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TECHNICAL MEMORANDUM

Warm Springs Commercial Corridor Safety Plan

DRAFT Recommended Safety Programs, Policies, and Projects

Date: November 15, 2016 Project #: 19780
To: Lonny Macy, Confederated Tribes of Warm Springs
From: Ashleigh Griffin, Jessica Spivey, and Brian L. Ray, PE
cc: Michael Duncan, Oregon Department of Transportation

This memorandum documents Kittelson & Associates, Inc.'s (KAI) draft safety programs, policies, and projects for the Warm Springs Commercial Corridor study area. These projects were identified based on the existing conditions analysis and input received from the Confederated Tribes of Warm Springs (CTWS) public and project stakeholders.

INTRODUCTION

The Warm Springs Commercial Corridor Safety Plan is intended to develop a set of goals, objectives, and strategies that improve safety on and around the Warm Springs Commercial Corridor. The Plan is intended to build upon goals, objectives, and strategies in the 2014 Warm Springs Transportation Plan to identify, prioritize, and refine safe and efficient infrastructure for all modes of transportation.

The Plan focuses on an approximately three mile section of US 26 from the intersection at Paiute Avenue (BIA 3) to the southeastern boundary of the reservation a Deschutes Crossing (milepost 105.20) and nearby streets, as illustrated in Figure 1.



Figure 1. Warm Springs Commercial Corridor Study Area

The development of the draft recommended safety program, policies, and projects is based on a data informed approach. KAI considered crash trends and risk in the development of the recommendations. The project is guided by a Public Advisory Committee (PAC) that has met twice to provide input on the safety needs of the community.

STRATEGY TOOLBOX

Prior to identifying projects for specific locations within the study area, KAI defined the general scope of potential safety projects by identifying an Improvement Toolbox from which to consider potential safety strategies based on the safety performance data and stakeholder input. Once the toolbox was established, we identified a broad range of potential treatments that could be adapted to specific locations in the study area. Treatment strategies would be adapted to each location's unique context. In identifying this broad range of potential treatments, we considered the crash types and contributing factors at each location. We also incorporated previous potential mitigations defined in the Warm Springs 2014 Transportation Plan. A primary focus was identifying specific treatments that would best address documented safety performance, risks, and anecdotal input from project stakeholders.

Project Toolbox

The Project Toolbox includes a diverse set of potential treatments ranging from low-cost/near-term to higher-cost/longer-term treatments. The toolbox establishes a common vernacular of what the various types of treatments are and to discuss with the CTWS stakeholders which types of treatments the CTWS stakeholders were comfortable exploring as potential treatments for the study area.

The following basic groups of treatments are included in the Project Toolbox.







- Gateway and Segment Speed Reduction (See Table 1)
- Intersection and Driveway (See Table 2)
- Pedestrian and Bicycle (See Table 3)

The tables on the following pages provide information about the different types of treatments. The CRF shown is the Crash Reduction Factor. This indicates the percentage of crashes that are estimated to be reduced if the treatment is installed. These numbers are based on national research. CRFs have not been established for all treatments recommended. Therefore, some treatments will not have any information in the table.

The implementation cost values shown are based on planning-level unit costs and do not account for factors such as engineering, right-of-way and major earthwork. These estimates will need to be refined during the project design and programming.

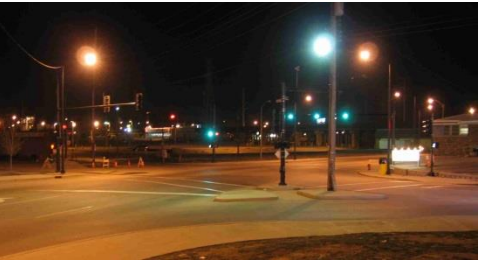
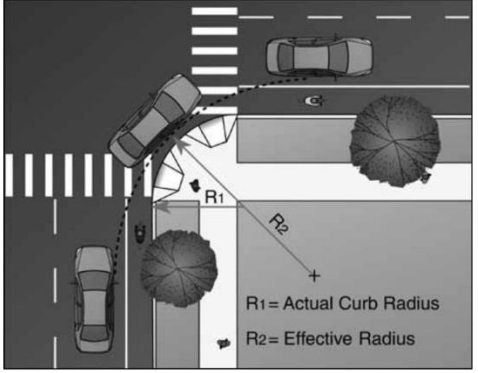




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Table 1. Gateway and Speed Reduction Treatments

