APPENDIX A
PEDESTRIAN & BICYCLE RECOMMENDATION PLANNING TOOLKIT

HALFF

Toole Design Group

This page was intentionally left blank.

Pedestrian & Bicycle Recommendation Planning Toolkit

Table of Contents

Strong citizen support for active transportation infrastructure throughout Texas has lead to the development of many creative facilities across the State, such as the Medina Trail in San Antonio.

Appendix A Bicycle and Pedestrian Toolkit

Introduction

The bicycle and pedestrian networks proposed for the Alamo Area MPO communities participating in this study include a variety of off-street and on-street facilities suitable for bicycling or walking – or for both modes of travel in a shared manner. Each of these key facilities is defined by unique dimensional characteristics which account for different types (age and skill) and volumes of users and the variable built environments in which they are located.

This Appendix of the Alamo Area MPO Regional Bicycle and Pedestrian Planning Study serves as a "Toolkit" - providing the basic parameters by which Alamo Area communities should design and construct bicycle-specific, pedestrian-specific, and shared use facilities as they build the active network that is recommended herein, and incorporate these networks into their overall transportation systems. Of equal importance is encouraging the development of bicycle and pedestrian facilities throughout Alamo Area MPO communities that are consistent in design over the extended period of time in which the region-wide active transportation network is constructed. Although this study was principally focused on the cities of Boerne, New Braunfels, San Antonio, Seguin, and the San Antonio Missions National Historical Park, the Toolkit facility recommendations can (and should) be easily applied by other Alamo Area communities.

Active Transportation Facility Categories

The diversity of active transportation user groups and environmental contexts can prove challenging when trying to categorize suitable facility types and design options. The Toolkit is structured to identify "principal" active transportation facility types according to three distinct categories ("principal" referring to the linear facility). The three active transportation facility categories include:

- **On-street Bicycle Facilities.** Facilities designed to be used exclusively by bicyclists, and located primarily within the street right-of-way (e.g. bike lanes, buffered bike lanes, protected bicycle lanes and shared lane markings).
- **On-street Pedestrian Facilities.** Facilities designed to be used exclusively by pedestrians, and located primarily within the street right-of-way (e.g. sidewalks).
- **Shared Use Facilities.** Facilities alternatively located outside of, or within, the street right-of-way that can be used by both pedestrians and bicyclists (e.g. shared use paths, sidepaths).

In addition to the three categories of principal active transportation facilities listed above, the Toolkit provides recommendations on accessory design considerations including, intersections, bridges, railroad crossings, access restrictions, on-site pedestrian facilities, bicycle parking, etc.

How The Toolkit Should be Used

When applying any of the design standards provided in the Toolkit - or other network recommendations contained within this study - it should be noted that they are rudimentary in nature. Toolkit design standards are intended to quickly help the staff and citizens of Alamo Area MPO communities evaluate where specific on or off-street facilities are viable and worth considering. They also promote continuity throughout the regional system, so that users know what to anticipate no matter where they go in the metropolitan area. More detailed design to adapt them to specific site conditions is needed prior to actual implementation.

Regardless of its general nature, Alamo Area MPO communities are encouraged to use the Toolkit as the basis for developing and adopting formal design policy guides. The adoption of complimentary active transportation ordinance amendments to existing land development regulations is also highly encouraged to ensure long-term network inter-connectivity, and the general incorporation of active transportation facilities as part of new development.

What These Standards Are Based On

Guidance in the design, placement, and construction of

the active transportation facilities included in the Toolkit comes from the 2004 Guide for the Planning, Design, and Operation of Pedestrian Facilities, and 2012 Guide for the Development of Bicycle Facilities published by the American Association of State Highway and Transportation Officials (AASHTO); and, from the 2014 Urban Bikeway Design Guide published by the National Association of City Transportation Officials (NACTO). Alamo Area MPO communities should remain aware of updates that are periodically made to these standards.

It is important to remember that even the nationally recognized sources for bicycle and pedestrian facility design referenced in this study are "guidelines" – albeit guidelines widely accepted by pedestrian and bicycle professionals. Still, the distinction is necessary because there will be specific cases in every community where variations from AASHTO or NACTO standards may be prudent in relation to the special character, conditions, or challenges of an area. For instance, applying recommended design standards within existing street corridors of constrained widths may inhibit the placement of an "ideal" bicycle or pedestrian facility in a particular location. Whenever design variations are necessary, appropriate engineering expertise is required to ensure that the best facility possible is being implemented.

All off-street facilities and areas recommended in this study that may be used by pedestrians should be required to meet accessibility requirements put forth by the Texas Department of Licensing and Regulation (TDLR).

Signage alone does not make a transportation system safe for pedestrians and bicyclists (above). Signage should serve as an enhancement to properly designed and constructed active transportation facilities.

Active Transportation Facility Matrix

Toolkit design recommendations for the active transportation facilities highlighted on the following pages address basic design parameters that should be applied by Alamo Area MPO communities in "standard" or unconstrained environments. In some instances, the Toolkit references design alternatives that may be applied on a case-by-case basis.

On-Street Bicycle Facilities

On-street bicycle facilities are designed for bicycles to operate in association with motor vehicles. While bicyclists may utilize streets without designated bicycle facilities, specific treatments can increase the safety and comfort of on-street bicycling. Toolkit facility types include bicycle lanes, buffered bicycle lanes, protected bicycle lanes, wide shoulders, and shared lane markings.

On-Street Pedestrian Facilities

On-street facilities designed exclusively for pedestrian use are largely confined to a single principal facility - sidewalks. Even so, sidewalk design and construction is the most variable of all active transportation facilities - accounting for innumerable physical contexts.

Shared Use Facilities

Shared use facilities are designed to support bicycling and walking alike – and tend to accommodate similar volumes of bicyclists and pedestrians. These facilities are frequently preferred by bicyclists and pedestrians of all abilities, since they provide almost complete separation from motor vehicle traffic. Toolkit facility types include shared use paths and sidepaths.

Bicycle Lanes

Bicycle lanes are designated by a lane stripe, pavement markings, and signage. Bicycle lane stripes promote the orderly flow of traffic by establishing specific lines of demarcation between areas reserved for bicycles and lanes to be occupied by motor vehicles. Typically, the solid stripe of the bike lane is either dropped or dashed prior to and through intersections, to allow for both bicyclist and motorist turning movements.

TABLE A.1 BICYCLE LANE DESIGN BASICS

Design Element	Criteria*
Lane Width	5 feet (min.); 6 feet (preferred)
Vertical Clearance	10 feet (min.)
Striping Width	4 inches (min.)

