Bicycle working group report

Concepts and recommendations for bicycle infrastructure design in Los Alamos County.

Bicycle Working Group

Hermann Geppert-Kleinrath
David North
Eddie Schoute
Christopher Cude-Woods
Silvie Adam
Sarah Thien
En-Chuan Huang
Emily Piltch
June Fabryka-Martin
Travis Moulton

Acknowledgment
County Staff

Keith Wilson
Juan Rael
Eric Martinez
Eric Ulibarri
Karen Henderson

June 9, 2025

Contents

Executive summery

Los Alamos is an active and outdoorsy community. However, bicycle ridership as a mode of transportation is low. Several surveys and polls indicated that citizens favored adding bicycle and pedestrian infrastructure throughout the County. The Bicycle Working Group was formed to give input to the Transportation Board on how to improve bicycle ridership and infrastructure. This report summarizes the work done by the Bicycle Working Group.

Studies have shown a strong correlation between quality of bicycle infrastructure and ridership. Ridership numbers in Los Alamos can be improved by building better and more extensive bicycle infrastructure. We describe the concept of Level of Traffic Stress (LTS). With low LTS riderships of up to 60% are possible. Los Alamos County has a low bicycle ridership of ∼3%, indicating a high LTS. This report gives guidance on infrastructure design in general as well as recommendations for specific intersections and areas in Los Alamos County, to reduce the LTS and increase bicycle ridership.

Bicycle infrastructure must be comprehensive, uninterrupted, and well designed to attract riders. The degree of separation between bicycles and cars should be based on vehicle speed and traffic volume. The highest degree of separation possible should be used in any given situation. Intersections should be designed to be safe and easy to navigate, to both increase safety and comfort. In general the recommendations given in this report should be incorporated in all future road work projects, to progressively improve the bicycle path network. Some particular dangerous and unpleasant routs and intersections critical for connectivity should be improved as soon as possible. We recommend following the guidance of the National Association of City Transport Officials (NACTO) for designing infrastructure. We urge the County to follow the recommendations laid out in the 'Bicycle Transportation Plan' of 2017.

Chapter 1

Introduction

Cycling is good for both physical health as well as mental well being. High cycling rates can significantly reduce greenhouse gas emissions, reduce traffic congestion, and have a positive impact on businesses in traffic calmed bicycle friendly areas [2, 10, 16]. Los Alamos County is dedicated to improving bicycle friendliness and was awarded bronze status as a Bicycle Friendly Community by the League of American Bicyclists in 2017, a status which it still retained as of Fall 2021 (see Appendix 1) [1]. [Update Reference 1 to refer to the 2021 report card]. In order for the County to achieve silver status, the report card points to (1) development of increased separation and protection of bicyclists based on levels of motor vehicle speed and volume, and (2) improvement of the bike network through the use of different types of bicycle facilities, such as protected bike lanes/cycle tracks, buffered bike lanes, and bicycle boulevards. Despite the outdoorsy population and Los Alamos' efforts to increase cycling rates in the county, the bicycle ridership is low at 3%.

The County's Bicycle Transportation Plan that was adopted by County Council in 2017 details the motivation, large scale concepts, survey results, and plans for a bike path network [31]. The survey results indicated strong support for cycling infrastructure, with Diamond Drive, Down Town Los Alamos, and White Rock being the most used areas. The biggest problem discouraging people from riding in the County, according to the survey, is that bicycling is not safe. This same sentiment was expressed in the November 2018 survey conducted by the LANL Bicycle Safety Committee [17] Not only were 60% of those survey respondents uncomfortable sharing roads with motor vehicles, but 30% also reported having been involved in some form of a bicycle crash around LANL.

This report by the Bicycle Working Group provides background information about the best types of bicycle infrastructure to use under different circumstances, general design guidelines, and specific examples for infrastructure in Los Alamos County to increase safety and ridership. The recommendations are based on peer-reviewed research and current design guidelines as well as Los Alamos specific needs. Well designed and safe bicycle infrastructure, especially when designed for all ages and abilities, will not only increase ridership, equity, and health, but will also help Los Alamos achieve a lower carbon footprint.

Chapter 2

Ridership and Level of Traffic Stress

Studies from all over the world and in the US show that the strongest correlations to high bicycle ridership are not terrain, weather, or population density but rather to the quality of bicycle infrastructure. The so-called winter cycling capital of the world is Oulu, Finland 2.1. Oulu is further north than Fairbanks Alaska, its average ridership is has 22%, and 19% ridership in winter [23, 30]. Oulu has over 600 miles of separated bike paths for a population of 200,000. This is just one example showing that weather is not a good predictor of bicycle ridership. Studies in the US also show that the strongest predictor for bicycle ridership is well built infrastructure [9, 22].

Figure 2.1: *Cyclist on a bike path and walkway with lanes indicated by projected signs in Oulu, Finnland*

Having low bicycle accident rates are not sufficient to increase bike ridership, cycling must also *feel* safe. The concept of Level of Traffic Stress (LTS) is a framework used to evaluate how comfortable or stressful a cycling environment feels, particularly in relation to adjacent motor vehicle traffic [3]. Developed by researchers at the Mineta Transportation Institute, LTS categorizes streets and bike facilities on a scale from 1 lowest stress, suitable for all ages and abilities, to 4 highest stress, suitable only for the most experienced and highly confident riders (figure 2.2).

Depending on the LTS, different percentages of the population are willing to ride their bicycles. Thigh highest LTS along a route dictates the overall appeal for cyclists. The population can be split into four groups:

- The highly confident riders willing to ride without any bicycle infrastructure make up depending on the study less than 1% and up to 7%.
- The somewhat confident riders who need separated bike lanes to ride their bicycles. They are up to 9% of the population.
- Up to 60% of interested but concerned riders prefer separated infrastructure. The people who will never ride bikes in traffic are less then a third of the population. Even in this group some people can be reach through micro-mobility and handicapped accessibility [4].

Cities with high-stress infrastructure — mostly unprotected or disconnected bike lanes — typically see bicycle mode shares of only 1–3%. The riders tend to be mostly middle-aged white men. In contrast, cities with low-stress, all-ages-and-abilities networks (e.g., Seville, Copenhagen, and Vancouver) report ridership in the range of 10–20% or higher [3]. The bike ridership is more diverse with more women, children and elderly people riding bikes. Even within U.S. contexts, targeted investments in low-stress networks — such as Portland's neighborhood greenways or New York City's protected lanes — have led to significant increases in cycling mode share. According to the National Association of City Transportation Officials (NACTO), if LTS meets the needs of the "interested but concerned" group—people, the ridership can be pushed up to 60%. Los Alamos County has a ridership of $\sim$3% indicating a high level of traffic stress of 3 to 4.

Continuity and comprehensiveness of the cycling network are also vital for reducing traffic stress. Comprehensiveness is important because, if you cannot reach places of interest by bike, cycling will not be an attractive alternative to a car. Infrastructure must maintain protection through intersections—often the most stressful and dangerous part of a cyclist's journey. NACTO's 'Don't Give Up at the Intersection' emphasizes that intersections should maintain or improve the level of comfort provided between blocks, using tools such as dedicated signal phases, curb extensions, and protected intersections [5]. Equally, a comprehensive network that covers the full geographic area of a city ensures that safe routes are available in all neighborhoods, not just a select few. Disconnected or piecemeal infrastructure discourages usage and reinforces perceptions of cycling as unsafe or impractical. Continuity can be interrupted by a single intersection with high level of traffic stress that deter safety concerned cyclists, or by temporary interruptions by construction sites, traffic stops, and accidents. If bicycle infrastructure is only available' as long as it is not used by motor vehicles, continuity is not a given and safety concerned cyclists will be deterred.

A key determinant of traffic stress is the degree of separation between cyclists and motor vehicle traffic. Facilities such as protected bike lanes, off-street paths, and neighborhood greenways that limit traffic volumes and speeds tend to fall under LTS 1 or 2 and are appropriate for users of all ages and abilities. In contrast, painted bike lanes on busy arterial roads or shared-use lanes with high-speed traffic typically fall into LTS 3 or 4, making them accessible only to a small segment of confident cyclists. According to NACTO, infrastructure designed to LTS 1 or 2 standards is essential to broaden bicycle ridership beyond the small percentage of "strong and fearless" riders and reach the broader "interested but concerned" population, which constitutes the majority of the public.

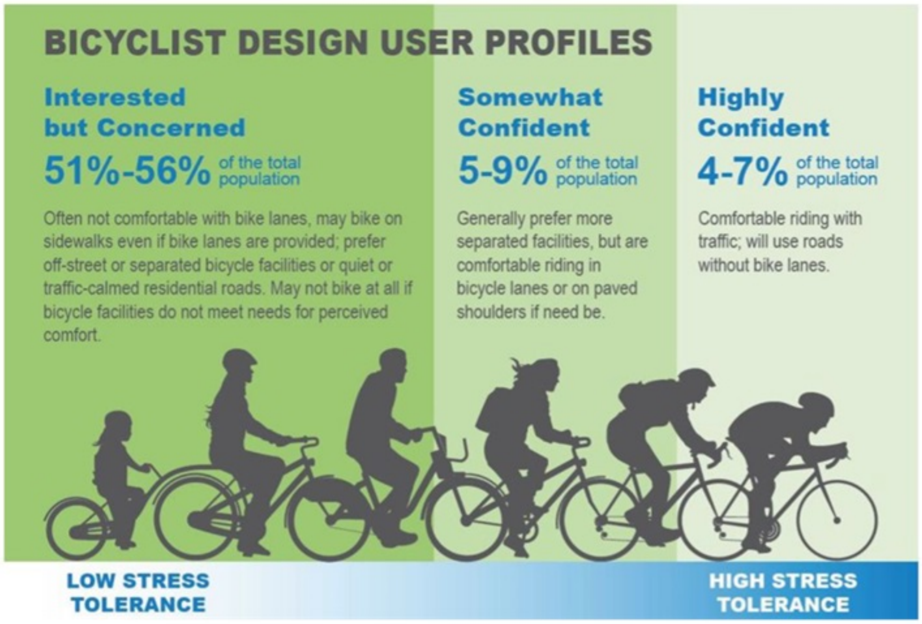


Figure 2.2: *Level of Traffic Stress (LTS) illustration. Bad infrastructure causing a LTS limits ridership. Well built infrastructure enables ridership of up to 60%. (Credit: Federal Highway Administration 2019)*

Together, these factors—low LTS design, separation, continuity, and geographic coverage—form the backbone of a bicycle network that is truly inclusive, enabling safe and appealing cycling for people of all ages and abilities.

Chapter 3

General Infrastructure Guidance

Well-built infrastructure is critical for safety, convenience, and capacity of the roads. Although this report is focused on cycling infrastructure, the suggested designs will improve pedestrian and vehicle safety as well. As a side effect well designed infrastructure will make driving more relaxing. Cities and countries with high bike ride shares and well designed infrastructure have happier and more relaxed drivers [29].

Vision Zero is a program developed by the Swedish government with the goal to reduce traffic fatalities to zero [28]. The ideas in Vision Zero have also guided design in other countries, effectively reducing traffic fatalities. Vision Zero states that it can never be ethically acceptable that people are killed or seriously injured when moving within the road transport system. Here are some guiding principles of Vision Zero:

- A system that is safe only if nobody makes mistakes, is not a safe system.
- People make mistakes. Design the system so the outcome is benign.
- Design intersections so that accidents are unlikely.
- Control vehicle speeds so that accidents that are likely to happen are not likely to be deadly.

