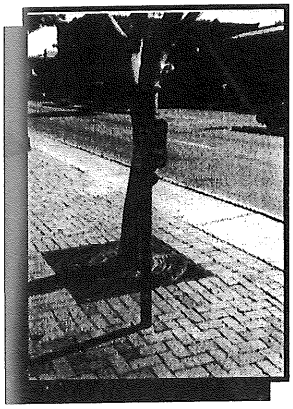
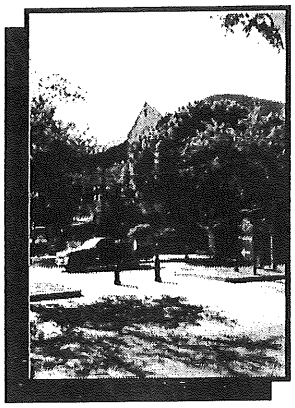
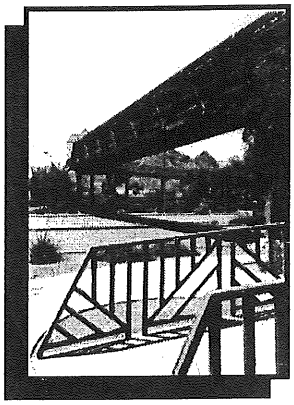
Alternative Solutions to Pedestrian Midblock Crossings at Canals







For:
Maricopa Association of Governments
in association with City of Tempe

Logan Simpson Design, Inc. with
A Dye Design
Lima & Associates Engineering

March 12, 1999

LOGAN SIMPSON DESIGN INC.

Tempe

MARICOPA ASSOCIATION of GOVERNMENTS

A DYE DESIGN

L & A LIMA & ASSOCIATES
Transportation - G.I.S.

PROBLEM DEFINITION

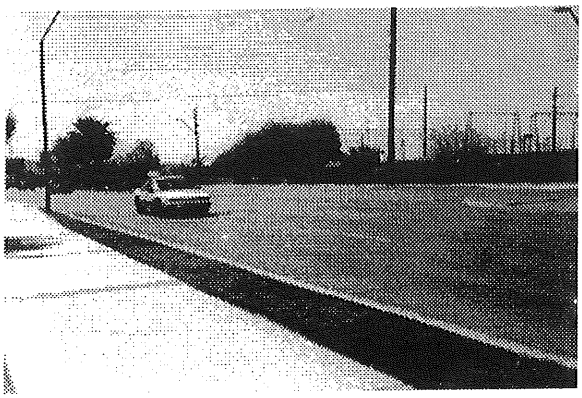
The network of canals in the MAG region is enjoyed by pedestrians and other users for recreation, exercise, and longer distance commuting. These canal routes cross more than 150 arterial streets in a midblock location, away from a vehicular intersection. Currently, these types of crossings are not consistently marked or signed as crossings or protected by other means.

As alternative transportation modes grow in popularity, these types of midblock crossings will be used more frequently. To ensure these crossings remain safe as the frequency of their use increases, the Maricopa Association of Governments Pedestrian Working Group initiated the midblock crossing design assistance project.

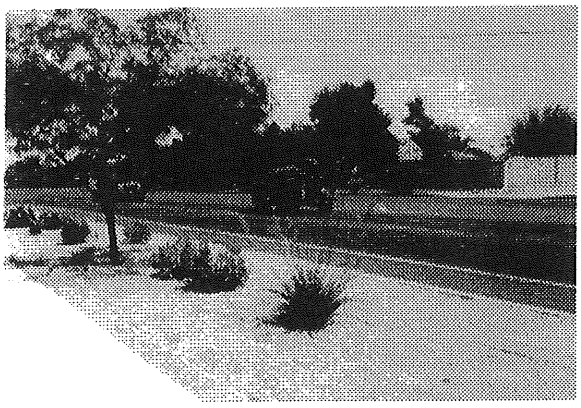
The purpose of this paper is to record the discovery of prototypes and solutions that are being used by other jurisdictions and entities to increase the safety for pedestrians, bicyclists, and vehicles and other at similar midblock crossing situations. These prototypical designs were then applied and tested as a means to enhance the pedestrian environment at two specific crossings. A cost estimate is included.

Project Area Crossings

The project area includes two east/west arterial streets. Both streets connect to Interstate 10 interchanges, providing access to the communities of Tempe, Chandler, and Gilbert as well as other points east. Project Crossing A is within approximately a 115 foot right-of-way for three travel lanes in each direction and a center turn lane with no bike lanes. The travel lanes are 11 feet inside, 11 feet middle, and 13 feet outside, with a turn lane of 14 feet. Project crossing B is not as wide, with two travel lanes each direction, and a center turn lane, including bike lanes. Travel lane widths for Project Crossing B are 11 feet inside and 12 feet outside with a turn lane of 11 feet.



Project Crossing A



Project Crossing B

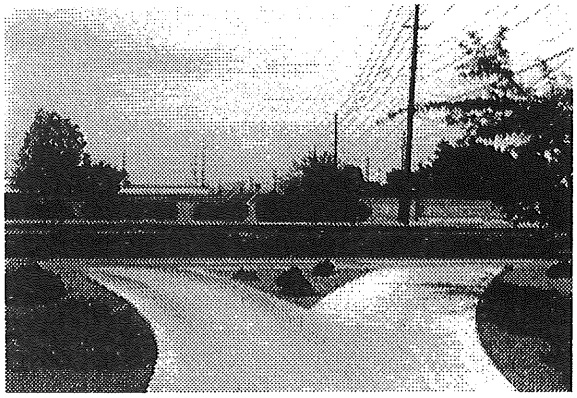
These roadways serve single family neighborhoods as well as offices and light industrial areas. Future commercial areas are planned west of the canal crossing at Project Crossing B. A large Salt River Project facility is located on the northwest side of Project Crossing A.

The bicycle program of this city anticipates connecting the canal system north/south to another canal which runs east/west with a multi- use path network. The canal system connects to other recreation and employment centers, including a park and golf course. The 1995 Bicycle Plan Facilities Update for

this city includes development of all city canals for non-motorized usage.

Canal Multi-Use Path

The canal intersecting the project crossings distributes water from the rivers flowing west through the metropolitan area to residential and agricultural areas in the southern part of the Valley. This canal is part of an extensive water distribution system which carries water throughout the valley. The canal itself is 12 feet wide with side slopes of native soil. For the segment between Project Crossing A and B, the canal bank has been upgraded by adding a 10 foot wide concrete multi-use path. A structure over the canal connects neighborhoods on

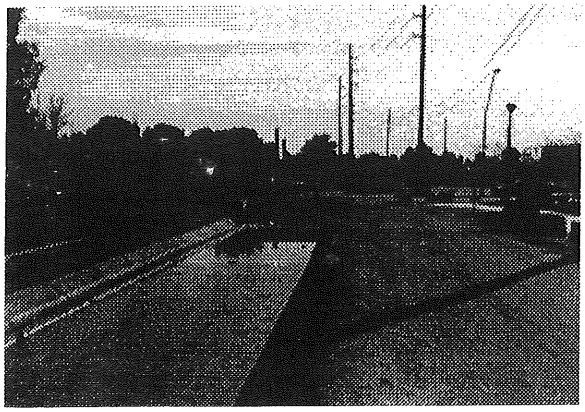


Looking north along the canal at Project Crossing A

the east and west sides of the canal. Developed open space/retention areas were recently completed on the west side of the canal in conjunction with residential home development.

The canal path is routinely used during the day and into the evening by residents of all ages. The following data was collected during four 15-minute periods on Thursday afternoon, Thursday evening peak, Friday morning peak, and Saturday morning on both roads.

Off-peak hours: 4 bicyclists, 1 runner, and 1 walker in 1 hour, 15 minutes.
PM peak: 2 runners in 45 minutes;
AM peak: 3 runners in 45 minutes;
Saturday: 8 runners and 2 walkers in 45 minutes.



