility with the physical surroundings of a residential neighborhood. It should only be considered when pedestrian facilities are located in residential areas (for example; sidewalks, paths, pedestrian/bicycle networks).

A checklist of favorable components (Fig. A-20) is followed by a checklist of unfavorable ones (Fig. A-21). The points in each checklist are to be added separately and then combined by subtracting the unfavorable point sum from the favorable point score. Nonapplicable points for a specific facility should be ignored (automatically assigning a neutral value of 0 to that component).

3.2 Commercial/Industrial Districts

The implementation of many, if not most, pedestrian facilities vitally concerns the affected business interests in the vicinity. Not only long-term benefits, but also survival during the construction and transition phase of the project, are major considerations, especially for small local business persons. This section directs special attention to short-term (1 to 5 years) effects on business enterprises from implementation of a pedestrian facility, with the highest ratings assigned for those plans estimated to have the least detrimental effect.

3.2.1 Gross Retail Sales

The change in gross sales from last year's performance for the period under question is probably the single most important evaluation criterion for any retailer. Even though different stores will operate at different profit margins, and any increase in sales is likely to be more profitable than average (since the fixed expenses of rent, utilities, and some or all of the payroll have already been recovered), retailers still prefer to evaluate only the change in gross sales. This often reflects business people's reluctance to allow any useful information to get into the hands of competitors. Frequently, however, the store owners are unsure of their actual marginal rate of profit because of the complexity of its determination.

Changes in gross sales result from improved customer access, a greater volume of pedestrian traffic passing the store, improved attractiveness of individual stores or the general area, and changes in the number of visitors, including out-of-town tourists. Individual store owners should be asked to estimate the effect of the facility on their businesses, although they may be reluctant or unable to do so without a trial experimental street closure. Although temporary or trial solutions lack many of the amenities of a permanent installation (such as attractive walking surfaces, trees, benches, and fountains), they can provide an indication of the public and business acceptance of the concept.

A more dependable source for estimates of changes in sales would be a large department store (often part of a chain) that has a research or statistics department, particularly if it has assembled data from previous experiences with similar projects. A chamber of commerce or merchants' association may be able to supply some data, but usually it will direct you to an executive of the major retailing firms, who will be the ultimate source of information.

One rule of thumb that has been developed based on the experience of Norwich, England, in 1967 (Wood, 1970) and Kalamazoo, Mich., in 1959 (Elliot, 1964) relates the increase in sales attributable to a successful facility (change in sales for the affected stores minus the change in sales for the region) to the increase in pedestrian traffic on the mall. Retailers know that sales are directly proportional to foot traffic, and from these two examples the ratio of changes in sales to changes in foot traffic was found to be about 1 to 10. For Norwich, there was a 5 percent improvement in

Structure and shape complementary to neighborhood architecture style ☐

Pleasing and complementary colors or textures ☐

Unobtrusive grade change features (ramps and steps should be masked if possible) ☐

Continuity of pathway with existing pedestrian paths ☐

Blended signing with no glare lighting ☐

Overall lighting complementary to existing light features and intensity levels ☐

Continues existing bicycle/jogging paths ☐

Reduced motor vehicle traffic ☐

Compatible noise levels; 50-55 db(A) in many neighborhoods ☐

Residential privacy protected ☐

Sum of positive components = ____________

Figure A-20. Positive compatibility components.

Unpleasant contrast between facility and existing architecture style ☐

Displeasing color or texture contrast ☐

Little pedestrian path continuity ☐

Obtrusive signing ☐

Uncomplimentary lighting and fixtures compared to existing features ☐

Increased motor vehicle traffic, especially trucks ☐

Increased noise levels--over 55 db(A) ☐

Privacy or sleep disturbed by users ☐

Additional litter or vandalism ☐

Fences, poles, or wires ☐

Sum of Negative Components = ____________

Total AESTHETICS AND COMPATIBILITY SCORE is

Positive Sum - Negative Sum = ____________.

Figure A-21. Negative compatibility characteristics.

sales that could be attributed to the street closure, and a 45 percent increase in pedestrian traffic. Gross sales in downtown Kalamazoo for 1959, the first year after the mall was completed, increased 15 percent. Retail sales for the county increased 12 percent for that same period, so the sales increase attributable to the mall is 3 percent. Pedestrian traffic on the mall increased 30 percent.

Experience also shows that the rate of sales increases is likely to be limited to the first few years of a mall's existence because the novelty of the installation wears off and another sales attractor will probably be introduced into the region. Stone and Surti (1975) assume that the first five years' increase in sales declines uniformly to zero over five years. In their example, a mall built in 1975 would account for a 15 percent sales increase for 1976 over 1975, 12 percent for 1977 over 1976, 9 percent for 1978 over 1977, 6 percent for 1979 over 1978, 3 percent for 1980 over 1979, and 0 percent for 1981 and subsequent years. Because sales are not expected to decrease beyond the 5-year projection period, the sales increases in the first year and subsequent four years build an increased sales base, attributable to the mall, that should continue for years into the future.

This theory can be supported, rather than its contra-theory which is that there would be a decline in sales, because historically, malls have proved to be a stimulus for new construction and investment after they have been in operation for a number of years. It seems most likely that the first year will account for a big surge, and so it is best to consider that year a settling-in-period, and try to estimate the average annual percentage increase in gross retail sales over at least the first two years of operation of the facility. Of course there will continue to be an increase in sales resulting from the pedestrian facility after the first two years, but it is felt that the experience of the first two years is sufficient to characterize the impact of the facility on gross sales.

In summary, then, estimate as accurately as possible the average annual change in retail sales attributable to the pedestrian facility for the first two years. This will be equal to the sales change for the affected stores minus the regional average for the same period. Use this percentage as the retail sales score. Inasmuch as a −10 to +10 scale is being used, indicate as −10 any two-year annual decrease in sales greater than 10 percent, and as +10 any two-year annual increase in sales greater than 10 percent. If projections indicate an expected sales volume decrease of greater than 10 percent, serious consideration should be given to alternatives with less severe impacts on local merchants and business persons.

It is expected that the projection of gross retail sales will be assessed at one time for the area affected by the facility as a whole, rather than scaling up from estimates from particular stores or groups of businesses. However, when the shopowners are contacted to determine their displacement or renovation costs for evaluating variable 3.2.2, they may be asked about their estimates of changes in gross sales, and this may be used as input to this estimation process.

RETAIL SALES SCORE selected = ______.

3.2.2 Displacement or Renovation Required or Encouraged by Facility

This variable consists of the out-of-pocket costs to businesses incurred as a result of implementing the pedestrian facility. Unreimbursed costs from business displacements by the facility should be calculated. This number could be negative if a business were reimbursed more than its actual costs.

The costs of renovation to storefronts should be estimated, including signing (such as the replacement of hanging signs by backlighted signs flush against the building), window displays, and the cleaning and painting of building exteriors, by sandblasting if appropriate. These may be:

- Required, as in the case of signing ordinances.
- "Voluntary" but encouraged by the merchants association and all the larger stores, which might typically be the case for comprehensive cleaning of building fronts.
- Completely voluntary, such as a remodeling of the front window display area.

If only a small number of stores is affected by the facility, or if a thorough evaluation is being made, contact every store and building owner to determine their estimates of the displacement or renovation expenses anticipated. If many businesses are involved, a suitable shortcut procedure is to select typical stores to represent the average, and multiply unit costs by the number of stores in that group, or scale unit costs on the basis of frontage feet, if that seems more accurate. Figure A-22 is intended to aid in assembling the necessary information.

The rating for this variable is based on the ratio of displacement and renovation costs to the anticipated change in gross sales, item 3.2.1. The following scale gives the relationship between this ratio and the point score:

Ratio of Displacements and Renovation Costs to Change in Gross Sales	Point Score
5	−10
4	−7.5
3	−5
2	−2.5
1	−0
0.8	2
0.6	4
0.4	6
0.2	8
0	10

DISPLACEMENT OR RENOVATION SCORE selected = ______.

For example, if a pedestrian facility required no business relocation, storefront renovation costs were $10,000, and building cleaning cost $40,000, while the average annual sales increase attributable to the mall was 4 percent on a base of $1,000,000, the rating would be based on the ratio

	Relocation	Storefront Renovation	Building Cleaning	Total
Store (or building) type				
Name of typical store (or building) type				
Frontage for typical store (or building)				
Cost for typical store (or building)				
Total frontage and/or number of stores (or buildings) in group				
Total costs for group				
Store (or building) type				
Name of typical store (or building)				
Frontage for typical store (or building)				
Cost for typical store (or building)				
Total frontage and/or number of stores (or buildings) in group				
Total costs for group				

Figure A-22. Relocation and renovation cost worksheet.

$\frac{10{,}000 + 40{,}000}{1{,}000{,}000 \times 4\%} = \frac{50{,}000}{40{,}000} = 1.25$. From the scale, the score must be interpolated between 0 and -2.5, and is -0.6. This is rounded to -1.

3.2.3 Ease of Deliveries and Employee Commuting

A significant purpose of a shopping mall or commercial district is to increase the flow of merchandise into and out of the area; hence, the ease of deliveries to an area is important. The flow of goods out of the area is usually handled by the pedestrians, particularly in downtown locations.

There are three major methods of truck deliveries to downtown businesses and other freight receivers. One is via off-street loading docks; another is on-street curb parking immediately adjacent to a rear door or side door to the store or building; and the third is on-street curb deliveries using the front customer entrance. Each of these will be affected differently by motor vehicle traffic restrictions.

Off-street loading docks can be found at very large freight attractors such as large department stores, hotels, and office buildings. They are preferable to other forms of goods delivery because conflicts between trucks and pedestrians or other motor vehicles are greatly reduced or eliminated. Therefore, if the facilities affected by motor vehicle restrictions have off-street loading bays, they will not be impacted by the restrictions (unless they apply to the street on which the approach to the loading dock is located) and thus they score a 0 (for no gain or loss). If the addition of off-street loading areas is included as part of a new building under construction concurrently with the pedestrian facility, it would merit +10 because it is a big improvement. On the other hand, if an off-street loading dock were required to be added to an existing building that does not now have one, it should score -10 because of the much greater expense of retrofitting, when compared with building the facility into the building from the beginning.

If there is now on-street curb parking, there may be priority parking for trucks, no special provision for truck parking, or illegal truck parking and standing. If curb deliveries will still be permitted, and the parking regulations remain the same, score 0 because there is no gain or loss, unless there is significant interference with sidewalk pedestrian traffic. If parking regulations are changed to make deliveries easier, score +5. An example of this regulation would be establishment of a truck loading zone with commercial vehicle parking only between 7 a.m. and 7 p.m. Similarly, score -5 if parking regulations and access are changed in a manner that makes deliveries significantly more difficult.

If motor vehicle traffic is prohibited during all or part of the day on a street, stores that receive their deliveries on that street will have to make other arrangements. Deliveries may be permitted only during certain hours of the day, depending on local conditions—store hours, office hours, and peak-hour congestion. This might require certain adjustments on the part of receivers and the trucking companies due to labor contracts and security considerations. However, over the long run, adjustment may be more efficient because there would be no vehicle congestion to compete with delivery trucks, and store personnel could be organized to receive goods for a few specified hours per day. Smaller stores are affected by changes in the hours of deliveries more than larger stores, inasmuch as the person needed to receive the goods represents a significant fraction of the labor force for a small store. The score for this situation might range from +2, reflecting more efficient deliveries, as described in the foregoing, to −8 if there were a major inconvenience and significant cost for most truckers and receivers.

Truckers are likely to benefit from changes in the hours of deliveries at the expense of the receivers. Also, as previously noted, different stores will be affected differently by changes in regulations. If this is the case, a table should be constructed which shows the benefits or disbenefits to each stakeholder on a scale from +10 to −10. These should be combined, using appropriate weights, to arrive at an aggregate score. For example, consider a simplified situation with two stores and a trucking firm that serves both of them. If the big department store benefits slightly from the change of delivery hours (+2), the small shop is severely inconvenienced (−8), and the trucking firm benefits (+6), the net score would be zero if all three were weighted equally. If the small shop were given more weight, the net result would be a disbenefit, whereas if the trucker or the large store were weighted more highly, the net result would be a positive benefit.

An alternative to restricting truck traffic to certain hours is to prohibit it at all times, in which case the drivers would have to park on the nearest street and transport the goods to the store by hand or with a dolly. This could be a significant problem if there are heavy, bulky, or frequent deliveries. Trucks would usually be parked out of the view of the driver, so they might have to be locked where they were not previously. A special case is currency shipments to and from banks by armored car. If the courier must walk with money any distance away from his truck, there is a company rule that he must walk with his gun drawn. This will detract from the atmosphere of the mall, so it is suggested that armored cars be exempted from restrictions that apply to other trucks. This has been done on the Sparks Street Mall.

The score for an outright prohibition of trucks, requiring truck drivers or receivers to use handcarts for goods to be delivered to stores, will range from −5 to −10, depending on the distances involved, frequency, and nature of deliveries. An alternative to accommodate outright prohibition of trucks would be establishment of local consolidated delivery centers that would receive shipments for all affected buildings, and deliver the goods manually or mechanically (such as an underground conveyor belt system) to the ultimate receivers. Colorful carts could be used on the mall, and goods could be stored up to a day or two at the central facility, so the actual deliveries could be made at a time most convenient to the shop owners, taking into account pedestrian traffic volumes. Once this facility were established, it could prove to be a net benefit, perhaps with a score of +5, depending on its operating costs and success.

It is not expected that a pedestrian facility will cause inconvenience to employees who commute to the site, because pedestrian access will be improved. For some employers, however, lack of parking or other inconveniences might cause difficulty in attracting and retaining employees. If this is the case, subtract up to 5 points from the ease of delivery score to reflect any special problems for employee commuters. Figure A-23 recapitulates the suggested scoring for this item.

3.2.4 Attractiveness of Area to Business

Check off the proper boxes in the following:

	YES	NO
Is there a significant rise in the rate of voluntary improvements to the property?	2	0
Is there a trend toward the acquisition of additional selling and storage space?	2	0
Is there a low vacancy rate for stores?	2	0
Is there expressed interest by out-of-town firms to move into the area of the pedestrian facility? (This may be measured by the volume of inquiries to the Chamber of Commerce or the local economic development administration if there is one.)	2	0
In addition to advertising for individual stores, do the merchants publicize the area surrounding the pedestrian facility as a place to go to shop?	2	0
Do the merchants show enthusiasm for the area as a place to do business?	2	0
Are there informative, educational, or entertaining displays in store windows or in hotel and office lobbies?	2	0
Are there any special promotional activities sponsored, such as car displays, boat shows, or sidewalk sales?	2	0
Is there a festive atmosphere, making the area pleasant for shopping?	2	0
Can many out-of-towners be found among the consumer foot traffic?	2	0

Total ATTRACTIVENESS TO BUSINESS SCORE is sum of values checked above

= ________ - 10 = ________.

4. GOVERNMENT AND INSTITUTIONS

4.1 Transportation and Land-Use Planning Process

4.1.1 Public Participation in the Planning Process

Societal attitudes and recent legislation have changed the role of the planner from one who works in relative isolation from the public as a whole, except perhaps for vocal private interest groups, to one who must solicit and obtain public input on current transportation projects that are in the planning and design phase (Yukubousky, 1974).

The public has become to a large extent wary, if not downright skeptical, of public decisions made in closed sessions outside of wide public discussion and has in effect "demanded" more voice in those decisions. This wariness is based on a confluence of three central emerging factors:

	Possible Score	Actual Score (leave blank if not applicable)
Facilities have off-street loading arrangements	0	
Off-street loading areas are to be added:		
For new construction	+10	
For existing buildings	-10	
Parking regulations:		
Remain the same	0	
Changed to make deliveries easier	+5	
Changed and make deliveries more difficult	-5	
Restriction of truck deliveries to certain hours	+2 to -8	
Outright prohibition of trucks	-5 to -10	
Above, but with local consolidated delivery centers	-5 to +5	
Inconvenience to employee commuters	0 to -5	

Total DELIVERIES AND COMMUTING SCORE is sum of values scored above = __________.

If sum of values exceeds +10, score +10.

If sum of values is less than -10, score -10.

Figure A-23. Urban goods movement point allocation.

- The emerging recognition by minority groups of their potential political power through organization and outspoken advocacy for minority-related issues.
- The recognition of a widespread abuse of public decision-making power for the benefit of a privileged few.
- The importance of the environmental protection movement as reflected in a wide variety of special-interest organizations.

If one accepts these precepts, the inclusion of public participation in public decisions is seen not so much as an inherent "good," but as essentially a political necessity. For example, it is entirely feasible that a public decision-making body could make decisions that had overwhelming public support without holding extensive public meetings and hearings. The degree of this public support has typically been based on "voting" records for funding specific proposals, and of course, for election of public officials. Over the past several years, the voting has more and more frequently rejected proposed bonding proposals and as a consequence has "forced" widespread public participation in the planning process as a practical necessity for their successful passage.

The current planning situation effectively requires a deliberate process for extensive public participation, and as a consequence of that realization we have provided a criterion to predict "in advance" the probable adequacy of that participation. In situations where comparisons of alternative pedestrian facilities for one site are under consideration, presumably the same planning process would apply to all, and this variable would then be logically dropped. Where different planning processes were in effect in different locations of a jurisdiction (for example, where local option determined the planning process), this variable would rate the most extensive public participation an inherent "good" and accordingly place it higher on the rating scale.

Figure A-24, adapted from Yukubousky (1974), describes a wide variety of community interaction techniques ranging from zero public participation to a high degree of community input. Some of the techniques that might involve the public to a major degree might, at first, seem inappropriate for simple pedestrian facilities, having been designed for preparation of comprehensive metropolitan and regional transportation plans. However, broad community participation is felt to be important for small projects also; therefore, the scale described in Figure A-24 is equally applicable to both small and large projects.

Because the primary purpose of the methodology described herein is evaluation, excluded from the discussion is an analysis of the significant roadblocks to achieving genuine levels of participation and increased input. For a holder of political power, these include paternalism and

Actions of Implementing Agency	Point Score
Monitor newspapers, radio, and television	-10
Conduct background studies and review election issues	-9
Catalog planning and design concepts	-8
Monitor impacts of complicated projects	-7
Initiate legislation	-6
Produce material for the media	-5
Present range of alternatives to public	-4
Map socioeconomic and attitudinal data	-3
Illustrate plans in nontechnical terminology	-2
Educate public about ongoing planning and decision-making process	-1
Maintain open planning and project files; listen to the public for suggestions	0
Survey opinions and attitudes	+1
Hold public hearings early in the planning process, with widespread publicity at least one month in advance of each meeting	+2
Hold a citizen referendum, to ensure draft plans will incorporate the majority opinion of the community	+3
Assemble a panel of community residents assisted by planners to make recommendations on alternative proposals at community meetings	+4
Set up community-led seminars	+5
Use a citizen advisory committee. Request a written review of all draft plans and alternative suggestions	+6
Mediate between parties	+7
Appoint a task force	+8
Hold workshops or informal neighborhood work meetings	+9
Employ community residents for brainstorming sessions, ombudsmen, and role playing	+10

PUBLIC PARTICIPATION SCORE selected = ________.

Figure A-24. Rating score for community interaction techniques.

resistance to power redistribution. On the public side, they include inadequacies of the political socioeconomic infrastructure and knowledge base plus extremes of self interest that do not allow proper consideration of the rights or needs of others. For further discussions of public participation in the planning process, the reader is directed to Yukubousky (1974), Manheim et al. (1975), Grigsby and Campbell (1972), and Fitzpatrick and Miller (1973).

4.1.2 Conformance with Requirements and Regulations

On the whole, it is judged to be advantageous if a proposed project can be implemented within existing local, state, and national laws and regulations without the requirement for a waiver or variance. Of course, inclusion of this variable weights the judgment in favor of the existing state of affairs and will thus make needed change all the more difficult. The rationale for its inclusion is to urge the planning process to make deliberate efforts to adhere to existing codes, regulations, and master plans, and thus avoid inclusion of unproved materials or design criteria unless they are deemed so desirable or necessary as to warrant the costly and timely process of seeking variances, the updating of codes and regulations, or the change to master plans.

Building code revisions are periodically presented to city councils, based on recommendations of the International Conference of Building Officials (or the Southern or Western Conference). They are adopted by most local jurisdictions with some amendments for local conditions and are available from most city halls. The city engineer or appropriate building inspector should be able to judge if a particular facility design is in compliance with existing codes.

Zoning ordinances are periodically assembled by local planning departments and forwarded to the planning commissions and city councils. There ordinances are on file with zoning maps and are accessible to the public. A member of the City Planning Department should be able to judge if a specific pedestrian facility complies with the local zoning ordinance. A facility will either comply or not; however, if it does not meet the regulations, a variance might be obtained following application for a waiver to the planning commission. Another possibility is that changes may be made to the regulations as a result of the review process for the pedestrian facility and then the modified regulations would apply to future projects, including those that are not pedestrian accommodations. For example, to create a charming atmosphere on Sparks Street, all hanging signs were required to be replaced by backlighted signs at the time a permanent mall was constructed. It was found that the backlighted signs improved the street so much that later an ordinance was passed stipulating that all new signs anywhere in Ottawa could not be of the hanging variety. This is an example of an indirect benefit attributable to the mall. In other cases, modifications made to building codes or zoning ordinances because of a particular pedestrian facility could be a benefit or a disbenefit, depending on the particular situation.

Assign a score between −10 and +10 to this variable. The following suggested values provide guidelines for the assignment:

+10 Original or desired design of facility conforms to all requirements, codes, and regulations; no modifications required.

+7 Minor changes to facility or variance to regulations required.

0 Some changes to facility design or regulations, or both, indicated.

−7 Modifications to facility design required, resulting in delay of implementation.

−10 Extensive modifications of planned or desired facility design required, resulting in much delay.

REQUIREMENTS AND REGULATIONS SCORE selected = _______.

4.2 Economic Impacts

4.2.1 Net Change in Tax Receipts and Other Revenue

Changes in government revenues can be estimated in dollars by the planner with inputs from appropriate government agencies.

Sales taxes are usually collected by the state and partially reimbursed to the cities (or sometimes *vice versa*), thus gross receipts data are available from the collection agency. Data are categorized by the state of sale and are considered confidential, but they should be available on an aggregate basis, either for geographic units or by type of business.

Corporate income statistics can be obtained from the state or federal revenue collection agencies on a countywide basis, which covers too wide an area for our purpose. However, geocoding programs of 1970 census data in some states have made it possible to measure data by city cells. These data are confidential, under the control and security restraints of the government, but are accessible on a contractual basis.

Change in assessed property valuation, and hence property tax revenues, may be estimated by the assessment office of the city or county government. If this total change is X percent, it is assumed that it occurs at a rate of $X\%/5$ for the first 5 years and then remains at the resulting level for the next 20 years, making a total planning horizon of 25 years. According to data collected by the Downtown Research and Development Center (1975) for Kalamazoo, Mich., Knoxville, Tenn., and Pomona, Calif., X can range from 20 percent to 75 percent.

The change in revenue from pedestrian moving violation fines may be determined by consultation with the appropriate judicial system.

If the pedestrian facility were strictly a business investment on the part of a municipal government, this variable would be the most important evaluation criterion. However, other motivations (i.e., the other variables) are likely to be more significant. Further, tax receipts and other government revenue resulting from a particular pedestrian facility will be mixed with other general revenue, not specifically earmarked to defray the facility's operating and construction costs. Thus, the magnitude of additional revenue can be compared with the government's total budget rather than merely with the expenditures for the pedestrian facility. For a small city within a metropolitan area, a major new shopping/commercial pedestrian facility might generate municipal revenue as much as 10 percent of the city budget, although in most cases it will be a smaller fraction. Ten percent is used to set the endpoint of the scale for this variable.

To evaluate this variable, estimate as accurately as possible the average annual change in sales, corporation income and property tax receipts; parking, motor vehicle, and pedestrian violation fines; and other government revenue attributable to the pedestrian facility for the first two years. The annual average over a two-year period is taken to compensate for the first year's settling-in period, as is done for retail sales in Section 3.2.1. Divide this annual change by the total city budget, exclusive of the pedestrian facility. When expressed as a percentage, the number will be equal to the rating for this variable. Because +10 is the maximum scale value, indicate as +10 any increase in revenue of more than 10 percent. If a decline in total municipal revenues is greater than 10 percent, discussions should be held to examine alternatives with less serious revenue impacts.

TAX RECEIPTS SCORE selected = _______.

4.2.2 Resulting Changes in Employment

This variable may be determined directly upon examination from the specifications for the pedestrian separation facility and discussions with affected business persons. There will probably be no major losses of employment due to a pedestrian facility. School crossing guards are perhaps the group that will be affected the most; if a facility were to result in a major loss of sales positions, it would not have been constructed in the first place. However, a major shopping mall or auto-free zone could result in a significant rise in the number of sales personnel. The following scoring scale takes these facts into account:

Decrease in Employment		Increase in Employment	
Number of Jobs Lost	Point Score	Number of Jobs Gained	Point Score
10	−10	100	+10
8	−8	80	+8
6	−6	60	+6
4	−4	40	+4
2	−2	20	+2
0	−0	0	0

EMPLOYMENT SCORE is value selected = ______.

4.2.3 Change in the Cost of Providing Community Services

This category covers all activities performed by local governing units. Revenue sources and expenditures may reflect a variety of categories, such as police and fire protection, transit, street maintenance and cleaning, beautification of adjacent areas, and lighting. In most locales, the budgets are divided along program lines. Present costs can be extracted from municipal budgets with the help of the city budget office, and cost projections can also be made with their help.

Express the increase or decrease in cost of providing community services as a signed percentage fraction of the present cost for providing these services citywide. This fraction (which will ordinarily be less than 10 percent) is equal to the rating for this variable after reversing the signs to indicate desired direction. If the fractional change in cost of providing community services for the entire political jurisdiction increases more than 10 percent, indicate the score at −10. If costs decrease by greater than 10 percent, indicate the score as +10.

COMMUNITY SERVICES SCORE selected = ______.

4.3 Community Impacts

4.3.1 Community Activities

The demand for community activities such as displays, exhibits, special events, recreation, arts and crafts festivals, and fund-raising drives can serve as an indicator of the attractiveness of the area and city in which the pedestrian facility is located. An increase or decrease in the number of such activities will show changes in public participation in the community. Although permits are the source for monitoring this type of activity, they are necessary only if the event occurs on city property or if a street closure or sidewalk obstruction is required. Many of these events take place on private property and do not require official sanction. Peddlers, solicitors, and auction licensing may be another source of monitoring.

Records of community activities are available from local police departments and licensing departments. However, files are not longstanding and are frequently destroyed on expiration dates or immediately thereafter. Forecasting the change in such activities is an extremely subjective undertaking unless representatives of community groups that sponsor the activities have been involved in the planning process.

Indicate the score for change in community activities on the following scale:

-10	0	+10
Large decrease in community activities	No change in community activities	Large increase in community activities

COMMUNITY ACTIVITIES SCORE selected = ______.

4.3.2 Adaptability to Future Urban Development Plans

The adaptability of the pedestrian facility (as a transportation link) to future transportation system development plans is covered in Section 1.3.1. However, many facilities, particularly those designed for the purpose of providing a safe and enjoyable place for pedestrians to move leisurely and stop, impact the land uses in the vicinity as much or more than they affect the transportation system. The degree to which the facility fosters or hinders planned land uses for the area is measured by this variable.

As an example, consider a downtown pedestrian mall. Although a pedestrian mall may introduce a revitalization to a downtown area, alone it might be insufficient to save a city that has already gone into decay. If businesses will be moving out of the area with no replacement, there will not be any pedestrians left to enjoy the mall.

Evaluation of the impact of the facility on planned development can be performed best by an urban planner responsible for the area in question. Indeed, if the facility has been proposed by the planning or development agency having jurisdiction over the area, there is assurance that the facility's operation will conform with long-term development plans for the area. Unless there is in-house struggling, the score for this situation would be +10. For other conditions, the rating should be assigned accordingly.

-10	-5	0	+5	+10
Requires significant modifications to existing land use and development to accommodate the facility		No significant effect on short- or long-term land use and development plans		Enhances desired land use and growth patterns

FUTURE URBAN PLANS SCORE selected = ______.

4.3.3 Construction Period

The complete evaluation methodology could be used for assessing the impacts of the construction period in the same way that the over-all project is evaluated. However, this would be needlessly time-consuming, unless the decision-maker were to attach an extremely high importance to this one factor. Hence, the following simplified procedure is proposed as an alternative to using the entire methodology for evaluating construction period impacts.

Check off the applicable boxes in Figure A-25. The first five items compare the impacts of the construction process on pedestrians, vehicles, and businesses with the situation immediately prior to the commencement of construction. The sixth item has to do with the noise level of the construction process. The final item (Figure A-26), concerning the length of the construction period, is weighted more highly than the others inasmuch as this affects the duration of all of the impacts.

	Compared with Existing Situation, Construction is:				
Effects of Construction On:	Much Worse	Slightly Worse	The Same	Slightly Better	Much Better
1. Pedestrian movement	-1	-1/2	0	1/2	1
2. Vehicle movement	-1	-1/2	0	1/2	1
3. Safety	-1	-1/2	0	1/2	1
4. Pedestrian environment	-1	-1/2	0	1/2	1
5. Local business	-1	-1/2	0	1/2	1

Effects Score is sum of values in boxes checked = ____________.

6. What is the level of regularly occurring construction noises?

None or less than 65 db(A)	1
65 to 77.5 db(A)	0
Louder than 77.5 db(A)	-1

NOISE SCORE selected = ____________.

Figure A-25. Construction effects scoring.

What is the length of time of the construction period?

Less than one month	4
1-2 months	3
2-3 months	2
3-4 months	1
4-5 months	0
5-7 months	-1
7-9 months	-2
9-11 months	-3
One year or longer	-4

Duration Score selected = __________

Total CONSTRUCTION SCORE is

Effects Score + Noise Score + Duration Score = _______.

Figure A-26. Construction duration scoring.

APPENDIX B

CASE STUDY REPORTS

TESTING OF DEVELOPED TECHNIQUES

To ensure that the methodology could be applied to real-life situations, the research plan called for testing the developed techniques at both existing and proposed pedestrian-vehicle separation facilities. Contacts were made early in the study with planners who were proposing pedestrian facilities: the purpose was to share preliminary plans and findings. After a first draft of the measurement techniques had been prepared, field trips were made to four sites in order to apply the techniques. Observations during these field trips were used to make substantial modifications to the measurement techniques.

Two planned and two existing pedestrian facilities were selected for testing of the evaluation methodology. The specific sites represent widely different types of facilities, as follows:

- A pedestrian overpass under construction at Rainier Avenue S. and Empire Way S. in Seattle, Wash.
- 20th Avenue N.E./Ravenna Park Bridge (Seattle) closure to motor vehicles.
- Sparks Street Mall, Ottawa, Ont.
- Proposed Fulton Mall, Brooklyn, N.Y.

Rainier Avenue and Empire Way (Fig. B-1) are major arterials in Seattle, and their intersection is a particularly hazardous one for pedestrians. After more than five years of study, construction of a $600,000 overpass crossing both streets began in the summer of 1975. Because only minor construction activity had started during the time of the evaluation, Rainier and Empire was treated as the location for a "planned" facility.

The 20th Avenue N.E. Bridge over Ravenna Park in Seattle was closed to motor vehicles beginning March 11, 1975 as a demonstration project to evaluate its impact on traffic patterns and the surrounding community. The trial period ended in August 1975, at which time a decision was made to continue with the closure and replace the temporary barriers with more permanent ones. It is good policy to wait several years before testing an existing facility to allow for settling-in effects, but the shorter period seemed justified in this case because the impacts of the bridge closure are very localized, and they are not continuing to change. The bridge is shown in Figure B-2.

Sparks Street Mall in Ottawa (Fig. B-3) is a success by any evaluation criteria. It has many amenities, is a very pleasant environment, and is crowded with pedestrians in the daytime. Property values on Sparks Street have tripled

Figure B-1. Intersection of Rainier Avenue and Empire Way, Seattle, Wash., site of planned pedestrian overpass.

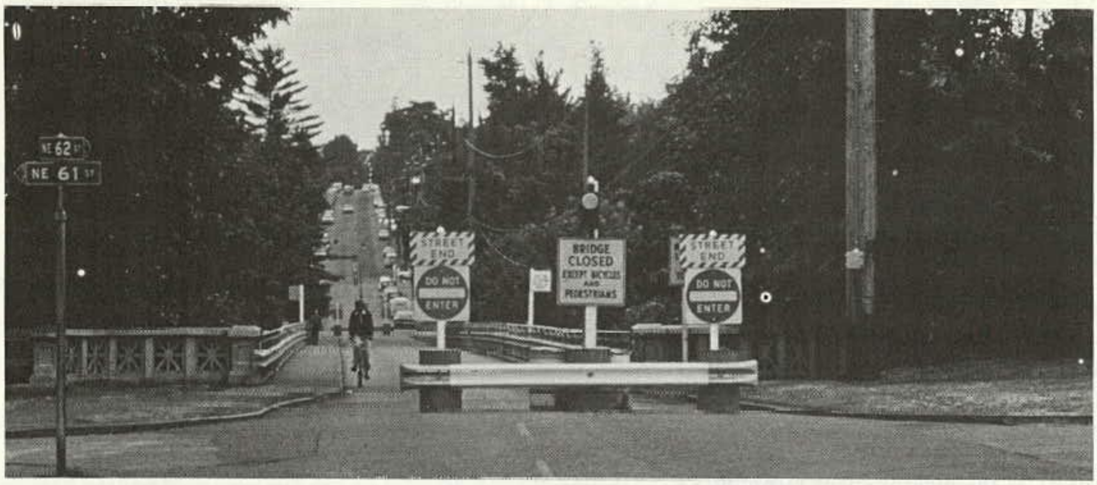


Figure B-2. Closure of 20th Avenue N.E./Ravenna Park Bridge to vehicular traffic, Seattle, Wash.

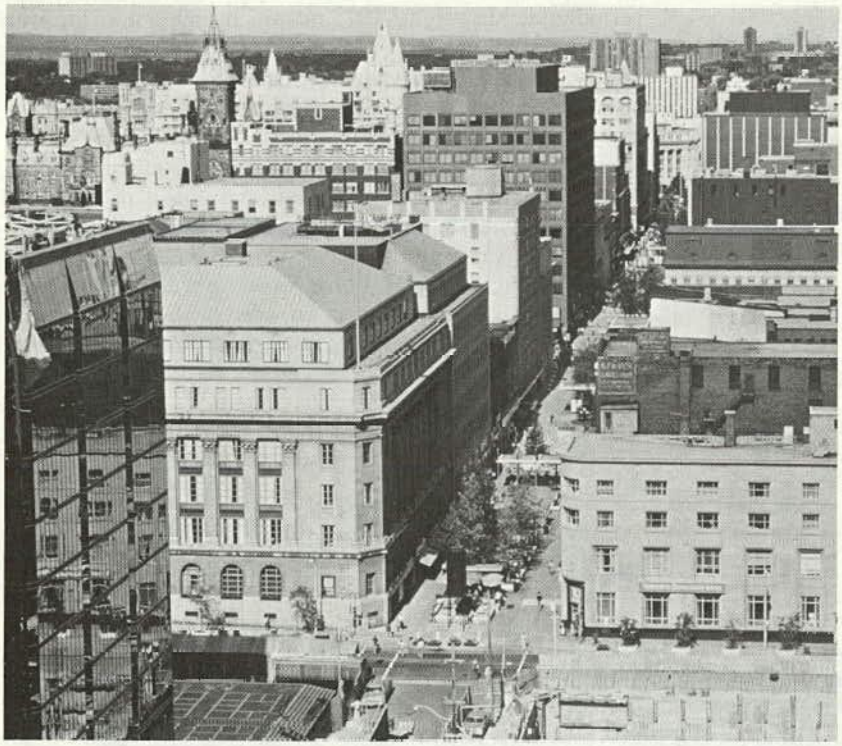


Figure B-3. Sparks Street Mall, Ottawa, Ont.

in the last ten years. The mall was first planned in 1959, and was experimented with as a temporary summer mall every year from 1960 through 1965, when it became a permanent street closure. The permanent mall was completed in 1967.

Fulton Street is the focus of retail activity in downtown Brooklyn, N.Y., attracting 200,000 shoppers each day. Figure B-4 shows Fulton Street as it is today. The Fulton Mall has been proposed as a pedestrian transitway to speed up pedestrian and bus flow (60 buses during the peak hour) by eliminating vehicle conflicts. Adjacent streets are sufficient to handle diverted traffic and sufficient off-street parking is available to replace the parking eliminated on the side streets approaching Fulton Street. The novel attraction of the Fulton Street closure, however, is the installation of a teflon-coated fiberglass canopy above the street. In addition to protecting pedestrians from direct overhead precipitation, the arcade has symbolic significance in showing the city's commitment to downtown Brooklyn and the rejuvenation of an already very busy shopping area. Figure B-5 shows an artist's concept of the proposed arcade.

The sites selected for testing range in complexity from the 20th Avenue N.E. bridge and the Rainier and Empire overpass, which are relatively simple facilities, to the Fulton Mall and the Sparks Street Mall. The diversity of these facilities is an important reason for selecting them as examples. Another reason was that the local planners were actively involved with their specific facilities and eager to work with the researchers.

The following sections describe the results of these field

Figure B-4. Fulton Street, Brooklyn, N.Y., site of planned pedestrian mall.

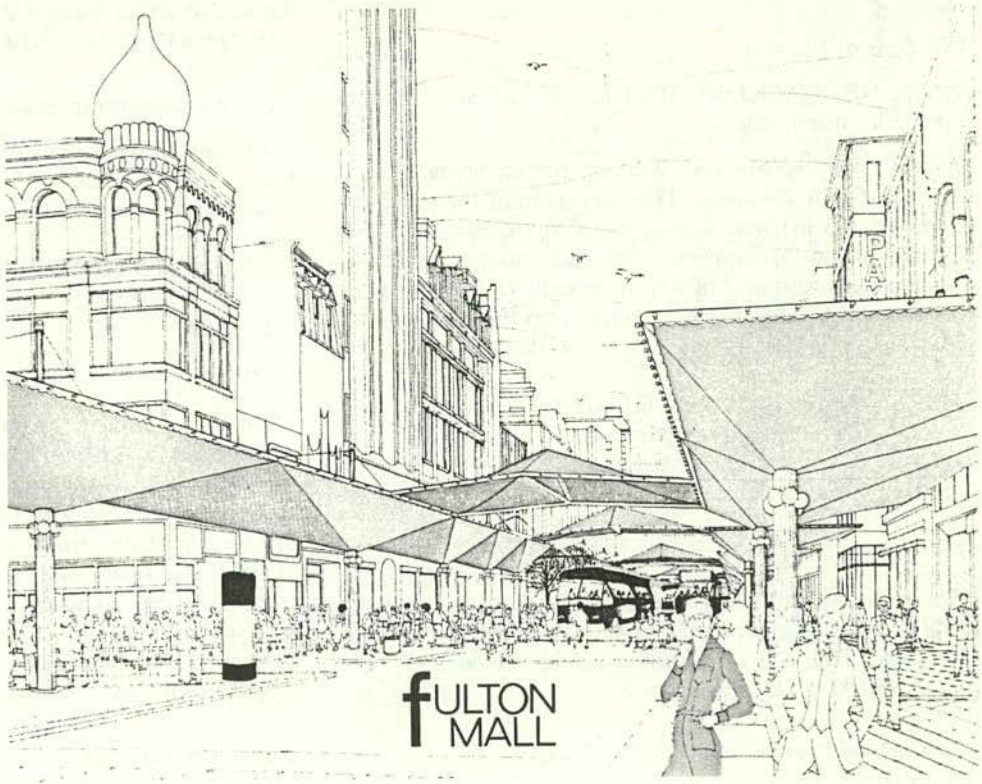


Figure B-5. Proposed Fulton Mall (see Fig. 4).

evaluations. For each facility, the score for each variable (and its components, if any) is provided, as well as a discussion of how the score was derived, and any other pertinent comments. A summary sheet has been completed for each facility, and these follow their respective sections.

RAINIER AVENUE S. AND EMPIRE WAY S. OVERPASS

This is a very hazardous intersection for pedestrians. Two major arterials converge at an oblique intersection close to a high school and several fast food outlets. The pedestrian signal across Empire Way is much too short for the 120-ft (36.6 m) crossing (see Fig. B-6). Indeed, the hapless pedestrian must begin to walk quickly (4 mph, 18 m/sec) at the very moment the light becomes green. There is also a conflict with turning vehicles at each pedestrian crossing, as also shown in Figure B-6.

The evaluation of this facility is described for each of the following variables, followed by a completed summary sheet.

1.1 Pedestrian Transportation

1.1.1 Travel Time

The proposed facility will result in significant travel time savings for pedestrians. Average route length will be reduced, and two delays at intersections will be avoided. Combining these fatcors yielded a travel time ratio before and after the facility of 1.0 to 0.4, respectively, for the crossing.

$$\text{TRAVEL TIME SCORE} = \frac{1.0 - 0.4}{1.0} \times 10 = +6$$

1.1.2 Ease of Walking

EASE OF WALKING SCORE = 2, the sum of the components listed below:

1.1.2.1 Walking Surface. Walking surface score = 1.

1.1.2.2 Grade Changes. The west ramp of the overpass rises 15 ft (4.6 m) over a distance of approximately 72 ft (22 m), almost 21 percent. The east ramp rises 16 ft (4.9 m) over a distance of approximately 71 ft (21.7 m), or 22.5 percent. The change in grade from the lowest point to the highest point is 20.9 ft (6.4 m). Grade score = $-1.7 + .2 = -1.5$.

1.1.2.3 Continuity. Continuity score = 2 − 1 = 1.

1.1.2.4 Signing. Signing score = 1.

1.1.2.5 Lighting. The overpass will have ornamental pedestrian-oriented lighting. Lighting score = 0.

1.1.3 Convenience

The overpass will be open at all hours and will provide access to bus stops, parking, Franklin High School, several fast-food outlets, and a residential neighborhood.

CONVENIENCE SCORE = 5

1.1.4 Special Provisions

The overpass will have handrails, and is safe for blind pedestrians. However, there are no special provisions for bicyclists or joggers, there are no telephones or drinking fountains, and traversing the facility requires the pedestrian to climb up and down 20 ft (6.1 m).

SPECIAL PROVISIONS SCORE = 0

1.2 Motor Vehicle Transportation

1.2.1 Vehicle Travel Costs

There is no significant change in motor vehicle travel costs or travel time with the overpass because they must still stop to allow opposing traffic to cross. Whereas previously during the red signal vehicles and pedestrians could cross, after the overpass is completed only vehicles will cross, but the signal cycle will still be the same. There will be no changes in parking supply or in vehicle ownership.

VEHICLE TRAVEL COSTS SCORE = 0

1.2.2 Use of Automobiles

USE OF AUTOMOBILES SCORE = 0

1.2.3 Signal/Signing Needs

Signs will be needed to direct pedestrians to the overpass and instruct them to no longer use the previous crossings.

SIGNAL/SIGNING NEEDS SCORE = 7

1.3 Other Community Transportation

1.3.1 Future Transportation Plans

The overpass does not affect any future transportation plans. Its height is sufficient for any future highway designations of either Rainier Avenue or Empire Way.

FUTURE TRANSPORTATION PLANS SCORE = 0

1.3.2 Existing transportation

Concurrent with construction of the overpass, bus stops will be slightly relocated into new indented curb bays, but this will have no significant impact on transit operations or use.

EXISTING TANSPORTATION SCORE = 0

2.1 Safety

2.1.1 Cost of Accidents

Because complete separation of pedestrians and vehicles is intended by this facility, the maximum benefit value would be expected. However, in spite of planned hedges to prevent pedestrian crossing at the street level, all such crossings probably will not be prevented and an 80 percent effectiveness factor is estimated. Note (see Appendix A) that this value could be scaled downward if comparison were being made among several different locations including some with greater accident risk.

COST OF ACCIDENTS SCORE = +8

2.1.2 Accident Threat

This variable does receive maximum points for complete separation of pedestrians and vehicles, and thereby reflects the point of view that at-grade crossers ignore the threat of accident.

ACCIDENT THREAT SCORE = | 10

2.1.3 Crime Concern

Except for possible vandalism, this variable does not apply.

CRIME CONCERN SCORE = −2

2.1.4 Emergency Access/Medical and Fire Facilities

This variable does not apply.

EMERGENCY SCORE = 0

2.2 Attractiveness of Surroundings

2.2.1 Pedestrian-Oriented Environment

The only amenities are the plants and trees that will be planted to block the previous pedestrian crossing. These

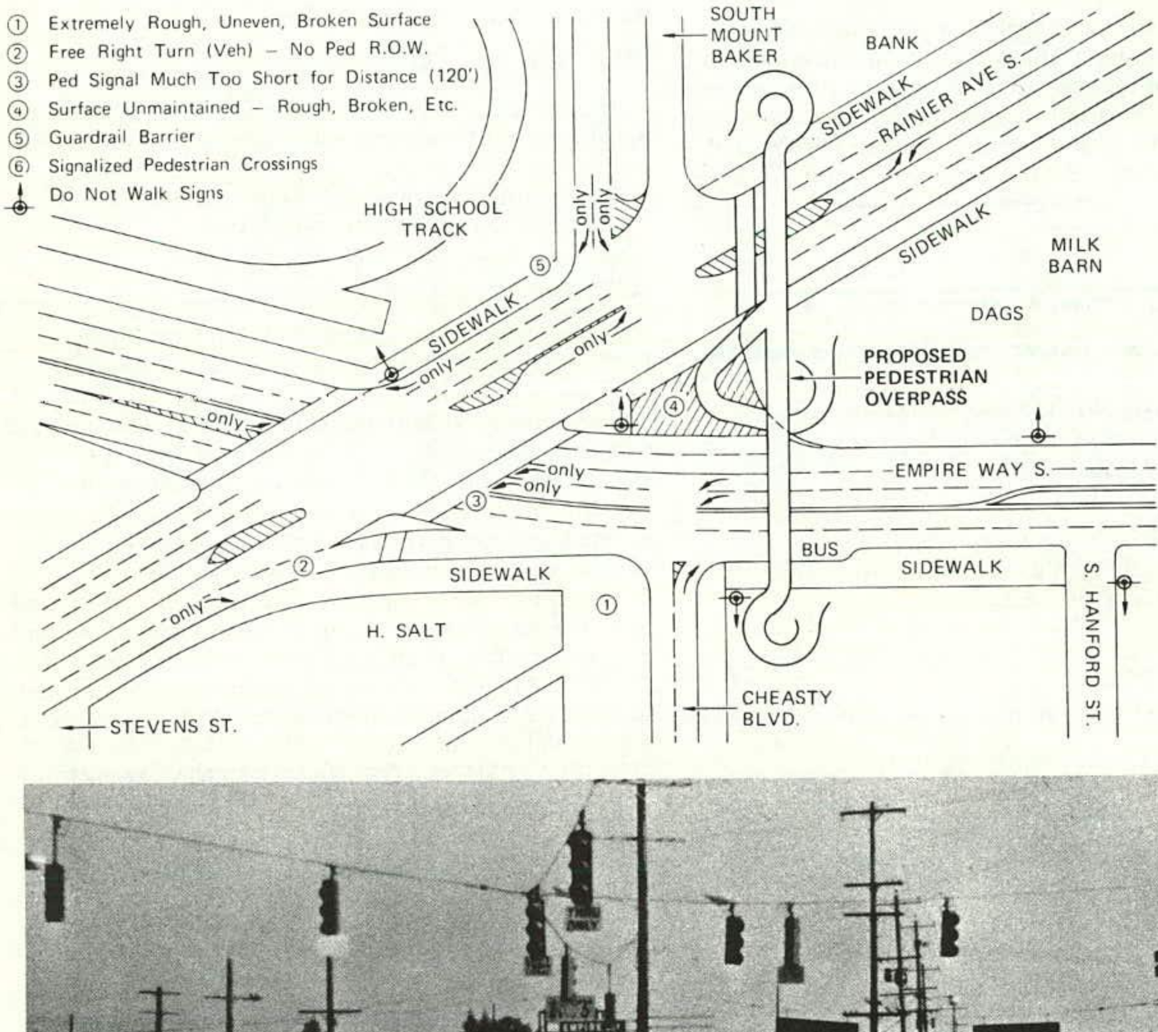


Figure B-6. Location of proposed Rainier and Empire pedestrian overpass (upper) with cars turning left into Rainier Avenue from Empire Way (lower).

are offset by the large signs advertising local fast-food outlets and the concentration of motor vehicle odors at the level of the overpass.

PEDESTRIAN-ORIENTED ENVIRONMENT SCORE $= -6$

2.2.2 Litter Control

The sidewalks are moderately clean of litter, and trash baskets are sufficiently placed.

LITTER CONTROL SCORE $= 4$

2.2.3 Density

The overpass will have slightly more than 2,000 sq ft (190 m^2). During most of the day, no more than two or three persons will use the facility at any one time, but on school days as many as 20 students might use the overpass simultaneously to travel to or from Franklin High School. Thus, peak and off-peak density might be 100 sq ft (9.3 m^2) and 700 sq ft (6.5 m^2) per person, respectively.

DENSITY SCORE $= 8$

2.2.4 Climate Control and Weather Protection

The overpass offers pedestrians no protection from the environment.

CLIMATE AND WEATHER SCORE $= -10$

2.3 Environment/Health

2.3.1 Air Pollution

Air pollution is essentially unaffected by this facility.

AIR POLLUTION SCORE $= 0$

2.3.2 Noise Impacts

Estimated noise level at 20 ft above the roadway traffic is about 68 db(A).

NOISE SCORE $= -10$ $[(90 - 68) \times 0.4] = 1.2$, which is rounded to -1.

2.3.3 Health Effects

Negative health effects are due primarily to the presence of high volumes of vehicle traffic close to the pedestrians.

HEALTH SCORE $= -3$

2.3.4 Conservation of Resources

Very low use of direct energy and low maintenance requirements during operation make this facility basically conservative in its use of resources.

CONSERVATION SCORE $= +7$

3.1 Residential Neighborhoods

3.1.1 Residential Dislocation

No residences will be displaced by the overpass.

RESIDENTIAL DISLOCATION SCORE $= 0$

3.1.2 Community Pride and Interaction

There is only a minor impact on the community.

COMMUNITY PRIDE AND INTERACTION SCORE $= 0$

3.1.3 Aesthetic Impact, Compatibility with Neighborhood

Positive compatibility components are continuity of pathway and complementary lighting. The single negative compatibility characteristic is the possibility of additional litter or vandalism.

AESTHETICS AND COMPATIBILITY SCORE $= +1$

3.2 Commercial/Industrial Districts

3.2.1 Gross Retail Sales

The overpass may increase sales at Dag's Hamburger Stand, which is located immediately adjacent to the center stairway, but this effect will be minimal, because almost all of Dag's current customers arrive by automobile.

RETAIL SALES SCORE selected $= +1$

3.2.2 Displacement or Renovation

No businesses have been displaced, but small parcels of land have been purchased at opposite sides of Rainier Avenue to accommodate bus bays at the new bus stop locations. The proprietors of Dag's refused to sell their land, because they were concerned that the overpass would obstruct the view of their sign. Several years ago, they purchased a lot and building that was then very near the location of the overpass, and demolished it, so passing motorists could get a better view of their sign. The purchase price of \$44,000 is a proxy measure of the value to Dag's of an unobstructed sign. Assuming current sales of \$1,000 per day, a 1 percent increase in sales would gross only an additional \$3,650 annually. \$44,000 is more than twelve times that amount, so from the scale given for this variable in Appendix A, read a point score of -10.

DISPLACEMENT OR RENOVATION SCORE selected $= -10$

3.2.3. Ease of Deliveries and Employee Commuting

The overpass has no impact on either truck deliveries or employee commuting.

DELIVERIES AND COMMUTING SCORE $= 0$

3.3.4 Attractiveness of Area to Business

The intersection of Rainier Avenue S. and Empire Way S. does not possess any of the attributes of an attractive area to do business.

ATTRACTIVENESS TO BUSINESS SCORE $= -10$

4.1 Transportation and Land-Use Planning Process

4.1.1 Public Participation in the Planning Process

A formal public hearing on the proposed overpass was held before the Seattle City Council on March 15, 1971.

PUBLIC PARTICIPATION SCORE selected $= +2$

4.1.2 Conformance with Requirements and Regulations

The design for the overpass complies with all applicable requirements and regulations, including height clearances.
REQUIREMENTS AND REGULATIONS SCORE = +10

4.2 Economic Impacts

4.2.1 Change in Tax Receipts

The overpass will not cause any change to Seattle's tax receipts or other revenue.
TAX RECEIPTS SCORE = 0

4.2.2 Changes in Employment

EMPLOYMENT SCORE = 0

4.2.3 Cost of Providing Community Services

The only change in costs will be gardening for the plants and trees to be planted adjacent to the overpass. These additional costs are negligible, however, compared to Seattle's total maintenance budget.
COMMUNITY SERVICES SCORE selected = 0

4.3 Community Impacts

4.3.1 Community Activities

There will be no change in community activities as a result of the overpass.
COMMUNITY ACTIVITIES SCORE selected = 0

4.3.2 Adaptability to Future Urban Development Plans

The land-use and development impacts of this facility will be negligible at the location where it is being constructed.
FUTURE URBAN PLANS SCORE selected = 0

4.3.4 Construction Period

Construction of the overpass will hinder pedestrian and vehicle movement slightly. It enhances the pedestrian environment slightly, because the activities are interesting to watch. Construction will have no impact on safety or local businesses. Average level noises are expected. The construction contract, however, will last for more than one year.
CONSTRUCTION SCORE = —½ + 0 — 4 = 4½ rounded to —5

Summary

Figure B-7 summarizes the evaluation variable scores for the proposed pedestrian overpass at Rainier Avenue S. and Empire Way S.

20TH AVENUE N.E./RAVENNA PARK BRIDGE

1.1 Pedestrian Transportation

1.1.1 Travel Time

The closure of this bridge to motor vehicles will have no effect on pedestrian travel time because no pedestrian-vehicle conflicts were eliminated. Traffic on the streets in the community adjacent to the bridge has been reduced, but the impact on pedestrian delay is minor because traffic was light to begin with. Also, these minor pedestrian delay savings are likely to be offset by corresponding increases in traffic to other through streets.
TRAVEL TIME SCORE = 0.

1.1.2 Ease of Walking

EASE OF WALKING SCORE = 3, based on summing the following five components.
1.1.2.1 The walking surface after the bridge closure remains the same as it was previously. Walking surface score = ½.
1.1.2.2 There are no grade changes for the pedestrian because the bridge takes him over a very steep ravine. Grade Change score = 2.
1.1.2.3 The pedestrian path across the bridge is straight and unhindered. Continuity score = 1.
1.1.2.4 Little signing exists now or is needed. Signing score = 1⅓.
1.1.2.5 There is no lighting on the bridge, although there are lights in the park below. Lighting score = —2.

1.1.3 Convenience

The bridge now provides an improved bicycle route; it serves the University of Washington and the surrounding residential area. The bridge is always open.
CONVENIENCE SCORE = 3

1.1.4 Special Provisions

Handicapped persons no longer have to negotiate a curb because they can use what was formerly the roadway. There are no telephones, drinking fountains, or special provisions for the blind or for joggers. Although it has not been designated as such, the curbs and white centerline could be used to delineate a bicycle path separate from that for pedestrians.
SPECIAL PROVISIONS SCORE = —1

1.2 Motor Vehicles

1.2.1 Vehicle Travel Costs

Approximately 3,000 vehicles per day were rerouted because of the bridge closure. This was well handled by the existing street network. Indeed, the level of service at one intersection approach (25th Ave. and N.E. 65th St., north approach) actually experienced an improved level of service (from C to B) during the A.M. peak period, whereas the level of service at all other intersection approaches remained the same. However, at the 25-mph speeds typical

Name of Project RAINIER AVENUE AND EMPIRE WAY

Cost initial $ 600,000 annual $ 100.00

+173 Total Score

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time	+6	2.5%	15
	1.1.2	Ease of Walking	+2	3.0	6
	1.1.3	Convenience	+5	3.5	18
	1.1.4	Special Provisions	0	2.5	0
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs	0	6.0	0
	1.2.2	Use of Automobiles	0	2.5	0
	1.2.3	Signal/Signing Needs	+7	2.0	14
1.3 Other Community Transportation	1.3.1	Future Transportation Plans	0	3.0	0
	1.3.2	Existing Transportation	0	3.0	0
2.1 Safety	2.1.1	Cost of Accidents	+8	12.0	96
	2.1.2	Accident Threat	+10	7.0	70
	2.1.3	Crime Concern	-2	3.0	-6
	2.1.4	Emergency	0	3.5	0
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment	-6	5.0	-30
	2.2.2	Litter Control	+4	1.0	4
	2.2.3	Density	+8	1.5	12
	2.2.4	Climate Control & Weather Protection	-10	1.5	-15
2.3 Environment/ Health	2.3.1	Air Pollution	0	3.0	0
	2.3.2	Noise	-1	1.5	-2
	2.3.3	Health	-3	1.5	-5
	2.3.4	Conservation	+7	1.5	11
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation	0	2.0	0
	3.1.2	Community Pride & Interaction	0	3.5	0
	3.1.3	Aesthetics & Compatibility	+1	3.0	3
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales	+1	1.5	2
	3.2.2	Displacement or Renovation	-10	1.5	-15
	3.2.3	Deliveries & Commuting	0	2.0	0
	3.2.4	Attractiveness to Business	-10	2.5	-25
4.1 Planning Process	4.1.1	Public Participation	+2	2.5	5
	4.1.2	Requirements & Regulations	+10	2.0	20
4.2 Economic Impacts	4.2.1	Tax Receipts	0	1.5	0
	4.2.2	Employment	0	1.0	0
	4.2.3	Community Services	0	1.5	0
4.3 Community Impacts	4.3.1	Community Activities	0	2.5	0
	4.3.2	Future Urban Plans	0	2.0	0
	4.3.3	Construction	-5	1.0	-5

Figure B-7. Evaluation summary sheet for proposed pedestrian overpass at Rainier Avenue and Empire Way, Seattle. Wash.

of this primarily residential area, the change in operating costs and travel time at this one intersection is less than 1%. Because there is no change in any of the other intersection approaches, the over-all impact of the bridge closure on motor vehicle operating costs and travel time is negligible. There is no impact on automobile ownership or parking.

VEHICLE TRAVEL COSTS SCORE = 0

1.2.2 Use of Automobiles

The bridge closure will have no effect on automobile travel.

USE OF AUTOMOBILES SCORE = 0

1.2.3 Signal/Signing Needs

Signs were needed (and were installed) at a number of locations on 20th Avenue N.E. to warn motorists that it is no longer a through street.

SIGNAL/SIGNING NEEDS SCORE = −5

1.3 Other Community Transportation

1.3.1 Future Transportation Plans

According to the city's evaluation of the experimental closure (van Gelder, 1975),

> The City's Comprehensive Bikeway Plan indicates 20th Avenue N.E. as a possible bikeway corridor. The increase in the number of bicycles indicates a substantial usage of 20th Avenue N.E. as a north-south route for cyclists and supports the current Comprehensive Plan.

FUTURE TRANSPORTATION PLANS SCORE = 5

1.3.2 Existing Transportation

Bicycle use of the bridge increased by approximately 20 percent after it was closed to motor vehicles.

EXISTING TRANSPORTATION SCORE = 5

2.1 Safety

2.1.1 Societal Cost of Accidents

Very few pedestrian/vehicle conflicts occurred in the vicinity of the bridge before closure so a "does not apply" score of 0 is appropriate (this variable measures change in accident costs).

COST OF ACCIDENTS SCORE = 0

2.1.2 Accident Threat

All vehicle conflicts have been eliminated for pedestrians, so the maximum score is assigned. The positive value when all conflict is eliminated reflects unrestricted use of the facility by pedestrians without fear of accidents.

ACCIDENT THREAT SCORE = +10

2.1.3 Crime Concern

Numerous positive features that alleviate crime concern (openness, long line of sight, community awareness programs, very few idlers, and cleanliness) are offset by important negative features such as infrequent police patrols, few fellow pedestrians, and no communication devices.

CRIME CONCERN SCORE = −1

2.1.4. Emergency Access/Medical and Fire Facilities

Access to emergency vehicles only is provided across the bridge. This is partially offset, however, by lack of communication facilities and the scarcity of fellow pedestrians in case of emergency.

EMERGENCY SCORE = +2

2.2 Attractiveness of Surroundings

2.2.1 Pedestrian-Oriented Environment

The positive impacts are Ravenna Park, complete with trees, gardens, birds, a stream, and picnic tables. The single negative impact is the existence of overhead utility wires.

PEDESTRIAN ENVIRONMENT SCORE = $(6-2\times 1)\div 2-5=-3$

2.2.2 Litter

20th Street N.E. is free of litter. However, this is offset by the fact that there are no litter baskets.

LITTER CONTROL SCORE = 0

2.2.3 Density

The bridge usually has no more than two or three pedestrians using it at any one time.

DENSITY SCORE = 6

2.2.4 Climate and Weather

There are no provisions for climate control or weather protection on the bridge.

CLIMATE AND WEATHER SCORE = 0

2.3 Environment/Health

2.3.1 Air Pollution

Similar to the situation for vehicle travel costs (1.2.1), the rerouted traffic does not significantly increase air pollution levels over the impact area because congestion does not increase. A local exchange does take place, however, because of eliminating vehicles in the vicinity of the bridge, and the lowering of traffic on 20th Avenue north of the bridge. This is offset by slight local increases on other streets.

AIR POLLUTION SCORE = 0

2.3.2 Noise Impacts

Peak-hour traffic before closure was about 6 veh per min, with an average of less than 1 veh per min over the rest of the day. Vehicle noise was low, but the old bridge structure was quite noisy. Present noise levels (with the closure) are below 50 db(A). Peak noise levels are caused by vehicles several blocks away, accelerating up an incline, and by overhead airplanes.

NOISE SCORE = $-10+[(90-50)\times 0.4]=+6$

2.3.3 Health Effects

Elimination of vehicles; wide lane suitable for joggers, bicyclists, and pedestrians; low noise levels; and a pleasant natural environment all encourage healthful activity.
HEALTH SCORE = +5

2.3.4 Conservation of Resources

This facility is a good example of reuse of existing materials, with almost no new resources needed. In fact, a more expensive alternative considered was to remove the bridge; a still more expensive alternative was to widen and strengthen the structure.
CONSERVATION SCORE = +10

3.1 Residential Neighborhoods

3.1.1 Residential Dislocation

RESIDENTIAL DISLOCATION SCORE = 0

3.1.2 Community Pride and Interaction

The community showed its approval of the project in response to a survey. A reduction of through traffic will increase privacy, and the bridge makes a good bicycle or jogging path.
COMMUNITY PRIDE AND INTERACTION SCORE = 4

3.1.3 Aesthetics and Compatibility

The bridge closure scores well on all of the positive components, except for color. The utility wires detract from the view.
AESTHETICS AND COMPATIBILITY SCORE = 7

3.2.1 Commercial/Industrial Districts

There are five automobile service stations, a fast-food franchise, and a convenience store on 25th Avenue N.E. that might benefit from the 7 percent increase in traffic on 25th Avenue N.E. If the relationship of a 1 percent increase in retail sales for each 10 percent increase in pedestrian traffic can be extended for motor vehicle traffic passing convenience stores, traffic rerouting would account for an increase in sales of 0.7 percent.
RETAIL SALES SCORE = 1

3.2.2 Displacement or Renovation

DISPLACEMENT OR RENOVATION SCORE = 10

3.2.3 Ease of Deliveries and Employee Commuting

DELIVERIES AND COMMUTING SCORE = 0

3.3.4 Attractiveness of Area to Business

There is a low vacancy rate and merchants are enthusiastic about doing business in the neighborhood.
ATTRACTIVENESS TO BUSINESS SCORE = −6

4.1 Transportation and Land-Use Planning Process

4.1.1 Public Participation

A deliberate attempt was made to include as much public input as possible for this project, and the decision that was made truly reflects the community's preferences. The City of Seattle has established a community opinion research group to evaluate citizen input for all of their public works projects. The bridge closure was one of the first transportation projects to be evaluated under this procedure. The group distributed 1,250 questionnaires (of which 41 percent were returned) before the trial closure. Of those responding, 73 percent stated that they would be inconvenienced only slightly or not at all. After the trial period, more than 1,000 questionnaires were returned by households in the affected area from more than 3,000 distributed to households. The response was 62 percent in favor of continuing the closure permanently.
PUBLIC PARTICIPATION SCORE = 3

4.1.2 Requirements and Regulations

REQUIREMENTS AND REGULATIONS SCORE = 10

4.2 Economic Impacts

4.2.1 Tax Receipts

Any change in taxes as a result of the bridge closure will be offset by a corresponding change elsewhere in the city.
TAX RECEIPTS SCORE = 0

4.2.2 Employment

EMPLOYMENT SCORE = 0

4.2.3 Community Services

Changes in the cost of providing community services resulting from the bridge closure are minor. Some service vehicles have been rerouted, but the changes in travel time and operating costs are small.
COMMUNITY SERVICES SCORE = 0

4.3 Community Impacts

4.3.1 Community Activities

The bridge closure has unified the community somewhat because the reduction in motor vehicle traffic facilitates personal interaction among the residents. It will now be much easier to close a street for the purpose of holding a block party.
COMMUNITY ACTIVITIES SCORE = 3

4.3.2 Future Urban Plans

Closure of the 20th Avenue N.E./Ravenna Park Bridge ensures perpetuation of the residential character of the community, with no future commercial development.
FUTURE URBAN PLANS SCORE = 7

4.3.3 Construction

Construction of the facility required only the placement of some signs, warning lights, and barriers at either end of the bridge.

CONSTRUCTION SCORE = 10

Summary

Figure B-8 summarizes the evaluation variable scores for the closure of the 20th Avenue N.E./Ravenna Park Bridge.

SPARKS STREET MALL

The Sparks Street Mall, completed in Ottawa, Ont., in 1967 after a series of temporary malls beginning in 1960, is probably the most successful pedestrian mall in North America. It thus demonstrates many of the amenities that a successful mall should possess, some of which are shown on the following pages.

The mall will ultimately be six blocks in length, twice as long as was originally planned. The first, second, third, and fifth blocks have been completed. The fourth block is under construction, and the sixth block has not yet been started. This evaluation considers only the first three completed blocks of the mall.