Infrastructure should be intuitive and inherently safe. The more intuitive infrastructure is the less education is needed for people to follow the intended design. We encourage color coding paths and crossing for both cyclists and pedestrians. Cycling paths and crossings are frequently colored green. Paint gets slippery when wet and should be avoided on bicycle paths. There are alternatives like colored epoxy glass mixtures that don't have that downside. Zebra crossings are a type of color coding for pedestrian crossings. Shark-tooth markings also known as yield lines can be used to indicate where traffic participants should yield. Bicycle infrastructure should be accessible to micro-mobility users. Examples for micro-mobility are kick scooters, roller skates, e-bikes, or wheel chairs [21]. It will be safer for micro-mobility users than driving on the road and will increase usage of bicycle infrastructure making it a better investment.

We also encourage education campaigns for all participants in traffic. Education and educational materials should be easily understandable preferably without the need for literacy

GUIDANCE FOR SELECTING ALL AGES & ABILITIES BIKEWAYS

Bikeway	Target Motor Vehicle Speed	Motor Vehicle Volume per day	Motor Vehicle Volume Peak Hour in Peak Direction
Protected Bike Lane	Any	Any	Any
Shared Spaces	≤10 mph ≤15 km/h	≤ 1,000	≤60
Bicycle Boulevard	≤ 20 mph ≤ 30 km/h	≤ 500 - 2,000	<50-150
Advisory Bike Lane	≤ 20 mph ≤ 30 km/h	≤ 500-2,000	<50-150
Constrained Bike Lanes	≤ 20 mph ≤ 30 km/h	≤ 1,500-3,000	≤ 300
Constrained Bike Lane *with Buffer*	≤ 25 mph ≤ 40 km/h	≤ 6,000	≤ 600

Figure 3.1: *The degree of separation of bicycle infrastructure should be a function of traffic volume and traffic speed [6].*

and designed for all ages. Educational material should be updated as needed. For example, did you know that New Mexico adopted the ”Idaho stop” [24]?

3.1 Degree of Separation

Car, bicycle, and pedestrian infrastructure must be separated based on speed and volume of traffic to ensure a low level of traffic stress. It is obvious that cyclists and pedestrians should not share the lane with cars on highways. But at what speeds and traffic volumes is it acceptable for cars and cyclist to share the road? The NACTO recommendations for degree of separation are given in figure 3.1.

Sharing the road is only recommended in traffic calmed areas with a vehicle speed of less than 10 mph. These include pedestrianized areas like shopping streets with low traffic volume and pedestrians, cyclists, and cars intermingling. Such areas are for source traffic only and not for through traffic. Mixed use paths for pedestrians and cyclists should be avoided outside such traffic calmed areas. While pedestrians are walking at ∼3 mph, a leisurely cycling speed is ∼10 mph. At these speed differentials a passing cyclist is uncomfortable for pedestrians and a pedestrian changing direction unexpectedly can cause accidents and injury. Everywhere else the highest degree of separation possible should be built to decrease the level of traffic stress.

For motor vehicle speeds above 25 mph only constrained bike lanes with buffer are recommended. This applies to almost all streets and roads in Los Alamos. More considerations on traffic separation and accessibility can be found in the guide 'Designing for all ages and abilities' [4]. Design considerations for different degrees of separation can be found in 'Urban Bikeway Design Guide' [6].

Figure 3.2: *Bike lane with buffer created by paint and bollards [7].*

Bollards are a cheap and simple way to create some physical separation between cars and cyclists. An example is shown in figure 3.2. Bollards can be installed on already existing bike lanes as a retrofit. However, a preferable way to create a buffered, raised, physically separated bike lane is shown figure 3.3. The curbs and trees give a higher degree of separation and yield a lower LTS. Trees close to the motor vehicle lane also reduce car speeds, because they make the perceived road width narrower. There is also a shallow curb separating the walk way from the bike lane. Raised bike lanes also reduce the amount of debris like glass shards and gravel being thrown onto the bike path.

3.2 Intersection Design Considerations

Figure 3.3: *Bike lane separated by buffer with green and trees on Rosemead Boulevard, Temple City, California.*

Most accidents in urban environments happen at intersections, which makes intersection design key to traffic safety. At intersections the amount of information that a traffic participant needs to absorb and act upon can be overwhelming, especially when multiple conflicts (where the paths of two traffic participants intersect) can occur simultaneously. It is especially important that appropriate mode separation is kept intact as much as possible through intersections.

Conflicts at intersections should only occur one at a time. This ensures that the drivers attention is not split between multiple other traffic participants, which increases the risk of missing something and causing an accident. Conflicts should occur as close to 90° angle between the parties as possible (figure 3.4). This makes it easier to see the other participant and to communicate. This is especially true for car drivers, since car pillars or co-drivers can obscure the field of view. Conflicts with shallow angle of conflict are dangerous since cyclists and pedestrians can easily be overlooked in the blind-spot of drivers (figure 3.5). These shallow angles also require drivers to look back over their shoulders which becomes harder with age or injury and makes safe driving harder for elderly or handicapped members of the community. Cyclists not being seen by drivers performing a right hand turn is the deadliest traffic scenario for cyclists and special attention should be

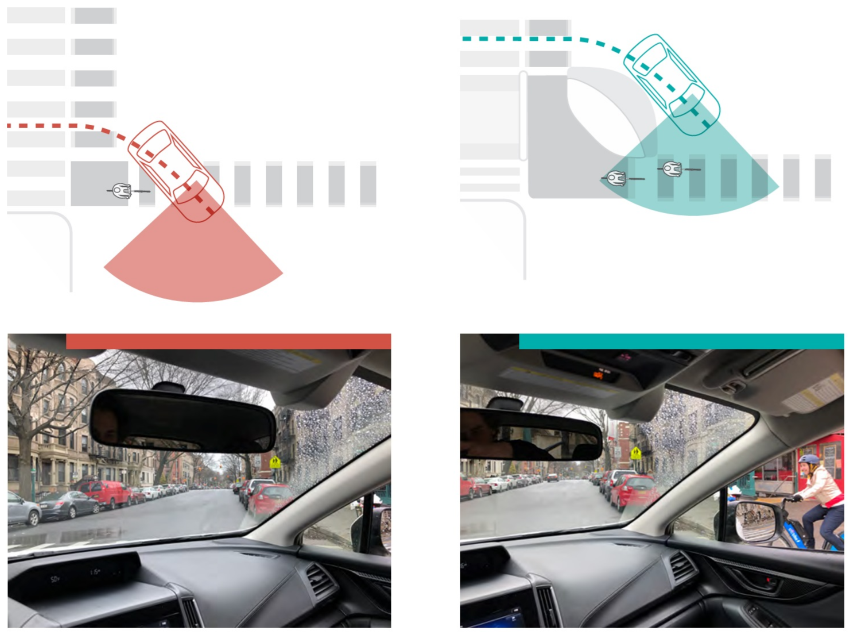


Figure 3.4: *Two different conflict scenarios highlighting the impact of angle between the two parties in a conflict. The closer to a* 90° *angle that the two traffic participants intersect the easier it is to see each other [5].*

paid in the design of intersections.

Conflicts should occur at manageable driving speeds giving parties enough time to react without causing an accident. The right-of-way should be clearly and easily ascertained by all traffic participants. Studies have shown that drivers are less likely with higher driving speeds to stop for pedestrians and cyclist that have the right-of-way [12]. At 25 mph turning speed only 25% of drivers stop for pedestrians having the right-of-way. At 10 mph it is more than 75%. Slowing turning traffic down therefore reduces accident rates [19] and makes accident outcomes less severe.

Cornering speeds can be controlled by the radius of the cars turning [13]. Corner islands can be designed so that personal vehicles have a sharp turn, while heavy commercial vehicles can partially mount the corner island to easily make a turn at low speeds. Smaller turning radii can also lead to shorter pedestrian crossings and therefore less time spent by pedestrians in the intersection (figure 3.6). Center line hardening is when physical obstacles are installed along the center line to avoid vehicles crossing into other lanes while aproaching or leaving the intersection. Center line hardening using flexible bollards that can be pushed over by large commercial and emergency vehicles can help enforce the vehicle design speed.

Counter flowing bicycle lanes (cyclists riding on the left side of the road) should be avoided, since drivers tend to overlook cyclists coming from the ”wrong” direction more frequently.

We recommend following the designs laid out in the NACTO guides ’Urban Bikeway Design Guide’, ’Don’t Give Up at the Intersection’, and ’Designing for all ages and abilities’ [6, 5, 4].

Figure 3.5: *Shallow angles of conflict make it particularly hard to see the other traffic participants. The cyclist in this figure might also not be able to see the signal of a passing car.*

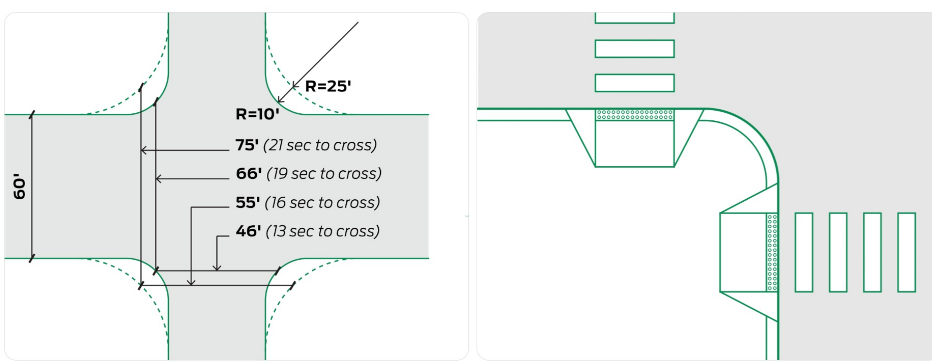


Figure 3.6: *Sharper corner radius reduces turning vehicle speeds and reduces crossing ditance for pedestrians.*

3.3 Major Protected Intersection

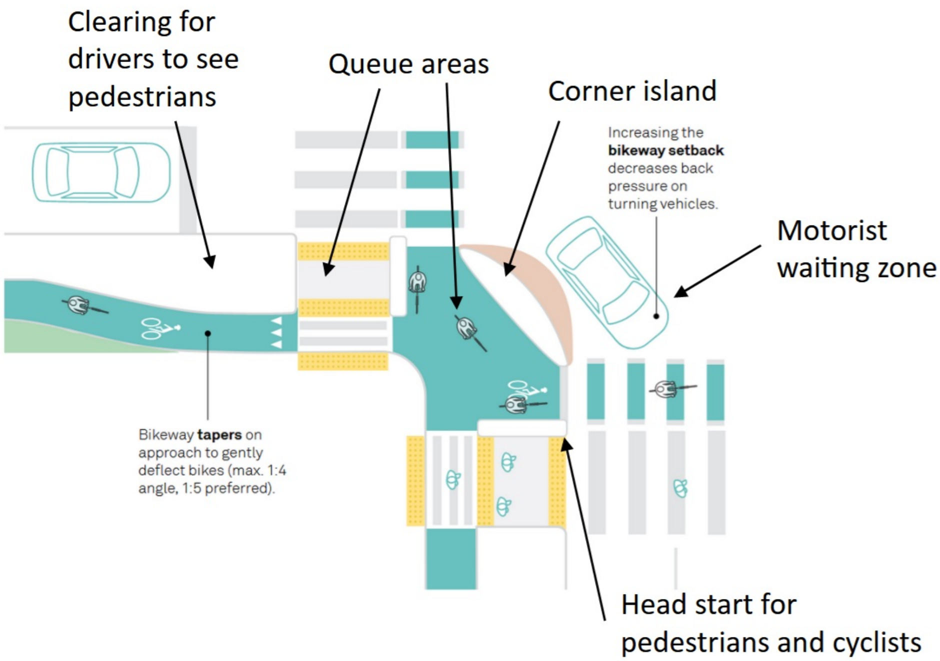


Figure 3.7: *Protected major intersection design [5].*

Protected intersections - also known as setback or offset intersections - keep bicycles and pedestrians physically separate from motor vehicles up until the intersection, providing a high degree of comfort and safety for people of all ages and abilities (figure 3.7). This design can reduce the likelihood of highspeed vehicle turns, improve sightlines, and dramatically reduce the distance and time during which people on bikes are exposed to conflicts.