Please refer to the section entitled "Design Notes" for additional information regarding minimum criteria.

Design Notes

Bicycle lanes should be development with the following additional parameters in mind:

Bicycle lane widths - A bicycle lane should be measured from the center of the bicycle lane stripe to the adjacent curb facing. Where slower vehicular speeds and no gutter occurs, a width of four feet (4') can be considered, but only for highly constrained areas.

Overall pavement width should continue to allow for a minimum ten foot (10') or eleven foot (11') wide motor vehicle lane depending on traffic volumes and design speed.

Bicycle lanes are suitable for streets with and without on-street parking, but variations in design will be necessary.

Along streets where a bicycle lane will be installed adjacent to on-street parking, a wider width of six to seven feet (6' to 7') should be considered to provide a greater buffer area from vehicle doors. The preferred configuration is a seven foot (7') wide parking area and a six foot (6') wide bicycle lane.

Bicycle lane striping - Bicycle lane striping should be at least four inches (4") wide. For greater visibility on shaded streets, a pavement striping width of up to six inches (6") should be considered. Bicycle lane symbol markings should be included. Spacing between markings can vary from 100 linear feet to 400 linear feet depending on intersection and driveway spacing.

Drainage inlets and utility covers - Inlet grates designed with slots to be used by bicycles should be included on all roads. Utility cover designs with grooves or stamped patterns that provide less slippery surfaces for bicycles should also be selected.

Buffered Bicycle Lanes

A buffered bicycle lane - sometimes called a "comfort lane" - is defined as a bicycle lane that is paired with a designated buffer space separating the bicycle lane from the adjacent motor vehicle lane and/or parking lane (NACTO Guide 2014). The buffer typically consists of a zone with diagonal striping or chevrons.

Design Notes

Buffered bicycle lanes should be developed in accordance with the following design parameters:

Buffered bicycle lane width - Along streets where the buffered bicycle lane is being added and is not replacing a travel lane, the buffer zone should be a minimum two feet (2') in width. A width of three feet (3') is preferred. The bicycle lane area should be a minimum of five feet (5') in width, but not exceed seven feet (7') wide. In instances where the buffered bicycle lane is replacing an existing motor vehicle travel lane, the buffer zone should be five to six feet (5' to 6') in width, and the bicycle lane area should be six to seven feet (6' to 7') in width. The remaining vehicular lane can be increased in width, but this is not preferred since it may give motorists the perception that they can drive faster. Typically, the remaining vehicular lane(s) will be a comfortable eleven to twelve feet (11' to 12') in width without the need for any additional widening.

Although integrated into the street surface, buffered bicycle lanes improve bicyclist's comfort by creating a greater separation from motor vehicles.

Protected Bicycle Lane

A protected bicycle lane is a bicycle lane that is physically separated from traffic with a row of parked cars, a raised curb, planters, or other physical separation. A protected bicycle lane is intended for bicycle use only, and is separated from a sidewalks or paths intended for pedestrian use.

Protected bicycle lanes are similar to buffered bicycle lanes except that the painted buffer zone is replaced with a physical barrier. Two-way protected bicycle lanes may also be developed.

Design Notes

Protected bicycle lanes should generally be developed in accordance with the following design parameters:

Application - Three methods of implementing protected bicycle lanes exist:

- Integrating the protected bicycle lane with the existing street surface but separated by a physical barrier. They are particularly useful and desirable for roads with high volume traffic.
- Constructing a bicycle-only facility within the street-side parkway area, or in a central median. This provides a location for bicyclists and requires a separate sidewalk for pedestrians.
- Widening the street to provide additional area for the protected bicycle lane.

Protected bicycle lane width - One way protected bicycle lanes should be a minimum of five feet (5') in width, with a six feet (6') wide travel lane preferred. For a two-way configuration, a minimum width of eight feet (8') is allowed, but a 10 to 12 foot width is preferred.

As they are not "shared" facilities, proper design requires that protected bicycle lanes remain distinct from adjacent sidewalks.

Barrier - A raised concrete curb with a 12 to 18 inch width is the preferred barrier technique. In retrofit locations, the curb area may be doweled into the existing pavement. Street drainage needs should be considered when installing a protected bicycle lane, with periodic gaps or slots provided for local drainage.

Pavement markings and signage - Pavement markings and signs should follow the type and frequency recommended by AASHTO for use in bicycle lanes and buffered lanes.

Wide Shoulders

A shoulder is defined by AASHTO as "the portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use" (AASHTO, 1999). A shoulder can accommodate bicyclists if it is adequate in width and pavement surface, and has few driveways or other crossings. Texas code allows for continuous use of the shoulder only by bicycles, emergency vehicles, and maintenance crews (Texas Transportation Code Section 545.058). Wide shoulders are typically used only by experienced riders.

Design Notes

Shoulders should be development in accordance with the following parameters to accommodate bicycle use:

Low-speed thoroughfares - A shoulder area should be at least four feet (4') in width along roadways with speeds under 45 miles per hour. However, a wider shoulder area of up to six feet (6') in width is preferred. If the shoulder width exceed six feet (6'), a buffered lane treatment should be considered.

High-speed thoroughfares - Along roadways with speeds at or over 45 miles per hour, streets with high volumes of traffic, or streets with significant truck or bus traffic, a wider shoulder width of six to eight feet (6' to 8') is preferred.

The use of wide shoulders by cyclists may gain greater community acceptance if complimented by accessory signage and pavement markings.

Shared Lane Markings

Along streets where there is insufficient width for a bicycle lane but where bicycle travel is likely, shared lane markings (or "sharrows") may be used to provide guidance to bicyclists and motorists. For motor vehicle operators, the marking indicates that a bicycle may be present. The shared lane marking indicates a general portion of the street where bicycles may be operated, but does not necessarily confine the bicyclist to a rigidly defined lane of travel.

Per AASHTO recommendations, shared lane markings should be used only on streets with lower traffic volumes and slower speeds. Shared lane markings are typically used only if other design options are infeasible.

Design Notes

Shared lane markings should be developed in accordance with the following design parameters:

Spacing - Shared lane markings should be placed immediately after intersections and spaced at intervals not greater than 250 feet thereafter (per AASHTO recommendations).

Lateral clearance - If used on a street with on-street parallel parking, shared lane markings should be placed so that the center of the markings is at least twelve feet (12') from the face of the curb or from the edge of the pavement.

Sharrows confirm a cyclists right to use the road without overly restricting operating space on narrow streets.