1.1 Pedestrian Transportation

1.1.1 Travel Time

Pedestrian travel times were affected by the Sparks Street Mall in several ways. The average trip length of many commuters and other travelers to the area, who came by bus, was increased by one block (about 250 ft) because bus routes were moved from Sparks Street onto adjacent parallel streets. However, all pedestrians who crossed Sparks Street experienced average delay reductions because of elimination of vehicle traffic. Based on a computed ratio of such travel times (because no pedestrian counts are available) an estimate was made of "before" and "after" travel times.

$$\text{TRAVEL TIME SCORE} = \frac{100 - 92}{100} \times 10 = +0.8,$$

rounded to +1.

1.1.2 Ease of Walking

EASE OF WALKING SCORE = $0 + 2 + 1\frac{1}{2} + 1\frac{1}{3} + 2 = 6.8$, rounded to 7, based on the following components.

1.1.2.1 Walking Surface. The color of the walking surface is not aesthetically appealing. It consists of various shades of white, off white, dirty white, and mosaic. The texture of the surface at the center strip of the mall, which is typically for sitting, resting, and lounging rather than walking, is an aggregate compound, pleasant to the eye, whereas the primary walking surface is smoother and less interesting.

There are no gratings or unexpected surface changes. There are some severe pavement cracks scattered throughout the mall. The surface is not slippery when wet, and it is cleared of snow and ice as early as possible. In total, the comfortable, slip-free walking surface is offset by the color and the cracks. Walking Surface score = 0.

1.1.2.2 Grade Changes. All grade changes are very minor and extremely gradual. Grade Changes score = 2

1.1.2.3 Continuity. It is possible to walk from one end of the mall to the other (three city blocks) in a perfectly straight line if one so desires, although there are many alternative paths available. At any point on the mall there are two (corresponding to the previous location of sidewalks) and sometimes three pedestrian pathways. These paths vary in width from about 10 ft to 25 ft and merge at various points. The attractions and pedestrian flows make it typical to switch from one pathway to another.

There are numerous obstacles (such as benches and the cafes) on the center path, which was not designed to be a continuous route lengthwise down the mall. However, five fire hydrants remain in their original curb position. Because this is now part of the pathway, they are obstacles to pedestrian flow. Continuity score = $2\frac{1}{2} - 1 = 1\frac{1}{2}$

1.1.2.4 Signing. No maps of the mall are provided, but at each block there is a listing of the name of every store, arranged by street address for each side of the street. There are practically no signs posted on the mall. Although they are not needed for safety reasons, regulations concerning the mall are not defined. The fact that bicycle riding is forbidden is not posted; nor are the hours that trucks are permitted on the mall, except on one of the three blocks. Every traffic light cycle throughout the day includes a short phase for trucks leaving the mall, even though they are only allowed three hours per day. This causes confusion and delay.

There are no signs on the mall other than those describing the stores. Those signs are exclusively in English; but inasmuch as they are proper names no other translation is available. The letters on these store directories are only ½ in. high, but a poor-sighted person may stand as close to them as he wishes. The store directories are only at one end of each block. At the opposite end and midblock, there is no information for those who need it. Signing score = $2\frac{1}{3} - 1 = 1\frac{1}{3}$

1.1.2.5 Lighting.

Level of Illumination—The evening level of illumination of the mall varies between 15 and 23 ft-c * at most places. Under a cluster of street lights the illumination may reach 25 ft-c, and next to some particularly well-lighted shops it reaches 35 and 40-ft-c. Wellington Street, one block north of the mall and the location of the Parliament Buildings, is between 15 and 20 ft-c in illumination with no brighter spots.

Sparks Street is also colorful at night, because all of the stores are lighted. They all have flat signs against the buildings (Fig. B-9) rather than hanging signs, which adds to the effect. Level of Illumination score = 0

* To convert foot-candles to lumen per square meter (lux), multiply by 10.764.

Name of Project 20TH AVE. N.E./ RAVENNA PARK BRIDGE

Cost initial $125,000 annual $1,000 (APPROX)

Total Score $\boxed{+206}$

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time	0	1.5	0
	1.1.2	Ease of Walking	+3	2.5	8
	1.1.3	Convenience	+3	3.5	11
	1.1.4	Special Provisions	-1	3.0	-3
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs	0	0.5	0
	1.2.2	Use of Automobiles	0	1.0	0
	1.2.3	Signal/Signing Needs	-5	1.5	-8
1.3 Other Community Transportation	1.3.1	Future Transportation Plans	+5	1.5	8
	1.3.2	Existing Transportation	+5	3.0	15
2.1 Safety	2.1.1	Cost of Accidents	0	3.0	0
	2.1.2	Accident Threat	+10	2.0	20
	2.1.3	Crime Concern	-1	3.0	-3
	2.1.4	Emergency	+2	3.0	6
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment	-3	10.0	-30
	2.2.2	Litter Control	0	2.0	0
	2.2.3	Density	+6	2.0	12
	2.2.4	Climate Control & Weather Protection	0	2.0	0
2.3 Environment/ Health	2.3.1	Air Pollution	0	4.0	0
	2.3.2	Noise	+6	2.5	15
	2.3.3	Health	+5	2.5	13
	2.3.4	Conservation	+10	2.0	20
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation	0	2.0	0
	3.1.2	Community Pride & Interaction	+4	6.0	24
	3.1.3	Aesthetics & Compatibility	+7	4.0	28
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales	+1	2.5	3
	3.2.2	Displacement or Renovation	+10	2.5	25
	3.2.3	Deliveries & Commuting	0	2.5	0
	3.2.4	Attractiveness to Business	-6	4.5	-27
4.1 Planning Process	4.1.1	Public Participation	+3	3.5	11
	4.1.2	Requirements & Regulations	+10	1.0	10
4.2 Economic Impacts	4.2.1	Tax Receipts	0	3.5	0
	4.2.2	Employment	0	2.0	0
	4.2.3	Community Services	0	1.0	0
4.3 Community Impacts	4.3.1	Community Activities	+3	5.0	15
	4.3.2	Future Urban Plans	+7	2.5	18
	4.3.3	Construction	+10	1.5	15

Figure B-8. Evaluation summary sheet for closure of 20th Avenue N.E./Ravenna Park Bridge, Seattle, Wash.

Figure B-9. Back-lighted storefront signs on Sparks Street Mall, Ottawa, Ont.

Type of Lighting. Incandescent. Type of Lighting score = 0

Height of Lamps. The poles are 9 ft (2.8 m) high, definitely pedestrian scale. Height of Lamps score = 0

Lighting Score. Lighting score = 0 + 0 + 0 +2 = 2

1.1.3 Convenience

1.1.3.1 Time Facility is Open for Use. The Sparks Street Mall is open at all hours of the day and night. Time Facility is Open for Use score = 0

1.1.3.2 Improved Travel Convenience to:

Transit	No	Buses and streetcars previously traveling on Sparks Street were rerouted.
Parking	No	On-street parking was eliminated from Sparks Street Mall.
Transportation terminals	No	No major transportation terminals are within walking distance of the mall.
Bike routes	Yes	Two major bicycle paths in Ottawa parallel the Rideau Canal and the Ottawa River. Their termini are not presently connected, hence one must travel across about a dozen city blocks in the heart of downtown to get to the other. A future connecting bikeway is proposed, but until it is completed Sparks Street is a very attractive alternative among the various routes available, even though bike riding is prohibited on the mall.
Schools	No	There are no schools nearby.
Parks or cultural facilities	Yes	Travel to the Garden of Provinces, just off the western end of the planned mall extension, will be improved. Travel to nearby Parliament buildings, the National Gallery, and the National Library and Archives is improved.
Medical facilities	No	No doctors' office complexes, clinics, or hospitals are located nearby.
Places of worship	Yes	St. Andrew's Church (Presbyterian) is located on the mall, and St. Peter's Evangelical Lutheran Church will be on the mall when it is extended.
Retail stores	Yes	Access to the retail stores on Sparks Street is greatly improved.
Residential areas	No	There are no residential neighborhoods nearby.

Accessibility score = 4

CONVENIENCE SCORE = 4

1.1.4 Special Provisions

		point	
6-in. (15 cm) maximum curb height	Yes	1	
Ramped curb cuts	No	0	The curbs are sloped slightly at crossings, but are not cut.
5-ft (1.5 m) wide passageway	Yes	1	There is a 20-ft wide (6.1 m) passageway designed to accommodate emergency and service vehicles.
Interior areas	No	1	The mall is outdoors.
Grade changes without ramps or elevators	No	1	There are no grade changes greater than 15 ft (4.6 m) on the mall.
Crossing signal buttons	No	1	There are no pedestrian-activated signals.
Public telephone	No	0	The telephones have 32-in. (81 cm) clearance underneath, but the touch tone panel is 55 in. (1.4 m) high.
Drinking fountain	No	0	The drinking fountains are approximately 36 in. (91 cm) above the ground.
Pavement texture	No	0	There are no changes in pavement texture for the benefit of blind people.
Special provisions for blind people	No	0	There are no braille signs or other accommodations.
Angular corners	No	0	There are no angular sidewalk corners.
Audible signals	Yes	3	At the signal control box, there are four clicks before the pedestrian phase, and eight clicks for the vehicle phase. The control box is located only on one side of the street. However, because of the mall, there is a crossing only of one street, and the noise of vehicles and pedestrians is discernible from the side of the street opposite the control box.
Bicycle racks	Yes	3	There is a bike rack on each of the three blocks of the mall; one holds 8, the other two each hold 11. Bikes are not allowed to be tied to posts or other places on the mall; however, this rule is rarely enforced, especially now that people are using the bike racks and they are sometimes filled to capacity. Figure B-10 shows one of the bicycle racks.
Separate bicycle path	No	0	It is against the law to ride a bicycle on the mall.
Jogging path	No	0	No provisions are made for joggers; it is rare to see a person jogging through the mall.
Handrails	No	1	There are no hazardous locations.
Gratings	No	1	There are no gratings.

SPECIAL PROVISIONS SCORE is $13 \times 0.8 - 10 = 0.4$, rounded to 0

1.2 Motor Vehicles

1.2.1 Motor Vehicle Travel Costs

Although it cannot be based on hard data, the Sparks Street closure probably reduced motor vehicle travel costs slightly, because traffic on the street was often congested.
VEHICLE TRAVEL COSTS SCORE = 1

1.2.2. Use of Automobiles

The Sparks Street Mall probably accounted for only a very minor change in the fraction of trips made to central Ottawa by automobile.
USE OF AUTOMOBILES SCORE = +1

1.2.3 Signal/Signing Needs Adjacent to Facility

Very few signs were posted to inform motorists of the Sparks Street closure.
SIGNAL/SIGNING NEEDS SCORE selected = 0

1.3 Other Community Transportation

1.3.1 Adaptability to Future Transportation Development Plans

The Sparks Street Mall is located at the center of the city, and thus is at the focus of its pedestrian, transit, and bicycle routes. It contributes a positive dimension to these modes.
FUTURE TRANSPORTATION PLANS SCORE selected = 5

1.3.2 Impact on Existing Transportation Systems

The Sparks Street Mall does not impact any transportation terminals, and the only mode affected by the mall was transit. A number of lines had to be rerouted one block, requiring people to walk an extra block to get to the stores on Sparks Street. A positive impact of the rerouting was a decrease in transit operating costs, presumably because

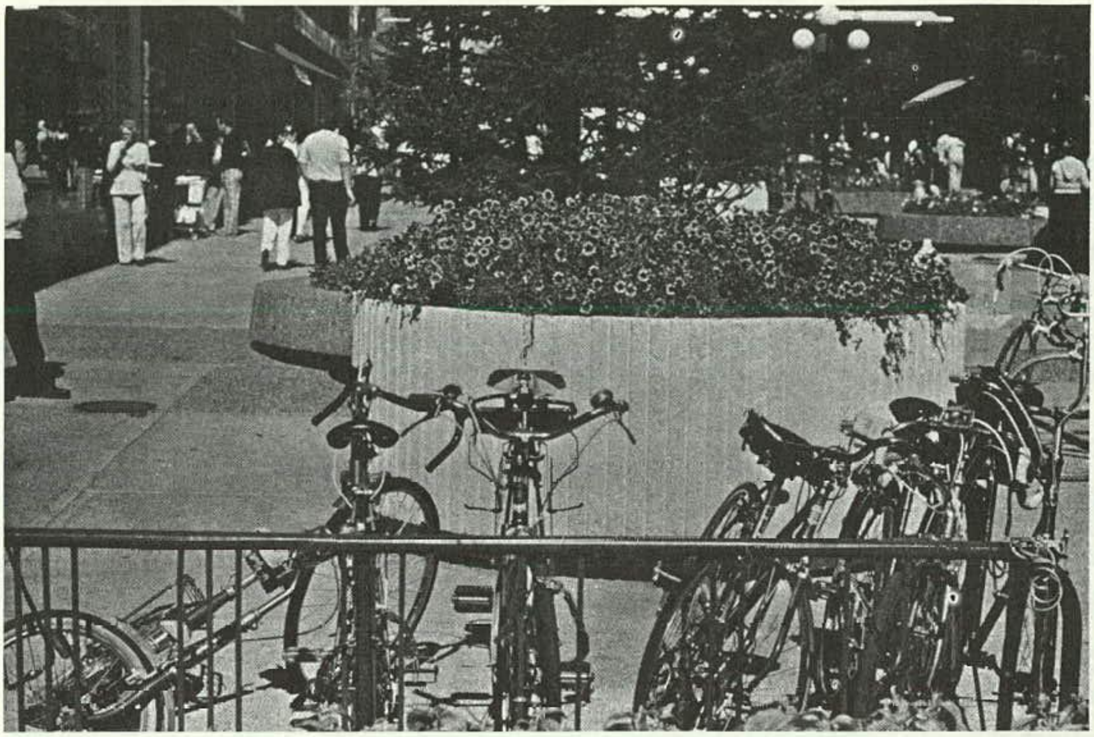


Figure B-10. Bicycle rack on Sparks Street Mall.

buses could avoid the stop-and-go traffic on congested Sparks Street. These two impacts tend to offset each other.

EXISTING TRANSPORTATION SCORE selected = 0

2.1 Safety

2.1.1 Societal Cost of Accidents

The major shopping area of the Sparks Street Mall is the three-block section from Bank to Elgin Streets. Since the mall was completed in 1967, exact pedestrian and vehicle movement is unavailable for evaluation. However, because it is a shopping and business area, with only the cross streets remaining open to vehicle traffic, a 50 percent reduction in pedestrian/vehicle crossing conflicts is estimated. This agrees with the observation that before the mall was put in pedestrian trips probably avoided crossing any street more than necessary due to the presence of vehicle traffic. Today pedestrian crossings of the previous roadway (Sparks Street) far exceed the number of cross-street crossings (O'Connor and Metcalf) because of the elimination of vehicle traffic.

The accident scoring system is designed so the ratio of before and after crossings can be used, as well as actual crossing counts; in this case, 2 to 1. The "before" accident involvement rate was calculated to be 1.05. using Figure A-13 (Appendix A). An "after" ratio of 0.74 was calculated, largely due to reductions in vehicle volume and turning conflict.

COST OF ACCIDENTS SCORE =

$$\frac{(2 \times 1.05) - (1 \times 0.74)}{(2 \times 1.05)} \times 10 = +6.48, \text{ rounded to } +6$$

2.1.2 Accident Threat Concern

The assessed vehicle factors in the Sparks Street Mall area (including cross streets) are: low traffic volume, medium traffic speeds, few turning conflicts (only during loading and unloading period, and occasionally during the rest of the day for special delivery, maintenance, and emergency vehicles), and mixed vehicle types on one-way streets. The vehicle factors yield +4 points.

The setting provides marked crosswalks, signalization for pedestrians and vehicles, good sight distances and good lighting when needed. These yielded +4 points.

ACCIDENT THREAT SCORE is +8

2.1.3 Crime Concerns

Crime concern is at a remarkably low level on the Sparks Street Mall because of many factors (only one window was broken by vandalism in 10 years). Highly visible police patrols (very friendly), high pedestrian volume, good lighting, little clutter, low vehicle traffic, and gentle discouragement of panhandlers, alcoholics, and other nuisance loiterers contribute to a very comfortable feeling in the area.

CRIME CONCERN SCORE is +8

2.1.4 Emergency Access/Medical and Fire Facilities

Full emergency vehicle access is provided by a minimum 25-ft wide unmarked serpentine path through the entire mall. It is unusual in that the pedestrian is unaware of its existence because the emergency path is simply the widest pedestrian path with the required width and gentle turning

Figure B-11. Emergency vehicle access on Sparks Street Mall.

radii necessary for emergency vehicles. Figure B-11 shows a police car rushing to the scene using the path.

High pedestrian volumes, good lighting, and telephones on the mall that do not require coins for emergency calling minimize the danger of unattended medical emergencies.

EMERGENCY SCORE = +6

2.2 Attractiveness of Surroundings

2.2.1 Pedestrian-Oriented Environment

Amenities (2 points/2 possible). There is a small Provincial Rock Garden (Fig. B-12) in the center block of the mall containing a rock from each province or territory. There is a water fountain (Fig. B-13) on each block of the mall. The fountain on the middle block also has a small waterfall.

The Arts (4 points/6 possible). There is a 15 by 19 ft (4.6 x 5.8 m) stage, 1½ ft (46 cm) above the ground, with an overhead canopy, near the western end of the mall. The stage is shown in Figure B-14. Performances are held there at least twice a week in the summer. There are no murals, but the metal sculpture "Joy," four happy people by Bruce Garner, sits near the eastern end of the mall. Guitarists and other street musicians play on weekdays, particularly during the lunch hours. They are not allowed to request or indicate that they will accept donations, for the same reason the street artists are not allowed to sell their products on the mall. A major purpose of the mall is to provide a refuge for one to be able to sit and not be solicited. There is background music playing from speakers in the telephone/ drinking fountain/directory kiosk on each block of the mall, but its volume is such that it can be heard only on less than one-third of the block. Thus, a person on the mall can choose to sit near or away from the music, as he prefers.

Buildings (1 point/2 possible). There is a wide variety of heights, colors, and designs of buildings facing the mall. The Bank of Nova Scotia (see Fig. B-15) and the Canadian Bank of Commerce Buildings, side by side, are particularly impressive. No renovations or restorations have been attempted.

Communications (3 points/3 possible). Mailboxes are located just off the mall at each intersection and there is a post office on Sparks Street at the eastern end of the mall. There is a stamp machine on each block of the mall, adjacent to the public telephones, of which there are two at the center of each block on the mall. Figure B-16 shows some of the public telephones. No coin is needed to call the operator.

On each block of the mall, there is an outdoor clock. One is actually a part of the mall; the others are attached to banks that face the mall.

Exhibits (2 points/2 possible). There are twelve 92 x 42 in. (2.3 x 1.1 m) display cases on the westmost block of the mall, and a four-sided 41 x 83 in. (1.0 x 2.1 m) display box at the eastern end of the mall. They are used mostly for tasteful exhibits by local merchants located both on and off the mall, particularly photographers and art galleries (Fig. B-17). Sample displays of a store's merchandise are not permitted. There are some additional exhibits in store windows.

At the western front of the mall there is a monument to

Figure B-12. Provincial Rock Garden, Sparks Street Mall.

Nicholas Sparks (1792-1862), who bought all of downtown Ottawa for £95 in 1826. Much of this land he later donated to the city, including two blocks (at that time all) of Sparks Street. Near the other end of the mall is a plaque commemorating the Vincent Massey Urban Environment Excellence Award, given to the people of Ottawa in 1971 for the Sparks Street Mall.

Nature (3 points/4 possible). There are 22 to 26 trees of various types and sizes on each block of the mall. There

Figure B-13. Fountain and delivery trucks, Sparks Street Mall.

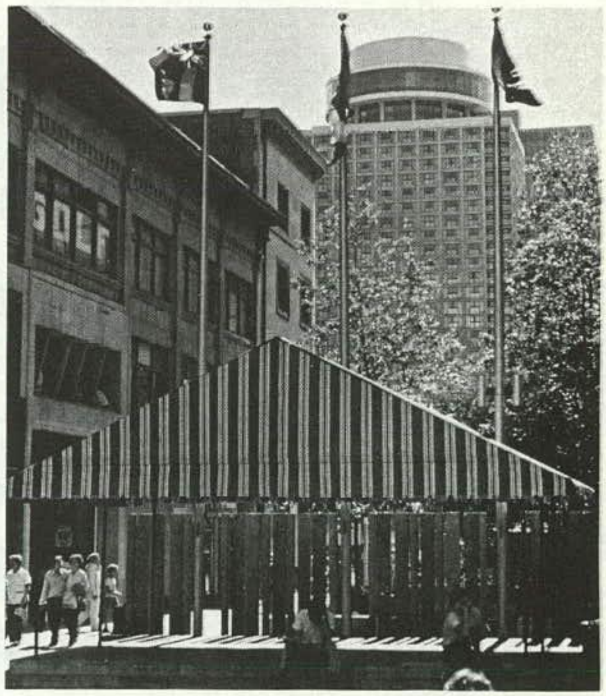
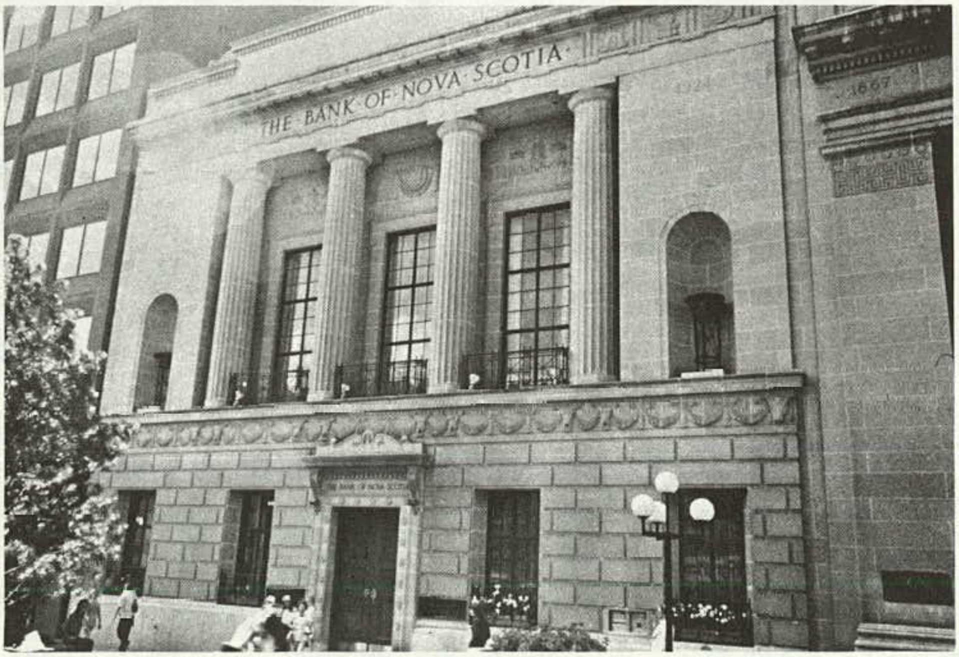


Figure B-14. Stage on Sparks Street Mall.

are also 31 to 35 separate flower boxes, plantings, or gardens on each block of the mall. There are no additional flower exhibits. Approximately 18 to 20 sparrows live in the trees on the mall.

Outdoor Eating (2 points/2 possible). There are three sidewalk cafes on the mall, one on each block. The westernmost one is small, serving only ice cream, hot dogs, ham sandwiches, and cold drinks. There are six picnic tables with umbrellas. On the center block, Sharry's outdoor cafe is associated with the adjacent dining room and lounge of the same name. They serve a variety of light chicken, beef, fish, and pizza dishes, sandwiches, non-alcoholic beverages, and beer. Open Air Cafeteria (Fig. B-18), has five round shaded tables for enjoyment of ice cream, hamburgers, hot dogs, and cold drinks. On weekdays, there is a fruit cart (Fig. B-19) and an ice cream cart on each block of the mall.

Physical Comfort (3 points/5 possible). The 38 benches



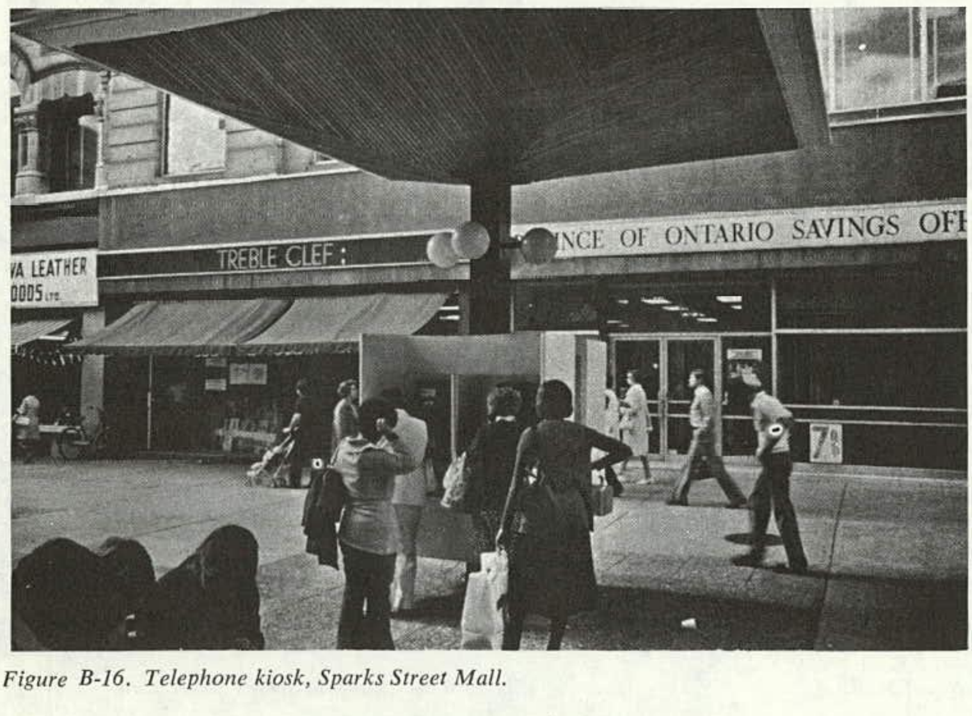


Figure B-16. Telephone kiosk, Sparks Street Mall.

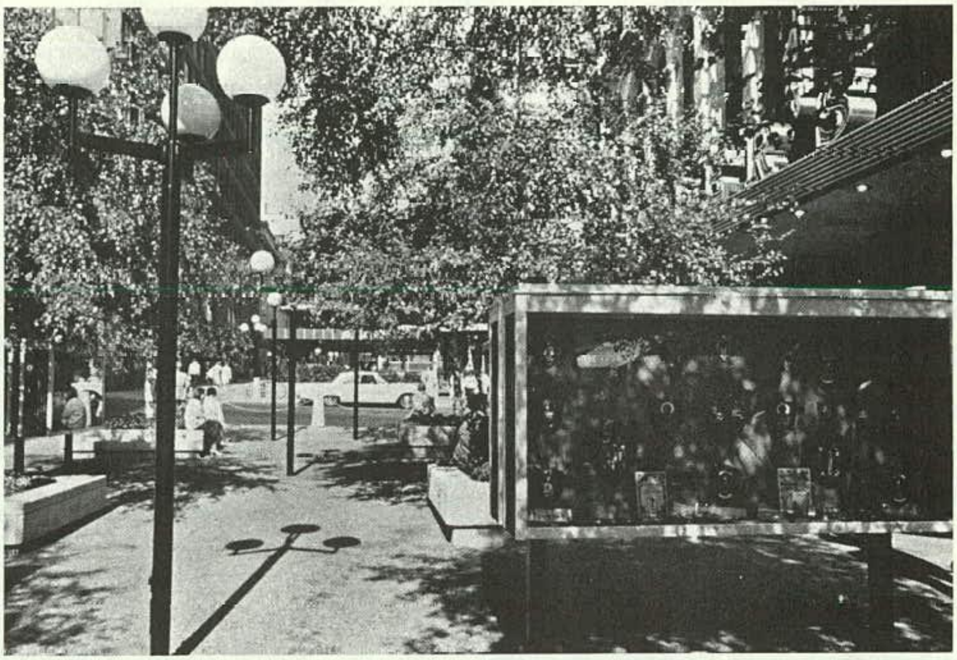


Figure B-17. Display case, Sparks Street Mall.

Figure B-18. Cafe on Sparks Street Mall.

on the mall are only 18 in. (46 cm) deep, and 92 in. (2.3 m) long (two on each block are only 68 in. (1.7 m) long). They are uncomfortable to sit on for long periods of time, although they are attractive and conveniently located. There are eight temporary benches due to the construction of a new building. Ledges on the mall have the capacity for seating more than twice as many people as the benches. The ledges are about 23 in. (58 cm) high, and 12 in. (30 cm) deep, and are heavily used during lunch hours, but also at times when there are empty benches available.

There is a drinking fountain on each block of the mall, next to the telephones. There are plenty of lampposts and building fronts available to lean against. No restrooms are provided, because the operating costs would more than double the entire operating budget for the mall.

Retail Outlets (4 points/4 possible). There is a flower cart (Fig. B-20) on each block of the mall on weekdays. Each of the 70 different shops facing the mall has something to catch the eye of the passerby. Figure B-21 shows a typical storefront. There are two bookstores and one newsstand on the mall.

Positive Impacts score = 24 out of possible 30; Negative Aspects score = 0.

PEDESTRIAN ENVIRONMENT SCORE = 24 ÷ 2 − 5 = 7

Figure B-19. Fruit vendor on Sparks Street Mall.

Figure B-20. Flower cart on Sparks Street Mall.

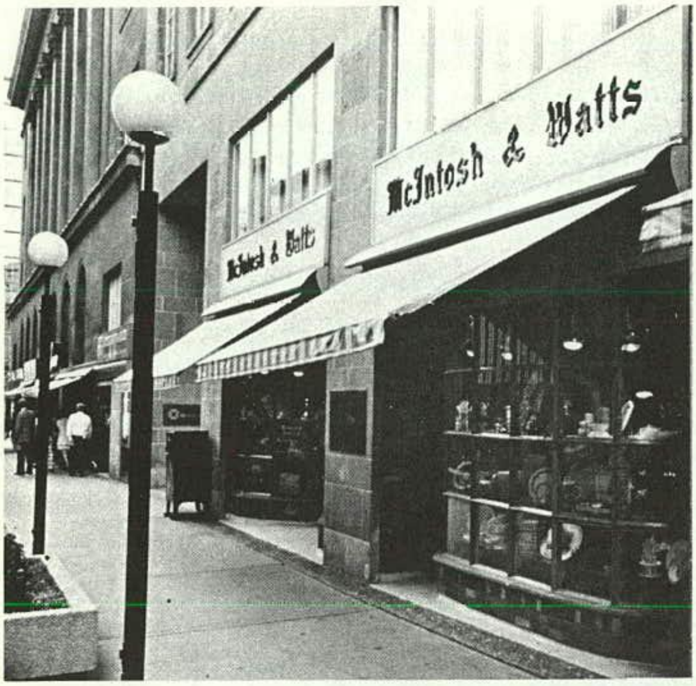


Figure B-21. Interesting storefront display, Sparks Street Mall.

2.2.2 Litter Control

Litter condition is 2.5—littered. There are more than slight accumulations of dirt and litter. Cigarette butts and matches, in particular, accumulate in and around sidewalk cracks and especially under benches. The mall is swept mechanically several times daily (Fig. B-22), but the machine cannot pick up all of the litter generated by the tens of thousands of people who use the facility daily. There is a noticeable accumulation of gum residue present. Litter Condition score = −8.

There is adequate placement of trash baskets, many, many more than on nearby streets in Ottawa. Existence of Trash Baskets score = +8.

LITTER CONTROL SCORE = 0

2.2.3 Density

The weekday lunch-hour pedestrian density on Sparks Street is about 15 sq ft (1.4 m^2) per person. No records were available as to the pedestrian density before Sparks Street was converted to a mall, when there were fewer pedestrians and less walking space, but it is believed that there is more available walking space per person now.

DENSITY SCORE selected = −4

2.2.4 Climate Control and Weather Protection

Because the facility is outdoors it is neither heated nor air conditioned. Ventilation is unnecessary.

The pedestrian is protected from direct sun, precipitation, gusts of wind, and snow accumulations. On each block, trees and canopies provide shade from the sun, in addition to that at the outdoor cafes. The canopies above the telephones provide shielding from direct precipitation for up to three dozen people comfortably and up to perhaps double that, if necessary, at each block. These canopies are more than 12 ft high and open at the sides. Because of their length and orientation, they may provide

Figure B-22. Street cleaner at work, Sparks Street Mall.

protection from rain coming straight down or from the north or the south (perpendicular to the mall), but they offer no protection from rain that is coming down from the east or west.

Most winds are from the west and the north, and thus are effectively blocked by the buildings on the north side of the mall.

The city gives Sparks Street first priority in snow removal, so the mall is cleared immediately after a snowfall. There is adequate drainage for rainwater.

CLIMATE AND WEATHER SCORE $= 0 + 0 + 0 + 4 - 10 = -6$

2.3 Environment/Health

2.3.1 Effects of Air Pollution

The position of Sparks Street in the previous traffic pattern was such that through traffic was forced to move to an adjacent parallel street within a few blocks on one end, and no through street existed at the other end. Thus few vehicle trips increased in length as a result of the street closure, inasmuch as the cross streets remained open.

A major contributor to air pollution is vehicle traffic congestion, and the narrow street plus heavy pedestrian traffic resulted in heavy congestion on the old street. Today, with the pedestrians concentrated on the mall, slightly increased volume on other streets probably moves better than before the mall was opened.

It was therefore estimated that 20 percent of the area traffic (from old Sparks Street) was rerouted to other streets, and that the average travel speed for this 20 percent increased from 15 to 20 mph (24 to 32 kph) because it no longer competed with pedestrians for space. The remaining traffic (80 percent) was estimated to be unaffected. The formulas for computing emission changes can also be used with vehicle volume ratios, as well as with actual vehicle counts. Because old data were not available (the Mall was completed in 1967) the formulas were computed using 10 vehicle-miles per day (vm/d) at 20 mph (32 kph) with 2 vm/d at 15 mph (24 kph) as the old (before) situation. Calculation yielded a 3 percent emission volume reduction, which translates to a +5 score using Figure A-21.

AIR POLLUTION SCORE $= +5$

2.3.2 Noise Impacts of Motor Vehicles

Noise effects on humans are difficult to determine. The same noise level (measured in decibels) is perceived differently by different people, depending on its source. Human speech may be tolerated, but a vehicle at the same noise level may be annoying. This variable considers the speech interference impact; perception is considered with health impacts (2.3.3).

Average sound level readings were taken at several points throughout the mall and at the cross streets; they varied from 70 db(A) to 52 db(A). Midblock values ranged from 52 to 58, so a value of 56 db(A) was selected as representative of most of the mall area. The scaled value was computed using Eq. A-17 (see Sec. 2.3.2 in Appendix A).

NOISE SCORE $= -10 + [(90 - 56) \times 0.4] = +3.6$, rounded to $+4$

2.3.3 Health Effects of Walking

Convenient resting places are available throughout the mall in the form of benches and many ledges. It is an exceptionally pleasant and attractive area providing psychological comfort because it is aesthetically pleasing, has low noise levels, and is essentially free of crime. However, the Sparks Street Mall does not significantly improve access to physical exercise facilities, nor does it provide for bicyclists or joggers.

HEALTH SCORE $= +4$

2.3.4 Conservation of Resources

Maintenance of the mall requires minimal amounts of all resources, including labor (the equivalent of one full-time groundskeeper, plus the street cleaning and police patrols).

CONSERVATION SCORE $= +10$

3.1 Residential Neighborhoods

3.1.1 Residential Dislocation

Sparks Street Mall is located in a commercial area, thus no residential relocation was necessary for its construction or continuation.

RESIDENTIAL DISLOCATION SCORE $= 0$

3.1.2 Community Pride, Cohesiveness, and Social Interaction

Although not located in a residential area, the Sparks Street Mall is enjoyed by city residents, business people, and tourists. It provides a place to meet and visit friends, access to many shops, a pleasant route to art and activity centers, and freedom from motor vehicles.

COMMUNITY PRIDE AND INTERACTION SCORE $= +4$

3.1.3 Aesthetic Impact, Compatibility with Neighborhood

This variable is only applicable to facilities in residental areas.

AESTHETICS AND COMPATIBILITY SCORE $= 0$

3.2 Commercial/Industrial Districts

The ratings for gross retail sales, as well as for displacement and renovation costs, are based on changes from the existing situation. Because the first temporary mall on Sparks Street began in May 1960, it is impossible to acquire quantitative data about the situation before that time, even from the businessmen who were instrumental in development of the mall. Therefore, the values given in the observations for variables 3.2.1 and 3.2.2 have been assumed.

3.2.1 Gross Retail Sales

Property values on Sparks Street tripled in value during the first ten years of the permanent mall. Suppose instead that the total volume of sales transacted on the mall tripled, whereas in other parts of the city they merely doubled. The average annual growth of sales on Sparks Street is thus

11.6 percent over the 10-year period, whereas it is only 7.2 percent for the remainder of the city. The difference, 4.4 percent, is the average annual growth in sales attributable to the pedestrian mall. If the rate of growth were uniform for the 10-year period, the average annual growth for the first two years would be equal to that for the first ten years, 4.4 percent.

RETAIL SALES SCORE selected = +4

3.2.2 *Displacement or Renovation Required or Encouraged*

The following is a specimen worksheet for this variable. The total renovation and cleaning costs are \$81,700. If the total sales volume for the year before the permanent mall was installed was \$2,000,000, the 4.4 percent average annual increase in sales would account for \$88,000 in additional sales. The ratio of renovation costs to annual change in sales is \$81,700/\$88,000 = 0.93. Interpolating from the table gives a score of +0.7, rounded to +1.

	Relocation	Storefront Renovation	Building Cleaning	Total
Store (or building) type			OFFICE	
Name of typical store (or building) type			METROPOLITAN LIFE	
Frontage for typical store (or building)			300'	
Cost for typical store (or building)			\$5,000	
Total frontage and/or number of stores (or buildings) in group			2500'	
Total costs for group			\$41,700	
Store (or building) type		VARIETY		
Name of typical store (or building)		DAVIS GALLERY		
Frontage for typical store (or building)		50'		
Cost for typical store (or building)		\$4,000		
Total frontage and/or number of stores (or buildings) in group		10 STORES		
Total costs for group		\$40,000		

DISPLACEMENT OR RENOVATION SCORE = +1

3.2.3 *Ease of Deliveries and Employee Commuting*

Trucks are prohibited from the mall except between 8 and 10 a.m. and 6 and 7 p.m. (see Fig. B-13).

DELIVERIES AND COMMUTING SCORE = −5

3.2.4 *Attractiveness of Area to Business*

All of the components of this variable are favorable except for interest by out-of-town firms to move into the area, and special promotional activities.

ATTRACTIVENESS TO BUSINESS SCORE = 16 − 10 = +6

4.1 Transportation and Land Use in the Planning Process

4.1.1 *Public Participation in the Planning Process*

The decision to construct a permanent pedestrian mall on Sparks Street was made by the local merchants and ratified by the property owners. However, in order "to get a broader, more objective appraisal of the mall's value to the community and downtown . . . a Citizen's Committee was formed" in 1963. The Committee was comprised of "representatives from local women's groups, architects, property owners, and citizens at large."

PUBLIC PARTICIPATION SCORE selected = +6

4.1.2 *Conformance with Requirements and Regulations*

The original design for the mall complied with all existing requirements, codes, and regulations.

REQUIREMENTS AND REGULATIONS SCORE selected = +10

4.2 Economic Impacts

4.2.1 *Change in Tax Receipts and Other Government Revenues*

The impact of the mall on municipal receipts in Ottawa is negligible because most of the increase in retail sales is simply a diversion from elsewhere, much of which is within the City of Ottawa. Also, motor vehicle fines that are no longer collected as a result of the mall will probably be accounted for elsewhere in the city.

TAX RECEIPTS SCORE selected = 0

4.2.2 *Changes in Employment*

One caretaker is employed by the Mall Authority to maintain the mall, and additional sales positions created probably number no more than 20. No jobs were lost as a result of the mall.

EMPLOYMENT SCORE selected = +2

4.2.3 *Change in Cost of Providing Community Services*

The Pedestrian Mall Authority maintains its own budget as a separate account in the city's books. Additional community service costs (principally cleaning of the pavement) beyond those incurred prior to Sparks Street being closed to traffic are charged to that account, which is reimbursed by property owners in the special assessment district on a front footage basis. The level of police protection (one officer patrolling the mall at all times) is the same as it was before the street was closed to traffic. Sparks Street is given priority by the city in snow clearance. but this does not incur any additional costs. Thus, the city's general budget has been unaffected by the mall.

COMMUNITY SERVICES SCORE selected = 0

4.3 Community Impacts

4.3.1 *Community Activities*

A number of concerts, acts, and other performances are held on the mall. They are generally well-attended, especially during the summer, on weekdays just after the lunch hour.

COMMUNITY ACTIVITIES SCORE selected = +10

4.3.2 Adaptability to Future Urban Development Plans

One long-term plan that has a number of supporters in Ottawa would have Sparks Street as a bridge connecting two other pedestrian/shopping malls. They are the Bank Street Promenade, intersecting with the west end of Sparks Street Mall, and the Rideau Street Mall, just opposite Confederation Square from Sparks Street. Bank Street will continue to accommodate vehicular traffic, expanding on some of the existing pedestrian amenities, whereas plans for the Rideau Mall call for having it enclosed.

Whether or not these plans actually come to fruition, the Sparks Street Mall still will continue to exert a pedestrian-social-commercial atmosphere in downtown Ottawa.

FUTURE URBAN PLANS SCORE selected = +10

4.3.3 Construction Period

Construction of the mall caused slight disbenefits to pedestrian movement, safety, and the pedestrian environment. However, these were offset by two characteristics—impacts on local businesses, and the length of construction. A large number of curious people came to Sparks Street to watch construction of the mall progress; as a result, sales improved. The construction period was short, requiring only three months (March 27 to June 28, 1967).

CONSTRUCTION SCORE = 0

Summary

Figure B-23 summarizes the evaluation variable scores for the Sparks Street Mall.

FULTON MALL

A pedestrian and transitway protected by an overhead canopy is planned for Fulton Street in the busy downtown shopping district of Brooklyn, N.Y. Detailed plans and cost estimates are currently being developed. Schematic design work is almost complete. Detailed site information and scoring of variables, followed by a project summary sheet, are presented in the following.

1.1 Pedestrian Transportation

1.1.1 Travel Time

A major reason for the Fulton Mall is to improve pedestrian flow through the area. Congestion presently is so high that average walking speeds are 10 to 12 percent lower than they could be with the increased walking space the project would provide.

The street-crossing problem is less clear. Cross-street traffic will continue, so no savings in pedestrian travel time will result from these crossings unless signal timing is changed significantly. Also, pedestrian crossings of Fulton Street may continue to be delayed because of bus volumes at peak hours. It is the understanding of the researchers that crossings of Fulton Street by pedestrians will be restricted to specific locations, probably with signalization.

If the restrictive patterns described are followed, minimal reductions in pedestrian travel time will result. Based on an 18 percent reduction in equivalent pedestrian travel time,

$$\text{TRAVEL TIME SCORE} = \frac{100\% - 82\%}{100\%} \times 10 = +1.8, \text{ rounded to } +2$$

1.1.2 Ease of Walking

EASE OF WALKING SCORE = 8, based on rounded sum of the following components.

1.1.2.1 Walking Surface. There is a great variety of pavement types, textures, and colors on each block of Fulton Street at present. There are three basic major colors—steel blue, off-white, and off-beige, plus some beautiful gray slate at two locations. The texture ranges from smooth to brushed, plus fine, medium, and coarse aggregates. Figure B-24 shows a particularly interesting pavement pattern outside the Off-Track Betting Corporation Office on Fulton Street. Walking Surface score = 1½

1.1.2.2 Grade Changes. Grade Changes score = 2

1.1.2.3 Continuity. Continuity score = 2

1.1.2.4 Signing. Signing score = 1⅓

1.1.2.5 Lighting. Lighting score = 1

1.1.3. Convenience

The Mall will improve accessibility to all of the attractions listed in Section 1.1.3.2, except bicycle paths. The Polytechnic Institute of New York, Brooklyn Law School, New York City Community College, the Zeckendorf Campus of Long Island University, and a part of Brooklyn College are all within walking distance of Fulton Street. Nearby residential Brooklyn Heights is a National Historic Landmark.

CONVENIENCE SCORE = 9

1.1.4 Special Provisions

The expected Federal Government participation in the funding of the Fulton Mall (as a tarnsit development project) ensures that it will satisfy the needs of the physically handicapped, but it is not yet clear that the design will accommodate many other special provisions.

SPECIAL PROVISIONS SCORE = −2

1.2 Motor Vehicles

1.2.1 Motor Vehicle Travel Costs

1.2.1.1 Motor Vehicle Operating Costs and 1.2.1.2 Travel Time for Motor Vehicle Occupants. A consultant's study (Wilbur Smith and Associates, 1974) shows that the traffic reassignment impacts of the Fulton Street closure would be minor at all times except the weekday evening peak hours, when 11 of the 115 major intersection approaches in the study area (9½ percent) would experience an increase in the volume/capacity ratio from below 0.6 to the 0.61 to 0.9 range, and three intersection approaches (2½ percent of the 115 in the study area) would experience an increase in the volume/capacity ratio from the

Name of Project SPARKS STREET MALL

Cost initial $1,500000 annual $34,800

+391 Total Score

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time	+1	1.5 %	2
	1.1.2	Ease of Walking	+7	2.5	18
	1.1.3	Convenience	+4	3.5	14
	1.1.4	Special Provisions	0	3.0	0
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs	+1	0.5	1
	1.2.2	Use of Automobiles	+1	1.0	1
	1.2.3	Signal/Signing Needs	0	1.5	0
1.3 Other Community Transportation	1.3.1	Future Transportation Plans	+5	1.5	8
	1.3.2	Existing Transportation	0	3.0	0
2.1 Safety	2.1.1	Cost of Accidents	+6	3.0	18
	2.1.2	Accident Threat	+8	2.0	16
	2.1.3	Crime Concern	+8	3.0	24
	2.1.4	Emergency	+6	3.0	18
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment	+7	10.0	70
	2.2.2	Litter Control	0	2.0	0
	2.2.3	Density	-4	2.0	-8
	2.2.4	Climate Control & Weather Protection	-6	2.0	-12
2.3 Environment/ Health	2.3.1	Air Pollution	+5	4.0	20
	2.3.2	Noise	+4	2.5	10
	2.3.3	Health	+4	2.5	10
	2.3.4	Conservation	+10	2.0	20
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation	0	2.0	0
	3.1.2	Community Pride & Interaction	+4	6.0	24
	3.1.3	Aesthetics & Compatibility	0	4.0	0
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales	+4	2.5	10
	3.2.2	Displacement or Renovation	+1	2.5	3
	3.2.3	Deliveries & Commuting	-5	2.5	-13
	3.2.4	Attractiveness to Business	+6	4.5	27
4.1 Planning Process	4.1.1	Public Participation	+6	3.5	21
	4.1.2	Requirements & Regulations	+10	1.0	10
4.2 Economic Impacts	4.2.1	Tax Receipts	0	3.5	0
	4.2.2	Employment	+2	2.0	4
	4.2.3	Community Services	0	1.0	0
4.3 Community Impacts	4.3.1	Community Activities	+10	5.0	50
	4.3.2	Future Urban Plans	+10	2.5	25
	4.3.3	Construction	0	1.5	0

Figure B-23. Evaluation summary sheet, Sparks Street Mall.

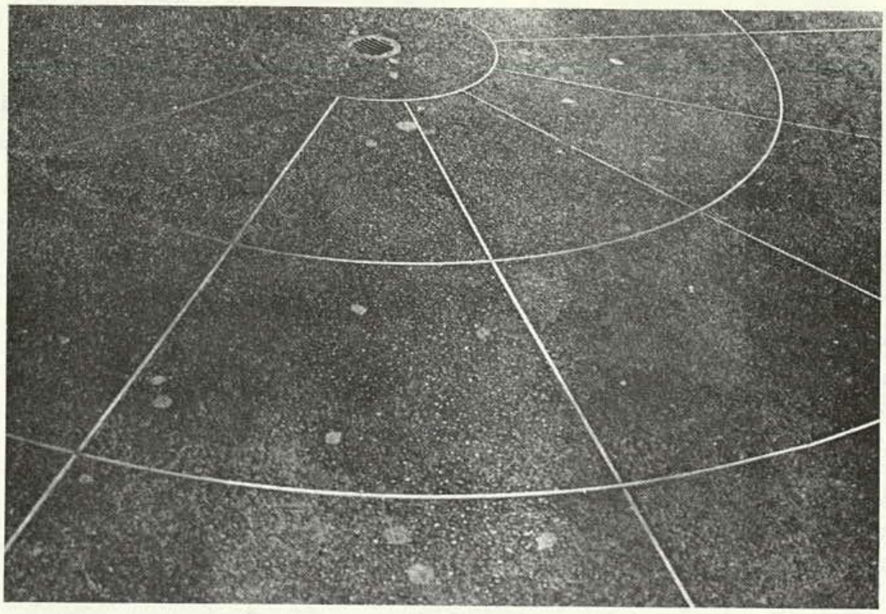


Figure B-24. Interesting pavement pattern on Fulton Street.

0.91 — 1.0 range to a fraction greater than one. Using the 25-mph speed limit (applicable to streets in New York City) in the lower left-hand nomograph of Figure A-7 (Basic Section Costs for Passenger Cars on Arterials); volume/capacity ratios of 0.60, 0.75, and 0.95 to represent the classes of congestion at intersection approaches; and the "level" line in the center nomograph of Figure A-7, extension to the "travel time" and "tangent running cost" axes gives the following.

- For 11 intersection approaches, travel costs increase 1.5 percent, from \$70 to \$71 per 1,000 veh-mi, and travel time increases 4 percent, from 50 to 52 hr per 1,000 veh-mi.
- For the three intersection approaches at which volume begins to exceed capacity, vehicle operating costs increase 5 percent, from \$72.5 to \$76 per 1,000 veh-mi, and travel time increases approximately 21 percent, from 62 to 75 hr per 1,000 veh-mi.

Multiplying the increase in travel time and operating costs by the fraction of intersections affected (using the simplifying assumption that traffic volume through the 115 intersection approaches is evenly distributed), it is determined that travel costs increase by only 0.25 percent and travel time increases 0.9 percent.

1.2.1.3 Parking Costs. At present, no parking is allowed on Fulton Street in the area that is to be closed. Some side-street parking spaces will be eliminated, but ample off-street parking is available; no major changes in parking are expected.

1.2.1.4 Vehicle Ownership. The Fulton Mall will have no effect on motor vehicle ownership in Brooklyn.

1.2.1.5 Total Motor Vehicle Travel Cost. If total motor vehicle travel time value and operating costs are assumed to be approximately equal, the average of the increases in these two components (about 0.6 percent) will equal the increase in motor vehicle travel costs. Eq. A-12 then yields

$$\text{VEHICLE TRAVEL COSTS SCORE} = \frac{1 - 1.006}{1.006} \times 10 = -0.06, \text{ rounded to } 0$$

1.2.2 Use of Automobiles

The total daily mode split in downtown Brooklyn is currently extremely high—73.6 percent according to an unpublished downtown Brooklyn transportation user survey prepared by the New York City Planning Commission. The Fulton Mall would probably not cause the mode split to increase beyond 75 percent.

USE OF AUTOMOBILES SCORE = +1

1.2.3 Signal/Signing Needs Adjacent to Facility

Signs will be needed throughout the downtown area to warn motorists of the Fulton Street closure.

SIGNAL/SIGNING NEEDS SCORE = −5

1.3 Other Community Transportation

1.3.1 Adaptability to Future Transportation Development Plans

No other new major transportation routes are planned for the area that will be affected by the Fulton Mall.

FUTURE TRANSPORTATION PLANS SCORE = 0

1.3.2 Impact on Existing Transportation Systems

The Fulton Mall will greatly improve Brooklyn's bus operations in this currently congested area (see Fig. B-25).

EXISTING TRANSPORTATION SCORE = +6

2.1 Safety

2.1.1 Societal Cost of Accidents

As a major shopping and business area, significant cross-street traffic is expected to remain. Therefore, a 50 percent reduction (for through traffic) in pedestrian/vehicle conflicts is estimated. This includes an estimate of the number of accidents likely to occur on Fulton Street between pedestrians and buses. This situation may be more hazardous than estimated because pedestrians are likely to consider (incorrectly) the Mall as a vehicle-free mall with unlimited crossing privileges.

The "before" accident involvement rate was estimated to be 0.91, and the "after" rate was estimated at 0.72, the difference being largely due to reductions in vehicle volumes and turning conflicts.

COST OF ACCIDENTS SCORE =

$$\frac{(2 \times 0.91) - (1 \times 0.72)}{2 \times 0.91} \times 10 = +6.04, \text{ rounded to } +6$$

2.1.2 Accident Threat Concern

Fear of accidents is estimated to be very low, resulting in a high score. Factors contributing to this perception are relatively low traffic volumes and speeds, a reduction in turning conflicts, signalization, and good sight distances in many cases.

ACCIDENT THREAT SCORE = +8

2.1.3 Crime Concern

Police patrol frequency and presence of others reduce concern for crime; but idlers, clutter caused by some merchants' practices, and much litter increase these fears.

CRIME CONCERN SCORE = +4

2.1.4 Emergency Access/Medical and Fire Facilities

Adequate access for emergency vehicles is planned for the Mall. However, communications and medical facilities are very limited.

EMERGENCY SCORE = +4

2.2 Attractiveness of Surroundings

2.2.1 Pedestrian-Oriented Environment

A large metal sculpture by Bolomey (Fig. B-26) now stands at Albee Square. The major department stores have already begun to renovate their exteriors.

PEDESTRIAN ENVIRONMENT SCORE = +1

2.2.2 Litter Control

Fulton Street is currently heavily littered, there are significant accumulations of gum residue present, and the trash baskets are often overflowing because they are not emptied frequently enough. Planned addition of maintenance teams will probably improve this situation somewhat.

LITTER CONTROL SCORE = −4

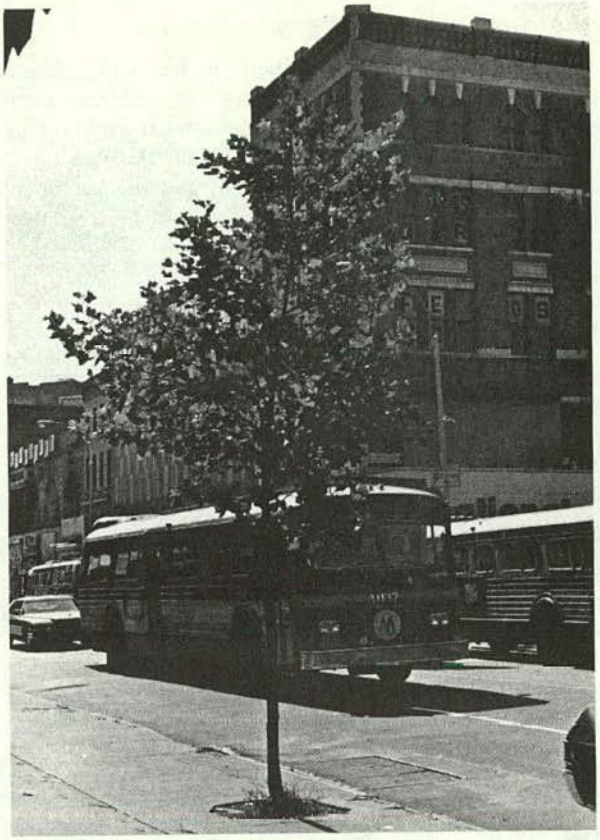


Figure B-25. Buses constitute a large percentage of traffic on Fulton Street.

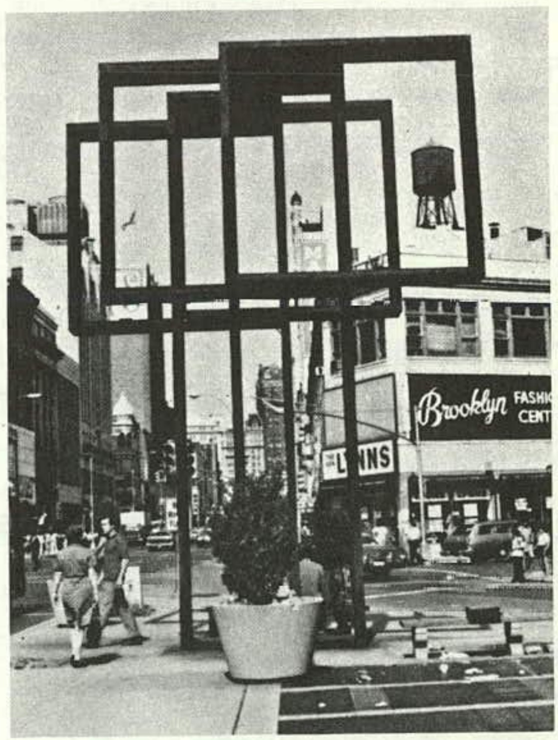


Figure B-26. Large metal sculpture in Albee Square, Fulton Street.

2.2.3 Density

On weekday afternoons there is frequently less than 15 sq ft (1.4 m²) per person, according to our own observations as well as a consultant's report (DMJM et al., undated). The Mall may double available walking space in many places. If the number of pedestrians does not increase, about 30 sq ft (2.8 m²) would be available per person.

DENSITY SCORE = +4

2.2.4 Climate Control and Weather Protection

The Mall would protect pedestrians from precipitation and puddles, but not from sun, heat, or cold.

CLIMATE AND WEATHER SCORE = −8

2.3 Environment/Health

2.3.1 Effects of Air Pollution

As discussed in Motor Vehicle Travel Costs (1.2.1), increased vehicle congestion, and thus increased air pollution, will occur at numerous intersections in the impacted area. Calculations using the vehicle data contained in Section 1.2.1 yield an emissions increase (in weighted volume) of +1.7 percent, or a corresponding point score of −3.

AIR POLLUTION SCORE = −3

2.3.2 Noise Impacts of Motor Vehicles

Average sound level readings were taken at many points throughout the proposed Mall area. Present noise levels range from 58 to 66 db(A) without significant vehicle volumes; with autos present the range was from 62 to 68 db(A). Trucks and buses peaked to 86 db(A), and subway air vents were over 90 db(A).

Without trucks and buses, the background will probably be an average of about 62 db(A). However, with bus peaks as indicated, and their frequency, a representative average of about 66 db(A) is being used.

NOISE SCORE $= -10 + [(90 - 66) \times 0.4] = -10 + 9.6 = -0.4$, rounded to 0

2.3.3 Health Effects of Walking

The weather protection afforded by the proposed canopy, relatively low crime rate, and improved appearance of stores and other features are somewhat offset by few (if any) benches and ledges to sit on.

HEALTH SCORE = +2

2.3.4 Conservation of Resources

Low use of direct energy and natural resources with moderate uses of other resources give the facility a relatively good rating.

CONSERVATION SCORE = +5

3.1 Residential Neighborhoods

3.1.1 Residential Dislocation

No known residential dislocation will take place because of the construction of the Mall.

RESIDENTIAL DISLOCATION SCORE = 0

3.1.2 Community Pride, Cohesiveness, and Social Interaction

Strong opinions have been expressed both for and against the proposed Mall. Few of the parameters within this variable are affected by a nonresidential facility location.

COMMUNITY PRIDE AND INTERACTION SCORE = +1

3.1.3 Aesthetic Impact, Compatibility with Neighborhood

Not applicable.

AESTHETICS AND COMPATIBILITY SCORE = 0

3.2 Commercial/Industrial Districts

3.2.1 Gross Retail Sales

A consultant's report prepared for the New York City Economic Development Administration (Perry Meyers, 1973) projected a maximum of two or three additional department stores in downtown Brooklyn by 1980 (independent of the Fulton Mall) with both the new and existing stores accounting for a 56 percent increase in sales over 1972. If one-third of this maximum possible expansion were due to the Mall, and the remainder attributable to other factors, the average annual increase in retail sales for the first two years' operation of the Mall would be about 2 percent.

RETAIL SALES SCORE = +2

3.2.2 Displacement or Renovation Required or Encouraged

DISPLACEMENT OR RENOVATION SCORE = −5

3.2.3 Ease of Deliveries and Employee Commuting

Pickup and deliveries on the Fulton Mall will be prohibited except for those stores which will have severe problems using side-street loading zones (see Fig. B-27). For those stores, special permits will be issued for on-street deliveries between 10:00 a.m. and 7:00 p.m.

On the side streets an additional 1,000 ft of curb space, as recommended by a consultant (Wilbur Smith and Associates, 1973), will be reserved for loading and unloading zones (see Fig. B-27). Side streets have enough capacity to handle the traffic, and work trips will be improved by adding wider sidewalks.

DELIVERIES AND COMMUTING SCORE = +5

3.2.4 Attractiveness of Area to Business

ATTRACTIVENESS TO BUSINESS SCORE = −2

4.1 Transportation and Land Use in the Planning Process

4.1.1 Public Participation in the Planning Process

The Office of Downtown Brooklyn Development is working very closely with the merchants and store owners. A Steering Committee has been formed of Fulton Street

Figure B-27. Truck loading zone off Fulton Street.

merchants, with representation from each block. The committee has direct input on the design of the Mall.
PUBLIC PARTICIPATION SCORE = +4

4.1.2 Conformance with Requirements and Regulations

The facility should comply with all existing codes and regulations. A uniform signing ordinance legislative proposal is currently being prepared.
REQUIREMENTS AND REGULATIONS SCORE = +10

4.2 Economic Impacts

4.2.1 Change in Tax Receipts and Other Government Revenues

Although the Fulton Mall is expected to increase the area's retail sales, these purchases will be diverted from other stores within New York City.
TAX RECEIPTS SCORE = 0

4.2.2 Changes in Employment

EMPLOYMENT SCORE = 6

4.2.3 Change in Cost of Providing Community Services

COMMUNITY SERVICES SCORE = 0

4.3 Community Impacts

4.3.1 Community Activities

Because no significant space in the proposed Mall is devoted to community activities, no changes are estimated.
COMMUNITY ACTIVITIES SCORE = 0

4.3.2 Adaptability to Future Urban Development Plans

The Fulton Mall is an integral portion of the planned revitalization of downtown Brooklyn. In particular, the Mall is symbolic of New York City's future commitment to the people who live and do business in this area.
FUTURE URBAN PLANS SCORE = +10

4.3.3 Construction Period

The construction period is estimated to be two periods of six months each. There will be major disruption of business and pedestrian environment, but lesser negative impacts on transit and pedestrian movement. This is because all vehicles except buses are to be relocated at the start of construction.
CONSTRUCTION SCORE = −7.

Summary

Figure B-28 summarizes the evaluation variable scores for the Fulton Mall.

Name of Project FULTON MALL

Cost initial $10 000 000 annual $ 350 000

Total Score: +271

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time	+2	2.5%	5
	1.1.2	Ease of Walking	+8	3.0	24
	1.1.3	Convenience	+9	3.5	32
	1.1.4	Special Provisions	-2	2.5	-5
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs	0	6.0	0
	1.2.2	Use of Automobiles	+1	2.5	3
	1.2.3	Signal/Signing Needs	-5	2.0	-10
1.3 Other Community Transportation	1.3.1	Future Transportation Plans	0	3.0	0
	1.3.2	Existing Transportation	+6	3.0	18
2.1 Safety	2.1.1	Cost of Accidents	+6	12.0	72
	2.1.2	Accident Threat	+8	7.0	56
	2.1.3	Crime Concern	+4	3.0	12
	2.1.4	Emergency	+4	3.5	14
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment	+1	5.0	5
	2.2.2	Litter Control	-4	1.0	-4
	2.2.3	Density	+4	1.5	6
	2.2.4	Climate Control & Weather Protection	-8	1.5	-12
2.3 Environment/ Health	2.3.1	Air Pollution	-3	3.0	-9
	2.3.2	Noise	0	1.5	0
	2.3.3	Health	+2	1.5	3
	2.3.4	Conservation	+5	1.5	8
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation	0	2.0	0
	3.1.2	Community Pride & Interaction	+1	3.5	4
	3.1.3	Aesthetics & Compatibility	0	3.0	0
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales	+2	1.5	3
	3.2.2	Displacement or Renovation	-5	1.5	-8
	3.2.3	Deliveries & Commuting	+5	2.0	10
	3.2.4	Attractiveness to Business	-2	2.5	-5
4.1 Planning Process	4.1.1	Public Participation	+4	2.5	10
	4.1.2	Requirements & Regulations	+10	2.0	20
4.2 Economic Impacts	4.2.1	Tax Receipts	0	1.5	0
	4.2.2	Employment	+6	1.0	6
	4.2.3	Community Services	0	1.5	0
4.3 Community Impacts	4.3.1	Community Activities	0	2.5	0
	4.3.2	Future Urban Plans	+10	2.0	20
	4.3.3	Construction	-7	1.0	-7

Figure B-28. Evaluation summary sheet, Fulton Mall, Brooklyn, N.Y.

APPENDIX C

QUESTIONNAIRE ON EVALUATION OF BENEFITS OF PEDESTRIAN FACILITIES

The questionnaire presented in this appendix was devised (a) to determine the practicality of a weighting system reflecting subjective community and decision-maker values and (b) to assist in development of guidelines for use as a starting point in determining representative weights for other communities.

The questionnaire consisted of (a) a cover letter containing a description of the project and a description of the objectives of the questionnaire, (b) instructions on the use of work sheets (with a completed sample) that listed each of the variables to be weighted, (c) a brief description of each of the variables, (d) a summary sheet to be returned to the researchers, and (e) a work sheet for the respondent.

A preliminary version of the questionnaire was distributed to two local agencies (the City of Menlo Park and the California Department of Transportation) for pretesting. After completed questionnaires and comments were received from these two agencies and other reviewers, the questionnaire was revised accordingly and sent to 124 individuals and agencies. A set of four questionnaires each was sent to 13 state highway or transportation agencies by NCHRP, and one questionnaire was sent by SRI to planning departments or other agencies of 93 city governments (65 of which were known to have pedestrian malls) and to 18 other individuals with whom the research team had made contacts.

