VERMONT
AGENCY OF TRANSPORTATION

Vermont Multimodal Roadway Guide

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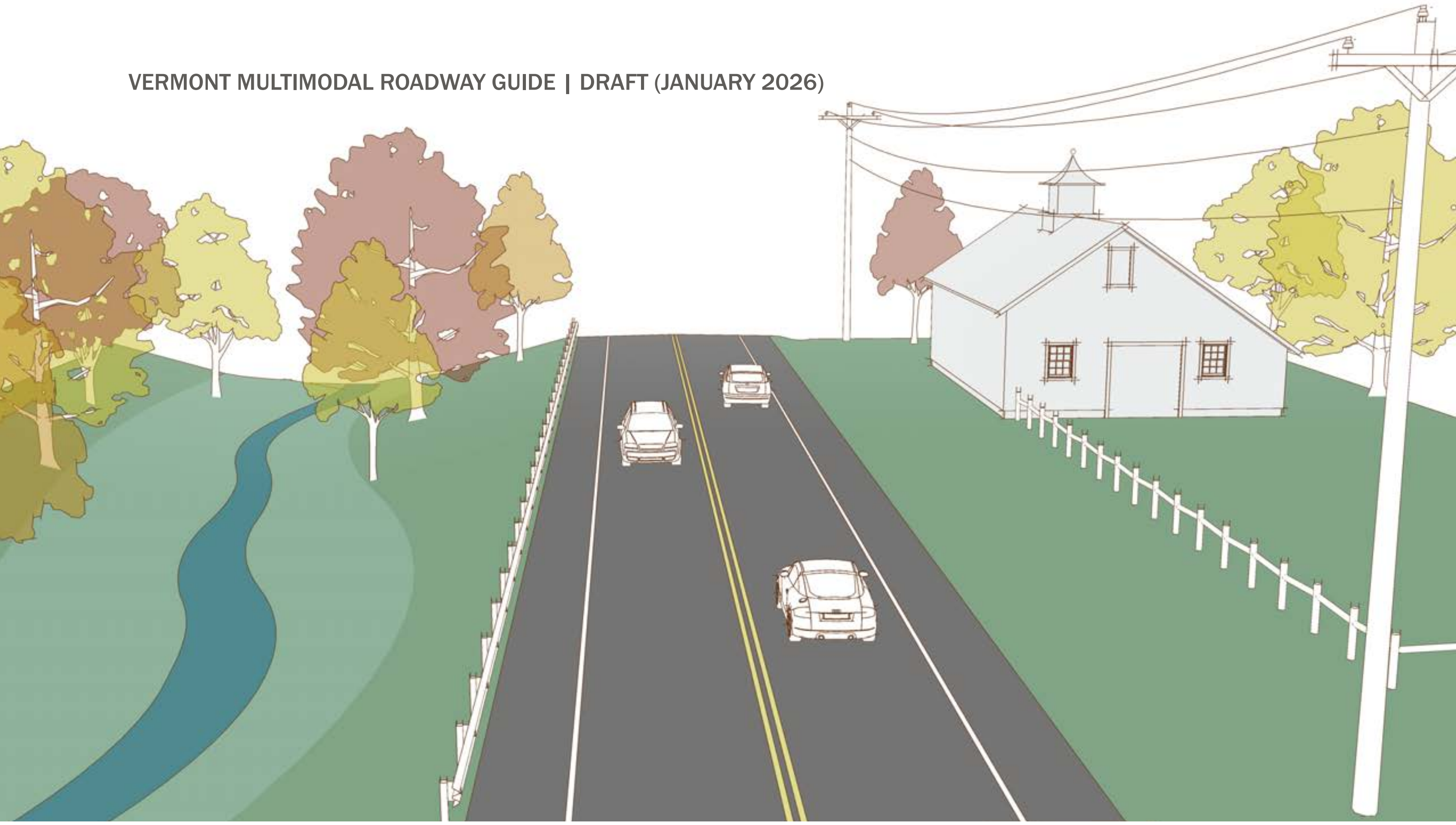

5

Roadway Types and Contexts: Rural

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5.1 Overview

Vermont is predominantly rural, and most of the state's roadway mileage serves rural places and trips. This chapter provides design guidance for rural roadways and intersections across a wide range of land use densities, terrain, and travel needs. It complements the context-setting framework in **Chapter 3** and the detailed design guidance in **Chapters 7 and 8**, and it introduces the transition concepts expanded in **Chapter 9**.

Consistent with **Chapter 3**, this Guide aligns its land use contexts with Act 181 (H.687, 2024). For rural areas, this means Tier 3 Rural and Conservation places—Rural—General, Rural—Agricultural and Forestry, and Rural—Conservation Overlay. Tier 2 places (e.g., Recreation/Resort Areas, Transition/Infill Areas, Enterprise Areas, and Hamlets) may occur in rural settings but are targeted for more focused development and therefore often require different design responses. Until Future Land Use mapping under Act 181 (2024) is finalized, existing federal-aid urban boundaries and the state's village center and downtown designations provide the best proxy for distinguishing rural from non-rural contexts. **Figure 5-1** illustrates the extent of rural Vermont and underscores that the vast majority of the state's acreage is rural.

Rural roadways must balance mobility, safety, and context-sensitivity in a landscape with dispersed destinations, constrained rights-of-way, significant environmental resources, and long stretches without parallel alternatives. As a result, this chapter emphasizes context-appropriate target speeds; clear predictable cross-sections that prioritize lane departure crash mitigation; shoulders as a default safety feature with context-sensitive accommodations for active transportation; and practical designs that recognize maintenance capacity and lifecycle costs.

Figure 5-1: Rural Delineation

MAP UNDER DEVELOPMENT

5.1.1 Rural Land Use Context

A large portion of Vermont's acreage is considered rural. As introduced in **Chapter 3 Section 3.2.1**, land use contexts in this Guide continue to align with the land use categories defined in Act 181 (2024). Act 181 (2024) establishes designations for rural areas that require more significant level of development review. The rural land use context in this Guide includes Tier 3 rural and conservation areas, including Rural—General, characterized by low-density residential or commercial development, Rural—Agricultural and Forestry, and Rural—Conservation Overlay, from the Act 181 (2024) designations. Tier 2 areas, such as Recreation Areas (including resort areas), Transition/Infill Areas, Enterprise Areas, and even Hamlets, can be rural areas, but these areas are targeted for focused additional development.

Until Future Land Use (FLU) mapping associated with Act 181 (2024) designations is finalized, the existing land use context associated with the federal-aid urban boundaries and state designations for village centers and downtown districts provides an understanding of Vermont's existing rural land use context. Over 97 percent of the state's acreage consists of rural areas.

The rural context in Vermont includes numerous land uses. Residential, agricultural, and recreation/tourism are primary land uses; however, there are commercial and industrial land uses in the rural context as well, just at a lower density than in urban or village environments. In addition, a large portion of rural land is set aside for conservation.

5.1.1.1 Residential

Rural residential land uses make up a significant portion of the developed land use in rural Vermont. This context is characterized by dispersed single-family homes on large lots, often with driveways intersecting directly with high-speed state roads. These areas are heavily automobile-dependent due to their low density and the long distances involved in typical daily trip making.

5.1.1.2 Agricultural

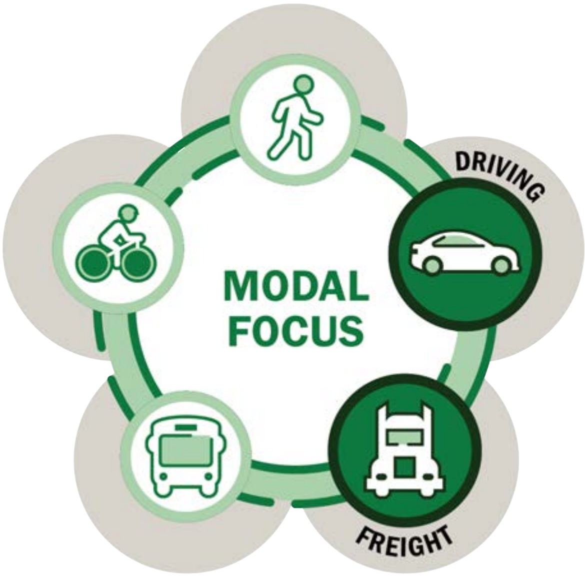
Due to the mountainous nature of the state, many river valleys have historically been used for agriculture, with the Champlain Valley being the most notable agricultural area. Because state roads often follow these valleys and serve agricultural operations, much of the state road network exists within agricultural areas. Larger agricultural land uses are characterized by cleared areas and a mix of through vehicle traffic and slow-moving farm equipment. The wide-open landscapes are often associated with higher vehicle speeds.

5.1.1.3 Recreational

Recreational land uses ranging from statewide and local trails for a variety of users to larger recreational resort areas are present in the rural environment. In the future, Act 181 (2024) land use designations will include resource-based recreational facilities, often concentrated around ski resorts, lakeshores, or trail networks, where they may provide infrastructure, jobs, or housing to support recreational activities. In addition, Act 181 (2024) includes Rural—General, Rural—Agricultural and Forestry, and Rural—Conservation, each of which may accommodate recreational land uses, but with significantly lower development potential.

5.1.2 Roadway Users and Modal Focus

Most roadways in the rural context are used for longer through trips (including daily commutes) as there are fewer local destinations and access points. Longer roadway segments primarily serve passenger vehicle trips, as well as transit and freight trips. In the rural context, agricultural traffic may also need to be accommodated. Although these roadways serve all users, bicyclists and pedestrians are less prevalent, except in locations such as recreational areas, trail crossings, or in pockets of denser development. Currently, a large portion of rural roadways have narrow or no defined shoulders, resulting in all users sharing the same space.



5.1.3 Environmental and Geographic Context

Added considerations in the rural environment include environmental and geographic conditions that affect rural roadway design. Vermont's mountains and river valleys create varying topography that constrains space available for roadway elements. Modifying cross-sections in these environments can have significant environmental, right-of-way (ROW), and cost implications. However, once a modal focus is determined for an area or a specific roadway link, attempts should be made to accommodate the modes identified in a consistent way throughout the corridor.

5.1.4 Resilience

As stated in **Chapter 3**, the Vermont context, in large part due to the rural nature of the State, creates a need for a focus on resilience. Vermont Agency of Transportation (VTrans) continues to work toward enhancing resilience in the state highway system through the Vermont Resilience Improvement Plan. Most of the highest-ranked locations in the plan are in rural areas, many of them along rivers and streams, which makes them more vulnerable to intense precipitation and resulting damage. Improving infrastructure by upsizing culverts, stabilizing slopes, and improving drainage helps make that infrastructure more resilient in storm events.