Gateway and Speed Reduction Treatments			
Treatment	Description	CRF	Unit Cost Estimate [^]
<p>Radar Speed Feedback Sign</p>  <p>Source: safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa12004/</p>	<p>Speed feedback signs inform drivers of their speed and encourage drivers to reduce their speed. Warm Springs currently has two signs on US 26.</p>	41% (all crashes)	\$10,000 per sign
<p>Gateway Treatments</p>  <p>Source: google.maps.com</p>	<p>Improvements that provide a transition from a rural environment to an urban environment provide an indication to drivers that they need to reduce speed. Potential improvements to change this environment include:</p> <ul style="list-style-type: none"> • Curbs • Raised medians • Narrow lanes • Speed reduction signage • Gateway signage 	30% (all injury crashes)	<p>\$12 per linear foot for 18" raised median</p> <p>\$15 per foot for curb</p>
<p>Context Sensitive Roadway Cross-Section</p>  <p>Source: google.maps.com</p>	<p>Maintaining an urban cross section through Warm Springs will provide indication to drivers that they are in an urban environment until they exit the core area.</p>	30% (all injury crashes)	<p>\$12 per linear foot for 18" raised median</p> <p>\$15 per foot for curb</p> <p>\$33 per linear foot for 6-ft sidewalk</p>
<p>Rumble Strips</p>  <p>Source: a1seakubinc.com</p>	<p>Rumble strips are grooves placed in the roadway in such a manner that, as the tires of the vehicle contact them, they produce sound and vibration intended to alert the driver. They can be placed on the centerline or shoulder.</p>	<p>Centerline rumble strips: 12% (all injury crashes in rural areas)</p> <p>Shoulder rumble strips: 22% (run-off the road crashes)</p>	<p>\$3,000 per mile for centerline rumble strips</p> <p>\$850/mile for shoulder</p>
<p>Turn Lanes</p>  <p>Source: ux.stackexchange.com</p>	<p>Exclusive lanes for turning movements direct vehicles that are turning into a separate lane. This removes stopped vehicles from through traffic.</p>	14 to 48% (depending on characteristics of location)	\$130,000 per turn lane
<p>Lighting/Illumination</p>  <p>Source: sciencedaily.com/releases/2013/02/130205094512</p>	<p>Roadway illumination enables road users to better see each other and the roadway conditions.</p>	28% (all injury, night-time crashes)	\$390,000 per mile, assuming 100-ft spacing and lighting on one side of the road

[^]Unit cost estimates are intended to be planning-level cost estimates and do not include engineering, contingency, right-of-way, or significant earth work.

Table 2. Intersection and Driveway Treatments







Intersection and Driveway Treatments			
Treatment	Description	CRF	Unit Cost Estimate [^]
<p>Lighting/Illumination</p>  <p>Source: dangerousintersection.org/2009/02/02/di-is-still-under-onstruction-but-now-theres-artwork-in-our-header</p>	<p>Roadway illumination enables road users to better see each other and the roadway conditions.</p>	<p>38% (all injury, night time crashes)</p>	<p>\$8,500 per pole</p>
<p>Tightening Turning Radii</p>  <p>Source: ITE Walkable Urban Thoroughfares</p>	<p>Large turning radii facilitate faster vehicle turning movements and increase crossing distance for pedestrians. Reducing the curb radii aids in slowing vehicles and improving pedestrian safety.</p>	<p>35%</p>	<p>Varies</p>
<p>Turn Lanes</p>  <p>Source: safety.transportation.org/htmlguides/UnsigInter</p>	<p>Exclusive lanes for turning movements direct vehicles that are turning into a separate lane. This removes stopped vehicles from through traffic.</p>	<p>14 to 48% (depending on characteristics of location)</p>	<p>\$130,000 per turn lane</p>
<p>Traffic Signal</p>  <p>Source: fhwa.dot.gov</p>	<p>Traffic signals are traffic control devices that provide an orderly movement of conflicting flows through an intersection. Traffic signals separate movements and conflicts with time separation.</p>	<p>67 to 77% for angle crashes -58 to -143% for rear-end crashes (<i>increase</i> in rear-end crashes)</p>	<p>\$250,000 per signal</p>
<p>Roundabout</p>  <p>Source: google.maps.com</p>	<p>A type of intersection characterized by its circular shape, channelized approaches and yield to entry.</p>	<p>82% (all injury)</p>	<p>\$300,000 - \$1 million</p>
<p>Alternate Truck Routing</p>  <p>Source: robertsterlingmusic.com/home/taking-an-alternate-route</p>	<p>Alternate truck routes provide a route that can accommodate trucks and large vehicles in special situations when the highway may be closed. Signage is needed to direct drivers to these routes.</p>	<p>N/A</p>	<p>\$500 per sign Roadway and intersection improvements may also be needed to accommodate larger vehicles.</p>