On the approach to the intersection both the walk-way and the bike lane are set back. This makes a clearing for drivers to see pedestrians and cyclists in the queue areas long before the driver enters the intersection. The clear zone cannot be used for parking. The queue areas give pedestrians and cyclist wanting to cross a waiting area where they are not interfering with other traffic participants. Pedestrians cross the bike path and the car lanes in two steps reduces the conflict at a times, crossing times, and stress for pedestrians. The same is true for cyclists. Right turning cyclists can bypass the intersection and only have to yield to pedestrians crossing the bike path.

Cyclists having to yield to pedestrians is indicated by shark-tooth markings in front of the pedestrian crossing. The setback allows for a motorist waiting zone and a corner island to control car speeds. The waiting zone gives turning cars a place to stop and let pedestrians and cyclists cross without feeling pressure to leave the intersection because of cars queuing behind the driver. The queue areas for pedestrians and cyclists are ahead of the stop line for cars giving pedestrians and cyclists a head start when the light turns green.

Cyclist turning left should do this in two stages. First cross the road straight and then turn left on the far side. This avoids mixing with car traffic, which only highly confident cyclists are comfortable with. Crossing the street to the left instantly, instead of turning left on the far side leads to cyclist counter flowing traffic. This is more dangerous since drivers overlook cyclist counter flowing more frequently.

Details on setbacks, clear sight distances, corner radius, design variations, and more can be found in 'Don't Give Up at the Intersection' [5].

3.4 Protected Intersection

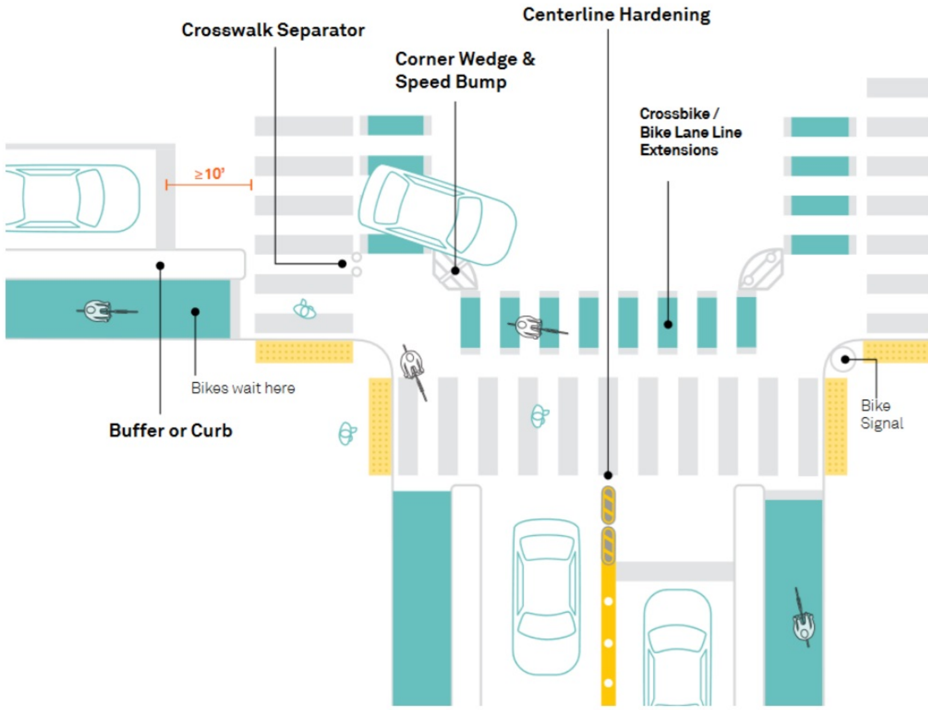


Figure 3.8: *Protected for smaller spaces and lower traffic volumes [5].*

The protected intersection as shown in figure 3.7 is a smaller design for lower traffic volumes than those for major protected intersection discussed in the previous section. There are no setbacks for cyclists and pedestrians and no motorist waiting zone. Leading up to the intersection a buffer curb separates cyclists from the car lane. Flexible bollards are used for separations, at corners, and for center line hardening. The corner island is reduced to a corner wedge or speed bump, that can be mounted by emergency vehicles. Details to this design and alternative designs can be found in 'Don't Give Up at the Intersection' [5].

3.5 Minor Street Crossing

The point where a bikeway crosses a minor street or driveway is a transition zone between a moderate speed, signalized traffic environment and a very-low speed street. A well-designed

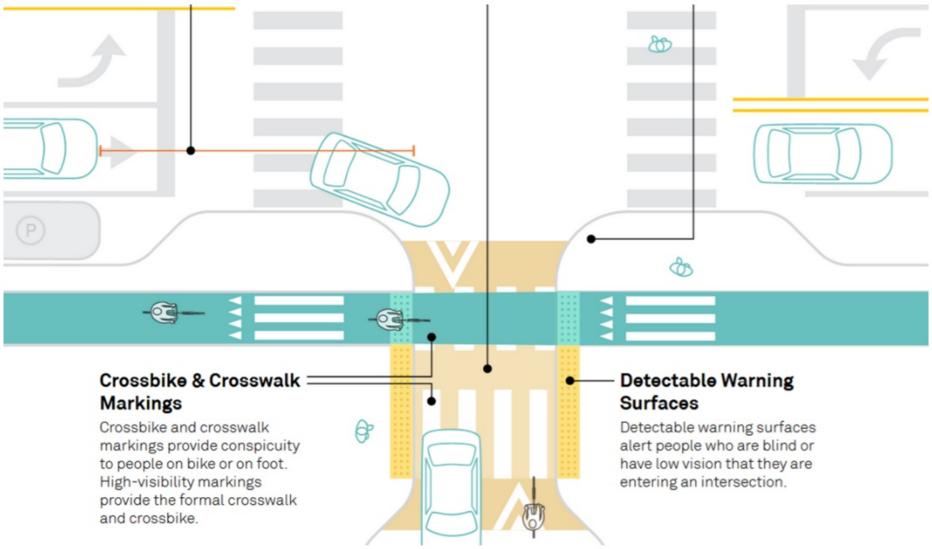


Figure 3.9: *Minor street crossing design [5].*

minor-street intersection gives everyone — people driving, biking, and walking — a clear indication that bikes and pedestrians have the priority when crossing the minor street (figure 3.9.

As was the case for protected intersections (figure 3.7), the corner radius is designed to control the target speed and a sight clearing in front of the pedestrian and cyclist crossings enables unobstructed view of the crossing. The clearing can also serve as a pedestrian queuing zone for pedestrians crossing the main road. A central refuge area can be included for pedestrians and cyclists crossing the main road.

The pedestrian and cyclist crossings are set back to allow for a motorist waiting zone. This design again takes the perceived pressure off the motorist to exit the intersection quickly, since he is not obstructing the intersection. The cyclist and pedestrian crossings are raised to the level of the sidewalk and cycling path. This acts as a speed table further enforcing the design cornering speed.In addition, there is a psychological aspect to speed tables: By having the motorist drive up to the level of the cyclists and pedestrians it feels like entering their space to the driver, in contrast to road level crossing giving the feeling that cyclists and pedestrians are entering the space of motorists. Shark-tooth markings on the ramp up to the raised crossing further emphasize that the driver has to yield.

3.6 Roundabout

Roundabouts are particular safe intersection designs, reducing crashes by up to 60% and fatal car accidents by 90% when compared to traditional signaled intersections [15]. The safety advantages come from the shallow collision angles between cars (no T-bone accidents), the almost perpendicular conflicts between cars and pedestrians and cyclists, and from splitting up individual conflicts so that drivers can handle conflicts one at a time. Roundabouts reduce CO_2 emissions because motorists don't necessarily have to stop and then accelerate,

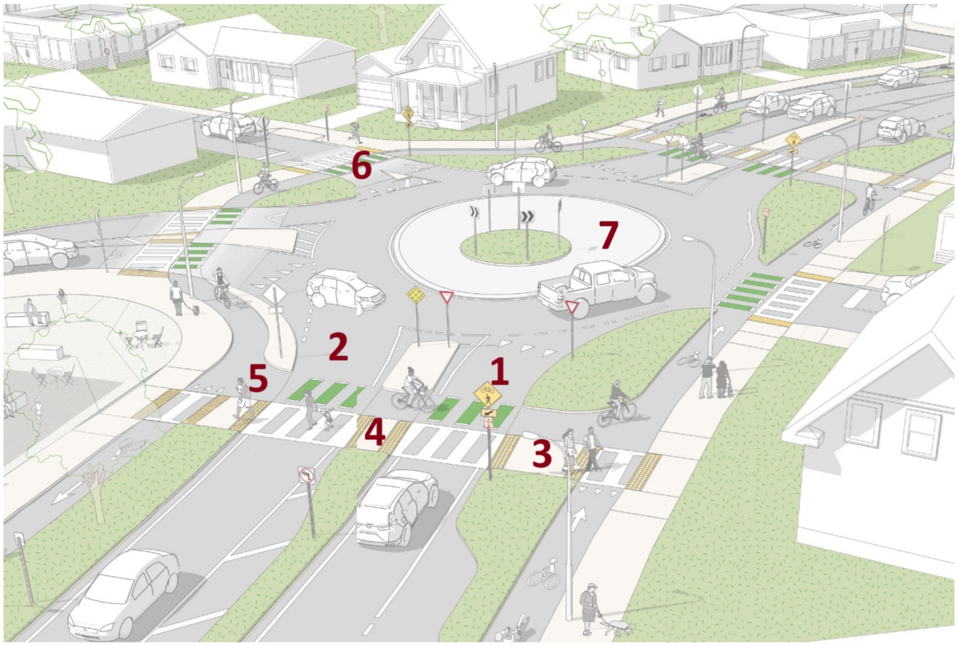


Figure 3.10: *Roundabout design study, showing motorist waiting zones, separated pedestrian crossings for the bike path and road, queuing areas for cyclists and pedestrians, and center refuge zones. [5].*

also reducing strain on breaks, tires, and engines.