Looking south along the canal at Project Crossing B

Nineteen of the users appeared to be exercising adults. The other users consisted of a junior high school student riding his bike and a father jogging with his son riding his bike. Two of the 21 users crossed the arterial streets. One was a bicyclist who crossed Project Crossing A and the other was a runner who crossed Project Crossing B. The bicyclist waited for a gap in traffic to cross, while the runner waited for a westbound gap in traffic, jogged to the center of the street and then waited for a gap in eastbound traffic to cross.

Organization of Report

This report is organized as follows:
(1) The type of pedestrian area, according to the *MAG Pedestrian Area Policies and Design Guidelines* is identified. Determining the type of pedestrian area set the minimum standards each midblock crossing must meet to be safe and pleasant for pedestrians.
(2) Midblock crossing elements are investigated and evaluated for effectiveness and conformity with the *Guidelines.*

(3) The approximate cost of each element is estimated.
(4) Preferred combinations of crossing elements are identified for a minimum standards situation and for an enhanced crossing.

(1) PEDESTRIAN AREAS

Pedestrian areas are defined in the MAG region by the *MAG Pedestrian Area Policies and Design Guidelines 1995* as "a location used by persons afoot, inclusive of the walkway, the roadway, and the adjacent surroundings or uses." The level of pedestrian area was determined for each prototype to identify minimum criteria for a safe and functional pedestrian environment at each crossing.

Pedestrian areas are described as four physical types and at three qualitative levels. Levels refer to a range of qualitative pedestrian area characteristics, including pedestrian intensities and the relationship of the pedestrian to vehicles, with Level 1 being the least intense and Level 3 being the most intense. Pedestrian intensities vary at different canal crossings, but are most likely to be Level 1 or 2. In this project, the trail itself is providing Level 1 service, but is escalated to a Level 2 at the crossing due to the high traffic volume on arterial streets. Project Crossing A had a traffic volume of 31,500 VPD (vehicles per day) in July 1995 and Project Crossing B had 28,500 VPD in November 1997. The speed limit on both roads is 45 MPH (miles per hour), also supporting a Level 2 description.

Types of areas are based on the mix of land uses and development densities adjacent to the pedestrian paths, expressed as Neighborhood, Community, Campus, and District. Using the criteria described in the *Guidelines* document, the canal crossings occur in all four types of areas, but the prototype crossings are in Neighborhood areas.

Based on these designations, the canal crossings at Project Crossings A and B should meet Level 2 - Neighborhood criteria in policies and design guidelines. Because this is a design project, only the design guidelines criteria which will apply to the crossing are discussed below.

The criterion as stated in the *Guidelines* document is shown in italics.

Level 2 - Neighborhood Criteria

Guideline. *Provide six to eight foot (1.8m to 2.4m) minimum effective walkway width. Add two feet to the width of the walkway if it is adjacent to a roadway over 5,000 average daily traffic.*

The crossing should be ten foot wide, as should the walkways leading into it.

Guideline. *Construct ADA accessible ramps in sidewalks, or provide intersection crossing free of obstacles.*

Ramps should be constructed in the sidewalk at the canal path entrance or exit. If above or below grade crossings are considered, they must be ADA accessible.

Guideline. *Create curb extensions such as bulbing or medians for refuge to reduce crossing distance where streets are greater than two (2) lanes wide. Minimum median width should be five feet (1.5m).*

On arterial streets such as Project Crossings A and B, median refuges are appropriate to reduce crossing distance. Due to the

presence of bicycles, the refuge should be wide enough for a bike at rest, approximately 84". Bulbing would not be appropriate where it would block bicycle or vehicular travel lanes.

Guideline. *Use stop signs rather than traffic lights (signing techniques).*

Stop signs would not be appropriate at an arterial, because the continuous unnecessary disruption of traffic when users were not present would encourage disregard of the stop sign.

Traffic lights may be appropriate, but must be pedestrian activated to minimize signal changes and allow for free vehicular traffic flow.

Guideline. *Combine several (*traffic calming*) treatments such as speed humps and channelization for a specific length of a street (slow streets).*

Speed humps and channelization may suffice at midblock crossings of an arterial, if user numbers warranted them and were consistently high during day and evening. There are not yet sufficient numbers to warrant this type of traffic calming at Project Crossing A or B.

Guideline. *Maintain a five lane maximum where there is no on-street parking and an average of 15,000 vehicles per day.*

Project Crossing A at the canal crossing has three (3) lanes in each direction, and a center two-way turn lane. Project Crossing B at the canal crossing is striped for two (2) lanes in each direction with a center two-way turn lane. The average vehicles per day on Project Crossing A is 31,500 (taken on July of 1995) and on Project Crossing B, it is 28,500 (taken from November 1997). There is and will be no on-street parking.

Project Crossing A and B exceed this guideline. However, because regional paths can cross arterials of six and seven lanes, it is recommended that the crossing is considered and implemented with a high degree of support and refuge for the pedestrian and bicyclist.

Guideline. *Provide a continuous walkable surface across driveways.*

This refers to both the continuousness of the sidewalk across the multi-use path, and the continuousness of the surface across the streets. Both should be of a compatible surfacing material so they read as one facility.

(Enhanced design guideline). *Upgrade the walkway surface to reflect the character of the area with decorative paving.*

There is not a strong need for this type of treatment at the prototype crossings or most neighborhood crossings, but it could be appropriate at other crossings closer to a neighborhood node or where the sidewalk surface was enhanced.

Guideline. *Establish trash receptacles and provide for their pickup at pedestrian gathering places such as transit stops and mailboxes.*

Guideline. *Provide seating opportunities at 500 foot (152m) intervals along the primary pedestrian route. Seating opportunities could be either fixed or moveable, or sittable surfaces such as low walls.*

(Enhanced design guideline). *Add drinking fountains and restrooms at nodes.*

(Enhanced design guideline). *Develop plazas and small green spaces adjacent to pedestrian areas.*

The crossings throughout the region may be near pedestrian gathering places, but should not be considered gathering places in their own right unless they are designated as a gateway or are developed in proximity to or conjunction with a larger activity center or facility. Therefore, they have no need for trash receptacles, seating, drinking fountains, restrooms, or plazas/green spaces.

Guideline. *Establish 50% shade along pedestrian routes and at gathering place locations.*

Establishing shade is critical to the functionality of the crossings in proportion to how long the pedestrian must wait to cross. If the crossing does not require a waiting time of longer than two minutes, shade is not crucial at the crossing itself. If the wait time is longer, shade is pivotal. Trees will also provide a sense of enclosure to the roadway and a gateway to the canal.

Guideline. *Provide local jurisdictional standard street lighting level or a minimum of one footcandle.*

One footcandle should be the minimum at all crossings, but we would recommend the upgraded requirement of two footcandles to enhance driver awareness and visibility for the users.

(Enhanced design guideline). *Provide pedestrian-oriented signs. Pedestrian signs are at eye-level to a walking person, are fairly detailed in design, and provide information at walkway intersections.*

Although this is considered an enhancement for Level 2 - Neighborhood pedestrian areas, implementation is recommended because the canal represents access from the neighborhood to a regional circulation system. Information should include destinations of note along the canal path or walkways, such as other recreation areas or activity centers.

Guideline. *Separate bicyclists and pedestrians.*

Separate crossings may not be feasible for bicycles and pedestrians, but adequate widths for both to cross at the same time at different speeds should be provided.

Stakeholder Neighborhood Design Criteria for Project Crossings

Neighborhood design criteria specifically for the project crossings were developed at a stakeholder meeting. The list of stakeholders for Project Crossing A and B is diverse and includes the municipality, Bike Advisory Committee, neighborhood associations, Allied Signal, Salt River Project, and office property owners.