The focus on rural resilience is due to the fragility of the highway network in rural areas, where a single blocked or destroyed roadway can leave entire communities isolated. The protection and proper design of key routes support reliable travel times and consistent transportation of emergency freight, including food, water, and other supplies, during disasters. Guidance in this chapter supports VTrans' resilience goals outlined in the Vermont Resilience Improvement Plan.

5.1.5 Maintenance

Effective planning and design with maintenance in mind are critical to implementing transportation infrastructure that provides long-term functionality and safety. Proactive and context-specific maintenance practices help preserve and extend the life of infrastructure. Conversely, when maintenance needs are not adequately planned for, agencies face unexpected costs, and infrastructure can prematurely fail. Considering maintenance requirements when evaluating alternatives in the rural context is especially important, as the relatively low traffic demand does not support the investment in new infrastructure associated with significant maintenance needs.

When contemplating facilities to accommodate bicyclists or pedestrians, additional maintenance actions, such as drainage maintenance and winter snow removal, may be required for sidewalks or shared use paths. When considering a landscaped buffer, there are additional vegetation control maintenance needs. When contemplating raised features, such as curbing for sidewalks or median islands, the resulting stormwater flows may create additional maintenance needs.

Maintenance implications are outlined more specifically for design elements in **Chapter 7** and discussed for transition zones in **Chapter 9**. Infrastructure maintenance costs need to be considered during project development, especially in environments where ownership and maintenance responsibilities fall on a different entity than the one developing the project.

5.2 Roadway Types: Rural

As outlined in **Section 5.1**, Act 181 (2024) identifies three rural land uses. Act 181 (2024) does not, however, define associated roadway types. This section identifies roadway types encountered in the rural context and provides information on user expectations and safety realities, common elements of rural road cross-sections, and design guidance.

Rural roads are paved or unpaved roads with typically lower residential, agricultural, and commercial land use activities. Rural roads range from facilities that accommodate high volumes of through traffic to small local roads that prioritize local access over mobility.

The limited frequency of access points creates expectations for moderate to high vehicle operating speeds, from 35 to 50 mph, along a substantial portion of rural roads in Vermont, with a less significant demand for pedestrian and bicyclist accommodations, except in priority bike corridors, pockets of greater density, and sections that connect proximate destinations. Although rural roads may not typically be

designed with a focus on these modes, Vermont prioritizes adding shoulders on rural roadways to improve safety for and accommodate pedestrians and bicyclists where possible, given the context constraints.

Nearly three in four fatal and serious injury crashes occur on rural roadways, primarily state highways, with single-vehicle lane departures being the most common crash type. Rural roadways are more susceptible to these crashes because of higher speeds and minimal recoverable space. Drivers who lose control on rural roadways are likely to strike trees or encounter steep slopes.

A roadway's cross-section influences safety in several ways. Additional lane width, shoulders, or clear zone improve safety on rural roads. However, the effects of these tools are not linear, and the incremental impacts of additional lane width are not well understood. For example, wider lanes can encourage faster speeds, but, on roads with high mobility needs such as state highways, shoulders and clear zones are important tools to preserve safety. On lower-volume roads, barrier and speed management techniques may be more practical options. Rural roadways, especially town roads, tend to be constrained from widening.

Table 5-1 shows rural road miles by speed and volume for federal aid system roads located in rural areas. This includes rural roads passing through villages and town centers. The most prevalent rural road type (on state roads and Class 1 or 2 town highways where data is available) has a 50-mph posted speed and a moderate 1,000–6,000 average annual daily traffic (AADT). Similarly, rural roads carrying the highest traffic volumes predominantly have posted speeds of 50 mph. The least common rural road type is a high-volume (greater than 6,000 AADT) road with low speeds under 35 mph.

Junctions of rural roads may accommodate higher traffic volumes. Land uses at these connections may include a cluster of residences or even a commercial anchor. These locations do not have the level of development of a village but do represent a change in the land use and roadway character within the surrounding rural environment and should be evaluated for the context specific to them and not the greater rural road. In some cases, these junctions create transitions into a denser urban or village context.

Section 5.7 provides additional information regarding transition zones in the rural context, while **Chapter 9** Transition Zones explains the overarching concept of transition zones.

Table 5-1: Rural Roadway Miles (on Federal Aid System) by Volume and Speed

		Volume (AADT)			
		No Data	Low (≤1,000)	Moderate (1,001–6,000)	High (>6,000)
Speed (mph)	No Data	262	3	31	–
	Low (≤35)	410	227	108	15
	Moderate (40-45)	198	206	277	29
	High (50)	216	414	1271	146
	High (>50)	23	18	407	234

Source: ESRI, VCGI, VTrans

5.2.1 Relationship With FHWA Roadway Classification

Current federal functional classification guidance prioritizes the function and service of a roadway above its context when classifying roads. In the Federal Highway Administration's (FHWA) *Highway Functional Classification Concepts, Criteria and Procedures* report, a "rural" distinction of a roadway is used as a sub-classification to improve the precision of the guidance. All principal arterial and collector subcategories have urban and rural forms, and both forms share the same point on the spectrum of mobility and access regardless of their subclassifications. The federal functional classification guidance asserts that rural development patterns are more diverse and less orderly, which makes determining the functional classification of rural roadways more challenging. Rural roadway characteristics for each FHWA Functional Classification are presented in **Table 5-2** and described below.

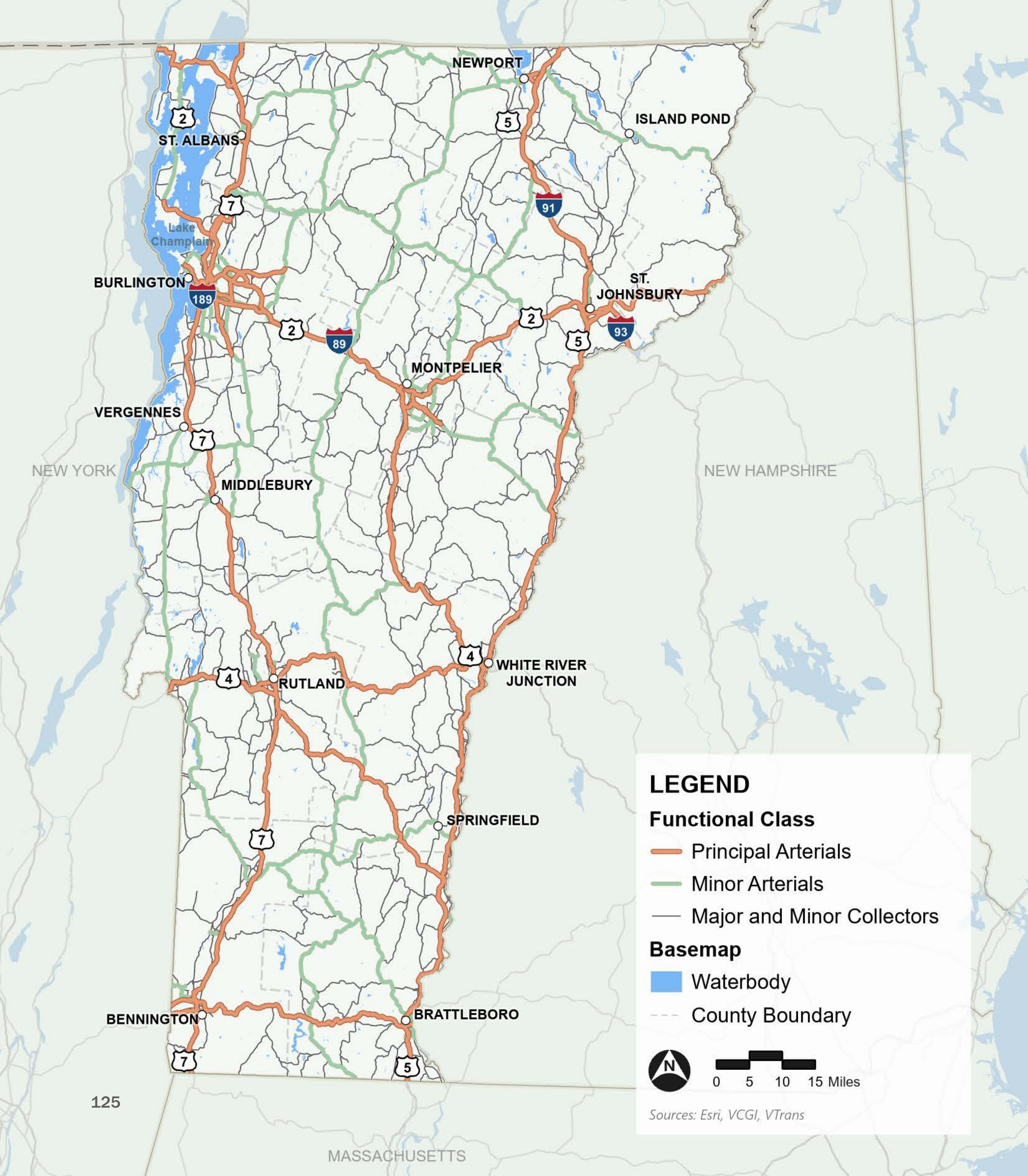
- **Rural Principal Arterials** are characterized as free-flowing roadways with limited access points. These roadways are designed at a level of service (LOS) C or better with a design speed of 35–50 mph.
- **Rural Minor Arterials** have limited access points and are designed at a LOS C or better. Design speed for rural minor arterials is generally between 35–50 mph.
- **Rural Collectors** are shorter-distance roadways with moderate design speeds of 25–50 mph. Although rural collectors are designed at a LOS C or better, there are exceptions. When significant traffic volumes are present or there is rolling/mountainous terrain, a LOS D is acceptable.
- **Rural Local Roads** contain the most access points to land uses and have design speeds between 25 and 45 mph. The design speed for these roadways will typically be the same as the anticipated posted speed.

The FHWA roadway classifications are superimposed onto the proposed VTrans rural context in the **Figure 5-2** illustration.

Table 5-2: Vermont Rural Roadway Characteristics by Functional Classification

	Principal Arterials			Minor Arterials	Collectors		Local Roads
	1	2	3	4	5	6	7
Traffic	High	High	High	High	Moderate	Moderate	Low
Rural AADT	12,000–34,000	4,000–18,500	2,000–8,500	1,500–6,000	300–2,600	150–1,100	15–400
Mobility	High	High	High	High/Moderate	Moderate	Moderate	Low
Access	Low	Low	Low/Moderate	Low/Moderate	Moderate	Moderate	High

Figure 5-2: Roadway Functional Class



5.2.2 Target Speeds

As discussed in **Chapter 3**, self-enforcing roadways use physical form, such as lane and shoulder width, to communicate target speeds rather than relying on posted speed limits and law enforcement. Self-enforcing roadways are less common in the Vermont rural environment, except where resource constraints result in design limitations associated with the target speed.