The full advantage of roundabouts is best utilized when certain design considerations are respected. In figure 3.10 a generic design study is shown. A driver approaching the roundabout can first stop for cyclists and pedestrians before moving on to the motorist waiting zone marked with '1' in figure 3.10. At this point all the attention of the motorist can be focused to the left looking for vehicles already in the roundabout. When exiting the roundabout the motorist has another waiting zone marked '2' in figure 3.10. Here he can yield to pedestrians and cyclists without feeling pressure to leave the roundabout since he is not blocking it. The center island consists of an un-mountable inner section and an outer section that can be mounted by slow moving heavy commercial vehicles (marked '7' in figure 3.10). The approach to the roundabout at mark '1' should have a radius similar to that of a corner island as described in section 3.3 and shown in figure 3.7. The corner island can be divided up into a mountable and an un-mountable portion. The combination of motor vehicle approach angle, corner island and center island should be used to control the vehicle target speed. If the approach angle is too shallow drivers will go faster though the roundabout. The same is true if the corner island is too far from the center of and the approach to the roundabout. The exit speed of the vehicles can be controlled in a similar way. Unfortunately, this vehicle speed management is not shown in figure 3.10, but a corner island is shown in figure 3.11 marked '1'.

Pedestrians and cyclists have queuing areas (marked '3' in figure 3.10) and center refuge islands (marked '4') in figure . If the roundabout has minor roads accessing the roundabout, raised pedestrian crossings can be used (marked '6'), similar to the minor street crossing discussed in section 3.5 and illustrated in figure 3.9.

Figure 3.11: *This roundabout has the disadvantage for a straight entry for cyclists onto the road. This lead to higher cyclist speeds and increases accident risk.*

The cyclist speed in the roundabout should also be controlled. To achieve a low cyclist speed a sharp turn with unobstructed view is introduced right before the cyclist queuing zone (marked '5' in figure 3.10). To contrast this design a negative example is given in figure 3.11. Here the cyclists approach to the crossing has no speed control measures (marked '2' in figure 3.11). This can lead to excess bicycle speed and higher accident risk compared to the design in figure 3.10. The higher bicycle speed gives both cyclists and motorists less time to judge the conflict and react accordingly.

Slip lanes on roundabouts should be avoided, since they lead to more potential conflicts and faster vehicle speeds on the slip lane. A similar effect to slip lanes can be achieved by multi-lane roundabouts. Mature designs of multi-lane roundabouts are currently built, but little high quality guidance is available right now. Lane dividers seem to be important to avoid vehicles crossing lanes within multi-lane roundabouts. Dedicated entries and dedicated exits should be well marked in advance. There also seems to be a learning curve for drivers until the benefits of multi-lane roundabouts materialize [14].

3.7 Bike Lane Width

Bicycle lanes must be wide enough for riders to feel comfortable (figure 3.12). The less experienced a bike rider is the more clearance from obstacles they need to feel comfortable. Bikeways must me designed to have enough rideable width for all expected users to operate comfortably, ride side-by-side, pull a child-trailer, or pass one another. Rideable width is the usable width of a bikeway for riding, excluding any shy distance or unrideable areas. The shy distance for bikeways is the unrideable surface next to a vertical object, such as a curb, barrier, streetlight, or sign pole.

- Gutter pans are not rideable and have a shy distance of 1-2 in.
- For beveled curbs, the shy distance is 6 in.
- For low curbs under 6 in tall, the shy distance is 8 in.
- For vertical curbs that are 6 in tall, the shy distance is 10 in.
- Barriers that are over 2 ft high have a shy distance of 20 in.

Bike path should be kept clean and in good repair. Figure 3.13 shows some examples of bad cycling path conditions in Los Alamos. Gutters on the bike path reduce the effective width. Potholes can cause a cyclist to loos control and cause accidents. Debris on the road can cause tire punctures or can lead to slipping wheels and loss of control. Bad road conditions increase the level of traffic stress and should be avoided.

MINIMUM AND PREFERRED RIDEABLE WIDTHS								
Control Device	One-Way Bike Lane				Two-Way Bike Lane			
	Minimum Recommended*		Preferred		Minimum Recommended*		Preferred	
Mini Device Widths cannot be less than a typical bike	6 ft	1.8 m	7-8 ft	2.1-2.4 m	8-10 ft	2.4-3 m	11-13 ft	3.3-3.9 m
Typical Bike Device width up to 2.5 ft (0.8 m)	6 ft	1.8 m	7-8 ft	2.1-2.4 m	8-10 ft	2.4-3 m	11-13 ft	3.3-3.9 m
Cargo Bike Device width up to 3 ft (0.9 m)	6.5 ft	2 m	8-9 ft	2.5-2.8 m	9-11 ft	2.7-3.3 m	12-14 ft	3.7-4.3 m
Extra-Large Bike Device width up to 4.5 ft (1.4 m)	7 ft	2.1 m	11.5-12.5 ft	3.5-3.8 m	12-14 ft	3.6-4.2 m	15-17 ft	4.7-5.3 m

Figure 3.12: *Bikeway widths as recommended by NACTO [6].*

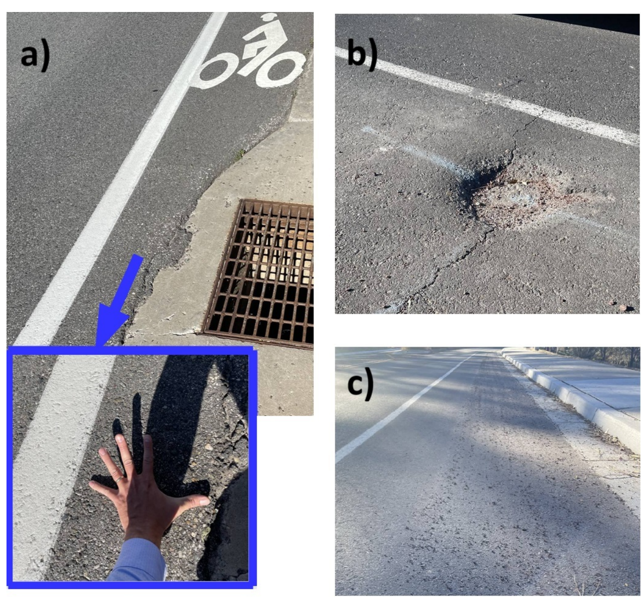


Figure 3.13: *Examples of bad bicycle path condition that are dangerous and deterring to cyclists. a) Narrowing of the rideable path with due to gutter. b) Potholes on the bike path. c) Road surfaces covered debris.*

3.8 Vehicle Target Speed Control

Vehicle speed is not only important for how safe a street feels, lower vehicle speed also reduces accident rates. Speed is also the strongest predictor for outcome severity of accidents. Results show that the average risk of severe injury for a pedestrian struck by a vehicle reaches 10% at an impact speed of 16 mph, 25% at 23 mph, 50% at 31 mph, 75% at 39 mph, and 90% at 46 mph. The average risk of death for a pedestrian reaches 10% at an impact speed of 23 mph, 25% at 32 mph, 50% at 42 mph, 75% at 50 mph, and 90% at 58 mph. Risks vary significantly by age. For example, the average risk of severe injury or death for a 70-year old pedestrian struck by a car traveling at 25 mph is similar to the risk for a 30-year-old pedestrian struck at 35 mph. At 35 mph cars have twice as much energy as at 25 mph [26]. Controlling vehicle speed is critical for LTS, reducing accidents, and reducing severity of outcomes.

Figure 3.14: *Side and center bollards on Kittiwake Drive, Ottawa, ON. These bollards reduced the 85% speed from 35 mph to 25mph without narowing the road [8].*

An effective way to slow car speeds is making the road appear narrower. This can be achieved by bollards on the side of the lane and on the center line like in figure 3.14. The lane width is not reduced but feels narrower to drivers and reduces vehicle speed. When placed right before and after pedestrian and cyclist crossings they reduce the speeds, heighten awareness, and prevent vehicles passing each other on the crosswalk. These bollards can be pushed over by large and emergency vehicles. The bollards are also very cost effective and quick to install without requiring a major redesign of the street. Bollards can cause issues with snow plowing, but are in use in many cities with more snow accumulation than Los Alamos [27].

Speed tables as shown in figure 3.15 left are also an effective way to reduce vehicle speed. Speed tables may require a specialized solution that allows for snow plowing operations. However, such designs do exist [25] generally consisting of a more gradual slope and are in common use in municipalities with similar or more snowfall than Los Alamos [27]. Speed tables allow for continuous sidewalks where pedestrians do not step down to street level to cross, but rather road users “step up” to sidewalk level, making it clear to drivers that pedestrians have priority and increase comfort and accessibility for pedestrians.

Traffic diversions shown on the right of figure 3.15 are also an effective way to reduce vehicle speed. They force car drivers to follow the curvature and adapt their speed accordingly. The perceived obstruction also reduces vehicle speed. Both these can be combined with pedestrian and cyclist crossings.

Speed reduction measures like discussed above are more effective then signage. Drivers are more likely to drive a speed that feels appropriate than driving the speed indicated by speed signs. A low traffic target speed can be enforced without the need for putting up more speed signs. This can be used to reduce effective vehicle speeds to levels safe for mixed traffic, such as cul-de-sacs, residential areas, and shopping streets. The effective speed reduction works best if reduced speed zones are established that cover a whole neighborhood

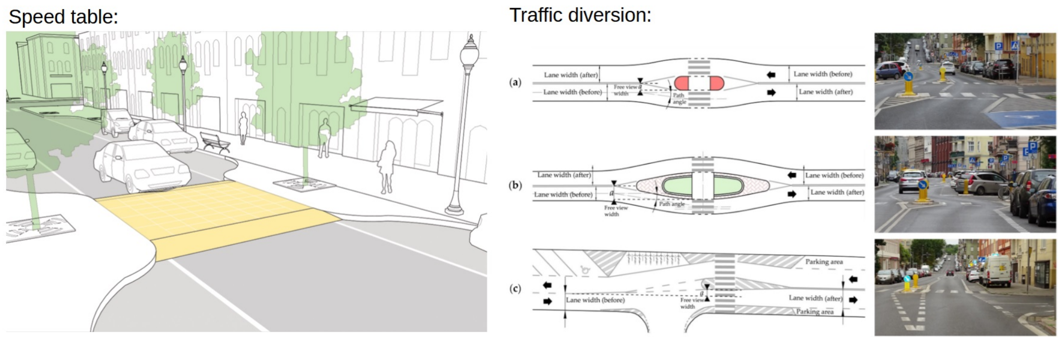


Figure 3.15: *[20].*

instead of single streets or sections of streets are designed for reduced speed.

3.9 Leading Bicycle Traffic Light Interval

Figure 3.16: *Options to enable leading bicycle interval at intersection, by either cyclists using the leading pedestrian light or having a separate bicycle light.*

Leading Pedestrian Intervals (LPI) give pedestrians crossing a road a head start over turning vehicles. LPIs have shown to reduce accidents involving pedestrians crossing at intersections due to better visibility to car drivers. LPI treatment reduces the crash risk of pedestrians as measured by the reduction in extreme vehicle–pedestrian conflicts by about 42% [18]. Cyclist profit from leading intervals in the same way pedestrians do. Los Alamos has introduced LPI, but cyclists are not using a leading light. We recommend either signs indicating that cyclists should use the LPI or separate bicycle lights.