If used on a street without on-street parking that has an outside travel lane that is less than fourteen feet (14') wide, the centers of the shared lane markings should be at least five feet (5') from the face of the curb or from the edge of the pavement.

Application - Shared lane markings typically should not be placed on roadways that have a speed limit above 35 mph, and shall not be used on shoulders.

Sidewalks

Sidewalks provide walking connections from neighborhoods to area destinations such as parks, schools and businesses. Sidewalks are typically located within or parallel to a street right-of-way, and are intended for pedestrian use only (since pedestrians and bicyclists travel at different speeds and sidewalks are often too narrow to accommodate both users). While bicycle travel is explicitly prohibited on sidewalks in many communities, some create legal exceptions for minors.

Standard Design

Sidewalks in suburban or auto-urban areas should be constructed according to the standard criteria provided in Table A.2 or as required by each community's standards. Supporting narrative follows the table.

TABLE A.2 SIDEWALK DESIGN BASICS

Design Element	Criteria*
Sidewalk Width	5 feet (min.)
Lateral Clearance	4 - 10 feet (from edge of curb; 2 feet (from adjacent property)
Vertical Clearance	10 feet (preferred)
Pavement Type	Concrete
Pavement Thickness	4 inch (min.)

Please refer to the section entitled "Design Notes" for additional information regarding minimum criteria.

Design Notes

Sidewalks in suburban and auto-urban areas should be development with the following parameters in mind:

Placement - Sidewalks should always be placed a minimum of four feet (4') from the adjacent back of curb on suburban/neighborhood streets. Where feasible, an even greater separation approaching eight to ten feet (8' to 10') is preferred to provide an area for planting street trees which act as a protective buffer from adjacent vehicular traffic on the street. Sidewalks that abut the curb are only appropriate in urban areas where adjacent vehicular speeds are lower and amenities for human comfort are provided.

Sidewalk width - Along major streets, and along neighborhood streets that provide a direct connection to a school, neighborhood park, or access point to a trail, the recommended minimum width of sidewalks is six feet (6'). The six foot (6') width allows two adults to comfortably walk side-by-side. Within residential neighborhoods where less frequent walking or lower concentrations of pedestrian activity is anticipated, five foot (5') sidewalks may be used.

Standard sidewalk design suggests separation from the roadway by a planting strip.

Vertical clearance - A clear zone of at least ten feet (10') between the ground level of the sidewalk and any overhead branches or other obstructions is recommended.

Pavement type and thickness - Sidewalks should be built with concrete. The concrete should be reinforced with steel rebar. In new installations or areas where uplifting by tree roots is possible, a thicker pavement depth of six inches (6") is recommended to increase the durability of the sidewalk. Root barriers are also recommended where new trees are planted adjacent to sidewalks.

Tree preservation - When replacing sidewalks in areas with mature trees or trees in close proximity to the sidewalk, the health of those trees should be considered, and extraordinary actions may be needed. These may include acquiring additional right of way from adjacent properties, reducing the width of the sidewalk for a short distance, installing tree wells, creating small "bridges" over exposed roots, or using decomposed granite as an alternative walking surface near the trees.

Width of replacement walks - When replacing existing sidewalk segments, the new recommended sidewalk width of six feet (6') along major streets and five feet (5') for local streets should be used. Where the new sidewalk segment adjoins an existing segment of narrower width, a flared transition should be used to join both segments.

Urban sidewalks

Sidewalks constructed in pedestrian-friendly urban environments should incorporate distinctly different design elements than those standard elements presented in the Toolkit. Minimum widths may be greater than those recommended herein. Paved segments may extend to the curb. Planting strips may be replaced by intermittent planters. The guide Designing Walkable Urban Thoroughfares: A Context Sensitive Approach (2011) by the Institute of Transportation Engineers (ITE) and Congress for The New Urbanism (CNU) provides guidance for urban sidewalk design

Shared Use Paths (Trails)

Shared use paths are intended to be used by both bicyclists and pedestrians. In some areas, shared use paths are alternatively referred to as multi-use trails; but regardless, such facilities are commonly referred to by the layperson simply as "trails." Trails occupy corridors that are completely separated from streets, such as drainage channels, utility rights-of-way, greenbelt corridors, or areas within parks.

Standard Design

Shared use paths should be constructed according to the standard criteria provided in Table A.3. Supporting narrative follows the table.

TABLE A.3 SHARED USE PATH DESIGN BASICS

Design Element	Criteria*
Corridor Width	20 feet (min.)
Trail Width	10 feet (min.)
Lateral Clearance (Shoulder)	2 feet (each side)
Vertical Clearance	10 feet (preferred)
Grade	Less than 5 percent
Pavement Type	Concrete or asphalt
Pavement Thickness	Concrete: 4 inch (min.); Asphalt: 2 inch (min.)

Please refer to the section entitled "Design Notes" for additional information regarding minimum criteria.

Design Notes

Shared use paths should be developed with the following additional parameters in mind:

Corridor width - Corridor easement or right-of-way width should be at least 20 feet to allow for at least five feet (5') of clearance between adjacent features and the trail. The edge of the trail should be at least two feet (2') away from adjacent landscaping.

Path width - Since shared used paths are intended to be used as two-way facilities, a minimum width of ten feet (10') is recommended - although twelve feet (12') is preferred. In constrained locations or along routes where a low volume of bicycle traffic and few pedestrians are anticipated, a width of eight feet (8') can be used for short distances, but is generally not preferred.

Lateral clearance - Trails should be placed a minimum of five feet (5') from adjacent obstructions. A minimum shoulder or clear area of two feet (2') is required.

Vertical clearance - A clear zone of at least ten feet (10') is preferred. In limited conditions, a minimum distance of eight feet (8') may be considered, but should be marked to be seen at night.

Shared use paths may be marked to encourage uniform positioning and allow for two-way travel.

Grade – Trail gradients should generally not exceed five (5) percent; however, where the gradient must exceed five (5) percent for limited distances, AASHTO guidelines should be followed.

Pavement type - Concrete is preferred for its long term durability, and a well designed and built trail may last for decades. However, runners and many bicycle riders prefer the smoothness and slightly higher level of "give" of asphalt. Asphalt may be somewhat less expensive initially, but deteriorates over time. If asphalt is used instead of concrete, periodic resurfacing and repair will be required.

Decomposed granite may be considered in some instances, particularly within parks to provide an alternate surface type which is softer and preferred by runners. However, decomposed granite will require more frequent maintenance than concrete surfaces.