As indicated above, rural roads typically have expectations for moderate to high operating speeds, from 35 to 50 mph, for the efficient movement of vehicles with reduced demand for pedestrian and bicyclist accommodations. An exception is local roads which are associated with slightly lower target speeds, 25 to 45 mph. Section 5.2.3, provides information regarding design elements associated with context-appropriate cross-sections for Vermont's rural context.

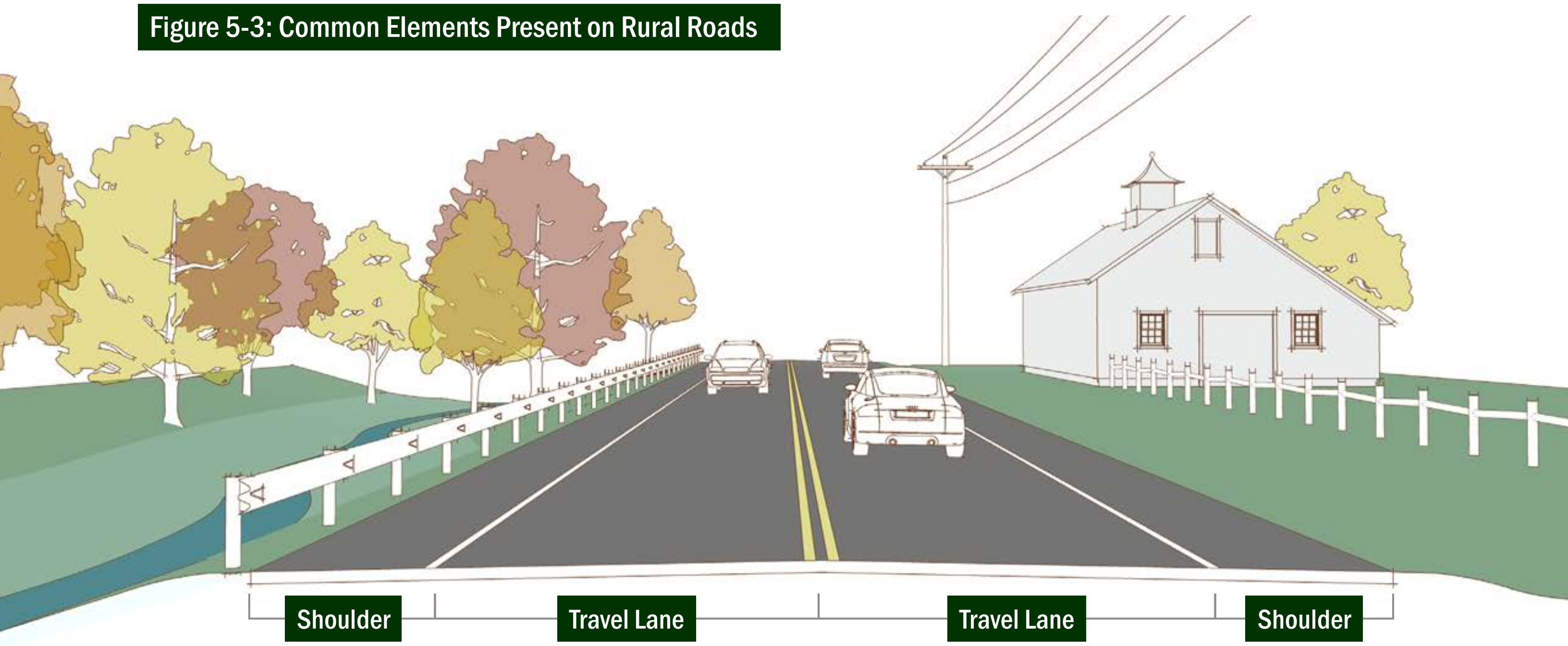
5.2.3 Common Elements of Roadways in a Rural Context

The typical rural cross-section predominately accommodates two-way vehicle traffic with countermeasures to reduce crash occurrence where possible and appropriate (SafetyEdge^{SM}, rumble strips, guardrail). As shown in **Figure 5-3**, inclusion of a shoulder provides recovery area for lane departure incidents and can also provide a space for active transportation uses. Lower volume rural roadways (400 vehicles per day or less) are less likely to include shoulders.

Active transportation accommodation should be considered where trails, recreational sites, villages, or other rural destinations are closely spaced. Additionally, bicycle-specific accommodation should be prioritized in rural areas along high-priority bicycle corridors (See the VTrans High-Use, High-Priority Bicycle Corridors Map).

Freight needs should be considered along priority freight routes or, when appropriate, near land uses generating high freight demand as this impacts design vehicle selection and may influence the choice of wider lane widths (within the range of acceptable widths).

Figure 5-3: Common Elements Present on Rural Roads



	Shoulder	Travel Lane	Active Transportation Element
Design Range	0-4' (low volume) 4-8' (high volume)	9-12'	5-8' shoulder for formal accommodation, or 10-14' side path

For additional design details on common elements for each "most common" rural cross-section type, see the following sections:

Section 5.3.1: Roads with No Paved Shoulders

Section 5.3.2: Roads with Narrow Paved Shoulders

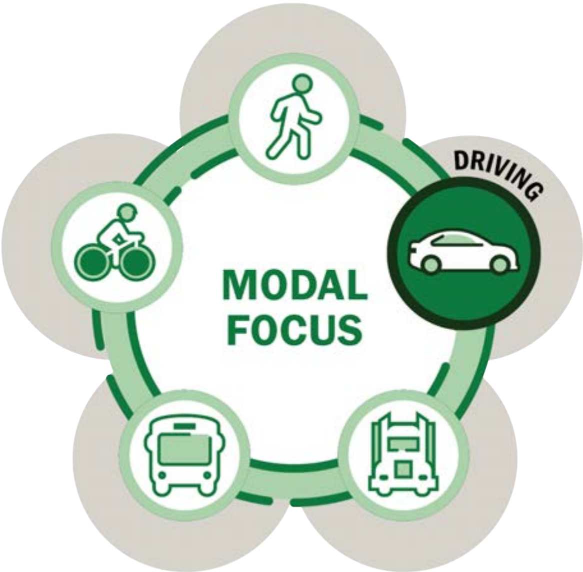
Section 5.3.3: Roads with Wide Paved Shoulders

5.3 Common Rural Roadway Cross-Sections

Common rural roadway cross-sections in Vermont include roads with no paved shoulders, roads with narrow paved shoulders, and roads with wide paved shoulders. Each of these cross-sections is present in a variety of locations ranging from minor local roadways to higher-volume, high-speed state highways. Ideally, the roadway cross-section is selected based on a project or corridor's context and desired outcomes for its users. The appropriate cross-section for a given situation depends on several factors, such as the land use and density, vehicular traffic volume, and the need to accommodate additional users (pedestrians, bicycles, transit, freight) along with an understanding of the site constraints.

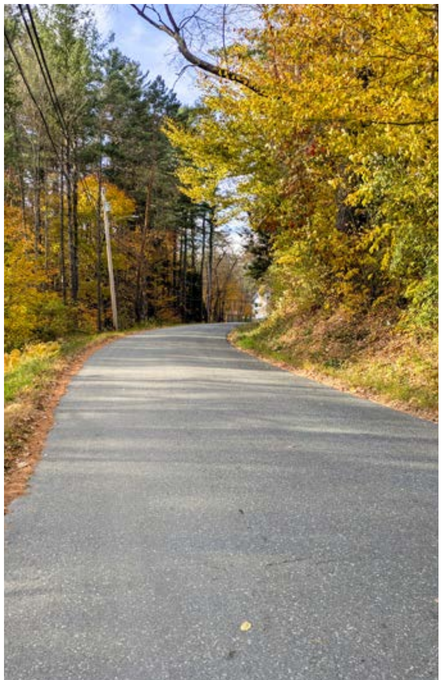
5.3.1 Roads With No Paved Shoulders

Rural roads with no paved shoulders are common in the rural Vermont context. This cross-section serves a variety of contexts ranging from small, local roadways providing access to a limited number of homes to larger collector roads that may connect rural communities. Given this range, the width and surface on this common cross-section can vary significantly.



Rural roads with this cross-section serve mostly local traffic, and generally have low vehicular, bicycle, and pedestrian volumes. In some cases, these rural roads are unpaved.


Main Road in Huntington


Barberry Hill Road in Woodstock


Prosper Road in Woodstock

Roadway width generally varies from 18 to 24 feet, and even when roadways are paved, lane markings may not be present, as this decision is typically based on roadway volume (per the MUTCD). Surface type (gravel or paved), width, alignment, and roadside hazards influence speeds along this typical cross-section, which generally range from 25 to 50 mph in a local road context. Roadside constraints may also limit the ability to widen the roadways in this cross-section.

This rural road with no paved shoulders cross section serves as a collector between communities and is typically slighter wider than the local version of roads with no paved shoulders. These roads are typically paved, potentially wider (at 20 feet or more), and more often have a centerline. Because mobility and access are more balanced for this cross-section, speeds tend to be higher (50 mph or more) when the physical environment allows. Some pedestrian and bicycle traffic should be expected along roadways with this context, generally traveling from local access to other nodes (which may include trails), but specific accommodations are not typically provided.

When rural roads with no shoulders reach widths greater than 24 feet, consideration should be given to striping shoulders. Adding an edge line to define a shoulder, even when narrow, better defines the travel way and allocates space when active transportation modes are present.

5.3.1.1 Roadway User Expectations and Existing Operational Realities

Most traffic on rural roads with no paved shoulders is comprised of local residents connecting to the larger roadway network. In most cases, the vehicular volumes are low, and speeds can range widely depending on context. Active transportation tends to be residents recreating or making short trips. Because this common cross-section primarily exists in areas of low density of development, user volumes are also low.

Context needs to be considered as rural roads with no shoulders travel through denser pockets of development (small villages) to determine if the cross-section should change to accommodate shoulders or sidewalks. At a minimum, consideration should be given to pavement markings to communicate change in context to drivers. For example, **Stage Road in Barnard** is a rural road with no shoulders that transitions to define shoulders, space for parking, and pedestrian spaces as it approaches the Silver Lake Access and Barnard General Store.

Rural roads with no paved shoulders can also provide connections between trail systems and villages or other trails. In these conditions, awareness of trail users may lead to future change to the cross-section to accommodate these users.

Low vehicular volumes allow bicyclists and pedestrians to be passed, even when traveling within the roadway, because the likelihood of oncoming traffic at the same time is low. If vehicular, pedestrian or bicyclist volumes or speeds increase, the ease of passing at the narrower cross-sections will become more difficult, potentially leading to conflicts that would require more intensive efforts to mitigate.

5.3.1.2 Safety/Crash Statistics and Crash Risk Mitigation Strategies

On unpaved roads, this cross-section is typical. On paved roads, shoulders are important for safety by providing drivers room to correct errors or make evasive maneuvers and providing some space for pedestrians outside the travel lane. This cross section should only be considered for paved roads under two circumstances: low speeds (25 mph or less) or low volume roads (AADT less than 750 vehicles/day per the American Association of State Highway and Transportation Officials (AASHTO)).