3.10 Bus Stops

Bus stops in areas with high pedestrian traffic and bus usage should be designed to reduce the potential for accidents and interference between different modes. A design scheme for a bus stop is shown in figure 3.17. Bus users wait on the island and boarding ramp with optional shelter. A crossing for the bike path limits pedestrian crossings to a specific area. This can be enforced by railings between the bike lane and the boarding area. This design reduces interference between cyclists and bus users. This design also prevents the bus from blocking the bike lane when passengers board.

The example shown is a near side-bus stop. Far-side bus stops are when the stop is located after the intersection Far-side bus stops are preferred. They allow pedestrians to cross behind the bus, which is safer than crossing in front of the bus. On multilane roadways, they also increase the visibility of crossing pedestrians for drivers waiting at the signal.

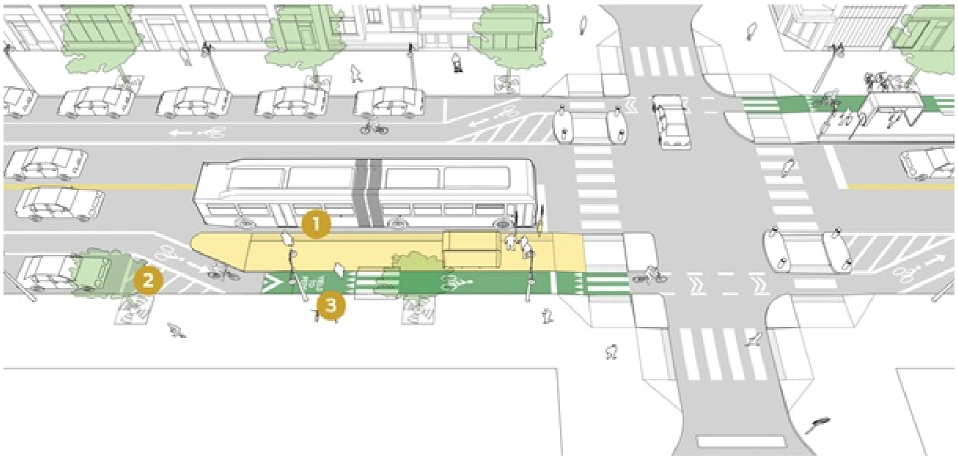


Figure 3.17: *Bus stop design scheme. Waiting area and boarding ramp marked 1. Set back bike lane marked 2. Pedestrian crossing for bike lane marked 3.*

3.11 Infrastructure Design Recommendations for Los Alamos

We recommend that the County adopt the following guidelines and policies as it continues to improve the convenience, effectiveness, and safety of its bicycling infrastructure.

- Adopt Vision Zero principles for all traffic projects (Chapter 3). Vision Zero principles all stem from the belief that it is never acceptable that people are killed or seriously injured while moving within the road transport system.
- Design cycling infrastructure that is safe and accessible to all ages and abilities of riders. Infrastructure should be intuitive and inherently safe. The more intuitive infrastructure is, the less one needs to rely on education for people to follow the intended design.
- Follow recommendations from the National Association of City Transportation Officials (NATCO) for degree of separation between bikes and motor vehicles (Section 3.1).
- Follow designs laid out in NATCO guidelines for 'Urban Bikeway Design Guide', 'Don't Give Up at the Intersection', and 'Design for all ages and abilities' (Section 3.2).
- At traffic lights for pedestrian crossings, install separate bicycle lights or put up signs allowing cyclists to use the 'Leading Pedestrian Intervals' (Section 3.9).
- Control vehicle speed using physical measures that encourage drivers to drive at the design speed (Section 3.8).
- Conduct education campaigns for all those who use the road network, including bicyclists, pedestrians, and vehicular drivers. Educational materials should be easily understandable and designed for all ages.

In the next chapter, we describe specific locations at this guidance should be applied.

Chapter 4

Los Alamos Specific Recommendations

4.1 General recommendations

We recommend that Los Alamos County applies the guidance in Chapter 3 in all future construction projects. This will lead to a naturally growing infrastructure for cyclists. As more projects are built the network will become more comprehensive and interconnected, particularly in residential areas, cul-de-sacs, and small roads. For larger roads that are more important for connectivity, such as Diamond Drive, Trinity Drive, San Ildefonso Road, and Barranca Road, we recommend immediate measures to improve cycling infrastructure and mode separation like bollards and buffers.

We also recommend that the County make an effort to improve the intersections at Diamond Drive and West Road, Diamond Drive and Trinity, and Diamond Drive and Canyon as soon as possible. These are high traffic volume for cars and cyclists, as well as crucial connections for most traffic in Los Alamos. In the long run these roads should have constrained raised bike lanes as shown in figure 4.1.

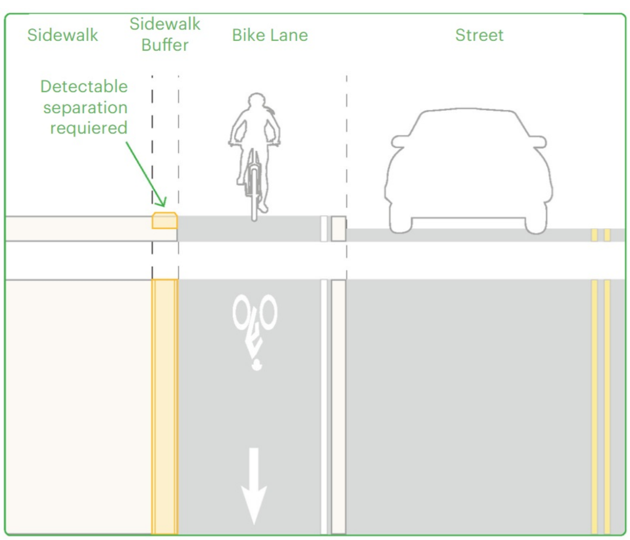


Figure 4.1: *Scheme for a constrained raised bicycle lane with sidewalk buffer [6].*

We recommend that the County always use the highest degree of mode separation possible. More and more people in Los Alamos are using kids trailers and cargo bikes for transport and shopping. We recommend a minimum bike path width of 7 ft for major roads like

Diamond Drive, Trinity Drive, and SR4 as well as in school zones, and as wide as possible elsewhere. We recommend to use asphalt for paving bicycle paths. A smooth surface without cracks, bumps, and grates increases comfort and safety for cyclists. Mixed use for cyclists and pedestrians should largely be avoided, other than for destinations like pedestrianized shopping streets, parks, and low volume recreational use areas. Mixed use should be considered for example on Central Avenue between 9^{th} Street and 20^{th} Street.

We recommend that, in places where cyclists and cars are intended to share the road, the County should design the road for a vehicle target speed of ~10 mph, as described in section 3.1 (Degree of Separation). Presently, several County roads in the Los Alamos townsite use pavement markings called 'sharrows' to indicate a shared lane. However, several studies in the US have found that shared lane markings called 'sharrows' are ineffective and can lead to higher commuter accident rates than having no infrastructure at all [11] (figure 4.2). On streets where such low vehicle target speeds are not reasonable, we recommend that the County build separated bicycle infrastructure like that illustrated in figures 3.2 and 3.3. We recommend that the County follow the priorities for infrastructure improvements as laid out in the 'Bicycle Transportation Plan' [31] (see Appendix 2). The remainder of this chapter provides details on aspects of these recommendations.

4.2 Diamond Drive from Canyon Road to Omega Bridge

Figure 4.2: *Shared lane markings called 'sharrows' [11].*

Diamond Drive is a main connector through Los Alamos is of vital importance to connectivity for vehicles and bicycles alike, especially during rush hour. Three intersections are of critical importance for connectivity and some of the highest traffic volume intersections in Los Alamos: Diamond Drive/Canyon Road, Diamond Drive/Trinity Drive, and Diamond Drive/West Road. The painted bike lanes are inadequate for the vehicle speeds and volumes in these areas. We recommend constrained separated bike lanes (as shown in figure 4.1) on both sides.

Access in south direction over Los Alamos Canyon is provided by the sidewalk across Omega Bridge. We recommend road markings and signs that better indicate that cyclists should use the sidewalk to cross the bridge. Good connection of bicycle paths to the Omega Bridge sidewalk is important. The Public Works Department recently presented several options to the Transportation Board for extending the Canyon Rim Trail to Omega Bridge, which would greatly improve safety and convenience for pedestrian commuters. For bicycle commuters, we recommend a bi-directional crossing on the west side of Diamond Drive and West Road as well as a well-marked bicycle and pedestrian crossing over West Road. On the south side, there are currently two redundant south accesses to Diamond Drive. We recommend removing the one further west. We recommend removal of the slip lane going from Diamond Drive to Trinity Drive and replacing it with a right turn lane. This reduces the number of crossings that pedestrians and cyclists need to make along the south side of Diamond Drive and on Trinity Drive. It would also make for a safer connection to the hospital.

We recommend that all three intersections in this area have a design like that described in

Figure 4.3: *Intersections Trinity-Diamond and Trinity Canyon*

section 3.3. The intersections Diamond Drive/Orange Street and Diamond Drive/Arkansas Avenue should also be designed this way.

4.3 Minor Intersections Along Diamond Drive

Figure 4.5: *A HAWK beacon raising awareness for people crossing.*

Many minor roads connect to Diamond Drive. These are important connectors to the residential areas and should have improved intersection design. Most vehicle and bicycle traffic however, will go along Diamond Drive and should be give priority at the minor intersections.

As an example, the intersection between Diamond Drive and Urban Street is shown in figure 4.4. This example can be applied to many intersections along Diamond Drive, like it's intersections with Ridgeway Drive, Sycamore Street, and Alabama Avenue. The blue lines in figure 4.4 indicate pedestrian infrastructure and the green lines indicate bicycle Infrastructure.

We recommend a raised, set back pedestrian and cyclist crossing as described in section 3.5 (Minor

Figure 4.4: *Intersections Diamond Drive and Urban Street. The blue lines indicate pedestrian infrastructure and the green lines indicate bicycle Infrastructure.*

Steet Crossing). The bike lanes should be designed as shown in figure 4.1. The crossing over Diamond Drive should be on car lane level and have a center refuge for cyclists and pedestrians. We recommend that the County install a High-Intensity Activated Cross Walk (HAWK) beacon to give higher visibility and awareness to people wanting to cross the road at these intersections (see figure 4.5).

4.4 Mountain Lion Roundabout at the Intersection of Diamond Drive and San Ildefonso

The roundabout connecting Diamond Drive, San Ildefonso, and North Mesa Road is used by everyone living on North Mesa or Barranca Mesa who want to go towards down town and is therefore a vital connection (figure 4.6). It also connects to the Bayo Canyon Trail used by many people to hike and ride mountain bikes.

This roundabout has large traffic volumes and vehicle speeds. We recommend a design as described in section 3.6, with some modifications. There is no need for a pedestrian crossing over Diamond Drive on the west side and on the north side over San Iledfonso Road. Pedestrians can use the tunnel under San Ildefonso Road and the crossings on the west side of the roundabout. The pedestrian volume is also low because most pedestrians are on recreational walks and not commuting. Also the traffic volume to and from Diamond Drive are highest and make this crossing stressful for pedestrians.