The state highway and transportation departments were sent questionnaires separately from local agencies, universities, and others because they are members of AASHTO, the sponsors of the research, and because it seemed reasonable to give large state transportation agencies with numerous departments and multiple jurisdictions an opportunity to express several different viewpoints. This separate treatment for state agencies was borne out by the results—14 questionnaires were returned by 9 states (69 percent response rate), whereas only 17 responses were received from other agencies (16 percent response rate). Four questionnaires were not tabulated for various reasons. This was a reasonable response considering that a minimum of several hours was required to complete the questionnaire.

Review of responses to a preliminary version of the questionnaire and discussions with respondents led the researchers to conclude that the weights developed by respondents varied by facility objective. Two types of pedestrian facility were designated by major purpose. The safety/movement type includes those facilities where severe pedestrian/vehicle conflicts occur or where high pedestrian volumes result in congestion, and the primary intent is to provide safe unimpeded pedestrian movement. The social/commercial type includes diverse pedestrian-oriented activities where the major purpose is to provide a safe and enjoyable place for pedestrians to move leisurely and linger, or to shop. Overpasses and pedestrian transit corridors are examples of the first type; malls and small urban parks are examples of the second type.

Responders to the questionnaire were requested to identify which type of facility they were considering, or if both types were being considered together. Ten respondents chose the safety/movement type, 3 chose the social/commercial orientation, and 14 indicated that both types were considered together (combined facilities). An assessment of the responses to the questionnaire is presented in Chapter Two (Findings) of the main report. A copy of the final questionnaire follows.

COVER LETTER

In the AASHTO-sponsored National Cooperative Highway Research Program (NCHRP), Stanford Research Institute is presently conducting Project 20-10, Benefits of Separating Pedestrians and Vehicles, an 18-month study whose objective is to develop a method for evaluating the benefits of pedestrian facilities. The scope includes:

- Identifying the direct and indirect benefits of separation considering transportation, safety, social, economic, environmental, community and health factors.
- Identifying specific population segments likely to benefit from pedestrian-vehicular separation.
- Developing or adapting techniques for measurement of qualitative, quantitative, and dollar values (where possible) for use in the evaluation and design of pedestrian facilities.
- Testing the developed techniques on specific pedestrian facilities.
- Providing suitable documentation for effective use of the results of this research by pedestrian facility planners and engineers.

We have developed four major categories to be evaluated: Transportation, Safety/Environment/Health, Residential/Business, and Government/Institutional. Because the individual benefit factors being considered in this research project cover such a broad range of subject areas, we have selected a weighting system to allow adequate inclusion of the necessarily subjective values of a particular planning or decision-making group.

As a person who plans, evaluates, or designs facilities for pedestrians, we are asking you to participate in an experiment to:

- Examine the practicality of a weighting system evaluation methodology.
- Identify the range of values from a broad selection of analysts, planners, and decision-makers in varying locations.
- Prepare guidelines for other potential users of the evaluation methodology.
- Give you, the participant, an opportunity to try the method, find out how others valued the factors, and provide you with information and a technique that you may find useful in other application areas of your work.

If you are not personally part of the pedestrian facility planning and evaluation process, please pass this questionnaire on to someone who is involved in such activities.

We have identified two types of pedestrian facilities based on their major purpose. The <u>safety/movement</u> type includes those facilities where severe <u>pedestrian/vehicle</u> conflicts occur or where high pedestrian volumes result in congestion, and the primary intent is to provide safe unimpeded pedestrian movement. The <u>social/commercial</u> type includes those pedestrianization facilities where the major purpose is to provide a safe and enjoyable place for pedestrians to <u>move leisurely and stop</u>. Overpasses are examples of the first type, and malls are typical examples of the second type.

We made this differentiation because of response variations and suggestions received during the pretest period for this questionnaire. We are interested in obtaining your personal values for either or both of these types of facilities. Please indicate on the Result Sheet (Figure 3) the type considered when you complete the questionnaire.

The object of this questionnaire is to identify your perception of the desired relative importance of changes in various benefit factor groupings for your community. Please do not attempt to measure the factor values based on a specific existing or planned pedestrian facility; instead develop values indicating your own preferences.

A brief explanation and forms to use are attached. The returns will be coded but all personal identification will be removed for processing and publication of results. If you have any questions or comments that you would like to address to us, write or call Ron Braun or Marc Roddin (collect) at area code 415, 326-6200. A pre-addressed label is enclosed for your convenience in returning the questionnaire to us.

Your contribution to this project will be greatly appreciated and will be reflected in the quality and usefulness of our final product to you. Thank you.

INSTRUCTIONS

The object of this experiment is to determine your perception of the relative importance of changes in various benefit factor groupings for your community. The end result will be a set of values expressed in percentages for each of the three levels of factor categories, the sum of each level being 100% (illustrated in Figure 1, three left-hand columns). The product of the percentage values of each level assigned by the evaluators and/or decision makers (illustrated by the right-hand column in Figure 1) thereby indicates the relative importance of each individual factor in the total evaluation process. For example, the 2.4% rating for "Travel Time" was arrived at by taking the product of the percentage values of each of the related headings: 20%--Transportation (main-head), 40%--Pedestrians (sub-head), 30%--Travel Time (subset), and multiplying (.2 x .4 x .3 = .024 = 2.4%).

When these weights are multiplied by a measurement for each individual factor (e.g., privacy) on a uniform scale such as -10 to +10 for each facility proposal being considered, a consistent methodology is available to evaluate proposed facilities and alternatives for a given community.

The following procedure is suggested to assist you in developing your set of relative values:

1. Remove Figure 4 (last page) which is a work sheet similar to Figure 1 for your use in assigning a set of values as described above.
2. Refer to Figure 2 (a narrative) to familiarize yourself with the categories and descriptions of the factors as listed on the work sheet (Figure 4).
3. Rank order (1, 2, 3, etc.) each subset of categories or factors. First rank order the major categories, then the smaller categories within each major category, and finally each subset of individual factors. This may be easier than attempting to assign actual percentage values on the first attempt.
4. Repeat step 3 refining the rank ordering into percentages as illustrated in Figure 1. Zero is a legitimate percentage value to use at any level (e.g., Signal/Signing Needs Adjacent to Facility in Figure 1).
5. Review your assigned weights and revise them if desired. You may wish to multiply the three level weights together to determine and compare the resulting relative weight of each individual factor.
6. Transfer your results to Figure 3 (Result Sheet), write any comments that you feel may be useful to us on the provided page, and return the Result Sheet and Comment Page to us. You may keep the Work Sheet (Figure 4) for your records.

Figure 1

SAMPLE VALUES

Types of Facilities Being Evaluated
[X] Safety/Movement Only
[ ] Social/Commercial Only
[ ] Both Types Together

Rank Order	Percent-Ages		Levels of Evaluation Factors	Weight of Each Factor (Optional)
2 /20%			I. Transportation	
	1 /40%		Pedestrians	
		1 /30%	Travel Time	2.4 %
		4 /20%	Ease of Walking	1.6
		3 /20%	Convenience (Access and Availability)	1.6
		2 /30%	Special Provision for Various Groups	2.4
		(100%)		
	2 /40%		Motor Vehicles	
		1 /90%	Motor Vehicle Travel Costs	7.2
		2 /10%	Use of Automobiles	.8
		3 /0%	Signal/Signing Needs Adjacent to Facility	0
		(100%)		
	3 /20%		Other Community Transportation	
		1 /80%	Adaptability to Future Transportation Development Plans	3.2
		2 /20%	Impact on Use of Other Transportation Systems	.8
	(100%)	(100%)		
1 /60%			II. Safety/Environment/Health	
	1 /80%		Safety	
		1 /70%	Societal Cost of Accidents	33.6
		2 /10%	Accident Threat Concern	4.8
		3 /10%	Crime	4.8
		4 /10%	Emergency Access/Medical and Fire Facilities	4.8
		(100%)		
	3 /10%		Attractiveness of Surroundings	
		2 /30%	Pedestrian Oriented Environment	1.8
		4 /10%	Litter Control	.6
		1 /40%	Density	2.4
		3 /20%	Climate Control and Weather Protection	1.2
		(100%)		
	2 /10%		Environment/Health	
		5 /10%	Property Damage Effects of Air Pollution	.6
		1 /40%	Health, Psychological and Other Effects of Air Pollution	2.4
		3 /30%	Noise Impacts of Motor Vehicles	1.8
		2 /10%	Health Effects of Walking (exercise, fatigue, etc.)	.6
		4 /10%	Conservation of Resources	.6
	(100%)	(100%)		
3 /10%			III. Residential/Business	
	1 /50%		Residential Neighborhoods	
		2 /20%	Residential Dislocation	1.0
		3 /30%	Community Pride, Cohesiveness, and Social Interaction	1.5
		1 /50%	Aesthetic Impact, Compatibility with Neighborhood	2.5
		(100%)		
	2 /50%		Commercial/Industrial Districts	
		2 /20%	Displacement, Replacement, or Renovation	1.0
		1 /50%	Profit After Taxes	2.5
		4 /10%	Ease of Deliveries and Employee Commuting	.5
		3 /20%	Attractiveness of Area to Business	1.0
3	(100%)	(100%)		
4 /10%			IV. Government/Institutional	
	2 /20%		Planning Process	
		1 /60%	Transportation and Land Use Planning Process	1.2
		2 /40%	Conformance with Requirements and Regulations	.8
		(100%)		
	3 /10%		Indirect Impacts	
		1 /80%	Net Change in Tax Receipts and Other Revenue	.8
		2 /20%	Resulting Changes in Employment	.2
		(100%)		
	1 /70%		Community Impacts	
		1 /60%	Community Activities	4.2
		2 /20%	Change in Cost of Providing Community Services	1.4
		3 /20%	Adaptibility to Future Urban Development Plans	1.4
(100%)	(100%)	(100%)		(100%)

Figure 2

Descriptions of Factors to be Measured in Assessing the Benefits of Pedestrian and Vehicle Separation Facilities

Four major categories of factors were selected to organize the total impact of pedestrian and vehicle separation facilities in a selected evaluation area. Each category represents a convenient and logical grouping of generally related individual factors. The four major categories are:

1. Transportation--includes the transportation impacts on actual and potential users of all transportation facilities within the evaluation area.

2. Safety/Environment/Health--includes the safety and health impacts of the facilities under study on all persons within the evaluation area (both users and nonusers); the attractiveness of the facility to pedestrians; also the impacts of pollution on property and the physical environment.

3. Residential/Business--includes the impacts on personal property, personal attitudes and interpersonal relationships of residents and guests within the evaluation area; also the impacts on industrial and commercial properties, retail sales and transactions within the evaluation area as a result of the facilities under study.

4. Government/Institutional--includes the impacts of the facility under study on government and community-wide services and activities.

The list which follows describes all of the individual factors to be considered under each of the four categories outlined above. The selection of individual factors was guided by the following criteria:

1. Include all social, environmental, and economic factors that may contribute significant benefits or disbenefits as a result of the construction of a large scale facility such as a pedestrian mall, recognizing that evaluation of smaller facilities such as a pedestrian overpass may require only a small subset of these impacts.

2. Select factors that can be reasonably described and understood whether or not generally accepted measurement techniques are available to determine the degree of impact. One objective of the study is to identify and extend the state-of-the-art in measurement techniques for a broad range of potential impacts.

3. Select and define factors so that each one is independent of all other factors to the greatest extent possible. This is essential to producing a reasonably accurate and acceptable evaluation methodology. Clearly, it is not always possible to achieve complete independence of impacts, particularly when secondary effects are considered. However, we feel that the factors to be described closely meet the outlined criteria.

A special point must be made about changes in land and property values (both residential and commercial) as a result of a separation facility. A long list of factors underlie the value of property and land. They include the location of the property, supply and demand, transition trends, substitution availability, highest and best use, conformity of use, anticipation of future benefits and uses, the economic base of the area, the time of purchase, use controls and improvement factors. All of these may be boiled down to the needs and desires of the buyer and the seller operating in the real estate marketplace. The extensiveness of our evaluation factor categories is such that these values are incorporated in other factors. Thus estimating changes in property values would double count values already included.

In a perfect marketplace, property value would rise or fall to reflect the total benefits or disbenefits of community modification including separation facilities. Unfortunately, estimating the direction and magnitude of such changes requires a knowledge of each of the underlying factors contributing to property values, or an accurate comparison with similar properties in different communities--a near impossible task. By estimating the value of each underlying factor and thereby determining the net benefit or disbenefit impact of a facility, we are predicting the ideal net increase or decrease in total property value. For these reasons, land and property value changes will not be directly estimated in determining benefits of separation facilities.

The following list of definitions briefly describes each of the individual factors within the four major categories:

I. Transportation

Pedestrian Impacts

Travel Time--Changes in travel time are dependent on route length and walking rate; travel time measurements reflect effects of delays due to barriers or crowding, walking surfaces and grade changes; travel time valuation reflects trip purpose and other individual parameters. Care will be taken in evaluating travel time to exclude elements of personal comfort and convenience since they are valued separately as indicated below.

Ease of Walking--Includes walking surface; grade change; path continuity; signing (information, direction, assurance, confirmation); lighting adequacy.

Convenience--Factors related to access and availability will be addressed; time facility is open for use and access to alternative transportation modes, alternative destinations and routes, and community facilities (schools and education centers, parks and recreation facilities, historical and cultural sites, doctors' offices, clinics and hospitals, places of worship, and retail stores).

Special Provisions for Various Groups--Measurement indices will be developed or adapted to value the ability of each facility to meet the special needs of such groups as young children, mobility limited and other handicapped, bicyclists, joggers, strollers, visitors, shoppers.

Motor Vehicle Impacts

Motor Vehicle Travel Costs--Effects of facilities on vehicle operating costs (fuel, oil, tires, maintenance and repairs) for specific trips will be assessed--these effects may be either benefits due to improved flow and fewer stops, or disbenefits due to increased route lengths and increased congestion; travel time changes for vehicle occupants will also be assessed as well as changes in parking costs.

Use of Automobiles--Changes in numbers of automobile trips, or reductions in automobile ownership (unlikely except for very large pedestrian networks) will be assessed; the resulting changes in operating costs and vehicle value will be included in benefit assessments; time saved by fewer trips may be offset by greater walking times than comparable vehicle trip times depending on the time of day.

Signal/Signing Needs Adjacent to Facility--Changes in signals and signing on adjacent streets and transit routes to direct and control traffic will be assessed.

Other Community Transportation

This factor is included to assess the impact of the facility on community transportation systems other than automobiles and pedestrians. Consistency with future transit, highway, and bikeway plans and impact on use of other modes of transportation are considered.

II. Safety/Environment/Health

Safety

Societal Cost of Accidents--Reductions in accident losses will be estimated based on past accident experience at the site or other representative experience. Included are medical costs, legal and court costs, property damage (usually slight), insurance overhead, payments to survivors, loss of earnings, etc.

Accident Threat Concern--Perception of danger from pedestrian/vehicular conflicts (including bicycles) will be estimated.

Crime--Impact of proposed police patrol services must be estimated; large scale pedestrian facilities are frequently associated with shopping areas and multifamily dwellings, and service calls to these areas frequently increase by significant percentages. Increased police patrols may be required to maintain acceptable citizen protection.

Emergency Access/Medical and Fire Facilities--An assessment of the adequacy of plans and available routes for providing police, fire, and medical services in emergency situations; also availability of emergency telephones, first aid materials, fire extinguishers, etc.

Attractiveness of Surroundings

Pedestrian Oriented Environment--Positive impacts of amenities, the arts, buildings, communications, outdoor eating, exhibits, nature, physical comfort, retail outlets, and fountains will be assessed; negative visible impacts such as caged overpasses, utility wires, extensive parking areas, and vacant walls or lots will be subtracted from the positive scores.

Litter Control--The cleanliness of the facility will be evaluated on a scale that ranges from clean to heavily littered, based on comparison with photographs of street and alley litter conditions; existence of trash baskets, antilitter laws and their enforcement, and public education against littering are also assessed.

Density--The available walking area per person, which indicates both activity and walking conflicts, will be evaluated on a scale that ranges from empty, through impeded and constrained, to numerous conflicts and measurable delay.

Climate Control and Weather Protection--The adequacy of heating, air conditioning, and ventilation for indoor facilities is assessed; shielding from sun, wind, and precipitation is also evaluated.

Health/Environment

Property Damage Effects of Air Pollution--An estimate will be made of changes in property and plant life damages averted or caused by changes in air pollution resulting from the facility under study. Because the most serious air pollution impacts occur near the polluting source, seemingly small changes may have significant results; for example, if an overpass near a school eliminated a vehicle stop on a heavily traveled roadway, a significant reduction in air pollution may result at that location if the traffic volume does not increase.

Health, Psychological, and Other Effects of Pollution--Estimates of changes in concentration levels of carbon monoxide, hydro carbons, nitrogen oxides, lead and sulphur compounds will be compared with presently available health impact data and other measures to obtain estimated values for reduction or increase in air contaminants resulting from the facility under study; the impact of personal attitudes and reactions to odors, affected visibility, and perceived health effects will also be estimated; both local and community-wide impacts will be assessed.

Noise Impacts--Estimates will be made of changes in sound levels resulting from the facility; these changes will be compared with effects of sound levels on conversation and other activities.

Health Effects of Walking--The generally accepted benefits of walking will be estimated but will be offset by adverse health impacts of fatigue and over-exertion by some groups of users, such as elderly and handicapped.

Conservation of Resources--Resource utilization will be used to estimate the impact of construction, use and maintenance on available resource materials such as land, energy, materials, water, and others; this measure will reflect desire to preserve resources rather than estimating the dollar value of resources saved or consumed, such as gasoline saved by fewer auto trips which is counted in motor vehicle impacts.

III. Residential/Business

Residential Neighborhoods

Residential Dislocation--Unreimbursed relocation costs will be counted as disbenefits; in addition, loss of use, access, interpersonal associations that are not adequately reimbursed will also be estimated as disbenefits;

reclamation or improvements to previously unused areas will be considered as benefits.

Residential Land Value Changes--As explained on page 6, land value changes essentially reflect changes in desirability and acceptability on the part of the buyers and sellers; thus the combination of residential and business property values ideally represent or reflect the sum of all benefits and disbenefits of a separation facility; as noted earlier, land and property value changes will not be included in the benefit evaluation procedure to avoid double counting of benefit values.

Community Pride, Cohesiveness, and Social Interaction--
The impact of pedestrian facilities on interpersonal relationships within the community in terms of community self image and neighborhood ties; voluntary improvement to, or degradation of, personal and community property is a potential indicator of changes in community attitudes and self evaluation.

Aesthetic Impact, Compatability with Neighborhood--Criteria will be developed to assist in assessing the probable personal reaction to the design attractiveness of the facility, and the way that it fits in with the character of the neighborhood.

Commercial/Industrial Districts

Displacement, Replacement, or Renovation Required or Encouraged by Facility--Unreimbursed relocation or renovation costs must be considered; some of these costs, such as improvements to stimulate business, will be recovered later but their initial cost must still be considered a disbenefit; increased sales are separately itemized.

Profit After Taxes--Changes in net profits after taxes may result from improved customer access, improved attractiveness of individual stores or the general area, changes in tourism possibly generated by the facility, or changes in store occupancy due to improved location desirability.

Ease of Deliveries and Employee Commuting--Benefits or disbenefits of changes in access for employees, deliveries and business contacts due to facility design will be assessed.

Attractiveness of Area to Business--Estimates of the intangible benefits or disbenefits of doing business (pleasant atmosphere, favorable attitudes towards business, etc.) at or near the separation facility exclusive of values due to changes in profits will be assessed.

IV. Government and Institutional

Planning Process

Transportation and Land Use Planning Process--Public input and interaction in the transportation and land use planning process will be assessed and changes due to the facility planning process will be estimated; cooperation between public and private planners will also be assessed.

Conformance with Requirements and Regulations--An assessment will be made of the adequacy of compliance of the facility with building codes and zoning ordinances; the benefits and disbenefits of permanent changes; and permitted exceptions to regulations will also be noted or and assessed.

Indirect Impacts

Net Change in Tax Receipts and Other Revenues--When business activities such as retail sales are or will be affected by a facility under study, changes in tax revenues will be assessed (only after-tax profits were included above to avoid double counting; net property tax revenues will be assessed, as will changes in fines and administtative costs associated with pedestrian and vehicle violations.

Resulting Changes in Employment--The benefits or disbenefits of changes in employment that may result from an extensive pedestrian separation facility will be estimated; care will be taken to exclude previously valued factors of employment changes such as sales increases and changes in cost of providing community services.

Community Impacts

Changes in Community Activities--Evidence of changes in overall community values may be assessed from participation and attendance at special events, plays and concerts, exhibits and displays, voter turnout and other public activities.

Change in Cost of Providing Community Services—Changes in demand for community services may result from separation facilities if access is improved or if basic community attitudes and opinions change.

Adaptability to Future Urban Development Plans--Consistency with future urban development plans, and possible impacts on them, will be considered.

Types of Facilities Being Evaluated

- ☐ Safety/Movement Only
- ☐ Social/Commercial Only
- ☐ Both Types Together

Figure 3

RESULT SHEET

Percent-Ages | Levels of Evaluation Factors

_____ % I. Transportation

- _____ % Pedestrians
  - _____ % Travel Time
  - _____ % Ease of Walking
  - _____ % Convenience (Access and Availability)
  - _____ % Special Provision for Various Groups
  - (100%)
- _____ % Motor Vehicles
  - _____ % Motor Vehicle Travel Costs
  - _____ % Use of Automobiles
  - _____ % Signal/Signing Needs Adjacent to Facility
  - (100%)
- _____ % Other Community Transportation
  - _____ % Adaptability to Future Transportation Development Plans
  - _____ % Impact on Use of Other Transportation Systems
  - (100%)
- (100%)

_____ % II. Safety/Environment/Health

- _____ % Safety
  - _____ % Societal Cost of Accidents
  - _____ % Accident Threat Concern
  - _____ % Crime
  - _____ % Emergency Access/Medical and Fire Facilities
  - (100%)
- _____ % Attractiveness of Surroundings
  - _____ % Pedestrian Oriented Environment
  - _____ % Litter Control
  - _____ % Density
  - _____ % Climate Control and Weather Protection
  - (100%)
- _____ % Environment/Health
  - _____ % Property Damage Effects of Air Pollution
  - _____ % Health, Psychological and Other Effects of Air Pollution
  - _____ % Noise Impacts of Motor Vehicles
  - _____ % Health Effects of Walking (exercise, fatigue, etc.)
  - _____ % Conservation of Resources
  - (100%)
- (100%)

_____ % III. Residential/Business

- _____ % Residential Neighborhoods
  - _____ % Residential Dislocation
  - _____ % Community Pride, Cohesiveness, and Social Interaction
  - _____ % Aesthetic Impact, Compatibility with Neighborhood
  - (100%)
- _____ % Commercial/Industrial Districts
  - _____ % Displacement, Replacement, or Renovation
  - _____ % Profit After Taxes
  - _____ % Ease of Deliveries and Employee Commuting
  - _____ % Attractiveness of Area to Business
  - (100%)
- 3 (100%)

_____ % IV. Government/Institutional

- _____ % Planning Process
  - _____ % Transportation and Land Use Planning Process
  - _____ % Conformance with Requirements and Regulations
  - (100%)
- _____ % Indirect Impacts
  - _____ % Net Change in Tax Receipts and Other Revenue
  - _____ % Resulting Changes in Employment
  - (100%)
- _____ % Community Impacts
  - _____ % Community Activities
  - _____ % Change in Cost of Providing Community Services
  - _____ % Adaptibility to Future Urban Development Plans
  - (100%)
- (100%)

(100%)

COMMENT PAGE

Please check off the types of existing or planned pedestrian facilities within your community:

- [ ] malls
- [ ] skyways
- [ ] sidewalks
- [ ] other ________________(please specify)
- [ ] overpasses
- [ ] grade-separated networks
- [ ] signalization
- [ ] underpasses
- [ ] barriers
- [ ] crosswalks

THE REMAINDER OF THIS PAGE IS RESERVED
FOR ANY COMMENTS YOU MAY WISH
TO MAKE TO THE RESEARCHERS

Figure 4

WORK SHEET

Types of Facilities Being Evaluated
- ☐ Safety/Movement Only
- ☐ Social/Commercial Only
- ☐ Both Types Together

Rank Order	Percent-Ages	Levels of Evaluation Factors	Weight of Each Factor (Optional)

___/___% I. Transportation

    ___/___% Pedestrians

        ___/___% Travel Time ______%
        ___/___% Ease of Walking ______
        ___/___% Convenience (Access and Availability) ______
        ___/___% Special Provision for Various Groups ______
        (100%)

    ___/___% Motor Vehicles

        ___/___% Motor Vehicle Travel Costs ______
        ___/___% Use of Automobiles ______
        ___/___% Signal/Signing Needs Adjacent to Facility ______
        (100%)

    ___/___% Other Community Transportation

        ___/___% Adaptability to Future Transportation Development Plans ______
        ___/___% Impact on Use of Other Transportation Systems ______
    (100%) (100%)

___/___% II. Safety/Environment/Health

    ___/___% Safety

        ___/___% Societal Cost of Accidents ______
        ___/___% Accident Threat Concern ______
        ___/___% Crime ______
        ___/___% Emergency Access/Medical and Fire Facilities ______
        (100%)

    ___/___% Attractiveness of Surroundings

        ___/___% Pedestrian Oriented Environment ______
        ___/___% Litter Control ______
        ___/___% Density ______
        ___/___% Climate Control and Weather Protection ______
        (100%)

    ___/___% Environment/Health

        ___/___% Property Damage Effects of Air Pollution ______
        ___/___% Health, Psychological and Other Effects of Air Pollution ______
        ___/___% Noise Impacts of Motor Vehicles ______
        ___/___% Health Effects of Walking (exercise, fatigue, etc.) ______
        ___/___% Conservation of Resources ______
    (100%) (100%)

___/___% III. Residential/Business

    ___/___% Residential Neighborhoods

        ___/___% Residential Dislocation ______
        ___/___% Community Pride, Cohesiveness, and Social Interaction ______
        ___/___% Aesthetic Impact, Compatibility with Neighborhood ______
        (100%)

    ___/___% Commercial/Industrial Districts

        ___/___% Displacement, Replacement, or Renovation ______
        ___/___% Profit After Taxes ______
        ___/___% Ease of Deliveries and Employee Commuting ______
        ___/___% Attractiveness of Area to Business ______
3 (100%) (100%)

___/___% IV. Government/Institutional

    ___/___% Planning Process

        ___/___% Transportation and Land Use Planning Process ______
        ___/___% Conformance with Requirements and Regulations ______
        (100%)

    ___/___% Indirect Impacts

        ___/___% Net Change in Tax Receipts and Other Revenue ______
        ___/___% Resulting Changes in Employment ______
        (100%)

    ___/___% Community Impacts

        ___/___% Community Activities ______
        ___/___% Change in Cost of Providing Community Services ______
        ___/___% Adaptibility to Future Urban Development Plans ______

(100%) (100%) (100%) (100%)

THE TRANSPORTATION RESEARCH BOARD is an agency of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 150 committees and task forces composed of more than 1,800 administrators, engineers, social scientists, and educators who serve without compensation. The program is supported by state transportation and highway departments, the U.S. Department of Transportation, and other organizations interested in the development of transportation.

The Transportation Research Board operates within the Commission on Sociotechnical Systems of the National Research Council. The Council was organized in 1916 at the request of President Woodrow Wilson as an agency of the National Academy of Sciences to enable the broad community of scientists and engineers to associate their efforts with those of the Academy membership. Members of the Council are appointed by the president of the Academy and are drawn from academic, industrial, and governmental organizations throughout the United States.

The National Academy of Sciences was established by a congressional act of incorporation signed by President Abraham Lincoln on March 3, 1863, to further science and its use for the general welfare by bringing together the most qualified individuals to deal with scientific and technological problems of broad significance. It is a private, honorary organization of more than 1,000 scientists elected on the basis of outstanding contributions to knowledge and is supported by private and public funds. Under the terms of its congressional charter, the Academy is called upon to act as an official—yet independent—advisor to the federal government in any matter of science and technology, although it is not a government agency and its activities are not limited to those on behalf of the government.

To share in the tasks of furthering science and engineering and of advising the federal government, the National Academy of Engineering was established on December 5, 1964, under the authority of the act of incorporation of the National Academy of Sciences. Its advisory activities are closely coordinated with those of the National Academy of Sciences, but it is independent and autonomous in its organization and election of members.

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NATIONAL COOPERATIVE
HIGHWAY RESEARCH PROGRAM REPORT 240

A MANUAL TO DETERMINE BENEFITS OF SEPARATING PEDESTRIANS AND VEHICLES

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

EXHIBIT 41

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
REPORT 240

A MANUAL TO DETERMINE BENEFITS OF SEPARATING PEDESTRIANS AND VEHICLES

MARC F. RODDIN
SRI International
Menlo Park, California

RESEARCH SPONSORED BY THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS IN COOPERATION WITH THE FEDERAL HIGHWAY ADMINISTRATION

AREAS OF INTEREST:
PLANNING
SOCIOECONOMICS
TRANSPORTATION SAFETY
OPERATIONS AND TRAFFIC CONTROL
(HIGHWAY TRANSPORTATION)

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
WASHINGTON, D.C. NOVEMBER 1981

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the Academy and its Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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NOTICE

The project that is the subject of this report was a part of the National Cooperative Highway Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council, acting in behalf of the National Academy of Sciences. Such approval reflects the Governing Board's judgment that the program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

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FOREWORD

By Staff
Transportation Research Board

This manual and the slide and videotape presentations are of interest to elected officials, transportation planners, traffic engineers, businessmen, and the general public. Transportation planning practitioners and traffic engineers will find the user guide and the supporting videotape to provide step-by-step instructions for determining the impacts of proposed pedestrian facilities. Such impacts can be applied to the evaluation of different designs for a single location or the determination of the need for a facility (warrants). Elected officials, businessmen, and the general public will find the slide show useful in the development of solutions to pedestrian/traffic conflicts and other pedestrian needs.

A comprehensive method for evaluating the social, environmental, and economic benefits of proposals for facilities separating pedestrians and vehicles was developed and demonstrated during the course of NCHRP Project 20-10 and is described in *NCHRP Report 189*. This report *(NCHRP Report 240)* documents results of Project 20-10(2), which extends the usefulness of the method by simplifying it and preparing audiovisual materials to supplement the technical user guide. The report contains (1) the analyses undertaken as part of the project, (2) the findings and recommendations of the researchers, and (3) the technical user guide.

The method used in the technical user guide was simplified by reducing the number of variables from 36 to 27, without loss of precision or detail. Scoring for some of the variables was simplified also. The possibility of using the method for pedestrian traffic warrants was evaluated, and a sample warrant was developed using 10 of the 27 variables.

The technical user guide was revised and simplified. Audiovisual materials were prepared to supplement the guide. A slide show with accompanying music, narration, and sound effects was prepared for use by those interested in evaluating pedestrian facilities (such as elected officials, merchants, and the general public) but who would not be involved with details of the method. For those who would personally use the method, a videotape has been prepared that illustrates an application addressed to the problems encountered by surburban railroad commuters walking to and from the train station. Both audiovisual products are available on a loan basis by writing to the Director, Cooperative Research Programs. They may be copied by users wishing to have their own copies.

CONTENTS

ACKNOWLEDGMENTS

The research reported herein was performed under NCHRP Project 20-10 (2) by the Transportation Industries and Economics Department, SRI International, under the supervision of Joel R. Norman. Ronald L. Braun, Operations Analyst, was initially the principal investigator, responsible for Tasks 1 through 3 and a portion of Tasks 4 and 5. He left SRI because of illness, and was succeeded as principal investigator by Marc F. Roddin, Senior Transportation Analyst, who was responsible for the remaining tasks.

Suzelle D. Ruano, Research Analyst (now Senior Research Analyst at Advanced Research and Applications Corporation, Sunnyvale, Calif.), worked on major portions of the project and served as task leader fully responsible for the literature review (Task 2) and for testing the user materials (Tasks 6, 7, and 8).

The videotape presentation was prepared, directed, and edited by Peter Shultz. Fred LaVigna was responsible for the audio portion of the slide presentation, and SRI's Photography Department, under the direction of Carl Moore, assisted with production of many of the slides. Artwork, music, and announcing for both presentations were done by SRI's Graphic Arts Department under the direction of Roger Bass; Jonathan Sacks (a composer in San Diego, Calif.); and Willard Tiffany, respectively. Sincere thanks for contributions of slides are extended to the National Highway Traffic Safety Administration, Stanford University Museum of Art, San Mateo County Planning Commission, California Department of Rehabilitation, Barton-Aschman Associates, and the National Geographic Society. Other contributors to the slide presentation were Zev Pressman, Gary Snodgrass, Karen Delk, and Barbie Gray.

Pamela McAlpine, Research Assistant, contributed to the preparation of this report, especially the technical user guide.

The assistance of the cities of Mountain View, San Jose, and San Francisco, Calif.; Boston and Cambridge, Mass.; New Orleans, La.; Portland, Oreg.; Bellevue, Wash.; Toronto, Ont.; and the California Department of Transportation is gratefully acknowledged for their review of the user materials.

A MANUAL TO DETERMINE BENEFITS OF SEPARATING PEDESTRIANS AND VEHICLES

SUMMARY

A comprehensive method for evaluating the social, environmental, and economic benefits of proposals for facilities separating pedestrians and vehicles was developed and demonstrated during the course of NCHRP Project 20-10, and described in *NCHRP Report 189*. This report documents the results of Project 20-10(2), which extends the usefulness of the method by simplifying it and preparing audiovisual materials to supplement the technical user guide. The report presents the analyses undertaken as a part of the project, as well as the findings and recommendations of the researchers.

In the past, evaluation methods for pedestrian facilities, like those of other transportation projects, were based largely on a comparison of economic benefits and design, construction, and maintenance costs. Today, however, increased awareness of the automobile's responsibility for depletion of natural resources and spreading concern for health, safety, quality of life, and the environment are providing the basis for a pedestrian renaissance—a return to pedestrian scale in the planning and design of facilities for people.

Accompanying the need for "pedestrianization" is the need for an evaluation methodology that can systematically measure the many diverse impacts of planned pedestrian facilities. The objective of this research was to update and refine the previously developed techniques for quantifying all of the significant direct and indirect benefits associated with the separation of pedestrians and vehicles. The SRI project staff conducted an extensive review of transportation literature and articles selected from relevant social, environmental, health, and economic research areas. The benefits are grouped into three categories:

1. Transportation—includes the transportation impacts on actual and potential users of all transportation facilities within the evaluation area (pedestrians, motorists, transit riders, and others).
2. Safety/Environment/Health—includes the safety and health impacts caused by the construction and use of the facilities under study on all persons within the evaluation area (both users and nonusers), as well as the impact on the physical environment.
3. Residential/Business—includes the impacts on interpersonal relationships, property, and attitudes of those persons within the evaluation area, also the impacts on industrial and commercial properties, and transactions within the evaluation area, as a result of the facilities under study.

Within each category are groups such as pedestrians, motor vehicles, and other community transportation. The next level items, called "variables," are the major focus of benefit measurements. For example, the variables for the pedestrians group are travel time, ease of walking, convenience, and special provisions. The number of variables has been reduced from 36 in the original report to 27, without any loss of precision or detail, by increasing the scope of some variables and by dropping unnecessary items. The measurement techniques are presented in the user guide (which appears in the main text of this report) and a sample application is shown in the videotaped demonstration prepared during this project.

Warrant Feasibility

During this project, the feasibility of applying the evaluation method for use in pedestrian traffic warrants was evaluated. The purpose is to quantify pedestrian conditions to the extent that requirements for specific separate pedestrian facilities can be established. Seven existing pedestrian warrant systems were studied and classified. It was found that a subset of the evaluation method, using only 10 variables, can be used for warrant purposes. Scores for these variables are computed, multiplied by an appropriate set of weights, and combined to obtain a score ranging between −1000 and +1000. For scores of +300 or lower, pedestrian separation from vehicles may be warranted, depending on pedestrian traffic volume. For weighted scores of −500 or less, only five pedestrians per hour are necessary to warrant separation. Potential users should note with caution that this proposed warrant (presented in the research report included in App. A) has not been field tested, having been produced by literature research and contemplation only. Field testing will be necessary to determine whether the warrants have been set at the appropriate level.

User Materials

Three different presentations of the method have been prepared by the researchers. The most comprehensive of these is the technical user guide (details of the research effort through which this user guide was developed are contained in App. A). For those potential users of the method who desire to be "walked through" an example using the method prior to conducting one's own evaluation, a videotape is available which illustrates a problem pedestrian location in a suburb, some potential solutions, and a portion of the evaluation of one solution. Some field work is shown, as well as results of evaluating the different alternatives.

The other presentation is a slide show designed for nontechnical audiences, such as elected officials, merchants, real estate developers, and the public. An accompanying tape cassette narration describes the need for consideration of the pedestrian, benefits of pedestrian facilities, how planners can evaluate a particular alternative, cost and results of using the method. The script for this presentation is included in Appendix B. Viewers of the slide show who do not have automatic synchronization equipment can use an ordinary cassette player, and advance the slides according to this script.

Testing the User Materials

The user materials were tested twice. In the first round of testing, a member of the research team personally presented either the videotape or slide show, depending on the audience. Then a group discussion was held for 20 or 30 min to answer questions raised by the viewers and the researcher. The researcher took brief notes during the discussion and subsequently prepared a meeting summary, which was used to evaluate the need for changes to the audiovisual materials. Six cities participated in this phase of the testing. Most of them informally expressed very pragmatic views on the role of politics in decision-making, even after very careful, objective staff review. Following this round of testing, the project team realized that extreme care should be exercised when comparing different pedestrian projects within the same city because of the political decision process. Thus, it was decided to completely redo the videotape and to make modest changes in the slide show.

The second round of testing was conducted by telephone and mail. Letters were sent to the mayors of 34 cities and to the California Department of Transportation (CALTRANS). Responses were received from 16 cities, but only three of them completed the whole program. Some of the other 13 cities reviewed the user guide but not the audiovisual materials. Test results are described in Appendix C. The results of this task, with comments received from panel members, were used to make substantial modifications to both presentations.

Conclusion

The evaluation procedure and the extensive range of measured parameters provide a broad perspective on the design of pedestrian facilities. It makes possible and encourages the use of many benefit measures usually excluded from conventional economic analysis. By reflecting social needs and values that are not easily quantified, use of the method may provide adequate justification for projects previously not defendable using only economic analysis. Thus, the direction of the method is to increase the number of impacts considered by the decision-maker, while making the decision task easier by use of explicit rather than implied evaluation factors. Several of the cities contacted during the study will likely use the method for their next evaluation, or at least incorporate some of its major ideas.

CHAPTER ONE

INTRODUCTION AND INSTRUCTIONS TO USERS

INTRODUCTION

In recent decades, the pedestrian has not been given adequate consideration in urban transportation. But increasing social concern for the environment, safety, energy, community cohesion, and health have contributed to a growing awareness of the pedestrian. In determining use of space, an inherent conflict exists between vehicles and pedestrians. This user guide is a result of research directed to the need of identifying and measuring the benefits of separating pedestrians and vehicular traffic.

After evaluating the state of the art, SRI International (formerly Stanford Research Institute) identified benefits of separating pedestrians and vehicles as well as the affected population groups. Hundreds of individual parameters were examined as candidates for describing benefits. At the same time, an intensive effort was begun to develop measurement techniques to quantify benefits. A goal in the development of the measurement techniques was to go one level deeper in precision than had been previously attempted by others. The results from these tasks were then incorporated into a comprehensive evaluation method that can be used to assess individual and alternative proposals for pedestrian separation facilities.

The evaluation method selected and described herein is a scoring method, in which all relevant attributes of a pedestrian facility are assigned scores over a designated range through specified objective measurement techniques. The scores are then weighted and summed to a total.

Benefits and disbenefits are quantified by a set of measurement techniques developed for the 27 variables listed in Table 1. The overall evaluation method combines analytic measurements of the 27 variables and explicitly stated community values (weights) expressed by decision-makers or their staff on the relative importance of each variable.

Because many of the variables are difficult to quantify or are subjective in nature (e.g., comfort, attractiveness, noise), the calculation of benefits is performed using a scale of positive and negative values (+10 to −10) for each variable. Positive values correspond to desirable characteristics; negative values indicate undesirable characteristics. Zero values indicate "average," "does not apply," or "indifference" (neither good nor bad).

This scoring system allows comparison of alternatives without the need for assigning dollar values to the many noneconomic impacts of pedestrian facilities (and many other public projects). Guidance is provided in Chapter Three for obtaining benefit values in dollars, if required, to allow comparison of pedestrian facilities with other budget expenditures.

The primary use of the developed method is for evaluation and comparison of proposals for pedestrian facilities. This application is described in detail in the following chapter. Another use of the scoring system is to evaluate existing pedestrian problem locations on a comparative basis, which could be used to indicate the priorities for more detailed study. The scoring system may also be used as a design evaluation tool to encourage alterations that will increase the benefits obtained from pedestrian facilities.

The evaluation method described in this user guide requires between 1 and 10 person-days of effort for evaluation of a reasonable number of alternatives at a single location, depending on the number and complexity of the alternatives.

Table 1. Pedestrian facility evaluation variables.

Pedestrian Transportation	1. Travel Time 2. Ease of Walking 3. Convenience 4. Special Provisions for Various Groups
Other Transportation	5. Motor Vehicle Travel Costs 6. Use of Automobiles 7. Impact on Existing Transportation Systems 8. Adaptability to Future Transportation Development Plans
Safety	9. Societal Cost of Accidents 10. Accident Threat Concern 11. Crime 12. Emergency Access/Medical & Fire Protection
Environment/ Health	13. Pedestrian Oriented Environment 14. Effects of Air Pollution 15. Noise Impacts 16. Health Effects of Walking
Residential/ Community	17. Residential Dislocation 18. Community Pride and Cohesion 19. Community Activities 20. Aesthetic Impact, Compatability with Neighborhood
Commercial/ Industrial Districts	21. Gross Retail Sales 22. Displacement, Replacement, or Renovation Required or Encouraged by Facility 23. Ease of Deliveries & Employee Commuting 24. Attractiveness of Area to Business
Urban Planning	25. Adaptability to Future Urban Development Plans 26. Net Change on Tax Receipts and Other Revenue 27. Public Participation in the Planning Process

Medium-to-large-size cities can use the method with their existing staff and resources.

Explicit weighting of the relative importance of each variable requires a formalization of preference values for the community. This determination may be made by the decision-maker alone, or may be the result of extensive public participation. Once developed, the explicit use of such weights provides consistent evaluation criteria. These preference weights may be applicable to other public projects as well.

Possibly the greatest advantage of the evaluation method is that it allows and encourages use of many benefit measures usually excluded from conventional economic analysis. By reflecting community needs and values that are not easily quantified, use of the method may provide adequate justification for projects not defendable previously by economic analysis alone.

A detailed description of the research approach SRI used to develop the evaluation method can be found in *NCHRP Report 189*, "Quantifying the Benefits of Separating Pedestrians and Vehicles" (*4*).

The researchers have also prepared audiovisual materials available from the National Cooperative Highway Research Program, which supplement this guide if required. A slide show describes pedestrian facilities and an introduction to the evaluation method for those interested in the method, but who will not apply the method personally, such as elected officials, merchants, and the general public. A videotape designed for planners and engineers illustrates an application of the method.

INSTRUCTIONS TO USERS

Transportation projects, including pedestrian facilities, should be evaluated early in the planning and design process so that shortcomings can be detected and steps taken to remedy them. The evaluation may then be repeated as often as new plans are proposed or major changes are made to existing plans. It may also be used as an aid to the design process by purposely designing facilities that will score high values.

The evaluation process should consider all anticipated benefits and negative impacts of each proposed transportation option. Whenever possible, the benefits and impacts should be expressed in dollar terms so that they can be readily compared with construction and operating costs to determine which project represents the best potential payoff on the investment of public funds. Traditionally, it has been more difficult to express all of the benefits of pedestrian projects in dollar terms than it has been for automobile or transit projects, and, for this reason, some traditional transportation decision-making processes are biased against pedestrian projects. This manual provides a means of overcoming these difficulties and of measuring the benefits of pedestrian facilities which defy monetary measurement.

Figure 1 is a flow chart of the steps to be performed for a pedestrian facility evaluation. The diamonds are decision points that allow the option of taking shortcuts within the overall procedure if time or resources are limited. Chapters One and Two should be reviewed in total before applying the evaluation process to a pedestrian facility.

Step 1—Describe Alternatives

The first step of the process is to describe all of the alternative facilities being considered as potential solutions to an existing pedestrian problem. The "no-build" or "do-nothing" option should always be considered as an alternative so that the amount of improvement achieved by the project can be measured. If the study is concerned with only one or a few problem locations or proposed projects, several alternatives representing a range of solutions should be considered and fully described. Location of the proposed facility, its proposed configuration, projected use levels, user profiles, operation and any modifications to existing laws or regulations should be specified.

Step 2—Estimate Costs

An integral component of identifying project alternatives is to estimate costs for the different pedestrian facilities being considered. Table 2 gives all of the major cost categories for implementation and operation of pedestrian-oriented facilities. The best estimates possible should be made for the costs associated with each category for the facilities being evaluated. Because the primary purpose in most cases is to compare alternatives, accuracy of the total cost estimate is not as important as the differences in costs for the various alternatives. This should give encouragement to the planner who is uncertain about the magnitudes of individual cost components. The same observation holds for the benefits determination process: differences between alternatives are more important than the actual score for a particular proposal. However, if a more detailed cost estimation procedure is

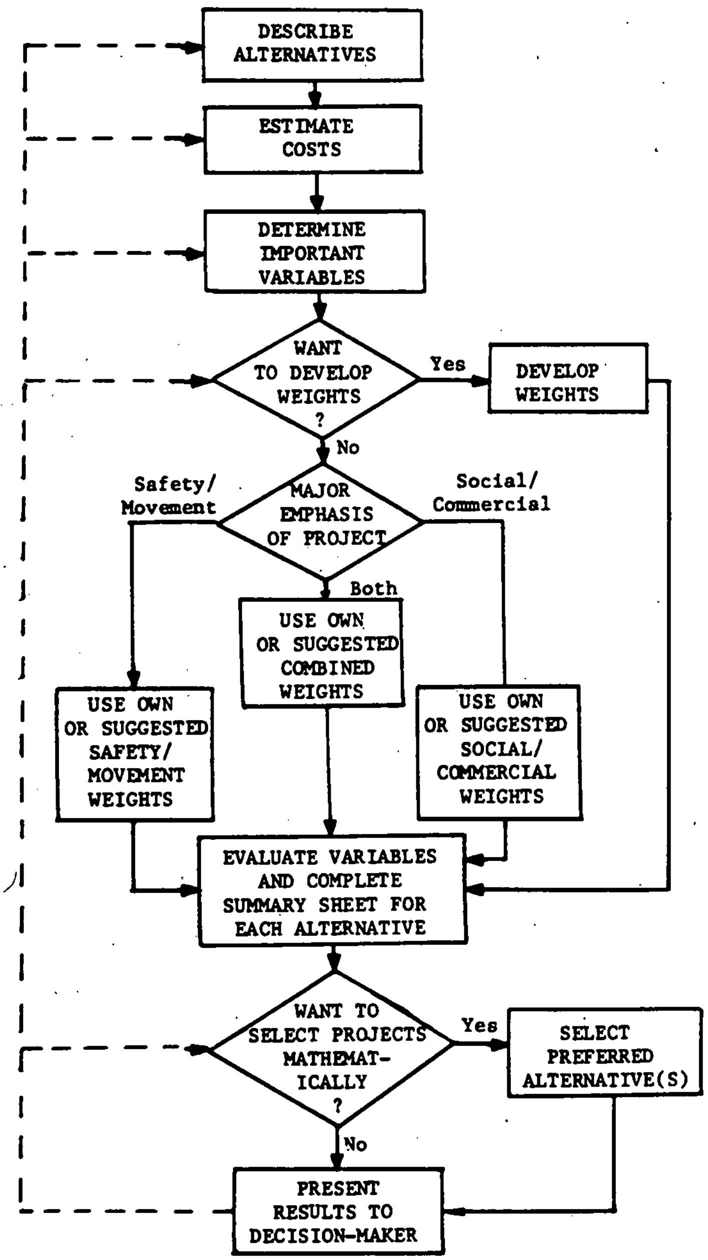


Figure 1. Pedestrian facility evaluation method.

desired at this stage in the evaluation process, the reader is directed to Chapter Five, "Facility Costs," of *A Manual for Planning Pedestrian Facilities* (*16*), a costing approach that is tailored for each type of facility.

Step 3—Project Summary Sheet

A project summary sheet (Fig. 2) should be prepared for each alternative under consideration. Before beginning the process, it is important to look through the variables and cross out those not desired for this particular analysis. (This is equivalent to assignment of zero benefit or zero weight to the variables that are eliminated.) Users are encouraged to eliminate at this point all of the variables that do not apply

Table 2. Major cost components of pedestrian facilities.

1. Design and architect costs
2. Financing costs and legal fees
3. Site preparation
   - Real estate acquisition
   - Demolition
   - Drainage
   - Grading
   - Utilities relocation
   - Foundation
   - Required permits
4. Construction
   - Height, width, and length of facility
   - Length of span (if any)
   - Method of support
   - Enclosures (if any)
   - Materials
   - Walkway paving, curbs
5. Finishing touches
   - Lighting
   - Street furniture
   - Amenities
   - Landscaping
6. Operation and maintenance
   - Cleaning
   - Gardening
   - Maintenance and repairs
   - Lighting
   - Security
   - Taxes
   - Insurance

because this will simplify the evaluation and decision-making procedures.

The variable score (column 1) is derived from the measurement techniques outlined in Chapter Two. Instructions for completing the remaining two columns are discussed in the remainder of this chapter.

Step 4—Assign Weights

The purpose of this step is to develop weights that reflect the relative priorities of the different impacts on the pedestrian facility. These may be determined directly by the decison-maker or evaluator based on concerns related to the facility; or may be selected from the suggested weights developed during this project on the basis of observations, discussions, and the researchers' judgment. These suggested priorities assign a positive weight to every variable, so if some of the variables were eliminated from the analysis in the previous step and the suggested weights are used without modification, it will not be possible for a facility to achieve a perfect score. This can be remedied by reallocating to other variables the weights of variables that have been eliminated, such that the weights for all variables still total 100 percent.

For a discussion of subjective probabilities applied to this

Name of Project ________________

Cost: initial $________ annual $________ | Total Score [ ]

		Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1 Travel Time	____	____	____
	1.1.2 Ease of Walking	____	____	____
	1.1.3 Convenience (Access & Availability)	____	____	____
	1.1.4 Special Provisions for Various Groups	____	____	____
1.2 Other Transportation	1.2.1 Motor Vehicle Travel Costs	____	____	____
	1.2.2 Use of Automobiles	____	____	____
	1.2.3 Impact of Existing Transportation Systems	____	____	____
	1.2.4 Adaptability to Future Transportation Development Plans	____	____	____
2.1 Safety	2.1.1 Societal cost of Accidents	____	____	____
	2.1.2 Accident Threat Concern	____	____	____
	2.1.3 Crime Concern	____	____	____
	2.1.4 Emergency Access/Medical & Fire Facilities	____	____	____
2.2 Environment/ Health	2.2.1 Pedestrian-Oriented Environment	____	____	____
	2.2.2 Effects of Air Pollution	____	____	____
	2.2.3 Noise Impacts of Motor Vehicles	____	____	____
	2.2.4 Health Effects of Walking (Exercise, Fatigue, etc.)	____	____	____
3.1 Residential/ Community	3.1.1 Residential Dislocation	____	____	____
	3.1.2 Community Pride and Cohesion	____	____	____
	3.1.3 Community Activities	____	____	____
	3.1.4 Aesthetic Impact and Compatibility with Neighborhood	____	____	____
3.2 Commercial/ Industrial Districts	3.2.1 Gross Retail Sales	____	____	____
	3.2.2 Displacement or Renovation Required or Encouraged by Facility	____	____	____
	3.2.3 Ease of Deliveries and Employee Commuting	____	____	____
	3.2.4 Attractiveness of Area to Business	____	____	____
3.3 Urban Planning	3.3.1 Adaptability to Future Urban Development Plans	____	____	____
	3.3.2 Net Change in Tax Receipts and Other Revenues	____	____	____
	3.3.3 Public Participation in Planning Process	____	____	____

Figure 2. Project summary sheet.

type of weighting system, the reader is directed to Hertz (*12*). Everett (*9*) adopts that approach to bicycle facilities, a labor intensive mode similar to walking.

Direct Determination

The purpose of developing a set of weights is to incorporate the decision-maker's perception of the relative importance of changes in degree of impact of the variables used in the evaluation. The procedure is to assign a separate set of values expressed in percentages for each of the three levels of impacts (categories, groups, and variables), the sum of each level being 100 percent. When the percentage values assigned to the three levels for a particular variable are multiplied together, the resulting product indicates the relative importance of that factor in the total evaluation process. For example, if values of 20 percent, 40 percent, and 30 percent are assigned to the headings transportation (category), pedestrians (group), and travel time (variable), respectively, by multiplying ($0.2 \times 0.4 \times 0.3 = 0.024$), a value of 2.4 percent is obtained as the relative weight of the variable "travel time" (1.1.1).

The following procedure is suggested to assist the reader in developing a set of relative values:

1. Refer to Figure 3, which is a worksheet for use in assigning a set of values as previously described.

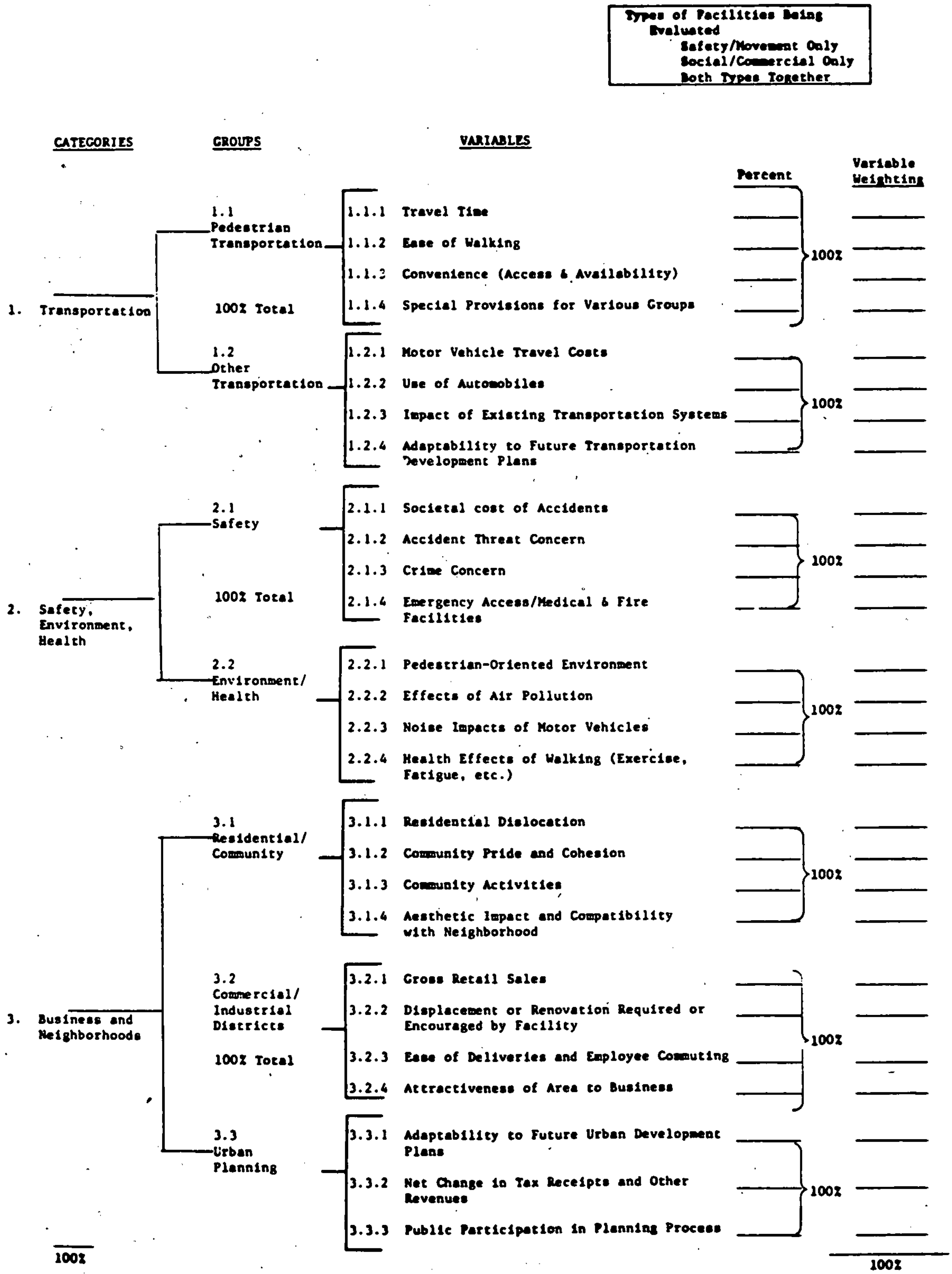


Figure 3. Variable weighting worksheet.

2. Review Chapter Two to become familiar with the categories and descriptions of the variables as listed on the worksheet.

3. Rank order (1, 2, 3, etc.) each of the three levels of impacts. First rank order the major categories, then the groups within each major category, and finally each subset of the individual variables. This may be easier than attempting to assign actual values on the first attempt.

4. Repeat step 3, refining the rank ordering into percentages. This is shown in Figure 4, a sample completed worksheet. Zero is a legitimate percentage value to use at any level. Zeroes should be assigned to the variables that are to be eliminated from the evaluation.

Types of Facilities Being Evaluated
- Safety/Movement Only
- Social/Commercial Only
- Both Types Together

CATEGORIES	GROUPS	VARIABLES	Percent		Variable Weighting
1. Transportation 2 30%	1.1 1 50% Pedestrian Transportation	1.1.1 Travel Time 1	30	100%	4.5%
		1.1.2 Ease of Walking 4	20		3.0
		1.1.3 Convenience (Access & Availability) 3	20		3.0
	100% Total	1.1.4 Special Provisions for Various Groups 2	30		4.5
	1.2 2 50% Other Transportation	1.2.1 Motor Vehicle Travel Costs 1	50	100%	7.5
		1.2.2 Use of Automobiles 3	5		0.8
		1.2.3 Impact of Existing Transportation Systems 4	5		0.8
		1.2.4 Adaptability to Future Transportation Development Plans 2	40		6.0
2. Safety, Environment, Health 1 60%	2.1 1 80% Safety	2.1.1 Societal cost of Accidents 1	70	100%	33.6
		2.1.2 Accident Threat Concern 2	10		4.8
		2.1.3 Crime Concern 3	10		4.8
	100% Total	2.1.4 Emergency Access/Medical & Fire Facilities 4	10		4.8
	2.2 2 20% Environment/Health	2.2.1 Pedestrian-Oriented Environment 1	40	100%	4.8
		2.2.2 Effects of Air Pollution 2	35		4.2
		2.2.3 Noise Impacts of Motor Vehicles 4	10		1.2
		2.2.4 Health Effects of Walking (Exercise, Fatigue, etc.) 3	15		1.8
3. Business and Neighborhoods 3 10%	3.1 2 40% Residential/Community	3.1.1 Residential Dislocation 3	10	100%	0.4
		3.1.2 Community Pride and Cohesion 4	0		0
		3.1.3 Community Activities 2	40		1.6
		3.1.4 Aesthetic Impact and Compatibility with Neighborhood 1	50		2.0
	3.2 1 40% Commercial/Industrial Districts	3.2.1 Gross Retail Sales 1	50	100%	2.0
		3.2.2 Displacement or Renovation Required or Encouraged by Facility 2	20		0.8
	100% Total	3.2.3 Ease of Deliveries and Employee Commuting 4	10		0.4
		3.2.4 Attractiveness of Area to Business 3	20		0.8
	3.3 3 20% Urban Planning	3.3.1 Adaptability to Future Urban Development Plans 3	10	100%	0.2
		3.3.2 Net Change in Tax Receipts and Other Revenues 2	40		0.8
		3.3.3 Public Participation in Planning Process 1	50		1.0
100%					100%

Figure 4. Sample completed worksheet.

5. Review the assigned weights and revise them if desired. Check arithmetic to see that each sum adds to 100 percent.

6. Multiply the three level weights together to determine and compare the resulting relative weight of each individual factor. Round the percentages to the nearest tenth (e.g., 25% × 35% × 30% = 0.2625 is rounded to 2.6%).

7. It is possible to allow different constituencies to express their individual preferences. Have a representative of each group indicate its preferences on a copy of Figure 3.

8. Transfer the results from the last column of the weight assignment worksheet (Fig. 3) to the second column of the project summary sheet (Fig. 2).

Use of Suggested Weights for Different Facility Types

Two types of pedestrian facilities have been identified based on their major purpose. The safety/movement type includes those facilities where pedestrian/vehicle conflicts cause a problem or where high pedestrian volumes result in congestion. For the social/commercial types, the primary intent is to prove a safe and enjoyable place for pedestrians to move leisurely and stop. Overpasses are examples of the first type; malls are examples of the second type.

Suggested weights for safety or movement facilities are shown in Figure 5. Figure 6 shows the recommended weights for social and commercial facilities. If the evaluation com-

Name of Project ______________

Cost: initial $________ annual $________ Total Score [ ]

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time	____	3%	____
	1.1.2	Ease of Walking	____	3.5	____
	1.1.3	Convenience (Access & Availability)	____	3.5	____
	1.1.4	Special Provisions for Various Groups	____	3.0	____
1.2 Other Transportation	1.2.1	Motor Vehicle Travel Costs	____	6.0	____
	1.2.2	Use of Automobiles	____	3.0	____
	1.2.3	Impact of Existing Transportation Systems	____	3.5	____
	1.2.4	Adaptability to Future Transportation Development Plans	____	3.5	____
2.1 Safety	2.1.1	Societal cost of Accidents	____	13.0	____
	2.1.2	Accident Threat Concern	____	8.0	____
	2.1.3	Crime Concern	____	3.5	____
	2.1.4	Emergency Access/Medical & Fire Facilities	____	3.5	____
2.2 Environment/Health	2.2.1	Pedestrian-Oriented Environment	____	9.0	____
	2.2.2	Effects of Air Pollution	____	3.5	____
	2.2.3	Noise Impacts of Motor Vehicles	____	2.0	____
	2.2.4	Health Effects of Walking (Exercise, Fatigue, etc.)	____	1.5	____
3.1 Residential/Community	3.1.1	Residential Dislocation	____	2.5	____
	3.1.2	Community Pride and Cohesion	____	3.5	____
	3.1.3	Community Activities	____	3.0	____
	3.1.4	Aesthetic Impact and Compatibility with Neighborhood	____	3.0	____
3.2 Commercial/Industrial Districts	3.2.1	Gross Retail Sales	____	1.5	____
	3.2.2	Displacement or Renovation Required or Encouraged by Facility	____	1.5	____
	3.2.3	Ease of Deliveries and Employee Commuting	____	2.5	____
	3.2.4	Attractiveness of Area to Business	____	2.5	____
3.3 Urban Planning	3.3.1	Adaptability to Future Urban Development Plans	____	2.5	____
	3.3.2	Net Change in Tax Receipts and Other Revenues	____	1.5	____
	3.3.3	Public Participation in Planning Process	____	3.0	____

Figure 5. Suggested safety/movement or combined weights.

Name of Project ____________

Cost: initial $________ [ ] Total Score
annual $________

		Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1 Travel Time		1.5%	
	1.1.2 Ease of Walking		3.0	
	1.1.3 Convenience (Access & Availability)		4.0	
	1.1.4 Special Provisions for Various Groups		3.5	
1.2 Other Transportation	1.2.1 Motor Vehicle Travel Costs		0.5	
	1.2.2 Use of Automobiles		1.0	
	1.2.3 Impact of Existing Transportation Systems		3.0	
	1.2.4 Adaptability to Future Transportation Development Plans		1.5	
2.1 Safety	2.1.1 Societal cost of Accidents		3.0	
	2.1.2 Accident Threat Concern		2.0	
	2.1.3 Crime Concern		3.0	
	2.1.4 Emergency Access/Medical & Fire Facilities		3.0	
2.2 Environment/ Health	2.2.1 Pedestrian-Oriented Environment		17.0	
	2.2.2 Effects of Air Pollution		4.0	
	2.2.3 Noise Impacts of Motor Vehicles		2.5	
	2.2.4 Health Effects of Walking (Exercise, Fatigue, etc.)		3.0	
3.1 Residential/ Community	3.1.1 Residential Dislocation		2.0	
	3.1.2 Community Pride and Cohesion		6.0	
	3.1.3 Community Activities		6.0	
	3.1.4 Aesthetic Impact and Compatibility with Neighborhood		4.5	
3.2 Commercial/ Industrial Districts	3.2.1 Gross Retail Sales		3.5	
	3.2.2 Displacement or Renovation Required or Encouraged by Facility		3.0	
	3.2.3 Ease of Deliveries and Employee Commuting		3.0	
	3.2.4 Attractiveness of Area to Business		5.5	
3.3 Urban Planning	3.3.1 Adaptability to Future Urban Development Plans		3.5	
	3.3.2 Net Change in Tax Receipts and Other Revenues		4.0	
	3.3.3 Public Participation in Planning Process		3.5	

Figure 6. Suggested social/commercial weights.

bines both project types, the weights given in Figure 5 are used. Transfer the weights from the final column of the appropriate figure to the second column of the project summary worksheet (Fig. 2).

Step 5—Assess Benefits

An important step of the evaluation method is to assess the benefits of the proposed facility. Because this is the focal point of the evaluation, it will require the greatest effort on the part of the user.

Detailed instructions for measuring impacts of the variables are given to Chapter Two. This chapter is designed to be completely self-contained, so application is a matter of following the step-by-step instructions given there. Each variable is scored on a uniform +10 to −10 scale. If for any reason it appears that a variable would not apply to a particular facility being evaluated, score zero for that variable.

Step 6—Summary

At this point in the evaluation, the project summary sheet, Figure 2, should have the first two columns (variable score and variable weighting) completed. The sheet should also indicate the name of the project and the initial construction and annual operating costs for each alternative considered. The third column (weighted score) is completed by multiplying the objective measurement score for each variable (first column) by the weight (second column). The total weighted score of the benefits for a pedestrian facility is simply the sum of all the individual weight scores. Use of percent values as indicated will result in a "total score" for the facility between +1,000 and −1,000, which is more suitable for comparing projects than the +10 and −10 scale that is used for measuring variables.