At low speeds, lane departure crashes are unlikely, and both drivers and pedestrians can react to one another. In practice, at low volumes, drivers can use more of the roadway than their lane and risks are also reduced. In those cases, a centerline should not be striped.

Crash risk can be mitigated by a low design speed, appropriate clear zones or barriers, and sight distances that meet or exceed *AASHTO Green Book (2024)* standards. Edge line striping (if the road is paved) helps mitigate lane departure risk. On unpaved roads, where traffic volume allows, drivers are likely to straddle the center of the road to keep some buffer between them and the roadway edge.

With most crashes on Vermont rural roads being single-vehicle lane departures, preventing and reducing the severity of these crashes should be a priority. Shoulders (including unpaved shoulders), barrier, fixed object removal, and recoverable side slopes (1:4 or flatter per *AASHTO Green Book (2024)*) are frequently considered.

The crash rate on roadways with no shoulders is significantly higher. Between 2020 and 2024, the average number of crashes per million miles driven on the federal-aid system in Vermont was:

- 861 crashes per million miles driven on roads with no shoulder;
- 241 crashes per million miles driven on highways with 1–4 foot shoulders; and
- 250 crashes per million miles driven on highways with 4-plus-foot shoulders.

5.3.1.3 Design Guidance Specific to This Cross-Section

The large number of lane miles and low volumes limit the cost effectiveness of significant volumes improvements on these roadways. In the event that road widening is plausible, designers should refer to cross-sections that include paved shoulders (**Sections 5.3.2 and 5.3.3**).

- Lane widths on these roads range from 9 to 12 feet, though lane markings are often not included, and thus lanes are more ambiguous. Roadways without lane markings should be kept narrow (20 feet or less) where feasible. Space is not dedicated to active transportation users on these roads; therefore, user comfort is more effectively supported by the lower speeds encouraged by narrow lane widths than the additional space from widening. Low vehicular volumes allow for the full roadway width to be used for passing in most cases.
- Aggregate shoulders provide space for active transportation use, especially pedestrians. It can also provide recovery space in the event of an incident or the rare case when vehicles pass.
- Roadside design is context-specific. In areas where target speeds are higher, recoverable side slopes and an adequate clear zone should be provided per AASHTO guidance (see **Chapter 7**). In denser pockets of rural development, or in overlay conditions such as trail connections, additional consideration should be given to the needs of bicyclists or pedestrians.
- Safety considerations
  - Adding shoulders provides additional recovery area when a vehicle departs a lane, as well as provides delineated space that can be used by bicyclists and pedestrians. When shoulders can be added, **Sections 5.3.2 and 5.3.3** provide guidance for different cross-sections with shoulders. As outlined in **Chapter 7** Elements of Design, the VTrans preferred lane width is 11 feet. However, as outlined above, a rural roadway, especially a local roadway with very low volume, may not be paved, include pavement markings, and/or provide 11-foot lanes. The AASHTO Guidelines for Geometric Design of Low-Volume Roads Second Edition (2019) provide recommendations for widths for these low-volume facilities. Roadways with volumes over 400 AADT should be constructed to a minimum of 23 feet wide, effectively providing two 11-foot lanes.
  - Because the most significant crash type in Vermont is associated with lane departures, practitioners should consult VTrans engineering instructions on appropriate design treatments which include guidance on items such as SafetyEdge℠ and Centerline Rumble Strips.

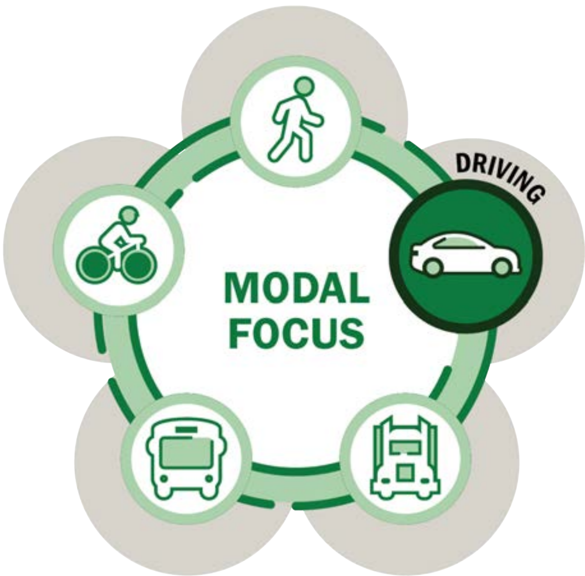
5.3.2 Roads With Narrow Paved Shoulders

Rural roads with narrow paved shoulders typically contain two travel lanes that are 9 to 12 feet in width with shoulders ranging from 1 to 3 feet within the ROW. Although rural roads are not typically designed with a focus on bicycle and pedestrian modes, Vermont prioritizes the addition of shoulders on rural roadways to improve safety and accommodate pedestrians and bicyclists where possible, given the context constraints. When roads are identified as being on the priority bike network, the minimal acceptable bicycle facility would be a 4-foot shoulder, moving into the next category of cross section, or a shared use path.

Like rural roads of all cross-sections, this cross-section serves a variety of classifications ranging from small local roadways to larger collector roads that connect between rural communities.

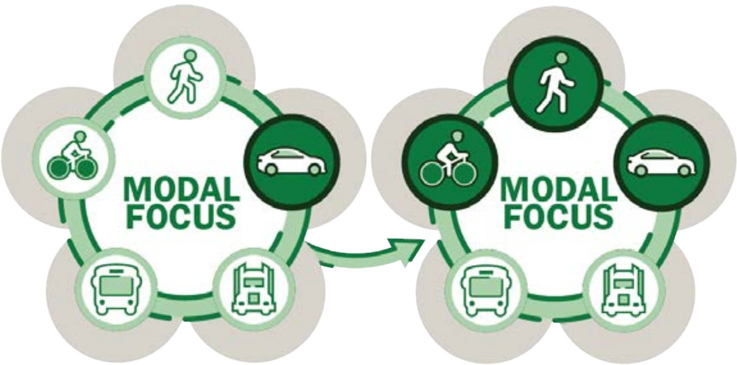
The first version of the of this rural road with narrow paved shoulders cross-section consists of small local roads with low density, serving mostly local traffic and generally having low vehicular, bicyclist, and pedestrian volumes. Context, width, alignment, and roadside hazards influence speeds along this rural road type, which generally range from 25 to 45 miles per hour. In this context, the primary mode served is passenger vehicles, but there can be minor pedestrian and bicycle traffic as residents use these modes for exercise or short trips.

The second version of the rural road with narrow paved shoulders cross-section serves as a minor or major collector between communities but is



Baptist Street in Graniteville

limited to narrow shoulders based on physical or environmental concerns. Because mobility and access are more balanced in this context, speeds tend to be higher, most often at 50 mph, when physical constraints allow. Some pedestrian and bicycle traffic in this context, traveling from local access to other nodes, which may include recreational trails, but only limited, narrow shoulders as existing accommodation.



Regardless of the application in which the rural road with narrow paved shoulders is found, land use and density context need to be considered where these facilities travel through denser pockets of development (small town villages) to determine whether the cross-section needs to change to accommodate wider shoulders or sidewalks. Consideration of the target speed for the context is critical, and properly transitioning drivers from the higher speed rural context to the lower target speed village context is required to achieve the desired outcomes, such as slower speeds and increase active transportation user comfort (as outlined in **Chapter 3** Using this Guide and **Chapter 9** Transition Zones).

Trails are sometimes located close to villages or other trails and rural roads with narrow paved shoulders can function as the primary connector between these destinations. In these settings, awareness of active transportation users should prompt practitioners to evaluate modifications to the cross-section to better accommodate active transportation. Section 4.3.2, *Rural Roadways*, of the *AASHTO Bike Guide* provides recommendations for bicycle facility selection in rural contexts based on motor vehicle speed and volume. The Section lists several other considerations for the inclusion of shoulders such as where rural roads connect nearby villages and town centers, and where the roadway serves as a connection between regional trail systems.

An example of this evaluation is the Killington Connecting Trails Scoping Study, which assessed connections along VT 100 between the Sherburne Trail System, Gifford Woods State Park, the park-and-ride facility, and the commercial center of Killington. The findings recommended a number of off-alignment path segments to accommodate bicyclists and pedestrians, as well as a wide shoulder segment, changing the proposed cross-section for that context, given the constraints identified.

5.3.2.1 Roadway User Expectations and Existing Operational Realities

Rural roads with narrow paved shoulders are primarily used by residents for local travel as well as intermunicipal and longer regional trips. Freight movement is limited as these roadway characteristics are not typical for freight routes.

Active transportation users represent a small portion of users on these roads given the limited density around them and space provided for them, except where a parallel facility exists.

5.3.2.2 Safety/Crash Statistics and Crash Mitigation Strategies

On paved roads, shoulders are important for safety, providing drivers with room to correct errors or make evasive maneuvers and space for pedestrians outside the travel lane.

Crash risk can be mitigated through low design speeds, appropriate clear zones or barriers, and sight distances that meet or exceed AASHTO Green Book (2024) standards. With most crashes on Vermont rural roads being single-vehicle lane departures, preventing and reducing the severity of these crashes should be a priority. Shoulders (including narrow shoulders), barrier, fixed object removal, and recoverable side slopes (1:4 or flatter per *AASHTO Green Book (2024)*) are frequently considered. At low speeds, lane departure crashes are unlikely and drivers (and pedestrians where present) can react to one another.

The crash rate on roadways with narrow shoulders is consistent with the rate for roadways with wide shoulders, likely due to the faster prevailing speeds found with wider shoulder width.

5.3.2.3 Design Guidance Specific to This Cross-Section

Design of this cross-section is based on context, design and target speeds, volumes of both vehicles and active transportation users, and safety history of the road.

- The width of travel lanes varies from 9 to 12 feet in this cross-section. On state roadways, the preferred lane width is 11 feet to accommodate larger vehicles; however, on local roadways or state roadways with lower volumes, this width can be reduced to shift additional space to the narrow shoulder.
- The width of the paved shoulders varies from 1 to 3 feet in this cross-section. If a project is not widening or narrowing the travelway, the width of the shoulder is a tradeoff between shoulder and lane width. A relatively high volume of bicyclists and pedestrians, vehicle speed issues, and a high frequency of lane departure crashes are reasons to reallocate space from the lane to the striped shoulder. Even narrow paved shoulders improve safety on a roadway. When possible, a paved shoulder is preferred as it reduces roadway departure risk and provides some space for active transportation to be out of the travel lane.
- Roadside design is highly context-specific in the rural context and this cross-section is present in several environments throughout the state, ranging from low-volume, low-speed local roadways to state highways like VT Route 100 where environmental and topographic constraints limit large stretches of the cross-section. On higher-volume roadways, recoverable side slopes and clear zones adequate for the design speed should be present or there should be roadside barrier. Lower-volume roadways may be designed for a lower speed to reduce clear zone impacts. In those cases, the focus may be bringing operating speeds in line with target speeds to improve safety.
- Because the most significant crash type in Vermont is associated with lane departures, VTrans Engineering Instructions on appropriate design treatments to address this phenomenon are updated as appropriate and include guidance on items such as SafetyEdge^{SM} and Rumble Strips.

