DESIGN GUIDANCE

Prioritized Statewide
BICYCLE NETWORK PLAN

DESIGN GUIDANCE

1. INTRODUCTION

This document presents context sensitive guidance for the selection and maintenance of bikeway infrastructure along roadway facilities owned and maintained by NMDOT. The design guidance serves as a key implementation component of the NM Bike Plan and fulfills two of the goals contained in the New Mexico 2040 Plan, NMDOT's statewide long-range multimodal transportation plan: (1) to improve safety for all system users, including bicyclists, and (2) to provide multimodal access and connectivity for community prosperity. The design guidance for the NM Bike Plan is organized by priority tier and by roadway context, and generally applies to on-street bikeway facilities.

The document is organized according to the following outline:

- Section 2: Introduction to the Prioritized Statewide Bicycle Network, which is divided into three tiers of routes
- Section 3: Introduction to the types of riders and bicycling contexts that influence bikeway design decisions
- Section 4: Priority tier definitions and desired bikeway infrastructure, based on the tier and the context of a particular roadway
- Section 5: Detailed bikeway design techniques and maintenance guidance, applicable to all tiers and roadway contexts
- Section 6: List of the benefits of dedicated bikeways to other roadway users
- Section 7: National and state design references that form the basis for the design guidance contained in the NM Bike Plan

2. PRIORITIZED STATEWIDE BICYCLE NETWORK

2.1 Tier Definitions

A primary objective of the NM Bike Plan is to categorize NM highways into tiers, reflective of current and potential demand for bicycling. The purpose of this categorization is to ensure that NMDOT's limited resources are used most effectively to improve bicycling conditions where improvements are needed the most, and with the goal of creating a connected, statewide network.

Priority tier designations were developed based on technical analysis and input from public agencies, technical committees, and the general public through the Plan outreach process. The tier designations do not indicate the order in which NM highways may be improved for bicyclists, but rather, indicate the benefits derived from improving conditions for existing and

potential bicyclists. For rural highways a Tier 1 designation indicates that a more robust level of infrastructure is desired than a Tier 2 facility. For urban highways, a Tier 1 facilities designation indicates the greatest regional benefit as a bicycling route among NMDOT facilities.

ROADWAY RETROFIT

A **roadway retrofit**, for the purposes of this plan, is defined as making modifications to the roadway's cross-section, without altering the overall width of the road. These changes typically occur during routine operations and maintenance activities, such as during pavement resurfacing. Implementing bikeway improvements during resurfacing is a cost-effective method to improve roadways to better accommodate bicyclists. This method is described in more detail in Section 5.3.

2.2 Tier I Routes – High Priority for Bikeways

Definition

Tier I routes are high priority for bikeways as they provide critical intra-urban and statewide connections between New Mexico's communities and for cross-state travel. Tier 1 routes exhibit high existing or latent demand for bicycling, and are highly appropriate for implementation of bicycle facilities. These facilities may appeal to recreational *and* utilitarian cyclists and demonstrate high tourism potential and recreational demand. Tier 1 routes are typically high-volume and/or high-speed roadways where additional separation between cyclists and motorists is desired.

Implementation Guidance

Dedicated bikeway facilities should be provided to the greatest extent possible on these roadways. NMDOT or local communities (in coordination with NMDOT) may choose to reconstruct a roadway specifically to improve the bicycling experience along the corridor, or make improvements during scheduled reconstruction activities. Additionally, as part of routine maintenance, the NMDOT District may explore opportunities to retrofit roadways to incorporate bicycle facilities.

If the right-of-way along the corridor is constrained, designers should consult the design interventions for constrained corridors (see section 5.4). An alternative route may also be identified where a dedicated bikeway facility or low-stress bikeway could be installed. For these alternative routes, coordination with local jurisdictions may be required.

2.3 Tier 2 Routes – Medium Priority for Bikeways

a) **Definition**

Tier 2 routes are medium priority for bikeways as they exhibit existing or latent demand for bicycling and are appropriate for the implementation of bicycle facilities. Tier 2 routes typically provide long-distance or statewide connections and may appeal to recreational and/or more confident utilitarian cyclists. Alternative routes to Interstates are typically designated as Tier 2 facilities.

Implementation Guidance

If the roadway is scheduled for reconstruction, dedicated bikeway facilities should be provided to the greatest extent possible on these roadways. Tier 2 routes may be considered for proactive retrofit or reconstruction projects that specifically improve bicycling conditions on a case-by-case basis. Additionally, as part of routine maintenance, NMDOT Districts are encouraged to explore opportunities to retrofit roadways to incorporate bicycle facilities.

2.4 Tier 2 Basic

a) **Definition**

Among the Tier 2 routes is a special category of roadways, referred to as *Tier 2 Basic* facilities, where some level of increased motorist awareness and additional bicycle treatment is desired, but where bikeway improvement opportunities across the length of the corridor are limited due to right-of-way constraints, environmental considerations, and/or challenging topography.

Tier 2 Basic routes include important bicycle connections and/or popular bicycling routes. Other common Tier 2 Basic roadways are spur routes (i.e. roads that dead end and do not connect to other roads) that have been identified as popular and desirable bicycling routes, particularly in mountainous areas and through federal lands in New Mexico.

TIER 2 versus TIER 2 BASIC

The designation of a route as Tier 2 Basic indicates that NMDOT considers physical improvements to be impractical or cost-ineffective. Widening of these roadway and shoulder bikeways or bike lanes should not be expected.

This guidance contrasts with Tier 2 corridors with constrained sections, where shoulder bikeways or bike lanes should be introduced wherever space allows.

Tier 2 Basic facilities generally feature low traffic volumes (e.g. less than 1,000 vehicles per day) that are not a high priority for roadway expansion in the form of widened shoulders. Tier 2 Basic designations may also apply to roadways where additional infrastructure is not necessary or financially feasible due to high construction or right-of-way acquisition costs.

Implementation Guidance

For Tier 2 Basic facilities, the guidance for Constrained Corridors, discussed in Section 5.4, should be followed. Design features for Tier 2 Basic facilities may be installed during routine maintenance and/or reconstruction activities.

2.5 Tier 3 Routes – Low Priority for Bikeways

Definition

Tier 3 routes include NM highways with little to no existing or latent demand for bicycling. Tier 3 routes do not provide critical statewide connections, and the provision of bikeway facilities is not likely to increase demand for bicycling. Bicyclists may travel along Tier 3 routes, but should not expect bicycle-specific infrastructure or signage to be introduced. Many Tier 3

routes in rural areas have low daily traffic volumes and conditions may be suitable for some cyclists.

Implementation Guidance

Nothing in this plan precludes NMDOT from adding bicycle facilities or signage if it is justified through a corridor study or other process. However, investing in these roadways specifically to improve bicycling conditions is likely not the best use of limited NMDOT resources. Bikeway improvements on these roadways during reconstruction or maintenance projects is a low priority.

3. TYPES OF BICYCLISTS AND ROADWAY CONTEXTS

3.1 Introduction

Bicyclists can be grouped into two broad categories: **utilitarian** and **recreational bicyclists.** Utilitarian bicyclists ride to complete destination-oriented trips, while recreational bicyclists ride for fitness and the enjoyment of bicycling. These categories of bicyclists have different design needs due to their level of experience bicycling. Land use is the primary determinant of where these bicyclists are most likely to be found; research suggests utilitarian trips are concentrated in urban areas, while the majority of trips in rural areas are made by recreational bicyclists.[1] The design guidance reflects the type of bicyclists that are most likely to ride in different contexts.

It is important to note that the definitions for utilitarian and recreational riders exist on a continuum. Utilitarian riders can also be recreational riders, and some recreational riders may be less experienced bicyclists. These general definitions are intended to capture the primary types of bicyclists that are expected to be riding on NM highways in different contexts, and the categories provide a useful planning tool to guide the selection of bikeway improvements in different areas of the state.

INTENDED USERS: URBAN VERSUS RURAL BIKEWAYS

Roads in urban areas where utilitarian trips are concentrated should be designed to be comfortable for a range of bicyclists, including novice riders.

Rural roadway facilities are generally designed with recreational riders as intended users.