This completes the project evaluation. A completed project summary sheet for each proposed alternative summarizes all of the important information about the impacts of the project. Priorities for a small set of alternatives or a single go/no-go decision may be made directly. If a large number of alternatives is being investigated or a budget allocation programming is being performed, the reader may wish to follow the discussion of "Decision Rules for Project Selection" in Chapter Three.

Figure 7 is a sample project summary sheet for the Sparks Street Mall, located in Ottawa, Ontario.

CHAPTER TWO

MEASUREMENT TECHNIQUES FOR EVALUATING PEDESTRIAN FACILITY VARIABLES

GENERAL

This chapter presents measurement techniques for 27 pedestrian facility evaluation variables. Table 3 gives the classification of these variables in three major categories: (1) Transportation, (2) Safety/Environment/Health, and (3) Residential/Business.

The categories are subdivided into groups of impact areas, such as Pedestrian Transportation (1.1) and Other Transportation (1.2). The groups consist of individual variables that are the major focus of benefit measurements. For example, the variables for the group "Pedestrian Transportation" are: travel time (1.1.1), ease of walking (1.1.2), convenience (1.1.3), and special provisions for various groups (1.1.4).

Many of the variables are composed of parameters called components, which are sometimes broken down even further into characteristics. For example, the variable travel time (1.1.1) is measured with the use of five component scores:

1.1.1.1 Number of pedestrians and route length
1.1.1.2 Walking speed
1.1.1.3 Signal delay
1.1.1.4 Total travel time
1.1.1.5 Unit pedestrian travel time savings.

A scoring procedure has been developed for each of the 27 variables listed. Benefit values are determined using a scale of positive and negative (+10 to −10) for each variable. Positive values correspond to desirable characteristics, and negative values indicate undesirable characteristics. Zero values indicate either "does not apply" or "indifference" (neither good nor bad). Large negative values usually indicate a serious deficiency in the design of a proposed facility which may cause its rejection or suggest possible modifications to improve it.

Great care was taken in selection and definition of the evaluation variables and in development of specific measurement techniques for each. Critical review meetings were held with a group of SRI specialists to ensure inclusion and logical arrangement of all significant impacts of pedestrian facilities, and to ensure that no items were included more than once (double counted) in the measurement process. Multiple use of components and characteristics (such as lighting) is limited in each appearance to a specific role, such as crime prevention.

Users of this research are encouraged to make changes to specific measurement techniques whenever such changes seem appropriate. When particular groups of evaluators or decision-makers feel that somewhat different values are more appropriate, they should be used. A primary objective to the development of these measurement techniques has been to develop a flexible, quantitative framework for examining and evaluating the many potential impacts of pedestrian facilities. Thus, the basic techniques can be used even if specific values for individual variables or components change over time.

1. TRANSPORTATION

Economic costs have traditionally dominated the planning, evaluation, and selection of transportation projects, not

Name of Project Sparks St. Mall

Cost: initial $1,500,000 | +427 Total Score

annual $ 37,500

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time	+1	1.5%	2
	1.1.2	Ease of Walking	+7	3.0	21
	1.1.3	Convenience (Access & Availability)	+4	4.0	16
	1.1.4	Special Provisions for Various Groups	0	3.5	0
1.2 Other Transportation	1.2.1	Motor Vehicle Travel Costs	+1	0.5	1
	1.2.2	Use of Automobiles	+1	1.0	1
	1.2.3	Impact of Existing Transportation Systems	0	3.0	0
	1.2.4	Adaptability to Future Transportation Development Plans	+5	1.5	8
2.1 Safety	2.1.1	Societal cost of Accidents	+6	3.0	18
	2.1.2	Accident Threat Concern	+8	2.0	16
	2.1.3	Crime Concern	+8	3.0	24
	2.1.4	Emergency Access/Medical & Fire Facilities	+6	3.0	18
2.2 Environment/ Health	2.2.1	Pedestrian-Oriented Environment	+5	17.0	85
	2.2.2	Effects of Air Pollution	+5	4.0	20
	2.2.3	Noise Impacts of Motor Vehicles	+4	2.5	10
	2.2.4	Health Effects of Walking (Exercise, Fatigue, etc.)	+4	3.0	12
3.1 Residential/ Community	3.1.1	Residential Dislocation	0	2.0	0
	3.1.2	Community Pride and Cohesion	+4	6.0	24
	3.1.3	Community Activities	+10	6.0	60
	3.1.4	Aesthetic Impact and Compatibility with Neighborhood	0	4.5	0
3.2 Commercial/ Industrial Districts	3.2.1	Gross Retail Sales	+4	3.5	14
	3.2.2	Displacement or Renovation Required or Encouraged by Facility	+1	3.0	3
	3.2.3	Ease of Deliveries and Employee Commuting	−5	3.0	−15
	3.2.4	Attractiveness of Area to Business	+6	5.5	33
3.3 Urban Planning	3.3.1	Adaptability to Future Urban Development Plans	+10	3.5	35
	3.3.2	Net Change in Tax Receipts and Other Revenues	0	4.0	0
	3.3.3	Public Participation in Planning Process	+6	3.5	21

Figure 7. Sample project summary sheet.

because the intangibles were viewed as unimportant, but rather because the means for measuring them were not generally accepted. Today, there is still no generally accepted procedure for assessing traveler- and travel-related impacts of transportation projects, but there is a definite trend and an established need for the inclusion of these factors in the analysis. A suggested solution to fill this need is provided with the eight variables described in the following.

1.1 Pedestrian Transportation

There are four variables used for the evaluation of pedestrian transportation: travel time, ease of walking, convenience, and special provisions for various groups. None of the four variables described are costable in dollars, although they can all be evaluated objectively. Pedestrian travel time (1.1.1.) can be expressed in dollars, but the objective is to

Table 3. Classification of pedestrian facility variables.

1. Transportation

1.1 Pedestrian Transportation

1.1.1 Travel Time
1.1.2 Ease of Walking
1.1.3 Convenience
1.1.4 Special Provisions for Various Groups

1.2 Other Transportation

1.2.1 Motor Vehicle Travel Costs
1.2.2 Use of Automobiles
1.2.3 Impact on Existing Transportation Systems
1.2.4 Adaptability to Future Transportation Development Plans

2. Safety Environment/Health

2.1 Safety

2.1.1 Societal Cost of Accidents
2.1.2 Accident Threat Concern
2.1.3 Crime
2.1.4 Emergency Access/Medical & Fire Facilities

2.2 Environment/Health

2.2.1 Pedestrian Oriented Environment
2.2.2 Effects of Air Pollution
2.2.3 Noise Impacts
2.2.4 Health Effects of Walking

3. Residential/Business

3.1 Residential/Community

3.1.1 Residential Dislocation
3.1.2 Community Pride and Cohesion
3.1.3 Community Activities
3.1.4 Aesthetic Impact, Compatability with Neighborhood

3.2 Commercial/Industrial Districts

3.2.1 Gross Retail Sales
3.2.2 Displacement, Replacement, or Renovation Required or Encouraged by Facility
3.2.3 Ease of Deliveries & Employee Commuting
3.2.4 Attractiveness of Area to Business

3.3 Urban Planning

3.3.1 Adaptability to Future Urban Development plans
3.3.2 Net Change on Tax Receipts and Other Revenue
3.3.3 Public Participation in the Planning Process

evaluate all variables on a unitless +10 to −10 scale. For the convenience of those performing other types of analyses for which a dollar assignment to pedestrian travel time may be useful, a discussion of unit pedestrian travel time values is included in Chapter Three.

1.1.1 Travel Time

This variable is concerned with the computation of total pedestrian travel time for a particular facility. It may be computed according to

$$\text{Total travel time} = \text{Number of pedestrians} \times \left(\frac{\text{Route length}}{\text{Walking speed}} + \text{Signal delay}\right) \tag{1}$$

A description of the procedures for evaluating the components of Eq. 1 follows.

1.1.1.1 Number of Pedestrians and Route Length. Both of these components are inherent to the planning and design process for pedestrian facilities. Route length may be determined from plans for the facility (such as engineering drawings or blueprints). In general, pedestrian routes will be less than 3,000 ft (915 m) in length. To avoid circuitous routing, walking distance should be equal to no more than approximately 1.4 times the straight-line distance from origin to destination, and preferably less than 1.2 times. If pedestrians have alternate routes from which to choose, average length should be determined based on the proportion of pedestrians who do (or are expected to) use the various routes.

1.1.1.2 Walking Speed. Average unimpeded pedestrian speed is about 295 ft per min (1.50 m/sec). (To convert the other travel speeds in this discussion from feet per minute to meters/second, multiply by 0.00508.) This is an average value for general applications, when there are no impedances to pedestrian flow. For commuters in busy downtown areas, 267 ft per min is a better value, whereas 320 ft per min is more appropriate for students. The researchers measured pedestrian travel speeds of 270 to 300 ft per min in downtown Ottawa, Ontario, and 244 ot 258 ft per min in downtown Brooklyn, New York (slower because of high density).

When there is a concentration of pedestrians in an area, these speeds will be reduced by an amount directly proportional to the density of the pedestrians—but this correction only becomes significant at high densities, such as one pedestrian per 10 sq ft.

In addition to density, walking speed reductions of up to 25 percent may occur for extreme age or grades. However, no corrections are necessary for ages less than 65 years or for grades of up to 5 percent. Also, pedestrians walk about 10 percent faster in subfreezing weather than they do in 65 to 76 F (18 C to 24 C) temperatures; therefore, when examining wintertime use of facilities in cold weather climates, increase the assumed walking speed by 10 percent.

1.1.1.3 Signal Delay. Pedestrian delay at signalized intersections can be determined from a simple calculation based on signal timing measurements. It is assumed from experience that pedestrians arrive at random times and that they will begin to cross at any time during the green phase. The mean delay is given by:

$$D = \frac{F(R+A)^2}{2(G+R+A)} \qquad (2)$$

in which

- D = average delay per pedestrian;
- F = the fraction of pedestrians who wait when they arrive at a red, amber, or flashing don't walk signal;
- R = the duration of the red or don't walk signal;
- A = the duration of the amber or flashing don't walk signal; and
- G = the duration of the green or walk signal.

Of course, for a pedestrian-actuated signal, parameters for pedestrians delay must be established based on the particular characteristics of the traffic control device.

Calculation of the delay most likely to be incurred by pedestrians at crossings without signals or signs has been made by Joyce et al. (*14*). The formula that assumes the pedestrian will cross the street directly in one movement rather than cross halfway and wait is

$$D = 6.7 \times 10^{-6} (Q)^2 + 0.3 \qquad (3)$$

in which D is the delay most likely to be incurred, in seconds, and Q is the total hourly vehicle flow in both directions. Equation 3 is not valid for vehicle flows greater than 1,600 per hour or for mean delays greater than 18 sec, at which points more site-specific relationships must be developed based on vehicle mix and speeds, street width, and pedestrian population.

1.1.1.4 Total Travel Time. Once the route length and walking speed for the types of pedestrians expected to use the facility have been determined, distance should be divided by speed to obtain total time. Symbolically, for each grouping of pedestrians:

$$\text{Time per trip} = \text{Route length} \div \text{Walking speed} \qquad (4)$$

$$\text{Total time} = \text{No. of pedestrian trips} \times \text{Time per trip} \qquad (5)$$

1.1.1.5 Unit Pedestrian Travel Time Savings. This information may be recorded on the following chart. Weighting

	BEFORE	AFTER
Number of commuters or workers on lunch break	______	______
Travel time per person	______	______
Total travel time	______	______
Number of people walking in the course of their work	______	______
Travel time per person	______	______
Total travel time	______	______
Multiply by 1.5	______	______
Number of elementary school children	______	______
Travel time per child	______	______
Total travel time	______	______
Multiply by 0.1	______	______
Number of other pedestrians	______	______
Travel time per person	______	______
Total travel time	______	______
Multiply by 0.5	______	______
Total travel time in equivalent minutes	______	______

for the four groups shown is recommended, based on each group's mean wage rate. The value of time for people who are walking in the course of their work should be valued at 1.5 times the value for commuters and workers on lunch break because of the money expended by their employers for salary, payroll taxes, and overhead or profit. Similarly, other pedestrians—particularly those on leisure trips, personal business—or persons who are not employed have a time value about one-half that for commuters because pedestrian travel time savings cannot be readily converted into employment for them. The value of time for elementary school children is very low (one-tenth of that for commuters, unless their travel decision is made by a parent, in which case it might be higher) because they have very little money but lots of free time.

Weighting commuters' time by 1, the travel time of people walking in the course of their work by 1.5, elementary school children's time by 0.1, and other pedestrian time by 0.5 will result in a total travel time in "equivalent" minutes, equivalent to the specified amount of travel time for commuters or those workers on their lunch break.

A unitless score for travel time is obtained by using Eq. 6 and the values of total travel time in equivalent minutes determined by using the foregoing chart.

$$\text{Total TRAVEL TIME SCORE} = \frac{(\text{Total travel time before} - \text{Total travel time after})}{\text{Maximum of above terms}} \times 10 = \_\_\_\_\_\_ \quad (6)$$

If this evaluation is being used to compare a number of sites, the maximum value indicated should be the largest term for all sites under consideration.

1.1.2 Ease of Walking

Ease of walking may be described in terms of five components: condition of the walking surface, grade changes, path continuity, signing, and lighting. Techniques for measuring these components are described in the following. The range in number of points assigned to each is given in the following table, which may also be used to summarize the scores of the different components:

	SCORING RANGE	SCORE
Walking surface	−2 to 2	
Grade changes	−4 to 2	
Continuity	−1 to 3	
Signing	−1 to 1	
Lighting	−2 to 2	
Total EASE OF WALKING SCORE	−10 to 10	____

1.1.2.1 Walking Surface. Check off the appropriate boxes in response to the following questions:

	YES	SOMEWHAT	NO
Is the walking surface esthetically appealing? Consider color, texture, and sound.	1/2	0	-1/2
Is the surface comfortable to walk on, even for someone who is wearing high-heel shoes or sandals? A comfortable walking surface is neither too hard nor too soft. Considering comfort only, dry soil is ideal. Concrete is too hard, whereas sand is too soft.	1/2	0	-1/2
Is the pavement free of severe cracks or holes?	1/2	0	-1/2
Is the surface slip-proof, especially when wet or freezing?	1/2	0	-1/2

WALKING SURFACE SCORE is the sum of values in boxes checked = ________.

1.1.2.2 Grade Changes. These scales assume bidirectional flows, hence both upgrades and downgrades. If the facility allows pedestrian flow in only one direction (e.g., a bus unloading area), an upgrade should result in a more negative score and a downgrade should result in a less negative score. Fruin (*10*, p. 41) provides data on how slope affects free-flow walking speed, which was used to help determine scores for the steepness of slope. Cantilli (*5*) supplies information on requirements for escalators, based on distances of activity areas below surface level.

Walkways and ramps built with federal funds must be accessible to qualified handicapped persons with grades no greater than 5 percent and 8.33 percent, respectively. If a slope greater than 25 percent is planned, serious consideration should be given to redesigning the facility.

STEEPNESS OF SLOPE

GRADE	POINTS
5% or less	1
8	0.5
15	−0.5
20	−1.5
25	−2.0

STEEPNESS SCORE selected ________.

VERTICAL DISTANCE TO CLIMB WITHOUT MECHANICAL (ELEVATOR OR ESCALATOR) ASSISTANCE

DISTANCE (FEET)*	POINTS
0	1
25	0
50	−1
75	−1.5
100 or more	−2

*To convert feet to meters, multiply by 0.305.

VERTICAL SCORE selected ________.
Total GRADE SCORE is Steepness Score + Vertical Score = ________.

1.1.2.3 Continuity. Check off the appropriate boxes in response to the following questions:

	YES	SOMEWHAT	NO
Are there continuous, unbroken, unambiguous pedestrian paths?	1	1/2	0
Are there small jogs or slight bends in the path, but not enough to make the route highly irregular?	1	1/2	0
Is there an absence of obstacles to the flow of pedestrians?	1	1/2	-1

CONTINUITY SCORE is the sum of values in boxes checked = ________.

1.1.2.4 Signing. Check off the boxes in response to the following questions:

	YES	NO	UNNECESSARY
Are directions to important destinations given or maps of the area provided?	1	0	1
Is there proper signing for safety?	1	0	1
Are any rules or other important information conveyed if necessary?	1	0	1
Are the signs simple and easy to understand?	1	0	1
Can they be understood by persons who cannot read English?	1	0	1
Can they be read by persons with poor eyesight or colorblindness?	1	0	1
Are signs located at likely points of confusion or indecision?	1	0	1
Is there a clear, unobstructed view of each sign?	1	0	1
Are the signs illuminated properly, free of glare?	1	0	1

Signing Point Score is sum of value in boxes checked = ________

Total SIGNING SCORE is Point Score ______ ÷ 4 ______ - 1 = ______

1.1.2.5 Lighting. Lighting effectiveness can be measured in terms of the amount of illumination, the type of lighting, and the height of the lamps.

Level of illumination. Now that energy conservation is generally accepted as a desirable public policy, lighting standards may be lowered accordingly if they continue to satisfy safety and comfort criteria. Thus, existing standards should not be accepted without question, and reassessment may be warranted.

The illumination level may be measured with a small hand-held light meter. Also, when making test measurements for outdoor facilities, it was found that the ambient light in a city can add 5 ft-c (to convert foot-candles to lumen per square meter (lux), multiply by 10.764) or more to each reading, so it is best to perform these measurements very late at night, after most of the city has gone to sleep. The measurements should be made about 5 ft (1.5 m) above the ground at representative pedestrian locations. Try to measure an average location, taking into consideration the placement of light, rather than to use an average of the measurements taken. The level of illumination can be translated into a point value according to the following table:

LEVEL OF ILLUMINATION (FT-C)	POINTS
15 or more	0
10 or more	−0.5
5 or more	−1.5
2 or more	−2.0
less than 2	−2.5

LEVEL SCORE selected = ____________

Type of lighting. Certain types of lighting (such as incandescent) are soft to the eye, whereas others (such as sodium or strontium vapor) are very harsh. Fluorescent and neon lights fall somewhere in between. Scores are assigned to these differing degrees of harshness or softness as follows:

TYPE OF LIGHTING	POINTS
Soft: incandescent	0
Medium: neon or fluorescent	−0.5
Harsh: sodium or strontium vapor	−1

LIGHTING TYPE SCORE selected = ______________

Height of lamps. Highways are wide and must accommodate tall vehicles, therefore the lights are located on poles 40 ft (12 m) high. This height is unnecessary and undesirable for pedestrian activity areas, for which 10- or 12-ft (3-m) pole heights are more suitable.

HEIGHT OF LAMPS	POINTS
Lighting is on a pedestrian scale	0
Lighting is automobile oriented	−0.5

HEIGHT SCORE selected = ____________

COMBINED LIGHTING SCORE = Level Score + Type Score + Height Score + 2

= ________________

1.1.3 Convenience (Availablity and Access)

This variable is measured by two components which consider the availability of the facility to its users and the variety of activities that make it more accessible to pedestrians.

1.1.3.1 Time Facility is Available for Use.

SITUATION	POINTS
Open at all times that facility is required	0
Open part-time for special purposes, e.g., lunch hours, school hours, daytime, peak travel hours, weekends, etc.	−2
Open part-time only for reasons indirectly related to the facility, such as when major stores are open or when there is (or is not) heavy traffic.	−6
Open only rarely, randomly, or irregularly	−10

AVAILABILITY SCORE selected = ______________

1.1.3.2 Accessibility. Does the facility make pedestrian travel more convenient to:

Transit	☐
Parking	☐
Transportation terminals	☐
Employment Centers	☐
School or education centers	☐
Recreational, historical, or cultural facilities	☐
Medical facilities	☐
Places of worship	☐
Retail stores	☐
Residential areas	☐

ACCESSIBILITY SCORE is number of boxes checked = ________

CONVENIENCE SCORE is Availability Score + Accessibility Score = ________.

1.1.4 Special Provisions for Various Groups

Special provisions to accommodate special groups of pedestrians (children, elderly, visually or mobility handicapped, bicyclists, joggers, strollers) usually benefit all pedestrians by making it easier for them to walk. Thus, signs that are intelligible to children or visible to partially sighted persons are included under Signing (1.1.2.4). Improved signs benefit all pedestrians, just as benches for the elderly can be used by any tired pedestrian, and thus are included in Pedestrian Oriented Environment (2.2.1). Only those provisions that were not included elsewhere are included here.

1.1.4.1 Physically Handicapped. Spencer (*20*) furnishes an excellent set of design criteria for accommodating physically handicapped pedestrians. If the federal government is providing funding for the project, additional criteria will need to be considered. A 1979 regulation of the Federal Highway Administration requires compliance with standards outlined in A117, sections 4.2, 5.1, 5.4, and 5.13 of the American National Standards Institute (ANSI). Among these requirements are height and extension of handrails on ramps and stairs, height of stair riser, provision for a rest every 30 ft on ramps, and maximum percent gradient of 5% for walks and 8.33% for ramps. These regulations support the Rehabilitation Act of 1973 which prohibits discrimination against qualified handicapped persons in programs and activities funded by the federal government.

The following questions are divided into four components and are self-explanatory. Check off the appropriate boxes.

	YES	NO	NOT APPLICABLE
Is maximum curb or step height 6 inches* or less?	1	0	1
Are ramped curb cuts provided?	1	0	1
Are all walkways at least 5 feet** wide?	1	0	
Are there any interior areas that are not accessible by at least one nonrevolving door, easy to open, at least 32 inches wide?	0	1	1
Are there any significant grade changes for which ramps or elevators are not provided?	0	1	
Are there any pedestrian-activated crossing signal buttons located more than 40 inches above the ground?	0	1	1
Is there any public telephone with at least 27 inches clearance underneath, but the dial a maximum of 48 inches from the ground?	1	0	
Is there a drinking fountain whose top is no more than 33 inches above the ground?	1	0	
Are changes in pavement texture provided to assist blind pedestrians through difficult crossings?	1	0	1
Are there angular corners, rather than rounded to allow for better directional orientation?	1	0	1
Are other aids provided for the blind (e.g., sound devices, braille signs, chains, guides)?	1	0	1
Are crossing signals audible?	3	0	3

PHYSICALLY HANDICAPPED SCORE is sum of boxes checked ________.

*To convert inches to centimeter, multiply by 2.540.

**To convert feet to meters, multiply by 0.305.

1.1.4.2 Bicyclists.

Are bicycle racks or storage areas for bicycles provided?	3	0
Is a right-of-way provided for bicycles, separate from that of pedestrians?	3	0

BICYCLISTS SCORE is sum of boxes checked ________.

1.1.4.3 Joggers.

	YES	NO	NOT APPLICABLE
Is there a dirt, wood chip, or other soft path available for joggers? Jogging on hard surfaces can cause "shin splints" and damaged arches, commonly known as flat feet, according to Hodges (1975).	3	0	

JOGGERS SCORE is sum of boxes checked ________.

1.1.4.4 Other Special Provisions.

Are there any locations appropriate for placement of handrails, where they are not provided?	0	1	1
Do sewers or gratings hinder access for vehicles with narrow wheels or persons with narrow shoes?	0	1	

OTHER SPECIAL PROVISIONS SCORE is sum of boxes checked ________.

Point Score is Physically Handicapped Score + Bicyclists Score + Joggers Score + Other Special Provisions Score = ________.

Total SPECIAL PROVISIONS SCORE is (Point Score x 0.8) - 10 = ________.

1.2 Other Transportation

It is important to remember that pedestrian facilities are only one part of the city's and, possibly, the region's transportation system. The following four variables consider the impact of the pedestrian facility on the larger transportation and urban environment in which it is situated.

1.2.1 Motor Vehicle Travel Costs

An important economic impact of a pedestrian facility is the increase or decrease in costs of automobile transportation resulting from changes in traffic flow and routes. Whereas pedestrian delay was a factor in variable 1.1.1, vehicle delay and changes in vehicle operating costs caused by the pedestrian facility are now considered.

1.2.1.1 Intersection Delay. The most major impact of a pedestrian facility on motor vehicle costs will usually be intersection delay. This is caused by slowing down and speeding up from a stop caused by an intersection or mid-block pedestrian crosswalk, or by a traffic control device. Score intersection delay as follows:

INTERSECTION	POINTS
Addition of stop sign where no stop was previously required	−8
Addition of traffic light where none existed previously	−5
New crossing requiring vehicles to stop when pedestrian is present	−4
No changes in vehicle stops	0
Elimination of at-grade pedestrian crossing	+4
Elimination of traffic light	+5
Elimination of stop sign	+8

INTERSECTION SCORE selected ____________.

1.2.1.2 Changes in Travel Speed. The other component of motor vehicle travel cost changes likely to occur with installation of pedestrian facilities is changes in travel speeds. On most residential or commercial streets with speed limits of 65 kph (40 mph) or less, increasing average vehicular travel speeds as a result of grade-separated pedestrian facilities will mean more economical operation. Decreasing vehicle travel speeds because of greater numbers of pedestrians crossing the street will increase travel costs. This is scored as follows:

TRAVEL SPEED CHANGE	POINTS
Average speed decrease of 16 kph (10 mph) or more	−2
Average speed decrease of about 8 kph (5 mph)	−1
No change in average vehicle speed	0
Average speed increase of about 8 kph (5 mph)	+1
Average speed increase of 16 kph (10 mph) or more	+2

CHANGE IN TRAVEL SPEED SCORE selected __________.
Total MOTOR VEHICLE TRAVEL COST SCORE is intersection delay score + travel speed change score = __________.

1.2.2 Uses of Automobiles

In contrast to variable 1.2.1, which takes into account the operation costs and delay time for motor vehicle trips, this variable simply considers the number of trips made by automobile, or the split between automobiles and pedestrians and transit. Estimates of the number of trips taken by automobile should be made at the same time that pedestrian and traffic volumes are forecast.

The score for this variable is computed according to

$$\text{Score} = 40 \times \left(\frac{M_a}{M_b} - 1\right) \tag{7}$$

The mode split after initial operation of a pedestrian facility, M_a, is equal to the number of trips taken by foot, bicycle, or transit during a specified period (day, month, or year) divided by the total number of trips, including those made by automobile. Similarly, M_b is the mode split of the existing situation (i.e., before there is a facility). If Eq. 7 produces a score greater than +10 or smaller than −10, use +10 or −10 as the rating. The formula is based on a change in mode split of 25 percent from the status quo accounting for a maximum score; smaller changes are scaled proportionately. Peak-period, off-peak weekday, evening, and weekend trips are all weighted equally, although the evaluator may choose to consider peak-period trips only for this analysis.

Total USE OF AUTOMOBILES SCORE = _______.

1.2.3 Impact on Existing Transportation Systems

Pedestrian and vehicle separation facilities may well have impacts on other transportation systems in the community. For example, vehicle or pedestrian rerouting might inconvenience bicyclists who had been accustomed to riding on uncongested routes. Transit lines might have to be rerouted, and buses might become overloaded in the vicinity of the pedestrian facility. Pupils' use of school buses might decline if the children can now cross a freeway safely or walk a shorter distance.

The worksheet shown in Figure 8 is used to specify the extent and magnitude of the impacts. Place a check in each box that corresponds to an expected impact on the indicated mode. If the impact is major, use two checks. Add up the total number of checks on the bottom line.

1.2.3.1 Signal/Signing Needs Adjacent to Facility. In addition to impacts on bikeways, transit, and transportation terminals, two points are designated for evaluation of this component.

The cost of signals and signs at and within the facility itself will be included for the total cost for the entire project. However, there may be a need for signs or signals adjacent to the facility: for detours or rerouting when a street is closed to motor vehicles, to direct pedestrians and bicyclists to the facility, and to indicate changes in the location of bus stops or routes.

Assign a value between −2 and +2 to the signing requirements, based on these sample guidelines:

SIGNAL/SIGNING NEEDS	POINTS
Dangerous situation; significant confusion at 3 or more locations	−2
Clear need for additional major signing	−1
Additional signs useful, but not essential	0
Need indicated only for small, routine signs, such as bus stops or route designators; or minor problem only at one or two locations	+1
No problem; no need for additional signs	+2

SIGNAL/SIGNING NEEDS SCORE selected ________.

To obtain the final score for this variable:

Total IMPACT ON EXISTING TRANSPORTATION SYSTEMS SCORE is existing transportation score + signal/signing needs score = ________.

1.2.4 Adaptability to Future Transportation Development Plans

As a part of the overall planning process, expected future transit and highway developments should be considered to determine if they are likely to have a measurable effect on the facility. For example, plans for a pedestrian crossing over a highway would certainly be changed if at a future date the highway were to be abandoned, relocated, or widened. Similarly, the design for a pedestrian tunnel would be different if plans existed for an underground rapid transit system crossing it. An excellent example of a major development planned to accommodate future improvements is the major shopping center in Scarbrough, Toronto, which is constructed to allow the light rail connection to Warden Station to pass through the shopping center.

This variable is intended to provide a judgmental rating for the adaptability of the proposed pedestrian facility to the present and planned transportation system. Based on the information that is known concerning private and public growth plans for the future of the area, evaluate the adaptability of the pedestrian facility to future transportation and urban development plans on a scale from -10 to $+10$, as follows:

-10	-5	0	+5	+10
Requires significant modification to city or regional transportation plans to accomodate the facility		No significant effect on current or planned citywide or regional transportation system		Enhances planned future transportation system

FUTURE TRANSPORTATION PLANS SCORE selected = ________.

2. SAFETY/ENVIRONMENT/HEALTH

2.1 Safety

2.1.1 Societal Cost of Accidents

The total societal cost of motor vehicle accidents involving pedestrians is a function of the number of accidents, their severity, and many direct and indirect costs such as medical and hospital, legal, income loss, pain and suffering, and insurance administration costs. This section provides a technique for estimating the relative risk of accident occurrence based on past experience of pedestrian, vehicle, environmental, and traffic control components. By multiplying the accident risk by the number of pedestrian exposures (in terms of pedestrian crossings of vehicle roadways), an estimate can be made of the number of accidents.

Dollar value estimates for total societal costs can be developed using the data from this section and the techniques and cost data given in Chapter Three. The rest of this section describes how relative accident risk is estimated and then used to determine a unitless accident score for alternative pedestrian facilities.

Transportation Systems	Change in Type of Use	Increase in Use	Noticeable Decline in Use	Modifications Required	Others
Bikeways					
Transit					
School buses					
Terminals					
Bus					
Railroad					
Airport					
Ferry					
Total					

Based upon the entries above, indicate on the scale below the degree of impact of the pedestrian facility on other community transport systems.

-8	-5	0	5	8
Very negative		Neutral impact		Very good

EXISTING TRANSPORTATION SCORE selected = ____.

Figure 8. Existing transportation worksheet.

The accident risk per crossing for each facility (or each crossing point affected by the facility if necessary) is estimated using the Accident Involvement Rate Adjustment in Figure 9. For each crossing to be analyzed (one representative crossing may be evaluated if several similar crossings are involved), check off the boxes that apply, then sum the results for both present and planned conditions using the formula below the table to obtain net involvement rates (NI rate) for both situations.

2.1.1.1 Pedestrian Accident Costs. Unitless scoring for pedestrian accident costs is accomplished by computing a comparative crossing risk for each situation by multiplying the annual number of crossings by the NI rate (limited to a maximum of 2.0) for that situation and comparing by use of

$$\frac{\left(\begin{array}{c}\text{Present}\\ \text{no. of}\\ \text{crossings}\end{array} \times \begin{array}{c}\text{Present}\\ \text{NI rate}\end{array}\right) - \left(\begin{array}{c}\text{Proposed}\\ \text{no. of}\\ \text{crossings}\end{array} \times \begin{array}{c}\text{Proposed}\\ \text{NI rate}\end{array}\right) \times 10}{\begin{array}{c}\text{Maximum of above products}\\ \text{for all facilities being compared}\end{array}} \quad (8)$$

Total COST OF ACCIDENT SCORE computed is ____.

If this evaluation is being used to compare a number of sites, the maximum value indicated should be the maximum comparative crossing risk of all sites under consideration.

If only the present situation is being compared for a number of sites, Eq. 9 should be used for each site. This will provide a relative accident risk index for comparing potential pedestrian improvement sites.

	Number of:	Rate Decreases				Average		Rate Increases			
PEDESTRIAN	Elderly (>65)	Few	10	5%	5	10%	0	20%	20	30%	40
	Very Young (<10)	Few	10	1%	5	2%	0	4%	20	8%	40
	Alcohol Involved	None	10	Few	5	Mod	0	Mod-High	20	High	40
	Illegal Crossings	None	5	Few	3	Mod	0	Mod-High	10	High	20
VEHICLE	Average Vehicle Volume	Low	5	Mod-Low	3	Mod	0	Mod-High	5	High	20
	Average Vehicle Speed (mph) (kph)	<15 (<25)	5	15-24 (25-39)	3	25-30 (40-49)	0	31-40 (50-65)	10	>40 (>65)	20
	Turning Conflicts	None	5	Few	3	Mod	0	Freq.	5	Many	10
	One-way Traffic		–	Yes	3		–	No	5		–
ENVIRONMENT	Sight Distance	Good	4	Fairly Good	2	Fair	0	Poor	5	Bad	10
	Crossings After Dark (Good Light)	Few	4	Mod-	2	Mod	0		–		
	Crossings After Dark (Poor Light)		–		–	Few	0	Mod	10	Many	20
	Weather	Mild	4	Mod-Mild	2	Mod	0	Mod-Severe	3	Severe	5
CONTROL	Signalization (Presence)			Ped & Veh	10	Veh Only	0	None	20		
	Police Enforcement (Ped Laws)			Heavy	3	Mod	0	Light	3		
	Active Public Education			Yes	2		–	No	2		

Sum the colums as indicated and divide each sum by 100: Decreases ___/100 = ___ Increases ___/100 = ___

Net Involvement Rate is Increase Rate - Decrease Rate ______ + 1 = ______

Avg = Average
Mod = Moderate
Ped = Pedestrian
Veh = Vehicle

Figure 9. Accident involvement rate adjustment.

$$\begin{array}{c}\text{Relative}\\ \text{accident}\\ \text{risk index}\end{array} = \frac{\begin{array}{c}\text{Present}\\ \text{no. of}\\ \text{crossings}\end{array} \times \begin{array}{c}\text{Present}\\ \text{NI rate}\end{array}}{\text{Maximum no. of crossings at any site}} \times (-10) = \underline{\qquad\qquad}. \tag{9}$$

In an example using Eq. 8, assume a four-block area of a street in a retail area closed lengthwise but with cross streets left open to motor vehicles. The street crossing locations are all similar; their before (present) and after (proposed) net accident involvement rates are 1.45 and 0.85, respectively. The present and estimated future number of person crossings are 12,500 per day and 14,500 per day, respectively.

$$\begin{array}{c}\text{Total COST OF}\\ \text{ACCIDENTS SCORE}\end{array} = \frac{(12{,}500 \times 1.45) - (14{,}500 \times 0.85)}{\text{Maximum of above products}} \times 10$$

$$= \frac{18{,}125 - 12{,}325}{18{,}125} \times 10 = \underline{+3.2 \text{ (or } +3)}.$$

2.1.2 Accident Threat Concern

This variable estimates the degree of anxiety caused by the perceived nature of conflicts between pedestrians and vehicles at conflict locations within the proposed facility or site. For all facilities where some degree of pedestrian/vehicle conflict exists, Figure 10 is used. Appropriate values are checked, and sums computed as indicated. If separation between pedestrians and vehicles is complete, the score is +10.

2.1.3 Crime Concern

The perception of crime by both pedestrians and nearby residents and business persons is looked at in this variable. It is extremely difficult to predict the number and types of actual crime incidences that will be induced or averted by any particular facility. Wide variations in the physical settings of different facilities, the necessity to incorporate previous crime patterns near the facility location, and lack of specific research in this area all contribute to these difficulties. Facilities that encourage large increases in the number of users may experience crime increases, particularly so-called "petty" crimes (such as vandalism and pick-pocketing). However, reasonable enforcement levels can maintain or attain low crime rates in the area of pedestrian facilities if proper consideration of this variable is taken in the planning and design of the facility.

Fear of crime by the users and nonusers of the proposed facility can be estimated using the values of Figure 11. Check the appropriate values and sum them to rate both the present and proposed facilities.

2.1.4 Emergency Access/Medical and Fire Facilities

This variable assesses the ability of the facility to allow emergency access and to support the treatment of both personal health and physical property damage. The most important of these is the adequate availability of access for emergency vehicles, a major design requirement for large-scale pedestrian facilities. Considerations must include adequate numbers of entrances and exits, ample turning radii, and sufficient height clearances for various types of emergency vehicles. In many cases this access will be required to obtain the necessary construction permits for the facility. Figure 12 is used to measure the degree to which a facility supports emergency services.

2.2 Environment/Health

The pleasantness of surroundings for a pedestrian may be measured in terms of pedestrian orientation of the environment, noise and air pollution, and health effects of walking.

		Positive		Average		Negative	
Vehicles	Traffic Volume	Low	2	Med	0	High	2
	Traffic Speed	Low	2	Med	0	High	2
	Turning Conflicts	Few	1	Mod	0	Many	1
	One-way Traffic	Yes	1	No	0		--
	Vehicle Mix		--	Mixed	0	High % Trucks Buses	1
Setting	Crosswalks	Marked	1		--	Unmarked	1
	Signalization	Veh and Ped	1	Veh Only	0	None	1
	Sight Distance	Good	1	Mod	0	Poor	1
	Lighting	Good	1	Mod	0	Poor	1

Sum the column values: Positive = ____ Average = 0 Negative = ____

Total ACCIDENT THREAT SCORE is Positive Sum - Negative Sum = ________

Med = Medium
Mod = Moderate
Ped = Pedestrian
Veh = Vehicle

Figure 10. Accident threat concern scoring.

	Positive		Average		Negative			
Frequency of Visible Police Patrols	High	2	Mod	0	Low	2		
Number of Hours per day Store is Open or Facility manned	More than 20	2	Between 10 & 20	0	Less than 10	2		
Pedestrian Density	High	4	Mod	0	Low	2	Very Low	4
Lighting	Good	3	Mod	0	Poor	4		
Visual Connection with Environment	View Outside	1	No View, Spacious	0	Narrow, Stark	2		
Line of Sight	Long	1	Mod	0	Short	1		
Communications	Pull Boxes, No Coin Voice	1	Coin Voice	0	None	1		
Community Awareness Programs	Active	1	None	0				
Vehicle Volume	Low	1	Mod	0	High	.5		
Idlers (drunks, panhandlers, teenagers)	Very Few	2	Few	0	Med	1	Many	2
Clutter (confusion, distaste)	Little	1	Some	0	Much	.5		
Litter	None	1	Some	0	Much	1		

Sum the column values: Positive = _____ Average = 0 Negative = ________.

Total CRIME CONCERN SCORE is Positive Sum + Negative Sum = _________ , + 2 = __________.

Figure 11. Crime concern scoring.

	Positive		Average		Negative			
Emergency Vehicle Access	Good	3	Partial	0	Poor, None	4		
Other Traffic	None	2	Little	0	Mod	1	Heavy	2
Pedestrian Density	High	1	Mod	0	Low	1		
Lighting	Good	1	Mod	0	Poor	1		
Communications	Pull Boxes, No Coin Voice	1	Coin Voice	0	None	2		
Medical Aid Stations	Yes	1	No	0				
Fire Extinguishes	Yes	1	No	0				

Sum the column values: Positive = _____ Average = 0 Negative = _____

Total EMERGENCY SCORE = Positive Sum - Negative Sum = __________.

Figure 12. Emergency scoring.

The surroundings are much more important for pedestrians than motorists because the pedestrian interacts directly with his/her environment. Measurement techniques have been derived for evaluating these variables.

2.2.1 Pedestrian-Oriented Environment

This variable is further divided by the components attractive environment, litter control, density and enclosed facility. Discussion of each of the components and means for measuring them follow.

2.2.1.1 Attractive Environment. Check off the boxes in Figure 13 that best describe the facility being evaluated.

2.2.1.2 Litter Control. Auto-free zones are more expensive to keep clean than equal areas of conventional city streets, partly because wind generated by moving traffic causes dust and litter to be deposited at the edges of the road, where it can be swept up by a street cleaning truck. Also, pedestrians in vehicle-free zones have more time to indulge in litter-producing activities, such as eating and smoking, so more litter is generated (*6*). Further, less energy intensive but more costly manual sweeping methods often have to be used to clean malls instead of, or in addition to, the mechanized process. Thus, it is particularly important to carefully evaluate the litter potential of pedestrian separation facilities because a "clean" atmosphere encourages a "do-not-litter" attitude.

The scoring techniques described below can be used to measure litter control for existing pedestrian facilities. The Urban Institute (*3*) in *How Clean is Our City?* defined four levels of cleanliness for streets and alleys, based on 400 photographs of scenes representative of the range of litter conditions in the District of Columbia. These photographs were judged independently by 19 persons, and those on which there was complete or nearly complete agreement were selected as reference standards. These photographs are shown in Figures 14 and 15 to facilitate the evaluation of cleanliness of pedestrian facilities.

Points have been assigned to the different conditions:

1. Positive Impacts

Amenities
- ☐ Small park or plaza
- ☐ Water fountain, artificial waterfall, or splashing water

The Arts
- ☐ Theater (open or enclosed)
- ☐ Mural(s) or other graphic art
- ☐ Sculpture
- ☐ Strolling musicians and performers
- ☐ Street artists, handcrafts
- ☐ Tasteful, unobtrusive background music in selected areas

Buildings
- ☐ Interesting architecture; creative entrances
- ☐ Renovation, restoration, or good paint job

Communications
- ☐ Attractive mailboxes
- ☐ Attractive telephones
- ☐ Clock or sundial

Exhibits
- ☐ Exhibits, displays or demonstrations
- ☐ Monument or statue

Nature
- ☐ Trees
- ☐ Gardens
- ☐ Floral exhibits, with seasonal variety
- ☐ Songbirds

Outdoor Eating
- ☐ Sidewalk cafes
- ☐ Food pushcarts

Physical Comfort
- ☐ Long, deep (30-inch), wooden benches
- ☐ Steps or ledges on which to sit
- ☐ Drinking fountains
- ☐ Leaning posts (walls, pillars, flagpoles)

Retail Outlets
- ☐ Street vendors (flowers, sundries)
- ☐ Colorful or interesting shop fronts
- ☐ Bookstore(s)
- ☐ Newsstand

POSITIVE IMPACT SCORE is sum of boxes checked = ________

2. Negative Impacts
- ☐ Caged pedestrian overpasses
- ☐ Utility poles and wires
- ☐ Automobile intrusion, extensive curb parking, parking lots, or garages
- ☐ Long, monotonous frontages (such as factory or warehouse walls)
- ☐ Vacant lots or buildings
- ☐ Billboards or distasteful advertising
- ☐ Long sections of tall (higher than 6 feet, 1.8 meters) fences
- ☐ Narrow walkway
- ☐ Noise
- ☐ Motor vehicles or industrial odors

NEGATIVE IMPACT SCORE is sum of boxes checked ______ x 2 = ______

Total ATTRACTIVE ENVIRONMENT SCORE is Positive Impact Score - Negative Impact Score = ________ ÷ 2 = _______ - 5 = _________.

Figure 13. Attractive environment evaluation scoring sheet.

CONDITIONS	POINTS
1. Clean: free of unsightly dirt and litter	0
2. Moderately clean: slight accumulations of dirt and litter	−1
3. Moderately littered: significant accumulations of dirt and litter	−2
4. Heavily littered: heavy accumulation of litter and rubbish in and near street (or promenade)	−3

LITTER CONDITION SCORE selected = ______.

Chewing gum that has been discarded on a walking surface sticks to it, captures dirt, melts, and eventually hardens into a black circle that is impossible to remove by almost any other means than steam cleaning. If this condition exists on the facility being evaluated, subtract 1 from the score selected.

In addition to an index of the accumulation of litter present on a particular pedestrian facility, placement and collection of litter from trash baskets are important. It is frustrating for a pedestrian who does not want to litter to be unable to find a trash basket when one is needed. An equally bad situation is when the trash cans are filled to the brim, and anything left on top is likely to fall off or blow away. The following scale provides an indicator of the effectiveness of trash receptacle placement:

SITUATION	POINTS
No trash baskets, or trash baskets emptied very rarely	0
Some trash baskets but they are not sufficient, are unattractive, or are infrequently collected	1
Adequate placement of trash baskets but they are not necessarily attractive	2
Adequate placement of attractive or innovative trash baskets	3

CONTROL CONDITION SCORE selected = ______.
Total LITTER CONTROL SCORE is Litter condition + Control condition = __________.

2.2.1.3 Density. Lower densities are usually preferable to greater densities, because the pedestrian may walk at the speed and direction he desires, not having to worry about conflicts with others. Also, at low densities, a person may stop to look into a store window without fear of having someone walk into him from behind. However, beyond a certain point, approximately 1,200 to 1,400 sq ft (111 to 130 m^2) per person, a mall will appear empty and less desirable than a mall full of activity. At high densities, however, crowding occurs, causing conflicts, frustration, delay, speed and direction changes, and perhaps even claustrophobia in some. As considered here, density pertains only to inputs on the pedestrians' level of comfort; the delaying effect of density is covered under pedestrian travel time (1.1.1).

On a large mall where people are traveling in all directions, density can vary tremendously from one minute to the next. This is because people often travel in groups, and, if the group is walking slowly, pedestrians become stuck behind it, temporarily increasing the density which will only fall again after the group passes. Thus, density must be observed over a certain time period (probably at least 15 min) to be meaningful. Determine the typical maximum density for the time observed (i.e., the density level reached at least three times during 15-min observation period).

Fruin (*10*) derived levels of pedestrian service for design of terminal facilities for the Port Authority of New York and New Jersey. These have been expanded by Pushkarev and Zupan (*18*) in standards for crowding and impeded flow in pedestrian facilities. This work has been used as a starting point, but new criteria were developed by the researchers based on observations of pedestrian flow, crowding, and conflicts on the Sparks Street Mall. One major difference is that in transportation terminals pedestrian flow is often directed to and from the vehicles, whereas on a mall pedestrians walk in all directions. People also walk much faster in transportation terminals than on malls.

Scoring pedestrian density is as follows:

AMOUNT OF SPACE PER PERSON*		
SQUARE FEET	SQUARE METERS	POINTS
Less than 12	Less than 1.1	−1
12 to 60	1.1 to 5.6	0
61 to 1,400	5.7 to 130	+1
More than 1,400	More than 130	−1

*Average peak period, e.g., lunchtime on a pleasant spring day.

DENSITY SCORE selected __________.

2.2.1.4 Enclosed Facility. Energy, environmental considerations, and increased value of central business district land as well as regulated climate attributes call for consideration of enclosed areas. The Galleria in Toronto, Omni Center in Atlanta, Bonadventure in Montreal, and even the Arco Plaza in Los Angeles are a few of the pedestrian-oriented facilities which have been extremely successful, and they not only provide a pleasant experience protected from the elements but also provide a strong incentive for adjacent rehabilitation with emphasis on pedestrian amenities. The Vancouver, Canada, protected shopping center next to the Granville Street Mall (a limited-vehicle facility) with its underground access covering half a dozen blocks is an excellent example of what can be done to provide for pedestrians in a central business district.

Score an enclosed facility as indicated:

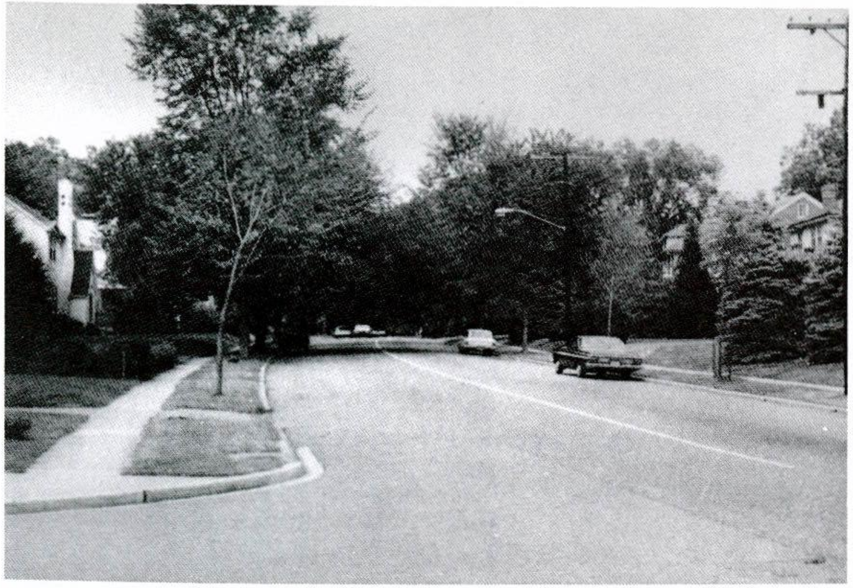
DESCRIPTION	POINTS
Facility is fully enclosed	+1
Facility is not enclosed	−1

ENCLOSED FACILITY SCORE selected is ______.

Total PEDESTRIAN ORIENTED ENVIRONMENT SCORE is attractive environment score + litter condition score + density score + enclosed facility = __________.

2.2.2 Effects of Air Pollution

Pollution results from the introduction of wastes into the environment in greater concentrations than can be absorbed over a given period of time. Motor vehicles contribute significantly to a number of major air pollutants. Because pedestrian facilities are structured around a nonpolluting mode of



CONDITION 1: CLEAN

CONDITION 2: MODERATELY CLEAN

CONDITION 3: MODERATELY LITTERED

CONDITION 4: HEAVILY LITTERED

Figure 14. Examples of street litter conditions.

CONDITION 1: CLEAN

CONDITION 3: MODERATELY LITTERED

CONDITION 2: MODERATELY CLEAN

CONDITION 4: HEAVILY LITTERED

Figure 15. Examples of alley litter conditions.

transportation (walking), they present opportunities to reduce motor vehicle pollution by decreasing the number of vehicle-miles traveled, and also by reducing or eliminating time and space conflicts between pedestrians and vehicles, thereby improving traffic flow. Such results would also reduce the consumption of fuel and oil and the wear on brake linings.

The pollutants generated by motor vehicles and considered here for their effects on humans and on property are:

- Carbon monoxide (CO)—resulting from incomplete combustion; injurious to human health at concentrations generated by heavy traffic volumes.
- Hydrocarbons (HC)—actually a group of organic gases such as ethylene, some of which pose serious threats to plant, animal, and human health in sufficient concentrations, as well as participating in the "smog" reaction with resultant eye and lung irritation and visibility restrictions.
- Nitrogen oxides (NO_x)—formed by high-temperature or high-pressure combustion processes and participate in photochemical reactions resulting in smog formation.

Damage to property includes damage to plant life, buildings, clothing, and other personal property. The results of air pollution damage to property are more frequent replacement and renovation rates such as replanting, cleaning, and refinishing. Because of the complex nature of pollution damage effects and the greater emphasis of past research on danger to humans, considerably less is known about the specific impacts of pollution on property as described. However, the range of air pollutant concentrations that affect human health and psychology is generally coincident with the range of pollutant concentrations that affect property. Thus, the need for a relative scale value can be met by a single score for both property damage and human impacts.

The effects of air pollution result from experiencing the ambient air quality, which is determined by: the number of, and distance from, air pollutant sources; the specific types and amounts of pollutants emitted; the physiological conditions. Analysis of these interacting characteristics to determine the pollution actually experienced by a person or an item of property is possible but not within the scope of the evaluation required here. Furthermore, even if the ambient concentrations experienced were accurately predicted, threshold reactions, synergistic effects, and varying responses of different individuals and materials to the same pollutants would make the effects analysis too complex for the evaluation of pedestrian facilities. Thus, to provide a practical evaluation technique, it was decided to assume a simple relationship between distance from source of motor vehicle emissions and health and property damage. The evaluation is based on the fact that although exposure to city and region-wide ambient air pollution cannot be completely avoided with pedestrian facilities that are separate from motor vehicles, separate pedestrian facilities can indeed provide an area that has less polluted air than is present at or nearer to vehicular traffic flow. Cleanliness of the air at a pedestrian facility increases with distance from motor vehicle traffic. Pedestrian overpasses are especially poor from this point of view because most pollutants tend to diffuse and thus are at very high concentrations directly above the roadway.

The user should be aware that this evaluation is very general. It cannot be used in place of an expert evaluation of the specific site and project plan to accurately determine the change in air pollution levels or their resulting effects. However, it does provide a reasonable method to allow an approximate comparison of alternate pedestrian facilities.

To evaluate the impact of air pollution for a planned or existing pedestrian facility, apply the appropriate scores.

SITUATION	POINTS
Pedestrian crossing over freeway	−10
Pedestrian crossing over major arterial	− 8
Other pedestrian crossing	− 4
Adjacent to roadway or below grade	0
At grade, 50 meters from roadway	+4
At grade, 100 meters from roadway	+6
At grade, 150 meters from roadway	+8
At grade, 200 meters from roadway	+9
At grade, 250 meters or more from road	+10
Fully enclosed, ventilated facility	+10

EFFECTS OF AIR POLLUTION SCORE selected ______.

2.2.3 Noise Impacts

Noise may be simply defined as any sound that is undesired by the recipient. Various sound levels are capable of producing speech masking, annoyance, sleep disturbance, and declines in property value near sources of noise. More seriously, noise can produce hearing losses, vasoconstrictive effects in the circulatory system, muscular tension, metabolic change, nausea, headaches, drowsiness, and respiratory irregularities.

Aspects of noise considered when measurement is made are the magnitude of the noise, the frequency distribution, and the variation and duration over time. The most commonly used measurement scale is the A-weighted decibel scale, db(A), which measures sound level in a way that emphasizes frequencies in a manner similar to human auditory systems. It was developed largely for use in measurement of motor vehicle noise (*2*).

Motor vehicle traffic noise seldom offers such physical danger to pedestrians. What it does do is annoy, cause discomfort, and interfere with speech. Heavy trucks and buses produce sound levels as high as 85 db(A) on city streets, as observed during this research. Figure 16 shows comparative sound levels from a range of noise sources (*2*, Fig. 5-3, p.214).

Because dangerous sound levels are seldom encountered by pedestrians, a scaling system to measure the impact of noise for pedestrian facilities can be restricted to the meaningful levels of sound usually encountered in typical types of pedestrian facilities:

70 db(A) An open overpass over heavy traffic;
65 db(A) A busy sidewalk on a commercial street allowing all types of vehicles with 70- to 85-db(A) peak;
60 db(A) An enclosed overpass over heavy traffic or a busy mall with buses and delivery traffic (with 70- to 85-db(A) peaks from those vehicles);
55 db(A) An open overpass over light traffic or a busy mall with buses and delivery traffic (with 70- to 85-db(A) peaks from those vehicles);
50 db(A) A quiet residential street.

The selected sound range for scaling pedestrian facilities is from 40 db(A) (a practical minimum) to 90 db(A) (a reasonable maximum). The upper value is exceeded by some subway-generated noises and other special noises, but speech is generally impossible beyond that level; therefore, it is a practical upper bound for pedestrian facility evaluation.

Sound level measurements in decibels using the A scale should be taken at a sufficient number of points to obtain a representative noise level for an existing facility. Estimates of the noise level for proposed facilities can be made by taking sound measurements from comparable facilities, or examining Figure 16 and the preceding list to select a reasonable value. The following scale can then be used to evaluate the noise levels for the proposed facility.

90 db(A)	77.5 db(A)	65 db(A)	52.5 db(A)	40 db(A)
-10	-5	0	+5	+10

Any noise level over 90 db(A) scores -10
Any noise level under 40 db(A) scores +10

Total NOISE SCORE $= -10 + \left[(90 - \text{observed or estimated noise level}) \times 0.4\right]$

= ________

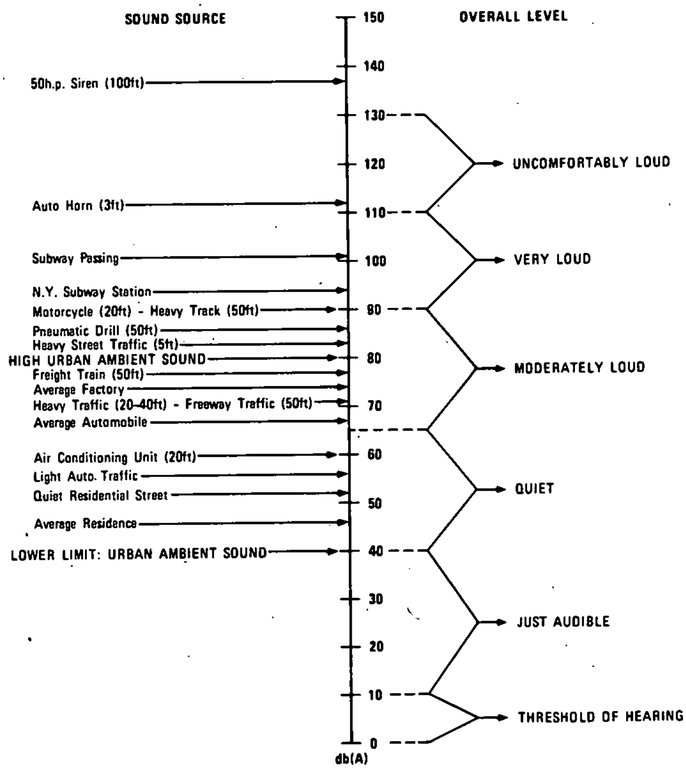


Figure 16. Comparison of sound sources and overall noise levels.

2.2.4 Health Effects of Walking (Exercise, Fatigue)

The primary anticipated health benefits of walking, jogging, running, or bicycling are improvements in physical health because of the physiological effects of exercise. Because society has become quite sedentary, a major health concern is toward coronary heart disease (CHD) and its prevention or control. The classical concept is that overall energy expenditure reduces the incidence of CHD; and the more exercise, the lower the risk. Other benefits of walking include caloric expenditure assisting in weight control, muscle tone development, reduced blood pressure, and reduction of psychological stress in many pedestrian environments. There is also a generally brighter mental outlook induced by attractive and comfortable pedestrian facilities. Against these must be weighed the possible disbenefits of induced fatigue (particularly the elderly), exposure to air pollution (particularly CO), and psychological stress if vehicles or excessive noise is present. Assessing the impact of a pedestrian facility on human health is, therefore, expressed in terms of those subelements that contribute (or detract) from the physical and mental well-being of its users.

Check the boxes in Figure 17 that apply to a given pedestrian facility to determine its score.

	Positive	Average	Negative
Volume of vehicle traffic within 100 ft (30 m) of pedestrians	None 2	Light 0	Mod 1 Heavy 3
Clear lanes for rapid walkers or joggers	Yes 1	No 0	--
Bicycle paths through or around facility	Yes 1	No 0	--
Improved access to tennis courts, swimming, other physical activity centers	Yes 1	No 0	--
Benches, ledges, and the like, available for rest stops	Yes 1	--	No 1
Adverse weather protection available (prevent exposure, physical discomfort)	Yes 1	No 0	--
Crime rate in area	Low 1	Mod 0	High 2
Aesthetically pleasing environment (conducive to mental health)	Good 1	Mod 0	Poor 2
Noise levels (psychological discomfort)	Low 1	Mod 0	High 2

Sum the columns as indicated: Positive = ______ Negative = ______

Total HEALTH SCORE is Positive Sum - Negative Sum = ________.

Figure 17. Health effects scoring.

3. RESIDENTIAL/BUSINESS DISTRICTS

3.1 Residential/Community

3.1.1 Residential Dislocation

This variable deals subjectively with the out-of-pocket costs and inconvenience to households (property owners and renters) incurred as a result of implementing a pedestrian facility. The score for this variable will usually be negative or zero unless special circumstances are present. The out-of-pocket costs considered include:

- Movement of household goods and furnishings.
- Temporary living expenses (housing, food, transportation).

- Residence renovation in new location to establish a comparable living environment.
- Cleanup and repair of residence at present location if movement is not required (stimulated pride of ownership).
- Property adjustments (such as fences) if property boundaries are changed by facility.

Inconvenience to those required to move includes time lost due to the movement and loss of access to friends, neighbors, schools, shopping, and neighborhood activities. Special circumstances that could offset some of these costs (for disbenefits) might be a reimbursement policy that compensates beyond the actual out-of-pocket costs or the availability of significantly better living quarters at comparable costs for those forced to move.

The final score for this factor is obtained by considering (1) number of households impacted, (2) the costable/noncostable components and reimbursement policy, and (3) any special circumstances.

A household index is selected from the following:

NUMBER OF HOUSEHOLDS IMPACTED	INDEX VALUE
0	0
1–2	1
3–5	2
6–10	3
11–20	4
21+	5

(1) HOUSEHOLD INDEX VALUE selected ________.

A reimbursement index is obtained using the following table:

Costable Impact Types	Reimbursement Policy 0%	50%	100%
Movement of goods	4	2	0
Temporary living expenses	3	1.5	0
Residence renovation (moved to)	1	0.5	0
Residence renovation (stay)	1	0.5	0
Property adjustment (stay)	1	0.5	0

(2) REIMBURSEMENT INDEX is sum of values in boxes checked ______.

A special circumstances index should be selected to range in value from 0 (no special circumstances) to 10 (exceptional circumstances) and reimbursement policies).

Points (0–5) for social policy such as a housing = ______.
Points (0–5) for excess reimbursement policy = ______.
(3) CIRCUMSTANCES INDEX is sum of values chosen = ________.

The final score for residential dislocation is obtained by the formula as follows:

$$\text{Total RESIDENTIAL DISLOCATION SCORE} = \text{Circumstances index} - \frac{\text{Reimbursement index} \times \text{Household index}}{10} - \text{Household index}$$

The following descriptors are used to illustrate the scoring method: 15 households impacted; 50 percent reimbursement policy for household goods movement and living expenses; no reimbursement for renovation or other costs; good housing program to assist homeowners in finding reasonable dwellings (also at moderate cost for low-income families); household index = 4; reimbursement index = 6.5; circumstances index = 5.

$$\begin{aligned}\text{Total score} &= 5 - \frac{6.5 \times 4}{10} - 4 \\ &= 5 - 2.6 - 4 \\ &= -1.6 \text{ (or rounded to } -2)\end{aligned}$$

3.1.2 Community Pride, Cohesiveness, and Social Interactions

This variable considers the impacts of proposed pedestrian facilities on neighborhood and community attitudes and personal relationships among residents. These impacts are difficult to assess, in part because of the wide diversity of neighborhood types.

As land values increase, cluster housing and other innovations which reduce areas devoted to the auto are increasing in popularity. These techniques often result in circuitous pedestrian travel paths unless special facilities are provided. Such circuity can result in a very low service level for public transit. The industry-accepted rule of thumb of service within ⅛ mile of a resident was based on a grid street pattern and is meaningless with streets designed to discourage auto traversing.

Variations of values and interactions within and between neighborhoods strongly suggest survey or interview techniques to adequately assess the impacts of proposed facilities. These techniques provide data that cannot be efficiently obtained in any other way, but care must be taken to minimize measurement errors in such data. However, unless the budget and schedule for the evaluation include provisions for a comprehensive interview of a scientifically selected probability sample, it is probably best to develop an informal interview guide appropriate to the particular project under consideration. Detailed attitudes about the proposed project, attitudes toward the community, and the nature of friendship and social interaction patterns can all be examined, as well as attitudes toward alternative proposals.

The most important assessment to be made in evaluating community impact is what degree of adaptation in behavior will be required as a result of the facility. The scoring system presented here is designed to assist in identifying the types of changes that may be caused by a pedestrian facility and the degree of desirability of such changes.

The evaluator should feel free to reassess the relative magnitude of individual changes by modifying the internal weights of each component. These weight modifications should be scaled to keep within the range of +10 to −10.

A total score for this variable is obtained using Figure 18. If a public meeting is held, copies of the figure could be given to participants with the responses tabulated on a blackboard at the front of the room. The type of impact is assessed and checked for a list of variable components, and the rating columns are summed. The total score is the sum of the favorable points minus the sum of the points for unfavorable outcome.

3.1.3 Community Activities

The demand for community activities such as displays, exhibits, special events, recreation, arts and crafts festivals, and fund-raising drives can serve as an indicator of the attractiveness of the area and city in which the pedestrian facility is located. An increase or decrease in the number of such activities will show changes in public participation in the community. Although permits are the source for monitoring this type of activity, they are necessary only if the event occurs on city property or if a street closure or sidewalk obstruction is required. Many of these events take place on private property and do not require official sanction. Peddlers, solicitors, and auction licensing may be another source of monitoring.

Records of community activities are available from local police departments and licensing departments. However, files are not longstanding and are frequently destroyed on expiration dates or immediately thereafter. Forecasting the change in such activities is an extremely subjective undertaking unless representatives of community groups that sponsor the activities have been involved in the planning process.

Indicate the score for change in community activities on the following scale:

-10	0	+10
Large decrease in community activities	No change in community activities	Large increase in community activities

COMMUNITY ACTIVITIES SCORE selected = ____________.

3.1.4 Aesthetic Impact, Compatibility with Neighborhood

This variable is used to assess the blending of a proposed pedestrian facility with the physical surroundings of a residential neighborhood. It should only be considered when pedestrian facilities are located in residential areas (e.g., sidewalks, paths, pedestrian/bicycle networks).

A checklist of favorable and unfavorable components is shown in Figure 19. The points in each checklist are to be added separately and then combined by subtracting the unfavorable point sum from the favorable point score. Nonapplicable points for a specific facility should be ignored, automatically assigning a neutral value of 0 to that component.

	Rating		
Component	Favorable or Improved	No Change	Unfavorable or Decline
Interest expressed in project	1	0	1
Access to neighbors and friends	1	0	1
The pedestrian facility as a meeting place	1	0	1
Neighborhood communications (e.g., bulletin boards)	1	0	1
Access to community facilities (e.g., shopping, theaters)	1	0	1
Access to public transit	1	0	1
Activities planned (e.g., block parties)	1	0	1
Protection of privacy	1	0	1
Fewer motor vehicles	1	0	1
Bicycle/jogging paths	1	0	1

Sum the columns as indicated: Favorable = ____ Unfavorable = ____

Total COMMUNITY PRIDE AND INTERACTION SCORE is

Favorable Sum - Unfavorable Sum = __________.