Design guidance is provided in full in **Chapter 7** Elements of Design.

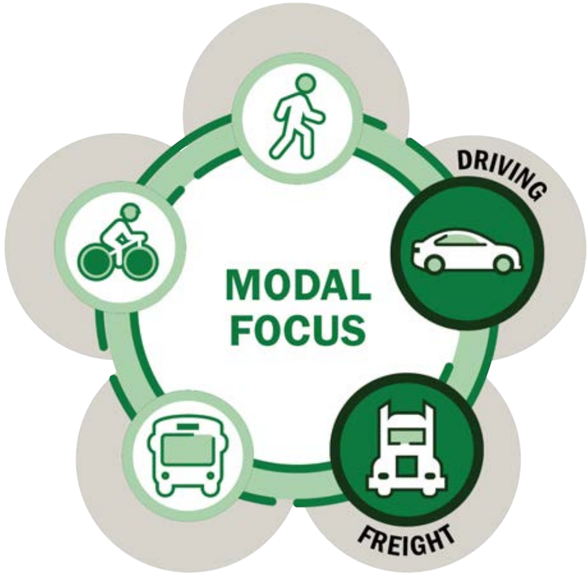
5.3.3 Roads With Wide Paved Shoulders

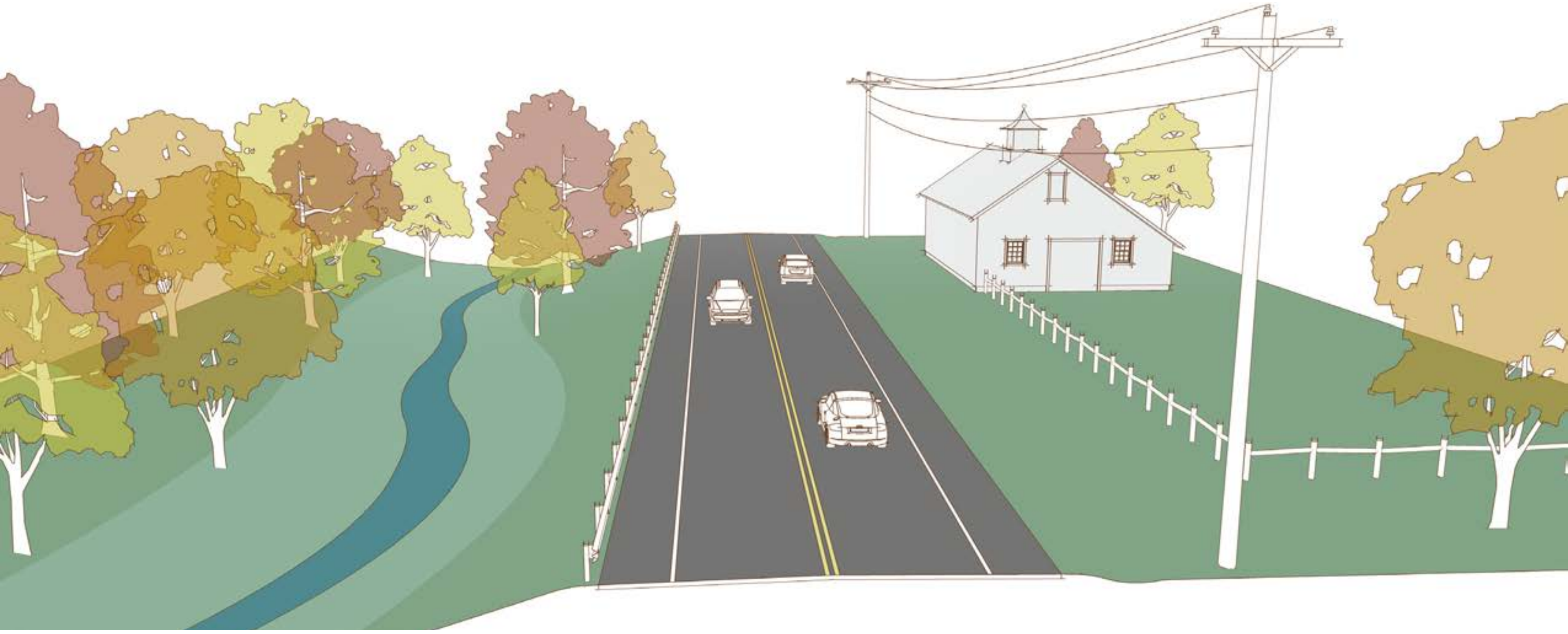
Rural roads with wide paved shoulders should be dedicated to high-volume transportation corridors that function as arterials or are on the freight network. However, not all high-volume corridors should be designed with wide paved shoulders, as the context and user outcomes vary significantly by location.

Vehicle speeds on the rural road with wide paved shoulder cross-section are generally among the highest on the highway network outside the Limited Access Highway system. As a result, this cross-section is typically associated with roadway segments that have high mobility and traffic volumes. Total paved roadway width is typically 30 feet or more, and lane markings are present and important to maintain due to the large amount of paved space. Lane widths vary from 10 to 12 feet, and shoulder widths vary from 4 to 8 feet or more. This type of cross-section provides enough shoulder space to accommodate active transportation modes, however, care must be taken to address the tendency for vehicle speeds to increase as cross-section width increases.

5.3.3.1 Roadway User Expectations and Existing Operational Realities

Traffic on these roadways typically is made up primarily of private motor vehicles, freight vehicles, and occasionally, longer-distance transit routes. Despite these roadways' emphasis on mobility over access, access is still regularly provided, when necessary, to adjacent land uses. Bicycle and pedestrian volumes tend to be low in remote sections; however, as these routes pass through populated areas, use can increase, representing an additional design consideration.





Like other common rural road cross-sections, this cross-section can also provide connections between trail systems and villages or between regional trail systems. In these settings, awareness of trail users should prompt practitioners to consider whether roadway width could be reallocated to provide improved accommodation for those users.

Section 5.3.2 includes a chart from the Rural Roadways section of the *AASHTO Bike Guide* that provides recommendations for bicycle facility selection in rural contexts based on motor vehicle speed and volume. The section also lists considerations for including shoulders or shared use paths, such as where rural roads connect nearby towns or serve as connections between regional trail systems.

5.3.3.2 Safety/Crash Statistics and Crash Risk Mitigation Strategies

Roads with wide shoulders reduce risk of lane departures by providing space for correction. If wide enough, they also offer a breakdown lane. They also provide space for bicyclists and pedestrians.

Shoulders do not necessarily need to be continuous. One of the benefits of this cross section is the flexibility to use space for auxiliary lanes where needed, including turn lanes, breakdown lanes, bypass lanes, or climbing lanes. Each of these can offer safety benefits in the appropriate context.

This cross-section tends to increase drivers comfort and raise operating speeds. As a result, it is generally not compatible with low target speeds.

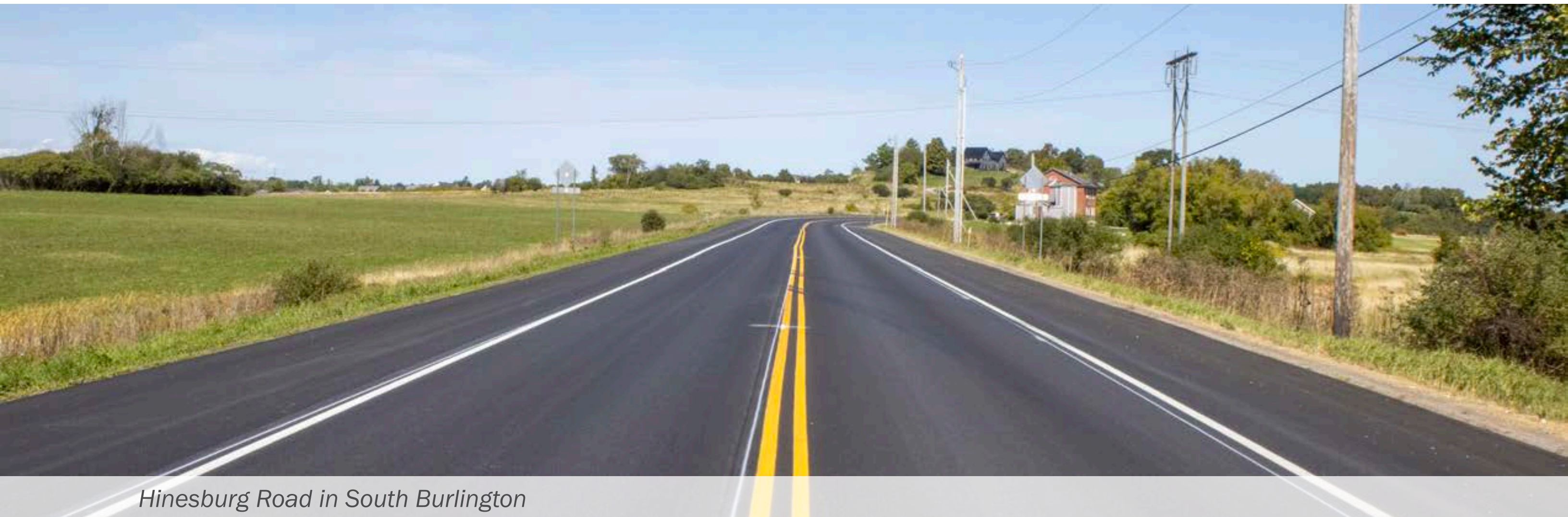
5.3.3.3 Design Guidance Specific to This Cross-Section

- Lane widths on this cross-section range from 10 to 12 feet, with a preference for 11 feet. Like other cross-sections, lane width selection should consider the design vehicle, particularly accommodation of larger vehicles on the freight network.
- Shoulder widths on this cross-section range from 4 to 8 feet. As outlined in **Chapter 7**, Elements of Design, as target speeds and roadway volumes increase, the corresponding shoulder width increases.
- Roadside design is especially important with this cross section. The prevalence of lane departures means the inclusion of recoverable side slopes and adequate clear zones, defined by AASHTO Roadside Design Guide for the target speed, is important.
- Because the most significant crash type in Vermont is associated with lane departures, VTrans Engineering Instructions on appropriate design treatments to address this phenomenon are updated as appropriate and include guidance on items such as SafetyEdge^{SM} and Rumble Strips.