The neighborhood design criteria identified by the stakeholders are to:

Provide for long distance connections to the city's bicycle system;

Minimize conflicts among users of the canal right-of-way, particularly SRP maintenance vehicles;

Provide clear sight distance and visibility of canal users by drivers of vehicles on the roadway;

Be cost effective for local communities to implement;

Provide for the safe crossing of all users, including children, persons with disabilities, and seniors;

Have regional applicability through meeting a minimum standard for implementation while suggesting enhancement techniques;

Provide sufficient lighting to extend winter use with the shorter days and summer use as the air cools;

Heighten drivers' awareness of the presence of a bicycle/pedestrian crossing, making it recognizable as something to expect valley wide;

Accommodate equestrian as well as pedestrian and bicycle use as much as is feasible and practical; and

Strive for parity between canal bank users and vehicles.

(2) TYPES OF MIDBLOCK CROSSINGS DISCOVERED

Relatively few examples of "built" midblock crossings over arterial streets were found in our research. However, several studies actually recommended midblock over intersection crossings on arterials due to four factors: pedestrians take responsibility for their own lives, using their own caution and judgment rather than relying on the drivers'; intersections can operate more efficiently for vehicles; there are fewer potential conflict points with vehicles; and sight visibility may be better.

A. RESEARCH METHODS

A limited literature search of paths, trails, pedestrian and bicycle literature was conducted. Also, a limited search was conducted on the Web, using key words such as pedestrian, path, bicycle, trail, and traffic calming. Municipalities suggested by the city and others as discovered in the literature and web searches were contacted by telephone and interviewed on the topics of pedestrian and bicycle midblock crossings, urban path systems, and user facilities. The resulting midblock crossings fall into two main categories: Grade Separated Crossings and At Grade Crossings. Groups for each of the two main categories are noted below. Combinations for crossing elements are also described in the text and in Matrix 1.

B. GRADE SEPARATED CROSSINGS

A grade separated crossing vertically separates the route that vehicles and pedestrians travel. There are two types of grade separated crossings - overhead bridges or underground tunnels.

In general, grade separated crossings are not recommended in a highly used pedestrian environment, because they reduce the liveliness of the main pedestrian route. Therefore, canal crossings near commercial districts, neighborhood centers or urban districts should generally be at grade. In the project area application, the locations are predominately within residential areas where liveliness at street level is not likely to be a criteria, and grade separated crossings should be considered.

Another criteria to determine if grade separation is an acceptable crossing type in a particular location is to determine the

potential use of the crossing. Crossings may be underused because of the inconvenience of walking up or down a significant grade change, if the at-grade crossing is perceived to be readily available.

To evaluate the use of a pedestrian bridge, the formula for determining the acceptance of the grade separated crossing is as follows:

expected usage of grade separated crossing (in numbers of people) equals

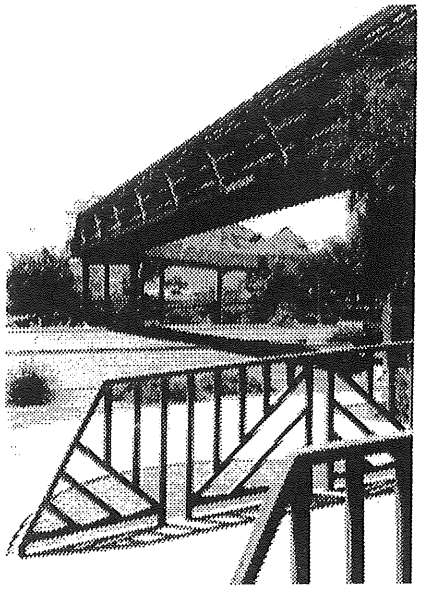
$$\frac{\text{time on grade-separated device}}{\text{time on at-grade device}}$$

If the ratio is equal (1.0), the grade separated device will be used by 95% of the pedestrians. However, if the overpass takes 50% longer or more than the at grade crossing (1.5), almost no one will use the device. (This formula was obtained from a presentation given by the Traffic Institute of Northwestern University, instructor Mr. Alex Sorton.)

Overhead Bridge/Overpass

An overhead crossing will work well when one or both sides of the crossing will remain elevated, or where the barriers below are so severe as to generate strong desire for a separated crossing, or where there is such high-vehicle speed and/or traffic volume so as to reduce all potential crossing gaps.

Advantages. An overhead crossing can have positive impacts when:
- there will be no impediments in volume or speed for the vehicle,
- the users will be ultimately secure from vehicular collisions due to separation.



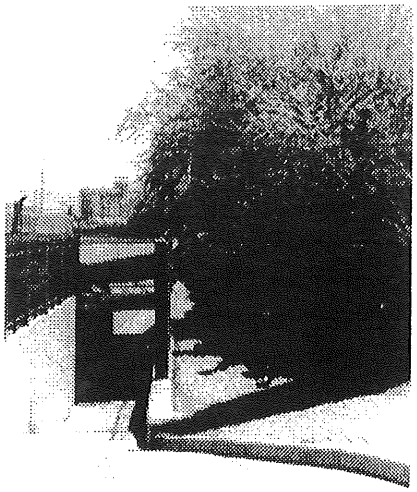
20th Street and Greenway Parkway

Disadvantages. However, an overhead crossing will also:
- require sufficient space for ramps and ramp access to meet ADA standards, sidewalks, utilities and other needs,
- possibly cause visual backyard intrusion,
- appeal to aesthetic issues,
- be a costly alternative devices.

No overhead structure should be built where the pedestrian perceives that the at grade crossing is feasible and will save time, though more dangerous.

Underground Tunnel/Underpass

An underground tunnel will work well where the barriers to crossing at grade above are so severe as to generate strong desire for a separated crossing, or where there is such high vehicle speed and/or high traffic volume so as to eliminate all perceived potential crossing gaps.



35th Avenue north of Dunlap Avenue

Advantages. An underground tunnel will have positive impacts when:
- there will be no impediments in volume or speed for the vehicle,
- the users will be ultimately secure from vehicular collisions due to separation.

Disadvantages. However, an underground tunnel will also:
- require sufficient space for ramps and ramp access to meet ADA standards, sidewalks, utilities and other needs,
- elicit strong security objections,
- be one of the most costly of the alternative devices;
- have a high maintenance/cleaning cost.

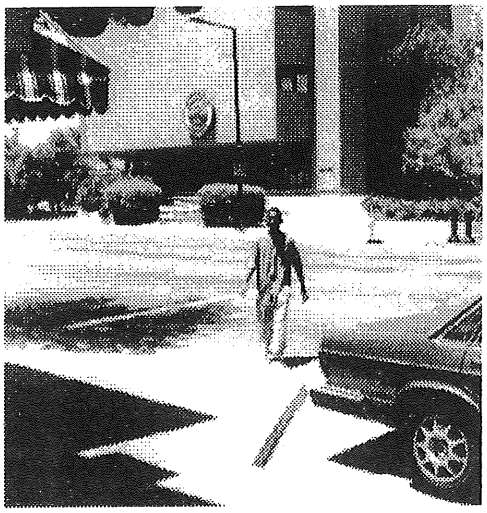
No underground structure should be built where the pedestrian perceives that the at grade crossing is still feasible, though more dangerous.

C. AT GRADE CROSSINGS

Several types of at-grade crossings were discovered, including curb extensions (also called bulbouts), pedestrian refuges (also known as medians), pedestrian-activated traffic signals and flashers, raised crosswalks, warning and regulatory signing and striping, and various combinations of these elements.

Curb Extension

Curb extensions extend the sidewalk into the roadway at a midblock or intersection crossing, and are used to reduce the vehicular travelway width on opposite sides at a specific part of the road. No literature on curb extensions or bulbouts or any application of this tool was found on a non-urban arterial street such as the two in the project area that are examined in this report.