Figure 18. Neighborhood/community impacts.

3.2 Commercial/Industrial Districts

The implementation of many, if not most, pedestrian facilities vitally concerns the affected business interests in the vicinity. Not only long-term benefits but also survival during the construction and transition phase of the project are major considerations, especially for small local business persons. This section directs special attention to short-term (1 to 5 years) effects on business enterprises from implementation of a pedestrian facility, with the highest ratings assigned for those plans estimated to have the least detrimental effect.

3.2.1 Gross Retail Sales

The change in gross sales from last year's performance for the period under question is probably the single most important evaluation criterion for any retailer. Even though different stores will operate at different profit margins, and any increase in sales is likely to be more profitable than average (because the fixed expenses of rent, utilities, and some or all of the payroll have already been recovered), retailers still prefer to evaluate only the change in gross sales. This often reflects business people's reluctance to allow any useful information to get into the hands of competitors. Frequently, however, the store owners are unsure of their actual marginal rate of profit because of the complexity of its determination.

Changes in gross sales result from improved customer access, a greater volume of pedestrian traffic passing the store, improved attractiveness of individual stores or the general area, increased retail space afforded by vertical separation of at least a portion of the pedestrian traffic, and changes in the number of visitors, including out-of-town tourists. Individual store owners should be asked to estimate the effect of the facility on their businesses, although they may be reluctant or unable to do so without a trial experi-

Positive Compatibility Components

Structure and shape complementary to neighborhood architecture style	☐
Pleasing and complementary colors or textures	☐
Unobtrusive grade change features (ramps and steps should be masked if possible)	☐
Continuity of pathway with existing pedestrian paths	☐
Blended signing with no glare lighting	☐
Overall lighting complementary to existing light features and intensity levels	☐
Continues existing bicycle/jogging paths	☐
Reduced motor vehicle traffic	☐
Compatible noise levels; 50-55 db(A) in many neighborhoods	☐
Residential privacy protected	☐

Sum of positive components = ___________

Negative Compatibility Components

Unpleasant contrast between facility and existing architecture style	☐
Displeasing color or texture contrast	☐
Little pedestrian path continuity	☐
Obtrusive signing	☐
Uncomplimentary lighting and fixtures compared to existing features	☐
Increased motor vehicle traffic, especially trucks	☐
Increased noise levels--over 55 db(A)	☐
Privacy or sleep disturbed by users	☐
Additional litter or vandalism	☐
Fences, poles, or wires	☐

Sum of Negative Components = ___________

Total AESTHETICS AND COMPATIBILITY SCORE is

Positive Sum - Negative Sum + ___________.

Figure 19. Compatibility with residential neighborhood.

mental street closure. Although temporary or trial solutions lack many of the amenities of a permanent installation (such as attractive walking surfaces, trees, benches, and fountains), they can provide an indication of the public and business acceptance of the concept.

A more dependable source for estimates of changes in sales would be a large department store (often part of a chain) that has a research or statistics department, particularly if it has assembled data from previous experiences with similar projects. A chamber of commerce or merchants' association may be able to supply some data, but usually it will direct one to an executive of the major retailing firms, who will be the ultimate source of information.

One rule of thumb relates the increase in sales attributable to a successful facility (change in sales for the region) to the increase in pedestrian traffic on the mall. Retailers know that sales are directly proportional to foot traffic, and the ratio of changes in sales to changes in foot traffic was found to be about 1 to 10. In Norwich, England, there was a 5 percent improvement in sales that could be attributed to a street closure with a 45 percent increase in pedestrian traffic. Gross sales in downtown Kalamazoo, Michigan, for 1959, the first year after a mall in the area was completed, increased 15 percent. Retail sales for the county increased 12 percent for that same period, so sales attributable to the mall is 3 percent. Pedestrian traffic on the mall increased 30 percent.

Experience also shows that the rate of sales increase is likely to be limited to the first few years of a mall's existence because the novelty of the installation wears off and another sales attractor will probably be introduced into the region. Because sales are not expected to decrease beyond the 5-year projection period, the sales increases in the first year and subsequent four years build an increased sales base, attributable to the mall, that should continue for years into the future.

Estimate as accurately as possible the average annual change in retail sales attributable to the pedestrian facility for the first two years. This will be equal to the sales change for the affected stores minus the regional average for the same period. Use this percentage as the retail sales score. Inasmuch as a −10 to +10 scale is being used, indicate as −10 any 2-year annual decrease in sales greater than 10 percent, and as +10 any 2-year annual increase in sales greater than 10 percent. If projections indicate an expected sales volume decrease of greater than 10 percent, serious consideration should be given to alternatives with less severe impacts on local merchants and business persons.

It is expected that the projection of gross retail sales will be assessed at one time for the area affected by the facility as a whole, rather than scaling up from estimates from particular stores or groups of businesses. However, when the shopowners are contacted to determine their displacement or renovation costs for evaluating variable 3.2.2, they may be asked about their estimates of changes in gross sales, and this may be used as input to this estimation process.

RETAIL SALES SCORE selected ________.

3.2.2 Displacement or Renovation Required or Encouraged by Facility

This variable consists of the out-of-pocket costs to businesses incurred as a result of implementing the pedestrian facility. Unreimbursed costs from business displacements by the facility should be calculated. This number could be negative if a business were reimbursed more than its actual costs.

The costs of renovation to storefronts should be estimated, including signing (such as the replacement of hanging signs by backlighted signs flush against the building), window displays, and the cleaning and painting of building exteriors, by sandblasting if appropriate. They may be:

- Required, as in the case of signing ordinances.
- "Voluntary" but encouraged by the merchants association and all of the larger stores, which might typically be the case for comprehensive cleaning of building fronts.
- Completely voluntary, such as a remodeling of the front window display area.

If only a small number of stores are affected by the facility, or if a thorough evaluation is being made, contact all store and building owners to determine their estimates of the displacement or renovation expenses anticipated. If many businesses are involved, a suitable shortcut procedure is to select typical stores to represent the average, and multiply unit costs by the number of stores in that group or scale unit costs on the basis of frontage feet if that seems more accurate. Figure 20 is intended to aid in assembling the necessary information.

The rating for this variable is based on the ratio of displacement and renovation costs to the anticipated change in gross sales, item 3.2.1. The following scale gives the relationship between this ratio and the point score:

	Relocation	Storefront Renovation	Building Cleaning	Total
Store (or building) type				
Name of typical store (or building) type				
Frontage for typical store (or building)				
Cost for typical store (or building)				
Total frontage and/or number of stores (or buildings) in group				
Total costs for group				
Store (or building) type				
Name of typical store (or building)				
Frontage for typical store (or building)				
Cost for typical store (or building)				
Total frontage and/or number of stores (or buildings) in group				
Total costs for group				

Figure 20. Relocation and renovation cost worksheet.

RATIO OF DISPLACEMENTS AND RENOVATION COSTS TO CHANGE IN GROSS SALES	POINT SCORE
5	−10
4	−7.5
3	−5
2	−2.5
1	0
0.8	2
0.6	4
0.4	6
0.2	8
0	10

DISPLACEMENT OR RENOVATION SCORE selected ______.

For example, if a pedestrian facility required no business relocation, storefront renovation costs were $10,000, and building cleaning cost was $40,000, while the average annual sales increase attributable to the mall was 4 percent on a base of $1,000,000, the rating would be based on the ratio.

$$\frac{10{,}000 + 40{,}000}{1{,}000{,}000 \times 4\%} = \frac{50{,}000}{40{,}000} = 1.25$$

From the scale, the score must be interpolated between 0 and −2.5, and is −0.6. This is rounded to −1.

3.2.3 Ease of Deliveries and Employee Commuting

A significant purpose of a shopping mall or commercial district is to increase the flow of merchandise into and out of the area; hence, the ease of deliveries to an area is important. The flow of goods out of the area is usually handled by the pedestrians, particularly in downtown locations.

There are three major methods of truck deliveries to downtown businesses and other freight receivers. One is via the use of off-street loading docks; another is on-street curb parking immediately adjacent to a rear door or side-door to the store or building; and the third is on-street curb deliveries using the front customer entrance. Each of these will be affected differently by motor vehicle traffic restrictions.

Off-street loading docks can be found at very large freight attractors, such as large department stores, hotels, and office buildings. They are preferable to other forms of goods delivery because conflicts between trucks and pedestrians or other motor vehicles are greatly reduced or eliminated. Therefore, if the facilities affected by motor vehicle restrictions have off-street loading bays, they will not be impacted by the restrictions and thus they score a "0" for no gain or loss. If the addition of off-street loading areas is included as part of a new building under construction concurrently with the pedestrian facility, it would merit +10 because it is a big improvement. On the other hand, if an off-street loading dock were required to be added to an existing building, it should score −10 because of the much greater expense of retrofitting.

If there is now on-street curb parking, there may be priority parking for trucks, no special provision for truck parking, or illegal truck parking and standing. If curb deliveries will still be permitted, and the parking regulations remain the same, score "0" because there is no gain or loss, unless there is significant interference with sidewalk pedestrian traffic. If parking regulations are changed to make deliveries easier, score +5. An example of this regulation would be the establishment of a truck loading zone with commercial vehicle parking only between 7 a.m. and 7 p.m. Similarly, score −5 if parking regulations and access are changed in a manner that makes deliveries significantly more difficult.

If motor vehicle traffic is prohibited during all or part of the day on a street, stores that receive their deliveries on that street will have to make other arrangements. Deliveries may be permitted only during certain hours of the day, depending on local conditions—store hours, office hours, and peak-hour congestion. This might require certain adjustments on the part of receivers and the trucking companies due to labor contracts and security considerations. However, over the long run, adjustment may be more efficient because there would be no vehicle congestion to compete with delivery trucks, and store personnel could be organized to receive goods for a few specified hours per day. Smaller stores are affected by changes in the hours of deliveries more than larger stores because the person needed to receive the goods represents a significant fraction of the labor force for a small store. The score for this situation might range from +2, reflecting more efficient deliveries, as previously described, to −8 if there were a major inconvenience and significant cost for most truckers and receivers.

Truckers are likely to benefit from changes in the hours of deliveries at the expense of the receivers. Also, as noted, different stores will be affected differently by changes in regulations. If this is the case, a table should be constructed which shows the benefits or disbenefits to each stakeholder on a scale from −10 to +10. These should be combined using appropriate weights to arrive at an aggregate score. For example, consider a simplified situation with two scores and a trucking firm that serves both of them. If the big department store benefits slightly frm the change of delivery hours (+2), the small shop is severely inconvenienced (−8), and the trucking firm benefits (+6), the net score would be zero if all three were weighted equally. If the small shop were given more weight, the net result would be a disbenefit; whereas, if the trucker or the large store were weighted more highly, the net result would be a positive benefit.

An alternative to restricting truck traffic to certain hours is to prohibit it at all times, in which case the drivers would have to park on the nearest street and transport the goods to the store by hand or with a dolly. A special case is currency shipments to and from banks by armored car. If the courier must walk with money any distance away from his truck, there is a company rule that he must walk with his gun drawn. This will detract from the atmosphere of the mall, so it is suggested that armored cars be made exempt from restrictions that apply to other trucks. This has been done on the Sparks Street Mall.

The score for an outright prohibition of trucks, requiring use of handcarts for delivering goods, will range from −5 to −10, depending on the distances involved, frequency, and nature of deliveries. An alternative to accommodate outright prohibition of trucks would be the establishment of local consolidated delivery centers that would receive shipments for all affected buildings, and deliver the goods manually or mechanically. These centers could prove to be a net benefit, perhaps with a score of +5, depending on its operating costs and success.

It is not expected that a pedestrian facility will cause inconvenience to employees who commute to the site because pedestrian access will be improved. However, lack of parking or other inconveniences might cause difficulty in attracting and retaining employees for some employers. If this case holds, subtract up to 5 points from the ease of delivery score to reflect any special problems for employee commuters. Figure 21 recapitulates the suggested scoring for this variable.

3.2.4 Attractiveness of Area to Business

Evaluation of this variable is made by reviewing items shown in Figure 22 and checking the appropriate boxes. The score is obtained by summing the values checked.

3.3 Urban Planning

3.3.1 Adaptability to Future Transportation Development Plans

The adaptability of the pedestrian facility (as a transportation link) to future transportation system development plans is covered in 1.2.4. However, many facilities, particularly those designed for the purpose of providing a safe and enjoyable place for pedestrians to move leisurely and stop, impact the land use in the vicinity as much as or more than they affect the transportation system. The degree to which the facility fosters or hinders planned land uses for the area is measured by this variable.

As an example, consider a downtown pedestrian mall. Although a pedestrian mall may introduce a revitalization to a downtown area, alone it might be insufficient to save a city that has already gone into decay. If businesses will be moving out of the area with no replacement, there will not be any pedestrians left to enjoy the mall.

Evaluation of the impact of the facility on planned development can be performed best by an urban planner responsible for the area in question. Indeed, if the facility has been proposed by the planning or development agency having jurisdiction over the area, there is assurance that the facility's operation will conform with long-term development plans for the area. Unless there is in-house struggling, the score for this situation would be +10. For other conditions, the rating should be assigned accordingly.

-10	-5	0	+5	+10
Requires significant modifications to existing land use and development to accommodate the facility		No significant effect on short- or long-term land use and development plans		Enhances desired land use and growth patterns

FUTURE URBAN PLANS SCORE selected = _________.

3.3.2 Net Changes in Tax Receipts and Other Revenue

Changes in government revenues can be estimated in dollars by the planner with inputs from appropriate government agencies.

Sales taxes are usually collected by the state and partially reimbursed to the cities (or sometimes vice versa), thus gross receipts data are available from the collection agency. Data are categorized by the state of sale and are considered confidential, but they should be available on an aggregate basis

	Possible Score	Actual Score (leave blank if not applicable)
Facilities have off-street loading arrangements	0	
Off-street loading areas are to be added:		
For new construction	+10	
For existing buildings	-10	
Parking regulations:		
Remain the same	0	
Changed to make deliveries easier	+5	
Changed and make deliveries more difficult	-5	
Restriction of truck deliveries to certain hours	+2 to -8	
Outright prohibition of trucks	-5 to -10	
Above, but with local consolidated delivery centers	-5 to +5	
Inconvenience to employee commuters	0 to -5	

Total DELIVERIES AND COMMUTING SCORE is sum of values scored above = _________.

If sum of values exceeds +10, score +10.

If sum of values is less than -10, score -10.

Figure 21. Urban goods movement point allocation.

	YES	NO
Is there a significant rise in the rate of voluntary improvements to the property?	1	-1
Is there a trend toward the acquisition of additional selling and storage space?	1	-1
Is there a low vacancy rate for stores?	1	-1
Is there expressed interest by out-of-town firms to move into the area of the pedestrian facility? (This may be measured by the volume of inquiries to the Chamber of Commerce or the local economic development administration if there is one.)	1	-1
In addition to advertising for individual stores, do the merchants publicize the area surrounding the pedestrian facility as a place to go to shop?	1	-1
Do the merchants show enthusiasm for the area as a place to do business?	1	-1
Are there informative, educational, or entertaining displays in store windows or in hotel and office lobbies?	1	-1
Are there any special promotional activities sponsored, such as car displays, boat shows, or sidewalk sales?	1	-1
Is there a festive atmosphere, making the area pleasant for shopping?	1	-1
Can many out-of-towners be found among the consumer foot traffic?	1	-1

Total ATTRACTIVENESS TO BUSINESS SCORE is sum of values checked above = _________.

Figure 22. Evaluation sheet for area attractiveness to business.

either for geographic units or by type of business. Geocoding programs of census data in some states has made it possible to measure data by city cells. These data are confidential, under the control and security restraints of the government, but are accessible on a contractual basis.

Change in assessed property valuation, and hence property tax revenues, may be estimated by the assessment office of the city or county government. If this total change is X percent, it is assumed that it occurs at a rate of X percent/5 for the first 5 years and then remains at the resulting level for the next 20 years, making a total planning horizon of 25 years. According to data collected by the Downtown Research and Development Center (*7*) for Kalamazoo, Mich., Knoxville, Tenn., and Pomona, Calif., X can range from 20 percent to 75 percent.

If the pedestrian facility were strictly a business investment on the part of a municipal government, this variable would be the most important evaluation criterion. However, other motivations (i.e., the other variables) are likely to be more significant. Further, tax receipts and other government revenue resulting from a particular pedestrian facility will be mixed with other general revenue, not specifically earmarked to defray the facility's operating and construction costs. Thus, the magnitude of additional revenue can be compared with the government's total budget rather than merely with the expenditures for the pedestrian facility. For a small city within a metropolitan area, a major new shopping/commercial pedestrian facility might generate municipal revenue as much as 10 percent of the city budget, although in most cases it will be a smaller fraction. Ten percent is used to set the endpoint of the scale for this variable.

To evaluate this variable, estimate as accurately as possible the average annual change in sales, corporation income, and property tax receipts; parking, motor vehicle, and pedestrian violation fines; and other government revenue attributable to the pedestrian facility for the first 2 years. The annual average over a 2-year period is taken to compensate for the first year's settling in period, as is done for retail sales in Section 3.2.1. Divide this annual change by the total city budget, exclusive of the pedestrian facility. When expressed as a percentage, the number will be equal to the rating for this variable. Because +10 is the maximum scale value, indicate as +10 any increase in revenue of more than 10 percent. If a decline in total municipal revenues is greater than 10 percent, discussions should be held to examine alternatives with less serious revenue impacts.

TAX RECEIPTS SCORE selected = ____________.

3.3.3 Public Participation in the Planning Process

Figure 23, adapted from Yukubousky (*26*), describes a wide variety of community interaction techniques ranging from zero public participation to a high degree of community input. Some of the techniques might appear inappropriate for simple pedestrian facilities, having been designed for preparation of comprehensive metropolitan and regional transportation plans. However, community participation is felt to be important for all pedestrian projects also; therefore, the scale described in Figure 22 is equally applicable to both small and large projects.

CHAPTER THREE

MEASURING DOLLAR COSTS AND BENEFITS OF A PEDESTRIAN FACILITY

DECISION RULES FOR PROJECT SELECTION

The usual rule for economic efficiency when costs and benefits are measured in dollars is to select the project or set of projects that yields the greatest net present value. This is defined as the difference between the present value of the benefits received from the projects and the costs of implementing the projects. When there is a budget constraint of total project construction cost, this decision rule amounts to maximizing the present value of benefits for the available budget. If there are several independent projects from which to choose, selection in the order of declining benefit-cost ratios will obtain the set that maximizes present value (Andersen et al. (*1*) gives a full discussion of using benefit-cost ratios, and Grant and Ireson (*11*) illustrates using the internal rate of return for project selection in a consistent manner).

In cases where all costs and benefits are not measured in dollars, such as the evaluation method for pedestrian facilities, decision rules are not so readily formulated and depend on some translation of points into dollar equivalents. For the purpose of illustration, consider a cost-effectiveness approach in which the cost and the score (as a proxy for effectiveness) of each facility are compared. Assume first a set of alternatives—A, B, C, and D—that score and cost as follows:

ALTERNATIVE	SCORE	COST ($1,000)	POINTS/$1,000
A	100	150	0.7
B	100	100	1.0
C	150	100	1.5
D	200	200	1.0

Actions of Implementing Agency	Point Score
Monitor newspapers, radio, and television	-10
Conduct background studies and review election issues	-9
Catalog planning and design concepts	-8
Monitor impacts of complicated projects	-7
Initiate legislation	-6
Produce material for the media	-5
Present range of alternatives to public	-4
Map socioeconomic and attitudinal data	-3
Illustrate plans in nontechnical terminology	-2
Educate public about ongoing planning and decision-making process	-1
Maintain open planning and project files; listen to the public for suggestions	0
Survey opinions and attitudes	+1
Hold public hearings early in the planning process, with widespread publicity at least one month in advance of each meeting	+2
Hold a citizen referendum, to ensure draft plans will incorporate the majority opinion of the community	+3
Assemble a panel of community residents assisted by planners to make recommendations on alternative proposals at community meetings	+4
Set up community-led seminars	+5
Use a citizen advisory committee. Request a written review of all draft plans and alternative suggestions	+6
Mediate between parties	+7
Appoint a task force	+8
Hold workshops or informal neighborhood work meetings	+9
Employ community residents for brainstorming sessions, ombudsmen, and role playing	+10

PUBLIC PARTICIPATION SCORE selected = __________.

Figure 23. Rating score for community interaction techniques.

It is clear that alternative B is preferable to A because it costs less and achieves the same score; and C is preferable to B because it achieves a higher score for the same cost. But what of D? Alternative D has a point-per-$1,000 ratio equal to that of B, but when D is compared to C, the added score is 50 points and the added cost is $100,000. This gives an incremental (or marginal) ratio going from C to D of only 0.5 points per $1,000. Incrementally, D offers less benefits per dollar than A, B, or C individually. Thus, C is the most preferable alternative.

To describe a project selection procedure, one must first be able to establish an acceptable score per $1,000. This is called an "acceptable level." Whatever this level is, it has the effect of setting a dollar equivalence to the score, because only projects with a higher score per $1,000 would be judged worth constructing. Based on experience with past projects, there may turn out to be different levels for different facility types, which would indicate the degree of preference for each project type relative to other types. In the case of projects A, B, C, and D in the foregoing example, if the minimum acceptable score was 0.8 points per $1,000 and the projects were independent, projects B, C, and D would be acceptable if they could all be funded within existing budget levels.

If the projects were mutually exclusive (alternatives for the same site), project C should be chosen because it dominates A and B, and the incremental score/dollar ratio of D compared with C is only 0.5 points per $1,000. Select nonmutually exclusive projects within a budget limitation in order of their score/dollar ratios until either the available budget is exhausted or the lowest acceptable score per $1,000 is reached. Note that an alternative to this cost-effectiveness approach to project selection is to simply apply the score/

dollar ratio to project scores and conduct the selection process as an economic analysis directed to maximizing net present value.

CONVERSION TO DOLLAR VALUES

Three of the 27 evaluation variables are costable; each of these is first expressed in dollar units and then scaled to the +10 to −10 range. Gross Retail Sales (3.2.1.) are translated to the +10 to −10 scale based on their average annual percentage increase. Displacement and Renovation costs (3.2.2) are transformed by expressing them as a fraction of the change in gross sales. The third costable variable, Tax Receipts and Other Revenue (3.3.2) is transformed to the +10 to −10 scale by dividing the existing total city budget for the previous year.

Value of Pedestrian Travel Time

Two other variables, pedestrian travel time (1.1.1) and societal costs of accidents (2.1.1) are frequently translated into dollar costs in transportation studies, but this assignment requires judgments to be made of the value to society of an individual's time and the value of reducing accidents, particularly fatalities and serious injuries. This assignment of value is not required by the methodology, but the procedure for imputing values to each of these variables is described subsequently for use by those who desire it.

By the same means that value can be established for savings in automobile travel time (by observing drivers' and passengers' willingness to pay for the time savings by using a faster toll road), pedestrian travel may be evaluated by willingness to pay transit fares to save time. However, there are other factors involved in the pedestrian's decision to take transit, particularly comfort and a chance to sit down while traveling. Nevertheless, a few attempts have been made to quantify the value of pedestrian travel time based on willingness to pay transit fares and other models.

Contemporary investigators have concluded that motor vehicle travel time savings for commute trips should be valued at approximately one-half the prevailing wage rate. Thomas (*22*) used 0.5 of the hourly wage rate, Ellis (*8*) used 0.5, and Webster (*25*) used 0.55. Thomas and Thompson (*23*) have shown that the value of travel time varies significantly with the magnitude of time saved per trip. Updated values of their findings presented in Andersen et al. (*1*) indicate values of 6.4 percent of the wage rate for time savings of less than 5 min, 32.2 percent between 5 and 15 min, and 52.3 percent over 15 min.

A higher value should be assigned to the travel time of pedestrians than that of passenger car occupants. This is because the motorist is in a climate-controlled environment, physically protected, and psychologically insulated from the outside. The pedestrian, on the other hand, pays a higher price for travel because of being rained upon, splashed on, exposed to cold, threatened by accidents, and possibly suffering an invasion of his psychological buffer zone. The pedestrian is frequently a purchaser. All of the face-to-face business transacted in a city, except for a limited number of drive-in facilities, is conducted by pedestrians. Because he makes shorter trips than the motorist, a given delay will account for a larger fraction of his total trip and, thus, causes more inconvenience. His time is at a different level of perception from that of the motorist and, therefore, has been valued by researchers at two or three times the rate for motorists. The values derived by various investigators are as follows:

INVESTIGATOR	RATIO OF PEDESTRIAN TRAVEL TIME VALUE TO MOTORIST TRAVEL TIME VALUE
Quarmby (*19*)	2 to 3
Lisco (*15*)	2.8
Ellis (*8*)	2
Pushkarev and Zupan (*17*)	3.2
Dawson*	2

*From personal correspondence, 1975.

The elderly, handicapped, young, and poor—because they often do not own automobiles—are likely to be overrepresented among pedestrians in suburban and rural locations. These people are often not employed; thus, they probably assign a lower value than average to their time. Hence, a lower value of time could be used for locations other than central business districts. It is also more appropriate to express pedestrian travel time as a value per minute (than per hour as for passenger car time) because pedestrian trips are usually shorter. Even though the time saved is small compared to the total trip time, it is still perceptible to the pedestrian.

The low values associated with small travel time savings for motorists are related to the variability in motor vehicle travel time for a given trip, which is a function of traffic congestion, time of arrival at traffic lights, presence of law enforcement officers, weather, and the time required to find a parking space. Pedestrians, on the other hand, are more in control of their total travel time, inasmuch as stops for rest, sight-seeing, shopping, or conversation are usually discretionary. Only delays due to conflicts with vehicles and other pedestrians are usually beyond the control of the pedestrian. Informal observation by project team members shows that pedestrians are acutely aware of, and quite irritated by, even small delays, such as turning vehicles or escalator queues. Additional evidence is provided by the design guidelines for new elevator installations in office buildings, which frequently specify average waits of no more than 30 sec and average travel times of no more than 60 to 90 sec (Strakosch (*21*) at a considerable cost expense per elevator. Thus even small changes in pedestrian travel time, particularly those caused by delays rather than changes in walking distance, should be appropriately valued in the methodology.

Considering all of the foregoing, and making the assumptions listed in the following, acceptable values have been developed for pedestrian travel time. The assumptions are as follows:

- The average wage rate is $8 per hour for pedestrians in a busy central business district (CBD) and $6 per hour for other pedestrians. Wage rates in CBDs are higher because a substantial fraction of pedestrians in the average CBD hold supervisory or professional positions at higher wage rates.
- Automobile travel time is valued at one-half the prevailing average wage rate, and pedestrian travel time is valued at 2½ times the value for an automobile traveler, or 1¼ times the wage rate.

- Delays of up to 5 min are valued at twice the average wage rate.
- Leisure travel and the time of limited-mobility groups is valued at ½ the normal rate.
- Children under the age of 16 have a travel time of $^1/_{10}$ that of commuters, except when the travel decision is made by the parents, in which case other trip characteristics (such as safety) may be more important than travel time.

When calculations are performed using the listed assumptions, the guidelines given in Table 4 are obtained. The reader is, of course, free to use other values, particularly to reflect the local economic conditions.

The total cost of pedestrian travel time is obtained by using the data summarized in Chapter Two, Section 1.1.1.5. The total travel time (in minutes) for each pedestrian group is multiplied by the corresponding values from Table 4 producing travel time costs for the existing situation and for a proposed facility.

Societal Costs of Accidents

The approach taken to the evaluation of accident costs is to estimate the total societal costs resulting, directly or indirectly, from motor vehicle accidents involving pedestrians. The monetary values presented here are based on the NHTSA study, "Societal Costs of Motor Vehicle Accidents" (*24*). When values from this study are updated to 1980 using a 6 percent cost increase per year, the average societal cost of a fatality is estimated at $320,000; the average cost of a nonfatal injury (average of disabling and nondisabling) is estimated at $11,600. These values include medical costs (doctors, medication, special services), legal and court costs, hospital costs, loss of income, employer losses, losses to others, funeral cost (for fatalities), cost of community services, pain and suffering, losses in assets, and insurance administration costs.

By combining the figures in Table 5 with an estimated probability of a pedestrian accident per person crossing in urban areas of 5×10^{-7} (*16*), an estimated societal pedestrian accident cost of 1.4 cent per person crossing is obtained. This combination provides an estimate of accident costs at an existing or planned pedestrian facility based on the number of pedestrians crossing vehicle lanes. But it also should be noted that complete vehicle/pedestrian separation will result in no such crossings, which will reduce the accident cost for such a facility to zero. Planners who are proposing facilities in an area with reliable historic accident experience data can use the previous data and scale it by the estimated number of pedestrian crossings in the proposed facility divided by the estimated number of pedestrian crossings during the corresponding accident data collection period.

A technique was developed to modify the basic pedestrian accident risk figure per crossing (5×10^{-7}) by considering several pedestrian, vehicle, environmental, and traffic control factors. The relative accident risk per crossing for each facility (or each crossing point within the facility if necessary) is developed using Figure 24. For each crossing to be analyzed (one representative crossing may be evaluated if several similar corssings are involved), check off the boxes that apply, then sum the results (using the formula below) under both present and planned conditions, obtaining net involvement rates (NI rate) for both situations.

Table 4. Values of pedestrian travel time.

Type of Pedestrian (or Trip)	Value of Time (per minute): Central Business Districts	Other Locations
Commuters, workers on lunch break, or unknown mix	17¢	12¢
People in the course of their work	20¢	15¢
Delays (such as stop lights)	27¢	20¢
Other: Leisure trips, personal business, handicapped, retired, or students	7¢	5¢
Elementary school children	2¢	1¢

Table 5. Accident frequency and cost by severity.

Accident Severity	Frequency of Severity per Accident	Cost per Accident by Severity
Fatality	3 per 100	$320,000
Disabling injury	40 per 100	$ 11,600
Nondisabling injury	57 per 100	
All	100 per 100	$ 20,850

After estimating the present and proposed number of pedestrian crossings per year, the following formulas can be used to obtain a dollar cost figure for each site alternative. Equation 10 can be used if reliable historic accident data are not available, and Eq. 11 or Eq. 12 can be used if such data are available.

$$\begin{aligned}\text{Annual Cost} &= \text{Estimated no. of annual accidents} \times \$20{,}850\\ &= \text{Accident risk per crossing} \times \text{Proposed no. of crossings} \times \$20{,}850\\ &= 5 \times 10^{-7} \times \text{Proposed NI rate} \times \text{Proposed no. of crossings} \times \$20{,}850\end{aligned} \tag{10}$$

$$\text{Annual Cost} = \text{Historic accident risk per crossing} \times \text{Proposed NI rate} \times \text{Proposed no. of crossings} \times \$20{,}850$$

	Number of:	Rate Decreases				Average		Rate Increases			
PEDESTRIAN	Elderly (>65)	Few	10	5%	5	10%	0	20%	20	>30%	40
	Very Young (<10)	Few	10	1%	5	2%	0	4%	20	>8%	40
	Alcohol Involved	None	10	Few	5	Mod	0	Mod-High	20	High	40
	Illegal Crossings	None	5	Few	3	Mod	0	Mod-High	10	High	20
VEHICLE	Average Vehicle Volume	Low	5	Mod-Low	3	Mod	0	Mod-High	5	High	20
	Average Vehicle Speed (mph) (kph)	<15 (<25)	5	15-24 (25-39)	3	25-30 (40-49)	0	31-40 (50-65)	10	>40 (>65)	20
	Turning Conflicts	None	5	Few	3	Mod	0	Freq.	5	Many	10
	One-way Traffic		–	Yes	3		–	No	5		–
ENVIRONMENT	Sight Distance	Good	4	Fairly Good	2	Fair	0	Poor	5	Bad	10
	Crossings After Dark (Good Light)	Few	4	Mod-	2	Mod	0		–		
	Crossings After Dark (Poor Light)		–		–	Few	0	Mod	10	Many	20
	Weather	Mild	4	Mod-Mild	2	Mod	0	Mod-Severe	3	Severe	5
CONTROL	Signalization (Presence)			Ped & Veh	10	Veh Only	0	None	20		
	Police Enforcement (Ped Laws)			Heavy	3	Mod	0	Light	3		
	Active Public Education			Yes	2		–	No	2		

Sum the colums as indicated and divide each sum by 100: Decreases ____/100 = ____ Increases ____/100 = ____

Net Involvement Rate is Increase Rate - Decrease Rate ______ + 1 = ______

Avg = Average
Mod = Moderate
Ped = Pedestrian
Veh = Vehicle

Figure 24. Accident involvement rate adjustment.

$$= \frac{\text{Historic no. of accidents}}{\text{Historic no. of crossings} \times \text{Historic NI rate}} \times \text{Proposed NI rate} \times \text{Proposed no. of crossings} \times \$20,850 \qquad (11)$$

$$\text{Annual Cost} = \text{Historic no. of accidents} \times \frac{\text{Proposed NI rate}}{\text{Historic NI rate}} \times \frac{\text{Proposed no. of crossings}}{\text{Historic no. of crossings}} \times \$20,850 \qquad (12)$$

The estimated accident cost savings of a proposed pedestrian facility equals the present accident cost minus the estimated accident cost of the proposed facility.

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APPENDIX A

RESEARCH REPORT

To expedite publication the research report included herein (and Appendixes B and C) are reproduced as submitted by the research agency.

CHAPTER ONE

INTRODUCTION AND RESEARCH APPROACH

NCHRP Report 189, published in 1978, describes a method for evaluating all of the major and minor impacts, both positive and negative, of facilities designed for the safety, convenience, or transportation of pedestrians. That method was applied by the researchers at four locations, two existing pedestrian facilities, and two planned facilities. Despite the comprehensiveness, uniqueness, and proven use of this method, it has not been used by very many cities to date.

The purpose of Project 20-10 (2) has been to fill this gap by refining the method, adding to it the results of any recent research on pedestrians or evaluation techniques, simplifying the method and the technical user guide which describes it, and to prepare audio-visual materials to supplement the technical user guide. Another objective has been to extend the method by applying it to warrants for pedestrian and vehicle traffic separation.

The two major efforts in this project were the literature review and the preparation and revision of audio-visual materials. Other tasks of the research were subsidiary to these; and a list of all of the tasks appears in Table 1. A computer-generated listing of research report and technical journal article abstracts was the first step in the literature review process. More than 1500 abstracts were produced.

Table 1
TASK LISTING

Number	Name
1	Prepare Working Plan
2	Review Current Literature
3	Subdivide Facilities and Variables
4a	Adapt Measurement Techniques
4b	Study Warrant Feasibility
5	Develop User Guide Materials
6	Review Test Plans
7	Initial Test Period
8	Second Test Period
9	User Guide Review and Report

These were reduced to approximately 100 items, which were ordered and then reviewed. As part of this process, slide shows on pedestrian related subjects were received from the National Highway Traffic Safety Administration, Downtown Research and Development Center, Highway Users Foundation for Safety and Mobility, and the Federal Highway Administration's National Highway Institute, and reviewed for style and format, plus possibly for slides that might be incorporated into one of the audio-visual presentations.

Preparation of first draft scripts for the audio-visual materials was delegated to media specialists. Then graphics were prepared, photography selected or taken, scripts refined, music recorded, and narrations made. The results were shown to members of the research team and their associates repeatedly during the period when revisions were made, before any showings to outsiders. The formal testing was accomplished in two steps. The first step consisted of personal presentations by one or two research team members. Discussions were held with the group of viewers immediately after each presentation in order to answer their questions and gauge their reactions. A list of questions had been prepared for the research team member to raise during this discussion, but this proved to be unnecessary because the viewers offered comments on the presentations, the method, and related topics with little or no prompting.

The second step of field testing took place after the user materials were revised following the initial test. Letters were mailed to cities identified in an Urban Mass Transportation Administration report on transit malls, plus those with which the researchers were familiar, and recommendations received from cities contacted during the first step of testing. Those that responded favorably (about half) were contacted by telephone and were sent copies of the technical user guide. Arrangements for sending out the audio-visual materials were made with the four cities that requested them. Comments were solicited by telephone, and it was generally agreed that they would be sent in letter form to the researchers. The results of the testing are described in Appendix C.

CHAPTER TWO

FINDINGS

OTHER EVALUATION TECHNIQUES

After a detailed literature review task encompassing about 100 documents selected from more than 1,500 computer-generated abstracts, it was discovered that there were no new measurement techniques beyond those reviewed by the researchers during the previous research project. In addition, there were no new methods or procedures designed for or applied to the evaluation of facilities for pedestrians. Although numerous discussions of measuring particular attributes and of evaluating pedestrian facilities in general terms were discovered, there were none that could be incorporated into the evaluation procedure. This could be interpreted flatteringly by the researchers for the thoroughness of their previous research, but another explanation could be the general neglect of the pedestrian compared with the emphasis given to other passenger transportation modes in urban areas, such as automobiles, transit, and bicycles.

WARRANTS*

The final report for the previous research project proposed an "extension of the research... to use the evaluation methodology as a basis for developing warrants for pedestrian facilities. Not all of the measurement techniques would be needed for this application because many of them are more applicable to evaluating proposed changes, rather than quantification of existing problems." This subject has been studied

*A warrant is a rule used to determine when the installation of particular traffic improvement is justified from a performance, safety, and cost point of view.

in the course of the research, and it was concluded that such a warrant could indeed be developed.

Background

An important need exists for a system that can quantify pedestrian conditions to the extent that requirements for specific separate pedestrian facilities can be established. A recent Federal Highway Administration (FHWA) study (documented in working papers for Contract DOT-FH-11-9247) investigated warrants and design selection criteria for highway over- and undercrossings for bicyclists, pedestrians, and the handicapped. Internal Working Paper 1 from that study (DeLeuw, Cather & Company, 1978) contributed many of the ideas that are in this background discussion, and, with ITE Project Committee 4E-A Informational Report (1972), is the source for the section below on types of warrants.

In order to have overall safe and efficient pedestrian traffic movement in a city or state, similar situations should be given similar treatments. Whenever certain combinations of conditions are present, the need for a specific type of control or facility is warranted. Thus, warrants are criteria or measures of need that serve as guidelines for the decision-making process, rather than absolute criteria to indicate a "must do" situation.

Pedestrian-oriented warrants were originally treated in the same way, although the current thinking is that pedestrian warrants are usually not even guidelines, but advisory in order to provide a rational basis for decision-making. With pedestrians, there are more considerations than with vehicular traffic only. For example, a separated pedestrian route that receives very little use could be a misapplication of taxpayer funds, but at least in most cases will not degrade the overall transport system. An unwarranted stop sign, on the other hand, increases vehicle operating costs for motorists and could increase the frequency of accidents.

Another example of the difference between vehicular warrants and pedestrian warrants is that vehicle warrants are calibrated and tested only with traffic counts and accident data. Because of the number of factors to be considered for evaluation of pedestrian facilities, data requirements are much greater.

Types of Warrants

Four types of warrants are used for evaluation of pedestrian facilities:

- Economic warrants
- System warrants
- Thresholds
- Point ratings.

In an economic warrant process, monetary benefits for both vehicles and pedestrians are compared with construction and maintenance costs. Benefits are usually limited to time savings and reduced accident losses. These are usually difficult to determine for pedestrians, especially where the facility permits pedestrian activity that did not exist before, such as a freeway or creek crossing.

System warrants are used to justify facilities that are essential components of an entire system, such as a circulation master plan. The circulation plan should include descriptions of all pedestrian elements. Development of a circulation plan is a thorough process during which numerous alternatives are considered. After the plan has been approved, evaluation of any particular pedestrian facility focuses on the degree to which the site is essential to the system as a whole.

Threshold warrants state that if a specified combination of factors exist, then a pedestrian facility is justified. FHWA's Manual on Uniform Traffic Control for Streets and Highways minimum pedestrian volume warrant is a good example of a threshold. It is satisfied when there are 600 or more vehicles and 150 or more pedestrians per hour during each of eight hours of an average day. Threshold warrants frequently result in the establishment of warrant conditions that are difficult to meet, and hence many borderline and "near miss" traffic situations (such as 149 pedestrians during one of the eight hours in the example given above). Threshold warrants are thus often inadequate because they are not sufficiently responsive to justification factors not considered by the warrant.

Point warrants utilize numerical values for various parameters. Weights are assigned to the factors, and summation of all values produces a score which can then be utilized as a comparison or ranking tool. The evaluation method developed during this project is an example. Point warrants can indicate potential benefits of proposed facilities that do not meet the conditions of the threshold, but approach them, and also have other important demonstrated needs.

Existing Warrant Systems

An extensive literature review by the researchers discovered a total of only six other pedestrian warrant systems. They are as follows:

1. City of Seattle (van Gelder, 1970)
2. New Jersey Department of Transportation (Batz et al., 1975)
3. FHWA Manual for Planning Pedestrian Facilities (Prokopy, 1974)
4. FHWA Manual on Uniform Traffic Control for Streets and Highways (FHWA, 1971)
5. Road Traffic Board of South Australia (Crinion, 1972)
6. NCHRP Project 3-20 (Lieberman et al, 1976).

Items 1, 2, and 3 are described on page 13 of NCHRP Report 189.

Three of these systems are threshold warrants, two are point warrants, and one is an economic warrant. This is shown in Table 2. No examples are shown for system warrants because they cannot be generally applied to different cities. A different circulation master plan, and hence system warrant, must be prepared for each city.

Table 2

EXAMPLES OF WARRANTS

Type	Examples
Economic	FHWA Manual for Planning Pedestrian Facilities
System	These depend upon the implementing agency
Threshold	Road Traffic Board of South Australia
	FHWA Manual on Uniform Traffic Control for Streets and Highways
	NCHRP Project 3-20
Point	City of Seattle New Jersey Department of Transportation NCHRP Project 20-10 (2)

Number of Parameters

There are wide differences in the number of parameters considered in the pedestrian warrant systems that were investigated. The number of parameters correlates with the type of warrant. Threshold warrants can consider as few as two variables (vehicle and pedestrian traffic volumes) to as many as seven, when speed limit, vehicular delay, accident rate, sight distance and roadway width are considered. The economic warrant explicitly considers nine costable benefit factors.

Point warrant systems, because of their design and flexibility, consider even more parameters--nine in New Jersey, eleven in Seattle, and 27 in NCHRP Project 20-10 (2). Those 27 variables are actually a summation of more than one hundred discrete elements. All these individual parameters are both practical and desirable in a comprehensive pedestrian facility evaluation and prioritization scheme such as the one developed in this project. However, for purposes of screening out locations where separate pedestrian facilities are not warranted and determination of which proposals should be fully evaluated, only a subset of the variables is really necessary.

Use of Method

Of the variables that are included in the evaluation method that is the subject of the current research project, about half evaluate the existing conditions only, and the other half develop a score that depends upon a comparison of existing conditions with the planned facility. Four of the variables evaluate a planned facility only, independently of what currently exists. Since warrants are applied to an existing situation, only the variables that evaluate existing conditions can be used in a warrant without modification. All but two of the eleven variables which evaluate only existing facilities are appropriate for use in a warrant. One additional variable, Societal Cost of Accidents, can be modified for warrant purposes, thus bringing the total number of variables to ten. These variables are listed in Table 3.

Table 3
FACTORS FOR USE IN WARRANTS

1. Pedestrian Transportation
   - 1.1 Ease of Walking
   - 1.2 Convenience (Access and Availability)
   - 1.3 Special Provisions for Various Groups
2. Safety
   - 2.1 Societal Cost of Accidents
   - 2.2 Accident Threat Concern
   - 2.3 Crime Concern
   - 2.4 Emergency Access/Medical and Fire Facilities
3. Environment/Health
   - 3.1 Pedestrian Oriented Environment
   - 3.2 Noise Impacts of Motor Vehicles
   - 3.3 Health Effects of Walking (exercise, fatigue, etc.)

Note: Except for variable 2.1, Societal Cost of Accidents, which is described in Figures 2 and 3, the procedure for evaluating these factors is described in the technical user guide.

Evaluation of the new Societal Cost of Accidents variable, modified so as to be applicable for an existing situation, is described in Figure 1. As modified, this variable no longer depends upon pedestrian volume, which is considered with the total score for all ten weighted variables, not separately for accidents.

Since there are now ten factors within the three major categories, only a two-level hierarchy is needed, as shown in Table 3. This makes determination of weights and scores easier than for the three-level hierarchy which is used in evaluation of planned facilities. Weights totaling 100% should be assigned to the ten variables by the decision-maker. This permits flexibility for any community to specify warrants that are tailored to its needs. No other pedestrian warrant system has this advantage.

Figure 1

EVALUATING SOCIETAL COST OF ACCIDENTS (Variable 2.1)

The total societal cost of motor vehicle accidents involving pedestrians is a function of the number of accidents, their severity, and many direct and indirect costs such as medical and hospital, legal, income loss, pain and suffering, and insurance administration costs. This section provides a technique for estimating the relative risk of accident occurrence based on past experience of pedestrian, vehicle, environmental, and traffic control components. By multiplying the accident risk by the number of pedestrian exposures (in terms of pedestrian cossings of vehicle roadways), an estimate can be made of the number of accidents. Relative accident risk is estimated and then used to determine a unitless accident score for alternative pedestrian facilities.

The accident risk crossing for each location under consideration is estimated using the accident involvement rate adjustment (Figure 2). For each crossing to be analyzed (one representative crossing may be evaluated if several similar crossings are involved), check off the boxes that apply, then divide the column sums by ten as shown in Figure 2.

Total COST OF ACCIDENT SCORE = Rate Decreases — Rate Increases +2.

= ______________.

If the score is lower than -10, indicate it as -10.

First, priorities should be established for the three major categories, and 100 percentage points should be divided among them. Then do the same thing for the variables that fall under each category. Zero is a legitimate percentage value to use at any level. After all of the weights have been assigned, review them and revise if desired. Check that each set of weights adds up to 100%. Finally, multiply the category weights and individual weights. Round the product to the nearest 1%. The result is a percentage weight for each variable.

Proposed Application of Warrants

After weights have been assigned, the ten variables (or fewer if some are given zero weight) are evaluated on the uniform +10 to -10 scale (as described in the workbook). The signed score for each variable is then multiplied by the percent weight for that variable. All of the products should be added together to obtain an overall score which could range from -1000 to +1000. Then, determination of whether or not a pedestrian separation facility is warranted at the site under consideration depends upon the pedestrian flow volume during the fourth highest hour of an average day, as shown in Table 4. Regardless of how low the score is, no facility is ever warranted if it will not have at least five users during the fourth highest hour of an average day. A site with a net score of zero (i.e., where the positive aspects of that location as far as pedestrians are concerned are exactly offset by the negative factors) must have a fourth highest hourly pedestrian traffic volume of at least 200.

When the 85th percentile speed of major street traffic exceeds 65 kilometers per hour (40 mi/hr), or when the site being considered

	Number of:	Rate Decreases				Average		Rate Increases			
PEDESTRIAN	Elderly (>65)	Few	10	5%	5	10%	0	20%	20	>30%	40
	Very Young (<10)	Few	10	1%	5	2%	0	4%	20	>8%	40
	Alcohol Involved	None	10	Few	5	Mod	0	Mod-High	20	High	40
	Illegal Crossings	None	5	Few	3	Mod	0	Mod-High	10	High	20
VEHICLE	Average Vehicle Volume	Low	5	Mod-Low	3	Mod	0	Mod-High	5	High	20
	Average Vehicle Speed (mph) (kph)	<16 (<25)	5	15-24 (25-39)	3	25-30 (40-49)	0	31-40 (50-65)	10	>40 (>65)	20
	Turning Conflicts	None	5	Few	3	Mod	0	Freq.	5	Many	10
	One-way Traffic		–	Yes	3		–	No	5		–
ENVIRONMENT	Sight Distance	Good	4	Fairly Good	2	Fair	0	Poor	5	Bad	10
	Crossings After Dark (Good Light)	Few	4	Mod-	2	Mod	0		–		
	Crossings After Dark (Poor Light)		–		–	Few	0	Mod	10	Many	20
	Weather	Mild	4	Mod-Mild	2	Mod	0	Mod-Severe	3	Severe	5
CONTROL	Signalization (Presence)			Ped & Veh	10	Veh Only	0	None	20		
	Police Enforcement (Ped Laws)			Heavy	3	Mod	0	Light	3		
	Active Public Education			Yes	2		–	No	2		
	Sum the colums as Indicated			Decreases ___/10 = ___				Increases ___/10 = ___			

Figure 2

ACCIDENT INVOLVEMENT RATE

lies within the built-up area of an isolated community having a population of less than 10,000, then Table 5 should be used instead of Table 4, because differences in the nature and operational characteristics of traffic in urban and rural environments and smaller municipalities. At the other extrem higher threshold levels should be developed for use in cities with very high pedestrian volumes, such as New York.

Table 4

PEDESTRIAN TRAFFIC VOLUMES NECESSARY TO WARRANT SEPARATION FROM VEHICLES

If the weighted score, when computed as described in the text is.....	Then a fourth highest hourly pedestrian traffic volume of at least the following is necessary to warrant separation.
-500 or lower	at least 5
-400	40
-300	80
-200	120
-100	160
0	200
+100	240
+200	280
+300 or higher	320 or higher

Table 5

SUBSTITUTE PEDESTRIAN TRAFFIC VOLUME WARRANT FOR RURAL AREAS AND SMALL TOWNS

For a weighted score of ...	Fourth highest hourly volume must be the following to warrant separation
-500 or lower	at least 4
-400	30
-300	60
-200	85
-100	110
0	140
+100	170
+200	200
+300 or higher	225 or higher

Requirement for Field Evaluation

Potential users should note with caution that this proposed warrant has not been field tested, having been produced by literature research and contemplation only. In particular, Tables 4 and 5 need to be calibrated on the basis of actual field data. An attempt was made to set these at a high level, so they would not warrant separate facilities that are not truly needed. Only field testing can validate whether the warrants were set at the appropriate level.

USER ACCEPTANCE OF THE EVALUATION METHOD

During the first round of testing the audio-visual materials developed during this project, the group discussions that the researchers held with city planners and engineers were very enlightening. They provided specific information about the audio-visual materials, and also some information about applications of the method itself. The informality of these discussions enhanced the flow of information on this subject, compared to the subsequent field test task, where the necessity of primarily communicating in writing in some cases limited the total amount of information, and in almost all cases limited the subject matter strictly to feedback on the user materials. Key insights developed during these discussions and subsequent correspondence are as follows:

- The procedure should be called an "evaluation method" rather than a "methodology." The original term infers an academic orientation that could not serve practical purposes.

- Many public works projects (including pedestrian facilities) are ultimately selected by politicians in order to serve the needs of special interests. Modifications of this type can occur at any time during the planning process, even after construction has already begun, regardless of how carefully the project is designed and evaluated.

- The method cannot be used to make a final decision among different pedestrian projects within the same city because of the political decision process. Planning officials in the first four cities visited during the field testing expressed frustration that the location for pedestrian projects is always selected either because of political pressure or because of restrictions placed on the use of federal or state funding grants, and never by objectively evaluated need. The method is well suited to evaluating alternative projects that are being considered for the same location, as illustrated in the videotape, especially when federal funding requires an analysis of alternatives, or if an environmental impact assessment is performed. The method can serve as a viable alternative to project selection on the basis of emotions, especially when pedestrian safety is involved.

- The method may be used by a state agency to compare pedestrian projects at different locations within the state. Political interests are less likely to override more technically derived decisions in a statewide setting than they are in any given municipality.

Table 6

PEDESTRIAN FACILITY EVALUATION VARIABLES

Pedestrian Transportation	1. Travel Time 2. Ease of Walking 3. Convenience 4. Special Provisions for Various Groups
Other Transportation	5. Motor Vehicle Travel Costs 6. Use of Automobiles 7. Impact on Existing Transportation Systems 8. Adaptability to Future Transportation Development Plans
Safety	9. Societal Cost of Accidents 10. Accident Threat Concern 11. Crime 12. Emergency Access/Medical & Fire Protection
Environment/ Health	13. Pedestrian Oriented Environment 14. Effects of Air Pollution 15. Noise Impacts 16. Health Effects of Walking
Residential/ Community	17. Residential Dislocation 18. Community Pride and Cohesion 19. Community Activities 20. Aesthetic Impact, Compatability with Neighborhood
Commercial/ Industrial Districts	21. Gross Retail Sales 22. Displacement, Replacement, or Renovation Required or Encouraged by Facility 23. Ease of Deliveries & Employee Commuting 24. Attractiveness of Area to Business
Urban Planning	25. Adaptability to Future Urban Development Plans 26. Net Change on Tax Receipts and Other Revenue 27. Public Participation in the Planning Process

CHAPTER THREE
INTERPRETATION, APPRAISAL, APPLICATION

POTENTIAL APPLICATIONS OF TECHNIQUES DEVELOPED

The primary objective of this research was to develop user materials that describe a comprehensive method for evaluating the social, environmental, and economic benefits of pedestrian facility proposals. Benefits and disbenefits are quantified by a set of measurement techniques developed for the 27 variables listed in Table 6. The overall evaluation method combines analytic measurements of the 27 variables and decision makers' explicitly stated subjective values (weights) for the relative importance of each variable.

Because many of the variables are subjective in nature (e.g., comfort, attractiveness, noise), the calculation of benefits is performed using a unitless scale of positive and negative values (+10 to -10) for each variable. Positive values correspond to desirable characteristics; negative values indicate undesirable characteristics. Zero values indicate either "does not apply" or "indifference" (neither good nor bad).

Unitless scoring allows comparison of alternatives at a single location without the need for assigning dollar values to the many noneconomic impacts of pedestrian facilities (and many other public projects). Guidance is also provided for obtaining benefit values in dollars, if required, to allow comparison of pedestrian facilities with other budget expenditures. The primary basic use of the methodology is for evaluation and comparison of proposals for pedestrian facilities, according to the objectives of this research. This application is described in detail in the technical user guide. Another use of the scoring system is to evaluate existing pedestrian problem locations on a comparative basis. This could be used to indicate the locations that deserve further study. The scoring system may also be used as a design evaluation tool to encourage alterations that will increase the benefits obtained from pedestrian facilities.

Explicit weighting of the relative importance of each variable requires a formalization of preference values for the community. This determination may be made by the decision-maker alone, or may be the result of extensive public participation. Once developed, the explicit use of such weights provides consistent evaluation criteria. Suggested sets of weights for safety and for suggested social/commercial oriented facilities are provided for those who choose not to develop their own weights.

Possibly the greatest advantage of the evaluation method is that it allows and encourages use of many benefit measures usually excluded from conventional economic analysis. By reflecting community needs and values that are not easily quantified, use of the method may provide adequate justification for projects not defendable previously by economic analysis alone. The evaluation method described in the user guide requires between one and ten person-days of effort for evaluation of a reasonable number of alternatives at a single location, depending on the number and complexity of the alternatives. Medium to large size cities can use the method with their existing staff and resources.

AUDIO-VISUAL MATERIALS

A finding of the original pedestrian facility evaluation study was that the "research report could be supplemented with the use of a well-designed visual display using sophisticated graphics techniques. A narrated slide show or a moving picture might be the best format. The presentation could convey the information presented in this report rapidly and effectively to decision-makers, community groups, and planners." In order to follow that recommendation, the most significant effort on Project 20-10 (2) has been the development of user materials. Included within that effort has been a simplification of the method and of the instructions for using it wherever possible. Now, the procedure is described as an evaluation "method" rather than "methodology." This is indicative of the attempt to switch from an academic emphasis to one that is more practically oriented. Ironically, this has reduced somewhat the need for audio-visual materials to supplement the Technical User Guide, but it is felt that they can be quite valuable for certain applications, particularly for technical personnel and nontechnical persons who are not especially knowledgeable about or sensitive to the needs for pedestrian facilities. For example, the nontechnical presentation could be used as an excellent introduction to a public meeting about proposed pedestrian facilities. The technical presentation might be shown to an individual assigned to evaluate alternative pedestrian facilities who has no previous experience in evaluations of this type.

Selecting Type of Presentation

It was known from the beginning of the research that the audio-visual materials must reflect the needs of two quite different types of stakeholders: technical persons (such as transport planners, designers, and evaluators), and nontechnical persons (such as facility users, political decision-makers, and other persons or groups affected by the facility). It was later realized that the needs of those two groups were so different that completely separate presentations would have to be developed. Then the type of presentation was determined. For large audiences, such as might view the nontechnical presentation, it was important to be able to project an image so people in the back of the room could see it. Thus, a movie, filmstrip, and slide show were considered. The technical presentation would probably have a much smaller audience, but the ability to have a moving picture was required so that concepts could be explained or illustrated fully. Thus, movies and video were considered. Movies were quickly eliminated because of the expensive production costs. Filmstrips were rejected because of the difficulty in finding equipment to show them. Thus, a slide show was selected for the nontechnical presentation, and videotape for the technical presentation.

Experience with the Presentations

During the preparation, testing, revision, retesting, and final revisions of the audio-visual materials, several important lessons were learned. At first we were afraid that some potential viewers of the presentations would experience difficulty in obtaining the proper equipment for viewing it, especially video playback monitors. Fortunately, this turned out not to be the case. Only one prospective viewer (a Panel Member) could not obtain a slide synchronizer, so he was able to read the script (Appendix B) and advance the slides manually on a regular slide projector that did not have the audio synchronization equipment. There were no reported difficulties in obtaining the U/Matic video cassette playback monitor required for viewing the technical presentation. Local television stations are usually happy to lend their equipment to government agencies or public interest groups for viewing tapes such as these. They do this for their own interest, since all television stations must be relicensed periodically by the Federal Communications Commission (FCC), and one of the factors that the FCC considers is the degree to which the station serves the community interest. Many schools and corporations with their own training programs have this equipment. During the first round of field testing, we were pleased to learn that the Boston Redevelopment Authority has several video cassette recorders, which were used for making a presentation there. They are attached to electric timers, and they record evening news broadcasts on different television stations; so on the next business day, city staff members can view segments that are of particular interest to the city government.

We found that all of the cities contacted were very eager to have one of the researchers come visit and make a technical or nontechnical presentation, as appropriate. This was not surprising because the cities invited to participate in the field tests were chosen from a list of 50 cities involved in various stages of planning pedestrian-oriented facilities. The list was compiled from a small literature search that included transportation control plans submitted by various states to the U.S. Environmental Protection Agency in order to demonstrate how they expect to reduce emissions from motor vehicles. We also used extensively the December 1977, Auto Restricted Zones Site Selection Methodology Final Report published by the U.S. Urban Mass Transportation Administration, for information about cities that were contemplating pedestrian projects. However, when the cities were offered a loan of the audio-visual materials, so they could make the presentation themselves, the enthusiasm waned considerably. This was because many of the planners we spoke to did not want to take an advocacy position of recommending the NCHRP evaluation method to their colleagues, especially without prior viewing of the audio-visual materials. Even though the planner could present the materials as "the NCHRP's method" (and not their own), in many cases they were afraid that their colleagues would perceive them as advocating the method. Perhaps this could be alleviated by scheduling a lunchtime showing or some other nonwork time. Alternatively, the video presentation cassette could be left in the video monitor room on certain designated days, and interested persons could view it individually or in small groups at whatever time is convenient for them. Since the liaison person would not be present during the viewing, then he or she would be less likely to be thought of as an advocate of the method.

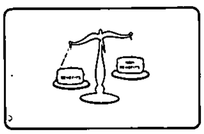
Preparation of the slide show was a difficult and lengthy process. This was because the script had to be perfected and expertly announced; photographs, drawings, and graphics had to be made or selected to best illustrate the message and all be consistent with one another; the timing had to be worked out precisely, with audio and visual presentations synchronized; and the music and sound effects had to be recorded and mixed. All of the viewers had their own opinions about what was lacking, what needed improvements, and how this should best be done. The best strategy is to first develop a script which leaves the audience with the desired message, and which most of the viewers find acceptable, and then select photographs and graphics to illustrate the words that are spoken. In addition to being keyed to the sound track, the graphics should be of a consistent style and theme.

One problem with the slide show has been to present a feeling for the depth and precision of the evaluation method, but not to overwhelm the viewers with details that could be gleaned from the technical user guide, if necessary. Thus, only 16 of the 27 variables are listed for the viewers of the presentation, and they are shown on the screen only for a brief period. In order to provide the viewers with a list that they can study at their leisure, and also to review the major steps of the evaluation, a handout was prepared, as shown in Figure 3 (A and B). If it is distributed before the presentation begins, then viewers will realize that it is unnecessary for them to take notes, and then they can more thoroughly enjoy the show.

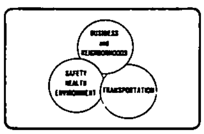
Figure 3A

Evaluating Pedestrian Facilities

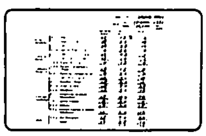
A system has been developed to measure the net benefit of a planned or existing pedestrian facility.



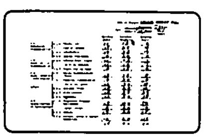
There are three major categories of impacts which relate to any pedestrian facility. Within these categories, there is a total of 27 primary factors that can be measured. These factors are listed on the reverse side of this sheet.



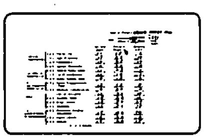
A facility is evaluated on a score of +10 to -10 for each factor.



Multiply the weight for that factor by the score from above.



Add the weighted scores to obtain a total score.



When used to evaluate and compare proposals for future pedestrian facilities, this procedure provides a good indication of the effects and impacts to be expected. It is also useful for evaluating existing situations where pedestrians and vehicles come into conflict, as well as in determining the adequacy of existing separated pedestrian facilities.

For further information, contact either of the persons listed below. Handbooks and a technical presentation which describe the evaluation system are available.

Mr. Marc F. Roddin
SRI International
Building 22
Menlo Park, CA 94025
(415) 326-6200, ext. 2438

Mr. R. Ian Kingham
Transportation Research Board
2101 Constitution Avenue, N.W.
Washington, D.C. 20418
(202) 389-6741

Figure 3B

27 Primary Factors for Pedestrian Facility Evaluation

TRANSPORTATION

- Travel time
- Ease of walking
- Convenience (access and availability)
- Special provisions for various groups
- Motor vehicle travel costs
- Use of automobiles
- Impact of existing transportation systems
- Adaptability to future transportation development plans

SAFETY/ENVIRONMENT/HEALTH

- Societal cost of accidents
- Accident threat concern
- Crime concern
- Emergency access/medical and fire facilities
- Pedestrian-oriented environment
- Effects of air pollution
- Noise impacts of motor vehicles
- Health effects of walking (exercise, fatigue, etc.)

RESIDENTIAL/BUSINESS

- Residential dislocation
- Community pride and cohesion
- Community activities
- Aesthetic impact, and compatibility with neighborhood
- Gross retail sales
- Displacement or renovation required or encouraged by facility
- Ease of deliveries/employee commuting
- Attractiveness of area to business
- Adaptibility to future urban development plans
- Net change in tax receipts and other revenues
- Public participation in the planning process

CHAPTER FOUR
CONCLUSIONS AND SUGGESTED RESEARCH

GENERAL CONCLUSIONS

A primary objective of this research, the refinement of a comprehensive method for evaluating the social, environmental, and economic impacts of proposals for pedestrian facilities, has been achieved. Measurement techniques were developed for variables that quantify all significant direct and indirect benefits and disbenefits of facilities separating pedestrians and vehicles. Hundreds of individual parameters are examined as components or characteristics of the 27 measurement variables in the user guide. The method combines analytic measurement of these variables with weights selected by the decision-maker on the relative importance of each variable. The result is a comprehensive and consistent, flexible and responsive tool for traffic engineers, planners, developers, architects, evaluators, political decision-makers, lobbyists, and community civic groups.

The extensive range of measured parameters provides a broad perspective on the design of pedestrian facilities. The inclusion and quantification of many subjective variables reflect the presence of needs and desires within the community that are usually excluded from conventional economic analyses. Thus, even though the methodology increases the number of impacts considered by the decision-maker, it makes the decision task easier by the use of explicit rather than implied evaluation factors.

Audio-visual materials developed during this research supplement and enhance the method by illustrating a potential application of its use, and also by providing a more general introduction to the subject of evaluating pedestrian facilities. Hopefully, the availability and use of these materials will encourage more use of the method for evaluating proposed pedestrian facilities, which will, in turn, provide feedback which can be used to further improve the method. Agencies that request the audio-visual materials or the technical user guide should be contacted about one year later to learn of their experiences in using the method and improvements that they wish to suggest. Prospective users of the method should be encouraged to telephone NCHRP or its contractor if they have any questions, and in this way the types of questions that are asked could provide insights as to how the method is being used and what the potential problem areas might be.

This project also evaluated the potential use of the method in the preparation of pedestrian traffic warrants. All of the variables in the evaluation method were considered as possible candidates for warrants. It was found that eleven of the variables consider only the existing situation, and therefore are applicable to warrants, whereas the other variables evaluated the planned facility or compared the existing and planned facilities. All but two of these variables were found acceptable for warrants, and a tenth variable, "Societal Costs of Accidents," was modified for use in the warrant. The research concluded that the evaluation method was indeed amendable to use as a warrant, and a sample warrant is presented in Chapter Two.

SUGGESTED RESEARCH

Field Testing of Warrant

The sample warrant that was developed and is presented in Chapter Two has not been field tested. The original pedestrian facility evaluation method itself was field tested in four locations, and this experience was very helpful in perfecting it. A similar testing regimen is necessary for the pedestrian traffic warrant developed during this study. Letters would be sent to the chief traffic engineers for a number of cities, inviting them to participate. State highway agencies and consulting traffic engineers would be contacted also. Those interested in participating in the study would be given a full briefing on the method. Potential problem locations would be identified, and necessary data would be collected. Assistance would be requested from political decision-makers and community interest groups to develop an appropriate set of weights. Locations that warrant pedestrian facilities would be more closely examined, and the list would be compared with those selected by using existing warrant evaluation procedures. If six to eight cities and one or two states (or regions of large states) were studied this way, potential application of the method for pedestrian warrants could be improved, demonstrated, and documented.

Further Refinement of the Measurement Techniques

This research has extended and refined a comprehensive method that evaluates all primary and secondary impacts of a wide variety of pedestrian-oriented facilities. The variables and their components were developed in their present form by the research team from minimal existing information in many cases. Inasmuch as the techniques have been tested only at four locations and only by the researchers responsible for their development, further refinement of the measurement techniques will undoubtedly occur when they are employed in future applications. Development and extension of this research should occur during the first few years that the method is used in the design and evaluation phases of a variety of projects that separate pedestrians from vehicles. It certainly would be desirable to collect all of these experiences at some future time.