Design guidance is provided in full in **Chapter 7** Elements of Design.

5.3.4 Supplemental Elements of Design

Although the cross-sections outlined above are those typically found in Vermont's rural environment, there are a number of design elements that may be added to the cross-sections to address specific safety challenges or operational needs. Common supplemental design elements used on rural roads are described below.



Hinesburg Road in South Burlington

5.3.4.1 Auxiliary/Turn lanes

In the rural context, roadway speed significantly influences the need for and length of auxiliary lanes, as the driver does not expect a vehicle queuing along a rural roadway, and at higher speeds, there is less time to understand and react to a stopped vehicle. In addition, the deceleration of a turning vehicle can significantly impact traffic flow when in the shared travel lane. As outlined in **Chapter 7**, National Cooperative Highway Research Program (NCHRP) Report 457, *Evaluating Intersection Improvements: An Engineering Study Guide*, should be referenced to determine the minimum criteria for adding auxiliary lanes and the appropriate auxiliary lane storage for the volumes and speed associated with the location.

5.3.4.2 Climbing Lanes

Evaluation of when to include a climbing lane for two-lane highways is based on the *AASHTO Green Book (2024)*. This guidance specifies three criteria that must be met for the installation of a climbing lane to be appropriate.

- Upgrade traffic flow rate in excess of 200 vehicles/hour
- Upgrade truck flow in excess of 20 vehicles/hour
- One of the following criteria exists:
  - A 10 mph or greater speed reduction for a typical heavy vehicle
  - LOS E or F exists on the grade.
  - A reduction of two or more levels of service is experienced.

The guidance also notes that a high crash frequency may justify climbing lane implementation but emphasizes consideration of fiscal constraints when implementing climbing lanes. Since the development of this guidance, truck technology has improved, reducing the need for the inclusion of a climbing lane.

Historically, climbing lanes have been installed in rural Vermont locations that do not meet the three criteria related to traffic flow improvement, truck flow improvement, and level-of-service degradation or speed reduction. When recorded speeds are significantly higher than appropriate based on posted speed limits and roadway context, the presence of climbing lanes may contribute to higher speeds. In rural towns especially, higher speeds can result in degradation of safety for all users and discontinuance of climbing lanes should be considered.

5.3.4.3 Drainage

In many rural contexts, drainage is open with flow traveling off the roadway into adjacent swales. In some rural towns, short sections of closed drainage may be present. Details on drainage are provided in **Chapter 7** Elements of Design.

5.3.4.4 Transit Stops

Accommodation of transit stops in the rural environment should focus primarily on safety, as many transit stops are located along arterials. Passenger loading and unloading space should be separated (horizontally and/or vertically) from the travelway and shoulder for pedestrian safety. Rural service is a mix of fixed-stop and flagged-stop, where drivers will pick up or drop off passengers anywhere along their route.

Where rural transit stops are present, the infrastructure provided tends to be minimal. Exceptions occur in locations where ridership density is higher than typical in rural environments. In resort areas, where seasonal or year-round transit usage is high for the rural environment, density and frequency rise to a level appropriate for incorporation of formal transit stops and shelters.

Another typical rural transit stop location is at park-and-ride facilities, which are often the only transit stop in a town. Facilities at these locations may include internal site sidewalks, lighting, transit shelters, and bicycle parking. The Colchester US Route 7 park-and-ride, for example, includes all of these amenities. There are currently 22 state-owned and 28 municipal-owned park-and-rides that are served by transit. There are currently 20 state-owned and 15 municipal-owned park-and-rides that provide transit shelters.

5.3.4.5 Driveway Access

VTrans requires a State Highway Access and Work Permit (19 VSA §1111) when an owner or developer seeks to access state-maintained highways. This process allows VTrans to approve driveway location and design, as well as how the driveway interacts with vehicular flow on the roadway. Applying for a VTrans Highway Access Permit involves a multi-step process outlined in the VTrans Access Management flow chart. **Chapter 7** provides design criteria for sight distance considerations at various design speeds for driveways.

5.3.4.6 Lighting

Lighting is rare on rural roadways. Absent extraordinary circumstances, segment lighting should not be used. Intersection lighting can be beneficial, particularly where grade or horizontal curves conceal an intersection, or where active transportation users may be present. Lighting should be present at trail crossings and marked crosswalks.

5.3.4.7 Parking and/or Emergency Pull-Off Areas

Parking or emergency pull-off areas may be present along rural principal arterials to allow slow-moving vehicles to safely exit the main roadway while traffic passes when other passing opportunities are limited. In addition, these pull-off areas allow winter maintenance vehicles, like snowplows, to safely change direction. They also provide space for scenic overlooks and a convenient space for drivers to rest if needed. *AASHTO Green Book (2024)* indicates that turnouts should be placed every one to three miles to allow for optimal traffic operations.

5.3.4.8 Shared Use/Side Paths

As covered earlier in this Chapter, shared use paths are another potential supplemental element of design for roadways in rural environments, serving the purpose of providing a separated facility for active transportation users.

The *AASHTO Bike Guide* provides detailed guidance on when these facilities should be considered. The guide includes **Figure 5-4**, which provides recommendations for when to consider shared use paths based on speed and volume. As with all design decisions, the context of the area, desired outcomes of a particular project or corridor, and known constraints and trade-offs should be evaluated when considering a supplemental element such as shared use paths. Although Figure 4-1 of the *AASHTO Bike Guide (2024)* is provided in **Section 4.3.2** “Streets in Urban Core, Urban, Suburban, and Rural Town Contexts”, the Guide notes that there are conditions where Figure 4-1 should be consulted when in (general) rural contexts. These conditions include corridors that function as popular bicycle routes; rural roads connecting nearby towns; proximity to schools, resorts, or vacation areas; and opportunities to connect regionally significant path or trail networks.

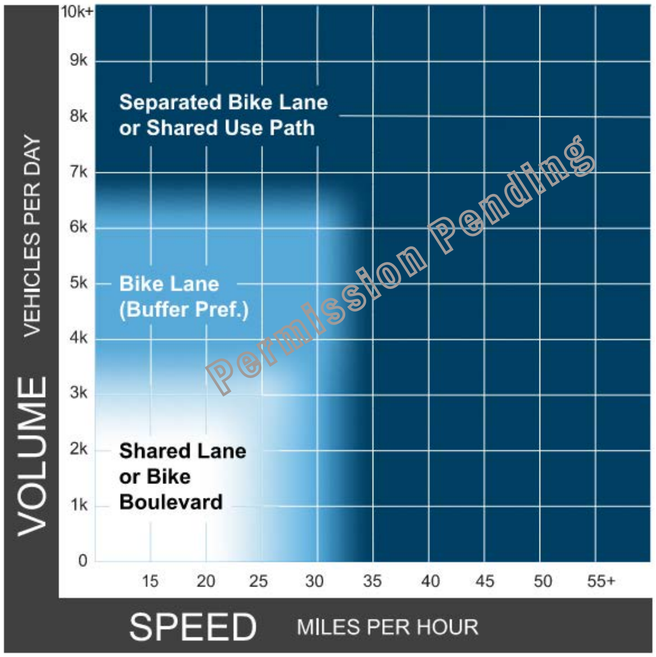
5.3.4.9 Maintenance-Related Design Considerations

Whenever roadway surfaces are expanded or elements are added, maintenance needs increase. For example, if a clear zone is established, it must be mowed or regularly trimmed.

On rural roads, lower-maintenance designs avoid features like slip lanes or physical separation of lanes that require multiple passes with a plow or grader. Establishing adequate drainage also reduces maintenance and repairs, while improving the long-term resilience and sustainability of a roadway corridor. Agencies should expect that guardrail may be struck and need repair or replacement.

Other foreseeable maintenance costs include annual repainting of pavement markings, snow and ice removal for sidewalks or shared use paths, cleaning of debris from culverts, and end-of-life replacement for signs, lights, and beacons.

Figure 5-4: Preferred Bikeway Type for Urban Core, Urban, Suburban, and Rural Town Contexts



Notes

1 Chart assumes operating speeds are similar to posted speeds. If they differ, use operating speed rather than posted speed.

2 Advisory bike lanes may be an option where traffic volume is <3K ADT. See Section 9.9 for more information on advisory bike lanes.

3 See Section 4.5 for a discussion of alternatives if the preferred bikeway type is not feasible.

Source: AASHTO Bike Guide (Figure 4-1)

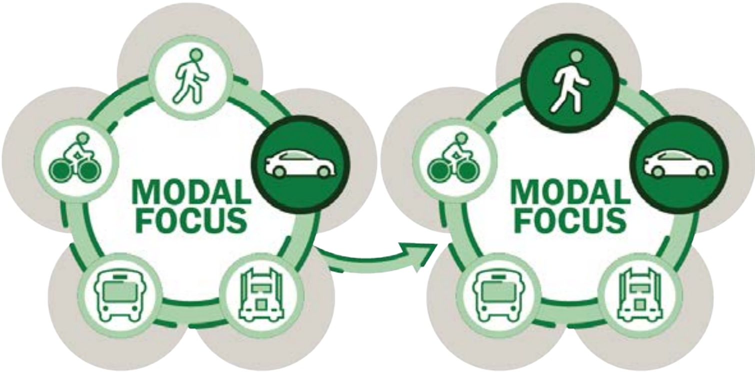
5.4 Rural Roadways: Comparing Cross-Sections

This section provides a high-level comparison of how different cross-sections can be used to improve safety and access for all users and can be referenced during an alternatives analysis.

When considering a roadway reconfiguration or reconstruction or widening project for a rural roadway, there are several design elements within the cross-section that impact mobility, safety, user comfort, and land use, including travel lane widths, shoulders, clear zones, active transportation accommodations, and landscaping. When reconstruction or widening is not an option due to environmental or fiscal constraints, roadway reconfiguration projects that maintain the existing roadway width may be implemented during reconstruction or pavement overlay projects.

5.4.1 Travel Lanes and Shoulders

Travel lane and shoulder widths affect vehicle speed and operational safety on rural roadways. As presented in **Chapter 7** Elements of Design, the VTrans preferred lane width is 11 feet. Historically, many rural roadways have had wider lanes without a shoulder. Where possible, edge lines should be striped to create distinct zones and avoid excessive lane width. When rural travel lanes are wider than 11 feet, for example, as shown in **Case Study 5-1**, pavement width should be reallocated to provide a shoulder or pedestrian and bicycle accommodations (if context and desired outcomes demand, and a 4-foot minimum shoulder width can be achieved). These changes can help manage speeds and improve conditions for bicyclists and pedestrians.



Given sufficient width, shoulders can even be converted to striped bicycle lanes and a buffer areas. **Case Study 5-2** demonstrates a cost-effective design strategy to serve all users while maintaining the function of the shoulder for stopped and emergency vehicles.