Pavement thickness - Shared use paths with a concrete surface should have a minimum pavement thickness of four inches (4") and be reinforced with steel rebar. The exact design may vary based on an evaluation of soil types and usage characteristics. Shared use paths with an asphalt surface should have a minimum thickness of two inches (2") of a type III asphalt surface course with an additional minimum four inches (4") of aggregate base.

In areas where impacts from nearby trees are anticipated, or where maintenance vehicles will use the trail, a thicker pavement depth is recommended to increase the durability of the trail. Where maintenance vehicles are anticipated to drive on the trail, deeper edge footings should also be considered.

Curvature - Curves in the trail should be gentle and should follow minimums established for the design speed. Guidance for the design of horizontal and vertical curves provided by AASHTO should be followed.

Trails at intersections and driveways - Each crossing should be carefully designed for safety. Crossings at intersections are preferred, and mid-block crossings are discouraged. Where mid-block crossings are considered, push button activated signals, flashing beacons or a High-Intensity Activated Crosswalk Beacon (known as a HAWK signal) should be included. Reductions in the amount of obstructions, landscaping or trees at intersections to increase the visibility of the bicycle riders may also be required.

Sidepaths

Sidepaths are essentially the same facility as a shared use path, but located adjacent to a roadway (and often within the street right-of-way). Unlike sidewalks, sidepaths are intended for use by both pedestrians and bicyclists, and are therefore wider than traditional sidewalks.

Standard Design

Sidepaths should be constructed according to the standard criteria provided in Table A.4. Supporting narrative follows the table.

TABLE A.4 SIDEPATH DESIGN BASICS

Design Element	Criteria*
Corridor Width	18 - 20 feet (min.)
Path Width	10 feet (min.)
Lateral Clearance	5 feet (from edge of curb) 2 feet (from adjacent property)
Vertical Clearance	10 feet (preferred)
Grade	Less than 5 percent
Pavement Type	Concrete
Pavement Thickness	4 inch (min.)

Please refer to the section entitled "Design Notes" for additional information regarding minimum criteria.

Design Notes

Sidepaths should be development with the following additional parameters in mind:

Corridor width - The overall corridor width should be at least 18 to 20 feet wide to allow for a minimum of five feet (5') of clearance between the street curb and the sidepath, and a minimum of two to four feet (2' to 4') between the facility and the adjacent property line.

Sidepath width - Since sidepaths are intended to be used as two-way facilities, a minimum width of ten feet (10') is preferred. In constrained locations or along routes where a low volume of bicycle traffic and few pedestrians are anticipated, a width of eight feet (8') can be used for shorter distances. In areas where a higher amount of both pedestrians and bicyclists are anticipated, a width of 12 feet should be considered.

Lateral clearance - Sidepaths should be placed a minimum of five feet (5') from the adjacent back of curb. Where feasible, a greater separation approaching eight to ten feet (8' to 10') is preferred to accommodate a planting strip. The sidepath edge should be at least two feet (2') away from adjacent trees or landscaping. A minimum of two feet (2') between the sidepath and any adjacent property line is recommended.

Sidepath and sidewalk design requirements should allow for route variability to incorporate natural features.

Vertical Clearance - A vertical clear zone of at least ten feet (10') is preferred. In limited conditions, an absolute minimum distance of eight feet (8') may be considered for short distances, but should be clearly marked so it can be seen at night.

Grade – Sidepath gradients should generally not exceed five (5) percent; however, where the gradient must exceed five (5) percent to maintain a running slope roughly consistent with the adjacent street, AASHTO guidelines should be followed.

Pavement type and thickness - The design of sidepaths is similar to that of sidewalks. The concrete should be reinforced with steel rebar and should have perpendicular jointing to control cracking. In areas where uplifting by tree roots or significant crossings by vehicles is anticipated, a thicker pavement depth of six inches (6") or greater, root barriers and additional steel or mesh reinforcement are recommended to increase the durability of the sidepath.

Curvature - Curves in the sidepath should be gentle and should follow minimums established for the design speed. Guidance for the design of horizontal and vertical curves provided by AASHTO should be followed.

Sidepaths at intersections and driveways - (See next page)

Replacing sidewalks

Where installing a sidepath in place of an existing sidewalk , an entire segment from block to block should be constructed at one time. It is always preferable to build an entirely new sidepath rather than adding to the width of an existing sidewalk, even if that existing sidewalk is new and in good condition. The new joint in the center of a widened sidepath can create uneven movement and become a future tripping hazard, and the overall longevity of the concrete can be compromised if not poured at the same time.

Sidepaths (Intersections and Driveways)

Sidepaths are preferred by many less experienced riders who desire facilities that are physically separated from motor vehicle traffic. These facilities are seen as a comfortable place to walk and ride on streets with high traffic volumes and speeds. To enhance the safety and comfort of facility users, streets upon which sidepaths are located or proposed should have few curb cuts for driveways or side street intersections.

Movements at intersections or driveways where motor vehicles are turning can be a concern since drivers may not anticipate bicyclists and pedestrians coming from either direction. Significant attention should be paid to the design of sidepath crossings of driveways, roadways or intersections.

Significant attention should be paid to the design of sidepath crossings of driveways, roadways or intersections.

Each crossing of a roadway or driveway by a sidepath should be carefully designed with each user in mind: pedestrians, bicyclists and motorists. The design should optimize the capabilities and comfort of each user while creating a safe environment. Designing the intersection so that motor vehicles must yield or stop for sidepath users allows bicyclists to maintain their kinetic energy, and therefore reduce energy expenditure when accelerating after stopping.

The following techniques serve to alert bicyclists and pedestrians of an upcoming intersection, and to alert motor vehicles that bicyclists and pedestrians may be traveling through the intersection or across a driveway.

- Create a curb extension or "bulb out" to increase visibility of crossing pedestrians and bicyclists and decrease time it takes for them to cross the road.
- Deviation of the sidepath or other devices near an intersection to stop the user at cross-streets.
- Signage and paint to alert the user to stop and look.
- Painted crossing areas, such as colored lanes.
- Additional signage to alert motorists to the presence of crossing pedestrians and bicyclists.
- Moving the vehicular stop bar location farther back from the intersection to allow for wider crossing areas.
- Reduction or removal of landscaping or trees near intersections to increase the visibility of users.
- At high volume intersections, give pedestrians and bicyclists their own crossing signal cycles apart from motor vehicles.
- At high volume intersections, give pedestrians and bicyclists their own crossing signal which functions independently/does not wait for traffic signals.

Walkways

Walkways are similar in function and design to a sidewalk, but are typically located outside of the street right-of-way. Walkways extend for short distances and provide access to trail networks, between streets, or between development parcels. Although intended principally for pedestrian use, walkway design anticipates limited volumes of bicycle traffic due to the "short-cuts" they provide between destinations.