Cycling infrastructure should be built as described in section 3.6. We recommend removing the slip lanes since they create additional crossings for cyclists and pedestrians, and

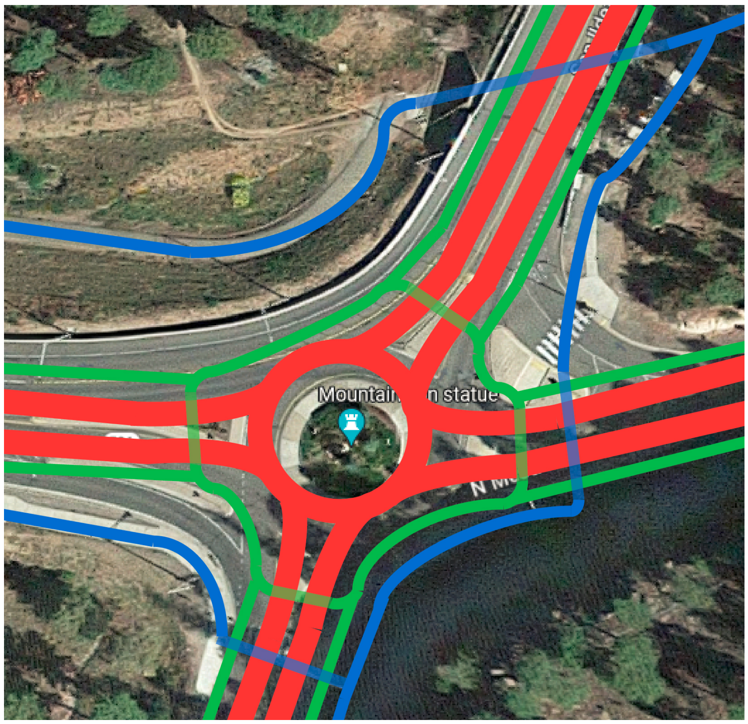


Figure 4.6: *Roundabout connecting Diamond Drive, San Ildefonso, and North Mesa Road. Red lines indicate car lanes, green lines bicycle lanes, and blue lines walkways.*

vehicle speeds are less controlled and much higher. Both high vehicle speed and complex intersections increase the LTS. We don't think a multi-lane roundabout is necessary, given the traffic volume.

North of Diamond Drive is a separate path that could be used by pedestrians. The tunnel connecting the path to the Bayo Canyon Trail is narrow and low. It is too narrow for cyclists and or pedestrians pass each other in the tunnel. This makes it inconvenient for larger cyclist volumes. We recommend that the County widen this tunnel, which would vastly improve its usability and make it more attractive to cyclists.

4.5 NM 502 East to Central Avenue

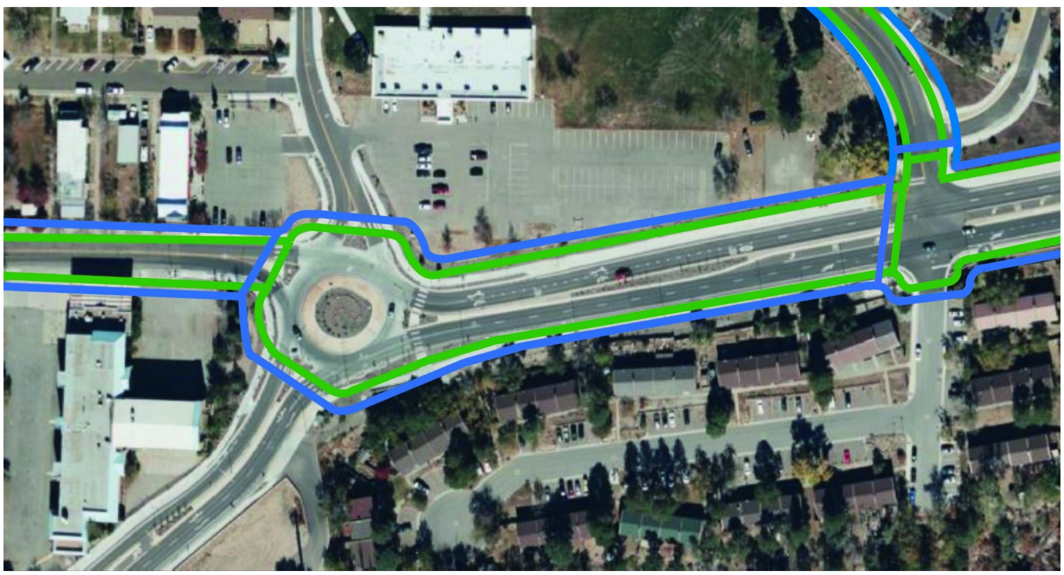


Figure 4.7: *Intersections Trinity-Diamond and Trinity Canyon*

This area includes popular destinations such as Central Avenue, churches, residential areas, and the East Park Pool. The main thoroughfare through this area is NM 502, which carries a high volume of traffic with high vehicle speed road. There is no alternative route for bicyclists; although the Canyon Rim Trail runs parallel to NM 502, this multi-user path is not well connected to any destinations along NM 502. The roundabout at the east end of Central Avenue is well-designed, with set back pedestrian crossings and center refuge islands (figure 4.7). However, the roundabout lacks any bicycle infrastructure. Only highly confident cyclists use the road here. We recommend that the roundabout be up- graded following the guidance described in section 3.6. We recommend improving the bicycle infrastructure along NM 502 by adding constrained raised bike lanes on both sides using the design shown in figure 4.1. The bike lanes should be connected to Central Avenue and along NM 502 to East Drive and the Canyon Rim Trail. The intersections of NM 502 with Canyon Road and and East Drive should be described in section 3.5 with possible connections to bike lanes on Canyon Road. The other minor connections should be treated like described in section 3.6. A schematic is shown in figure 4.7, in which blue lines indicate pedestrian paths and green lines delineating cycling infrastructure.

4.6 Central Avenue

Central Avenue is a major artery for transporting road users east-west through the Los Alamos downtown area. The downtown area has only two other through-going connector routes: Trinity Drive and Canyon Road. In evaluating where bicycle and pedestrian improvements would be the most useful for creating a safer and more comfortable transportation infrastructure, we concluded that Central Avenue would be the best place option. Trinity Drive is a large, state-owned road that moves a lot of vehicle traffic at high speeds. A two-way bicycle path along the westbound section on the north side of this road, while probably an improvement over the current situation, will likely cause safety and comfort concerns for riders. Research shows that bicycles going against traffic increases the number of accidents because drivers may not expect bicycles going the “wrong” way.

Central Avenue connects to many small businesses and destinations along the road and its side streets. Destinations south of Diamond Drive can be accessed easily by crossing once and with little detour. But Central Avenue poses its own set of challenges:

- The street is more constrained by surrounding properties, which limits options for separte bike paths.
- The hill up from the Aquatic Center is too steep for (non-motorized) cyclists of all ages and abilities.
- Currently, the speed limit is 25 MPH, to fast for a cyclist mixed in with road traffic, especially uphill.
- Central Avenue experiences a lot of through traffic from drivers going through the down- town area.

We recommend that Central Avenue be established as a destination with through traffic greatly reduced, if not preventedc. Because there are already a lot of parking lots close to Central Avenue, the few parking spots on Central Avenue itself could be removed, thereby creating more space for cyclists and pedestrians. Businesses could use the space gained for outdoor seating. Four different options could be considered for improving the stretch between 9^{th} Street and 20^{th} Street: reduced vehicle target speed, turning it in a one-way street, a modal filter, or pedestrianizing.

Reduced Vehicle Speed

Major intersections on Central Avenue, such as Knecht, 15^{th}, and 20^{th} Streets, could be raised intersections, in which the whole intersection becomes a speed table where cars yield to pedestrians and cyclists. On established pedestrian crossings, minor intersections like Central Park Square, and parking lot exits, we recommend raised pedestrian crossings (see section 3.5). This design leads to reduced traffic speed and can also make mixed use for cyclists and cars viable. This will also reduce through traffic, since the reduced speed would make Trinity Drive more attractive to vehicular traffic than Central Avenue. Another benefit of a reduction in traffic volume and speed will be that Central Avenue will become a more attractive destination for spending time, making a positive impact on businesses.

Figure 4.8: *The modal filter allows pedestrians and cyclists to go straight through the intersection but cars must turn.*

One-Way Street

Turning Central Avenue into a one-way street would likewise reduce traffic and make Central Avenue more appealing to pedestrians and cyclists. Space will be gained that can be used for cycling paths, pedestrians walkways,and outdoor seating. The car lane could be zigzagging or have other diversion to reduce the length of straight sections, which reduces traffic speed and can make for a more appealing road.

Modal Filering

Modal filtering refers to a section in the street that can be crossed by pedestrians and cyclists but not by cars. The objective would be to close Central Avenue to any vehicular through traffic other than bikes and busses. This could be achieved by trees, traffic islands, or bollards that block the road for cars but not for other modes. Installation of automatically retracting bollards or a bar gate could allow buses to continue to drive through Central Avenue. . The modal filter could be designed as shown in figure 4.8. This configuration could allow cars coming from the east to go up to 15^{th} street and turn right towards Canyon Road. Cars coming from the west on Central Avenue would turn right on 15^{th} Street towards Trinity Drive. Both of these options would be bidirectional. This would reduce traffic on Central to source traffic, but buses could still go most of the way in both directions on Central Avenue. This modal filter option could be combined with speed reduction measures as discussed above.

Pedestrianizing

Central Avenue could be fully pedestrianized and cyclists could share the space with pedestrians. This could create a park-like space that could be used as a business and recreational hub for Los Alamos, complete with park benches and attractions. Figure 4.9 shows an example of a pedestrianized street in Denver, Colorado. A street mall on 16^{th} Street in Denver combines a pedestrianized zone with public transport. In Los Alamos, such a pedestrianized area could be tested in a pilot project during the summer month, similar to what is done

Figure 4.9: *A pedestrianized street in Denver.*

for parades in Los Alamos. If unsuccessful, it can be removed easily and, if successful, a permanent design can be developed.

4.7 School Zones

We recommend traffic calmed areas around schools. Measures for controlling vehicle speed as described in section 3.8 should be applied to the school zones. Pedestrian and cycling crossings should ever be raised above the street grade, or else speed tables should be installed as shown in figure 3.15.

4.8 Pedestrian and Cyclist Bridge

The County investigated the option of a bridge over Pueblo Canyon, connecting Canyon Road to North Mesa. A car bridge over such a long span is prohibitively expensive. However, construction of a pedestrian and cyclist bridge would be significantly cheaper. This bridge could span ∼1300 ft directly from Canyon Road to North Mesa (blue line in figure 4.9). Alternatively, the bridge could be split into two spans (red lines in figure 4.10), with the first section spanning ∼900 ft from Canyon Road to Walnut Street and the second section extending ∼1000 ft from Walnut Street to North Mesa. Any design would need to take into account the fact that the endpoints of the bridge are at very different elevations, which could be addressed on the bridge itself and/or through access paths.

The county investigated the option of a bridge over Pueblo Canyon connecting the main hill to north mesa. A car bridge over such a long span is prohibitively expensive. However, a pedestrian and cyclist bridge could be built significantly cheaper. This bridge could span ∼1300 ft directly from the Main Hill to North Mesa see the blue line in figure 4.10. This bridge could also be split into two spans, see red lines in figure 4.10. First spanning ∼900 ft from Canyon Road to Walnut Street and further another ∼1000 ft from Walnut Street to North Mesa see 4.10. These connection points are not on the same sea level and the elevation difference must be compensated for, either on the bridge itself or through access paths.