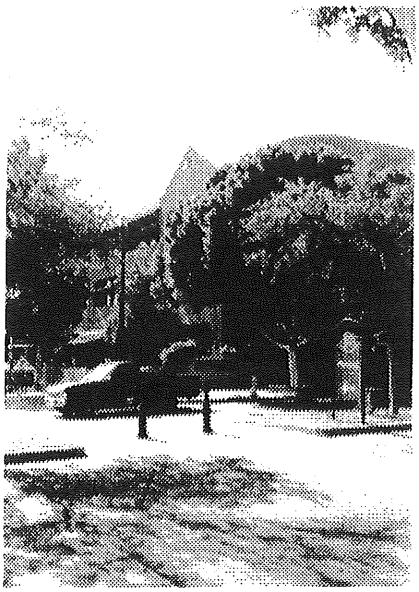


Downtown Glendale

Advantages. Reducing the travelway width by curb extension will have many positive impacts:
- the driver will see a barrier at the edge of the roadway and slow down,
- the driver will recognize that the facility is for pedestrians and bicyclists and will use extra caution,
- users will achieve better visibility to the driver,
- and users will have less distance to travel across the roadway.

Disadvantages. Reducing lane width will:
- only work on an arterial street that has a generous lane width (more than 11' wide lanes)
- result in accommodations needing to be made where painted bicycle lanes exist. There must be a continuous ride for the cyclist along the roadway, so that the bicyclist does not have to compete with the vehicle for lane space.

Combinations. Curb extensions can be effectively used in conjunction with pedestrian refuges, signals, raised crosswalks, and signing and striping to create a more usable crossing.



4th Street and Mill Avenue in Tempe

Pedestrian Refuge

Pedestrian refuges are curbed median islands or delineated refuge islands in the center of the roadway designed to provide a layover place in the center of a wide street, so the pedestrian can make a two stop crossing.

The length of the median in either case should be at least 12' long. The width of the median must be adequate for resting a bike (84" minimum). Curbed medians are a common application on arterial streets, though they are usually installed to control vehicular access and not as a pedestrian refuge.

The delineated refuges may be marked with paint striping or some type of stanchions. Refuges delineated by stanchions or dagmars are less common, and are usually a response to retrofit requests or reflect a testing phase.

Advantages. The curbed median refuge can have several positive impacts:
- vehicle speeds may be reduced,
- the safety and visibility of the users will be enhanced,
- it may prevent passing at pedestrian and bicycle crossings, especially if used with a sidewalk extension,
- the refuge provides a place for slower users to rest and wait for the next gap in traffic,
- if the median is landscaped, or otherwise celebrated, it will draw attention to the canal path system itself, and create a sense of enclosure for the entry.

The delineated refuge islands offer a low-cost approach with a low impact on vehicle delay or safety. Delineations can be with dagmars or stanchions.

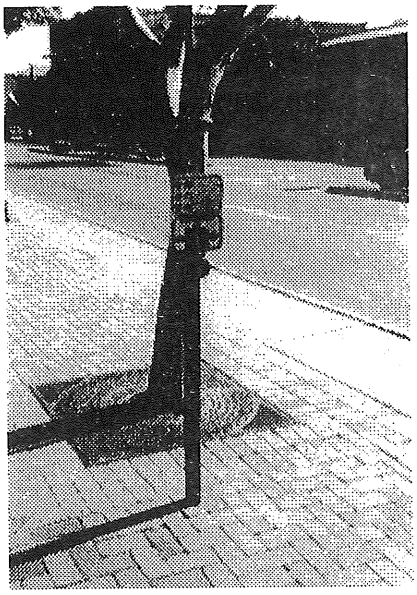
Disadvantages. Reducing lane width by adding a refuge:
- can only be contemplated where lanes are wider than 11'.
- has a limited effect on speed of traffic,

- may impede access for canal maintenance vehicles,
- may add landscape maintenance costs,
- puts bicyclists on the roadway at risk in a similar situation to the curb extensions by being squeezed where insufficient room has been left between a central median and the adjacent curb.

Combinations. Refuge medians can be used in conjunction with curb extensions, signals, raised crosswalks, and signing and striping to create a more usable crossing.

Signals

The use of traffic signals and some type of pedestrian activating device for midblock crossings is generally dictated by the *Manual on Uniform Traffic Control Devices for Street and Highways*, (MUTCD) Section 4C-5. Under these criteria, pedestrian and bicycle counts are taken, and the traffic signal is either warranted or not warranted. Warrant 3 has recently been revised to provide more opportunities for traffic signals based on the needs of pedestrians.



Several municipalities use this device in an urban setting. The city of Glendale uses a flashing light at 59th Avenue south of Thunderbird Road. The Town of Gilbert uses a flashing light at Gilbert Road and Bruce Avenue.

Advantages. Adding traffic signals at each canal intersection (regardless of warrant) will have several positive impacts:
- the safety of the users will be greatly enhanced,
- the motorist understands and responds well to this type of device,
- the user feels in control of the situation,
- sight distances can be improved,
- there are no turning movement conflict points,
- and the midblock flashing signal provides a warning to the driver.

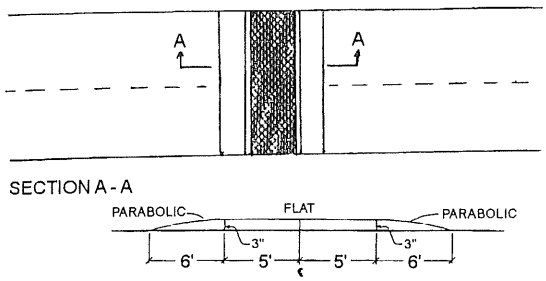
Disadvantages. A warrant study as defined by MUTCD may need to be undertaken at each crossing. The disadvantages to this type of device are that:
- most crossings will probably not be able to meet warrant conditions (a ballpark figure would be volumes in the range of 200 to 300 pedestrians per hour),
- a high installation cost,
- additional maintenance is involved,
- the flashing signal does not provide a barrier for safe crossing.

It was noted that some municipalities included cyclists in the pedestrian counts to achieve the warrant, even though bicyclists are unlikely to walk their bikes across. Also, a second warrant can be obtained if the canal crossing is used as a school crossing, where the number of gaps in the traffic stream during the period that children are using the crossing is less than the number of minutes in the same period.

Combinations. Signals can be used in conjunction with curb extensions, refuge medians, raised crosswalks, and striping.

Raised Crosswalks

A raised crosswalk is essentially a mid-block crossing striped as a crosswalk and raised to curb height above the level of the roadway. Portland, Oregon has used these successfully on arterial streets. Portland uses these in combination with regulatory signage.



Advantages. Adding raised crosswalks at each canal intersection will have several positive impacts:
- traffic speeds will be reduced,
- pedestrian and wheelchair users are provided with a much easier street crossing,
- the crosswalks are more visible to drivers.

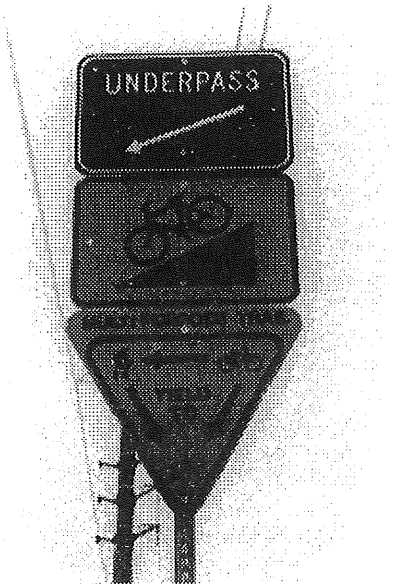
Disadvantages. Raised crosswalks:
- may be somewhat expensive to build,
- may impact bicyclists (if constructed curb-to-curb),
- may impact drainage,
- are recommended (by the National Highway Institute) to be constructed only on roadways with two lanes and where the 85th percentile speeds are less than 45 miles per hour.