3.2 Utilitarian Bicyclists

Utilitarian bicyclists are defined as **those who use a bicycle to reach a particular destination**, such as work, a business, or a park. Utilitarian trips are primarily concentrated

[1] The Oregon Dept. of Transportation, Colorado Department of Transportation and Vermont Transportation Agency have all developed methodologies to assess the level of comfort of roadway networks in urban and rural areas of the states. These assessments are sensitive to rider type: novice riders are expected to bicycle in urban areas, while more experienced riders are most expected to bicycle along rural roadways.

in urban areas, including suburban and small village/town centers, where destinations are grouped more closely together, and where the distance between a person's origin and destination is relatively close. Most utilitarian bicycle trips are less than 2.5 miles on average.[2]

Utilitarian bicyclists represent a range of age and skill levels. In urban contexts, bicycling constitutes a relatively convenient form of transportation to complete short trips; research also suggests that a significant portion of the population would consider bicycling if dedicated bicycle facilities were provided.[3] Cities across the country offer proof of this hypothesis: as the total mileage of dedicated bicycle facilities in urban areas increases across the United States, the percentage of people who bicycle for all types of trips has increased as well.[4] Best practices suggest that roads in urban areas where utilitarian trips are concentrated should be designed to be comfortable for a range of users, including novice bicyclists. To support bicycling activity by a broad range of users, in urban areas, bikeway facilities should provide a high-level of comfort in all roadway contexts. Greater spatial separation from motor vehicles should be provided as speeds and volumes increase, with physical separation desirable on higher-speed/higher-volume roadways.

3.3 Recreational Bicyclists

In rural areas, destinations are more spread out and population density is much lower. As a result, rural roads attract primarily recreational bicyclists. Recreational bicyclists are defined as **those who ride long distances for exercise, training, and/or general enjoyment**. Recreational bicyclists are confident riders that travel long distances, and who tend to have a higher tolerance for stress when riding adjacent to motor vehicle traffic.[5] Shoulders on rural roadways typically provide sufficient accommodation for recreational bicyclists. Best practices suggest that the shoulder width should increase as speeds and volumes of the roadway increase.[6]

[2] When examining fiftieth percentile trip distances from the 2009 National Household Travel Survey for bicycle trips, bicyclists, on average, traveled 1 mile to 2.5 miles to reach destinations. Bicyclists travel the furthest to reach work destinations, or 2.5 miles on average.
[3] Four Types of Cyclists? Test a Typology to Better Understand Bicycling Behavior and Potential. 2012. http://web.pdx.edu/~jdill/Types_of_Cyclists_PSUWorkingPaper.pdf
[4] Bicycle Commuting and Facilities in Major U.S. Cities: If you Build Them, Commuters Will Use Them. Transportation Research Record, Volume 2587, 2014
[5] Strava is a GPS based mobile application that bicyclists can use to record their trips. It is important to note that the user of this application tends to be heavily skewed towards recreational bicyclists. In 2014, the average trip length of a Strava user in the UK was 23.3 miles per trip, significantly longer than the NHTS average trip lengths for utilitarian trips. Source: Strava (https://roadcyclinguk.com/sportive/strava-2014-year-numbers.html)
[6] AASHTO Guide for the Development of Bicycle Facilities, 2012 Paved Shoulders (4-7)

4. ROADWAY CONTEXT AND DESIGN GUIDANCE BY TIER

4.1 Introduction

Selecting the best facility type for a given roadway can be challenging, due to the range of factors that influence user comfort and safety, as well as the expected level of bicycle and vehicle traffic along a given roadway segment. In some cases, there is no single correct facility, and the selection of an appropriate bikeway improvement must balance traffic conditions, land use context, and implementation cost. To simplify the selection of a design treatment, this guide refers to roadway tier, established through the NM Bike Plan and the roadway's context (urban vs. rural). The designer is to use these factors as a guide to select the appropriate design treatment(s). The process for facility selection is illustrated in Figure 1: Bikeway Improvement Selection Guide.

4.2 Determining Roadway Context: Urban versus Rural

The bicycle-related design guidance that should be applied varies depending on whether the NM highway segment in question is located within an urban or rural context. **Urban design guidance** applies to the following situations:

- Roadways within the four designated metropolitan planning areas, plus the portion of the El Paso (TX) metropolitan planning area located in southern New Mexico
- Roadways located within incorporated municipal limits
- Other locations at the discretion of the NMDOT District Engineer

Rural design guidance should be applied to all NM highway segments outside of the locations described above. Designers may use discretion as to whether urban or rural design guidance should be applied on NMDOT facilities within small incorporated communities (i.e. less than 1,000 residents) with low traffic volumes (i.e. less than 2,000 vehicles per day).

LOOKING AHEAD

Roadway context information and guidance by tier are complemented by more detailed information on design techniques and their general applicability. The guidance provided in Sections 4 and 5 should be used in combination to determine appropriate design treatments and solutions by location.

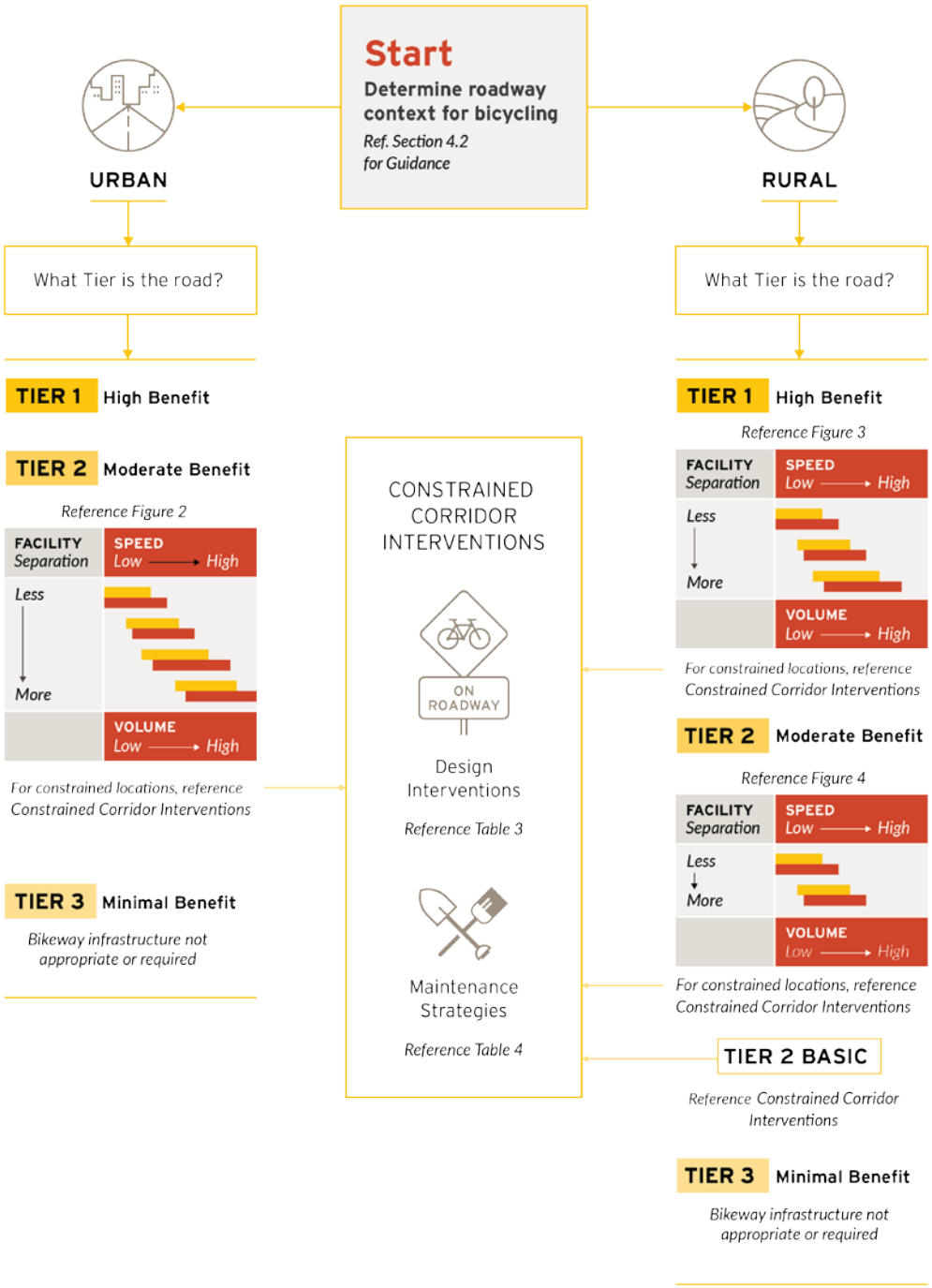
Table 1 summarizes the type of design guidance that should be applied based on the tier designation and the roadway context. See the following sections for additional guidance on bikeway improvement treatments by location.