CASE STUDY 5-1

Roadway Reconfiguration to Narrow Lanes and Create Shoulders

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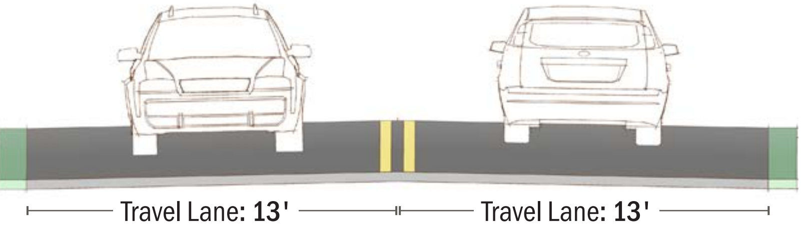

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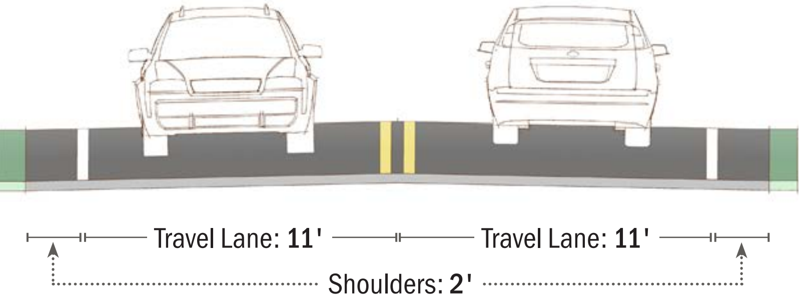


Context

- Low-volume, low-density residential, agricultural, conservation
- Provides local access for residents
- Limited bicyclists and pedestrians

Existing Safety Challenges

- Bicyclists and pedestrians must share the road with vehicles
- Wide 13-foot lanes promote higher speeds

User Comfort After

- Narrower 11-foot travel lanes result in reduction of travel speeds and improved safety. Defining some shoulder space for pedestrians and bicyclists enhances safety for alternative modes when vehicles are passing.

Example Roadway

- Maquam Shore Road, Swanton, VT

5.4.2 ROW Constraints and Strategies for Integrating Non-Motorized Facilities

In locations with demonstrated bicycle or pedestrian demand, identified as priority bicycle corridors, or locations that have significant bicycle or pedestrian destinations, accommodating these users should be considered. The safest accommodation for these users is facilities separated from vehicular traffic, where ROW and other constraints allow for development of those facilities.

The ROW available on Vermont's rural roadways varies significantly. In addition, many roads have topographic and environmental constraints that further limit the cost-effective accommodation of traditional infrastructure for active transportation. In these situations, altering the usage of the existing roadway width may be necessary.

5.4.3 Retrofit Strategies and Tradeoffs

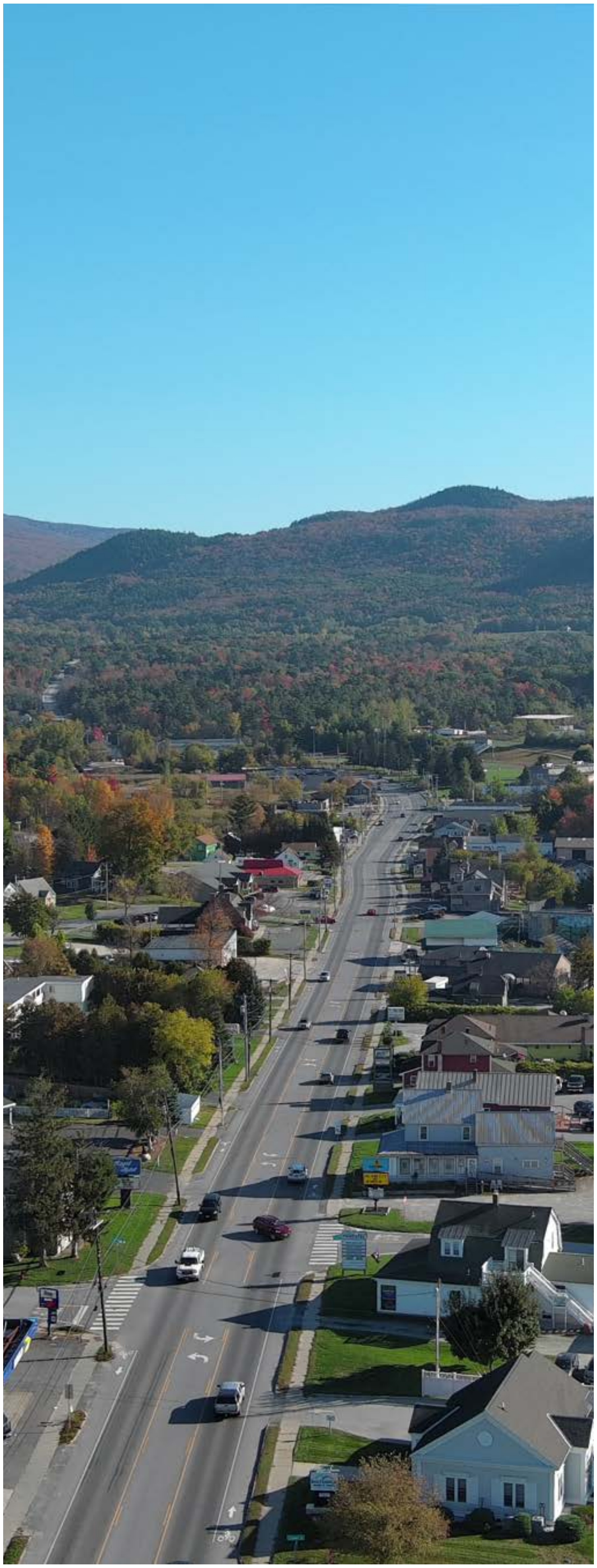
When roadway widening or reconstruction is determined not to be feasible, opportunities exist to reallocate space within an existing roadway width to enhance mobility, safety, and access for all users. Retrofit projects are lower in cost and easier to install; however, they require ongoing maintenance of pavement markings and still require consideration through the lens of context-sensitivity and designing for the determined desired outcomes. Space reallocated from travel lanes, for example, can be used for shoulders, landscaping, and pedestrian and bicycle accommodations. The goal of a retrofit project may be to achieve lower travel speeds, and traffic calming devices appropriate for reaching those target speeds may be incorporated into the design.

A simple example of a retrofit is creating a narrow shoulder along roadways that have wider lanes and no shoulders. Other retrofits involve reallocating wide shoulder space to a striped buffer area separating the shoulder from the travel lane. Images of these retrofits are shown in **Case Studies 5-1 and 5-2**.

Another common roadway reconfiguration strategy is a road diet, where the number of lanes on a multi-lane roadway is reduced to achieve desired outcomes such as accommodating bicyclists and pedestrians in the additional space that is created.

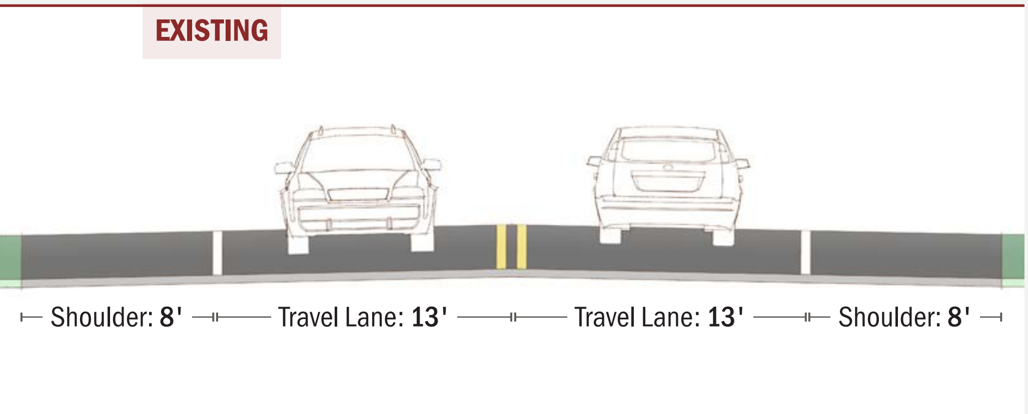
Road diets are considered an FHWA proven safety countermeasures with the potential to reduce total crashes by 19 to 47 percent. Additional safety benefits include reductions in rear-end and left-turn crashes, right-angle crashes, and the number of lanes pedestrians must cross. Road diet projects may also result in more consistent vehicle speeds and traffic calming. The remaining space resulting from the reduction of one travel lane in the cross-section may be used to install bicycle lanes or shared-use paths or shoulders. Facilities with more than two travel lanes and less than 20,000 ADT are good candidates for this type of retrofit strategy per the VTrans Traffic Safety Toolbox. **Case Study 5-3** illustrates a road diet on US 5 in Hartford.

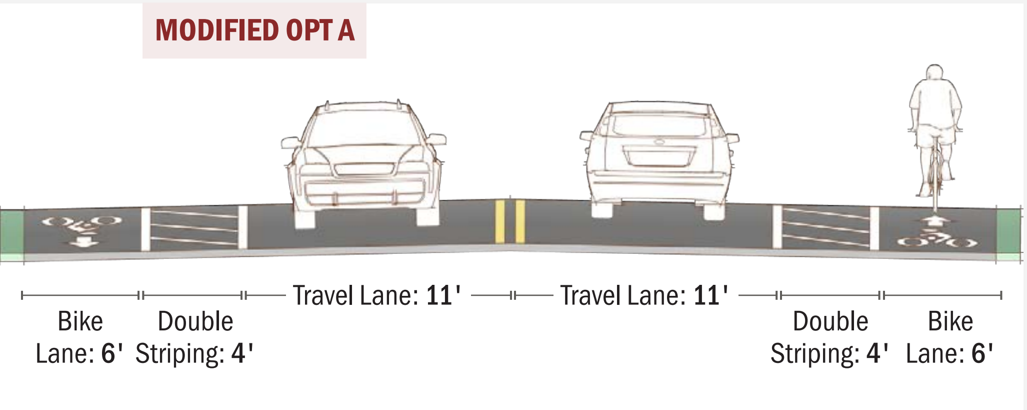
A traffic capacity analysis should be completed when determining whether a road diet is an appropriate retrofit strategy for a specific corridor due to the reduction of travel lanes. The Transportation Research Board's Highway Capacity Manual should be consulted when determining whether a lane or road diet is appropriate for a specific project.