It is believed that further refinement of the measurement structure, the addition or deletion of variable characteristics and components, the technique for evaluating each component characteristic, the internal weighting of the various components, and the phrasing of the narrative and graphics could be embarked upon as a separate research study for almost any of the 27 evaluation variables. Indeed, some suggestions along this line were offered during review of the technical user guide, but these were received during the time when finishing touches were being made on the audio-visual materials. This was too late for seriously considering them for incorporation into the method, since we wanted the audio-visual materials to accurately represent the evaluation method. The suggested additional variables were "Enclosed Facility" and "Geographic Location."

For most variables, the important components that characterize the particular impact have been identified, but the four case studies were insufficient to perfect the relative weightings given to the various components. The implicit weights for each variable were determined as best estimates, based on reading the literature, discussions with facility planners and designers, the four case studies, and personal experience as pedestrians. In some cases, though, assignment of a particular set of weights was not justified, and all of the characteristics were assembled into a checklist, implicitly assigning them all equal weight. The following seven variables should be examined more thoroughly in an effort to develop more precise internal weights of their components:

1.1.2 Ease of walking.

1.1.4 Special provisions for various groups.

2.2.1 Pedestrian-oriented environment.

2.2.4 Health effects of walking.

3.1.2 Community pride.

3.1.4 Aesthetic impact, and cohesion compatibility with neighborhood.

3.2.4 Attractiveness of area to business.

In view of the experience gained in the conduct of this project, five additional variables (and one component) are believed to be candidates for more comprehensive study and reformulation. These variables deserve more concentrated attention than was possible to this study because little previous research had been done in their particular domain. These six items are described as follows:

1. Impact on existing transportation systems (1.2.3) provides the user with a chart for recording changes in the type of use and required modifications to existing transportation modes, but the analyst must use his own judgment to convert the entries on this table to a final score. The impacts of proposed pedestrian facilities on other transportation systems are poorly understood. In anticipation of ever-increasing emphasis on energy conservation, on efforts to decrease urban air, water, and noise pollution, and on citizen demands for less congestion, an effective and comprehensive evaluation of these multiple impacts is expected to become increasingly important to the urban planner.

2. For societal cost of accidents (2.1.1), greater accuracy is needed in predicting the frequency of pedestrian accidents, basing the predictions on facility design, use, and environmental characteristics. Also, an effort should be made to predict the severity of injuries and the probability of a fatal pedestrian accident, given these same parameters.

3. Additionally, research is needed to more accurately predict the occurrence and effects of criminal incidents (crime, 2.1.3), given information about the design and operation of the pedestrian facility and information about social content of the surrounding community.

4. A major component of the litter control (2.2.1.2) component is the cleanliness index developed by the Urban Institute to evaluate street and alley litter conditions. This work should be extended to produce photographs illustrating the levels of cleanliness of pedestrian facilities such as malls and overpasses.

5. For residential dislocation (3.1.1), further research should be directed to better understanding the social and psychological impacts to individuals who are relocated, and how social assistance may be designed to meet these needs.

6. Finally, a better means is needed for predicting and measuring how a pedestrian facility affects the level of community activities (3.1.3).

Further study on any one of the 12 variables mentioned is believed to be a candidate subject for university research, and particularly well suited for dissertation or thesis topics.

Other Related Research Topics

Other suggestions for research in areas related to this project, but not direct extensions of this study, are described in the following.

The current research project was undertaken because pedestrians and motor vehicles usually cannot safely or comfortably coexist on land that is intensively used for transportation or other commercial purposes. An increasingly attractive alternative to separating pedestrian and motor vehicle traffic is to allow only one of them within carefully defined borders. One solution is to restrict the operation of motor vehicles in central cities. The means for accomplishing this have been researched extensively and rough estimates made of the impacts of such actions. However, no definitive study has been made on comparative costs to supporting and operating an urban transport system centered around the automobile. The results of this study might prove to be very enlightening, for if the results show from a broad social perspective that the automobile is more expensive to maintain and operate than the alternatives, cities would be able to more completely compute the financial and other advantages that would accrue by eliminating automobiles from congested city centers.

An objective of this research project has been to assess a comprehensive range of social, economic, and environmental impacts of proposed pedestrian facilities and to organize these impacts in a fashion that enables decision-makers to act with full knowledge of the implications of the various alternatives. Further research directed toward developing a rational decision-making strategy for local governments and others might bring the process further into the public eye. If more knowledge were available on how decisions may be guided by informed public inputs, community civic associations could learn to make themselves more effective, and presumably everyone would benefit as a result; relationship could be studied further with modern shopping malls and downtown business districts. This study could have a broader scope of the impacts of pedestrian facilities on retailers, how retailers can develop pedestrian facilities in order to improve business, and the potential for joint public-private participation.

Finally, an extension of the evaluation method could be to develop a broad set of pedestrian facility design concepts and selection criteria related to facility purpose and stakeholder interests. Facilities intentionally designed to achieve a high rating are likely to be well received in the community. With generally accepted pedestrian design criteria, cost savings would be realized in materials, assembly, and construction if modular, multipurpose components for pedestrian facilities would be developed. The need is for a system that will help to optimize tradeoffs. Additionally, model ordinances and building codes could be developed for use by cities desiring to guarantee that future public works and private developments would be planned with the pedestrian user in mind.

Another potential research topic would be to study attitudes held by staunch automobile advocates, especially in the western states, towards individuals who choose to walk to their destinations or take public transit. Some people are made to feel inferior because they prefer walking to driving. The proposed study should examine these attitudes, attempt to document them, and see what can be done to change them.

The effect of pedestrian facilities on gross retail sales is covered by variable 3.2.1. The rule of thumb used in the calculation is based on data from Norwich, England, and Kalamazoo, Michigan; but those studies are old. Perhaps this variable could be reworked to include the most recent research findings and observations of merchants.

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APPENDIX B
SCRIPT FOR SLIDE PRESENTATION

1. Evaluating Pedestrian Facilities. 2. Caveman trudging up slope.	(Music for focusing and lighting adjustment.)
3. Same man in toga. Rain is pouring, slope now muddy.	MAN HAS ALWAYS HAD TO SUFFER INCONVENIENCE, DISCOMFORT, AND DANGER. (Wind, noise, lightning crash.)
4. Same man in modern dress w/truck bearing down on him.	FOR THE PEDESTRIAN, DANGER IS ALWAYS NEAR.
5. Fountain of Tortoises (Rome, 1850).	IN THE PAST, THE PEDESTRIAN WAS BETTER OFF WHEN IT CAME TO SPACE IN WHICH TO MOVE ABOUT. IN THOSE DAYS EVERYONE WAS A PEDESTRIAN.
6. Plaza in Versailles, with market/ recreation area (circa 1850).	(Telemann music) PEDESTRIAN PLAZAS WERE NOT ONLY SAFE FROM VEHICLES, BUT COMBINED MARKETS, MEETING PLACES AND RECREATION AREAS.
7. Athenian Plaza at time of Pericles.	GALLERIES AND CANOPIES SHELTERED PEDESTRIANS FROM THE SUN AND RAIN.
8. Clock tower, hotel and City Hall Plaza (Zurich, 1820).	PLAZAS ADDED TO THE CHARM OF THE CITY. FOR PEDESTRIANS, IT WAS GREAT!
9. Crowded freeway at night.	THE INCREASING VOLUME AND SPEED OF VEHICULAR TRAFFIC PLACED GREATER DEMANDS ON THE TIME AND TALENTS OF PLANNERS. (Freeway sounds)
10. Woman at median island waiting for a gap in traffic.	THE PEDESTRIAN TOOK SECOND PLACE TO THE VEHICLE...
11. "Pedestrians Prohibited" sign.	.....AND SECOND PLACE...WAS LAST PLACE.
12. Person in wheelchair, confronted by steps.	AND THE HANDICAPPED?
13. Cut curb with support bar.	THEY WERE IGNORED, TILL RECENTLY.
14. Split screen; three photos of pedestrians and vehicles in conflict.	WE HAVE REACHED A POINT WHERE WE MUST GIVE GREATER CONSIDERATION TO THE PEDESTRIAN.
15. Photo of wheel and feet.	THE ALARMINGLY HIGH NUMBER OF PEDESTRIANS KILLED OR MAIMED IN TRAFFIC ACCIDENTS MUST BE REDUCED.
16. Imminent pedestrian accident at intersection.	(Car skid, scream, dull thud.) THERE IS A PEDESTRIAN ACCIDENT EVERY MINUTE SOMEWHERE IN THE UNITED STATES......
17. Pedestrian fatality.	(Metronome ticking) ...AND ONE FATALITY EVERY HOUR. ALL DAY LONG. EVERY DAY OF THE YEAR.
18. Air pollution over city skyscrapers.	WE NEED TO REDUCE AIR POLLUTION.....
19. Drawing of hotrod at gas station, with thick black smoke coming from exhaust.	...AND, DECREASE OUR DEPENDENCE ON IMPORTED PETROLEUM.
20. Intersection crowded with pedestrians.	WE MUST GET PEOPLE OUT OF THEIR BUCKET SEATS AND ONTO THEIR FEET.
21. Children crossing street, holding hands.	PARKING THE CAR AND WALKING IS HEALTHY. FOR THE WALKER. FOR EVERYONE.
22. Overhead walkway.	PEOPLE NOW SEE THE NEED FOR ATTRACTIVE, EFFICIENT PEDESTRIAN FACILITIES, SEPARATE FROM VEHICULAR TRAFFIC.
23. Howard Jarvis on magazine cover.	IT COULD BE ARGUED THAT SEPARATE PEDESTRIAN FACILITIES COST TOO MUCH IN THESE TIGHT TIMES. BUT.....
24. Drawing of: policeman, fireman, teacher, nurse, engineer.	THERE ARE INCREASED COSTS AND DEMANDS FROM SCHOOLS, POLICE AND FIRE DEPARTMENTS AND HEALTH AND SOCIAL PROGRAMS. IN FACT, ALL THE BASIC COMMUNITY SERVICES.

25. Man crossing street.	IT IS CHEAPER TO BUILD UNSEPARATED FACILITIES...
26. Highway with sidewalk beside it.	LIKE, HIGHWAYS WITH SIDEWALKS BESIDE THEM. THE BENEFITS ARE IMMEDIATE, DIRECT, AND TANGIBLE.
27. Graph with: -fatalities going down -pollution going down -auto expenditures going down.	BUT SAFE, CONVENIENT <u>SEPARATED</u> PEDESTRIAN FACILITIES SAVE LIVES...CUT POLLUTION... AND CERTAINLY REDUCE VEHICLE OPERATING COSTS.
28. Shopping mall.	SEPARATE PEDESTRIAN FACILITIES WILL ALSO INCREASE RETAIL SALES IN ADJACENT STORES AND PARTICIPATION IN.....
29. Sidewalk crafts sale.	CRAFT DISPLAYS, STREET FESTIVALS, AND OTHER COMMUNITY ACTIVITIES. THESE ARE BENEFITS THAT PAY OFF, YEAR AFTER YEAR.
30. People wandering through pedestrian facility.	SO... ALTHOUGH MONEY IS TIGHT... SEPARATE PEDESTRIAN FACILITIES ARE A WAY FOR COMMUNITIES TO GET THE MOST FOR THEIR MONEY.
31. Graphic: benefits going up non-benefits going down.	LIKE ANY PUBLIC EXPENDITURE, THEY MUST BE FUNDED ON THE BASIS OF MAXIMIZING BENEFITS FOR PEDESTRIANS AND MINIMIZING COSTS AND NEGATIVE IMPACTS, THE NON-BENEFITS.
32. Sketch of balance scale with benefits on one side and non-benefits on the other.	PLANNERS MUST THOROUGHLY ASSESS THE NET BENEFIT OF PROPOSED PROJECTS AND EXISTING FACILITIES.
33. Graphic/total benefits: -total non-benefits -net benefit.	THE NET BENEFIT IS WHAT YOU GET WHEN YOU SUBTRACT THE TOTAL NON-BENEFITS FROM THE TOTAL BENEFITS FOR A GIVEN PEDESTRIAN PROJECT. BEFORE WE TALK ABOUT MEASUREMENTS, LET'S TALK ABOUT OBJECTIVES.
34. Town meeting photograph (San Mateo County Planning Commission).	TO DEVELOP STANDARDS FOR JUDGING PLANNED FACILITIES, WE MUST FIRST KNOW WHAT OUTCOME THE COMMUNITY WANTS.
35. Pedestrians on Skyway.	THE FIRST OBJECTIVE IN PROVIDING PEDESTRIAN FACILITIES IS THE SMOOTH FLOW OF PEDESTRIAN TRAFFIC...
36. Pedestrian overpass.	PEDESTRIAN OVERPASSES AND UNDERPASSES.....
37. Pedestrians emerging from subway station.	PASSENGER LOADING AND UNLOADING AREAS AT TRANSIT DEPOTS.....
38. Moving sidewalks.	AND MOVING SIDEWALKS, ARE EXAMPLES OF FACILITIES THAT KEEP TRAFFIC FLOWING, ALLOWING MORE PEOPLE TO MOVE.
39. Pedestrians strolling through park.	THE SECOND OBJECTIVE IS TO PROVIDE PLACES WHERE PEDESTRIANS CAN MOVE IN A SAFE, LEISURELY FASHION... WHERE THEY···
40. Mall.	CAN RELAX OR SHOP. MALLS...
41. Mini-Mall.	MINI-MALLS.....
42. Small urban park.	PARKS.....AND
43. Lawn bowling.	RECREATION AREAS MEET THIS OBJECTIVE. AS YOU CAN SEE, THIS IS SOMEWHAT DIFFERENT FROM THE FIRST OBJECTIVE. THE PLANNER MUST UNDERSTAND WHICH OF THE OBJECTIVES MUST BE MET FOR A GIVEN FACILITY, BECAUSE IT WILL AFFECT THE VALUES ASSIGNED IN DETERMINING THE NET BENEFIT.
44. Videotape and workbook.	THIS SLIDE PRESENTATION DESCRIBES A PROVEN METHOD FOR EVALUATING PROPOSED PEDESTRIAN FACILITIES. AS YOU WILL SEE, THE METHOD COMBINES MEASURED QUANTITIES WITH COMMUNITY PREFERENCES. THE REMAINDER OF THIS PRESENTATION SUMMARIZES THE PROCEDURE AND ITS APPLICATIONS. A MORE TECHNICAL DISCUSSION IS AVAILABLE IN VIDEOTAPE AND WORKBOOK FORMAT.
45. Graphic: -transportation -safety/health/environment -business and neighborhoods	TO DETERMINE THE NET BENEFIT OF A FACILITY, WE MUST COME UP WITH A SET OF FACTORS RELATING <u>TO</u> THAT FACILITY. FACTORS THAT CAN BE MEASURED. WE GROUP THEM INTO THREE MAJOR CATEGORIES...
46. City street.	IMPACTS ON TRANSPORTATION.....
47. Jogger.	IMPACTS ON SAFETY, HEALTH AND THE ENVIRONMENT...
48. Neighborhood bicycle path.	AND, IMPACTS ON BUSINESS AND NEIGHBORHOODS. IMPORTANT FACTORS TO TRANSPORTATION
49. Bike racks on mall.	...INCLUDE CHANGES IN TRAVEL TIME FOR WALKERS AND RIDERS AND EASIER ACCESS TO PLACES SUCH AS STORES OR PARKS.
50. Pedestrian plaza in front of office building.	SAFETY, ENVIRONMENTAL AND HEALTH IMPACTS INCLUDE THE FACILITY'S EFFECT ON CRIME RATES, NOISE, AND CONSERVATION OF NATURAL RESOURCES.
51. House for sale.	BUSINESS AND RESIDENTIAL IMPACTS COVER RELOCATION OF HOUSEHOLDS, CHANGES IN PROPERTY VALUES AND EFFECTS ON TOURISM.
52. Graphic/List of transportation factors	WITHIN THESE CATEGORIES, WE'VE IDENTIFIED 27 PRIMARY FACTORS THAT CAN BE MEASURED.
53. Graphic: list of safety/health/environment factors.	EACH OF THESE PRIMARY FACTORS HAS SEVERAL IMPORTANT COMPONENTS OR CHARACTERISTICS.
54. Graphic/list of business and neighborhood factors.	IN THIS WAY, MORE THAN 100 INDIVIDUAL ELEMENTS ARE GIVEN CONSIDERATION IN MEASURING EFFECTS... OR IMPACTS, SUCH AS.....
55. Elderly person walking.	EASE OF WALKING.....
56. Imminent pedestrian accident.	THE COST OF ACCIDENTS...

57. Store window with "Grand Opening" sign.	IMPACTS ON GROSS SALES....
58. Bicycle bridge exiting into parking lot.	EFFECTS ON COMMUNITY PRIDE, NEIGHBORHOOD COHESIVENESS AND SOCIAL INTERACTION...
59. Flower pots next to footpath.	AND, IMPACTS ON THE ATTRACTIVENESS OF SURROUNDING AREAS. TO MEASURE THE IMPACTS, WE FIRST...
60. First few lines of worksheet, emphasizing scores.	ASSIGN TO EACH FACTOR A SCORE FROM PLUS TEN TO MINUS TEN, ACCORDING TO...
61. Evaluators.	HOW THE EVALUATORS BELIEVE A PARTICULAR FACILITY MEETS THE CRITERIA ESTABLISHED FOR EACH OF THE FACTORS.
62. Worksheet with multiplication indicated.	THEN, WE MULTIPLY EACH SCORE BY A WEIGHT THAT REPRESENTS THE IMPORTANCE OF THAT FACTOR IN RELATION TO THE OTHERS.
63. Table showing weights totaling 100%.	THE SUM OF THE PRIMARY VALUES IS 100 PERCENT. WHEN SELECTING WEIGHTS, KEEP IN MIND THE ORIGINAL OBJECTIVE, THE SMOOTH FLOW OF PEDESTRIAN TRAFFIC, OR, PROVIDING MORE LEISURELY MOVEMENT.
64. Top of worksheet. Emphasizing the heading.	ADDING THE PRODUCTS FOR EACH FACTOR WILL GIVE YOU THE TOTAL SCORE FOR A GIVEN FACILITY. THEN YOU CAN RANK THE PROPOSED FACILITIES ACCORDING TO THE SCORES.
65. Sketch of proposed mall.	ALTERNATIVES WITH THE HIGHEST SCORES ARE THOSE FOR WHICH INVESTMENT OF COMMUNITY MONEY WILL ACHIEVE THE GREATEST NET BENEFIT. THESE MEASUREMENTS PROVIDE A VALUABLE PLANNING TOOL TO LEGISLATIVE DECISION-MAKERS, PLANNERS, ADMINISTRATORS AND DEVELOPERS.
66. Photo of pedestrian crossing street.	THEY CAN BE USED TO EVALUATE ANTICIPATED IMPACTS AT LOCATIONS WHERE PEDESTRIANS AND VEHICLES COME INTO CONFLICT.
67. Split screen with special interest group signs.	THEY CAN HELP SPECIAL INTEREST GROUPS AND THE PUBLIC TO DEVELOP A GREATER ROLE IN THE PLANNING PROCESS.
68. Drawing of public meeting.	BUT MOST IMPORTANT, THIS SYSTEM DISPLAYS TO THE COMMUNITY THE VALUE OF ALL TYPES OF PEDESTRIAN FACILITIES.
69. Pedestrian facility with reflecting pool.	THIS METHOD REQUIRES BETWEEN ONE AND TEN PERSON-DAYS OF EFFORT FOR EVALUATION OF A REASONABLE NUMBER OF ALTERNATIVES AT A SINGLE LOCATION, DEPENDING ON THE NUMBER AND COMPLEXITY OF THE ALTERNATIVES. MEDIUM TO LARGE SIZE CITIES CAN USE THE METHOD WITH THEIR EXISTING STAFF AND RESOURCES.
70. Pedestrian overpass.	THE METHOD CAN GIVE YOU CONSISTENT AND OBJECTIVE ESTIMATES OF A FACILITY'S WORTH. AND, YOU'LL HAVE GREATER ATTAINMENT OF COMMUNITY OBJECTIVES....
71. Graphic/National Cooperative Highway Research Program.	(Begin theme music, quietly.) PROVIDING THE BASIS FOR IMPROVED RELATIONS AMONG THE PUBLIC, SPECIAL INTEREST GROUPS AND GOVERNMENT.
72. Graphic/SRI International.	(Music ends after about 20 seconds.)

APPENDIX C

RESULTS OF SECOND PHASE OF TESTING

Work on this task began in August 1980 and was completed at the end of January 1981. The purpose of this second test period was to broaden the experience with the evaluation method and the user materials, and to determine their adequacy and effectiveness when used with little or no assistance from the project team.

A letter similar to the one used in the first test period was sent to the mayors of 34 cities during the last week in August 1980 (see Figure C-1). A letter was also sent to the California Department of Transportation (CALTRANS).

Responses indicating interest in participating in the test program were received from the planning directors of the following 16 cities:

Tucson, Arizona
Anaheim, California
Riverside, California
Danbury, Connecticut
Hartford, Connecticut
Atlanta, Georgia
Boise, Idaho
Chicago, Illinois
Louisville, Kentucky
New Orleans, Louisiana
St. Paul, Minnesota
New York City, New York
Portland, Oregon
San Juan, Puerto Rico
Spokane, Washington
Toronto, Ontario, Canada

The director of planning at CALTRANS also expressed interest in the test program, although he could not allocate enough staff time to view the audio/visual presentations. However, he was able to provide us with a very thorough review of the User Guide.

Response time to the initial letter varied considerably. Some cities replied within a few days of receiving the letter, and two cities did not respond until early November. The majority of the responding cities were heard from in late September.

While all of the above cities initially expressed interest in participating in the test program, only three of them (New Orleans, Portland and Toronto) actually completed the whole program. The other thirteen cities either participated in reviewing only the User Guide, or dropped out at various stages.

Figure C-1

SRI is conducting a study for the National Cooperative Highway Research Program (NCHRP) on evaluation of pedestrian facilities. The objective of this study is to extend the usefulness of a comprehensive method we've developed for evaluating all significant primary and secondary impacts of a wide variety of pedestrian-oriented facilities such as shopping malls, auto-free zones, overpasses, underpasses, and transit malls. In order to supplement the 120-page user guide that describes how to use the method, we've developed audio/visual materials to illustrate both the purpose and the application of the evaluation method.

To determine the effectiveness of the user guide and audio/visual materials, we are testing them in cities that are contemplating future development of pedestrian facilities. Based on the response to the audio/visual presentations and feedback from those who utilize the method, we will refine the user guide, audio/visual materials, and the method itself. The final results will then be made available for practical use by facility planners, evaluators, and decision-makers.

There are two different types of presentations: a videotape designed for transportation planners, designers, and evaluators who would be actually using the method; and a slide show for political decision-makers, facility users, merchant associations, and others who desire an introduction to the subject of evaluating pedestrian facilities, but will not be directly involved with the method.

We would like to obtain your participation as one of the test cities for using our evaluation method. The first step involves viewing of the videotape (14 minutes) by your planning staff, or viewing of the slide show (15 minutes) by those involved in the community decision-making process (perhaps your city council), or both. If after viewing the presentations you decide that you would like to apply the evaluation method to your own planning process, the user guide and limited assistance will be made available at no cost.

If you are interested in participating in SRI's study, please return the enclosed stamped, preaddressed postcard, or call me at (415) 326-6200 ex. 2297.

Sincerely,

Sue Ruano
Research Analyst
Transportation and Information
Management Systems Center

SRI International
333 Ravenswood Ave. • Menlo Park, CA 94025 • (415) 326-6200 • Cable: SRI INTL MNP • TWX: 910-373-1246

All of the cities with the exception of New Orleans requested to receive the User Guide prior to making a commitment to view either the videotape or the slide show. Several of the city planning directors felt that if the evaluation method was clear to them after reading the User Guide, it would not be necessary to view the videotape. Others simply did not want to make a commitment solely on the basis of the explanation letter because they were not sure that the evaluation method would be useful to their staff. Although this was not an anticipated occurrence, the project team complied with the requests to send copies of the User Guides before scheduling the audio/visual presentations for the cities.

The reaction to the User Guide and the evaluation method was very positive, with only one city (Hartford) responding negatively. Several cities said that they definitely plan to use the method when there is an opportunity for them to do so, and New Orleans had hoped to be able to begin an evaluation before the end of the test period.

While the cities were enthusiastic about the User Guide and the evaluation method, the project team met with extreme reluctance in trying to schedule the audio/visual presentations. There were several reasons for this, but the primary one given was that since the presentations were to be held without assistance from the project team, too much time, effort, and responsibility was required by the city's planning staff. Also, some of the cities questioned the need for the technical videotape, saying that the User Guide seemed straightforward enough to be used without having to see an example.

Three cities agreed to view the presentations in addition to reviewing the User Guide: New Orleans, Portland, and Toronto. A fourth city, New York, had asked to see both presentations, but returned them after more than a month, apparently without viewing them. No explanation was given, and repeated attempts to contact the Transportation Department's Director of Urban Design were unsuccessful.

New Orleans showed both the technical videotape and the non-technical slide show to several different audiences. The results were favorable, although it was felt that the slide show achieved its purpose better than the videotape did.

Portland requested both presentations, but after preliminary screening it determined that the slide show was too basic even for the citizens' advisory group and so only the technical videotape was shown to the planning staff. The viewers did not think that the videotape should be seen before reading the User Guide. They also would have liked to see a more detailed introduction on the various uses for the method and what it can accomplish.

Toronto's planning department was shown the videotape, as well as other interested planners from various organizations in the metropolitan area. Their main concern was that the "on-site" element of the evaluation process was not demonstrated clearly enough. This was corrected in the subsequent revision of the videotape during Task 9.

None of the cities using the presentations reported any problems in obtaining the required equipment for viewing (video playback device and/or slide projector and synchronizer) or encountered difficulties using the audio/visual materials.

Letters from these three cities giving their comments and suggestions follow, as well as letters from CALTRANS and some of the municipal officials who reviewed the User Guide.

—for a better downtown

October 22, 1980

Sue Ruano
Research Analyst
Transportation and Information
Management Systems Center
SRI International
333 Ravenswood Avenue
Menlo Park, CA 94025

Dear Sue:

Thank you for sending the materials describing SRI's process for evaluating pedestrian facilities. (We are returning them herewith.) The videotape and slides were used on several occasions before different audiences - Downtown Development District staff, a technical group, and commissioners and civic leaders associated with the project in question.

In response to your query about the slides and tape, the consensus seemed to be that the slide show achieved its purpose better than the videotape did. Those commenting thought the tape showed "how subjective the process really is" without putting it in the context of those factors that do lend objectivity to the process. There was concern expressed also that the applicability of the process to varying kinds of projects is not entirely clear. The comprehensiveness of the process was considered impressive. It was noted that while encompassing a multiplicity of relevant factors, the process was still not difficult for staff to handle.

We are interested in implementing the evaluation process. What we need now is four more workbooks. When we get into this I am sure I shall be back on the phone to you with questions.

Thank you for your assistance.

Sincerely,

Marion Andrus
Director of Planning and Information

DOWNTOWN DEVELOPMENT DISTRICT • 301 CAMP STREET • NEW ORLEANS, LA 70130 • 561-8927

CITY OF
PORTLAND, OREGON
BUREAU OF PLANNING

Mildred A. Schwab, Commissioner
Terry D. Sandblast, Acting Director
621 S.W. Alder
Portland, Oregon 97205
(503) 248-4253

27 January 1981

Marc F. Roddin, Transportation Analyst
Transportation Economic Program
SRI International
333 Ravenswood
Menlo Park, CA 94025

Dear Mr. Roddin:

Transportation and other Bureau of Planning staff have viewed the videotape and slide presentations. They are being returned to you under separate cover. After viewing the slide show, we agreed with your concern that it is too general for the design committee, and therefore, no public group reviewed the material.

The idea of visual aids is very desirable. The current format does not, however, take full advantage of the visual aids. Both of the visual aids are somewhat disjointed and really do not successfully serve as introductions to the workbook or the method. In fact, it appears practically essential to read the workbook before watching the video material. The slide presentation begins at an extremely general level and then turns immediately to the detailed evaluation criteria without transition. A framework which explains what the suggested evaluation can accomplish and why any evaluation is desirable should be included. For the videotape, a similar introduction (on the various purposes the evaluation methodology can serve, the general format of the SRI evaluation method, etc.) would be helpful before going directly to the example. The example itself is probably too long and a site plan would help the viewer follow the actual evaluation.

Thank you for the opportunity to review this material and the user guide. If you have any comments or questions, please let me know.

Sincerely,

Steve Dotterrer
Chief Transportation Planner

SD:db

CODE ADMINISTRATION 248-4250 | LONG RANGE PLANNING 248-4260 | SPECIAL PROJECTS 248-4509 | TRANSPORTATION PLANNING 248-4254 | HOUSING AND POPULATION 248-5525

The Municipality of
Metropolitan Toronto

Metropolitan Planning Department
City Hall, East Tower, 11th Floor
Toronto, Ontario, Canada M5H 2N1
Telephone: (416) 367-8112 Telex: 06-23472

THE MUNICIPALITY OF METROPOLITAN TORONTO · 1953 ·

January 19, 1981

S.R.I. International
333 Ravenswood Avenue
Menlo Park, CA
U.S.A.
94025

Attention: Ms. Sue Ruano

Dear Ms. Ruano:

We have reviewed the Technical User Guide and the videotape as previously arranged. The time available did not permit an intensive review, and certainly the comments made are not based on an application or testing of the System on a specific case study.

The Technical Guide impresses as a very comprehensive check list of evaluation criteria. A System of this detail is presumably designed for situations where decisions are likely to involve controversy and/or financing problems. As indicated in the Guide it will not always be necessary to use all the variables and in practice we would not anticipate having to use such detail in many cases. The categories most likely to be dropped would be those which

(a) tend to have components duplicated elsewhere e.g. 2.2.4 Health Effects of Walking; 3.1.4 Aesthetic Impact . . . ; or

(b) tend to be most subjective in approach and/or deal with elements of design which generally should be basic to all facilities e.g. 2.2.1 Pedestrian-Oriented Environment (the description of scoring appears incomplete on page 63).

Component 3.1.1. Residential Dislocation is difficult to understand. If these are legitimate costs of the project(s), would not the rate of reimbursement remain the same? If so, should not the negative impacts of a high rate (e.g. 100%) be reflected directly as an actual cost (per point scored) rather than as an attribute variable?

It is noted that the cost components listed on page 16 do not include either

(1) costs incurred during construction e.g. disruption of business or travel; or

. . . 2

The Municipality of
Metropolitan Toronto

Planning Department

(2) such administrative costs as advertising or promotion.

Another observation found that the various references to bicycles were ambivalent about whether direct contact with pedestrians is desirable/not desirable.

The videotape was viewed after a knowledge of the System had been gained from the Technical Guide. In that sequence the film probably impacted less because it was not serving its normal introductory function. In particular, the portrayal of the on-site evaluation as an in-office exercise did not register strongly as the essential part of the process, possibly because

(1) reliance on frequent views of the site drawing did not provide enough of the areal context or the differences between the conditions being compared;

(2) the rating is shown as a low-key procedure without any hint that opinions on the treatment and/or weighting of components could become debatable.

I thank you for the opportunity to review and comment on the material which is very well researched and presented.

Yours truly,

F. Wyers
Director
Policy Development Division

FW/cf

STATE OF CALIFORNIA—BUSINESS AND TRANSPORTATION AGENCY EDMUND G. BROWN JR., Governor

DEPARTMENT OF TRANSPORTATION
DIVISION OF TRANSPORTATION PLANNING
1120 N STREET
P.O. BOX 1499
SACRAMENTO, CALIFORNIA 95807
(916) 445-6740

October 16, 1980

Ms. Sue Ruano
Research Analyst
Transportation and Information
Management Systems Center
SRI International
333 Ravenswood Avenue
Menlo Park, CA 94025

Dear Ms. Ruano:

Comments on draft of the
Technical User Guide --
Evaluation of Pedestrian Facilities

As requested by your letter of September 23, 1980, George Gray has reviewed the above. His comments and suggestions are enclosed.

The evaluation study certainly is a worthwhile effort and one which is overdue. We feel that the user's guide will help establish parameters for pedestrian facilities which will encourage rational decisions in providing for the user.

Sincerely,

ANN BARKLEY
Chief

Enclosure.

Comments by George E. Gray on
SRI Draft Report, Technical User Guide --
Evaluation of Pedestrian Facilities

OVERALL:

A good effort. The handbook should help in decision-making regarding pedestrian facilities by providing a structured, rational approach to evaluation. However, the work, in my opinion, is slanted toward particular pedestrian facilities and isn't uniformly broad enough to cover the subject as inferred by the title. My impression is that the handbook would be appropriate for an urban mall, especially a conversion of an existing street, but might not be of much help in developing a skyway system (like Minneapolis) or an underground system (like Houston) although most of the 27 identified factors apply to both. Nor would it be as much help in providing evaluative data for a suburban walkway system intended to reduce distance to local facilities and transit access points.

To provide for these perceived shortcomings, it is suggested that:

- A 28th factor "Geographic Location" be added. This could be broken down to reflect urban and suburban (commercial and residential may be better). An option would be to add the geographic location input to category 3 (Business and Neighborhoods). The suggested factor would provide input to accommodate the overall weather impacts, which in some cases are severe. Examples abound in the northern latitudes (i.e., Montreal, Toronto, Edmonton, Minneapolis, Stockholm) and more recently in the south where air-conditioned underground walkways encourage pedestrian movements (Houston and Dallas). It should be remembered that one of the most successful pedestrian areas provided in the United States is the fully enclosed shopping center -- which is really just a mall surrounded by parking rather than cut by streets.

  The handbook does provide (under 2.2.1.3) for a rating of climate control and weather protection under a subset of one variable but, in my opinion, this isn't adequate. Energy, environmental considerations and increased value of CBD land as well as regulated climate attributes call for more consideration of enclosed areas. The Galleria in Toronto, Omni Center in Atlanta, Bonadventure in Montreal and even the Arco Plaza in Los Angeles are a few of the pedestrian oriented facilities which have been extremely successful and provide not only a pleasant experience protected from the elements, but have provided a strong incentive for adjacent rehabilitation with emphasis on pedestrian amenities. The Vancouver, Canada protected shopping center next to the Granville Street Mall (a limited-vehicle facility) with its underground access covering half a dozen blocks is an excellent example of what can be done to provide for pedestrians in a CBD.

- Another area which I feel needs some strengthening is under variable 3.1.2. In the component listing, no mention is made of providing pedestrian facilities to improve access to public transit except indirectly under "Links to Rest of Community" (page 85). As land values increase, cluster housing, and other innovations which reduce areas devoted to the auto are increasing in popularity. These techniques often result in circuitous pedestrian travel paths unless special facilities are provided. Such circuity can result in a very low service level for public transit. The industry accepted rule of thumb of service within 1/8 mile of a resident was based on a grid street pattern and is meaningless with streets designed to discourage auto traversing unless pedestrians are otherwise provided for.

- The requirements of full accessibility for elderly and handicapped are not highlighted as they should be. As you know, use of any federal funding (and in this State under many programs - State funding) requires adherence to the 504 regulations of HEW (1973 Rehabilitation Act).

SPECIFIC COMMENTS FOLLOW:

Page 2, line 4 -- typo "of".

Pages 6 and 7 -- Some mention of the combination of the two major reasons for different types of facilities needs to be made. There are numerous examples of combined services, such as shopping areas, incorporated into transit stations. As long as the shopping areas do not overly impede through movements, they are an added amenity and the rental income serves to offset operating costs.

Page 19 -- The weighting concept application to the three levels of impacts is introduced rather abruptly. It might be less confusing to add a couple of sentences about the three-tier concept of categories, groups and variables and place Figure 3 closer to the description.

Page 38 -- Subvariable 1.1.2.2. Grade Change. This is a logical place to refer to the 504 regulations.

Page 40 -- Subvariable 1.1.2.3. Continuity.

I suggest you add a question to cover "clutter" which would penalize for too many obstacles. Some older transit stations are so cluttered that the rating should provide for a negative value.

Page 42 -- Penultimate line. English units are given as a range -- metric are not.

Page 45 -- Subvariable 1.1.3.2. Accessibility.

This may not be the logical place, but some notice of the problem of pedestrian trip length and continuity needs to be made. An example: In San Francisco where the S.P. Depot for the commute service is 5,000± feet from the centroid of employment to Peninsula cities, riders are switching to express bus rather than a combined walk-ride transit (Muni)--walk-ride commute service. There needs to be some simple way to evaluate the value of shortening the distance between origin and destination for the pedestrian and eliminating a mode change. Existing procedures require considerable data which is expensive to collect (or must be guessed at). This, however, is no doubt beyond the requirements of your study.

Page 50 -- Variable 1.2.3. Impact on Existing Transportation Systems.

Gives the same problem as above. In addition, possible changes to existing systems should be included in the evaluation. Many mall developments (such as the transit malls in Portland, Minneapolis, Vancouver and Chicago) owe their existence to planned, improved transit service although to some, the actual service improvements are considered more as perceived than actual).

Page 59 -- Variable 2.2.1. Pedestrian-Oriented Environment.

In my opinion, the value of open retail outlets or 24-hour manned services (such as the cab dispatch facility at the LIRR Station in Hicksville, N.Y.) is significant and a factor for such crime deterrents should be included on Figure 11.

Page 69 -- The litter control score might also include a factor to cover leash laws for animals.

Page 70, line 17 -- typo "again".

Page 71 -- Variable 2.2.1.3. As previously mentioned, I feel this factor is underrated.

Page 75 -- Situation. This table should indicate that enclosed facilities should not necessarily be rated according to location relationship to a roadway.

Page 87 -- Variable 3.2.1. Gross Retail Sales.

No mention is made in the discussion of this variable of the value of increased retail space afforded by vertical separation of at least a portion of the pedestrian traffic. For instance, the tunnel systems in several cities have afforded a second floor of commercial stores -- also in several instances, major department stores (for instance, the Emporium in San Francisco, Hudson Bay in Toronto, Woodward & Lothrop in Washington, D.C., and Marshall-Fields in Chicago) have benefited by upgrading basement space to take advantage of increased pedestrian traffic resulting from improved pedestrian facilities.

Page 101 -- Variable 3.3.1. Adaptability to Future Transportation Development Plans.

The discussion on this item doesn't include any provisions for new facilities (construction, rather than reconstruction). I would like to see this highlighted. Often major developments are implemented with little consideration for eventual pedestrian improvements. An excellent example of a major development planned to accommodate future improvements is the major shopping center in Scarbrough, Toronto, which is constructed to allow the light rail connection to Warden Station to pass through the shopping center.

* * * *

THE CITY OF PORTLAND OREGON

Commissioner Schwab

BUREAU OF PLANNING
621 S.W. ALDER ST.
PORTLAND, OR 97205

Terry Sandblast
ACTING DIRECTOR
248-4253

CODE ADMINISTRATION
248-4250

LONG RANGE PLANNING
248-4260

SPECIAL PROJECTS
248-4509

TRANSPORTATION PLANNING
248-4254

HOUSING AND POPULATION
248-5525

31 December 1980

Ms. Sue Ruano
Research Analyst
Transportation and Information
Management Systems Center
SRI International

Dear Ms. Ruano:

Thanks for the opportunity to review the Users Guide for Pedestrian Facilities. Attached are written comments received from reviewers. Also enclosed is my copy of the report, with written comments. As this copy was my only copy, please return it or send another copy.

In general, the list of factors is very helpful. More desirable than a detailed weighting or measuring scheme, however, would be more information on gathering the basic comparative statistical information. The Users Manual assumed a much greater availability of technical information than is typically available in the governmental setting (at least in my experience). The rough data usually available generally will not justify much of the sophisticated calculations and weighting proposed in the manual.

Some of this problem might be eliminated if several evaluation criteria lists were prepared. Combining all criteria into one list serviceable for several types of evaluation (priority setting, determination of most desirable alternative, and design evaluation, etc.) makes the process appear more formidable than it probably is. A list of criteria needed to do priority setting evaluations (degree of problem, amenability to physical solutions, cost, etc.) and further help on gathering the important evaluation data would be a useful aid to policy-makers and those staff charged with providing recommendations to same. The information needed for an evaluation of alternative solutions and for a design evaluation is substantially different, and is useful to different groups (designers, engineers, etc.). If these three criteria areas were separated I believe that the evaluation process would be simplified and much more useful.

I hope the comments are useful to you. We are looking forward to receiving the visual materials for review the week of January 19th.

Sincerely,

Steve Dotterer

Steve Dotterer
Chief Transportation Planner

SD:db

Attachment

CITY OF SPOKANE, WASHINGTON

SPOKANE
ALL-AMERICA CITY

TRAFFIC ENGINEERING DEPARTMENT
553 CITY HALL

B. J. SCHMITZ
DIRECTOR

J. L. BOESEL
ASSISTANT DIRECTOR

October 9, 1980

Ms. Sue Ruano
Research Analyst
Transportation and Information
Management Systems Center
SRI International
333 Ravenswood Avenue
Menlo Park, California 94025

Dear Ms. Ruano:

The copy of the "Pedestrian Facilities Evaluation Users Guide" which you sent to us was thoroughly reviewed by an engineer on our staff - I have attached a copy of his memorandum to me regarding your evaluation process. As was stated in the memorandum, we have no plans in the immediate future that would require such an evaluation but we do plan to use the process when an appropriate project arises. We will forward to you our data and results at that time.

We would like to thank you for including Spokane in your offer.

Very truly yours,

B. J. Schmitz

B. J. Schmitz
Traffic Engineering Director

BJS/tb

encl.

M E M O R A N D U M

October 9, 1980

TO: B. J. Schmitz, Traffic Engineering Director

FROM: Donald Ramsey, Traffic Systems Engineer

SUBJECT: Pedestrian Facilities Guide

The SRl pedestrian facilities guide is a comprehensive method to evalute one or more proposed pedestrian facility projects. Examples of use of the SRl technique are evaluating the desirability of a pedestrian overcrossing at a particular location or rating a proposed pedestrain mall, sky bridges and pedestrian undercrossings. It can also be used to establish a priority array of several pedestrian projects at different locations.

The SRl guide is not intended for use in a survey to locate deficiencies in current pedestrian facilities over a broad area. It does contain information that would be useful in developing such a survey.

The SRl evaluation technique will be relatively expensive to use. A substantial amount of information must be collected to use the technique and a good deal of professional level manpower would be required to complete the evaluation.

The use of the SRl technique is warranted for any major pedestrian facility the City is planning for the future, both for evaluation and design of the project.

We do not have an immediate use for the technique, but the user guide is complete and should be retained for future use.

CITY OF SAINT PAUL
DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT
DIVISION OF PLANNING
25 West Fourth Street, Saint Paul, Minnesota, 55102
612-298-4151

GEORGE LATIMER
MAYOR

November 3, 1980

Ms. Sue Ruano
Research Analyst
Transportation and Information Management Systems Center
SRI International
333 Ravenswood Avenue
Menlo Park, California 94025

Dear Ms. Ruano:

Our staff has reviewed the User Guide for Evaluation of Pedestrian Facilities which you sent to us on October 6, 1980. We have not, as of this time, used this system to review any pedestrian projects. Therefore, our understanding of the content of the report is confined to the general ideas presented.

We find this pedestrian project evaluation method interesting, and it appears to have a good deal of potential as a useful method for determining the desirability of pedestrian facility projects. It appears to be a well thought-out proposal.

One question that occurs to us is: How well does this system consider potential interrelationships with other new untried modes such as an automated people-mover system in a downtown area?

Thank you for this opportunity to review this report. If you have any further questions you may contact William Butz of our staff at (612) 292-6222.

Sincerely,

Peggy Reichert

Peggy Reichert
Planning Administrator

THE TRANSPORTATION RESEARCH BOARD is an agency of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 250 committees, task forces, and panels composed of more than 3,100 administrators, engineers, social scientists, attorneys, educators, and others concerned with transportation; they serve without compensation. The program is supported by state transportation and highway departments, the modal administrations of the U.S. Department of Transportation, the Association of American Railroads, and other organizations and individuals interested in the development of transportation.

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TRANSPORTATION RESEARCH BOARD

National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

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JAMES W HILL
RESEARCH SUPERVISOR

IDAHO TRANS DEPT DIV OF HWYS
P O BOX 7129 3311 W STATE ST
BOISE ID 83707

Stepping into a new future

Safe Routes to Kihei High School: *Pedestrian Route Study*

Kihei, Maui, 2014

EXHIBIT 42

Walkable and Livable Communities Institute

Prepared for Group 70 and Hawaii Department of Education
Prepared by Walkable and Livable Communities Institute

Table of Contents

A MESSAGE
From Dan Burden

I have dedicated the bulk of my life to helping North America get back on its feet by working with communities to improve their built forms to be more walkable, livable and welcoming of people of all ages and abilities, while still preserving the need to move people and goods by motor vehicle. As the Director of Innovation and Inspiration and Co-Founder of the Walkable and Livable Communities Institute, I am pleased to have the opportunity to assist communities like Kihei as they strive to ensure the most vulnerable amongst us—our children—have safe access to their schools, their sport fields, their homes, their lives.

Having met with and seen the commitment of the Hawaii Department of Education, school officials, elected leaders, county staff, parents, landowners, and community members who took part in this report, I am a believer in your future. The right people are coming together to make safe routes and complete streets a reality and model on Maui.

There is no doubt, though: Kihei has its fair share of challenges to achieving safe routes, such as policy oversights, siting of the school in today what still is a remote area, streets that encourage too-fast vehicle speeds, a street network that lacks connectivity, and more. The good news is that all of these challenges are opportunities that can be overcome and this report provides the guidance for beginning to do just that.

We are in a major shift in how we design communities. For more than 60 years travel by automobile became the dominant mode of transportation for most communities in the United States. During the past decades, significant resources have been invested and advanced engineering have been applied to move more cars and to move them faster. The result is streets that accommodate cars and deter people from active transportation. It has also influenced local, regional and state land settlement practices—strip centers, cul-de-sacs, poorly sited schools and single-use zoning—that compound the problem, producing auto dependency. These decisions have affected economies, community and environmental health, and overall quality of life. Today we are being asked to solve a new problem: how to re-imagine the public realm that honors people and place, while continuing to move people and goods in motor vehicles. I worked in Florida State Department of Transportation (DOT) for 35 years, I know the challenge we face first hand. The task is immense, and work on it must begin now.

State leaders, including governors, legislators and DOT officials, have the ability to transform the transportation system by changing policies and priorities to ensure streets become the hallmarks of diverse, vibrant and thriving cities and towns. Hawaii has passed a Complete Streets Policy, and the counties have followed suit. We now need to move towards implementation and creating the model projects. Choose places where the community is ready, supportive and there is a high priority destination, such as a school. The future Kihei High School is a project waiting to showcase collaboration and the new proven safety countermeasures that help to include all modes—pedestrians, bicyclists, transit, trucks, emergency vehicles, and automobiles—in the design of our streets. Until we have healthy communities, we cannot have healthy people. In addition to supporting improved health, safe routes and complete streets to school help to boost students' academic performance, broaden their social networks and help them learn important self-reliance skills that will last them a lifetime.

This report provides guidance to support the Hawaii DOT and Kihei community in energetically changing the built environment by planning, engineering and re-working streets that build the communities as whole, livable places. It is my observation that once people come together and agree to work upon a common vision and develop a plan, the desired outcomes come quite fast. As you read this report, consider the main goal of the entire study: to provide safe routes to and from school for people—children—who do not drive and who have much to gain from commuting under their own power. Envision the recommended changes and you will see how they will help each driver who comes to or passes a school to be more alert, yielding, caring and considerate when in the vicinity of children. May the winds of change bring much good to you, and through you.

Sincerely,

Dan Burden
Director of Inspiration and Innovations
Walkable and Livable Communities Institute

Creating an environment that supports active modes of transportation requires scaling our streets. While this photo shows a "Walk" signal, the street is not conducive to walking. It is out of scale for active transportation. Successful and sustainable communities include a range of distinct places—from quiet residential streets to bustling village centers. Following a long period of auto-centric street development and the unintended and negative effects this has had on the health, economic vitality, connectedness and well-being of entire communities, many organizations, agencies and advocates are working together to make towns healthy and sustainable again. This major shift requires that the community approach transportation planning with a focus on integrating all modes: pedestrians, bicyclists, transit, freight and motorists.

INTRODUCTION: Toward A More Prosperous Future

Walking and bicycling contribute to the developmental health of children.

There are many benefits of physical activity for youth including[1]:

- Weight and blood pressure control
- Bone, muscle and joint health
- Reduction in the risk of diabetes
- Improved psychological welfare
- Better academic performance[2]

1 American Heart Association. Exercise (Physical Activity and Children). Available: www.americanheart.org/presenter.jhtml?identifier=4596.

2 California Department of Education. A study of the relationship between physical fitness and academic achievement in California using 2004 test results. Available: http://www.cde.ca.gov/ta/tg/pf/documents/2004pftresults.doc.

Many of us can still remember when walking and bicycling to school was a part of everyday life. Our stories recount experiences of independence, self-discovery, accessibility, and overall freedom. Today, however, the story is very different. Many children today have less independence than their parents did, negatively impacting their social development.[1] For example, driving a child from home to school limits the child's opportunities to interact with their neighborhood and peers, creating an environment where children lose relatively "safe" opportunities to make decisions independently.[2] In addition, a growing body of evidence has shown that children who lead sedentary lifestyles are at risk for a variety of health problems such as obesity, diabetes and cardiovascular disease. Seventy percent of Hawaii school children get inadequate physical activity and 30 percent are overweight/obese. Walking and bicycling positively impact childhood physical activity. However, safety concerns prevail; Hawaii is ranked first in pedestrian and third in bicycle fatalities.[3]

As communities have turned their focus away from ensuring children can walk or bike safely to school, communities also have allowed their streets to become designed only for vehicle speed and capacity, and not for people. Level of Service focuses on vehicle mobility at the expense of all other modes. Up until recently, Levels of Service for pedestrians, bicyclists and transit users has not been considered acceptable.

National trends show the share of automobile miles driven by Americans in their twenties has dropped from 21 percent in the late nineties to just 14 percent today. The number of nineteen year-olds who have chosen not to earn driver licenses has almost tripled since the late seventies, from 8 percent to 23 percent.[4] According to Wilson Okamoto's Traffic Impact Report, historical traffic count data obtained from the Hawaii Department of Transportation, Highway Division survey stations in the vicinity of the future Kihei High School indicates that traffic volumes have remained relatively stable [over the last several years]. These statistics are particularly meaningful when one reflects on how the U.S. landscape has changed since the seventies when most American teens could, and did, walk to school, to the store, to the sports field, to the beach, a stark contrast from today.

1 Huttenmoser M. Children and Their Living Surroundings: Empirical Investigations into the Significance of Living Surroundings for the Everyday Life and Development of Children. Children's Environments 1995 December; 12(4), Available:http://www.colorado.edu/journals/cye/CYE_BackIssues/.

2 Hillman M. The Impact of Transport Policy on Children's Development. Presentation at the Canterbury Safe Routes to Schools Project Seminar, London U.K. May 29, 1999. Available:http://www.spokeseastkent.org.uk/mayer.htm.

3 2007 Hawaii Physical Activity and Nutrition (PAN) Plan http://activelivingresearch.org/comprehensive-multi-level-approach-passing-safe-routes-school-and-complete-streets-policies-hawaii

4 Jack Neff, "Is Digital Revolution Driving Decline in U.S. Car Culture?"

The last sixty-plus years have focused on applying advanced engineering to move more cars and to move them faster. Most roadways have been designed primarily for automobile and truck travel, which in many cases has made streets less safe for pedestrians, older adults, children, people with disabilities, and bicyclists. The overall result is streets that accommodate cars and that deter people from active transportation. Land settlement practices—strip centers, cul-de-sacs, poorly sited schools, and single-use zoning—compound the problem, producing auto dependency. Our auto dependency is furthered by development patterns that have changed the form of communities from walkable, transit oriented, street grid systems to strip and single-family development accessed by regional automobile corridors. Emphasis on only one mode and not fully integrating other users into the design of roadways has severely impeded the safety of pedestrians and the overall connectivity for non-motor vehicle users.

Various trends are changing the projections for future travel demands; that is, they are changing our understanding of the type of transportation systems people will want and need in the future. Aging population, a millennial generation who is choosing not to drive, rising fuel prices, growing traffic problems, increasing safety, health and environmental concerns, and changing consumer preferences are all increasing demand for walking, cycling and transit. When we restore streets as places that are safe for children, we will also be supporting communities that are vibrant and safe for all.

Taking the steps to include pedestrians and bicyclists in street design

Kihei High School, projected to open in 2018, will be located mauka (mountainside) of Piʻilani Highway at Kulanihakoʻi Street between the Kulanihakoi and Waipuilani gulches. Today, the majority of the population of Kihei is concentrated on the makai (seaside) of the Piʻilani Highway. Students and community members will be traveling along and across the highway to access the school. Because the Kihei High School campus is envisioned as a place for the community to gather, the main issue facing the community of Kihei is how students will cross Piʻilani Highway on foot or bike. The State Land Use Commission and Maui County Council have imposed zoning conditions requiring a Pedestrian Route Study (regarding FHWA/RD-84/082, see Supporting Documents page 66) and require an overpass or underpass be provided, as well as at-grade improvements. This report was created to address the above conditions and is intended for the Department of Transportation's approval.

The report recommends that the Department of Transportation approve an at-grade crossing that includes all roadway users at Piʻilani Highway and Kulanihakoʻi Street, a location where pedestrians need to be included first and foremost at-grade. Pedestrian overpasses and underpasses allow for pedestrian movement separate from vehicle traffic. However, they are usually considered as a last resort measure. It is more appropriate to install safe crossings that are accessible to all pedestrians and bicyclists at-grade. Due to the local topography and community in-

The State Land Use Commission and Maui County Council condition, in part, reads:

"[Department of Education] shall complete a pedestrian route study for Phase 1 of the Project which includes ingress and egress of pedestrians through defined location(s) approved by DOT and shall analyze compliance with proposed warrants in FHWA/RD-84/082 (July 1984) to the satisfaction of DOT. The pedestrian route study and analysis shall be completed and approved prior to [Department of Education] executing a contract for the design of Phase I of the Project."

put this report also recommends an underpass, although this will take partnership with state and county government agencies, private landowners and the community of Kihei to complete the pedestrian network so that the underpass is used.

Hawaii State Complete Streets Act 54 (2009), focuses on a multi-modal transportation system:

"to accommodate convenient access and mobility for all users of the public highway, including pedestrians, bicyclists, transit users, motorists, and persons of all ages and abilities."

The safety of all street users, especially the most vulnerable users (children, elderly, and disabled) and modes (pedestrians and bicyclists) should be paramount in any design of the roadway. The safety of streets can be dramatically improved through appropriate geometric design and operations. A Federal Highway Administration safety review found that streets designed with sidewalks, raised medians, better bus stop placement, and traffic calming, such as roundabouts and raised medians, improves pedestrian safety while still allowing it to move efficiently and effectively: a virtuous cycle.[5]

Ensuring people are included in the design of our streets

As Dr. Richard Jackson, author of *Designing Healthy Communities* states, "The metric needs to be people. The purpose of transportation is not to move cars and other vehicles; it's to move people; it's to move people using automobiles, buses, bicycle and their own feet. If you make people the benchmark you end up making better decisions."

The overarching principle of this report is: all streets and intersections should be studied and designed with the expectation that pedestrians and bicyclists will use them, along with motor vehicles. Designs should create an environment that is conducive to walking and bicycling, encourages people to walk and bike, and where the street becomes a place people want to be. This is reinforced in Hawaii State Complete Streets Policy, Maui County Complete Streets Resolution, Maui County General Plan and Hawaii's State Pedestrian Plan, which states the following vision: "Hawaii's integrated and multi-modal transportation system provides a safe and well-connected pedestrian network that encourages walking among all ages and abilities. The system promotes a positive pedestrian experience; promotes environmental, economic and social sustainability; fosters healthy lifestyles; and conserves energy. More people in Hawaii choose to walk for both transportation and recreation as a result of enhanced walking environments, mobility, accessibility, safety, and connectivity throughout the transportation system." A new opportunity exists for the Department of Transportation to put these policies and plans into action by including people—especially youth—on foot and bicycle in the design of the intersection at Piʻilani Highway at Kulanihakoʻi Street.

5 B.J. Campbell, et al. (2004). A Review of Pedestrian Safety Research in the United States and Abroad, Federal Highway Administration.

Furthermore, the Department of Transportation, State Department of Education, County of Maui and community of Kihei are encouraged to work together and focuses on the following:

- Design for people of all ages and physical abilities whether they walk, bicycle, use a wheel chair, ride transit, deliver freight or drive. A well-designed road provides appropriate space for all street users to coexist.
- Integrate connectivity and traffic calming with pedestrian-oriented site and building design to create safe and inviting places.
- Involve local residents, land, property and business owners, elected officials and technical staff to share responsibility for designing Pi'ilani Highway.
- Create inviting places with interesting architecture, street furniture, landscaping, and public art that reflect the diversity and cultures of Kihei.
- Strengthen and enhance neighborhoods as envisioned by community members without displacing current property owners.
- Encourage active and healthy lifestyles.
- Integrate environmental stewardship through green streets, building and site design.

The Department of Transportation, working with other state and Maui County departments and the Kihei community, has the opportunity to strike a delicate balance between providing for motorists while also delivering a safe, comfortable and accommodating environment for pedestrians and bicyclists. This report outlines the community engagement process, key findings, best practices and built environment recommendations. This report doesn't constitute a traffic study. It is based on observations at key locations and traffic projections from Wilson Okamoto's Traffic Impact Report (TIR) (2012), and assumes that as sites next to the high school are developed, supporting road networks will be built to spread out the traffic flow and not concentrate it all in a single hot-spot to the detriment of other users. The report lays out important recommendations and conceptual designs for leaders to consider as they strive to improve safety, health, and access to the future Kihei High School through a more walkable and livable built environment.

The recommendations on the following pages incorporate best practices from cities, towns and suburbs nationwide. They're based upon tools and strategies aimed at improving neighborhood quality of life; supporting local economic development; and providing a safe, efficient transportation system that gives choice, convenience and accessibility for all.

The Report is organized into the following sections:

1. Process: Setting the Vision & Documenting Existing Conditions for Pi'ilani Highway and Kihei High School shares observations about the corridor's existing conditions, and documents the community's shared vision for the corridor.

2. Best Practices & Recommendations addresses the State Land Use Commission and Maui County Council conditions and consideration of a overpass or underpass, at-grade improvements. This section also includes additional street treatments that further enhance and promote Complete Streets and safe routes to school.

3. Next Steps addresses the need for partnerships, funding ideas and short- to long- term next steps.

Key Concepts

Active Transportation: Also known as non-motorized transportation, this includes walking, bicycling, using a wheelchair or using "small-wheeled transport" such as skates, a skateboard or scooter. Active modes of transportation offer a combination of commuting options, recreation, exercise and transportation. (See Victoria Transport Policy Institute, www.vtpi.org.)

Aging in Place: Also called "living in place," this is the ability to live in one's home safely, independently and comfortably, regardless of age, income or abilities, in a familiar environment, with opportunities to participate in family and other community activities. (See National Aging in Place Council, www.ageinplace.org.)

Charrette: [pronounced, "shuh-RET"] A collaborative session to solve urban-design problems that usually involves a group of designers working directly with stakeholders to identify issues and solutions. It can be more successful than traditional public processes because it focuses on building "informed consent." (See www.walklive.org.)

Complete Streets: Roads that are designed for everyone, including people of all ages and abilities. They are accessible, are comfortable for walking and biking, and include sidewalks, street trees and other amenities that make them feel "complete." (See National Complete Streets Coalition, www.completestreets.org.)

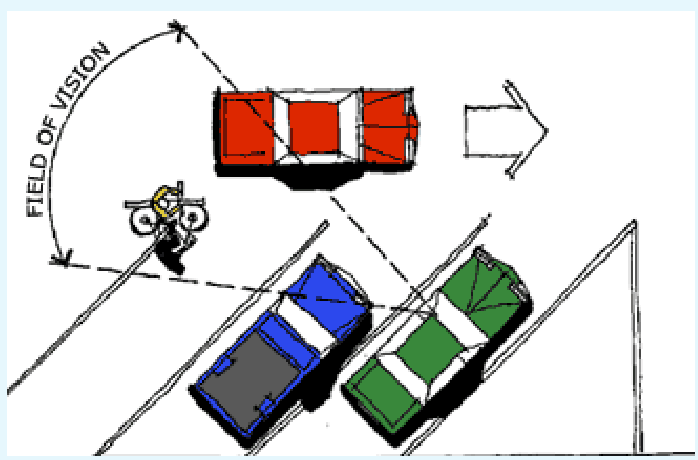
Head-Out Angled Parking: Also called "back-in" or "reverse" angled parking, this is arguably the safest form of on-street parking. It offers multiple benefits, including creating a sight line between the driver and other road users when "un-parking." Additionally, head-out parking allows the driver to load their trunk from the curb, instead of adjacent to the travel lane. And for drivers with young children, seniors or others who need extra help, the open car doors direct passengers to the safety of the sidewalk behind the car, not into traffic. Getting into a head-out angled spot is simple—a driver signals their intention, slows, pulls past the spot and then backs into it, which is roughly equivalent to making only the first maneuver of parallel parking. (Watch a brief video about head-out angled parking at www.walklive.org.)

Livability: In the context of community, livability refers to the factors that add up to quality of life, including the built and natural environments, economic prosperity, social stability and equity, educational opportunity, and culture, entertainment and recreation possibilities. (See Partners for Livable Communities, www.livable.org.)

Median Crossing Island: A short island in the center of the road that calms traffic and provides pedestrian refuge. They can be six to 12 feet wide and 20 to 80 feet long. They should be landscaped with low, slow-growth ground cover, and tall trees without branches or leaves at ground height that help motorists see the islands well in advance but don't obstruct sight lines.

Sharrows: A "shared roadway marking"—usually paint—placed in the center of a travel lane to alert motorists and bicyclists alike to the shared use of the lane. They help position bicyclists away from the opening doors of cars parked on the street, encourage safety when vehicles pass bicyclists and reduce the incidence of wrong-way bicycling.

Safe Routes to School: A national program to improve safety and encourage more children, including children with disabilities, to walk, bike and roll to school. The program focuses on improvements through the five E's: engineering, education, enforcement, encouragement and evaluation. (See National Center for Safe Routes to School, www.saferoutesinfo.org.)



Above: This diagram from the City of Northampton, MA illustrates one of the benefits of head-out angled parking: a driver's ability to see oncoming traffic as they pull into the travel lane from their parking spot.

Road Diet: On an overly wide road that has too many vehicle travel lanes to be safe, lanes can be removed and converted to bike lanes, sidewalks, a buffer between the travel lanes and sidewalks, on-street parking, a landscaped median or some combination thereof. A common road diet transforms a four-lane road without bike lanes into a three-lane road (one travel lane in each direction with a center turn lane or median) with bike lanes and street trees. (See Project for Public Spaces, www.pps.org/reference/rightsizing/.)

Sidewalks: With some exceptions, sidewalks, trails, walkways and ramps should be on both sides of streets. Where gaps exist or ramps are missing, fix them on a priority basis, working out block-by-block from schools, medical facilities, town centers, and other areas where people should be supported in walking and biking. Sidewalks in people-rich areas should be at least eight feet wide and separated from the curb by a zone that can accommodate planter strips, tree wells, hydrants, benches, etc.

Street Trees: Street trees not only provide shade and a nice environment, but also help protect people walking and bicycling. When placed within four to six feet of the street, trees create a vertical wall that helps lower vehicle speeds and absorb vehicle emissions. They also provide a physical buffer between moving cars and people. On streets with a narrow space between the sidewalk and curb, trees can be planted in individual tree wells placed between parking stalls, which further reduces travel speeds. Depending on the species, they should be spaced 15 to 25 feet apart.

Traffic Calming: Using traffic engineering and other tools designed to control traffic speeds and encourage driving behavior appropriate to the environment. Examples include street trees, bulb outs, medians, curb extensions, signage, road diets and roundabouts. Traffic calming should encourage mobility for all modes.

Walking Audit: Also called a "walking workshop," this is a review of walking conditions along specified streets conducted with a diverse group of community members. Participants experience firsthand the conditions that either support or create barriers to walking and biking. (See more about walking audits, see the Walkable 101 series of resources at www.walklive.org.)