TABLE 1 | Bikeway Infrastructure Guidance by Tier and Context

Context	Tier	Preferred Infrastructure
Urban	1	Bikeway facility design in urban areas is based on the roadway conditions and context rather than the priority tier. The priority tier indicates the level of benefit associated with the bicycle infrastructure. See Figure 2.
	2	
	3	Bikeway infrastructure not appropriate or required.
Rural	1	High level of dedicated infrastructure. See Figure 3.
	2	Medium level of bicycle infrastructure. See Figure 4.
	3	Bikeway infrastructure not appropriate or required.

Figure 1 provides a flow-chart of how the design guidance should be used by the designer to select the appropriate bikeway improvement given a roadway's context and tier.

Figure 1. Bikeway Improvement Selection Guide



4.3 Urban Bikeway Design Guidance

Figure 2 presents a continuum of bikeway facilities for NM highways passing through or located within urban areas. All Tier 1 and 2 routes that pass through urban areas in New Mexico, including large cities, suburban areas, and small town/village centers, are to reference the design guidance listed in Figure 2. The intent of bikeway improvements listed in Figure 2 is to provide a high level of comfort to bicyclists of different ability levels as speeds and volumes increase.

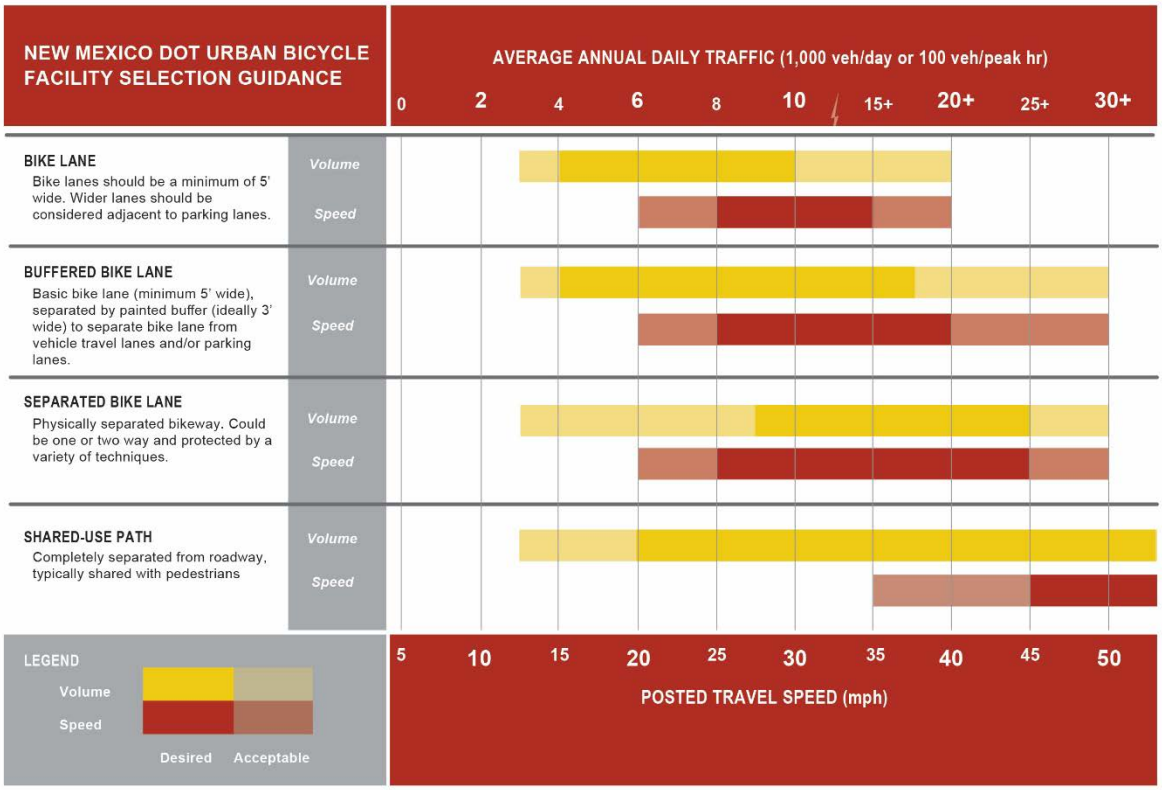
The tier of the roadway in urban areas indicates the benefits associated with bikeway improvements, with Tier 1 indicating the NMDOT facilities that are most important for regional bicycle mobility. The design guidance for urban roadways is based on the premise that all NMDOT maintained roadways in urban areas should be developed based on the same set of design guidance, regardless of what tier the roadway becomes once it leaves the urban area.

Tier designations for NMODT facilities in urban areas were developed in coordination with local and regional bicycle networks. Tier 2 and Tier 3 designations may indicate that a preferred route and improved bikeway infrastructure is available on a parallel local roadway. Designers should review the local bicycle network prior to determining the appropriate improvement as a parallel route on a local road may provide better opportunities for bikeway infrastructure.

While the goal for urban routes is to provide dedicated space for bicyclists, constraints may exist that prevent such space from being provided in the near-term. The treatments listed in Table 1 can also be applied during routine maintenance efforts as interim design treatments to improve bicycling conditions before dedicated bikeway infrastructure can be installed.

Descriptions of the bikeway facilities presented in Figure 2 are provided in Section 5.2.

Figure 2. Urban Routes - Facility Selection Chart



4.4 Rural Bikeway Design Guidance

The primary design intervention for rural Tier 1 and 2 roadways is the provision of a dedicated shoulder, also known as a **shoulder bikeway**. The intent of these facilities is to provide a comfortable bicycling experience for recreational bicyclists as speeds and volumes increase. In rural areas, paved shoulder bikeways act similarly to bike lanes in urban areas, providing a dedicated space for bicyclists to ride adjacent to motor vehicle traffic. For rural roadways, the tier of the roadway should dictate the level of bikeway infrastructure provided, with the most robust infrastructure design on Tier 1 facilities. Additional design features are discussed in the sub-sections below. Design considerations for Tier 1 and Tier 2 facilities, presented in Figure 3 and Figure 4, are provided in Section 5.2.

While the goal for Rural Tier 1 and Rural Tier 2 routes is to provide dedicated space for bicyclists, constraints may exist that prevent such space from being provided in the near-term. The design interventions for constrained corridors listed in Table 3 can also be used as interim design treatments to improve bicycling conditions before dedicated bikeway infrastructure can be installed.

DISCUSSION ON SHOULDER BIKEWAY WIDTH FOR RURAL ROADWAYS

The AASHTO *Guide for the Development of Bicycle Facilities* specifies the minimum effective width of the paved shoulder should be at least 4 feet to safely accommodate bicyclists. The effective width of the shoulder does not include a rumble strip, if present. AASHTO states that shoulders wider than 4 feet are desirable if higher bicycle usage is expected or if motor vehicle speeds exceed 50 miles per hour; if use by heavy trucks, buses, or recreational vehicles is considerable; or if static obstructions exist at the right side of the roadway. Shoulders wider than this minimum provide numerous benefits to both bicyclists and motor vehicles. **To the greatest extent possible, wide shoulder bikeways should exceed the minimum design width for the following reasons**:

- **Safety**: A large portion of bicycle-vehicle crashes on rural roadways occur when a vehicle attempts to overtake a bicyclist on a roadway with no or little available paved shoulder width. As traffic volumes increase, overtaking conflicts increase as well.[1] To maintain the physical minimum operating width for a bicycle (2.5 feet) and to provide adequate space when passing, a wide shoulder is necessary (29 states, but not including New Mexico, have passed laws that require motorists to provide bicyclists a minimum 3-foot berth when passing). Providing this dedicated space can also reduce motorist stress when passing bicyclists at high rates of speed.