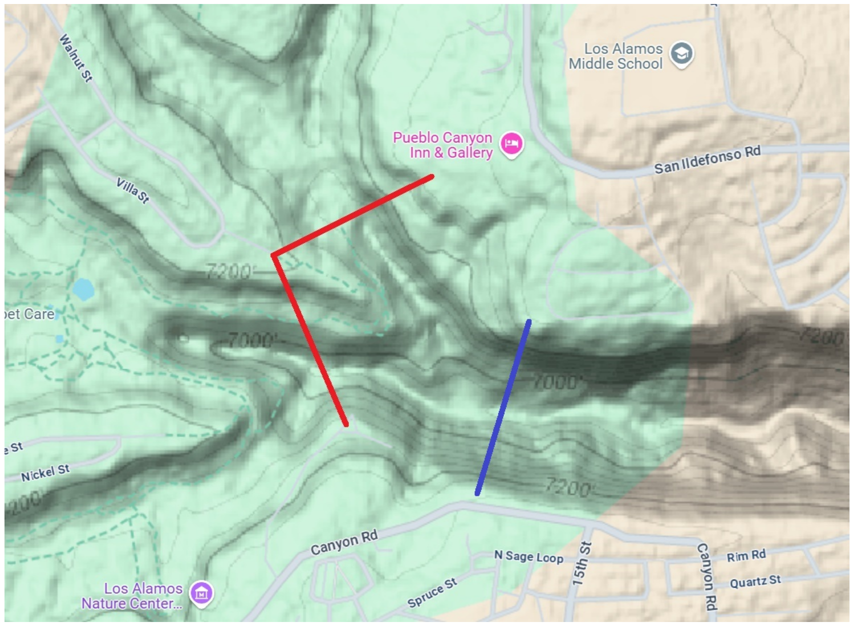


Figure 4.10: *Possible locations for a cyclist and pedestrian bridge. The blue line indicates a direct connection from the Canyon Road to North Mesa. The red lines indicate a second option including a connection to Walnut Street.*

This bridge could reduce commute distances for residents in the connected areas significantly shorter and cycling and walking more attractive. We do understand that such a project is very costly and unlikely to be pursued. However, if the county considers such a project we would fully support it, as it would be a dramatic improvement to the cycling and pedestrian network in Los Alamos.

4.9 White Rock

Because White Rock has a simpler road layout and relatively benign traffic, little if any major alterations to its roads are necessary. A major contributor to White Rock's bicycle-friendly nature is the abundance of cut-through and alternative trails, many of them paved and almost all usable by all bicycle types. However, many of those trails are in extremely poor repair and have been so for years. Some of them are slated for updating as part of the SR4 projects related to the completion of the Mirador subdivision, but more needs to be done in the way of maintenance. We still recommend improving bicycle infrastructure on the main roads in White Rock as prioritized in the 'Bicycle Transportation Plan' [31] (see White Rock map in Appendix 2). Separated buffered bike lanes would be best on NM4. Rover Boulevard, Grand Canyon Drive, and Meadow Lane would profit from having separated bike lanes. Speed control measures could be implemented on smaller roads and cul-de-sacs.

4.10 Los Alamos - White Rock Connector

A connection between Los Alamos and White Rock has been suggested on multiple occasions. We support efforts to have a paved bicycle connection between Los Alamos and White Rock. In the survey conducted for the 2017 Bicycle Transportation Plan, this connection was by far the top-ranked improvement desired by the respondents.

Given the ~1000 ft of elevation gain from White Rock to Los Alamos, a route with a smooth and steady gradient is preferable. The bicycle path should also be separated from major commuter roads like East Jemez Road or NM502 since a large volume of fast moving traffic will deter riders. Los Alamos Canyon, with its steady gradient, separation from major roads and existing dirt road that could be improved with asphalt, represents a great option for a connector route.

Bibliography

[1] League of American Bicyclists. “Bicycle Friendly Community Fall 2017 Report Card Los Alamos NM”. In: (2017). URL: https://bikeleague.org/sites/default/files/bfareportcards/BFC_Fall_2017_ReportCard_Los_Alamos_NM.pdf.

[2] Christian Brand et al. “The climate change mitigation effects of daily active travel in cities”. In: *Transportation Research Part D: Transport and Environment* 93 (2021), p. 102764. ISSN: 1361-9209. DOI: https://doi.org/10.1016/j.trd.2021.102764. URL: https://www.sciencedirect.com/science/article/pii/S1361920921000687.

[3] Mekuria M. C., Furth P. G., and Nixon H. “Low-Stress Bicycling and Network Connectivity.” In: *Mineta Transportation Institute.* (2012). DOI: https://transweb.sjsu.edu/research/low-stress-bicycling-and-network-connectivity.

[4] National Association of City Transportation Officials. *Designing for alll ages and abilities*. New York: Island Press, 2017. URL: https://nacto.org/publication/urban-bikeway-design-guide/planning-and-developing-a-bikeable-city/designing-for-all-ages-and-abilities/.

[5] National Association of City Transportation Officials. *Don’t Give Up at the Intersection*. New York: Island Press, 2025. URL: https://nacto.org/wp-content/uploads/NACTO_Dont-Give-Up-at-the-Intersection.pdf.

[6] National Association of City Transportation Officials. *Urban Bikeway Design Guide*. New York: Island Press, 2025. ISBN: 978-1-64283-384-3.

[7] *DeveloTech*. Accessed 2025. URL: https://www.develotech.com/en/bicycle-path-flexible-bollard/layout/.

[8] *DeveloTech*. Accessed 2025. URL: https://www.develotech.com/en/sign-speed-reduction/ped-zone-at-work/.

[9] Jennifer Dill and Theresa Carr. “Bicycle Commuting and Facilities in Major U.S. Cities: If You Build Them, Commuters Will Use Them”. In: *Transportation Research Record* 1828.1 (2003), pp. 116–123. DOI: 10.3141/1828-14. URL: https://doi.org/10.3141/1828-14.

[10] Zhufeng Fan and Corey D. Harper. “Congestion and environmental impacts of short car trip replacement with micromobility modes”. In: *Transportation Research Part D: Transport and Environment* 103 (2022), p. 103173. ISSN: 1361-9209. DOI: https://doi.org/10.1016/j.trd.2022.103173. URL: https://www.sciencedirect.com/science/article/pii/S1361920922000050.

[11] Nick Ferenchak and Wesley Marshall. *The Relative (In)effectiveness of Bicycle Sharrows on Safety Outcomes*. 2025. URL: https://onlinepubs.trb.org/onlinepubs/Conferences/2016/UTC/IB-3-Marshall.pdf.

[12] D.R. Geruschat. *Driver Behavior in Yielding to Sighted and Blind Pedestrians at Roundabouts*. 2005.

[13] A Policy on Geometric Design of Highways and Streets. *American Association of State Highway and Transportation Officials*. Washington D.C., 2011.

[14] Wen Hu et al. "Truck and Bus Safety; Roundabouts". In: *Transportation Research Record* 2402 (2014). URL: https://www.iihs.org/topics/bibliography/ref/2033.

[15] Hillary Isebrands and Shauna Hallmark. "Statistical Analysis and Development of Crash Prediction Model for Roundabouts on High-Speed Rural Roadways". In: *Transportation Research Record* 2312.1 (2012), pp. 3–13. DOI: 10.3141/2312-01. eprint: https://doi.org/10.3141/2312-01. URL: https://doi.org/10.3141/2312-01.

[16] Liu J. "Understanding Economic and Business Impacts of Street Improvements for Bicycle and Pedestrian Mobility - A Multi-City Multi-Approach Exploration". In: *National Institute for Transportation and communities* (2019). URL: https://nitc.trec.pdx.edu/research/project/1161.

[17] *LANL Bicycle Safety Committee – November 2018 Survey Results.* Report LA-UR-19-22187. URL: https://www.osti.gov/servlets/purl/1501763/.

[18] "Leading pedestrian intervals". In: *Accident Analysis and Prevention* 181 (2023), p. 106929. DOI: https://doi.org/10.1016/j.aap.2022.106929.

[19] Kendra K. Levine. "Curb Radius and Injury Severity at Intersections". In: *Berkeley: Institute of Transportation Studies Library* (2012).

[20] Stanisław Majer and Alicja Sołowczuk. "Traffic Calming Measures and Their Slowing Effect on the Pedestrian Refuge Approach Sections". In: *Sustainability* 15.21 (2023). URL: https://www.mdpi.com/2071-1050/15/21/15265.

[21] *Micromobility*. Accessed 2025. URL: https://en.wikipedia.org/wiki/Micromobility.

[22] Arthur C. Nelson and David Allen. "If You Build Them, Commuters Will Use Them: Association Between Bicycle Facilities and Bicycle Commuting". In: *Transportation Research Record* 1578.1 (1997), pp. 79–83. DOI: 10.3141/1578-10. URL: https://doi.org/10.3141/1578-10.

[23] *Oulu County Homepage.* Accessed 2024. URL: https://oulu.com/en.

[24] *SENATE BILL 73*. Accessed 2025. URL: https://www.nmlegis.gov/Sessions/25%20Regular/bills/senate/SB0073.HTML.

[25] *SPEED HUMP FACT SHEET*. Accessed 2025. URL: https://www.montgomerycountymd.gov/DOT-Traffic/Resources/Files/PDF/SpeedHumps/Fact%20Sheet.pdf.

[26] B.C. Tefft. *Impact Speed and a Pedestrian's Risk of Severe Injury or Death*. Tech. rep. AAA Foundation for Traffic Safety, 2011. URL: https://aaafoundation.org/impact-speed-pedestrians-risk-severe-injury-death/.

[27] *Traffic calming, Minneapolis.* Accessed 2025. URL: https://www2.minneapolismn.gov/government/departments/public-works/traffic-parking-services/traffic-calming/.

[28] *Vision Zero Global*. Accessed 2025. URL: https://visionzero.global.

[29] “WAZE driver satisfaction study”. In: *WAZE data* (2017).

[30] *Winter Cycling Federation*. Accessed 2024. URL: https://wintercycling.org/.

[31] Public Works. “Bicycle Transportation Plan”. In: *Los Alamos county* (2017). URL: https://www.losalamosnm.us/files/assets/public/v/1/2017-bicycle-transportation-plan-adopted-6-27-17.pdf.