Intersection and Driveway Treatments			
Treatment	Description	CRF	Unit Cost Estimate [^]
<p>Improve Sight Distance</p>  <p>Source: www.fabb-bikes.org/guide/commonissues2</p>	<p>Providing adequate sight distance at intersections and driveways allows drivers to have adequate time to see and react to potential conflicts.</p>	<p>48% (all injury crashes)</p>	<p>Varies*</p>
<p>Define Access to Properties</p>  <p>Source: shutterstock.com</p>	<p>Creating defined access points reduces the number of potential conflict points on the roadway and minimizes confusion of drivers. It also reduces pedestrians' exposure to potential conflicts with vehicles.</p>	<p>25% (all injury crashes)</p>	<p>\$15 per foot for curb, in addition to new pavement and landscaping</p>
<p>Truck Parking Locations</p>  <p>Source: nedapidentification.com/solutions/cases/nedap-deploys-smart-truck-parking-system-in-denmark</p>	<p>Having designated locations for trucks to park would help alleviate the amount of trucks parking along the highway. This would increase visibility, both for those on the highway and those trying to access the highway.</p>	<p>N/A</p> <p>At some locations, this improvement would reduce the number of trucks parking on-street, thus improving sight distance.</p>	<p>\$500 per sign for directional signs;</p> <p>Cost of new parking locations would vary</p>

[^]Unit cost estimates are intended to be planning-level cost estimates and do not include engineering, contingency, right-of-way, or significant earth work.

*In some situations, sight distance can be improved with low-cost treatments such as landscaping modifications. In other situations, intersection realignment may be required, which is more expensive to complete.

Table 3. Pedestrian and Bicycle Treatments

Pedestrian and Bicycle Treatments			
Treatment	Description	Crash Reduction Factor (CRF)	Unit Cost Estimate [^]
<p>Sidewalk</p>  <p>Source: type.dvrlists.com/sidewalk/</p>	<p>Sidewalks provide physical space for pedestrians separate from the vehicle travel lanes. They provide safety and mobility while improving pedestrian comfort and accessibility on streets.</p>	N/A	\$33 per linear foot for 6-ft sidewalk
<p>Shared Use Path</p>  <p>Source: englewoodindependent.com</p>	<p>A shared-use path physically separates pedestrians, bicyclists, and other non-motorized users from vehicular traffic by either a barrier or an open space.</p>	N/A	\$20 per linear foot for 10-ft path
<p>Marked Crosswalks</p>  <p>Source: safety.fhwa.dot.gov</p>	<p>Marked crosswalks indicate optimal or preferred locations for pedestrians to cross and help designate right-of-way for motorists to yield to pedestrians.</p>	15%	\$2,000 per crossing
<p>Enhanced Crosswalks (Rectangular Rapid Flashing Beacon - RRFB, Pedestrian Refuge Island, etc.)</p>  <p>Source: carmanah.com/traffic/products/r920-solar-rectangular-rapid-flashing-beacon-rrfb</p>	<p>There are a variety of options available for increasing the visibility of a pedestrian crossing:</p> <ul style="list-style-type: none"> • High visibility markings, • Pedestrian refuge islands, • Pedestrian activated signs, • Raised crosswalks, • Flashing beacons. 	56% for RRFB with median on a 3-lane or more roadway	\$50,000
<p>Lighting/Illumination</p>  <p>Source: type.dvrlists.com/sidewalk/</p>	<p>Illumination at crossings provides better visibility of the pedestrian so that drivers have greater time to react and slow before reaching the crosswalk.</p>	42% for intersection illumination for bike & ped crashes at night (injury)	\$8,500 per pole
<p>Gap Closures (footbridge, stairs, etc.)</p>  <p>Source: caithness.org/bridges/gallery.php?gallery=0&image=4</p>	<p>Gap closures would connect existing routes/paths together to create a more cohesive pedestrian/bicycle system throughout Warm Springs. These closures could include footbridges, stairs, etc.</p>	N/A	Varies depending on surface type, slope, etc.