- **Comfort**: Wider shoulders provide more dedicate space for bicyclists to ride and maneuver, separate from motor vehicles. This has been found to improve comfort when bicycling on rural roadways.[2] Additionally, wider shoulders lessen the impact of wind-blast caused by passing vehicles, especially trucks passing at high rates of speed.

- **Maintenance**: Roadways deteriorate from the roadway edge first, and this deterioration minimizes the effective width of the shoulder for bicycling. As the shoulder deteriorates, the bicyclist may need to ride closer to the travel lane, and as the effective width of the shoulder narrows, drivers may have to exit their lane to provide the 3-foot effective berth. Providing wide shoulder bikeway represents a pro-active method that may minimize the need for vehicles to exit their lanes as pavement deteriorates overtime.

Wide shoulders provide many benefits to other roadway users as well, beyond providing a dedicated space for bicyclists to ride. These additional benefits are listed in Section 7.

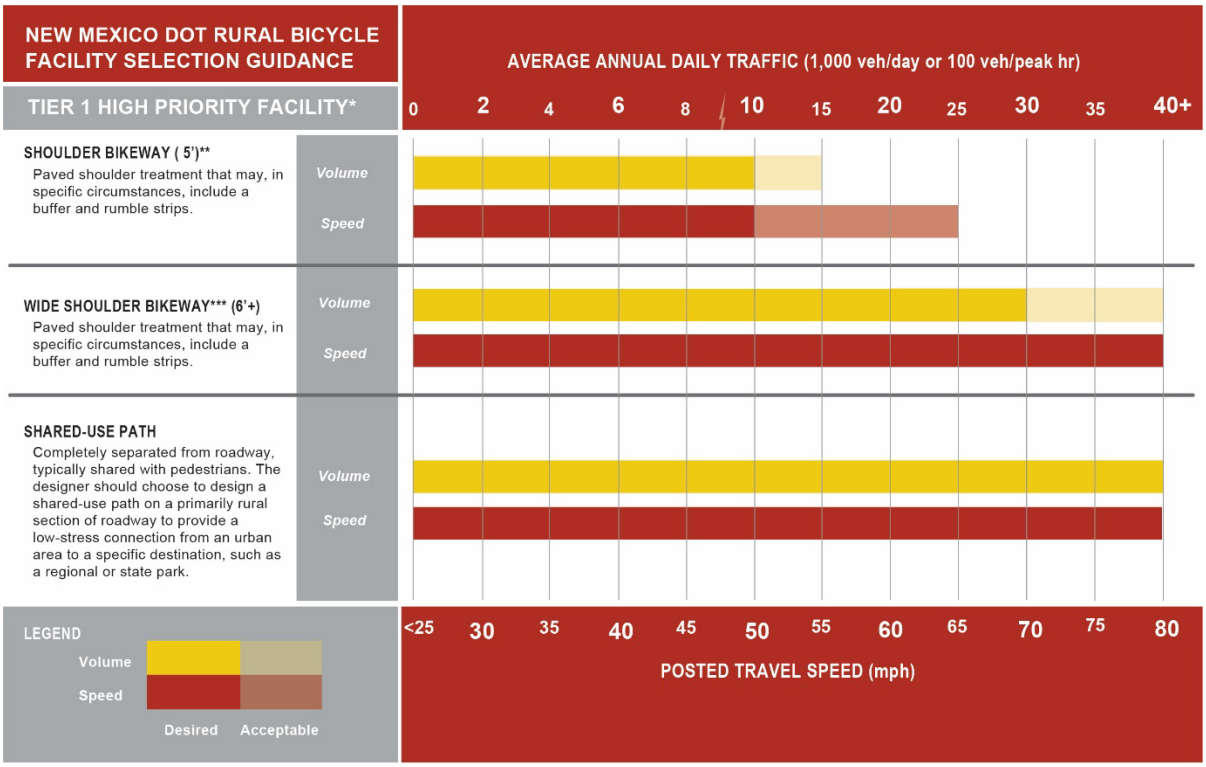
[1] *Analysis Procedures Manual, Chapter 14 Multimodal Analysis. Oregon Department of Transportation (ODOT) December, 2012*

[2] *Respondents to the NM Bike Plan survey indicated shoulders are the #1 factor that influence why they select a particular bicycle route; A series of images were presented to the survey respondents with different roadway characteristics. Of all characteristics, the presence of shoulders had the most consistent impact on bicyclist comfort. The #1 obstacle to rural bicycling was found to be poor pavement condition/lack of dedicated shoulders.*

4.4.1 Rural Tier 1 Routes - Facility Selection Guidance

Figure 3 presents three bikeway improvement types for Rural Tier 1 routes. The primary design intervention for these roadways is the provision of a dedicated shoulder, also known as a **shoulder bikeway**. The width of the shoulder should increase as speeds and volumes increase. Properly designed rumble strips may also provide benefits to bicyclists. See the Rumble Strip Design Guidelines for Shoulder Bikeways for additional information. The designer should consult section 5.2.4 on for additional guidance on shoulder bikeways. *Shared use paths may be considered in special circumstances.*

Figure 3. Rural Tier 1 Routes - Facility Selection Chart



*Tier 1 level design elements may be installed on a Tier 2 Facility.

**The minimum operational shoulder width shall be at least 4 feet of clear space, which represents the effective width of the shoulder. Minimum 4' effective width measured between rumble strip and edge of pavement, if rumble strips are used, per AASHTO Guide for the Development of Bicycle Facilities, 4th Edition Chapter 4.7. Best practices for installing rumble strips are included in Table 1 of the NM Bike Plan Design Guidance. Rumble Strips should only be installed on bike routes where there is a warrant for them. Rumble strips should be avoided on formal race routes, where bicyclists will ride outside of the roadway shoulder.

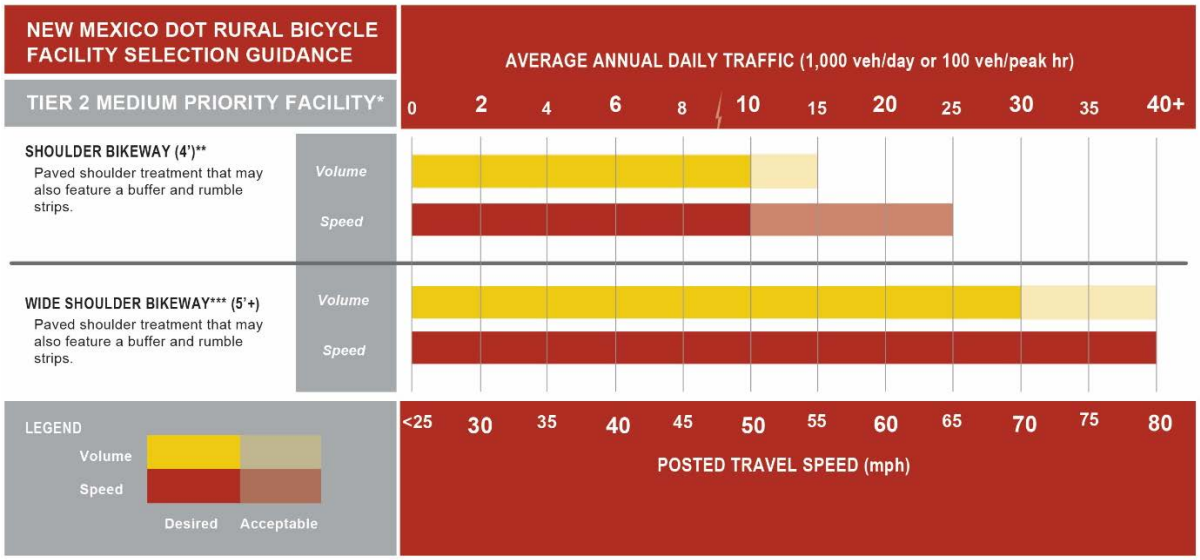
***Paved shoulder widths greater than 5' are desirable on higher-speed/higher volume roadways, as well as on roadways where the average daily traffic volumes exceed 1,500 vpd AND the percentage of truck traffic is greater than or equal to 10% of the traffic stream.

4.3.2 Rural Tier 2 Routes - Facility Selection Guidance

Figure 4 presents two bikeway improvement types for Rural Tier 2 Routes. The primary design intervention for these roadways is the provision of a dedicated shoulder, also known as a **shoulder bikeway**. The width of the shoulder should increase as speeds and volumes

increase, and rumble strips may be considered in some circumstances. The designer should consult section 5.2.4 on for additional guidance on shoulder bikeways.