Roundabouts, Mini Circles and Rotaries

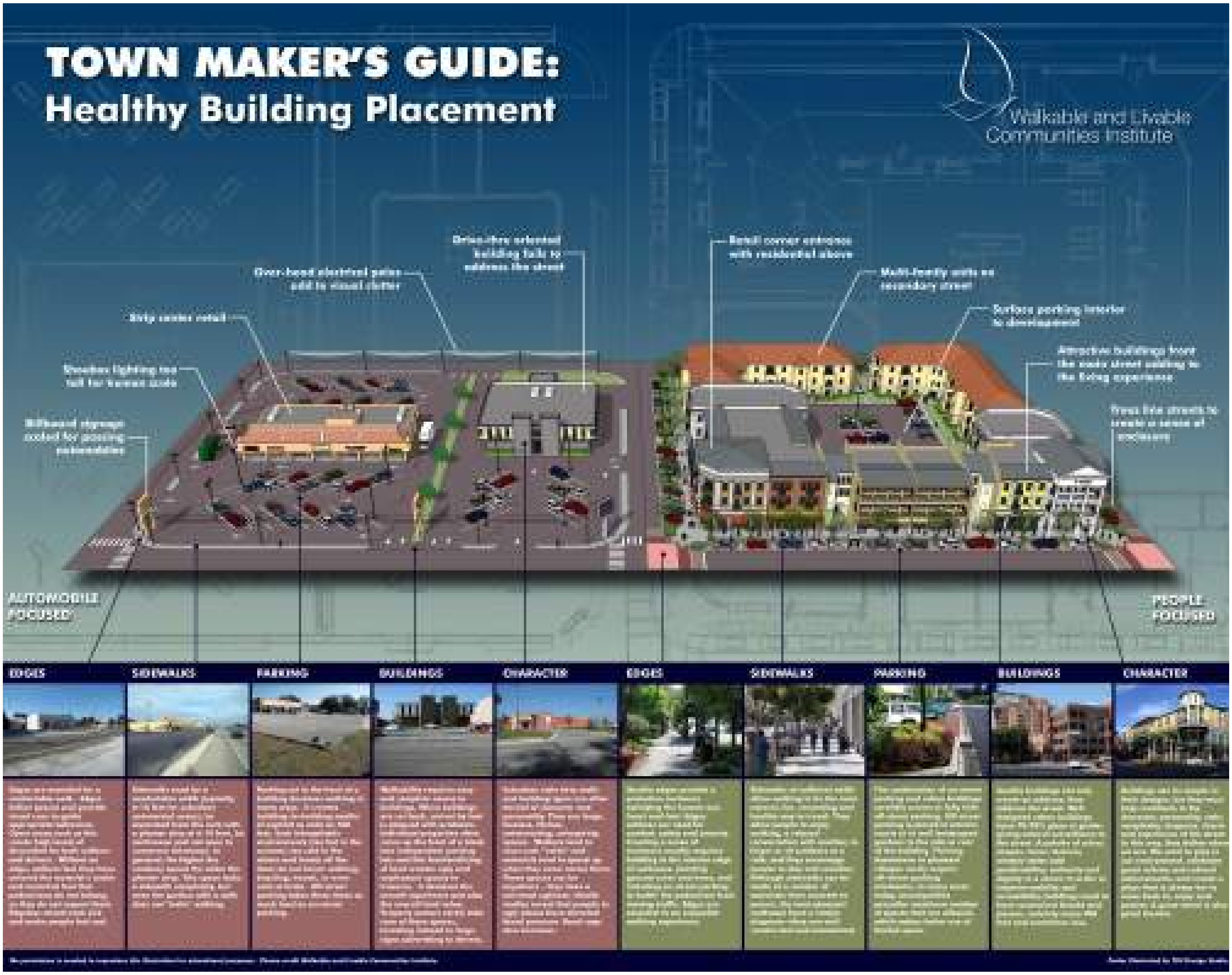
Roundabouts: Modern roundabouts navigate cars around a circulating island, usually 50 to 135 feet in diameter. They are ideal for collector and arterial roads, on Main Streets, and at freeway on-off ramps. They eliminate the need for cars to make left turns, which are particularly dangerous for pedestrians and bicyclists. Properly designed, roundabouts hold vehicles speeds to 15 to 20 mph and reduce injury crashes by 76 percent and reduce fatal crashes by 90 percent compared to signalized intersections. (See http://www.iihs.org/research/topics/roundabouts.html.) Roundabouts also can increase capacity by 30 percent by keeping vehicles moving. When installing roundabouts in a community for the first time, take care to make roadway users comfortable with the new traffic pattern and to educate them about how use roundabouts properly. (See the educational video at http://bit.ly/fhwasafetyvideo.)

A modern, single-lane roundabout in San Diego, CA calms traffic, improves safety, and supports people walking and biking, all while carrying about 25,000 vehicles per day.

Mini Circles: Often used in neighborhoods, these intersections navigate vehicles around a small island—eight to 15 feet in diameter—that can be either lightly domed or raised. If raised, they should be visible from hundreds of feet away, creating the feeling of a small park in the neighborhood. They should be designed to reduce speeds to 15 to 18 mph at each intersection.

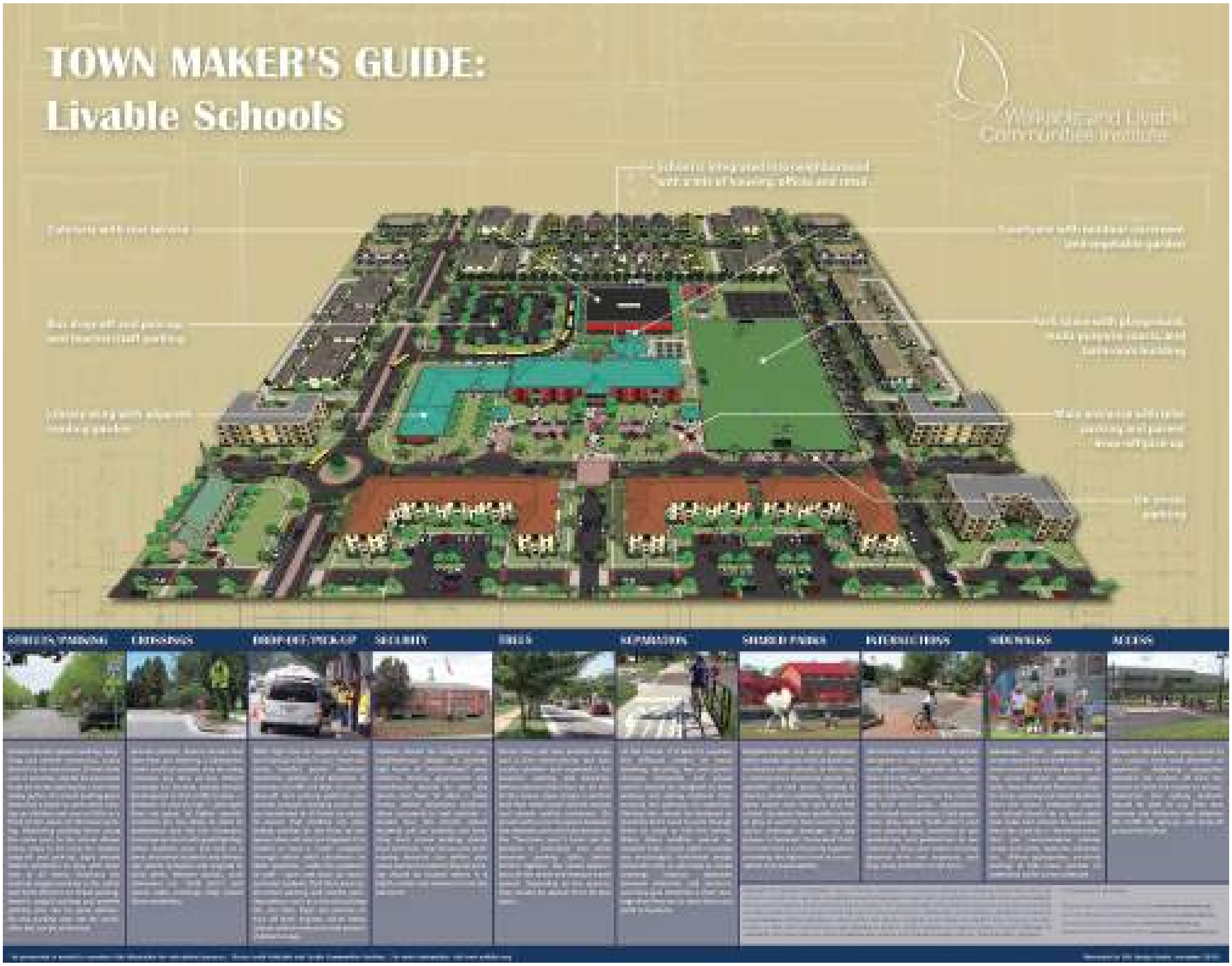
Rotaries and Traffic Circles: These can be as big as football fields and might include stop signs and signals. Rotaries can be cumbersome and complicated and often induce higher speeds and crash rates. Many rotaries in North America and Europe are being removed and replaced with modern roundabouts.

Key Concepts



In the past, cities were weakened as land-use experts did what they did best and transportation experts did what they did best. The failure to integrate transportation with land use led to a devalued or compromised set of land uses and roadways. For instance, with roads designed for high speeds, developers cannot develop a village that is enjoyable. This, then, increases the number of miles people drive, so more roads are built to handle the resulting traffic to more distant places. The opposite effect is also true. If the developer builds too many land uses with driveways, roadway capacity and safety degenerates, roads and intersections are widened, and land is further devalued. As roads are widened, people drive farther to distant shopping, and central town parcels are abandoned. By working together, traffic is better handled and balanced, land use goes up in value, people have better places to live and town economies heal and eventually thrive. Additionally, when we place a person at the center of the design scale, we end up with land that retains its value, less costly infrastructure and safer conditions for all users. The graphic above shows the different forms that are generated by using an automobile as the design vehicle (left) versus placing a person at the center of the design scale (right). For a full-resolution copy of the Town Maker's Guide to Healthy Building Placement, visit the Resources section of www.walklive.org.

Key Concepts



A school's physical relationship with its surrounding affects whether students can easily —and safely—walk, bike or roll to school. Thus, school siting issues should be considered in developing any program to promote active transportation of getting to and from school. The Town Maker's Guide to Livable Schools illustrates many of the important components that help make a school supportive of active living, walkability and livability. For a full-resolution copy visit the Resources section of www.walklive.org.

Key Concepts: Livable Schools

Streets and Parking

Streets should support walking, bicycling and vehicle movement. Vehicle travel lanes should be no more than 10 feet wide and, when possible, should be separated from on-street parking by a two-foot valley gutter. There should be no more lanes on a road section than needed to safely carry out its mission. Signs should inform motorists to remain in their cars at all times. Head-out (or reverse) angled parking is a safe and efficient way to provide on-street parking.

Security

Schools should be integrated into neighborhood designs to provide high levels of "watchfulness" over children. Homes, apartments and townhouses should be near the streets and their "A" sides — their fronts, where abundant windows allow occupants to look outside — should face the streets where students will be walking and bicycling. This orientation provides "eyes on the street." Each school building should have windows. Low fences and landscaping features can define play areas and access points. Bicycle parking should be located where it is highly visible and protected from the elements.

Separation

It is best to separate the different modes of travel (walking, bicycling, bus and parent driving) at schools. Sidewalks and school entries should be designed to keep walking and cycling students from crossing the pathway of motorists. Parking lots should be designed so students do not need to walk through them to enter or exit the school. Where sidewalks and driveways must cross each other, a level sidewalk should continue. Additional design elements such as colorized or raised crossings should give motorists a clear message that they are to slow down and yield to students.

Trees

Street trees not only provide shade and a nice environment, but also help protect students walking and bicycling. When placed within four to six feet of the street, trees create a vertical wall that helps lower vehicle speeds and absorb vehicle emissions. They also provide a physical buffer between cars and children. On streets with narrow space between the sidewalk and curb (also known as the "furniture zone"), trees can be planted in individual tree wells placed between parking stalls, which further reduces travel speeds. Depending on the species, they should be spaced 15 to 25 feet apart.

Dropping Off and Picking Up

With high rates of students arriving and leaving school in cars, many "conflict points" arise between motorists and walkers/bicyclists. If volumes of traffic are high, on-school drop-off and pick-up patterns can include compact stacking areas that are monitored at all times by adults to ensure that children are only exiting vehicles at the front of the queue when all cars are stopped. It is helpful to have a "valet" program through which adult volunteers or older students (under guidance of staff) open and close car doors and help students find their parents. On-street parking and nearby parking options, such as church parking lots, can help. Signs ask parents to turn off their engines, which helps reduce vehicle emissions and protect children's lungs.

Sidewalks

Sidewalks, trails, walkways and ramps should be on both sides of streets around the entire perimeter of the school. Where sidewalk gaps exist or ramps are missing, they should be fixed on priority basis, working out block-by-block from the school. Sidewalks around the school should be at least eight feet wide and separated from the curb by a "furniture zone" that can accommodate planter strips, tree wells, hydrants, benches, etc. Where appropriate, on-street parking or bike lanes can provide an additional buffer to sidewalks.

Access

Students should have easy access to their campus from every direction. Adjoining properties should not be walled off from the school or from the routes to school. Walking and bicycling students should be able to use links that shorten trip distances and disperse drop-off/pick-up traffic.

Shared Parks

Neighborhoods are most complete when public spaces such as parks are co-located with schools. In this way, a community's important assets are available in one place. Parking is shared; shade is available; neighbors keep watch over parks and schools; students have quality places to play or wait for their parents, and social exchange amongst all age groups is fostered. Co-located facilities help hold a community together, providing the highest level of conservation and sustainability while building cooperation, collaboration and social capital.

Intersections

Intersections near schools should be designed to keep motorists' speeds under control — typically no higher than 15 to 20 mph (at most) — no matter what time of day. Turning speeds are especially important and can be controlled with mini-circles, roundabouts and raised intersections. Additionally, curb extensions (also called "bulb outs") and inset parking make it easier for drivers and walking students to see each other and slow motorists down.

Crossings

Around schools, drivers should feel that they are entering the pedestrian realm and that people may be using crossings any time of day. Where crossings are located, streets should be designed so that traffic is slow — between 15 and 20 mph — and sight lines are good. At higher speeds, motorists are less likely to yield to pedestrians and risks increase. Crossings are best with good lighting, where one lane can be crossed at a time, and where students and drivers can clearly recognize each other. Median islands, curb extensions (or "bulb outs") and raised crossings help create these conditions.

DEFINING THE VISION

In the Hawaii State Pedestrian Plan the following vision is stated:
Hawaii's integrated and multi-modal transportation system provides a safe and well-connected pedestrian network that encourages walking among all ages and abilities. The system promotes a positive pedestrian experience; promotes environmental, economic and social sustainability; fosters healthy lifestyles; and conserves energy. More people in Hawaii choose to walk for both transportation and recreation as a result of enhanced walking environments, mobility, accessibility, safety, and connectivity throughout the transportation system.

Above: Nick Nichols, Department of Education, stands just above the intersection of Pi'ilani Highway and Kulanihako'i Street, gazing at the vacant site that will soon be Kihei High School.

The site of the future High School is priming the land and the greater community for a new future, creating an opportunity to demonstrate how transportation and land-use planning can coexist; where future development supports active-living; and where the existing built environment—streets and buildings—transforms to honor people and place. Over time, Pi'ilani Highway can become an attractive and bustling corridor that connects residents to education, jobs, shopping and recreation options, all in an environment where it's just as appealing to ride a bike or walk as it is to drive a car. It's a place where the third, fifth or ninth-grader can safely walk home from school to one of the residential neighborhoods that lie just beyond the highway, as his/her older brother/sister rides a bike to his/her job at a restaurant half a mile away. If Kihei can build a school that integrates and connects to the town for children, then the school and town is built for all people.

The future Kihei High School will serve the growing population in the Kihei region. The Directed Growth Plan (Chapter 8) of the Maui Island General Plan (December 2009) identifies the need for a high school for South Maui. The surrounding area to the future high school site also includes the "Kihei Mauka" planned growth area. Kihei Mauka is approximately 500 acres of existing undeveloped ranch land planned for mixed use development, including approximately 1,500 single-family and multi-family residential units. Maui Research and Technology Park is located adjacent to the school site, across the Waipuilani Gulch, and is actively planning a mixed-use devlopment. The future high school and planned mixed-use community are demanding that policies and practices, such as formed-base code— where buildings honor and are built-to the street versus set-back—and the right-size streets designed for pedestrians, bicyclist and automobile, create compact and walkable environments that do not induce vehicle traffic.

The Maui Island General Plan advocates for smart growth and walkable neighborhood design, identifying that accessibility issues on Maui can be addressed by *"expanding transportation alternatives, including public transit, biking, and pedestrian movement."* Supporting this vision is the State's Complete Streets Act 54 (2009), which focuses on a multi-modal transportation system: *"to accommodate convenient access and mobility for all users of the public highway, including pedestrians, bicyclists, transit users, motorists, and persons of all ages and abilities."* Although the remaining federal Safe Routes to School funding cannot be applied to high school safe routes projects, the philosophy and tools of the program should still help guide the process to ensure that the streets transform to support youth on foot and bike. Schools create priority areas within communities, meaning schools should be some of the first spots where communities come together to lead planning and implementation projects that will reduce vehicular travel and congestion, encourage walking and bicycling, and promote health and safety. This vision is further supported nationally with the Federal Highway Administration's (FHWA) guide: *Flexibility in Highway Design,* which emphasizes that community values and surrounding land-use need to be taken into consideration when designing highways in order to incorporate creative solutions to enhance the safety, efficiency, and effectiveness of the roadway "for the movement of people and goods."[1]

Measuring only level of service of motor vehicles, overlooking the flexibility of national and state standards and guidebooks, and not taking into full consideration community values can cause a road to be out of context with its surroundings. FHWA's Flexibility in Highway Design is a guide that encourages highway designers to expand their consideration in applying the Geometric Design of Highways and Streets (Green Book) criteria*****. "The setting and character of the area, the values of the community, the needs of the highway users, and the challenges and opportunities are unique factors that designers must consider with each highway project. It shows that having a process that is open, includes public involvement, and fosters creative thinking is an essential part of achieving good design." An important concept in highway design is that every project is unique, and there are new guides such as National Association of City Transportation Officials (NACTO) that U.S. DOT has endorsed to further guide states and counties in the new traffic-calming and street treatments that have been proven as safety countermeasures.

Pi'ilani Highway is unique; today it is a barrier for pedestrians and bicyclists, dividing the existing community of Kihei from the high school site and the future development because vehicle speeds are high and crossing distances are overly wide to support people, especially our youngest, who choose to use active transportation. The Highway also acts as the main route into Kihei; the future land use—school, signal family, multi-family and commercial buildings—demand that the highway starts to transition into a road that creates safe routes at grade, for pedestrians and bicyclists, while continuing to move vehicles at a safer speed and efficiently.

The section of Pi'ilani Highway between Kulanihakoi and Waipuilani Gulches provides an excellent opportunity to implement the State Complete Streets Policy and goals and policies from the Hawaii Pedestrian Plan along to support active transportation— children walking and biking to school. It will take partnerships, many which will be new, to achieve this vision. Maui County should continue to right-size the other streets in Kihei, while completing many important street networks. The State Land Use and Maui County Council should re-envision the outdated zoning condition of an overpass or underpass. The opportunity for an underpass is present with the gulches, however will take more community support and commitment from all the state departments and Kihei community to properly build a trail system that connects the community mauka-makai, a very important undertaking and opportunity that should be pursued.

The main goal of this Pedestrian Route Study is to provide safe routes to and from school for people—children—who do not drive and who have much to gain from commuting under their own power. The best practices and recommended changes on the pages to follow will help each driver who comes to or passes a school be more alert, yielding, caring and considerate when in the vicinity of children; envision this opportunity.

Above: The Walkable and Livable Communities (WALC) Institute team lead a walking audit with Department of Education, Group 70, and Munekiyo & Hiraga Planning, walking gulch to gulch to discover opportunities to ensure safe routes for youth both at grade and through separated paths.

1 Federal Highway Administration: http://www.fhwa.dot.gov/environment/publications/flexibility/flexibility.pdf

* The Green Book, published by the American Association of State Highway and Transportation Officials (AASHTO), contains the basic geometric design criteria that establish the physical features of a roadway.

STAKEHOLDER MEETINGS

During public meetings in Dec. 2013, community members set the following vision for Kihei High School and Piʻilani Highway:

> "The school will be a hub on the mauka side of the highway from which spokes will radiate to adjacent neighborhoods. Connections will be multi-modal, innovative, shaded and inviting setting the standard for all future development, a corner-stone for change, reinventing Piʻilani Highway from a high-speed arterial into an asset that honors the community and promotes walking, biking and driving—overall, active living."

The findings of this report are informed by the input received from the community stakeholders. Through focus group meetings, personal interviews, walking audits, and a public meeting, the WALC Institute team gained insights and understanding of Kihei's preferences for the new high school. Maui County's General Plan 2035 states the community's long-term vision is to unite land use and transportation planning. "Land use patterns and transportation have a very close relationship—land use decisions affect transportation planning, and transportation planning affects land use patterns. Coordination must exist between transportation and land use planning decisions so they are complimentary rather than contradictory. When designing new communities, expanding current communities, or increasing density in existing communities, ensuring mobility and circulation must be a top priority. Providing for efficient movement of all levels of transportation – pedestrian, bicycle, public transit and automobile—is essential to assuring the livability of a community."

FOCUS GROUP MEETINGS

On December 18, 2013 the WALC Institute team facilitated focus group meetings with the following stakeholder groups:

- Maui County Departments of Planning, Public Works, Parks and Recreation, and Police. Maui County Department of Fire and Safety, Hawaii State Department of Land and Natural Resources, and Hawaii State Department of Transportation were invited but no representation was present.
- Landowners representing Haleakala Ranch, Kaonoulu Ranch, Maui Research and Technology Park, and elected officials, including and Senator Roz Baker and Representative Kaniela Ing.
- Community Advocates, including Public Access Trails Hawaii (PATH)-Maui Director Joe Bertram, Kihei Community Association (KCA) President Mike Moran and several other KCA members and resident advocates.
- School leaders, including the principals from Kihei elementary schools.

The attendees commented on the high vehicle speeds along Piʻilani Highway and expressed a desire for an at-grade crossing to create a safer and consistent pedestrian experience. They were enthusiastic about ideas that would slow down vehicles, such as roundabouts and medians, while preserving traffic efficiency, making the area more walkable. Additionally, many expressed the need for better street connectivity.

PUBLIC MEETING

The project's main public meeting was held on December 19, 2013, and included a presentation and discussion in the evening. About 30 people attended the evening meeting. County staff, members of Kihei Community Association, and Representative Kaniela Ing were present, among others.

Participants shared their vision, ideas, and objectives to ensuring future students and residents can access the high school by foot or bike:

1. Rowena Dagdag-Andaya, Deputy Director of Maui County Department of Public Works identifies the need to slow motorists and include all users along Pi'ilani Highway near the school.

2. Sgt. Lawrence Pagaduan, Maui Police Officer, reinforces the need for good design, along with education and enforcement.

3. A resident advocate addresses the need for pedestrian and bicycle greenways that create mauka-makai connections, linking the future school and development to existing homes, businesses, schools, beach parks, and other destinations.

4. Local elementary school principal notes her school's barriers to Safe Routes to School stating, "it is time to get Safe Routes to School right."

5. Joe Bertram, founding member of PATH-Maui, shares members vision to "reestablish walking as a culturally fundamental transportation mode by creating a walkable Kihei, connecting existing paths, building new ones, and making Kihei a safer and more enjoyable place in which to travel on foot, increasing health, environmental and cultural benefits for all."

6. "Our community both youth and adults will look for the path of least resistance," stated Senator Baker, understanding human behavior. She wants to create routes of the least resistance for youth at-grade.

7. Father-daughter landowners, Henry Rice and Wendy Peterson want to continue to support the transformation of the school site into a place that supports the safety of youth.

8. Jonathan Starr shares his vision as Rep. Ing looks on, "Traffic calmed with roundabouts and other grade level devices with fun paths for biking and walking from all directions, promoting safety."

WALKING AUDIT

The WALC Institute led a walking audit with Department of Education, Group 70, and Munekiyo & Hiraga Planning to identify conditions that affect active living, social connectivity, safe routes to school, and access to daily needs at the new high school site along Pi'ilani Highway between the Kulanihakoi and Waipuilani gulches.

Today, the majority of the Kihei community lives makai (seaside) of the highway, with future development planned mauka (mountainside). Students will be traveling across the highway to access the school. Because the Kihei High School campus is envisioned as a place for the community to gather, the main issue facing the community is how people will get across the highway safely and efficiently. The State Land Use Commission and Maui County Council are requiring an overpass or underpass be constructed, as well as at-grade improvements.

In addition, the WALC Institute led a second walking audit along Liloa Drive with elected leaders and Kihei stakeholders to look at best practices that are built in Kihei, such as the roundabout on Piikea Avenue and Liloa Drive and the pedestrian/bicycle greenway. These projects are examples of the County of Maui working with the community to address the design of the built environment. The County of Maui and Kihei community leaders will continue to be instrumental partners in ensuring Safe Routes to School and complete streets are created to and from Kihei High School.

These efforts should address the following:

1. High Vehicle Speeds & Incomplete Streets
2. Complex Intersections
3. Missing Connections
4. Zoning Condition for an Overpass or Underpass

Above: Council Member Don Couch joins in walking audit.

1 High Vehicle Speeds. DESIGN FOR TARGET SPEED & RIGHT-SIZE STREETS

2 Complex Intersections. BUILD SAFER INTERSECTIONS

3 Address Off-Street Pedestrian and Bicycle Crossings and Networks OVERPASS OR UNDERPASS

4 Missing Connections. IMPROVE CONNECTIVITY

Process: Examining Existing Conditions

High Vehicle Speeds. Destinations—places where people wish to gather—require low, safe vehicle speeds. Like many places on the Hawaiian Islands and throughout the country, vehicle speeds in Kihei have crept up over time. This has been the result of focusing public investments and built environment designs on vehicle flow and efficiency, to the exclusion of people walking, biking or using other active modes of transportation. The State of Hawaii's Complete Streets Policy, Act 54 (2009), which focuses on a multi-modal transportation system, supports the need to accommodate all users along Pi'ilani Highway. By utilizing different design treatments, transportation engineers can move traffic more efficiently, and at lower and safer speeds that include all users, and support children getting to school safely by foot and bike.

Incomplete Streets. Pi'ilani Highway and Kulanihako'i Street are not "complete." A dedicated right-turn lane with overly wide turning radii allows vehicles to exit the highway onto Kulanihako'i Street at fast speeds. As the new intersection is redesigned to support all users this section of Kulanihako'i Street should be considered for a road diet. A road diet involves road conversion measures to right-size travel lanes and to remove excess lanes from streets primarily by moving paint. The remaining space is used for bike lanes, transit-stop bays, sidewalks or on-street parking. A road diet can improve the performance and safety of the corridor and encourage active transportation and economic vitality. This would be an important partnership with the County of Maui in tandem with the intersection improvements.

Complex Intersections. The school entrance and exit will convert the existing t-intersection at Pi'ilani Highway and Kulanihako'i Street into a four-way intersection. It is critical that this location support all users—pedestrians, bicyclists, transit users, and vehicles. The intersection will have an increased amount of turning movements. The future intersection at Pi'ilani Highway and Kulanihako'i Street will become more complex due to the future high school and mixed use development. To ensure intersection safety for all users, especially the most vulnerable users pedestrians, children and seniors intersection treatments, either a signal or roundabout need to be applied. A signalized intersection helps control significant turning volumes, however signals do not reduce vehicle-to-vehicle or vehicle-to-pedestrian conflicts. A roundabout should be considered first. The modern roundabout is an intersection treatment that reduces vehicle speeds, enhances the efficiency of the road, reduces conflicts between users, overall better supports all roadway users, and creates place as it acts as a gateway treatment.

Natural Opportunity for Underpass. The gulches on either side of the school provide the natural topography for a underpass. During the focus group meetings landowners and Maui's Public Access Trails Hawaii (PATH) agreed that the gulches were ideal candidates for an underpass and pedestrian/bicycle trail. Maui Research and Technology Park shared that they have concept plans to create a trail that would connect their campus to the future high school campus over the Waipuilani Gulch, making this gulch the ideal place to start. The underpass connection to the school would be a pedestrian and bicycle path, creating another safe route to school for future high school students and Kihei residents. The underpass would also help reconnect the community to the cultural, spiritual, communal and physical importance of paths and walking. Over time, it would connect to the greenway path that will be on the North-South Collector Road, providing easy and safe connections between homes, schools, businesses, shopping and other destinations. A major element that needs to be taken into consideration is flooding. This can be managed with early detection systems, enforcement, and designing with native species and materials that can handle extreme weather conditions.

Missing Connections. Complete the street network. The County of Maui is in the process of working towards completing Liloa Drive or the North-South Collector Road (incomplete section pictured on left) that runs parallel to Pi'ilani Highway and South Kihei Road. Once complete this will greatly improve overall traffic circulation in Kihei. The North-South Collector Road will also extend the greenway, a separated pedestrian and bicycle path. A prime opportunity is to further link and enhance the pedestrian and bicycle connection to the school from the residential areas and town-center.

Pi‘ilani Highway Today

Today, Pi‘ilani Highway has no pedestrian environment and is an overly wide road that encourages motorists to travel at speeds higher then posted speeds. High speeds kill people and place. The surrounding land use mauka of Pi‘ilani Highway is transforming from ranch land to Kihei's new upper community with the new high school and future mixed-use developments. Overtime, Pi‘ilani Highway will need to transform to honor the urbanizing community of Kihei and not remain a barrier. A catalyst area will be Pi‘ilani Highway and Kulanihako‘i Street where the future Kihei High School will be located.

Pi‘ilani Highway and Kulanihako‘i Street form a t-intersection. The Northbound approach of Pi‘ilani Highway, heading towards Kulanihako‘i Street, has an exclusive eleven foot left-turn lane that starts over 580 feet back from the intersection, two through lanes (11 to 12 feet), and a six to seven foot shoulder. The Southbound approach of Pi‘ilani Highway, heading towards Kulanihako‘i Street, has two through travel lanes, an exclusive twelve foot right-turn lane that starts over 440 feet from the intersection, a five foot bike lane marked periodically within the right-turn lane, and a shoulder that varies in width from six to twelve feet. Kulanihako‘i Street is a stop sign controlled left-only turn lane, and exclusive right-only turn lane. The splitter islands, or pork-chop islands are painted. There is no marked crossing on any of the legs of the intersection. The existing geometric design is to move cars fast, and excludes pedestrians in the design. The existing peak traffic volumes at Pi‘ilani Highway and Kulanihako‘i Street, according to Wilson Okomoto Traffic Impact Report (TIR) are:

- 1,344 vehicles Northbound on Pi‘ilani Highway at peak AM; 1,633 at peak PM
- 1,677 vehicles Southbound on Pi‘ilani Highway at peak AM; 1,654 at peak PM
- The more used turning movement is the left-hand turn from Kulanihako‘i Street onto Pi‘ilani Highway at 207 and 121 vehicles during AM and PM peak, respectively
- Average Daily Traffic (ADT): 18,000 vehicles per day

One travel lane can move 1,800 vehicles per hour uninterrupted. It is at the intersections where additional turning movements interrupt a single through travel lane. As new developments change an area, existing roads take on new responsibilities for moving people on foot, bicycle, transit and automobile. It is at intersections where all these users meet, creating a space that has many conflict points. The good news is that there are new tools, such as roundabouts and raised medians that are recognized by the Federal Highway Administration (FHWA) as "proven safety countermeasures," that when applied provide safer crossings for pedestrians, bicyclists and drivers, while continuing to maintain vehicle efficiency and flow.

Given that this intersection is in front of a future high school, building a pedestrian-friendly environment is critical. Traditional traffic engineering practices orders that an intersection must be built for the busiest 15 to 20 minutes of the day, and uses biased language such as the intersection “fails” when delay reaches an arbitrarily chosen threshold. This report is not looking for this intersection, or any intersection, to literally “fail” but rather to “thrive” economically, environmentally, aesthetically, and from the transportation perspective of safety and people-moving capacity through the intersection.

The Traffic Impact Report (TIR), April 2012, produced by Wilson Okamoto, for Kihei High School states that: “historical traffic count data obtained from the State Department of Transportation, Highway Division survey stations in the vicinity of the project, indicates traffic volumes have remained relatively stable [over the last several years].” The siting of the new high school in Kihei along Piʻilani Highway and the future mixed-use development demands that new tools be applied to Piʻilani Highway to transform the road into a place that safely moves and connects all people and all modes, while not growing traffic.

The new school will alleviate long travel distance for families driving their children back and forth to school in Central Maui and for students who ride the bus to and from Central Maui. The TIR reassigned the current high school students trips along Piʻilani Highway to get to/from school in Central Maui to the school site. The TIR states that “upon [the school] opening traffic operations are expected to remain similar to today’s existing volume.” The Wilson Okamoto TIR assumes that for the years leading to the year 2025, there will be a steady one percent growth in traffic every year. By 2025 traffic operations are expected to deteriorate slightly due to ambient growth. This report makes the assumption that any growth, on top of site generated growth, will be minimal, and therefore instead uses the 2015 volumes in the TIR and assumes that the 2015 volumes will stay relatively steady through the year 2025.

As communities continue to grow, transportation planning can no longer continue to induce traffic by only measuring and planning for a single mode—the automobile. An integrated system needs to be the focus and the measure needs to be moving people and goods on foot, bicycle, and automobile. This means the built environment, specifically roads—existing and new—need to be designed first for pedestrians, especially around schools. Intersections need to be compact and have safe crossings that promote better stopping behavior of motorists and create safe routes for people, especially students, to walk. This shift will help alleviate capacity pressure from the current roadway system because, overtime, people shift their behavior and walk or bike instead of drive for more trips or choose to travel slightly outside of the peak travel hours.

This report utilizes more progressive traffic engineering principles which acknowledge that an excessively wide intersection will induce more trips. More trips lead to more congestion, leading to widening roads again, and the vicious cycle will continue if new tools are not used. By the same token, a more compact street design will lead to a “virtuous cycle” where when capacity is limited drivers will be encouraged to arrive at school or work 20 minutes earlier, leading to a spreading out of the peak hour flow, less congestion, and an intersection that works for all modes of travel. Furthermore, this report assumes that as sites next to the High School are developed, a parallel road behind the High School will be built to spread out the traffic. The following best practices and recommendations strike a delicate balance between providing for motorists while also delivering a safe, comfortable, and accommodating environment for pedestrians and bicyclists.

MOVING FROM VISION TO IMPLEMENTATION

The following section further identifies best practices, recommendations and next-steps on design treatments that, when included, help maximize the capacity of the street for all users:

1. DESIGN FOR TARGET SPEED: RIGHT-SIZE STREETS
2. BUILD SAFER INTERSECTIONS
3. ADDRESS OFF-STREET PEDESTRIAN AND BICYCLE CROSSINGS & NETWORKS
4. IMPROVE CONNECTIVITY


ROAD X-ING


NO
MOTOR
VEHICLES


AHEAD

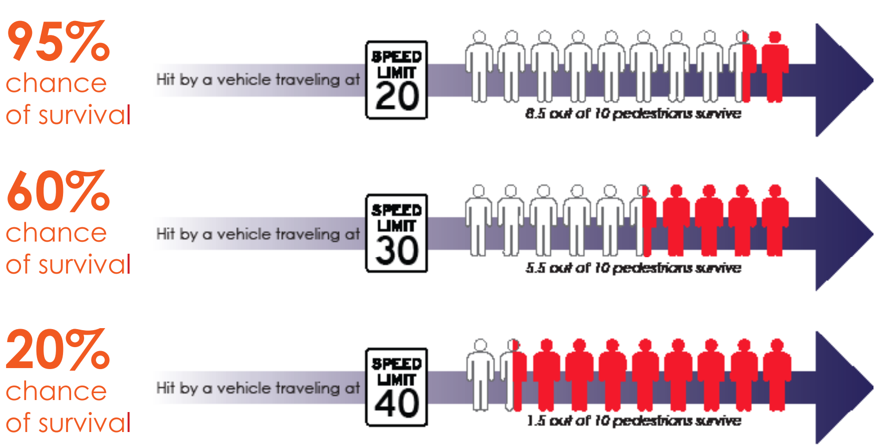
1 Design for Target Speed

The foundation to designing streets that honor communities—people and places—begins with addressing the appropriate target speed. Also known as the "desired operating speed" of a street, "target speed" is the speed desired on the roadway to ensure that all modes (vehicular traffic, transit, freight/delivery, pedestrians and bicyclists) can operate efficiently, effectively, safely and with enjoyment. Designing to a target speed means including only those design elements that best reflect the function of the roadway and its land uses.

Traditional street design practice in the transportation profession has been to set design speed and posted speed limit on 85th percentile speeds—how fast drivers are actually driving—rather than how fast drivers ought to drive. It is now recognized that such actions tend to induce greater speeds, which can cause a significant rise in crashes, especially to the most vulnerable roadway users. Design speeds should match the desired target speed. A lower target speed is a key characteristic of streets in walkable, mixed use, urban areas and school zones. Major arterials have the poorest walking condition, due to higher traffic volumes, high traffic speeds, wider streets, and complex intersections. Fewer than one-third of drivers go the speed limit on urban and suburban arterials. Therefore, the design of our roadways must be consistent with the target speed desired.

Target Speed = Design Speed = Posted Speed

Lower design speeds reduce observed speeding behavior, providing a safer place for people to walk, bicycle, use transit and drive. Speed plays a critical role in the cause and severity of crashes. The graphic below shows a pedestrian's likely survival rate if hit by a vehicle traveling 20, 30, 40 miles per hour.



Source: *Killing Speed and Saving Lives*, UK Dept. of Transportation, London, England. Also see: Limpert, Rudolph. Motor Vehicle Accident Reconstruction and Cause Analysis. Fourth Edition. Charlottesville, VA. The Michie Company, 1994, p.663.

Safety in Numbers

Visibility is impacted by the design and operating speed of a roadway. Designers need to proactively lower speeds near conflict points—intersections, mid-block crossings, for example—to ensure that sight-lines are adequate and movements are predictable for all users. As a driver's speed increases, his/her peripheral vision narrows severely, illustrated below.

Source: National Association of City Transportation Officials (NACTO) Urban Streets Design Guide

1 Design for Target Speed: Right-Size Streets

The following design features that have been found to affect operating speeds:

Horizontal and Vertical Curvature — A tight curve radius has a greater impact on operating speed than any cross-section or roadside element.

Sight Distance — As sight distance decreases, so do operating speeds.

Street Trees — Street trees in planting strips have a traffic calming benefit.

Lane Widths — Narrower lane widths are associated with lower speeds.

Total Roadway Widths — Narrower roadway widths are associated with lower operating speeds.

Access Density — Higher density of access points is associated with lower operating speeds.

Median — Roadways without medians have higher speeds than roadways with medians.

On-Street Parking — On-street parking leads to lower speeds, due to side friction between moving and passing vehicles.

Curbs — Speeds appear to be lower on streets with curbs than streets without curbs.

Pedestrian Activity — Speeds are lower on roadways with higher pedestrian activity.

Roadside Development — Building setbacks also influence speed.

1 Design for Target Speed: Right-Size Streets

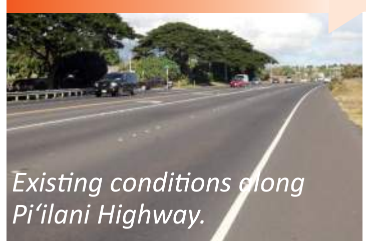
Narrow Travel Lanes; Add Landscaped Medians; Buffered Sidewalks

A person's decision to walk is influenced by many factors, including distance, perceived safety and comfort, convenience, and visual interest of the route. Pedestrians feel exposed and vulnerable when walking directly adjacent to a high-speed travel roads. Vehicle noise, exhaust and the sensation of passing vehicles reduce pedestrian comfort. Factors that improve pedestrian comfort include a separation from moving traffic and a reduction in speed, improving safety for all roadway users. Applying the following design treatments to Piʻilani Highway will design the road for the appropriate target speed (25 to 30 mph in the school zone), creating safe paths of travel for all modes.

Narrow Travel Lanes. The wider a roadway, the faster cars tend to travel. Wide roadways also make for wide pedestrian crossings, increasing the amount of time a person is exposed to the threat of being hit by a car and the amount of time that cars are held back. The same is true with auto-to-auto crashes and bicycling crashes. Reduce vehicle lanes to 10 feet wide, 11 feet wide maximum. This should be the default lane width. In addition to lowering vehicle speeds, this practice saves on materials, reduces environmental impacts, adds to vehicular efficiency and performance, and provides physical space for wider sidewalks, or bike lanes, or wider buffers between sidewalks and passing vehicles. Studies by the Transportation Research Board reveal that there is slight improvement in safety when narrower lanes are applied. The AASHTO Green Book provides guidance that states, counties, and cities often unnecessarily treat as standards. The Green Book encourages flexibility in design within certain parameters, as evidenced by AASHTO publication: A Guide to Achieving Flexibility in Highway Design. For example, 10-foot lanes, which many states often shun out of concern of deviating from standards, are well within AASHTO guidelines. Nine-foot lanes have even been permitted for lower speed environments. Thus a 10 or 11 foot (maximum width) for this lower speed area falls well into the normal range for both a travel lane or turn lane. There is no reason for any travel lane to exceed 11 feet. The center turn lane should be at maximum 10 feet because the lane's primary function is to store cars waiting to make a left hand turn. In many areas, the narrower lanes also make intersections more compact and efficient. When it comes to the width of vehicle lanes, less can be more.

Landscape the Median. A landscaped median with street trees will create a buffer, green the street and further act as a traffic calming tool, creating a boulevard effect.

Envision: From this... To this.



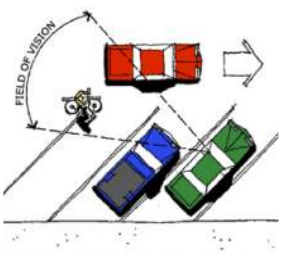
Existing conditions along Piʻilani Highway.

Example of a median in Colorado.

Build Buffered Sidewalks or Multi-Use Trail. On the school side along the highway wide sidewalks or multi-use trail should be built at a minimum of 12 feet wide. A landscaped buffer with shade trees should be included to protect pedestrians and bicyclist from moving vehicles. A model example is the greenway on Liloa Drive in Kihei.

1 Design for Target Speed: Right-Size Streets with On-Street Parking

Off-street parking takes up three times more space than on-street parking. On-street parking visually narrows streets and helps to bring down vehicle speeds, while providing the most sustainable and affordable parking. Speeds are brought down even more when tree wells are used to provide a canopy to the street. Tree wells can be placed every three to five parking spaces to create a beautiful green edge. The primary reason for maximizing parking on-street is to help civilize the street that was overbuilt for speed. On-street parking belongs on center city streets, near schools, employment centers, and residential neighborhoods, acting as a buffer between pedestrians and moving cars—a natural traffic calming tool —and one that honors the surrounding land. The majority, if not all, of the 955 parking spots needed at the high school can be moved on-street, helping to calm traffic, save costs, and provide more green space on the school campus.



The diagram (above) from the City of Northampton, MA illustrates one of the benefits of head-out angled parking: a driver's ability to see oncoming traffic as they pull into the travel lane from their parking spot.

Head-Out Angled Parking, also called "back-in" or "reverse" angled parking, is arguably the safest form of on-street parking. It offers multiple benefits, including creating a sight line between the driver and other road users when "un-parking." Additionally, head-out parking allows the driver to load their trunk from the curb, instead of adjacent to the travel lane. And for drivers with young children, seniors or others who need extra help, the open car doors direct passengers to the safety of the sidewalk behind the car, not into traffic. Getting into a head-out angled spot is simple—a driver signals their intention, slows, pulls past the spot and then backs into it, which is roughly equivalent to making only the first maneuver of parallel parking. (Watch a brief video about head-out angled parking at www.walklive.org.)

Left: The illustration was created for Solana Beach, CA, offering inspiration for how Kihei High School's access road could be designed.

1 Design for Target Speed: Right-Size Streets with On-Street Parking

Above: La Jolla Boulevard in Bird Rock California converted 5-lanes to 2-lanes. One of the greatest challenges of the design team was to drop to the two travel lanes and include angled parking on one side. A "transition lane" was created, allowing parking and un-parking to occur without interrupting the flow of traffic. This same tool can be applied for head-out angled parking on the street of the new high school.

Above: Head-out angled parking in Seattle, WA improves motorists sight lines as the are looking directly out at on-coming traffic--vehicles or bicyclists.

Convert Off-Street Parking to On-Street Parking. The Department of Education has the opportunity to improve Kihei High School campus design by moving the majority, if not all, of the off-street parking to on-street parking. This will help calm the school streets, provide for more street connectivity and thus better traffic circulation on campus. On-street parking is a key ingredient to creating a vibrant and pedestrian-friendly street. Using the curbside for parking saves considerable amounts of land from life as an off-street surface parking lot, making a better land use decision. On-street parking also increases safety. Motorists tend to drive at slower speeds in the presence of features such as on-street parking. Slower vehicle speeds provide pedestrians, cyclists and drivers more time to react, and if a crash were to occur, the chance of it being life-threatening is greatly reduced. On-street parking helps to create a safer environment and honor the community.

The new high school and future development have the greatest potential to be a model of walkability and livability for the town of Kiehi. In order to achieve this the design of the street needs to be integrated with the surrounding land use, and a new way of thinking about the design of our built environment needs to happen, shifting from building for the movement of cars (inducing traffic) to a focus on moving people. Failing to install on-street parking may contribute to the speeding of motorists, while removing an important physical buffer between people on the sidewalks and people passing them. Change policies to set a maximum for off-street parking when a new development goes in, instead of requiring a minimum; even better work towards not having a minimum or maximum. Kihei High School has already been successful in reducing the current parking requirements. The opportunity is right to move most, if not all, of the parking onto the street by using the most efficient for of parking—head-out angled parking.

Above: Ulune Street in Aiea Heights, Honolulu, transformed through the use of paint as the City and County of Honolulu's first Complete Streets demonstration project. The island's first head-out angled parking was done on Ulune Street and in front of Aiea Heights High School.

2 BUILD SAFER INTERSECTIONS
Through Compact Design

"All transportation projects need to consider pedestrians' needs, including limited access freeways and highways that pedestrians cross or that intersect with streets that serve pedestrians. Because in Hawaii, highways are often the 'main streets' of villages and towns, pedestrians often walk along and cross highways." - Hawaii Pedestrian Toolbox

Most conflicts between roadway users occur at intersections, where travelers cross each other's path. Good intersection design indicates to those approaching the intersection what they must do and who has to yield or stop. Conflicts for pedestrians and bicyclists are exacerbated due to their greater vulnerability, lesser size, and reduced visibility to other users.

Kihei, Maui is considered one of Maui's urban centers according to the Hawaii Pedestrian Plan, 2011. Intersections, particularly in urban or village areas, have a significant placemaking function as well as transportation function. Pi'ilani Highway and Kulanihako'i Street will become a multi-modal intersection filled with pedestrians, bicycles, cars, trucks and buses with the future high school and mixed-use residential development. The diverse use of intersection users creates a high level of activity and need to share space.

Intersections with high motor vehicle volume, high vehicle speed, and multi-lane intersections with complex signal phasing or without any traffic control at all are the most hazardous types of intersections for pedestrians. Pedestrians are even at risk at simple STOP-or YIELD-sign intersections because of the common disregard of traffic control devices by both motorists and pedestrians. [1] People on foot may avoid difficult crossings or subject themselves or their children to considerable risks while crossing a street at a poorly designed intersection.

1 Institute of Transportation Engineers (ITE). Issue Briefs 9: Pedestrian Safety at Intersections. 2004. http://www.ite.org/technical/IntersectionSafety/Pedestrians.pdf

The new intersection that will be created at Pi'ilani Highway and Kulanihako'i Street for Kihei high school needs to address an at-grade intersection design that accommodates the needs of all road users. Intersection design should promote eye contact between users, creating a streetscape in which pedestrians, bicyclists and drivers are aware of one another and can effectively share space. The following are guiding principles to ensuring that the intersection is built to function for everyone, regardless or age or mode choice.

The following principles apply to all users of intersections:

- Good intersection designs are compact.
- Design should account for existing and future land uses.
- Conflicts should be avoided by applying treatments such as the Federal highway Administration (FHWA) proven safety countermeasures, which include roundabouts and medians and pedestrian crossing islands.
- Simple right-angle intersections are best for all users since many intersection problems are worsened at skewed and multi-legged intersections.
- Signal timing should consider the safety and convenience of all users and should not hinder bicycle or foot traffic with overly long waits or insufficient crossing times.

Intersection geometry is a critical element of intersection design, regardless of the type of traffic control treatment used. Geometry sets the basis of how all users traverse intersections and interact with each other. Taking into consideration the existing conditions—multi-lane road, high vehicle speeds and overly-wide corner radii—of the intersection at Pi'ilani Highway and Kulanihako'i Street, current traffic data and the changing land use with a school and future development the design of the intersection needs to ensure a compact, multi-modal intersection is implemented. The following pages outline the benefits, disadvantages and next steps for intersection treatments that create a safe and connected multi-modal transportation system to the future Kihei High School through best practices and conceptual design drawings.

Modern Roundabout: A Safer Choice.

Some people think roundabouts can't be constructed on state roads, but that is not true. This is why the Federal Highway Administration strongly encourages state and local leaders to first look at roundabouts as an alternate to conventional intersection design.

2 BUILD SAFER INTERSECTIONS
Through Compact Design: Modern Roundabouts

Modern roundabouts are proven safer than signals. The Federal Highway Administration (FHWA) strongly encourages state and local leader to look at roundabouts as an alternate to conventional intersection design.

Every day in the U.S., about 20 people are killed at conventional intersections, and many more are seriously injured.[1] Roundabouts can help reduce these deaths and injuries: they are calmer and safer, and in recent years have been deemed a "proven safety counter-measure" by the U. S. Department of Transportation.[2]

Modern roundabouts increase safety, reduce delays at intersections, reduce crashes, traffic delays, fuel consumption, air pollution, construction costs and maintenance costs. Roundabouts enhance the beauty of intersections and effectively control speeds. Compared to signzalized intersections, studies show that roundabouts provide a:

- 90-percent reduction in fatal crashes
- 75-percent reduction in injury crashes
- 30- to 40-percent reduction in crashes involving pedestrians

When designed properly, roundabouts result in safe vehicle speeds—between 15 and 25 mph, depending on the size and objective of the roundabout—which increases drivers' ability to judge and react to other vehicles and pedestrians. The slower vehicle speeds also are one of the keys that make roundabouts work for pedestrians: drivers are more inclined to yield as required when they're already going slowly. Conditions are easier for older and novice drivers. All modes are safer and integrate better. Despite the slower speeds, roundabouts tend to increase traffic efficiency—sometimes by as much as 50 percent—because they keep traffic flowing. In some places, including the Bird Rock neighborhood of San Diego, CA, single-lane roundabouts successfully carry 25,000 vehicle trips per day. Today, roundabouts grace about 2,000 intersections in the U.S., with more planned.[3]

Roundabouts also reduce environmental and noise impacts, and require much less maintenance and repair than signalized intersections. Roundabouts improve the visual quality and character through landscaping, sculptures and other gateway features that celebrate place while providing traffic calming benefits.

1 Modern Roundabouts: A Safer Choice, U.S. DOT's Federal Highway Administration (FHWA), http://safety.fhwa.dot.gov/intersection/roundabout/fhwasa10023/transcript/audio_no_speaker/

2 Proven Safety Countermeasures, FHWA, http://safety.fhwa.dot.gov/provencountermeasures/fhwa_sa_12_005.htm

3 Modern Roundabouts. http://roundabout.kittelson.com/Roundabouts/Search

2 BUILD SAFER INTERSECTIONS
Through Compact Design: Modern Roundabouts

Roundabouts provide:

90%
reduction in fatal crashes

75%
reduction in injury crashes

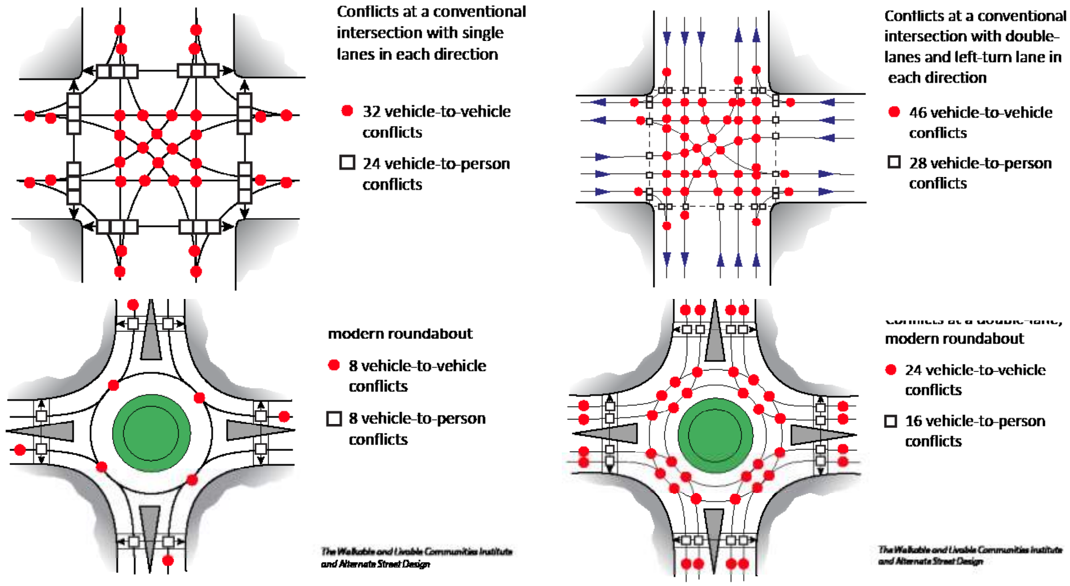
30-40%
reduction in pedestrian crashes

10%
reduction in bicycle crasheS

30-50%
increase in traffic capacity

Lower maintenance costs with no signal equipment to install, repair and rebuild, which has a saving of **$13,000 to $20,000** per year for every signalized intersection

Roundabouts are inherently safer because they reduce the number of points of conflict within the intersection, as shown in the illustration below.



Roundabouts are circular intersections that move traffic counterclockwise around central islands, but not like large, high-speed 'rotaries' or 'traffic circles.' Rather modern roundabouts range from mini-roundabouts that fit on neighborhood streets that span up to 80 feet in diameter and handle 10,000 or more vehicles per day, to double-lane roundabouts 200 feet in diameter that handle 45,000 vehicles a day.[1]

Roundabouts are typically more efficient than traffic signals. At traffic signals there is "lost time" where vehicles on all approaches are stopped simultaneously between phases when the signal changes from green on one approach and turns to green on another. At roundabouts, vehicles can enter the circulating roadway whenever there is a suitable gap, most often without coming to a full stop. Additionally, vehicles can enter from multiple approaches simultaneously. These factors mean that roundabouts can process more vehicles in a given time with less delay than traffic signals. During off-peak traffic periods (the majority of the day) roundabouts excel, as there is no need to be stopped waiting for a green light.

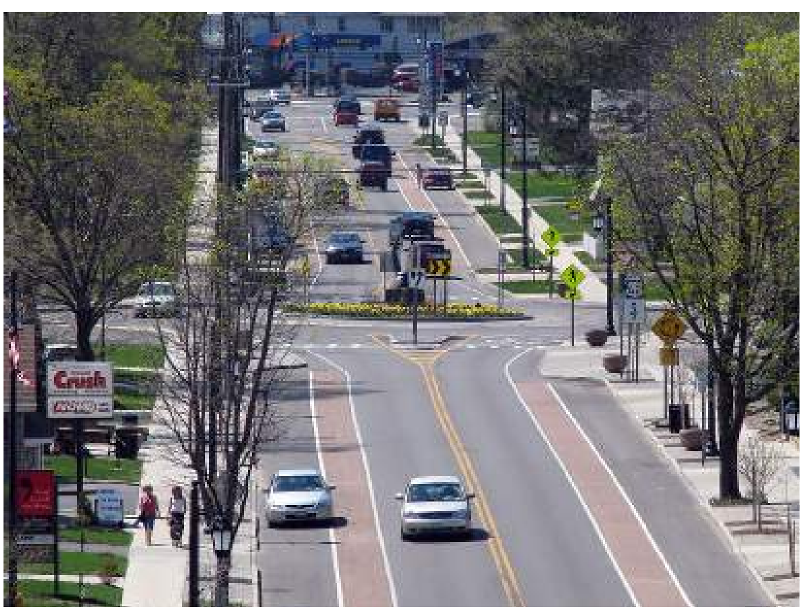
Many people oppose change, especially of new things that aren't yet understood. For example, before two 2-lane roundabouts were first installed in Bellingham, Washington, only 34% of people surveyed by the Insurance Institute for Highway Safety said that they were supportive of a roundabout. Once they went in, however, the numbers reversed, and 70% became supportive. In another study conducted by the Institute, support for 6 different roundabouts, went from a low of 22% at first to a high of 87% up to five years after installation.

1 Roundabouts: An Informal Guide, FHWA, hhttp://www.fhwa.dot.gov/publications/research/safety/00067/000674.pdf

Above: The Clearwater Beach, FL roundabout is one of the busiest in the nation, handling 58,500 motorists daily at peak season, along with 8,500 pedestrians.

Above (Left): Speeds on Grandview Drive in University Place, WA were once as high as 50 mph. After the installation of the roundabout motorized crashes went from one every nine months, to zero for the past 14 years.

Above (Right): The roundabout on La Jolla Blvd in San Diego, CA has reduced crossing distances from 64 feet to 14 feet. Pedestrians no longer have to cross multiple high-speed lanes at once.



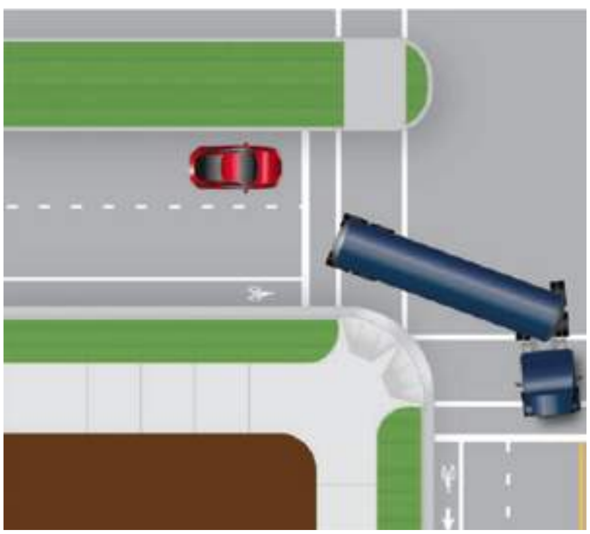
Left: By the 1990s, business had declined along Route 62 in Hamburg, New York's commercial district. Empty storefronts pushed shoppers out to malls and big box stores. The road was often congested and presented hazards for bicyclists and pedestrians. A state plan emphasized wider roads and signalized intersections. But a group of residents banded together as the "Route 62 Committee" and created a new vision for Route 62 based on walkability and calmer traffic. Roundabouts have reduced the number and severity of crashes, congestion has been eased and emissions from idling cars have been reduced.

2 BUILD SAFER INTERSECTIONS
Through Compact Design: Signalized Intersection

Today the Federal Highway Administration (FHWA) strongly encourages State and local leaders to first look at roundabouts as an alternate to conventional intersection design, as roundabouts are one of the U.S. Department of Transportation's proven safety countermeasures.
This is due to the roundabout's proven ability to move motorists efficiently, effectively and more safely while creating an inclusive environment that supports all other modes of transportation and people of all ages over traditional signalized intersections.

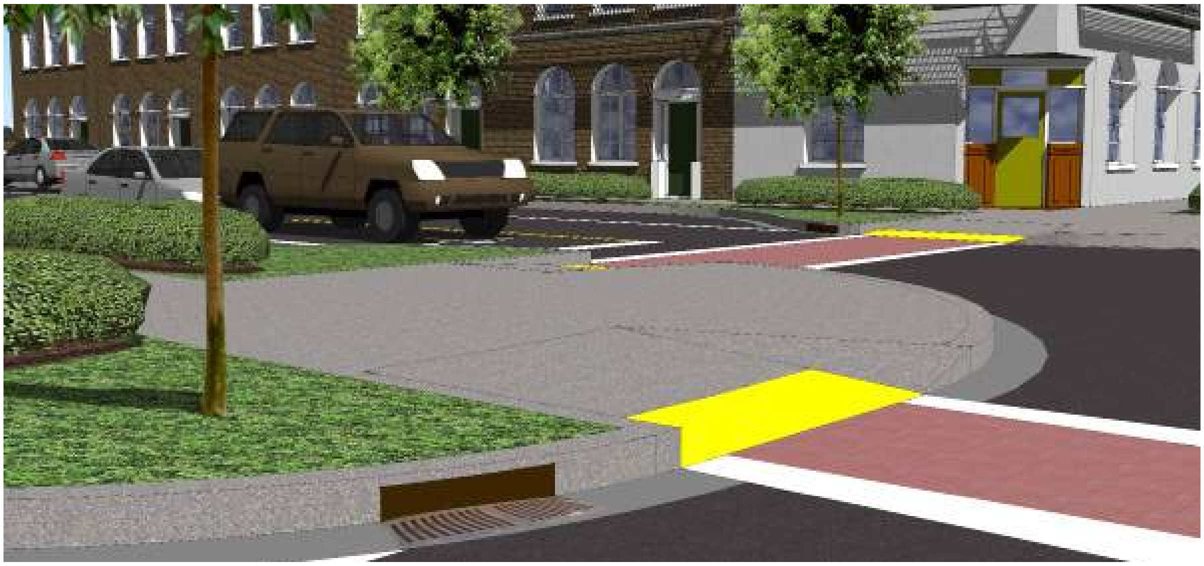
The vision of the community is to continue to enhance Kihei's walkability and access to community destinations. This also aligns with the State's vision (per the Hawaii Pedestrian Plan) to create a more integrated system that promotes a positive pedestrian experience while still moving motorists. Although, the report recommends a roundabout first, a signalized intersection would also be feasible, as long as it is designed to be compact and the design honors people and place. The following are best practices for creating compact signalized intersections, which apply to the new intersection being created at Pi'ilani Highway and Kulanihako'i Street.

A compact signalized intersection means that design treatments are used such as curb extensions, or "bulb-outs," that create a more compact curb radii and low-speed right-hand turns, which eliminates high-speed right-hand turns. The addition of bike lanes also creates a greater effective turning radius at corners and driveways, allowing large vehicles to turn without off-tracking onto the curb. Other treatments should include medians and median noses or pedestrian island crossings helping to minimize and brake-up the crossing distance for pedestrians. This will also help minimize the waiting time of motorists as the crossing distance determines how long the motorist is held back to allow a person on foot to cross.



Left: Crossings are improved by tightening the curb radius and building raised medians with pedestrian refuges. Bike lanes support the effective corner radius , which controls turning speeds and the ability of large vehicles to turn. Note crosswalks can be enhanced with high visibility lateral striping.

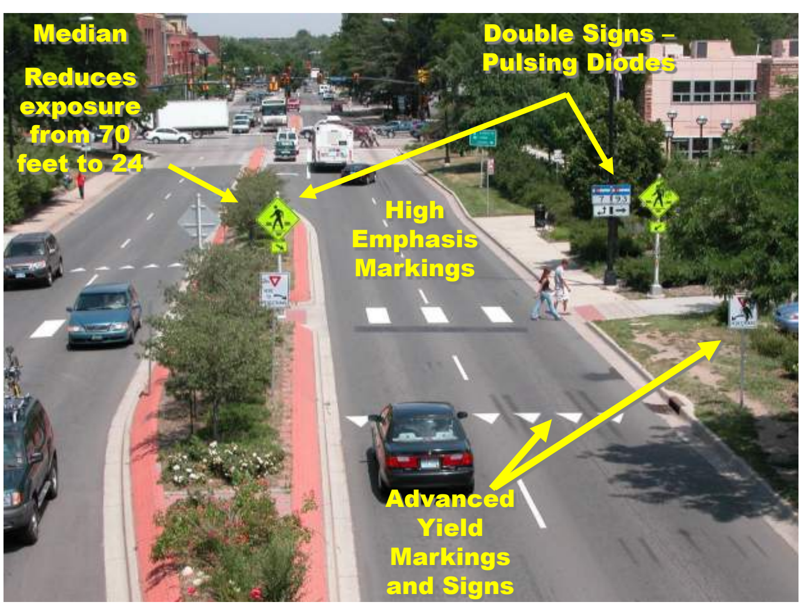
Illustration by Michele Weisbart; source: LA County's Model Design Manual for Living Streets



Above: Curb extensions, of "bulb-outs," reduce the crossing distance and exposure of a person on foot, as well as, greatly improve ADA compliance. Helping children cross the street safely also benefits elders, people with disabilities and parents with strollers.

Above (Left): This intersection in West Sacramento, CA has two ADA ramps per corner with high visibility marked crossings, helping to communicate that pedestrians are expected here.

Above (Right): Lincoln Highway in West Sacramento, CA is transforming. Today, a tree lined and landscaped median has been implemented, including a median nose at a signalized intersection to help pedestrians more safely cross six travel lanes.



Left: A landscaped median and marked midblock crossing in Boulder, CO. Note, Hawaii is a STOP for pedestrian state so the marking would be a solid bar instead of the triangular yield marking shown in this photograph. It is also important to note that the advanced yield or stop bar is placed, at minimum, 30 feet back from the crossing to reduce multiple threat crashes. A multiple threat crash is when a motorists stops to let a person cross too close to the marked crossing, and sets up a blind for an approaching motorist in the adjacent travel lane.

Vision: Before

The photo-vision illustrates how a modern roundabout at the of Kihei High School creates a gateway for the school and community, honoring place and quieting the street. It reduces the crossing distance (exposure) for students on foot by providing space to pause on the 'splitter island,' and pedestrians only need to consider one direction of traffic at a time, simplifying the task of crossing the street. The low vehicle speeds through a roundabout increase driver vigilance, allowing more time for drivers and pedestrians to react to one another. Bicyclists are given the option of riding in the lane of slow moving traffic, or riding on the shared pedestrian path.

Vision: After

2 BUILD SAFER INTERSECTIONS
Through Compact Design

Choose a Roundabout. Many roundabouts have been installed near schools in the United States, including Montpelier, Vermont; Howard, Wisconsin; University Place, Washington; and Kennewick, Washington. The low speed and safety aspects for both drivers and pedestrians at the intersection, along with the traffic calming effects seen several hundred feet from the intersection, make roundabouts an ideal choice near schools. The conceptual design (above) illustrates a double-lane roundabout along the Pi'ilani Highway leg and a single-lane on the Kulanihako'i Street and school street leg. Double-lane roundabouts typically are 200 feet in diameter can have a large right-of-way requirement, however this is not an issue given the sufficient right-of-way along this section of Pi'ilani Highway. The conceptual design factored in the nearby intersections of Pikea Avenue, Kaonoulu Street and Ohukai Road to ensure that traffic at these intersections would not backup into the proposed intersection. The findings prove that there will be no backup; Pikea Avenue is 3,900 feet away and Ohukai Road is 5,000 feet away. Kaonoulu Street currently is unsignalized creating no queue length. Design details are important; ensure it is done by an engineer experienced with modern, double-lane roundabouts that are traffic-calming, include the pedestrian and bicyclist, and act as placemaking tools.

To manage peak twenty-minute school traffic a metering signal can be installed. The reason why a roundabout can become congested is because the traffic flow within the roundabout circulation prevents motorists from other legs entering due to a lack of gaps. A metering signal is similar to a ramp metering where the approaching vehicle queue is metered and a part time signal is used to stop the conflicting vehicle flow to allow the congested approach to enter the roundabout.[1] To better signal to drivers a pedestrian is present a Rectangular Rapid Flash Beacon can also be installed, in a way that is similar to a half signal so only one direction of traffic is stopped at a time.

1 Clearwater Beach, Florida Roundabout. http://www.sidrasolutions.com/Documents/KenSIDESClearwaterROUPaperITE.pdf

2 BUILD SAFER INTERSECTIONS
Through Compact Design

When driving through a roundabout:

1. Slow down.

2. When there is more than one lane, use the left lane to turn left or make a u-turn, the right lane to turn right, and all lanes to go through.