Combinations. Raised crosswalks can be used in conjunction with curb extensions, refuge medians, signing and striping to create a more usable crossing.

Signing and Striping

This category of devices includes signing, pavement marking, colored and textured pavement treatments, inpavement lights, and rumble strips. These devices provide visual and audible cues about the crossing area.

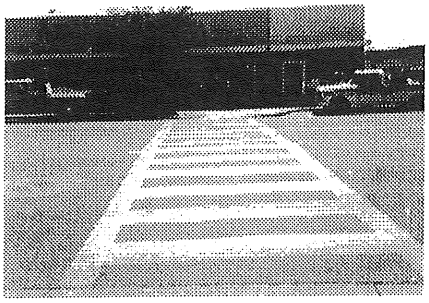
Traditional signing, with the "walking person" symbol is currently used by most MAG municipalities to provide advance warning to the midblock crossing. In addition, some crossings are delineated by a painted at grade crosswalk.



Advantages. Adding traditional signing and striping at each canal intersection will have these positive impacts:
- this is a relatively low-cost solution,
- it is widely recognized by motorists,
- it enhances the visibility of the crosswalks for drivers.

Several studies recommended a different striping system than that usually used at

intersections, such as diagonal bars or solid infill.



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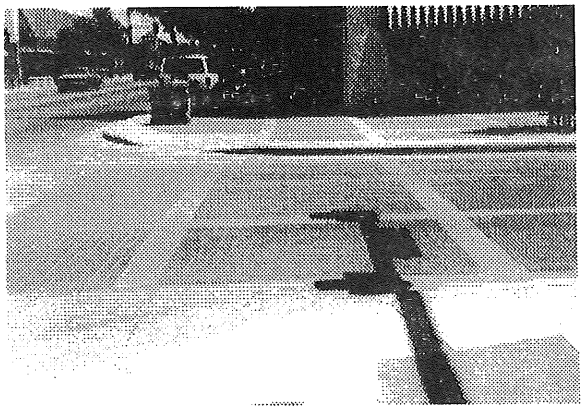
Disadvantages. Many municipalities, however, specifically discourage this type of response, citing that
- painted crosswalks give users a false sense of security,
- signing and marking do not physically prevent or deter vehicles from high speeds and inattention.

Combinations. Traditional signing and striping could be used in conjunction with curb extensions, refuge medians, traffic signals and raised crosswalks.

Textures

Surface textures, such as special paving in the crossing or before the crossing, are another common response to midblock crossings. Rumble strips are included in this category.



Downtown Glendale

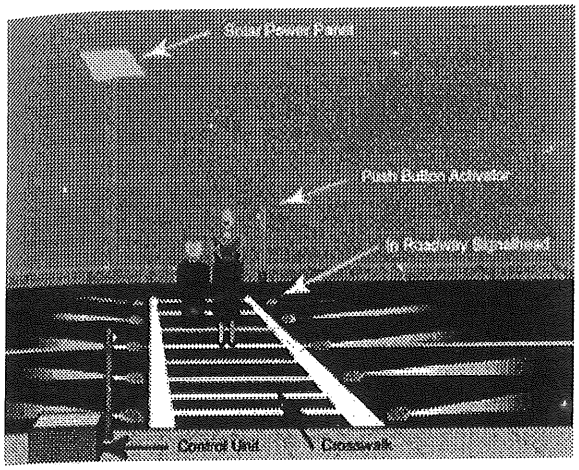
Advantages. Adding surface textures before each canal intersection will have several positive impacts:
- if strongly contrasting enough, the surface texture will provide a cue of a changing environment and increase alertness to users and/or drivers;
- this treatment is also potentially aesthetically pleasing (such as decorative pavement).

Disadvantages. Surface textures alone:
- do not physically prevent or deter vehicles from high speeds,
- do not provide enhanced accessibility to users in the crossing;
- may add unwelcome noise to a residential neighborhood,
- are not generally favored by bicyclists.

Combinations. Surface textures such as rumble strips or concrete pavers should be used in conjunction with curb extensions, traditional signing and striping, refuge medians, traffic signals and raised crosswalks.

Inpavement lighting

Inpavement lights are a relatively new response to a pedestrian activated warning system. The two applications discovered in our research were in the cities of Santa Rosa, California and Maryland County, Delaware. They both provided generally the same type of lights, installed in the ground along the edges of the crosswalk, with a user activator post and button.



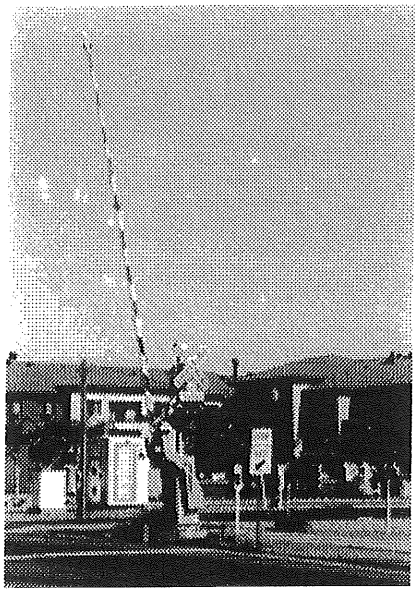
Advantages. Adding inpavement lights at each canal intersection will have several positive impacts:
- the crosswalks will be more visible to drivers,
- users will have some control over traffic gaps,
- and the device will be activated only when it is needed, leaving the vehicular access uninhibited otherwise.

Disadvantages. Disadvantages of the inpavement lights are:
- that they may be somewhat expensive to build,
- and it is a relatively new technology without many case studies associated with it.

Combinations. Inpavement lights can be used in conjunction with refuge medians, signing and striping, special paving, and raised crosswalks.

Railroad Arm Crossings

User activated railroad arm crossings were not discovered in use in our research, but would have a bar similar to that found controlling a railroad crossing, that would be activated by a push button or electric eye.



Advantages. The railroad arm crossing would have several positive impacts:
- the drivers will stop for the arms,
- users will have good control over traffic gaps,
- this is a device readily recognizable to drivers,
- the device will be activated only when it is needed, leaving the vehicular access uninhibited otherwise.

Disadvantages. The railroad arm crossing would be:
- relatively expensive to install,
- this type of device is not currently used in this type of application.

D. DEVICES CONSIDERED INAPPROPRIATE FOR THIS TYPE OF CROSSING

Several traffic calming devices were considered and rejected for arterial canal crossings. These include speed bumps and humps (too many travel lanes and an unwarranted decrease in the expected speed limit), chicanes and woonerfs (residential application, no need for shared space), and

rerouting to corner (not a part of the scope of this project)(suggested distance: more than 150' from an intersection Virginia study or 600' MUTCD).

(3) COSTS

To better understand and compare the cost efficiency of grade separated and at grade crossing alternatives, a series of five matrices was constructed on the following five pages (Matrices 1-5).

Matrix 1 illustrates that most at grade elements can be used together, but that grade separated crossings are self-sufficient.

Matrix 2 is a summary of advantages and disadvantages for each type of midblock crossing.

Matrices 3-5 showed that at grade crossings are considerably more cost efficient that grade separated crossings. Pedestrian overpasses and underpasses cost substantially more than any of the at grade crossing alternatives. The railroad arm and raised crosswalk were the highest costing alternatives for at grade crossings.

NOTE: Certain costs will vary based on the width of the road and number of lanes. The cost estimates for alternatives within this category have been configured under Project Crossing B dimensions. Costs are calculated in 1998 dollars.