Figure 4. Rural Tier 2 Routes - Facility Selection Chart



**Tier 1 level design elements may be installed on a Tier 2 Facility.*
***The minimum operational shoulder width shall be at least* 4 feet of clear space, which represents the effective width of the shoulder. Minimum 4' effective width measured between rumble strip and edge of pavement*, if rumble strips are used, per AASHTO Guide for the Development of Bicycle Facilities, 4th Edition Chapter 4.7*
***Paved shoulder widths greater than 5' are desirable on higher-speed/higher volume roadways, as well as on roadways where the average daily traffic volumes exceed 1,500 vpd AND the percentage of truck traffic is greater than or equal to 10% of the traffic stream.*

4.3.3 Rural Tier 3 Facilities

Tier 3 routes exhibit little to no existing or latent demand for bicycling. As a result, investing in bikeway improvements on these roadways specifically to improve bicycling conditions is likely not the best use of limited NMDOT resources. In limited situations, the designer may choose to improve the roadway for bicycling; these decisions should be made on a case-by-case basis. If the designer deems it appropriate to make a bikeway improvement for a Tier 3 route, the designer may consider the installation of shoulders as described in Figure 4 (related to Tier 2 routes), or review strategies for constrained corridors, listed in Tables 2 and Table 3.

5. GENERAL BEST PRACTICES FOR IMPROVING BICYCLING CONDITIONS ON ALL STATE ROADWAYS

5.1 Introduction

This section presents an overview of bikeway facility types, implementation strategies, and design/maintenance strategies. Section 5.2 includes a description of bikeway facility types that are listed in the figures in the previous section are provided below (Section 5.2), along with references to additional design guidance. The bikeway facility types include:

- Conventional Bike Lane
- Buffered Bike Lane
- Separated Bike Lane
- Shoulder Bikeway
- Shared Use Path

Section 5.3 provides a summary of techniques that designers can use to provide dedicated space for bicyclists. These techniques can be used to install the bikeway facilities described in this document. In some circumstances, the techniques to accommodate bicyclists will not be feasible due to right-of-way constraints. In these instances, designers have other tools available to improve bicycling conditions in constrained situations, which do not require substantial roadway modification.

Strategies for constrained corridors are grouped into two categories, Design Interventions and Maintenance Strategies, and are described in Section 5.4. These strategies represent best practices that can be used to improve bicycling conditions on all NM highways, regardless of tier designation.

The guidance included in the NM Bike Plan is based on national and local design manuals, detailed in Section 7, which provide additional details on the specific application of the design techniques described here. The guidance included in this document is not a substitute for a more thorough evaluation by a Professional Engineer.

5.2 Bikeway Facility Types

Bikeway facilities provide a dedicated space for bicyclists to ride. Due to the range of roadway conditions in New Mexico, different bikeway improvements are available for designers to consider. In general, as traffic volumes and speeds increase, more separation from motor vehicle traffic is necessary to maintain comfort levels for bicyclists. The most basic form of bikeway infrastructure are conventional bike lanes and shoulder bikeways. It is important to note that bikeway facilities, once implemented, can evolve into more robust facilities over time. As an example, a conventional bike lane or buffered lane can be installed in an urban area through lane narrowing and reallocation of roadway space. If additional interventions and improvements are desired, buffered bike lanes can be upgraded to separated bike lanes during roadway reconstruction or as a stand-alone project.

5.2.1 Conventional Bike Lanes

Description

Bike lanes are portions of the roadway that have been designated by striping, signing, and pavement markings for preferential and exclusive use by bicyclists. Bike lanes are typically located on both sides of the road and carry bicyclists in the same direction as adjacent motor vehicle traffic. Bike lanes should be 5 feet wide, not inclusive of the gutter pan. If a bike lane is adjacent to on-street parking, the combined width of the parking space and bike lane should be at least 13 feet. Bike lanes are most appropriate in urban areas.

Conventional bike lane.

Additional Design Guidance

- See NACTO Urban Bikeway Design Guide, 2014, 2nd Ed. – Conventional Bike Lanes, Pg 3
- See AASHTO Guide for the Development of Bicycle Facilities, 2012, 4th Ed. Typical Bike Lane Cross Sections, 4-15

5.2.2 Buffered Bike Lanes

Description

Buffered bike lanes are conventional bike lanes paired with a designated buffer space, separating the bike lanes from the adjacent motor vehicle travel lanes and/or parking lanes. Buffered bike lanes are designed to increase the space between bike lanes and the travel lanes and/or parked cars, providing more comfortable conditions for bicyclists. This treatment is appropriate for bike lanes on roadways with high motor vehicle traffic volumes and speeds, adjacent to parking lanes, or a high volume of truck or oversized vehicle traffic. The minimum buffer width is 18 inches, with a recommended width of 3 feet. If the buffer is 3 feet or wider, the buffer area should have interior diagonal cross hatching or chevron markings.

Buffered bike lane.

Additional Design Guidance

- See NACTO Urban Bikeway Design Guide, 2014, 2nd Ed.- Buffered Bike Lanes, Pg 9
- See Manual of Uniform Traffic Control Devices 2009, 3D.02

5.2.3 Separated Bike Lanes

Description

Of all on-street bicycle facilities, separated bike lanes (SBLs) offer the most protection and separation from adjacent motor vehicle traffic. SBLs are bicycle facilities that are physically separated from motor vehicle traffic by a painted buffer and physical barriers such as flexible delineators, curbs, or planters. Parking lanes can also be used as a means of separation if there is a buffer space between the bike lane and the parking lane. SBLs are ideally placed on streets with few driveways or mid-block access points for motor vehicles. SBLs can be one or two-way facilities and are most appropriate in urban areas.

Separated bike lane.

The standard width for directional separated bike lane width is 7 feet to allow safe passing behavior. For bi-directional bike lanes, a width of 12 feet is desired, with 8-10 feet acceptable for short segments in constrained corridors. The separation width for directional and bi-directional SBLs depends on physical separation method.[7] The minimum separation width next to on-street parking is 3 feet to accommodate opening doors. Pavement markings, symbols, and/or arrows should be placed at the beginning of the SBL and at intervals along the facility, based on engineering judgment, to define the bike direction.

In the long-term, roadways can be reconstructed to include grade-separated bikeways. These bikeways can either be at the same grade as the sidewalk, or at an intermediate grade between the roadway and sidewalk.

Additional Design Guidance

- See NACTO Urban Bikeway Design Guide, 2014, 2nd Ed. – Cycle Tracks, Pg 27
- See FHWA Separated Bike Lane Guide, 2015

5.2.4 Shoulder Bikeway

Description

Shoulder bikeways provide a dedicated space that is wide enough for bicycles travel and are most appropriate for application in rural areas. The AASHTO *Guide for the Development of Bicycle Facilities* specifies that the minimum effective width of a shoulder bikeway, the unobstructed usable space for bicyclists, to be 4 foot, with a minimum effective width of 5 feet

[7] To simplify operation concerns, bidirectional separated bike lanes function best on the left side of one-way streets. An evaluation of turning movements across the bikeway must be conducted to understand potential conflicts and how the bikeway will function.

when vertical obstructions exist immediately adjacent to the roadway, such as a curb or guardrail.

The effective width of the shoulder bikeway should be measured from the edge line to the edge of pavement, or from the edge of the rumble strip (if present) to the edge of pavement. The AASHTO guide specifies the following situations when the effective width of a shoulder bikeway should be wider than the minimum 4-foot width:

Shoulder bikeway.

- Where higher bicycle usage is expected
- When motor vehicle speeds exceed 50 MPH
- If use by heavy trucks, buses, or recreational vehicles is considerable
- If static obstructions exist at the right side of the roadway

Wider shoulders, in general, are recommended on Tier 1 roadways, since higher bicycle usage is expected on these roads. For both Tier 1 and 2 roads, wide shoulder bikeways are recommended along roadways with speeds exceeding 50 MPH, and where heavy vehicles exceed 10 percent of the overall traffic flow.