Standard Design

Walkways should be constructed according to the standard criteria provided in Table A.5. Supporting narrative follows the table.

TABLE A.5 WALKWAY DESIGN BASICS

Design Element	Criteria*
Corridor Width	18 feet (min.)
Walkway Width	6 feet (min.)
Lateral Clearance	2 feet (each side)
Vertical Clearance	10 feet (preferred)
Grade	Less than 5 percent
Pavement Type	Concrete
Pavement Thickness	4 inch (min.)

Please refer to the section entitled "Design Notes" for additional information regarding minimum criteria.

Design Notes

Walkways should be development with the following additional parameters in mind:

Corridor width - Corridor easement or right-of-way width should be at least 18 feet to allow for six feet (6') of clearance between adjacent features and the trail. The edge of the walkway should be at least two feet (2') away from adjacent landscaping.

Walkway width - Although similar in form and function to a sidewalk, a minimum width of six feet (6') is recommended in order top accommodate limited volumes of use by bicyclists.

Lateral clearance - Walkways should be aligned with the center of the corridor easement to maintain a minimum of six feet (6') separation from adjacent property lines. A minimum shoulder or clear area of two feet (2') is required.

Vertical clearance - A clear zone of at least ten feet (10') is preferred. In limited conditions, a minimum distance of eight feet (8') may be considered, but should be marked to be seen at night.

Grade – Walkway gradients should generally not exceed five (5) percent; however, where the gradient must exceed five (5) percent for limited distances, AASHTO guidelines should be followed.

Walkways are intended to connect two points for short distances. When connecting two points over several hundred feet, or where a high percentage of bicycle traffic is expected, a shared use path may be a more appropriate facility.

Pavement type and thickness - The design of walkways is similar to that of sidewalks. The concrete should be reinforced with steel rebar and should have perpendicular jointing to control cracking. In areas where uplifting by tree roots or significant crossings by vehicles is anticipated, a thicker pavement depth of six inches (6") or greater, root barriers and additional steel or mesh reinforcement are recommended to increase the durability of the sidepath.

Curvature - Curves in the walkway should be gentle and should follow minimums established for the design speed. Guidance for the design of horizontal and vertical curves provided by AASHTO should be followed.

Trails at intersections and driveways - Each crossing should be carefully designed for safety. Crossings at intersections are preferred, and mid-block crossings are discouraged. Where mid-block crossings are considered on high volume streets, push button activated signals, flashing beacons or a High-Intensity Activated Crosswalk Beacon (known as a HAWK signal) should be included. Mid-block crossings on low volume streets may be accompanies by traffic calming features, or signage and/or pavement markings of lower impact and cost. Reductions in the amount of obstructions, landscaping or trees at intersections to increase the visibility of the bicycle riders may also be required.

Active Transportation Facility Costs

General active transportation facility cost estimates are presented in **Table A.6**. These cost estimates for the facilities presented on pages A-5 through A-14 were calculated on a per linear foot basis. Costs also include an additional allowance for: **A)** Surveying; **B)** Design; and, **C)** Associated construction administration.

These costs represent a general pre-design cost projection, and are developed at an "order of magnitude" or master planning level. These estimates should be treated as a starting point for establishing budgets and identifying funding sources. Ultimate costs will vary from those presented in **Table A.6** based on more detailed case-by-case assessments.

In considering local budget estimates Alamo Area MPO communities must also consider the following:

- **Right-of-way acquisition.** No allowance for right of way acquisition is included in these typical costs. Costs shown are in 2015 dollars and do not include an escalation factor since precise construction dates have not been established. When a time frame for development is established by a community, escalation factors should be added and should be based on actual construction costs at the time and recent inflation trends.
- **Network support facilities.** Bridge costs should be added where a bridge is determined to be needed. Additional amenities such as benches and trail signage are not included. Also, other extraordinary features, such as trail lighting or extensive landscaping are not included but can be added on a case by case basis where appropriate.

TABLE A.6 ACTIVE TRANSPORTATION FACILITY COST RANGES

Facility Type	Details	Potential Cost Range
Bicycle lane	Lane striping, pavement markings, both directions	$50,000 to $55,000 per mile
Buffered bicycle lane	Buffer zone striping, pavement markings, both directions	$70,000 to $75,000 per mile
Protected bicycle lane	Barrier curb, pavement markings, one direction	$150,000 to $300,000 per mile
Shared lane marking	Pavement markings, both directions	$15,000 to $25,000 per mile
Sidewalk		
Shared use path (Trail)	10 foot wide, concrete	$750,000 to $1,000,000 + per mile
Sidepath	10 foot wide, concrete	$600,000 to $900,000 per mile
Walkway		
Route signage*	*Should be placed every 250 linear feet +/-*	*$5,000 to $15,000 per mile*
Lane diet*	*Reduce lane widths to add bicycle facility*	*$75,000 to $150,000 per mile*
Road diet*	*Remove travel lane to add bicycle facility*	*$75,000 to $150,000 per mile*

*Methods of integrating on-street bicycle facilities into existing street segments.

Active Transportation Design Challenges

Identifying the appropriate type of bicycle or pedestrian facility for a particular location (or to accommodate specific user groups) represents only a small part of the challenge of building an active transportation network. The facility must be integrated into the community's overall transportation system – and in such a way that potential conflicts with motor vehicles are reduced. This may often require incorporating a bicycle or pedestrian facility into an existing street right-of-way. The principles presented in this section assist in anticipating and recognizing potential challenges to active transportation facility design.

Bicycle and Pedestrian-Friendly Streets

Neighborhood streets can and should be great places to walk or ride a bike. Such streets are often characterized by low traffic volumes and speeds at or under 30 miles per hour. As such, many should be excellent places to walk or ride a bicycle. Unfortunately, many streets in the older neighborhoods of Alamo Area MPO communities are narrow, have significant on-street parking, and lack continuous sidewalks. Many also rely on traffic calming measures to slow vehicular speeds.