3. Yield to pedestrians and bicyclists.

4. Yield to circulating motorists.

5. Stay in the same lane within the roundabout and use the right-turn signal to indicate intention to exit.

6. Always assume trucks need all available space - don't pass them.

7. Clear the roundabout to allow emergency vehicles to pass.

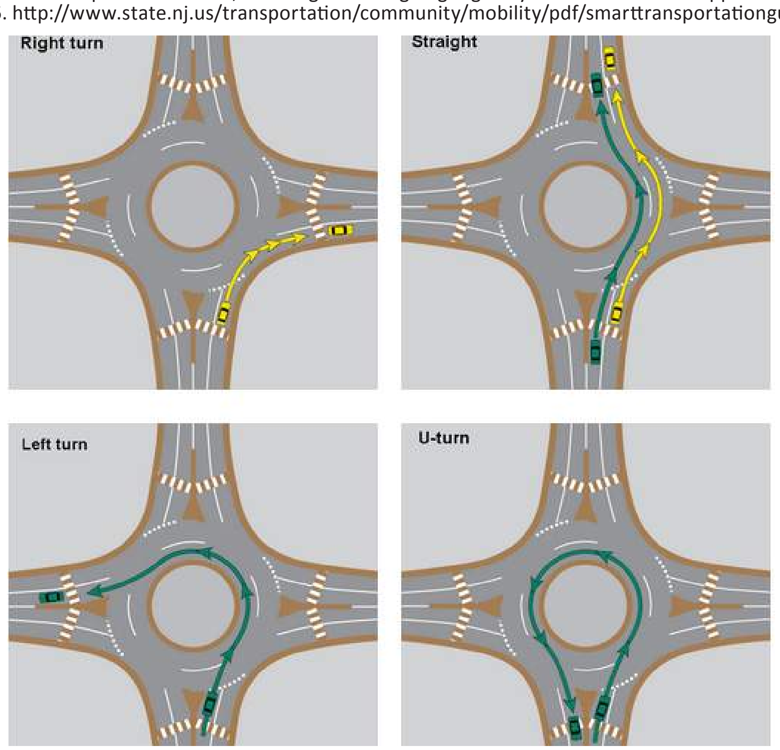
Watch a video demonstration Carmel, Indiana: http://www.carmel.in.gov/modules/showdocument.aspx?documentid=911

To further support a roundabout as the viable intersection treatment:

Adopt a Roundabout-First Policy. Whenever a project includes reconstructing or constructing an intersection, analyze the feasibility of using a roundabout instead. This approach is recommended by the U.S. Department of Transportation's Federal Highway Administration and backed by the Insurance Institute for Highway Safety.[1] HDOT in 2008 adopted a " Modern Roundabout Policy Guideline" which notes roundabouts should be considered by transportation professionals and communities (http://goo.gl/lfmpTK).

Promote the Design Through Education and Awareness. People may be concerned with driving in a multi-lane roundabout. Many may ask questions, such as *how do I choose which lane to enter and exit?* Education is vital to the acceptance and success of a roundabout. Navigating a roundabout is easy, but because people are apprehensive about new things, it's important to educate the public about roundabout use. In general, multi-lane roundabouts should be approached the same way as any other intersection. If the motorist wants to turn left, use the left-most lane and signal the intention to turn left. If the motorist wants to turn right, use the right-most lane and signal the intention to turn right. In all cases, motorists circulate counterclockwise around the central island. Motorists entering the roundabout always need to yield to people crossing and motorists that are currently circulating in the roundabout.

1 Smart Transportation Guide, Planning and Designing Highways and Streets that Support Sustainable and Livable Communities. Chapter 6. http://www.state.nj.us/transportation/community/mobility/pdf/smarttransportationguidebook2008.pdf



Above: The graphic, from Washington State DOT, shows what turns can be made in multi-lane roundabouts. The arrows in yellow show the movements that can be made from the right lane, and the arrows in green show the movements that can be made from the left lane.

Top (right): A graphic illustrating a roundabouts main characteristics. Bottom (right): A graphic illustrating walking and biking through a roundabout. Learn more here: http://safety.fhwa.dot.gov/intersection/roundabouts/fhwasa08006/

Although a roundabout is the recommended first choice for creating an inclusive environment that supports all modes of transportation and people of all ages, the report conceptually illustrates a signalized intersection. The most important point is that the intersection needs to honor the future land use and set the tone for safe and convenient at-grade routes for all people and all modes of travel.

If a signal is implemented the intersection should be built compactly to reduce turning speeds and minimize conflict points between motorists and pedestrians. Design treatments such as curb extensions to eliminate high-speed right-hand turns and medians with median noses should be applied, helping to minimize and brake-up the crossing distance. This will also help minimize the waiting time of motorists as the crossing distance determines how long the motorist is held back to allow a person on foot to cross. Signal timing also needs to be addressed to ensure that it allows time for pedestrians on foot and minimizes conflicts due to turning movements. The following street treatments are recommended to ensure a compact intersection designed to safely and conveniently allow all modes an at-grade crossing:

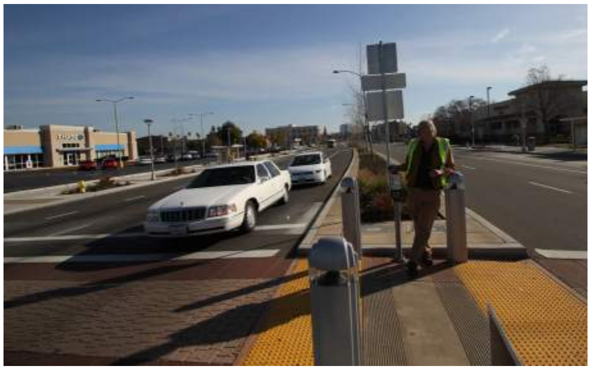
- Install curb extensions.
- Paint high-visibility ladder-style marked crossings.
- Enhance visual clues to motorist by installing landscaped medians.
- Include median noses at intersections to reduce crossing distance for people on foot.
- Set signal timing not just for the movement of motorists, but also for pedestrians, bicyclists and public transit users to create a safer environment that supports everyone.

2 BUILD SAFER INTERSECTIONS
Through Compact Design

Install curb extensions. Reduce high speed right-hand turning radii and crossing widths by installing curb extensions. To still allow for truck turning movements stop bars can be set further back from the crosswalk marking, and the addition of bicycle lanes provides the additional benefit of increasing the effective turning radius. Any new design should include American with Disabilities Act (ADA) Requirements. This is a federal law. ADA compliance is improved through the use of curb extensions. Not only is it easier to position the ramps where they need to be the pedestrian is positioned where they can see traffic, and where drivers can see them. Curb extensions help improve motorists yielding behavior, and sight lines are better protected for both motorists and pedestrians.

Paint high-visibility ladder-style marked crossings. Ladder-style crosswalk markings provide the highest visibility to a driver from afar because there is more surface area to be seen. They also provide added support for people with visual limitations. The color contrast shown in El Cajon, CA (left) is not required in uniform traffic standards, but can be adopted by communities to better support active transportation. Raised crossings also help create a more enhanced crosswalk marking and slow motorists.

Enhance visual clues to motorist by installing landscaped medians. Medians reduce the number of conflicts and conflict points, decreasing vehicle crashes, providing pedestrians with a refuge as they cross the road, and space for landscaping, lighting and utilities. These medians are usually raised and curbed. Landscaped medians enhance the street, or help to create a gateway entrance into the community. Medians with trees planted in them create a sense of enclosure, helping to improve driver vigilance.



Include median noses at intersections to reduce crossing distance for people on foot. Median noses, similar to pedestrian crossing islands that are used for mid-block crossing locations, are often placed near schools, trail crossings, high pedestrian flow zones, transit stations, work centers and shopping districts. The minimum width of a crossing island or median nose is six feet in width. A pedestrian activated signal should be placed in the median nose to allow pedestrians waiting to activate the signal cycle. Creating a refuge helps people of all ages cross a multi-lane road, by creating an environment where people are not stranded if they are unable to make the full signal length.

Equally important to the allocation of space for the design of the intersection, is the allocation of time performed by traffic signals. In combination, space and time govern how streets operate and how well they provide mobility, safety and access. Signal timing is an essential tool, not just for the movement of traffic, but also for a safer environment that supports walking, bicycling public transit use and surrounding land use.

Set signal timing not just for the movement of motorists, but also for pedestrians, bicyclists and public transit users to create a safer environment that supports everyone. Basic pedestrian signal timing principles should be combined with innovative pedestrian signal timing techniques to enhance pedestrian safety and convenience, especially near a school. To improve livability and pedestrian safety, signalized intersections should:

- Provide signal progression at speeds that support the target speed of a corridor;
- Provide short signal cycle lengths, which allow frequent opportunities to cross major roadways, improving the usability, accessibility and livability of the surrounding area for all modes;
- Ensure that signals detect bicycles;
- Place pedestrian signal heads in locations where they are visible;
- Set the signal timing to automatic recall, so pedestrians don't have to seek and push a pushbutton. If this is not included, place pedestrian pushbuttons in convenient locations, using separate post that are accessible.

To ensure pedestrian signal phasing is included to increases safety and convenience for pedestrians refer to the *LA County's Model Design Manual for Living Streets here: http://www.modelstreetdesignmanual.com/ or National Association of City Transportation Officials (NACTO) here: http://nacto.org/usdg/intersection-design-elements/traffic-signals/*

2 BUILD SAFER INTERSECTIONS
Through Compact Design

In addition to at-grade intersection improvements for all users at Pi‘ilani Highway and Kulanihako‘i Street the County of Maui should compliment improvements by addressing the crossing distances on many of the residential streets along Kulanihako‘i Street, which today are overly-wide due to the overly-wide right-hand turn radii, encouraging high speed turns. Walkable low-volume neighborhood streets should have a crossing distance of 28 feet maximum (includes two travel lanes and turning radius).

Install curb extensions. The County of Maui should add curb extensions to fix overly-wide street crossings on Kulanihako‘i Street.

Above: Residential, cul-de-sac, streets are overly-wide with the crossings over 40 feet, on some streets crossings are close to 70 feet. The maximum width of low-volume neighborhood streets should be 28 feet.

3 ADDRESS OFF-STREET PEDESTRIAN & BICYCLE CROSSINGS & NETWORKS

Underpass or Overpass

The State Land Use Commission and Maui County Council have imposed a zoning condition that an overpass or underpass be considered (see supporting documents, page 66), as well as at grade improvements, the following section will address this condition.

Pedestrian overpasses and underpasses allow for pedestrian movement separate from vehicle traffic. However, they are usually considered as a last resort measure. It is more appropriate to install safe crossings that are accessible to all pedestrians and bicyclists at grade. Separated facilities are extremely high-cost and create other problems. “Eyes on users” and ADA compliance are two very common problems associated with over/underpasses. For example, to meet ADA extensive ramping typically is needed to accommodate wheelchairs and bicyclists at grade changes, resulting in long crossing distances and routes, which discourage use. Studies have shown that many pedestrians will not use an overpass or underpass if they can cross at street level in about the same amount of time or less. Keeping in mind that students will be using this feature, peer pressure to “race for it” and cross at grade may also be likely.

Careful consideration should be given to potential negative impacts on the pedestrian environment.

- Use sparingly and as a measure of last resort. An overpass or underpass is most appropriate over high-volume, high-speed highways, railroad tracks, or natural barriers.
- People will not use the structure if a more direct route is available.
- Lighting, drainage and security are also major concerns with underpasses.
- Must be ADA accessible, which generally results in long ramps on either end of the overpass or underpass, depending on topography.[1]
- Decreased on-street vibrancy due to a reduction in movement and activity by pedestrians.
- Increased construction expenses.

Costs for pedestrian and bicycle overpass or underpasses vary greatly from state to state and city to city. Costs will vary greatly based on site conditions, materials and other contexts. Underpasses (excluding bridges) range from slightly over $1 million to over $15 million in total or around $120 per square foot. Overpasses (excluding bridges) have a range from $150 to $250 per square foot, depending on site conditions. More detailed cost information can be found here: http://www.pedbikeinfo.org/data/library/casestudies_details.cfm?id=4876.

1 Pedestrian and Bicycle Information Center. Overpass/Underpass. http://www.pedbikeinfo.org/planning/faciliites_crossings_over-underpass.cfm

3 ADDRESS OFF-STREET PEDESTRIAN & BICYCLE CROSSINGS & NETWORKS

Underpass or Overpass

Taking these factors into consideration, an overpass should not be considered due to the areas topography, costs, and understanding of pedestrian behavior. During the focus group sessions the majority of participants agreed that due to the contexts of the surrounding area of the new school site an overpass is not an appropriate treatment.

If this condition is to be met, an underpass is the most viable option given the gulches on either side of the school, which provide the natural topography for an underpass. However, additional measures need to be taken into account for the planning and design of an underpass due to concerns regarding flash flooding in Maui County. An underpass is the more widely accepted and supported treatment within the community.

Choose an underpass. The first priority is to address at-grade crossings for pedestrians and bicyclists. A mid- to long-term treatment is an underpass due to the natural topography of the area with the gulches: the most viable option for an additional pedestrian and bicycle-only travel-way. This however will require additional engineering studies and multi-government agency and public-private relationships. Of the two gulches, the Waipuilani gulch would be the best gulch to start with. Maui Research and Tech Park has already shared their interest and conceptual designs for a non-motorized trail connecting their campus to the school campus along the Waipauilani gulch.

Left: The Hendrix College Tunnel in Conway, AR provides a tunnel with a musical fugue and light show to make the passage more interesting and to encourage use.

Envision: From this...

Above (Left): Existing conditions at Waipuilani Gulch.

To this.

Above (Right): The Tunnel Underpass in Boulder, CO

Envision: From this...

Above (Left): Existing conditions at Waipuilani Gulch.

To this.

Above (Right): An underpass trail in Davis, CA.

4 IMPROVE CONNECTIVITY
Complete the Street Network

Maui County General Plan 2035:
Objective: 6.8.2 Provide a more expansive network of safe and convenient pedestrian-friendly streets, trails, pathways, and bikeways between neighborhoods and schools where appropriate.

Policies: 6.8.2.a Encourage the State to build new school facilities in appropriate locations that minimize time and distance for students to travel to and from school.

6.8.2.b Encourage the State to implement the Safe Routes to School initiative with funding commitments to help the County plan and fund projects that ensure safe access routes to school

Implementation Actions:
6.8.2-Action 1 Conduct an inventory to determine safety obstacles along school access routes and work with the State to address safety concerns for students who are unable to utilize school bus transport.

6.8.2-Action 2 Work with the State to coordinate the siting and development of future school facilities, bikeways, pedestrian paths, and greenways to encourage mobility.

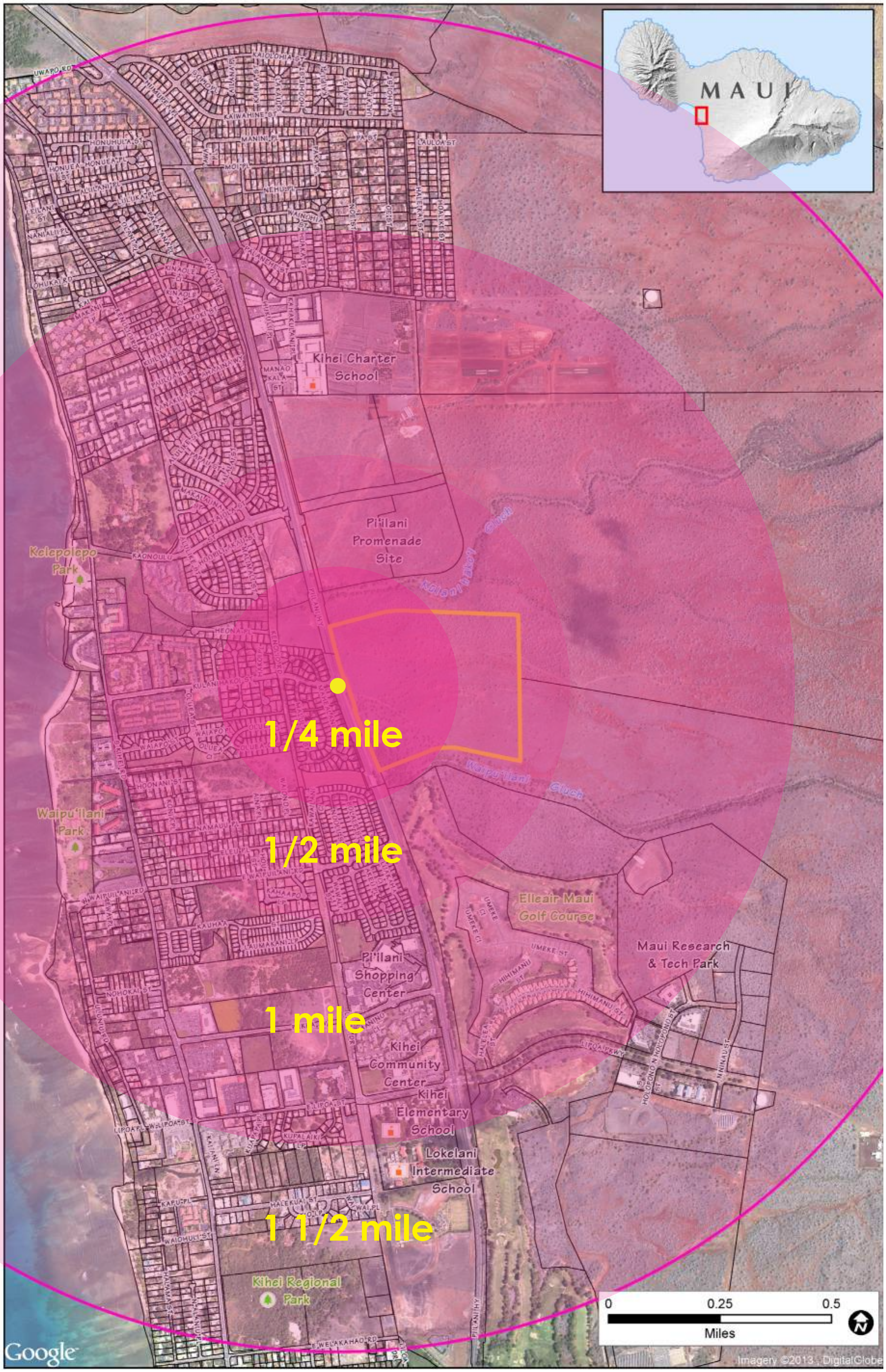
6.8.2-Action 3 Amend County zoning and subdivision regulations to require development within the vicinity of schools, libraries, community centers, and other public facilities to provide bike-and pedestrian-friendly infrastructure and traffic calming features.

The location of the high school is within walking distance to existing and future residential areas, thereby encouraging students to walk and bike to and from school. However current conditions of the streets are hostile to someone on foot, especially for youth. Pi'ilani Highway needs to transition, other street networks need to be completed, such as the North-South Collector road, as well as, new pedestrian and bicycle networks need to be created. All of these are opportunities in which partnerships are needed. This work cannot be done alone.

Creating a walkable and bikeable community starts with the built environment: having destinations close to each other; siting schools, parks, and public spaces appropriately; allowing mixed-use developments; having sufficient densities to support transit; creating commercial districts that people can access by bicycle, foot, wheelchair and motor vehicle. Most walking trips are less than a-half mi, so having a compact environment is essential. Similarly, while half of all household trips are three miles or less, fewer than two percent of those trips are made by bicycle, allowing for the opportunity for more people to shift to bicycling if there is the infrastructure to make it feel safe and comfortable.

The design of the built environment greatly influences the sustainability of all communities and the overall quality of life for all residents. Land use patterns and transportation have a very close relationship – land use decisions affect transportation planning, and transportation planning affects land use patterns. Coordination must exist between transportation and land use planning decisions so they are complimentary rather than contradictory. When designing new communities, expanding current communities, or increasing density in existing communities, ensuring mobility and circulation for all modes of transportation must be a top priority; it is essential to assuring the livability of a community.

The County of Maui, Hawaii State Department of Education, Hawaii State Department of Transportation, elected leaders, and the greater community need to work together to continue prioritizing built environment improvements starting at the new high school site and working outwards. Maui County General Plan 2035 outlines this goal in more detail. Local community plans should be honored and followed.

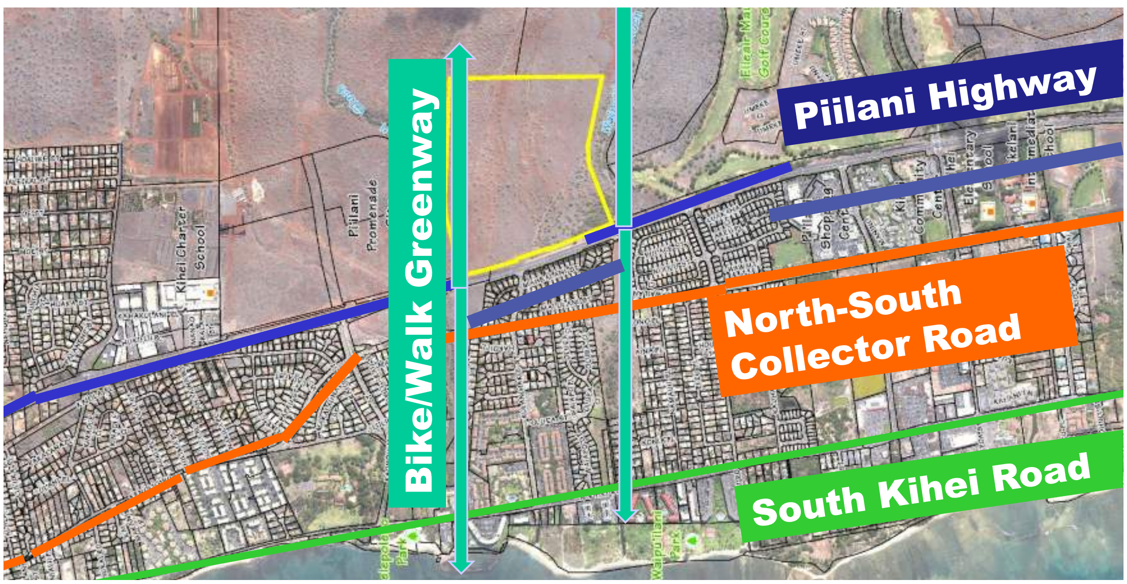


This map illustrates the walk/bike shed, or the area encompassed by walking and bicycling distances from adjacent neighborhoods that could be taken to/ from Kihei High School.

Although the new high school will be located centrally within Kihei, a major barrier exists--Pi‘ilani Highway. The good news is that the school, it’s access road and the highway can transition to reduce congestion and road maintenance costs, reduce busing demand and cost, increase safety, restore the youth’s freedom, and help make the school truly a center of the community.

4 IMPROVE CONNECTIVITY
Complete the Street Network

Complete the Street Network. The County of Maui and the Kihei community should continue prioritizing completing the street network with a traffic circulation study. The completion of the North-South Collector Road should remain a top priority. Completing this road will help create better traffic circulation in Kihei as it will alleviate pressures from the highway and South Kihei Road. Any new road design should incorporate people, specifically people on foot and bike. Make pedestrians at the top of the transportation planning hierarchy. Create an action plan for a pedestrian and bicycle trail network and look to create new connections mauka to makai; the gulches provide a natural opportunity for greenways. As new development continues to occur in Kihei ensure that codes are updated, new design standards are adopted such as LA County Living Streets Design Manual or National Association of City Transportation Officials (NACTO) to ensure that streets are not over-built for one mode, the automobile, and are built to accommodate all users. Kauai County has adopted the LA County Living Streets Manual and are in the process of rewriting portions to more specifically address local conditions.



Left: When University Place, WA incorporated in 1995 there were zero sidewalks, today they have installed over 23 miles of sidewalks, in addition to the first roundabout in the State of Washington located at the High School. Today high school students walking home is a daily scene.

Create More Connectivity within the School Site. It is important to consider a school's physical relationship to its surroundings. For example, at the site plan scale, it is key to evaluate how a sidewalk connects to the school's entrance and how it relates to driveways and parking lots. On a larger scale, it is important to evaluate how a school relates to the neighborhood around it, particularly people's homes, as well as, take into account future development. This is critical because the proximity of homes and schools has been found to be the most important influence of walking and bicycling to school (Active Living Research 2009).

It is important to note that billions of dollars of taxpayer money are used for school construction on an annual basis. Given this investment, it is important for communities to have school buildings and sites that are meaningful, lasting and are able to serve a community that changes through time.

The school siting process can be very complicated, with many factors that districts have to consider, including educational programming and safety. The ability of youth to walk and bicycle to school is a as critical component. When a new school is planned, a collaborative and open planning process that brings together policy-makers and staff, county representatives, residents and parents leads to schools that are cherished and respected by the community.

To better compliment the recommendation to move parking on-street, the school with community partners has the opportunity to enhance the campus by addressing traffic circulation, by adding street connectivity through the campus. Current conceptual designs of the school create what is called a super-block that will negatively contribute to the walkability of the future development of this area of Kihei. Set the target speed for 15-20 mph. Make two travel lanes, 10 foot each. Work together to refine the conceptual site plan to apply traffic calming tools, such as short medians, raised crossings, mini-circles, bike lanes or a "sharrow" park/unpark lane, and on-street parking, to prime the area for future walkable developments, which will bring more "eyes to the street" and ensure a strong street network is created on the mauka side of Kihei. Consider an inner connector street that allows for some teacher parking and deliveries, but during school hours is closed to vehicular traffic, creating a flexible and festival street. Adding street connectivity will set the stage for a walkable, livable mauka community.

Conceptual School Campus Traffic Circulation and Parking Plan

STRENGTHEN PARTNERSHIPS

The Kihei community is preparing itself to build on successful Smart Growth planning and complete street engineering efforts, as noted in Maui County Comprehensive Plan. To fully achieve this the new school site is a fresh canvas to capitalize on the energies of a team that are able to collaborate effectively and foster change. Collaboration between the Department of Education, Department of Transportation, and county can lead outcomes with far-reaching benefits. Communities with a high degree of collaboration have been able to build and maintain facilities that would not have been possible otherwise, utilize each other's data to better plan for future needs, and create vibrant real-world life-long learning opportunities.

Collaborative projects have higher-quality outcomes, are easier to implement, face fewer legal challenges, better serve the public and make better use of available resources. Keys to success include recognizing there is common ground and interest in working together, that there are distinct planning needs and regulations for each group involved and the importance of regular communication.

The future high school brings forward the opportunity to continue to work with the community to overcome any past history to create safe routes to school; working partnership to gather information and identify issues; create a framework for community outreach and education that looks at incentives and encouragement for improving walking, biking and enforcement; and expands the safe routes to school partnership school by school.

To achieve this level of collaboration there needs to be a designated point person or program coordinator to help unite and focus on the engineering, education, enforcement, encouragement and evaluation (Five E's) that various partners are leading. The good news is that each county of Hawaii will be able to hire a Safe Routes to School County Coordinator to be the central person to assist with safe routes to school-related projects, like the high school. The Hawaii Safe Routes to School special fund established by HB 2626 in 2012 consists entirely of State funds collected from traffic violations in school zones. The State Department of Transportation (DOT) is currently finalizing Administrative Rules necessary to distribute to counties for county-level programs. The DOT should share their status to confirm whether or not this future position will be filled within a time-line that works for the new high school project.

The following potential partners should be engaged in creating safe routes and complete streets to the new high school:

Education

Department of Education, Department of Health: Healthy Hawaii Initiative Maui County, Maui PATH, local elected leaders, PTA, teachers, students, and principals.

Tasks: Getting everyone on the same page to understand what works best for the high school to do outreach within the schools and the community to educate everyone on the benefits of creating a new school campus that honors the community by creating safe streets for all.

Encouragement

Principals, teachers, Maui PATH, Department of Health: Healthy Hawaii Initiative Maui County, parents, PTA, local elected leaders, other grass roots non-profits, and business community.

Tasks: Locating and providing incentives, finding the fun and tailoring the program to suit the needs of the high school.

Engineering

County departments such as planning, public works, and parks and recreation, Maui MPO, fire, police, Hawaii DOT, and Department of Education

Tasks: Prioritizing and completing the recommended engineering improvements at or near the school.

Enforcement

Police/Sheriff, parents, students, principals, teachers, Department of Education

Tasks: Regular and random police presence during pick-up/drop-off to encourage good motorist behavior. Enforcement of traffic laws around schools to ensure safety, reducing parental concerns about traffic congestion and "stranger danger."

Evaluation

PTA, principals, teachers, parents, students, Department of Education, Hawaii DOT, Maui County

Tasks: Collecting baseline data to evaluate how implemented solutions and tools are providing safe routes to school.

Additional avenues to partner for achieving the engineering, education and engagement and enforcement may include partnering with local before- and after- school programs for students to walk or bike to or from, or involve residents, landowners, and business owners who might be interested in creating or maintaining a safe route such as a trail.

The following are next steps related to the built environment recommendations made in this report. To implement many of the recommendations, a strong working partnership between government agencies, leaders and the greater community may be needed.

NEXT STEPS

Short-term

- **Set the target speed within the School Zone to 30-35 mph.**
State Department of Transportation, Department of Education and Maui County officials need to agree on setting an appropriate target speed for the new section of Pi'ilani Highway which will transform into a school zone due to the siting of the new Kihei High School. Design the road and intersection along Pi'ilani Highway at the school site so that motorists behave and drive the target speed. Fast-moving vehicles kill people and divide places. A pedestrian hit by a vehicle at 20 mph has a 90 percent chance of survival while the odds of surviving a 40 mph impact are only 10 percent.

- **Prioritize an at-grade crossing, first and foremost.**
Creating a built environment that honors the community means that all modes of transportation should first be included, and at-grade crossings for pedestrians and bicyclist should be a top priority in the design of intersections and at other street crossings especially near schools.

- **Update HDOT 2008 roundabout guideline policy and adopt a roundabout-first policy.**
To support the Department of Transportation in effectively analyzing and implement Federal Highway Administration proven safety countermeasures elected leaders can adopt a roundabout-first policy. Whenever a project includes reconstructing or constructing an intersection, such is the case for the new Kihei High School, analyze the feasibility of using a roundabout. This approach is recommended by the U.S. Department of Transportation's Federal Highway Administration and backed by the Insurance Institute for Highway Safety. This report has conceptually analyzed the feasibility of a roundabout at the intersection of Pi'ilani Highway and Kulanihako'i Street, showing that a roundabout is a viable option, and through good design ensures that drivers slow down to 20 mph, while maintaining traffic flow. A roundabout protects pedestrians, reduces pollution and noise, and creates a more pleasant gateway into the community and school. The following are next steps to move from the report's conceptual engineering recommendation for a roundabout toward implementation.

- **Share the report findings with the State Land Use Commission and Maui County Council, specifically highlighting the section on overpasses and underpasses.**
Due to the topography of the surrounding area of the high school site and the community's

preference for an underpass, the commission and county Should evaluate if an overpass can come off the table. Either way, building an overpass or underpass can have high costs and involves many government agencies, departments, and the greater community to effectively implement. If the commission and council still want the zoning condition of an overpass or underpass to be met, the Department of Education should work with these agencies to recieve an extended time-line to achieve this goal, as long as, an inclusive and accessible at-grade intersection for all users is implemented first.

- [ ] **Build support.**
Since roundabouts and other traffic calming tools can be a new idea, support elected leaders and agency staff by continuing to build community support. Public support first will help inspire the approval and navigate implementation. Share the report with stakeholders who participated in the focus group meetings, walking audit, and public workshop along with others who were not able to make these events. This also recognizes the individuals who participated and whose input helped form the recommendations in this report. For example, community advocates can print this document and/or the photo vision, talk to neighbors, build community support, and then meet with decision makers, news outlets, experts and others to discuss the benefits of roundabouts, underpasses and other traffic calming tools recommended. Agency staff can engage the public in meaningful process, hosting charrettes or interactive design workshops to continue building public acceptance and understanding.

- [ ] **Department of Education should address traffic calming and additional street network recommendations into the school campus conceptual designs.**
This includes treatments like on-street parking, tree lines streets that buffer sidewalks, bike lanes, and ten foot travel lanes.

Mid-term

- [ ] **Design a compact at-grade intersection that supports and includes all modes of travel—people on foot, bicycle and motor vehicle**
A modern roundabout should be the first choice for the at-grade intersection of Pi‘ilani Highway and Kulanihako‘i Street. It has been proven to be an intersection treatment that provides for the safest movement for all modes at an intersection, while keeping traffic moving and creating an environment that is attractive and encourages people of all ages to walk or bike. If the next steps for designing a roundabout are not followed, then the intersection should be a compact signalized intersection to help control the many new turning movements by motorists and an increase in people on foot or bike in this location. A signalized intersection has more vehicle-to-vehicle and vehicle-to-pedestrian conflicts when compared to a modern roundabout, however applying curb extensions, landscaped medians, median noses for pedestrian’s to take refuge, bicycle lanes, and signal timing that accounts for people on foot and bicycle improves drivers’ vigilance and operations for all modes becomes more inclusive. Department of Transportation and Department of Education need to work together with the greater community to implement a compact multi-modal intersection.

Next Steps

Right-size Piʻilani Highway

To ensure that motorist behave and vehicle speeds meet the target speed (30 to 35 mph) the following tools should be implemented:

- **Narrow Travel Lanes:** Ensure that travel lanes are not wider then 11 feet, 10 feet is the recommended width.
- **Install a Landscaped Median:** Create a sense of enclosure, slowing motor vehicle speeds and increasing driver vigilance by creating landscaped medians with street trees. This also will create a gateway element to the school area.
- **Build a Sidewalk or Multi-Use Trail:** Sidewalks should be prioritized on both sides of the highway, and should be added on all sides of the intersection, then as future land use evolves sidewalks can be extended and connected. If one side has to be chosen to be implemented first, it should be the school side. A sidewalk or multi-use path should be implemented along the school edge, and leading up the school road. The sidewalk should be a minimum of 6 feet wide and a multi-use trail should be a minimum of 12 feet wide. Use the Hawaii Pedestrian Toolbox to guide in the design of the sidewalk or trail. Use the Hawaii Pedestrian Toolbox.
- **Place the Proper School Zone Signage Along the Corridor:** Remind motorists to obey posted speeds with the right school zone signage per MUTCD guides. The addtion of signs and designing the road to achieve the desired target speed makes motorists more vigilant and aware. Further back with enforcement.
- **Colorize Bike Lanes:** Colorized bike lanes further communicate to motorists that bicyclists use the roadway too, by sending visual cues to the motorist. Bike lanes also provide an additional benefit by further creating a buffer between moving vehicles and pedestrians on the sidewalks and increase the effective turning radius for oversized vehicles.

Right-size Kulanihakoʻi Street

Maui County should work towards reducing overly wide right-hand turn radii by installing curb extensions, remove obstacles from sidewalks, reduce travel lanes to ten feet, and add bike lanes and on-street parking along Kulanihakoʻi Street.

Long-term

Improve Street Connectivity and Network, Including Pedestrians and Bicycles.

Maui County should continue working towards completing parallel street networks to Piʻilani Highway to provide additional routes for motorists, further helping the community's overall traffic circulation. A traffic circulation study should be completed. These connections should prioritize pedestrians as the top of the design hierarchy. These networks can continue to be prioritized and supported through a community-wide pedestrian and bicycle master plan. Ensuring strong street connectivity should be reinforced by updating County codes to insure that any new development helps to build in street connectivity.

Transform Gulches into Pedestrian and Bicycle-Only Trails. Overtime, as new street networks are completed, such as the North/South Collector Road additional mauka-makai links should be made to better connect the community to the high school and future neighborhoods that will be developed on the mauka side of Kihei. The gulches create a natural geographic feature that would allow for trails. Trails have less of an impact environmentally and can withstand the occasional flood. To implement this vision it will take many partners, including state agencies.

Address Other Intersections Along Pi'ilani Highway. Working with the community, the Department of Transportation should study other intersections along the highway to apply proven safety countermeasures, such as roundabouts and raised medians and other traffic-calming treatments, to make all the intersections more compact and safer for all roadway users.

FUNDING

Unique funding opportunities can be discovered when partners around the table pool resources to complete projects. Funding opportunities can be identified once the partnership know what the task is, how much it will cost, and what it will take to implement. Knowing what is needed is much of the effort.

Funding for engineering improvements can come from various sources such as:

- Private foundations with missions seeking to reduce childhood obesity fund improvements that change the built environment to create opportunity for physical activity such as Robert Wood Johnson, Kellogg, General Mills, Aetna, Heinz and others.
- State and federal government grant options include Community Development Block Grants, HUD grants, and DOT Transportation Alternatives funding through MAP-21, although this federal funding cycle ends in the Fall of 2014.
- Non-traditional government sources including air-pollution and water-quality agencies.
- The development community, which should be required to create projects that support the vision of the Comprehensive Plan, but also may contribute funding to improve children's access to school as a show of good faith and to help build goodwill toward their work.

Safe Routes and school coordinators can approach membership clubs, Wal-Mart, Target, Home Depot; and local health foundations to provide in-kind donations such as giveaways for encouragement events, bike racks, signage, crosswalk striping and staff time to help build awareness. The State Department of Health could be a key partner in education initiatives to create and encourage safe routes to school is this is a key goal and objective in their statewide Nutrition and Physical Activity Plan. The National Highway Traffic Safety Administration is a source that provides funding to train police and crossing guards for school traffic safety.

Concluding Thoughts

This report has laid out a path to creating safer routes to Kihei High School. Now the difficult—but rewarding—work begins. Towards implementation:

The future Kihei High School brings an opportunity to the Department of Transportation, and the greater community, to showcase new proven safety countermeasures, such as a modern roundabout and raised medians, to improve the operation and accessibility of Piʻilani Highway for all users in the section adjacent to the future school. The changes will be incremental, first addressing the section of Piʻilani Highway that lies between the gulches. This report serves as a good start for heading down that path.

The report is intended to be a guide for the Department of Transportation, as much as it is a guide for other agencies and the greater community. It is critical to remember that our communities are incredibly dynamic and ever changing, so this work takes patience, collaboration and vision.

Today, there are new tools and approaches to transportation planning to ensure our communities are desirable places to live, learn, work, and play. The Department of Transportation, in partnership and support from the Department of Education, the State Land Use Commission, County of Maui, elected leaders and community members, should address the engineering improvements identified, starting with the intersection of Piʻilani Highway and Kulanihakoʻi Street. Current conditions are hostile to a person on foot, especially the most vulnerable children and elderly. It is also important to note that up until today the current intersection design has, for the most part, served its need: moving people in cars. The future high school is creating a destination that will attract people on foot, bicycle and motor vehicle.

The Kihei community's vision is for Kihei to continue to transform into a walkable, more livable community. The school should be viewed as a catalyst project that demonstrates how land-use and transportation decisions can be in sync with each other. It is an opportunity for the Department of Transportation to implement it's well crafted Complete Streets Policy, and Pedestrian Plan and Toolbox. Residents and stakeholders of Kihei recognize that integrating transportation and land use planning improves safety, protects resources, improves health, encourages living in place, and provides opportunities for residents to interact.

Attention also should be focused on fixing incompatible policies and setting up a working group that engages the many potential partners identified in this document as possible to continue building support and education.

The energy, passion and leadership is there. It is time to act; to take charge in forging new understandings and relationships that will propel Kihei into a key destination for livability within the Island of Maui and the state of Hawaii.

Additional Resources

Healthy Development Checklist, from Walkable Communities:
http://www.walkable.org/assets/downloads/healthy_development_checklist.pdf

Active School Neighborhood Checklist, from the Arizona Department of Transportation:
http://www.azdot.gov/Highways/swprojmgmt/Enhancement_Scenic/saferoutes/SafeRoutes_Common/Apply_Active_School_Neighborhood_Checklist.asp

Healthy, Active & Vibrant Community 2009 Toolkit, from Trailnet:
http://www.trailnet.org/HAVC_Toolkit.php

Safe Routes to School Guides:

Why Johnny Can't Walk to School
http://www.saferoutesinfo.org/program-tools/why-johnny-cant-walk-school

Media and Visibility
http://www.saferoutesinfo.org/guide/media/index.cfm

Education
http://www.saferoutesinfo.org/guide/pdf/SRTS-Guide_Education.pdf

Enforcement
http://www.saferoutesinfo.org/guide/pdf/SRTS-Guide_Enforcement.pdf

Evaluation Guide for Community Safe Routes to School Programs
http://www.saferoutesinfo.org/guide/pdf/SRTS-Guide_Evaluation.pdf

Many more guides and tools are available at www.saferoutesinfo.org.

Supporting Documents

1. State Land Use Commission (LUC) and Maui County Condition
2. Hawaii State Complete Streets Policy
3. Hawaii State Safe Routes to School (SRTS) Policy
4. Conceptual Drawing: Roundabout Intersection Treatment
5. Conceptual Drawing: Signalized Intersection Treatment
6. Photo Vision

1. State LUC and Maui County Council Condition

Introduction

In granting the land use approvals for development of a high school at this location, the State Land Use Commission and the Maui County Council placed conditions concerning a number of transportation and non-transportation items. The condition relevant to this Pedestrian Route Study reads, in part:

"Petitioner shall complete a pedestrian route study for Phase I of the Project which includes ingress and egress of pedestrians through defined location(s) approved by DOT and shall analyze compliance with the proposed warrants in FHWA/RD-84/082 (July 1984) to the satisfaction of DOT. The pedestrian route study and analysis shall be completed and approved prior to Petitioner executing a contract for the design of Phase I of the Project. Petitioner shall cause to be constructed, or ensure that there is an available above or below ground pedestrian crossing and implement such mitigation or improvements as may be required or recommended by the study and analysis to the satisfaction of DOT prior to opening Phase I of the Project...Petitioner shall submit copies of the studies and analyses to the State of Hawai`i DOT for review and approval, and to the County of Maui Department of Public Works for review and comment."

The research document cited by the condition, FHWA/RD-84/082 (July 1984) "Warrants for Pedestrian Over and Underpasses", was prepared for the Federal Highways Administration (FHWA) and studied factors that make a grade separated pedestrian crossing (GSPC) such as an overpass or underpass well-utilized or, conversely, not well-utilized. The objective of the research document was "to develop and validate warrants which can provide a basis for determining when a grade separated pedestrian crossing (GSPC) would most likely be successful and well-utilized by pedestrians."

Based on the research, the study's authors presented the following proposed warrants in FHWA/RD-84/082 (July 1984):

1. Pedestrian volume should be a total of over 300 in the 4 highest continuous hour period if vehicle speed is over 40 mph and the proposed sites are in urban areas and not over or under the freeway. Otherwise, pedestrian volume should be a total of over 100 pedestrians in the 4 highest continuous hour period.

2. Vehicle volume should be over 10,000 in the same 4 hour period used for the pedestrian volume warrant or ADT over 35,000 if both vehicle speed is over 40 mph and the proposed sites are in urban areas. If the two conditions are met, vehicle volume should be over 7,500 in 4 hours or ADT over 25,000.

3. A proposed site should be at least 600 feet from the nearest alternative "safe" crossing. A "safe" crossing is where a traffic control device stops vehicles to create adequate gaps for pedestrians to cross. Another "safe" crossing is an existing over or underpass near the proposed one.

4. A physical barrier to prohibit at-grade crossing of the roadway is desirable as part of overpass or underpass design plan.

5. Artificial lighting should be provided to reduce potential crime against users of underpasses and overpasses. It may be required to light underpasses 24 hours a day and overpasses all night.

6. Topography of the proposed site should be such that elevation changes are minimal to users of overpasses

and underpasses and construction costs are not excessive. Elevation changes is a factor effecting the convenience of the users.

7. A specific need should exist or be projected for a GSPC based on existing or proposed land use(s) adjoining the proposed site which generate pedestrian trips. These land use(s) should have direct access to the GSPC.

8. Funding for construction of the pedestrian overpass or underpass must be available prior to construction commitments.

Response to FHWA/RD-84/082 Report
FHWA/RD-84/082, published in 1984, is now 30 years old and has never been adopted as policy or standards by the FHWA. The Notice fronting the document states "The contents do not necessarily reflect the official policy of the Department of Transportation" and "This report does not constitute a standard, specification, or regulation."

Assessing the report today, the research has low relevance to modern science, human factors and modern traffic engineering. The document was written at a time when the vast majority of transportation planners and engineers were failing to fully accommodate people on foot. Today modern engineering and FHWA policy looks at the much broader context of where a tool is to be placed, appropriate speeds for that context, and a more comprehensive look at circulation systems. If the FHWA/RD-84/082 report is intended as a 'guideline' then a context sensitive approach needs to be accounted for and flexibility to the warrant needs to be applied. This Pedestrian Route Study for Kihei High School cites information from the Pedestrian and Bicycle Information Center (PBIC) literature on the topic of grade separated pedestrian crossings (see Section 3. Address Pedestrian and Bicycle Connections and Networks: Overpass or Underpass, page 49).

Assessment of Project with respect to Proposed Warrants in FHWA/RD-84/082

In compliance with the Hawaii Land Use Commission and Maui County Council conditions, this Pedestrian Route Study includes the following assessment of the Kihei High School project with the FHWA/RD-84/082 proposed warrants.

1. Pedestrian volume should be a total of over 300 in the 4 highest continuous hour period if vehicle speed is over 40 mph and the proposed sites are in urban areas and not over or under the freeway. Otherwise, pedestrian volume should be a total of over 100 pedestrians in the 4 highest continuous hour period.

Response: Currently the posted speed along Piilani Highway is 40 mph, however it is observed that many motorists drive at higher speeds. The proposed use (high school) does not currently exist and there are no recorded pedestrian counts at Piilani Highway and at Kulanihakoi Street intersection. The TIAR study estimates that pedestrian volume may be over 100 in the 4 highest continuous hour period once the high school is construction and open.

Need for a Context Sensitive Approach
The viability and safety of pedestrian travel depends on well-designed roadways and pedestrian facilities. Basic design features can affect the ability of the public right-of-way to accommodate persons on foot, bike or wheelchair. The walking infrastructure—or physical elements on a street segment which serve pedestrians, or which affect the

feeling of safety, security, convenience, or comfort—are missing today along Pi'ilani Hwy and at Kulanihakoi Street intersection.

Land uses, both the type and mix of use in a given area, strongly affect the level of demand for walking as a means of travel by residents and visitors to an area. Some land uses are known to generate relatively high levels of walking: schools, civic institutions like libraries and museums, hospitals, and shopping districts. Mixing of complementary uses (e.g. housing near jobs, schools in residential areas, etc.) in close proximity can increase the demand for walking as a mode of travel. This will be true with the future Kihei High School and mixed-use development. To fully support walking as a mode of travel, pedestrian accessibility needs to be addressed. Pedestrian accessibility must take account of the pedestrian infrastructure available for walking, as well as the likelihood of needing to walk generated by the land uses served by the pedestrian infrastructure. It takes a context sensitive and integrated approach to ensure that roadways are designed for the safety and accessibility of all users, at all times of day. Resource: Wisconsin DOT: http://www.dot.wisconsin.gov/projects/state/docs/ped-guide-chap5.pdf

2. Vehicle volume should be over 10,000 in the same 4 hour period used for the pedestrian volume warrant or ADT over 35,000 if both vehicle speed is over 40 mph and the proposed sites are in urban areas. If the two conditions are met, vehicle volume should be over 7,500 in 4 hours or ADT over 25,000.

The current Average Daily Traffic (ADT) along Pi'ilani Highway near Kulanihakoi Street is less then 25,000 vehicles per day. Currently the ADT is 18,000 vehicles per day.

3. A proposed site should be at least 600 feet from the nearest alternative "safe" crossing. A "safe" crossing is where a traffic control device stops vehicles to create adequate gaps for pedestrians to cross. Another "safe" crossing is an existing over or underpass near the proposed one.

The proposed Piilani Highway and Kulanihakoi Street intersection needs to be developed as a safe crossing for all roadway users—pedestrians, bicyclists, transit users, and motorists. Regarding GSPC, there is a natural opportunity for an underpass in gulches located north and south of the intersection. Both of the gulches are located over 600 feet away from Piilani Hwy and Kulanihakoi Street intersection, making these locations feasible with this warrant. A GSPC located near Kulanihakoi Street would not be located over 600 feet away from the proposed intersection.

4. A physical barrier to prohibit at-grade crossing of the roadway is desirable as part of overpass or underpass design plan.

A physical barrier to prohibit at-grade crossings is not desirable. Some designers will build elaborate fencing, to force use, which forces even more out of route travel.

5. Artificial lighting should be provided to reduce potential crime against users of underpasses and overpasses. It may be required to light underpasses 24 hours a day and overpasses all night.

Lighting and security are major concerns for grade separation—overpass and underpass. Lighting is critical element that needs to be included in the design, taking into account users at all times of the day.

6. Topography of the proposed site should be such that elevation changes are minimal to users of overpasses and underpasses and construction costs are not excessive. Elevation changes is a factor effecting the convenience of

the users.

Due to the topography of the area an overpass would create significant elevations changes, which would lead to high costs due to extensive ramping needed to accommodate people in wheelchairs (meet ADA requirements) and people on bicycles. People will not use an overpass or underpass if they can cross at street level in the same amount of time, or less. The gulches near the site provide a natural opportunity to create a trail system that connects mauka-makai and gives students, other residents and visitors an off-street connection from the existing Kihei village and beach to the high school and future mixed-use development. Ramping will also be required to appropriately connect a gulch trail with the high school site.

7. A specific need should exist or be projected for a GSPC based on existing or proposed land use(s) adjoining the proposed site which generate pedestrian trips. These land use(s) should have direct access to the GSPC.

The proposed new high school is expected to generate pedestrian trips by students and other community members. While establishing this proposed warrant, FHWA/RD-84/082 findings also note that, based on observation and interviews, a predictor for an underutilized GSPC is locations near a junior or senior high school (serving 13-18 year old age group).

Additional pedestrian and bicycle infrastructure, connections and networks are needed within Kihei to affect the level for walking and bicycling. The gulches can provide the foundation for an underpass and trail network that connects existing residential and commercial neighborhoods to a future mixed-use neighborhood and school, which are land uses that will generate more walking.

8. Funding for construction of the pedestrian overpass or underpass must be available prior to construction commitments.

Funding for construction of a grade separated facility near the future site of Kihei High School is not currently appropriated. An overpass is expensive to build, costing an estimated $10 to 15M. A more modest amount of investment is an underpass due to the topography of the site and the bridges that exist today over the gulches. The cost to create an underpass, which includes a wide trail, is estimated at $1 to $10M. Costs vary greatly based on site conditions, materials, etc. so a full analysis would be needed to determine costs on the Island of Maui.
Source: http://www.pedbikeinfo.org/planning/facilities_crossings_over-underpasses.cfm

Summary:

In most cases, the emerging patterns from the analyses in the FHWA/RD-84/082 document confirmed that if it is safe to cross at-grade on the roadway, pedestrians will chose an at grade crossing over a grade separated pedestrian crossing.

The analysis and recommendations are to have an at grade intersection at Piilani & Kulanihakoi with further analysis of whether a roundabout would be a suitable alternative to the warranted signals. The condition requires that the underpass proposals will have to be implemented prior to opening Phase 1. So the necessary connections to the adjacent subdivisions and public trails or paths will need to be in place too for those underpass paths to be functional.

2. Hawaii State Complete Streets Policy

GOV. MSG. NO. 671

EXECUTIVE CHAMBERS

HONOLULU

LINDA LINGLE
GOVERNOR

May 6, 2009

The Honorable Colleen Hanabusa, President
and Members of the Senate
Twenty-Fifth State Legislature
State Capitol, Room 409
Honolulu, Hawaii 96813

Dear Madam President and Members of the Senate:

This is to inform you that on May 6, 2009, the following bill was signed into law:

SB718 SD1 HD1	A BILL FOR AN ACT RELATING TO TRANSPORTATION. **ACT 054 (09)**

Sincerely,

LINDA LINGLE

Approved by the Governor
on MAY 6 2009

THE SENATE
TWENTY-FIFTH LEGISLATURE, 2009
STATE OF HAWAII

ACT 054

S.B. NO. 718 S.D. 1 H.D. 1

A BILL FOR AN ACT

RELATING TO TRANSPORTATION.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

SECTION 1. Chapter 286, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"§286- **Complete streets.** (a) The department of transportation and the county transportation departments shall adopt a complete streets policy that seeks to reasonably accommodate convenient access and mobility for all users of the public highways within their respective jurisdictions as described under section 264-1, including pedestrians, bicyclists, transit users, motorists, and persons of all ages and abilities.

(b) This section shall apply to new construction, reconstruction, and maintenance of highways, roads, streets, ways, and lanes located within urban, suburban, and rural areas, if appropriate for the application of complete streets.

(c) This section shall not apply if:

<u>(1)</u> <u>Use of a particular highway, road, street, way, or lane by bicyclists or pedestrians is prohibited by law, including within interstate highway corridors;</u>

<u>(2)</u> <u>The costs would be excessively disproportionate to the need or probable use of the particular highway, road, street, way, or lane;</u>

<u>(3)</u> <u>There exists a sparseness of population, or there exists other available means, or similar factors indicating an absence of a future need; or</u>

<u>(4)</u> <u>The safety of vehicular, pedestrian, or bicycle traffic may be placed at unacceptable risk.</u>"

SECTION 2. (a) There is established a temporary task force, exempt from section 26-34, Hawaii Revised Statutes, to review existing state and county highway design standards and guidelines, for the purpose of:

(1) Determining standards and guidelines that can be established to apply statewide and within each county to provide consistency for all highway users;

(2) Proposing changes to state and county highway design standards and guidelines; and

(3) Making recommendations for restructuring procedures, rewriting design manuals, and creating new measures to

track success, within one year after implementation of the recommendations under subsection (c).

(b) The members of the task force shall be selected by the director of transportation, and shall include one member representing:

(1) The department of transportation;

(2) The department of health;

(3) Each county's public works department or transportation department;

(4) Hawaii Bicycling League;

(5) Peoples Advocacy for Trails Hawaiʻi;

(6) AARP Hawaii;

(7) Hawaii Highway Users Alliance;

(8) University of Hawaii's department of urban and regional planning or department of civil and environmental engineering;

(9) Developers;

(10) Federal Highway Administration; and

(11) Other interested parties.

(c) The task force shall submit to the legislature, through the department of transportation, the following:

(1) An interim progress report no later than twenty days prior to the convening of the regular session of 2010; and

(2) A final report, including findings, recommendations, and proposed legislation, no later than twenty days prior to the convening of the regular session of 2011.

(d) The task force shall cease to exist upon filing of its final report.

SECTION 3. New statutory material is underscored.

SECTION 4. This Act shall take effect upon its approval; provided that section 1 shall apply to any development for which planning or design commences on or after January 1, 2010.

APPROVED this 6 day of MAY, 2009

GOVERNOR OF THE STATE OF HAWAII

http://www.capitol.hawaii.gov/session2009/Bills/HB983_CD1_.htm

H.B. NO. 983

Report Title:
Schools; Traffic Safety

Description:
Requires the director of transportation to conduct a statewide pupil travel evaluation to study how students get to school and to use that information to award federal grants for school-based workshops and community planning that will reduce traffic congestion, encourage walking and bicycling, and increase health and safety. Requires the director of transportation to streamline the grant application process. Requires annual reports.

HOUSE OF REPRESENTATIVES
TWENTY-FIFTH LEGISLATURE, 2009
STATE OF HAWAII

H.B. NO. 983

A BILL FOR AN ACT

RELATING TO EDUCATION.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

SECTION 1. The legislature finds that almost every school in Hawaii is plagued by traffic congestion that results from poor planning and increased vehicular traffic. It is estimated that as much as twenty to twenty-five per cent of morning traffic consists of parents driving their children to school. Ironically, safety concerns lead parents to drive their children to school, which increases the traffic and makes it even less safe for others to walk and bike. Unfortunately, fifty per cent of children who are hit by cars near schools are hit by cars driven by parents of other students.

As part of the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, Public Law No. 109-59, Hawaii has been awarded $1,000,000 per year for five years for the Safe Routes to School program. Program funds may be used for both infrastructure-related and behavioral projects designed to reduce traffic, fuel consumption, and air pollution in the vicinity of schools and provide a safe and appealing environment for primary and secondary school children to walk and bicycle to school. Unfortunately, Hawaii has not made optimum use of its $5,000,000 share of Safe Routes to School grant funding. Implementation of the program and distribution of funds has been slow, and as a result, $3,000,000 remains unused.

Efficient and effective use of Safe Routes to School funding requires planning that includes the full range of community stakeholders so that projects have the support of parents, students, and schools needed to succeed. Planning also needs to deemphasize very expensive engineering changes, like additional traffic lights that can consume one-third of the annual grant budget. Smaller projects involving more stakeholders and more schools are necessary to generate change across a broad spectrum of the State. The process must begin with assembling basic information about transportation issues confronting students, parents, and the community.

The purpose of this Act is to reduce traffic congestion around schools and to make it safe for more students to walk or bicycle to school.

SECTION 2. (a) The director of transportation, through the Safe Routes to School coordinator, shall conduct a statewide pupil travel evaluation to study how students get to school and use that information to provide Safe Routes to School program funds to each school for school-based workshops and community planning that will reduce vehicular travel and congestion, encourage walking and bicycling, and increase health and safety.

(b) The evaluation required by subsection (a) shall:

(1) Identify the modes of travel used by students to get to each school;

(2) Using direct observation, determine the number of students using each mode of travel;

(3) Survey the parents of each student to gather information regarding the factors involved in the choice of transportation mode for the student and, where the student travels by automobile or bus, what would need to change for the parent to permit the student to walk or ride a bicycle to school;

(4) Identify traffic infrastructure elements in the immediate vicinity of each school, including multi-lane roadways, speed limits, and traffic calming features that, either by their presence or absence, contribute to the use of automobiles to as a student's mode of travel to school; and

(5) Prepare a map of the immediate vicinity of each school that can be used to identify alternate locations for students to be dropped off by automobiles and buses and safe routes for students to walk and ride bicycles to school.

SECTION 3. (a) The director of transportation, through the Safe Routes to School coordinator, shall distribute Safe Routes to School program funds in amounts ranging from $500 to $1,000 for school-based workshops and community-based planning that, based upon the evaluation required by section 2, will develop ways to reduce traffic congestion around schools, including walking and bicycling to school, safety education and traveling in groups, and improving safety for those students who are driven to school by automobile or bus with remote drop-off points and traffic management measures. The planning shall include community stakeholders and engineers, police, school administrators, parents, staff, and safety officials.

(b) The director of transportation shall develop a streamlined application process for federal Safe Routes to School grants that expedites release of funding for the individual projects developed pursuant to subsection (a).

SECTION 4. The director of transportation shall submit a report of the results of the statewide pupil travel evaluation required by this Act and the school-based workshops and community-based planning projects funded by the Safe Routes to School program, no later than twenty days prior to the convening of the regular session of 2010.

SECTION 5. This Act shall take effect upon its approval.

INTRODUCED BY: Marilyn B. Lee

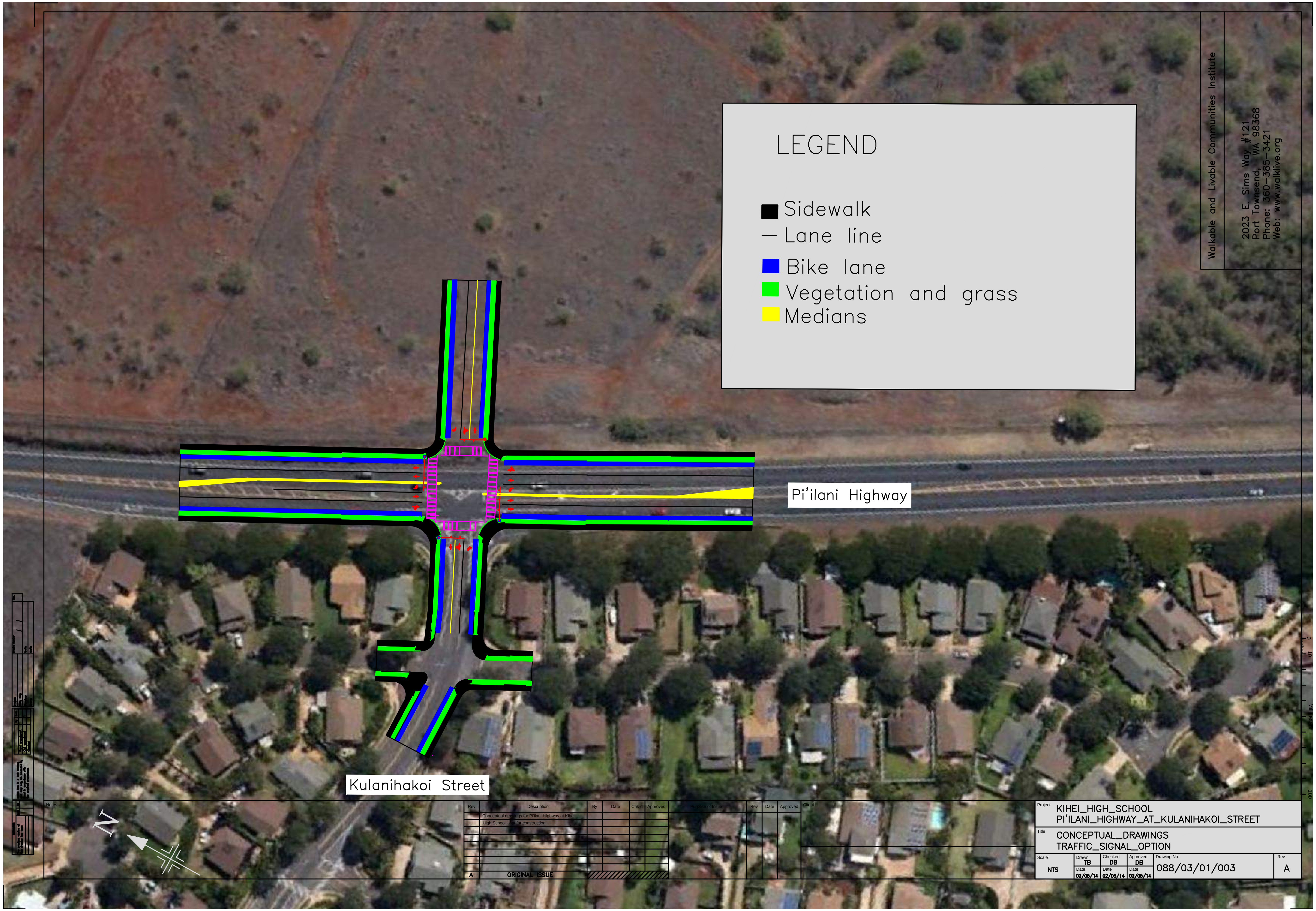
Denny Coffman

Mele Carroll

Cindy Evans

JAN 26 2009

LEGEND
Sidewalk
Lane line
Bike ramp
Bike lane
Vegetation and grass
Medians and splitter islands
Pedestrian crossing
Cycle track
140 feet of R/W
155 feet of R/W
150 feet of R/W
Pi'ilani Highway
R/W Line
R/W Line
Kulanihakoi Street
Walkable and Livable Communities Institute
2023 E. Sims Way #121
Port Townsend, WA 98368
Phone: 360-385-3421
Web: www.walklive.org
ORIGINAL ISSUE
Project
KIHEI_HIGH_SCHOOL
PI'ILANI_HIGHWAY_AT_KULANIHAKOI_STREET
Title
CONCEPTUAL_DRAWINGS
ROUNDABOUT_OPTION_WITHOUT_RAISED_CROSSINGS
Scale NTS
Drawn TB Date 4/7/14
Checked DB Date 4/7/14
Approved DB Date 4/7/14
Drawing No. 088/03/01/002
Rev A



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ORIGINAL ISSUE
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TRAFFIC_SIGNAL_OPTION
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Drawn TB
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Approved DB
Date 02/05/14
Date 02/05/14
Date 02/05/14
Drawing No. 088/03/01/003
Rev A


Kihei High School

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAIʻI

In the Matter of the Petition of DEPARTMENT OF EDUCATION, STATE OF HAWAIʻI, To Amend the Agricultural Land Use District Boundaries into the Urban Land Use District for Approximately 77.2 acres of land at Kihei, Maui, Hawaiʻi, Maui Tax Map Key Nos. 2-2-02: 81 and 83.	DOCKET NO. A11-794 CERTIFICATE OF SERVICE

CERTIFICATE OF SERVICE

I HEREBY CERTIFY THAT a copy of Supplemental Exhibits to Petitioner Department of Education, State of Hawaii's Motion to Amend the Land Use Commission's Findings of Fact, Conclusions of Law and Decision and Order Filed July 29, 2013; Exhibit "39"-"42"; was duly served via Electronic Mail upon the following at:

MOANA LUTEY (Moana.Lutey@co.maui.hi.us)
Corporation Counsel
THOMAS KOLBE (Thomas.Kolbe@co.maui.hi.us)
MICHAEL K. HOPPER (Michael.Hopper@co.maui.hi.us)
Deputies Corporation Counsel
County of Maui
200 South High Street
Kalana O Maui Building, 3rd Floor
Wailuku, Maui, Hawaiʻi 96793

Attorneys for Respondent
DEPARTMENT OF PLANNING, COUNTY OF MAUI
Bryan Yee (Bryan.C.Yee@hawaii.gov)
Alison Kato (Alison.S.Kato@hawaii.gov)
Deputy Attorney General
425 Queen Street

Honolulu, Hawaiʻi 96813

Attorneys for State Office of Planning and Sustainable Development

DATED: Honolulu, Hawaiʻi, August 31, 2021.

/s/ Stuart N. Fujioka
STUART N. FUJIOKA
RYAN W. ROYLO
MELISSA J. KOLONIE
CARTER K. SIU
Deputy Attorneys General

Attorneys for Petitioner
DEPARTMENT OF EDUCATION,
STATE OF HAWAIʻI

Docket No. A11-794; In the Matter of the Petition of Department of Education, State of Hawaiʻi, before the Land Use Commission of the State of Hawaiʻi; SUPPLEMENTAL EXHIBITS TO PETITIONER DEPARTMENT OF EDUCATION, STATE OF HAWAII'S MOTION TO AMEND THE LAND USE COMMISSION'S FINDINGS OF FACT, CONCLUSIONS OF LAW AND DECISION AND ORDER FILED JULY 29, 2013; EXHIBIT “39”-“42”; CERTIFICATE OF SERVICE