At intersections, the designer should consider transitioning the shoulder bikeway to a through shoulder lane, especially where right turn lanes are present. This will position the bicyclist to the left of the right turn lane, facilitating through movements for bicyclists and reducing conflicts with right turning vehicles exceed 10 percent of the overall traffic flow

Providing a through shoulder bikeway where dedicated right turns are present helps to separate through moving bicyclists and right turning motor vehicles in advance of intersections, which reduces right turn conflicts. This image shows an example of this treatment installed on US 180, a rural roadway west of Flagstaff, Arizona. (Source: Google Maps).

SHOULDER BIKEWAYS vs BIKE LANES

Shoulder bikeways and conventional bike lanes are distinct bikeway facilities. The primary differences between the two relate to the following:

Exclusivity: Bike lanes are dedicated lanes for the exclusive use of bicyclists. Motor vehicles are prohibited from loading, parking, or blocking the bike lane. Conversely, shoulder bikeways do not provide exclusive space for bicycling. Shoulder bikeways may be temporarily blocked by motor vehicles, such as when a vehicle is disabled.

Pavement Markings: Bike lanes are marked by bike lane pavement markings (MUTCD Figure 93.C), which communicate that the lane is for the exclusive use of bicyclists. Shoulder bikeways do not include bicycle-specific pavement markings.

Intersection Design: Bike lanes, and related buffered bike lanes and separated bike lane, typically incorporate a range of intersection treatments that provide clarity for bicyclists and motorists moving through intersections. These designs can include pavement markings, vertical delineation, and dedicated bicycle signals. Shoulder bikeways typically do not include intersection treatments. The one exception being the provision of a through shoulder lane at locations where a dedicated right turn lane is present.

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Rumble Strip Design Guidance for Shoulder Bikeways

Rumble strips are an FHWA Proven Safety Countermeasure for reducing roadway departure crashes and can improve bicyclist safety by creating separation between motorists and bicyclists traveling in the shoulder. However, AASHTO, FHWA, and state-level guidance recognizes that they may negatively impact bicycle travel if they are improperly designed, since bicycling on the strips can be very hazardous for bicyclists, especially as bicycling speeds increase (such as down steep hills).[8] Designers should reference NMDOT's forthcoming rumble strip policy, being developed at time of this Plan's finalization.

Increasingly, State DOTs are modifying rumble strip design practices to both effectively prevent run-off-the-road crashes, and better accommodate bicyclists. In this example, a narrow rumble strip is used to provide a more effective width for bicyclists to ride in the shoulder.

Best practices for rumble strip design that better accommodate bicyclists include:

- Place the rumble strip as close to the travel lane as feasible, to maximize the space from the edge of the rumbles to the edge of pavement (the effective width). Rumble strips may also be placed on the roadway edge line (called rumble stripes), which has the added benefit of making the striping more visible at night.
- Maintain a minimum of 4 feet of clear, ridable surface between the edge of the rumble strip and the pavement edge, if space allows.[9] NMDOT guidance specifies an additional 1-foot shy distance from all vertical faces, including guard rails and concrete wall barriers (CWB), to ensure adequate space for bicyclists.
- A minimum effective shoulder width of 5 feet is recommended where a curb and gutter, guardrail, or another roadside obstacle exists.
- Install a bicycle-friendly bicycle gap pattern. NMDOT's Standard Drawing 631 displays a rumble strip gap pattern, which is consistent with best practices. The gap pattern consists of a 12-foot clear gap followed by 48-foot rumbles. These gaps allow the bicyclist to maneuver into and out of the shoulder area. The designer should consider longer or more frequent gaps where bicycle speeds increase, such as down hills.[10]
- NMDOT Standard Drawing 631 specifies a 16" offset from the center of the edge line to the edge of rumble strip. This 16" offset is compatible with bicyclist accommodation when at least 4 feet or more of effective shoulder width is provided outside of the rumble strip.[11] In constrained situations, the designer should consider reducing the width of the rumble strip to provide the minimum effective-width. In reducing rumble strip widths, trade-offs for vehicular performance should be considered.[12]

Arizona DOT has developed a rumble strip policy that recommends wider rumbles strips on roads with wider shoulders, and more narrow rumble strips on roads with more narrow shoulders. The AZDOT guidance is displayed in Table 2.

TABLE 2 | Arizona DOT Rumble Strip Guidance[13]

Type of Roadway	Right Shoulder Width	Groove Width (right shoulder)	Groove Width (left shoulder)
Undivided	Less than 5'6''	6" *	N/A
Undivided	Greater than or equal to 5'6"	8"	N/A
Divided	Less than 6'	8"	N/A
Divided	Greater than or equal to 6'	12"	12"

*typically placed under the edge line

[9] AASHTO Guide for the Development of Bicycle Facilities, 4th Edition, 2012

[11] AASHTO Guide for the Development of Bicycle Facilities, 4th Edition, 2012

[12] As of 2018, NMDOT is reviewing its policy on rumble strips.

[13] ADOT Traffic Engineering Guidelines and Processes, January 2018 – Section 480, Longitudinal Rumble Strips

Additional Design Guidance

- See AASHTO Guide for the Development of Bicycle Facilities, 2012, Paved Shoulders (4-7), Rumble Strips (4-9)
- See FHWA Small Town and Rural Multimodal Networks, 2016, Paved Shoulder (3-5), Rumble Strips (3-6)

CONSIDERATIONS WHEN ADJUSTING RUMBLE STRIP DESIGN

FHWA provides the following guidance, which is consistent with the AZDOT guidance, that designers can reference if rumble strips are desired on bicycle routes: 12" spacing center to center, 6-8" long perpendicular to roadway, and 6" wide measured parallel to roadway.

The decision to use adjusted rumble strip design should be made with the understanding that reducing the dimensions can significantly reduce the altering noise and associated safety effectiveness of the rumble strip for motorists. Engineering judgment is required when altering rumble strip design.

General physical dimensions of rumble strips are based on common designs described in NCHRP Synthesis 490, with bicycle specific enhancements to improve maneuvering by bicyclists identified in FHWA Technical Advisory on Shoulder and Edge Line Rumble Strips 2011.

5.2.5 Shared Use Path

Description

Shared use paths, or multi-use trails, allow for two-way, off-street use by multiple non-motorized users, including bicyclists. These facilities are frequently found in parks, along canals, railroads, or utility corridors where there are few conflicts with motorized vehicles, as well as parallel to roadways. To enable two-way travel, shared use paths should be a minimum 10 feet, with wider paths (e.g. 12 feet) encouraged where user volumes are moderate or high. In constrained circumstances, a width of 8 feet may be acceptable.[14] In high-volume areas,

Shared use path.

[14] AASHTO calls for a minimum width of 10 feet; in constrained circumstances, 8 feet may be used.

delineating space for bicycles and pedestrians can be desirable. This separation can be achieved through pavement markings, textual differences in surface material, or providing physical buffers between the bicyclist and pedestrian zones, such as a planting strip.

Additional Design Guidance

- See AASHTO Guide for the Development of Bicycle Facilities, 2012, 4th Ed., Design of Shared Use Paths, Chapter 5
- See FHWA Small Town and Rural Multimodal Networks, 2016, Shared Use Path, 4-3

5.3 Designing Roadways to Accommodate Bicyclists

Designers can use a variety of techniques to provide the dedicated bikeway facilities described in Section 5.2. In some instances, especially in rural contexts, the roadway may already have dedicated bikeway facilities in the form of paved shoulders. In these cases, the existing roadway cross-section should be maintained, and techniques listed in Table 1 and Table 2 should be reviewed during maintenance activities to ensure that the shoulder remains suitable for bicycle travel.

In other instances, there may be opportunities to retrofit existing highways to add bikeways without widening the roadway. Roadway retrofits involve: 1) reallocating existing pavement width through striping modifications, or 2) removing travel lanes to provide additional width for dedicated bikeways.

Bikeways can also be provided by widening the roadway during reconstruction projects to provide width necessary to install dedicated bikeways. These three techniques are described in this section. If the designer cannot achieve the recommended bikeway facility due to corridor constraints, interventions to improve bicycling conditions can still be made. These Constrained Corridor Interventions are described in Section 5.4.