Traffic Calming and Bicycle Boulevards

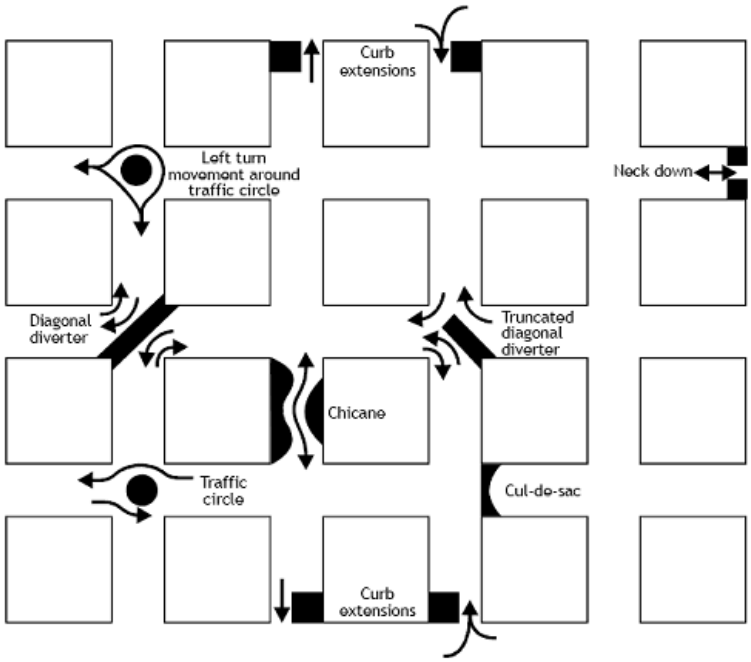
Communities install traffic calming devices on public streets to reduce motorized vehicle speeds, improve the environment and livability of a surrounding property, and provide real and perceived safety improvements for pedestrians and bicyclists. Traffic calming devices that are used by many Texas cities include: speed humps or "cushions," traffic circles, chicanes, semi-diverters, and curb extension - as well as other devices identified by the Federal Highway Administration (FHWA). One or more of these treatments might be considered on neighborhood streets to create specific bicycle friendly corridors.

Intersection Considerations

Intersections, driveways and roadway crossings are locations with the highest potential for interaction between motorized vehicles, bicyclists, and pedestrians. Enhancing crossing locations is particularly important for bicyclists on sidepaths or shared use trails. Both types of shared use facilities favor continued momentum, and since stopping requires additional effort to get moving again, bicyclists may be tempted to disobey traffic signals and signs.

Each crossing location requires its own specific design to take into account unique conditions of the area. Note that improvement requirements at each intersection should be developed as each facility is designed and implemented. The following techniques represent some of the "tools" that can be used to improve crossings.

- **Highly visible crosswalk markings.** Ladder style crosswalks have been shown to be more visible to approaching vehicles than a more typical double striped line crosswalk.
- **Median refuge.** On wider streets that take longer to cross on foot, a refuge provides a protected mid-crossing location. These are installed as part of curbed medians.



Traffic calming devices (above right) are intended to control motor vehicle volumes and/or speed. Facility selection can have an equally positive or negative effect on bicycle travel. Source: FHWA, 2006, p. 235

Sidepaths and Public Perceptions

In providing for enhanced bicycle mobility along streets, many Texas communities have opted to construct a system of sidepaths. The separated nature of sidepaths is often viewed as the best way to increase bicyclist safety. Sidepaths may also be viewed as an extension of a community's off-street shared use path network - a system often constructed to meet recreational rather than transportation objectives.

The presence of a sidepath adjacent to a street does not negate a bicyclist's right to travel within the roadway (as provided in Chapter 551 of the Texas Transportation Code). Nonetheless, installation of sidepaths - instead of facilities integrated with motor vehicle travel lanes (such as bike lanes) - can create mixed signals for both motorists and bicyclists. Motorists may feel that the bicyclist has no right to share the travel lane when a sidepath is available. In contrast, bicyclists might have difficulty adhering to the operational requirements of the Texas Transportation Code when relegated to a facility shared with pedestrians.

Sidepath design should promote bicycle thru-traffic to maintain bicyclists' rights and operational responsibilities.

For sidepaths to serve as a more effective transportation facility, design characteristics must promote unimpeded bicycle travel at driveways; and, bicycle signalization that corresponds with motor vehicle traffic signals.

- **Raised crosswalks.** Typically used at mid-block crossing locations, raised crosswalks can enhance the visibility of pedestrians crossing a street and also help slow vehicle speeds when approaching the crossing.
- **Pedestrian crosswalk signals.** At intersections, timed pedestrian crosswalk signals help guide pedestrians crossing the street.
- **Painted or paver crosswalks.** In areas with a high volume of turning vehicles, enhancement of the crossing area through the use of paint or highly visible pavers should be considered. In particular, this can be effective where sidepaths cross driveways into private businesses.
- **Access management.** Reducing the number of driveways or access points may help reduce the number of conflict points along on-street and off-street facilities. Amendments to local land development regulations may be necessary.
- **Prohibit right turn on red.** At intersections with a higher frequency of pedestrian crossings - and where traffic volumes permit - a right turn on red may be prohibited to enhance pedestrian safety.
- **Sidepath or trail "deviators" to slow users at intersections.** The path deviates to focus the pedestrian's line of sight on approaching traffic, and to reduce the bicyclist's speed.
- **Pedestrian crossing warning signs.** Additional warning signs that follow the Manual on Uniform Traffic Control Devices (MUTCD) may be appropriate to further alert motorists to the presence of pedestrians or bicyclists.
- **Curb extensions.** At intersections, an outward extension of the pedestrian area may be installed to reduce the crossing distance to the opposite curb. These extensions also help reduce the speeds of motorized vehicles travelling through the intersection.
- **Reducing turning radii at intersections.** Smaller turning radii at intersections can reduce the speed of vehicles turning right at intersections, increasing reaction times and creating safer crossings for pedestrians.

- **Enhanced visibility by relocating landscaping or signs.** Landscaping, signs and in some cases trees may be relocated or adjusted to increase visibility.
- **Enhanced painted symbols at intersection crossings.** Additional dashed bicycle lane striping and bicycle symbols may be used across intersections to guide bicycles and to further alert motorists as to the direction of bicycle traffic.

The use of bright markings, textured surfaces, and curb extensions - individually, or combined (above) - can enhance pedestrian safety at intersections. Similar treatments have gained acceptance where necessary to improve bicyclist safety (below).

- **Transition from on-street to off-street facility.** In some instances, an on-street bicycle lane may need to transition to an off-street sidepath or shared use path.
- **Green Lanes.** Green painted bicycle lanes can be used to mark bicycle lanes or mark the extension of a bicycle lane through intersections and other traffic conflict areas.

It is important to note that new technology and best practices related to bicycle and pedestrian facility design are evolving at a rapid pace. Communities referencing this Toolkit should continue to monitor advances in best practices and incorporate where appropriate in the future.