Midblock Crossing Element Combination Potentials

Matrix 1

Design Options

	Overhead Bridge/ Pedestrian Overpass	Underground Tunnel/Underpass	Curb Extension	Pedestrian Refuge	Signals	Raised Crosswalks	Signing and Striping	Textures	Inpavement Lighting	Railroad Arm Crossing
Overhead Bridge/ Pedestrian Overpass										
Underground Tunnel/Underpass	N/A									
Curb Extension	N/A	N/A								
Pedestrian Refuge	N/A	N/A	●							
Signals	N/A	N/A	●	●						
Raised Crosswalks	N/A	N/A	●	●	●					
Signing and Striping	N/A	N/A	●	●	●	●				
Textures	N/A	N/A	●	●	●	●	●			
Inpavement Lighting	N/A	N/A	○	●	○	●	●	●		
Railroad Arm Crossing	○	○	●	●	N/A	●	●	●	○	

Legend

● Successful midblock crossing combination

○ Unsuccessful midblock crossing combination

N/A Not applicable to any midblock crossing combination

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Midblock Crossing Elements

Matrix 2

Design Options Summary

Type of Midblock Crossing	*Advantages*	*Disadvantages*
Overhead Bridge/ Overpass	* *No impediments in volume or speed of traffic* * *Pedestrian security from vehicular collisions*	* *Requires sufficient space for ramps and utilities* * *Not very cost efficient*
Underground Tunnel/ Underpass	* *No impediments in volume or speed of traffic* * *Pedestrian security from vehicular collisions*	* *Requires sufficient space for ramps and utilities* * *Not very cost efficient* * *Strong security objections* * *High maintenance/ cleaning cost*
Curb Extension	* *Barrier at edge of roadway will slow down drivers* * *Driver recognition of facility for pedestrians* * *Better pedestrian visibility of drivers* * *Less travel distance for pedestrian across roadway*	* *Only works on streets with wider than 11' lanes* * *Additional accommodations for bicyclist space*
Pedestrian Refuge	* *Reduced vehicle speed* * *Enhanced pedestrian safety and visibility* * *May prevent passing at pedestrian crossings* * *Provides pedestrian space to wait for gaps in traffic* * *Added attention to canal trail system*	* *Applied only where lanes are wider than 11'* * *Limited effect on speed of traffic* * *Limited access for canal maintenance vehicles* * *Possible maintenance costs, if landscaped* * *Lack of bicyclist space along roadway*
Signals	* *Enhanced pedestrian safety & visibility* * *Motorist understand & respond to this device* * *Increased pedestrian control* * *Improved sight distances* * *No turning movement conflict points*	* *Most crossings will not meet warrant conditions* * *High installation cost factor* * *Additional maintenance involved* * *Flashing signal does not help pedestrian cross*
Raised Crosswalks	* *Reduced vehicle speed* * *Easier crossing for pedestrians & wheelchair users* * *More visible to drivers*	* *Somewhat expensive to build* * *Impacts on bicyclist* * *Impacts on drainage* * *NHI recommendations on implementation*
Signing and Striping	* *Cost efficient* * *Widely recognized by motorist*	* *False sense of security for pedestrian* * *No physical prevention of vehicle high speeds*
Textures	* *Increased alertness to pedestrians & drivers* * *Aesthetically pleasing*	* *No physical prevention of vehicle high speeds* * *Lack of accessibility to pedestrian in crossing* * *Unwelcomed noise to neighborhood* * *Not favored by bicyclist*
Inpavement Lighting	* *More visible to drivers* * *Some pedestrian control over traffic gaps* * *Activated only when needed*	* *Somewhat expensive to build* * *Relatively new technology*
Railroad Arm Crossing	* *Drivers will stop for arms* * *Good pedestrian control over traffic gaps* * *Readily recognizable to drivers* * *Activated only when needed*	* *Relatively expensive to install* * *Not previously used in this type of application*

Estimate of Probable Costs

CANAL CROSSING ALTERNATIVES

Item #	Item Description	Qty.	Units	Unit Price	Total
	OVERHEAD BRIDGE/PEDESTRIAN OVERPASS	1	EA	$750,000.00	$750,000.00
		Subtotal			$750,000.00
		8% Design & Engineering Cost			$60,000.00
		15% Construction Contingency			$112,500.00
		Estimate of Probable Cost			**$922,500.00**
	UNDERGROUND TUNNEL/UNDERPASS	1	EA	$750,000.00	$750,000.00
		Subtotal			$750,000.00
		8% Design & Engineering Cost			$60,000.00
		15% Construction Contingency			$112,500.00
		Estimate of Probable Cost			**$922,500.00**
	CURB EXTENSION				
	SIDEWALK RAMPS	300	SF	$4.00	$1,200.00
		Subtotal			$1,200.00
		8% Design & Engineering Cost			$96.00
		15% Construction Contingency			$180.00
		Estimate of Probable Cost			**$1,476.00**
	SIGNALS				
	PEDESTRIAN PUSH BUTTON	2	EA	$50.00	$100.00
	POST FOUNDATION (WIRING AND INSTALL)	2	EA	$15,000.00	$30,000.00
	TRAFFIC SIGNAL FACE	2	EA	$1,000.00	$2,000.00
	POLE/MAST ARM (45')	2	EA	$15,000.00	$30,000.00
		Subtotal			$62,100.00
		8% Design & Engineering Cost			$4,968.00
		15% Construction Contingency			$9,315.00
		Estimate of Probable Cost			**$76,383.00**

* *SEE NOTE PAGE 14.*

Estimate of Probable Costs
CANAL CROSSING ALTERNATIVES

Item #	Item Description	Qty.	Units	Unit Price	Total
	RAISED CROSSWALK	1	EA	$12,000.00	$12,000.00
		Subtotal			$12,000.00
		8% Design & Engineering Cost			$960.00
		15% Construction Contingency			$1,800.00
		Estimate of Probable Cost			**$14,760.00**
	SIGNING				
	SIGN POST (U-CHANNEL)	6	EA	$83.00	$498.00
	SIGN POST FOUNDATION	6	EA	$132.00	$792.00
	SIGN (30"x30")	72.5	SF	$16.00	$1,160.00
		Subtotal			$2,450.00
		8% Design & Engineering Cost			$196.00
		15% Construction Contingency			$367.50
		Estimate of Probable Cost			**$3,013.50**
	STRIPING	1395	LF	$0.30	$418.50
		Subtotal			$418.50
		8% Design & Engineering Cost			$33.48
		15% Construction Contingency			$62.78
		Estimate of Probable Cost			**$514.76**
	TEXTURES	300	SF	$5.00	$1,500.00
		Subtotal			$1,500.00
		8% Design & Engineering Cost			$120.00
		15% Construction Contingency			$225.00
		Estimate of Probable Cost			**$1,845.00**

*** SEE NOTE PAGE 14***

Estimate of Probable Costs
CANAL CROSSING ALTERNATIVES

Item #	Item Description	Qty.	Units	Unit Price	Total
	INPAVEMENT LIGHTING				
	FOUR LANE CROSSWALK SYSTEM (12) FIXTURES	1	EA	$6,500.00	$6,500.00
	PEDESTRIAN PUSH BUTTON	2	EA	$375.00	$750.00
	POST FOUNDATION	2	EA	$240.00	$480.00
		Subtotal			$7,730.00
		8% Design & Engineering Cost			$618.40
		15% Construction Contingency			$1,159.50
		Estimate of Probable Cost			**$9,507.90**
	RAILROAD ARM CROSSING	2	EA	$6,200.00	$12,400.00
	INCLUDES FOUNDATION, ARM, LIGHTS, BELLS, & SUPPORTS	***Subtotal***			$12,400.00
		8% Design & Engineering Cost			$992.00
		15% Construction Contingency			$1,860.00
		Estimate of Probable Cost			**$15,252.00**

SEE NOTE PAGE 14

COMPARISON OF ELEMENTS TO CRITERIA

Another critical point in better understanding the type of crossing to recommend for Project Crossing A and B is to compare the MAG and neighborhood design guidelines to each of the crossing alternatives. Logan Simpson Design has compiled this information into two matrices on the proceeding pages (matrices 6 and 7).