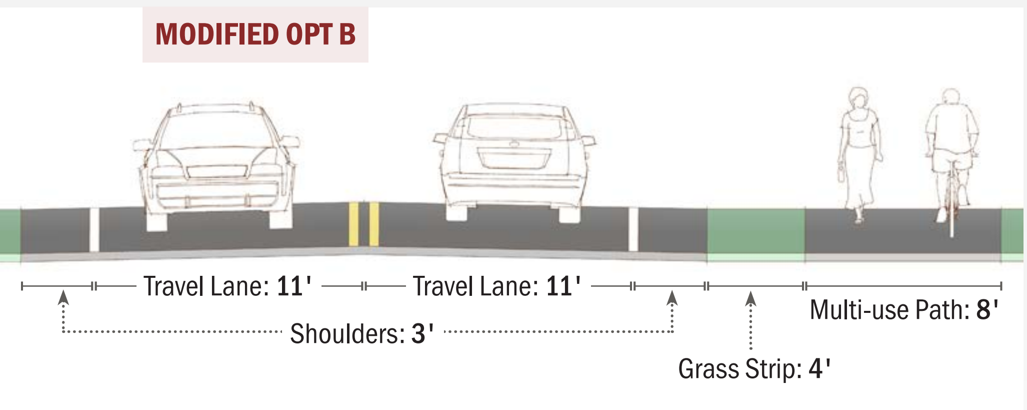


CASE STUDY 5-2

Roadway Reconfiguration to Reallocate Wide Lane and Shoulder Widths







Context

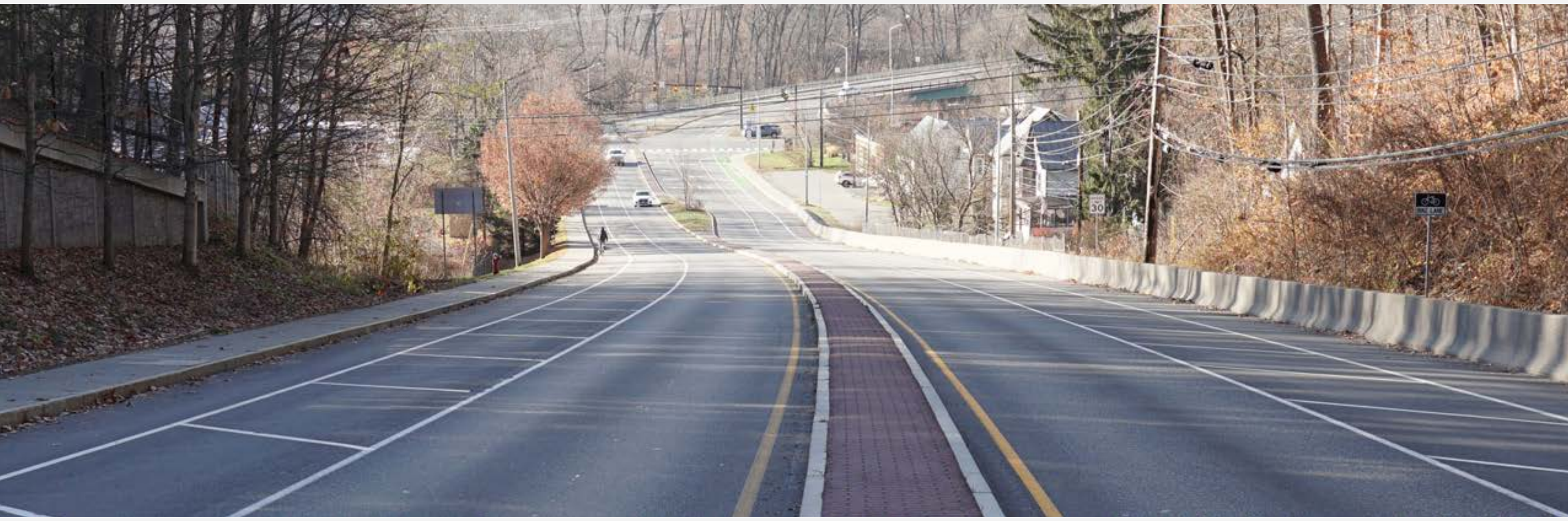
- High volume
- Provides access for longer distance private vehicle trips, freight vehicles and inter-city buses.
- Bicyclists and pedestrians are not primary focus but access to adjacent land uses still important for those users. Volume of these users varies by context.

Existing Safety Challenges

- No dedicated bicycle or pedestrian facility.
- Wider lanes promote higher vehicle speeds.
- Existing 8-foot-wide shoulder provides clear zone and can be used by pedestrians and bicyclists.

User Comfort After

- Narrower travel lanes reduces vehicle speeding. Dedicated bike lanes with bugger or multi-use path significantly improve pedestrian and bicyclist safety.



CASE STUDY 5-3

Road Diet along US 5 in Hartford

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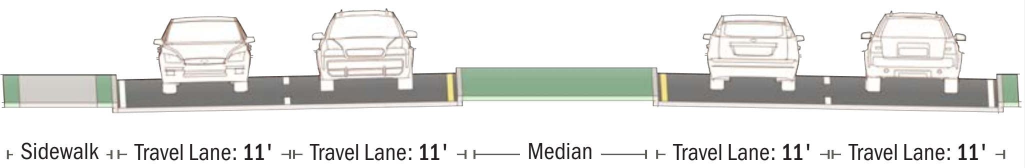

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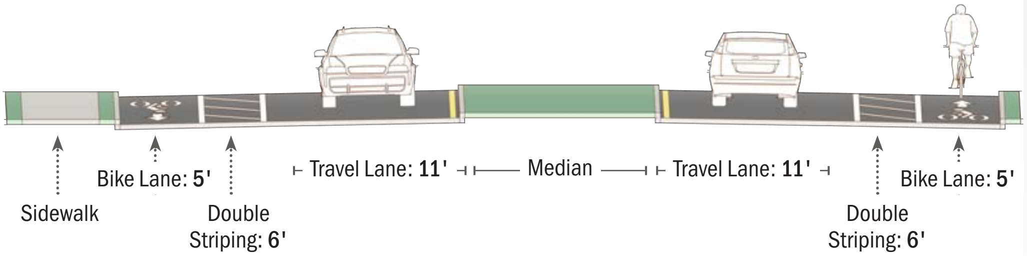

Context

- 8,000 AADT
- A long a two mile long connection between Sykes Mountain Avenue, Veterans Affairs services facility, and White River Junction.

Existing Safety Challenges

- Bicyclists must share the road with vehicles, no dedicated facilities.
- Lower volumes on a four lane cross section.

User Comfort After

- Traffic Calming: travel lane reduction: will result in slower travel speeds.
- Dedicated buffered bike lane significantly improves safety for bicyclists.
- Modification of pavement markings to accommodate change resulted in lower cost project

VT 116 and CVU Road in Hinesburg

5.5 Intersections in Rural Areas

Like rural roadways, the rural context dictates that rural intersections tend to prioritize vehicular movement. However, land use, density, and roadway user context can dictate that intersections in small villages include a modal focus that accommodates other users. **Chapter 8** provides an overview of approaches to designing and controlling intersections and **Chapter 7** details the elements of intersection design.

5.5.1 Relationship Between Roadway and Intersection

Designers should pay particular attention to safety within the "influence zone" of an intersection, defined in the Highway Safety Manual as 250 feet from the center of the intersection in rural areas. This is the zone in which intersection-related crashes may occur. It can be extended farther than 250 feet if an intersection feature, such as turn lanes, extend farther or queues frequently exceed 250 feet.

5.5.2 Common Design Considerations

There are over 10,000 rural intersections in Vermont; however, there are few standalone intersection projects. More frequently, minor treatments such as refreshing signs and pavement markings come about as ancillary parts of a paving project. Opportunities to redesign or substantially alter an intersection are relatively rare and generally limited to major intersections.

This subsection focuses on situations in which project scope allows more substantial changes. Intersections often reach this point due to capacity issues. In any redesign, it is important to evaluate delay, queuing, and LOS using microsimulation software. These metrics are critical in determining whether to change the intersection control (for example, from minor stop to all-way stop) or add or modify turn lanes. Further guidance on selecting an intersection control type is provided in **Section 5.5.3** Intersection Decision-Making Framework/Matrix. Additional guidance on turn lanes is provided in **Chapter 7**.

5.5.2.1 Multimodal accommodation

As with roadways and intersections of all types, in the rural environment, the modal focus at intersections will vary significantly based on context. When a rural intersection is remote and surrounded by low-density development, the most common user is likely to be a driver. However, when an intersection is located in an area with a variety of land uses (municipal, commercial, residential, and recreational) and higher density, the modal focus may shift to consider the addition of sidewalks or shared use paths. If an intersection is located along a transit route, increased density may warrant consideration of transit stopping at the intersection. Each of these items is outlined more specifically in **Chapter 7** Elements of Design and **Chapter 8** Intersections.

5.5.2.2 Design-control vehicle/user

Engineers must consider the appropriate design vehicle for each movement. Most public roads must accommodate school bus and fire truck movements. Roads serving commercial properties, farms, or are the primary route between two villages, should accommodate tractor trailers. If these movements require encroaching into opposing lanes, stop bars must be far enough back to allow the design vehicle to clear the turn. However, stop bars should not be placed so far back that drivers do not have a clear view of the intersection.

5.5.2.3 Safety considerations

Because the approaches in a rural setting tend to have higher posted speeds, sight lines and communication to the driver (and other users of the roadway) through signage and pavement markings must convey the presence and control of the intersection in a manner consistent with the MUTCD. When sight lines are deficient, safe intersection design should address the deficiency. When resource or other constraints limit sight lines, signing, markings, and other tools should be used to improve condition conspicuity.

Safe intersection design also considers approach geometry and seeks to modify skew angled intersections into perpendicular intersections. The common “Vermont Y” intersection, which consists of three intersections, should be considered for removal to provide a single perpendicular T-intersection, thereby reducing conflicts.

Other safety considerations include intersection lighting; evaluation of sight distances and the need for physical modifications or advance warning signs to address deficiencies; and elimination of channelized or slip lanes. More detailed information regarding these design considerations is provided in **Chapter 8**.

5.5.3 Intersection Control Evaluation

The VTrans Intersection Control Evaluation (ICE) guide should be used when evaluating intersection control strategies for rural locations. This ICE guidance should be referenced when planning and designing new intersections and when improving existing intersections. Conventional intersection control strategies considered in the preliminary phases of ICE analysis include minor-road stop control, all-way stop control, signalized control, and roundabout control. More innovative control approaches, including jughandles or restricted crossing U-turns (RCUT), may be considered as needed based on context.

5.5.4 Alternative Strategies

The most common retrofit situations for rural intersections involve standardizing Y-intersections, correcting highly skewed intersections, and addressing other legacy designs. When making intersection improvements, truck turning radii should be considered where high volumes of large trucks are present (see **Chapter 7** Elements of Design). Excessive deflection should be avoided to achieve right angles. All-way stop control may help address visibility challenges. Access management strategies, such as removing low-volume intersection legs that can be accommodated nearby, may improve operations.

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