Grade Separated Crossings

Convenience is essential in designing and locating overpasses and underpasses. Pedestrians and bicyclists will seldom use a poorly located crossing. Grade separated facilities for bicyclists and pedestrians should be considered under the following conditions:

- Where channels that may convey periodic floodwaters and can create a hazardous condition occur.
- Where grade separation could create a route that avoids having to cross roads or railroads with high levels of vehicular or rail traffic.

Bridges

Pedestrian bridges are needed to cross barriers such as drainage channels in various locations. Pre-fabricated bridges can span distances ranging from 100 feet to over 250 feet. Enhancements, such as decorative railings or upscale pedestrian lighting, should be included to fit the context of the area around the bridge.

From a user's perspective, bridges should preferably be the width of the pathway, plus an additional two feet (2') of clearance area on each side. At a minimum, bridge widths should be 12 feet (12') wide for an eight foot (8') shared use path.

Any bridge that is specifically designated for bicycle traffic must incorporate appropriate railings for bicyclists. Texas has adopted the AASHTO's Bridge Design Specifications requirement that bridge railings designated for bicycle traffic should be a minimum of 54 inches high with the

same restrictions on openings as for pedestrian railings. Pedestrian railing openings between horizontal or vertical members must be small enough that a 4-inch sphere cannot pass through them in the lower 27 inches. For the portion of pedestrian railing that is higher than 27 inches, openings may be spaced such that an 8-inch sphere cannot pass through them. Decking material should be firm and stable. Bridge approaches and span should not exceed five percent (5%) slope for ADA access. Pedestrian bridges should be designed to accommodate the weight of maintenance vehicles. The bottom span

Bicycle and pedestrian bridge design should adhere to AASHTO's Bridge Design Specifications, and should not reduce the width of the traveled way.

should be at an elevation above the 100-year floodplain, and the bridge should not constrict the floodway. Footings should be located on the outside of the stream channel at the top of the stream bank. All bridges and footings in the stream corridor will need to be designed by a registered geotechnical or structural engineer. Cost, design and environmental compatibility will dictate which structure type is best for the shared use path corridor.

Underpasses

Underpasses can provide a more direct route by crossing under instead of around a busy street or railroad. From the standpoint of a user, underpasses should be well lit, attractive, and project a sense of security. The exit should be visible from the entrance area. A minimum height clearance of ten feet (10') is recommended. If enclosed, the underpass width should be at least 14 feet in width, and in some cases wider if the underpass exceeds 100 feet in length. If enclosed, gravity or pump systems to remove storm drainage should be provided.

New or reconstructed vehicular bridges over key sidepath or shared use path corridors should be considered as possible candidates for an underpass. In some cases, this may mean elevating the roadway higher than otherwise necessary, but the added convenience to pedestrians and bicyclists may increase the use of the active transportation corridor.

Underpasses may be incorporated into new street construction projects (above). Existing bridges may also be candidates for underpasses (below).

Railroad Crossings

Pedestrian and bicycle enhancements at railroad crossings include the following:

- **Location of pedestrian facility.** When a pedestrian facility crosses railroad tracks, the facility should be located outside of the railroad gate arms that block vehicles in the roadway, since the gate arms are counter-weighted and can be manually raised by pedestrians if they passed under the gate.
- **Cross at a perpendicular angle to the tracks.** To reduce the potential for narrow bicycle or stroller wheels getting caught in the tracks, sidepaths and sidewalks crossing the tracks should do so at a 90 degree angle.
- **Concrete planking.** Concrete planking that meets the rail line owner's specifications should be installed. The planking for the road and the pedestrian facility should be continuous, which allows for better drainage and prevents debris buildup that would occur in a "gap" between roadway and pedestrian planking.
- **Separate pedestrian crossing arms or gates.** Consideration could be given to installing separate pedestrian barrier gates or arms. Triggered to close when a train is approaching, these may be appropriate at a double track condition. However, a separate gate at sidewalks or sidepaths is generally unnecessary since pedestrians and bicyclists can go around the gates fairly easily.
- **Pedestrian level signals.** Visual signals such as flashers specifically designed to alert pedestrians should be considered. These enhance safety for users who are hearing is impaired, such as the deaf or individuals who are listening to headphones. Warning signs should be installed that direct pedestrians and other sidepath users to look both ways before crossing the tracks.

A combination of these treatments as well as others designed for a specific location may be considered. Each individual crossing should be separately designed to take into account the unique constraints of the area.

Properly designed railroad crossing approaches and surfaces (above) may be further improved by bicycle and pedestrian-specific signalization or gates.

Network Support Facilities

Communities wishing to promote their active transportation networks as viable additions to otherwise automobile-exclusive systems recognize that it is necessary to augment sidewalks, bicycle lanes, and trails with accessory facilities. Paths and routes to connect various destinations are not enough. Other key facility needs include:

- End of trip facilities (such as short term and long term secure bicycle parking, equipment storage, and changing facilities);
- Wayfinding improvements;
- Lighting; and,
- Trailhead enhancements.

Recommendations for each of these areas are discussed in this section, as well as strategies as to how to implement and fund these components.

End of Trip Facilities

Recreation trips on a bicycle may be relatively short in duration - beginning and ending at a place of residence. For purposeful trips such as commuting to work or school or trips to specific destinations such as the downtown area or even a local park, end of trip facilities are critical. End-of-trip facilities include:

Bicycle Parking

- **Short term bicycle parking.** Readily available and secure bicycle parking is a key requirement to building a community-wide bicycle network. Bicycles are easy to steal, and whatever the cost of a rider's bicycle, residents who ride regularly want to be sure that they have a secure place to lock up their bicycle. The key is that bicycle racks become available in visible locations.

  The preferred bicycle parking facility today allows both wheels or a minimum of two points on a bicycle to be secured. A variety of different styles are available, and Alamo Area MPO communities should adopt a standard model. Ease of use, appearance (i.e. modern vs. traditional), cost and durability should be considered. Many cities have adopted an inexpensive upside down "U" shaped rack that can be installed individually or in multiples. In some areas, bicycle racks that double as public art can be considered.

  Bicycle parking should always be highly visible and placed near the main entrance to the destination. The message by placing the bicycle parking in that location is that bicycle riding to this destination is encouraged and rewarded by being near the main entrance. Also, bicycle parking should be designed to allow for maneuvering space and adequate clearance from nearby walls or obstructions. On a case by case basis, signage directing bicyclists to where bicycle parking is located may also be necessary.