When the applicable MAG guidelines were evaluated towards the midblock crossing alternatives, curb extension and pedestrian refuge had the most conformity. The pedestrian bridge/overpass had the lowest conformity. This also strengthens the support of at grade midblock crossings.

In contrast, the pedestrian overpass has the most conformity in the relationship between the midblock crossing alternatives and neighborhood design criteria. Paving textures were discovered to have the least amount of conformity according to the neighborhood design criteria.

MAG Guideline Conformity

Design Options

MAG Guidelines ⇒ / **Type of Midblock Crossing** ⇓	*Provide 6' to 8' minimum effective walking width. Add 2' to width of walkway if adjacent to roadway over 5,000 VPD*	*Construct ADA accessible ramps in sidewalks, or provide intersection crossing free of obstacles*	*Create curb extensions such as bulbing or medians for refuge to reduce crossing distance where streets are greater than 2 lanes. Min. median width 5'*	*Maintain a five lane maximum where there is no onstreet parking & an average of 15,000 VPD*	*Provide a continuous walkable surface across driveways*	*Provide local standard street lighting level or a minimum of one footcandle*	*Separate bicyclist & pedestrians*
Overhead Bridge/ Pedestrian Overpass	●	◍	N/A	○	◍	●	○
Underground Tunnel/ Underpass	●	◍	N/A	●	◍	●	○
Curb Extension	●	●	●	●	◑	●	○
Pedestrian Refuge	●	●	●	●	◑	●	○
Signals	●	◍	N/A	◍	◍	●	○
Raised Crosswalks	●	●	N/A	◍	◑	●	○
Signing and Striping	●	◍	N/A	◍	◍	●	○
Textures	●	◍	N/A	◍	◍	●	○
Inpavement Lighting	●	●	N/A	◍	◍	●	○
Railroad Arm Crossing	●	◍	N/A	◍	◍	●	○

Legend

●	Midblock crossing conforms with MAG guideline
◍	Midblock crossing partially conforms with MAG guideline
○	Midblock crossing does not conform with MAG guideline
N/A	Midblock crossing is not applicable to either category

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Stakeholder Guideline Conformity

Matrix 7

Design Options

Neighborhood Design Criteria → **Type of Midblock Crossing** ↓	*Provides continuous connections to Tempe Bicycle System*	*Eliminates conflicts between users, particularly SRP vehicles*	*Provides clear sight distance & visibility of canal users by vehicles*	*Cost effective for a range of communities*	*Provides safe crossing for all users*	*Regional applicability through minimum standards for implementation*	*Sufficient lighting could be provided*	*Heightens driver's awareness of canal crossing*	*Accommodates equestrians as well as pedestrian & bicycle*	*Provides parity in use for canal users as well as vehicles*
Overhead Bridge/ Pedestrian Overpass	●	●	●	○	●	◍	●	●	◍	●
Underground Tunnel/ Underpass	●	● 2	●	○	○	◍	●	○	●	●
Curb Extension	◍	○	●	●	○	●	◍	●	●	●
Pedestrian Refuge	◍	◍	●	●	◍	●	◍	◍	●	●
Signals	◍	◍	●	○	○ 3	◍	◍	●	●	●
Raised Crosswalks	◍	○	●	◍	◍	◍	◍	◍	●	◍
Signing and Striping	○	○	○	●	○	●	◍	◍	●	◍
Textures	○	○	○	●	○	◍	◍	◍	●	◍
Inpavement Lighting	● 1	○	●	○	○	◍	●	●	●	◍
Railroad Arm Crossing	◍	○	●	○	●	◍	◍	●	●	●

Legend

●	Midblock crossing conforms with neighborhood design criteria for canal crossing
◍	Midblock crossing partially conforms with neighborhood design criteria for canal crossing
○	Midblock crossing does not conform with neighborhood design criteria for canal crossing
N/A	Midblock crossing is not applicable to either category

Footnotes:

1. With preactivated switch plate
2. Route is shared with SRP vehicles
3. With flashing signal

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PREFERRED COMBINATIONS

Each of the individual types of devices discovered in our research has been described previously. Program elements that each device must meet were developed in the *Pedestrian Area Policies and Design Guidelines.* The comparisons of criteria and devices are found in the previous three matrices.

According to the criteria established for the Level 2 - Neighborhood and by the stakeholders, the basic midblock crossings at Project Crossing A and B from the canal must:

Provide heightened awareness to the vehicle driver of the crossing pedestrians by traffic calming or signalization.

Provide some boundaries for the pedestrian crossing by enhancing visibility of the crossing itself.

Reduce the crossing distance to two lanes at a time.

RECOMMENDATIONS FOR PROTOTYPES

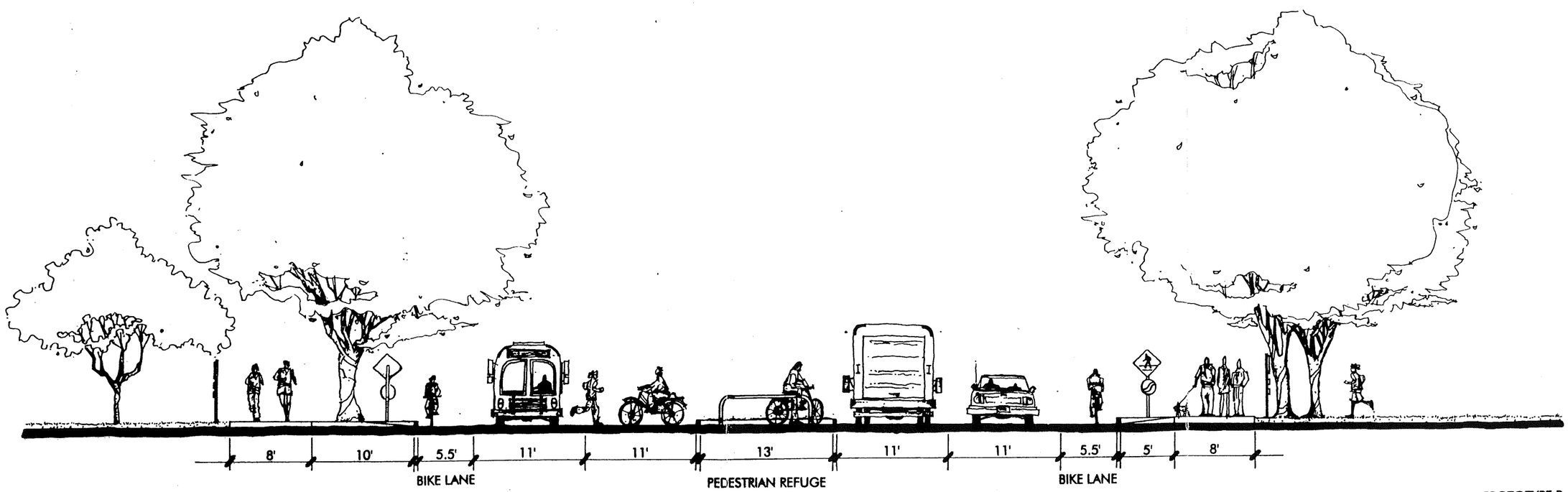
Our recommendations for Project Crossing A and B crossings include combining several of the features to meet the criteria for these particular crossings. The combinations include:

1. Curb extension to narrow lane width raised crosswalk, and a rumble strip on approach.

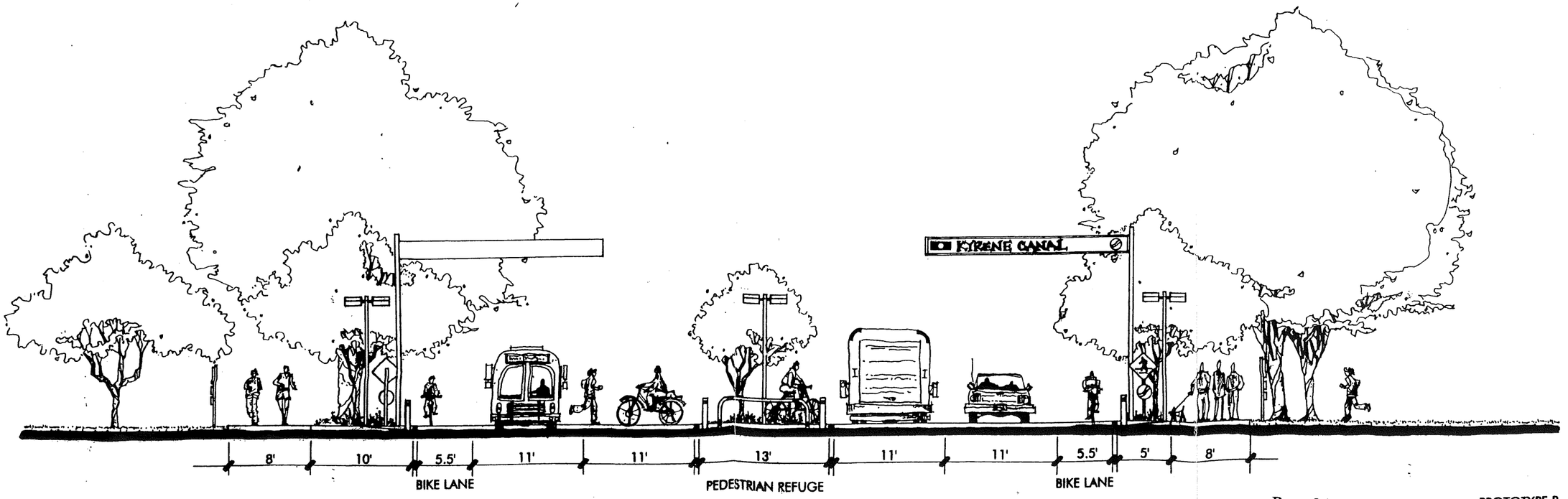
2. Median island refuge and surface textures on approach, with traditional signing, and an option for inpavement lighting.

3. Pedestrian activated traffic signal device and traditional striping.

The following sketches show the recommended elements applied to Prototype B. The upper sketch shows the minimum treatment necessary to establish a project crossing, and the costs are reflected in Matrix 9. The lower sketch reflects typical enhancements, with costs shown in Matrix 10.



PROTOTYPE B
PROPOSED MINIMUM STANDARDS



PROTOTYPE B
PROPOSED ENHANCEMENTS

MAG Pedestrian Design Assistance Program/LSD Inc.

Matrix 9

Estimate of Probable Costs

Minimum At Grade Crossing Standard
PROTOTYPE B

Item #	Item Description	Qty.	Units	Unit Price	Total	
	CONCRETE CURB, 6" (VERTICAL) (NO GUTTER)	900	LF	$12.00	$10,800.00	
	LEAST EXPENSIVE OPTION RIVER ROCK FOR MEDIAN (11/2"-3")	50	T	$11.25	$562.50	
	OPTIONAL DECOMPOSED GRANITE FOR MEDIAN	3400	SF	$0.65	$0.00	$2,210.00
	OPTIONAL RIVER ROCK FOR MEDIAN (3"-8")	85	T	$11.95	$0.00	$1,015.75
	OPTIONAL EXPOSED AGGREGATE FOR MEDIAN	3400	SF	$4.00	$0.00	$13,600.00
	OPTIONAL CONCRETE PAVERS FOR MEDIAN	3400	SF	$5.00	$0.00	$17,000.00
	OPTIONAL SAGUARO (6-8' TALL) FOR MEDIAN	10	EA	$400.00	$0.00	$4,000.00
	OPTIONAL YUCCA (5 GALLON) FOR MEDIAN	15	EA	$20.00	$0.00	$300.00
	PERMANENT WHITE STRIPING (8" WIDE)	1395	LF	$0.30	$418.50	
	STOP SIGN (30"x30")	12.5	SF	$16.00	$200.00	
	SPEED LIMIT SIGN	12.5	SF	$16.00	$200.00	
	SPECIALTY SIGN (CANAL IDENTITY MARKER)	4	M2	$175.00	$700.00	
	STREET NAME SIGN	12.5	SF	$16.00	$200.00	
	CANAL NAME SIGN	25	SF	$16.00	$400.00	
	LEANING RAIL	2	LF	$60.00	$120.00	
	ADA RAMP	275	SF	$4.00	$1,100.00	
	SIGN POST FOUNDATION	6	EA	$132.00	$792.00	
	SIGN POST (U-CHANNEL)	6	EA	$83.00	$498.00	
	PEDESTRIAN CAUTION SIGN (30"x30")	12.5	SF	$16.00	$200.00	
	ASPHALT REMOVAL	568	SY	$2.00	$1,136.00	
	ASPHALT SAWCUT	5110	SF	$1.00	$5,110.00	
	ASPHALT PATCHING	203	SY	$18.50	$3,755.50	
	PAINT BULL NOSES	2	EA	$55.00	$110.00	
	TRAFFIC CONTROL	1	LS	$7,000.00	$7,000.00	
		Subtotal			$33,302.50	
		8% Design & Engineering Cost			$2,664.20	
		15% Construction Contingency			$4,995.38	
		Estimate of Probable Cost			**$40,962.08**	

NOTE: CANAL MARKER & CANAL NAME SIGNS SHARE ONE POST
NOTE: PEDESTRIAN CAUTION & SPEED LIMIT SIGNS SHARE ONE POST
NOTE: STREET NAME, STOP, & CANAL NAME SIGNS SHARE ONE POST
**** SEE NOTE PAGE 14***

MAG Pedestrian Design Assistance Program/LSD Inc.

Matrix 10

Estimate of Probable Costs

Enhancements To Minimum At Grade Crossing Standard
PROTOTYPE B

Item #	Item Description	Qty.	Units	Unit Price	Total
	LANDSCAPE (5 GALLON SHRUB)	26	EA	$20.00	$520.00
	LANDSCAPE (24" Box Tree)	25	EA	$250.00	$6,250.00
	DECOMPOSED GRANITE FOR MEDIAN	3400	SF	$0.65	$2,210.00
	RAISED CROSSWALK	1	EA	$12,000.00	$12,000.00
	PERMANENT WHITE STRIPING AT CROSSWALK (8" WIDE)	140	LF	$0.30	$42.00
	LIGHT POLES (POLE, FIXTURE, FOUNDATION)	6	EA	$2,500.00	$15,000.00
	CODUIT/TRENCHING/BACKFILL FOR LIGHTING & UG POWER	200	LF	$5.50	$1,100.00
	MAST ARM (45'), POST, FOUNDATION, SIGNAL, WIRING & INSTALL	2	EA	$31,050.00	$62,100.00
	AUDIO STRIPS (10 STRIPS IN EACH DIRECTION)	460	LF	$0.12	$55.20
	DECORATIVE PAVEMENT FOR CROSSWALK	300	SF	$5.00	$1,500.00
	REMOVABLE BOLLARDS	20	EA	$300.00	$6,000.00
	DRIP IRRIGATION SYSTEM	1	LS	$80,000.00	$80,000.00
	TRAFFIC CONTROL	1	LS	$7,000.00	$7,000.00
		Subtotal			$193,777.20
		8% Design & Engineering Cost			$15,502.18
		15% Construction Contingency			$29,066.58
		Minimum Standards Estimate			$40,962.08
		Estimate of Probable Cost			**$279,308.04**

SEE NOTE PAGE 14

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