5.3.1 Lane Narrowing

Lane narrowing reallocates existing roadway space that exceeds minimum standards prescribed in NMDOT's Design Manual for bike lanes or shoulder bikeways. In New Mexico, the standard travel lane width is 11 feet wide in urban areas, and 12 feet on rural and high speed and/or high-volume roadways. Where lanes are wider than these minimums, opportunities exist to reallocate additional roadway width to shoulders, providing dedicated space for bicyclists in the form of paved shoulders or bike lanes. This reallocation of pavement space typically occurs during routine resurfacing and restriping activities.

It is typically much less costly to install bikeway improvements as part of a resurfacing project compared to implementing the same improvement as a standalone project.[15] When preparing to implement resurfacing projects, the designer should reference the NM Bike Plan and

[15] Incorporating On-Road Bicycle Networks into Resurfacing Project. FHWA. March 2016.

associated recommendations, as well as the FHWA Resurfacing Workbook, to determine if adding bikeway facilities to the project is appropriate.

If target shoulder widths specified in Figure 2 and Figure 3 cannot be achieved, lane narrowing can still be an effective interim strategy to provide some level of bikeway accommodation prior to a larger reconstruction project. Providing a shoulder, even a narrow one, can help improve the comfort and safety of bicycling on a rural road.[16]

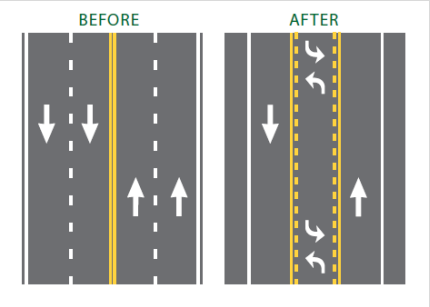
5.3.2 Lane Reconfiguration

Streets with excess vehicle capacity provide opportunities for bike facility retrofit projects. Lane reconfiguration, such as the removal of one or more travel lanes, generally provide sufficient space for bike facilities on both sides of the roadway. Depending on a street's existing configuration, traffic operations, user needs, and safety concerns, various lane reduction configurations may apply. Prior to implementing this measure, a traffic analysis may be necessary to identify potential impacts. For projects where turn lanes can be provided, such as the four-lane to three-lane conversions, substantial safety benefits can be realized.

Lane reconfiguration can be implemented during routine repaving and reconstruction projects, provided the public and local entity is engaged as part of the decision-making process. Designers should reference the NMDOT Road Diet Guide for additional guidance on lane reconfigurations in New Mexico.

LANE RECONFIGURATION

A four-lane street (with two travel lanes in each direction) could be modified to provide one travel lane in each direction and a two-way left turn lane, with space remaining for bicycle facilities.



Source: FHWA Safety Program

5.3.3 Roadway Reconstruction and Widening

Roadway reconstruction is an optimal time to widen roadways to accommodate desired shoulder widths or bike lanes. During scheduled roadway reconstruction, the designer should reference the recommended bikeway facilities for the roadway tier and context. If undertaking a corridor study, the options outlined in this document should be further selected and refined based upon public and stakeholder involvement, as well as the specific roadway context. In constrained situations, or situations where the roadway will not be reconstructed for many years, the designer is to reference Section 5.4 to determine if interim treatments can be applied.

[16] The ODOT Analysis and Procedures Manual – Chapter 14 Multimodal Analysis states: "The occurrence of bike crashes is highest on higher volume rural facilities with little or no paved shoulders, poorly placed rumble strips, or deteriorated shoulder pavement conditions." Source: ODOT.

5.4 Constrained Corridor Interventions

Inevitably, there will be situations along Tier 1 and 2 routes where the roadway design techniques to provide dedicated bikeway facilities (listed in Section 5.3) are not feasible or appropriate.

If a corridor is constrained, the designer has two options. The first is to choose an alternative route where a dedicated bikeway facility or low-stress bikeway can be installed. If the most appropriate alternative route is along a non-NMDOT facility, coordination with the local municipality is required.

If no alternative route exists, the second option is to apply design interventions for constrained corridors, as listed in Table 3, and to use engineering judgment to select the intervention(s) that will have the greatest impact on improving the constrained roadway for bicycling. The designer should also review *Table 4: Maintenance Strategies* to determine if any of these strategies can be used to improve bicycling conditions.

OPTIONS FOR IMPROVING CONSTRAINED CORRIDORS

1. Seek parallel route for bikeway facilities

2. Apply design interventions for constrained corridors

CONSIDERATIONS FOR TIER 2 BASIC FACILITIES

Design interventions listed in Table 2 should be applied to NM highways designated as Tier 2 Basic routes.

TABLE 3 | Design Interventions for Constrained Corridors

Design Feature	Best Practices & Guidance	Appropriateness
Shared Lane Marking 	Shared lane markings are pavement markings that direct motorists and bicyclists to operate in the same travel lane. Depending on the roadway configuration, this can be side by side or single file. This facility typically serves as a connection between other bikeways (usually bike lanes), or as preferred routes through high-demand corridors.	**Urban**: Shared lane markings are appropriate on local streets with low motorized traffic volumes and speeds. Roads should have maximum posted speeds of 25 MPH and, ideally, less than 1,500 vehicles per day, but no more than 3,000 vehicles per day.
Advisory Lane 	Advisory lanes act as paved shoulders or bike lanes that can also accommodate encroachment by motorists when vehicles in opposing directions converge. Advisory bike lanes are for consideration in constrained situations only, and require an approved FHWA Request to Experiment. Additional guidance for this type of facility can be found in the FHWA Small Town and Rural Multimodal Networks (Chapter 2 – p. 17–24).	**Urban or Rural**: This design treatment can be considered on lower-speed (i.e. less than 35 MPH), lower volume (i.e. less than 3,000 vehicles per day) roadways that are constrained, and where the roadway cannot be widened to accommodate a dedicated bikeway facility. Advisory lanes should be avoided on curvy roadways with poor site lines.

TABLE 3 | Design Interventions for Constrained Corridors, Cont.		
Design Feature	**Best Practices and Guidance**	**Appropriateness**
Uphill Shoulder Lane 	If a dedicated shoulder cannot be provided in both directions on a roadway due to right-of-way constraints, the designer may consider installing an uphill shoulder lane (i.e. a lane that can be used by bicyclists to climb the hill). Uphill shoulder lanes can be achieved through restriping the existing roadway cross-section or reconstructing the roadway on the uphill side of the road. Figure 2 and Figure 3 should be referenced to determine the appropriate width of the uphill shoulder lane. Additional guidance for this type of facility is provided in the AASHTO Guide for the Development of Bicycle Facilities.	**Urban or Rural**: The speed difference between a bicyclist travelling uphill and a vehicle travelling uphill is much greater than the speed difference between a bicyclist travelling downhill and a vehicle travelling downhill. Due to this disparity in speeds, it may be advantageous to provide an uphill shoulder lane. This strategy is most appropriate on roadways with consistent grade increase, such as roadways through mountainous areas.
Flashing Beacons  *Photo by Jonathon Maus for Bike Portland*	On constrained roadways where a shoulder bikeway cannot be provided, a potential safety enhancement is the addition of flashing activated warning beacons. Warning beacons can be passively activated by bicyclists riding by a sensor (preferred over continuous flashing). The warning beacon displays a flashing pattern to alert motorists of the presence of bicyclist, and indicates the need to adjust their speed and passing behavior accordingly.[17] Engineering judgment should be used when considering installation.	**Urban or Rural**: This intervention should only be used at specific "pinch-point" locations, such as a tunnel, bridge, narrow roadway section, or at locations where sight distance is limited, such as sharp turns. This limited use provides a specific and clear signal to motorists to be aware of bicyclists through the pinch-point. Flashing beacons are not an appropriate intervention for long stretches of roadway.
Regulatory Signage – Urban Areas  	Signage helps to alert motorists to the presence of bicyclists. In urban contexts with posted speeds of 30 MPH or less, the MUTCD Compliant "Bicycles May Use Full Lane" regulatory sign (R4-11) can be used. [18] Engineering judgment should be used to determine appropriate placement intervals.	**Urban**: Along urban roadways where providing a dedicated bikeway facility is not feasible, and the posted speed is 30 MPH *or less*.