- **Longer term bicycle storage or secured parking.** In some locations, such as at businesses where bicycle commuting is encouraged or where bicycles will be left for an entire day or even overnight, more secure bicycle parking may be desired. The availability of a secure storage locker for a relatively expensive bicycle can be a determining factor for whether a commuter chooses to bicycle to work or not. Areas such as corners where cars cannot park can readily be adapted to hold bicycle lockers. Other locations include adjacent to buildings or in internal working areas. The type of bicycle locker chosen should be coordinated with law enforcement to alleviate concerns about the placement of dangerous items such as explosives in places where they cannot be seen or readily retrieved, and mesh enclosures may be preferred.

For new development, land development codes in each area community should be amended to require the inclusion of bicycle parking spaces. Bicycle parking should be in a visible location near the building's primary entrance(s) or along the length of a facade in developments with multiple tenants (such as a linear shopping center). In parking structures, some provision for bicycle parking spaces within the structure should be included. In an existing parking garage, this is often accomplished by re-striping one or two vehicle parking spaces and replacing them with bicycle racks.

In areas with a higher development density such as a downtown area, consideration may be given to reducing the number of vehicular parking spaces in exchange for widely increased bicycle parking.

To "jump start" the availability of bicycle parking at

existing destinations, many cities have allocated funds to purchase bulk quantities of bicycle racks and then sell them at cost to existing businesses and property owners.

Bike parking requirements may also be applied to businesses that remodel. Many cities establish a redevelopment threshold to ensure that this provision is reasonably applied (for example for remodeling that exceeds $25,000 to $50,000 in value). The availability of at-cost racks also makes it easier for existing property owners to install racks.

Changing Facilities and Showers

To encourage greater use of bicycles for transportation to schools and work, Alamo Area MPO communities may explore ways to encourage destinations to provide facilities in which to clean up after a bicycle trip. These facilities can also serve fitness-minded employees who choose to ride, walk or run for exercise during lunch or breaks. Methods used by public agencies and private developments to incorporate showers and changing facilities include the following:

- **Incentives as part of the development code.** Many cities are exploring incentives to encourage developments and businesses to provide changing facilities. These include reducing the number of parking spaces, providing extra development bonuses such as higher building densities, or in some cases by requiring the provision of these facilities for buildings that exceed a certain threshold.
- **Incentives for existing businesses.** Area businesses that pro-actively install changing facilities can be given recognition by each community or even supported through a city grant program that provides small matching grants to businesses that are considering adding changing facilities.
- **Developing "bike stations" that provide changing facilities.** As bicycle ridership increases, bike stations can be developed in key locations. These are commonly developed in high density locations such as downtown areas, and provide bicycle storage, changing facilities, snacks, sales of equipment, and even maintenance services and bicycle rentals. In many cases, these are operated by a private or non-profit entity. As new bike lanes leading into the downtown areas are developed, communities should consider promoting a central bike station at some level in the downtown area.

Equipment Storage

Lockers or storage areas for helmets, baskets, bags and other equipment may be needed at schools or in places where employees do not have access to individual spaces. Each community can help provide information to businesses, schools and other entities as to the need for equipment storage areas.

Wayfinding Improvements

Wayfinding helps pedestrians and bicycle riders find their way around the City, and typically consists of signs, pavement markings, or materials such as maps. Route or destination signage can help bicyclists navigate throughout a city when the bicycle route deviates from one street to another.

Use of gateway features and signs to make the bicycle and pedestrian network more visible - Wayfinding signs should also serve to "brand" each community's growing network of pathways and on-street bicycle facilities. Each city should create a design that provides an attractive and uniform system of signs and gateway markers throughout the community and at key access points to the pedestrian and bicycle to celebrate it and promote use of the system.

At a neighborhood level, route signs can be used to guide residents to routes that lead out of the neighborhood. Wayfinding signs should follow standard Manual of Uniform Traffic Control Devices (MUTCD) designs. Also, custom pavement markings to enhance wayfinding can be used, such as the "bike dot" pioneered by the City of Seattle.

Lighting along Trails and Paths

Many pedestrian and bicycle facilities may be used in the evening hours. Communities should welcome evening use, and an adequate amount of lighting should be factored into the design of each facility. Key citywide routes or facilities in areas with demonstrated evening use should receive enhanced lighting first. Lighting fixtures should be consistent with other light fixtures in the City, possibly emulating a historic theme on some

trails.

AASHTO guidelines call for general lighting levels between 0.5 and 2.0 footcandles, but specific levels should be set for each location. Higher lighting levels may be appropriate in some locations to enhance personal safety. Pedestrian-scale lighting may be appropriate along some streets where higher levels of nighttime use are anticipated. Individual lighting measurements and field observation should be conducted to determine where these lighting treatments are needed. Increased lighting should also be considered at intersections where shared use paths and sidepaths cross roadways to increase the visibility of users of those facilities.

Trailheads and Other Trail Amenities

Trailheads should be developed at key locations in each community. Two types of trailheads are recommended.

Type A - Simple Gateway Trailhead - At the neighborhood level, simple trailheads should include features that indicate an entrance to the trail area, along with a map that shows where the trail goes. A simple trailhead can also include benches and occasionally a small shade structure. They can be installed after the trail itself is built, and could be sponsored by local businesses and entities.

Type B - Major Trailheads - At key locations, more elaborate trailheads are recommended. These should serve as destination points where residents can access trails from further away. In addition to gateway features, benches, maps and shade structures, Type B trailheads should also include parking areas for 10 to 20 trail users.

Trailheads should be placed at the start or terminus of a trail, at intersections with other trails, or at key access points from area neighborhoods. Access points to area neighborhoods along each trail should be as frequent as possible, ranging from as little as 1/8th of a mile apart for neighborhood trails, and typically no more than a 1/4 mile to a 1/2 mile for all other trail types.

Other Trail Features

Benches at key rest areas and viewpoints encourages people of all ages to use the trail by ensuring that they have a place to rest along the way. Benches can be simple (e.g. wood slats) or more ornate (e.g. stone, wrought iron, concrete).

Milepost markers can increase use of the trail by joggers and cyclists looking for set workout distances. Milepost marker signage should be consistent with other trail signage. 1/4 mile and 1/2 mile increments can be used to add further interest.

Trash cans and dog waste pickup bag dispensers should be included at trailheads and key neighborhood access points along the route. Signs should be placed periodically along the trail notifying dog owners to pick up after their dogs.

Restrooms can be included where available in parks or at major trailheads. Restroom locations should be coordinated with park locations and the Parks & Recreation Department in each community.

Art Installations can be commissioned by local artists to provide art for key locations along major trails to give each a unique character. Many trail art installations are functional as well as aesthetic, as they can provide places on which to sit and play.