Chapter 5

Appendix

1. Bicycle Friendly Community Report Card for Los Alamos (Fall 2021).
Source: LAC report card

2. Los Alamos County Bicycle Transportation System (as adopted by County Council on July 26, 2005). Source: Bicycle Transportation Plan, Council Adopted June 27, 2017

BICYCLE FRIENDLY COMMUNITY
Fall 2021
BRONZE
THE LEAGUE OF AMERICAN BICYCLISTS

LOS ALAMOS, NM

TOTAL POPULATION	POPULATION DENSITY
19,419	178

TOTAL AREA *(sq. miles)*
109

# OF LOCAL BICYCLE FRIENDLY BUSINESSES	1
# OF LOCAL BICYCLE FRIENDLY UNIVERSITIES	0

10 BUILDING BLOCKS OF A BICYCLE FRIENDLY COMMUNITY

	Average Silver	*Los Alamos*
High Speed Roads with Bike Facilities	35%	110%
Total on- and off-road Bicycle Network Mileage to Total Road Network Mileage	48%	107%
Bicycle Education in Schools	GOOD	VERY GOOD
Share of Transportation Budget Spent on Bicycling	11%	25%
Bike Month and Bike to Work Events	GOOD	AVERAGE
Active Bicycle Advocacy Group	YES	YES
Active Bicycle Advisory Committee	MEETS EVERY TWO MONTHS	MEETS AT LEAST MONTHLY
Bicycle–Friendly Laws & Ordinances	GOOD	VERY GOOD
Bike Plan is Current and is Being Implemented	YES	YES
Bike Program Staff to Population	1 PER 78K	1 PER 9.7K

CATEGORY SCORES

ENGINEERING *Bicycle network and connectivity*	3.3/10
EDUCATION *Motorist awareness and bicycling skills*	3.7/10
ENCOURAGEMENT *Mainstreaming bicycling culture*	3.9/10
EVALUATION & PLANNING *Setting targets and having a plan*	5.3/10

KEY OUTCOMES

	Average Silver	*Los Alamos*
RIDERSHIP *Percentage of Commuters who bike*	2.7%	2.64%
SAFETY MEASURES **CRASHES** *Crashes per 10k bicycle commuters*	537	39
SAFETY MEASURES **FATALITIES** *Fatalities per 10k bicycle commuters*	6.3	0

KEY STEPS TO SILVER

» Continue to expand and improve Los Alamos County's on-road bike network and ensure that your community follows a bicycle facility selection criteria that increases separation and protection of bicyclists based on levels of motor vehicle speed and volume, to maximize safety and comfort for bicyclists of all ages and abilities. Identify gaps and add new facilities that complete and expand the bicycle network, and work to upgrade existing facilities, such as by converting wide paved shoulders into dedicated protected bike lanes and turning roads with sharrows into dedicated bicycle boulevards through traffic calming measures. Consider using FHWA's Bikeway Selection Guide to inform these upgrades: https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf

» Continue to increase the amount of high quality bicycle parking throughout the community, and to upgrade the quality of existing bike parking to meet APBP standards. Adopt a bike parking ordinance for new and existing buildings that specifies the amount and location of secure, convenient, APBP-compliant bike parking available.

» Develop bicycle education opportunities for adults. Consider ways to target demographics who currently do not feel safe riding with classes or events that address their concerns and create an inclusive, welcoming environment.

» Host a League Cycling Instructor (LCI) seminar to increase the number of local LCIs in your community. Having several

KEY STEPS CONTINUED ON PAGE 2...

LOS ALAMOS, NM

Fall 2021

KEY STEPS TO SILVER CONTINUED

active instructors in the area will enable you to expand cycling education for youth and adults, recruit more knowledgeable cycling ambassadors, deliver Bicycle Friendly Driver education to motorists, and have experts available to assist in encouragement programs. Visit bikeleague.org/ridesmart for more information.

» Expand on-bike bicycle safety education to be a routine part of education for students of all ages, and ensure that schools and the surrounding neighborhoods are particularly safe and convenient for biking and walking. Work with the school district, local bicycle groups, and interested parents to create on-bike learning opportunities and Safe Routes to School programming for all K-12 schools. Providing more bicycles in schools for on-bike education ensures that all students can learn to safely ride a bicycle regardless of the availability of a bicycle in their household.

» Work with the local school district and interested parents to organize a Bike to School Day event every Fall and Spring. Bike to School Day events can include competitions related to bicycle use, outreach to parents, and coordination between the schools and the city to create safer routes to schools.

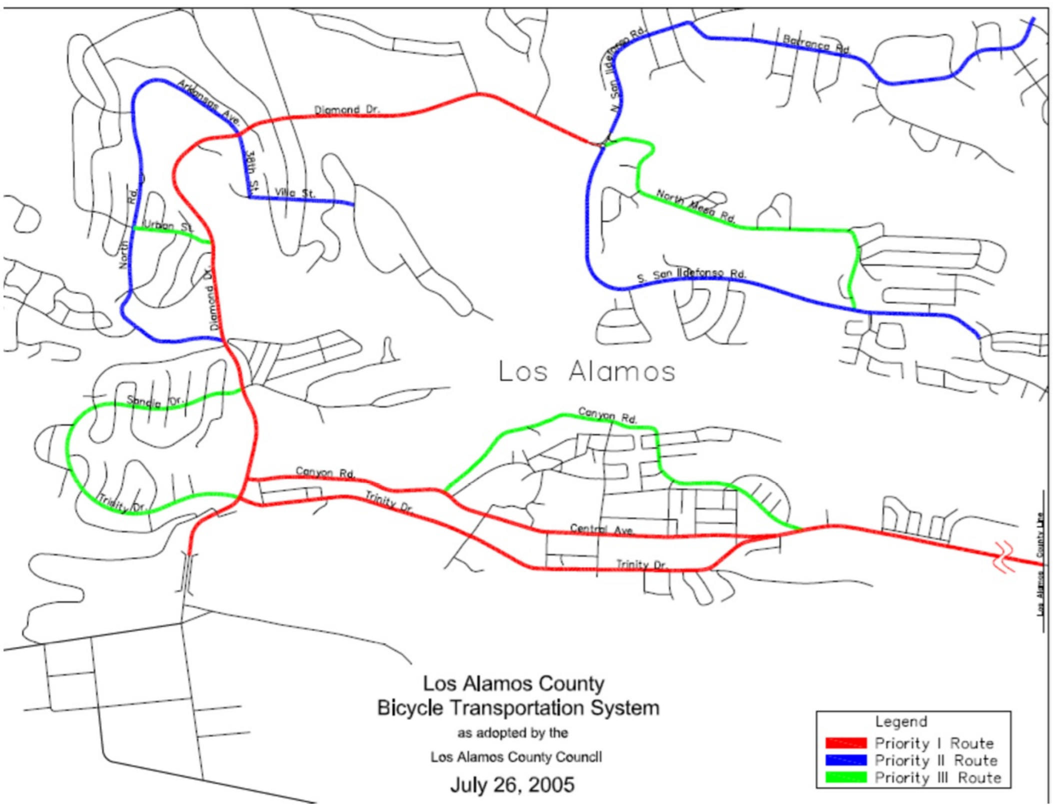
» Continue to develop a bicycle count program that utilizes several methods of data collection including automated bicycle counters to provide long-term data on bicycle use at fixed points and mobile counters to provide periodic or before/after data related to a changes in your community's road or bicycle network. Observational counts and surveys can supplement automated data in order to collect demographic information and examine social equity goals.

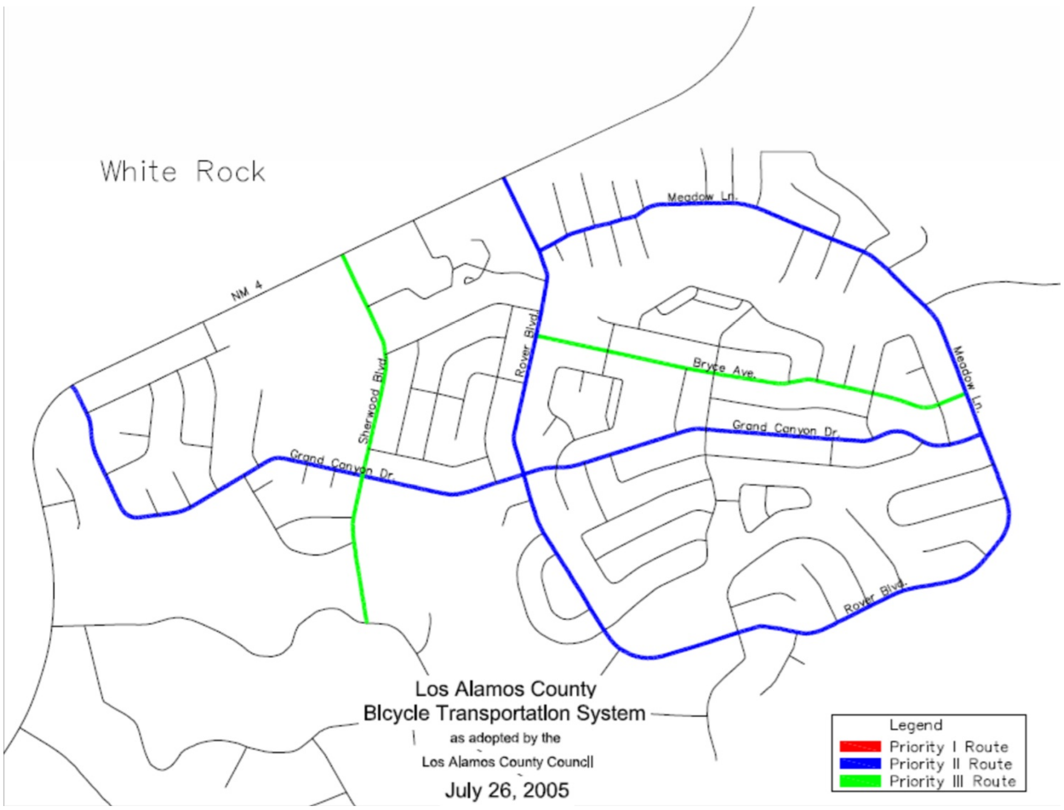
» Adopt a target level of bicycle use (percent of trips) to be achieved within a specific timeframe, and ensure data collection necessary to monitor progress.

» Launch a bike share system that is open to the public. Bike sharing is a convenient, cost effective, and healthy way of encouraging locals and visitors to make short trips by bike, make bicycling more accessible to all, and to bridge the 'last mile' between public transit and destinations.

MORE RESOURCES FOR IMPROVING YOUR COMMUNITY:

- **League of American Bicyclists: https://www.bikeleague.org**
- **Guide to the BFC Report Card: https://bikeleague.org/sites/default/files/Guide_to_the_Bicycle_Friendly_Community_Report_Card.pdf**
- **Resources for Building a Bicycle Friendly Community: https://bikeleague.org/BFC_Resources**
- **Building Blocks of a Bicycle Friendly Community: https://bikeleague.org/content/building-blocks-bicycle-friendly-communities**
- **About the BFC Application Process: https://bikeleague.org/content/about-bfc-application-process**
- **The Five E's: https://bikeleague.org/5-es**
- **Tips for Current and Aspiring BFCs: https://bikeleague.org/BFC-tips**
- **Smart Cycling Program: https://bikeleague.org/ridesmart**
- **Advocacy Reports and Resources: https://bikeleague.org/reports**
- **Bicycle Friendly Business Program: https://bikeleague.org/business**
- **National Bike Month: https://bikeleague.org/bikemonth**


Los Alamos
Diamond Dr.
Arkansas Ave.
36th St.
Villa St.
North Rd.
Urban St.
Diamond Dr.
Sandia Dr.
Trinity Dr.
Canyon Rd.
Trinity Dr.
Central Ave.
Trinity Dr.
Canyon Rd.
N. San Ildefonso Rd.
Barranca Rd.
North Mesa Rd.
S. San Ildefonso Rd.
Los Alamos County
Bicycle Transportation System
as adopted by the
Los Alamos County Council
July 26, 2005
Legend
Priority I Route
Priority II Route
Priority III Route


White Rock
NM 4
Meadow Ln.
Sherwood Blvd.
Rover Blvd.
Bryce Ave.
Meadow Ln.
Grand Canyon Dr.
Grand Canyon Dr.
Rover Blvd.
Los Alamos County
Bicycle Transportation System
as adopted by the
Los Alamos County Council
July 26, 2005
Legend
Priority I Route
Priority II Route
Priority III Route