TABLE 3 | Design Interventions for Constrained Corridors, Cont.		
Design Feature	**Best Practices & Guidance**	**Appropriateness**
Warning Signage – Rural Areas – Option A  	On high-speed rural roadways, best practices suggest using the MUTCD compliant W11-1 with a custom legend plaque reading "*ON ROADWAY*." This sign should be used on roadways with no shoulder, or where the shoulder effective width is less than 4 feet. Engineering judgment should be used to determine appropriate placement intervals. ***NOTE:*** The "Share the Road" (W11-1/W16-1P) assembly is not recommended for application on NM highways. This sign's usefulness has been challenged, based on arguments that it is ambiguous, imprecise, and frequently misinterpreted. [19] [20]	**Rural**: Along roadways where providing the target shoulder bikeway is not feasible or where they are not recommended (such as along Tier 2 Basic routes) and where posted speeds are *greater than* 30 MPH.
Warning Signage – Rural Areas – Option B  	An alternative option for rural roadway advisory signage is MUTCD compliant *W11* with custom plaque reading: *"IN LANE".* Delaware DOT has adopted this sign assembly as the standard sign for rural bike route application. Engineering judgment should be used to determine appropriate placement. NMDOT would need to formally adopt the alternative "*IN LANE*" plaque.	**Rural**: Along roadways where providing the target shoulder bikeway is not feasible or where they are not recommended (such as along Tier 2 Basic routes) and where posted speeds are *greater than* 30 MPH.

[17] It should be noted that the effectiveness of this strategy has not been studied extensively.

[18] The findings from one study suggested that the R4-11 is more effective in conveying the rules of the roadway for all road users, when compared to shared lane markings and the combination W11-1/W16-1P "Share the Road" assembly. Hess G, Peterson MN (2015) "Bicycles May Use Full Lane" Signage Communicates U.S. Roadway Rules and Increases Perception of Safety. PLoS ONE 10(8): e0136973. https://doi.org/10.1371/journal.pone.0136973

[19] Bike Delaware (2014) Why "Share the Road" is gone in Delaware. Available: http://www.bikede.org/2014/04/07/why-share-the-road-is-gone/.

[20] Pein W (2012a) The Share the Road Sign. Available: http://bicyclingmatters.files.wordpress.com/2008/04/the-share-the-road-sign3.pdf.

5.5 Interim Design Treatments

The treatments listed in Table 3 can also be used as interim design treatments to improve bicycling conditions before roadway reconstruction or dedicated bikeway infrastructure can be installed. These interim design treatments are particularly appropriate if resources are not available to install dedicated bikeways during maintenance activities and if bikeway improvements are desired in the near-term. On Tier 1 and Tier 2 routes, the use of interim design treatments should be considered the first step toward bicycle accommodation.

5.6 Maintenance Strategies

Table 4 below lists strategies that can be employed to maintain a roadway so that it is more suitable for carrying bicycle traffic. Maintenance is performed on an ongoing cycle on NMDOT roadways. Utilizing these techniques is part of NMDOT efforts to implement the NM Bike Plan and support statewide bicycle travel.

TABLE 4 | Maintenance Strategies

Consideration	Best Practices
Rumble Strip Placement Design	During maintenance activities, such as resurfacing, the designer should review rumble strip design and placement to make certain it is compatible with bicycle usage and designed to maximize space available to bicyclists, if opportunities exist. The designer should consider the following when designing rumble strips along bike routes: • a history of run-off-road crashes along corridor • placement of the rumble strips • dimensions of the rumble strips See Section 5.2.5 for additional guidance, as well as the forthcoming NMDOT Rumble Strip Design Policy.
Repaving/ Resurfacing	When resurfacing roadways, pave to the edge of the existing to avoid creating a seam/lip in ridable shoulder area, which can be dangerous to bicyclists.
Open Graded Friction Course	Ensure all surfacing work spans the full width of the existing paved surface to avoid creating a seam/lip in ridable shoulder area, which can be dangerous to bicyclists. Open Graded Friction Course also provides safety benefits for bicyclists.
Crack Seal	Shoulders should be included when crack sealing a roadway. When using on shoulders, instruct contractor to install to create as smooth of a surface as possible.
Sweeping	For scheduled events, event organizers may request for the appropriate NMDOT District Office to sweep prior to the event.
Snow Removal	In rural areas, along popular bicycling routes, the NMDOT District Office should plow the shoulders. They should not store snow on shoulders along popular bicycling routes, unless no other option exists. In urban areas, the NMDOT District Office should plow bicycle lanes. They should also not store snow on bicycle lanes, unless no other option exists.

6. BIKE LANES AND SHOULDERS – BENEFITS TO OTHER USERS

Bike lanes and shoulders provide benefits for roadway users beyond providing a dedicated space for bicyclists to ride. These benefits can be grouped into three categories: Safety, Capacity, and Maintenance. When determining the feasibility of providing bike lanes or shoulders, these additional benefits should be considered by the designer. Benefits include:

6.1 Safety

Highways with paved shoulders have reduced accident rates, as paved shoulders:

- Provide space to make evasive maneuvers
- Accommodate driver error
- Add a recovery area to regain control of a vehicle and have been found to reduce rates of run-off-road crashes
- Provide space for disabled vehicles
- Provide increased sight distance for through-vehicles and for vehicles entering the roadway (in brushy, rural areas, and in urban areas with many sight obstructions)
- Provide lateral clearance to roadside objects such as guardrail, signs and poles
- Contribute to driving ease and reduced driver strain
- Reduce passing conflicts between motor vehicles and bicyclists and pedestrians
- Make the crossing pedestrian more visible to motorists
- Provide for storm water discharge farther from the travel lanes, reducing hydroplaning. Removing standing water also reduces splash and spray to following vehicles and nearby pedestrians and bicyclists.

6.2 Capacity

Highways with paved shoulders can carry more traffic, as paved shoulders:

- Provide greater intersection and stopping sight distance
- Allow for easier exiting from travel lanes to side streets (also a safety benefit)
- Provide greater effective turning radius for trucks
- Provide space for off-tracking of truck's rear wheels in curved sections
- Provide space for disabled vehicles, mail delivery and bus stops
- Provide space for bicyclists to ride at their own pace
- Provide space between motor vehicles and pedestrians, increasing pedestrian comfort

6.3 Maintenance

Highways with paved shoulders are easier to maintain, as paved shoulders:

- Provide structural support to the pavement
- Discharge water further from the travel lanes, preserving the base and subgrade
- Provide space for maintenance operations
- Provide space for portable maintenance signs

7. NATIONAL AND STATE DESIGN REFERENCES

The NM Bike Plan focuses on the appropriateness of bikeway infrastructure for NM highways in urban and rural areas, and provides basic guidance on infrastructure types. National and state design manuals that are referred to in the design guidance included for the NM Bike Plan are described below. These documents may be referenced for additional information on bikeway infrastructure design, as well as guidance on technical roadway specifications and geometric design.

7.1 National Design Guidance

The Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices (MUTCD)* defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public traffic. The MUTCD is the primary source for guidance on lane striping requirements, signal warrants, and recommended signage and pavement markings.

The American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities* (current version, 2012) provides guidance on dimensions, use, and layout of specific bicycle facilities. This guide is currently being updated, with the new version scheduled to be released in 2018.

The National Association of City Transportation Officials' (NACTO) *Urban Bikeway Design Guide* (current version, 2014) offers guidance on the current state of practice in the design of bikeway facilities in urban areas.

The AASHTO *A Policy on Geometric Design of Highways and Streets* (current version, 2011) commonly referred to as the "Green Book," contains the current best practices roadway geometric design. The Green Book should be referenced by designers for roadway technical specifications. Use of the Green Book should be complemented by a dedicated bicycle design guide, including guidance provided in the NM Bike Plan, the AASHTO Bike Guide, and the NACTO Urban Bikeway Design Guide.

FHWA's *Separated Bike Lane Planning and Design Guide* (2015) offers guidance on separated bike lanes (also known as protected bike lanes, or cycle tracks). The guide includes information on design and implementation of facilities including intersection treatments and interactions with parking, transit, and loading.

FHWA's *Small Town and Rural Multimodal Networks* (2016) document is a design resource and idea book to help small towns and rural communities support safe, accessible, comfortable, and active travel for people of all ages and abilities.

7.2 State Design Guidance

New Mexico Department of Transportation Design Manual, October 2016

New Mexico Department of Transportation Road Diet Guide, November 2016

New Mexico Department of Transportation Rumble Strip Policy, forthcoming

New Mexico Department of Transportation Signing and Striping Manual, March 2008