Pedestrian and Bicycle Treatments			
Treatment	Description	Crash Reduction Factor (CRF)	Unit Cost Estimate [^]
<p>Routes to School</p>  <p>Source:thecalifornian.com/story/news/2016/08/19/school-crosswalks-unfinished-business/89025232</p>	<p>Having maintained routes to school would allow for pedestrians to more safely commute to school.</p>	N/A	Varies depending on surface type, slope, etc.
<p>New Paths</p>  <p>Source:http://appvoices.org/2016/08/12/trailbuilding-forging-new-paths/</p>	<p>Creating new pedestrian and bicycle paths could increase safety for both users. These paths could connect to other paths in the area and would allow for pedestrians and bicycles to have routes that do not conflict with vehicles.</p>	N/A	Varies depending on surface type, slope, etc.

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PRELIMINARY PROJECT RECOMMENDATIONS

Based on the discussions with project stakeholders, KAI took the full range of safety strategies from the Project Toolbox and focused it to fit within the project area and context to address the specific needs and stakeholder interests at each location.

The following sections summarize the recommendations in two general location categories:

- Projects in the “US 26 Corridor” area: These projects includes locations along the US 26 study corridor and at intersections within this corridor.
- Projects in the Warm Springs “Off-Highway Area”: The Off-Highway Area refers to projects within the study area but located off the highway. This includes the downtown/campus area, Hollywood Boulevard, Tenino Road, Quail Trail, and Chukar Road.

To establish a focused group of potential projects, we identified three treatment categories for the study area:

- **Gateway / Speed Reduction Treatments:** The gateway treatments, which may include elements such as raised median, curb, narrower lanes, and signage, are intended to inform drivers that they are in a different context of US 26 as they arrive in Warm Springs. Drivers approaching the study area from the east and west directions have been traveling through rural, high speed sections of US 26. These sections generally require a limited driver workload and have fewer activity zones when compared to the Warm Springs section. As drivers enter the relatively urbanized area (i.e., businesses, public access driveways, pedestrian crossings) within Warm Springs, the intent of the gateway treatments is to encourage slower speeds and increased awareness of potential conflicts at intersections or pedestrian crossings. The speed reduction treatments that are carried throughout the corridor are intended to encourage drivers to maintain slower speeds and be aware of vulnerable users through the Warm Springs portion of US 26. This may be accomplished through cross-section elements, pedestrian and bicycle facilities, and signage.
- **Multimodal Connectivity Treatments:** The multimodal connectivity treatments are intended to create defined and visible facilities and connections for non-motorized users. This could include enhancing existing facilities or creating new facilities along and crossing roadways. The majority of these treatments provide pedestrian and bicycle connections where none exist today. Without appropriate facilities, pedestrians and bicyclists are forced to walk/bike along the roadway, which increases conflicts with vehicles and diminishes the quality of service for non-motorized users. Pedestrian and bicycle specific facilities along roadways provide users with a separated facility, reducing the potential for conflicts between different modes. Treatments crossing roadways define crossing locations, alert users to conflict areas, and support pedestrian and bicycle mobility in Warm Springs.

- **Intersection / Driveway Treatments:** These treatments are intended to reduce crash frequency and severity while raising driver awareness at access points and may include turn lanes, intersection control changes, intersection geometry changes, illumination, and sight distance improvements.

Figure 2 through Figure 4 illustrate the locations along the corridor where KAI recommends specific treatments. The projects are identified as immediate projects, near-term projects, long-term projects, and development-driven projects. The priorities and timelines are based on the crash trends, identified risk factors, community input, effectiveness of the treatment, and relative cost and ease of implementation.

- The immediate projects are the highest priority and lowest cost and are expected to be implemented within the next 1-to-2 years.
- The near-term projects include those that are also high priority but may take longer to implement since they may require more design details to support project programming. The near-term projects are expected to be implemented within approximately 2-to-5 years.
- The long-term projects are those identified by KAI and the community for their potential safety benefits but may be lower priority than other projects and/or take longer to construct due to challenges such as funding and right-of-way.

Some projects are identified on the long-term plan but are also considered development-driven projects. These include are those that are recognized for their benefits but are lower priority under existing conditions. However, a change in land use or development nearby may trigger the need for or opportunity to include these elements in response to a specific project catalyst.

The implementation plan is meant to be flexible and adaptive over time. The priorities and timelines could to shift over time as the conditions and context within the community change. However, the foundational nature of the implementation approach does not diminish as the CTWS adapts to varying community needs. The priorities are intended to serve as guidelines for Warm Springs without binding the CTWS to complete all near-term projects before beginning long-term projects. The CTWS is encouraged to use these project groupings to determine the most efficient use of future funding.

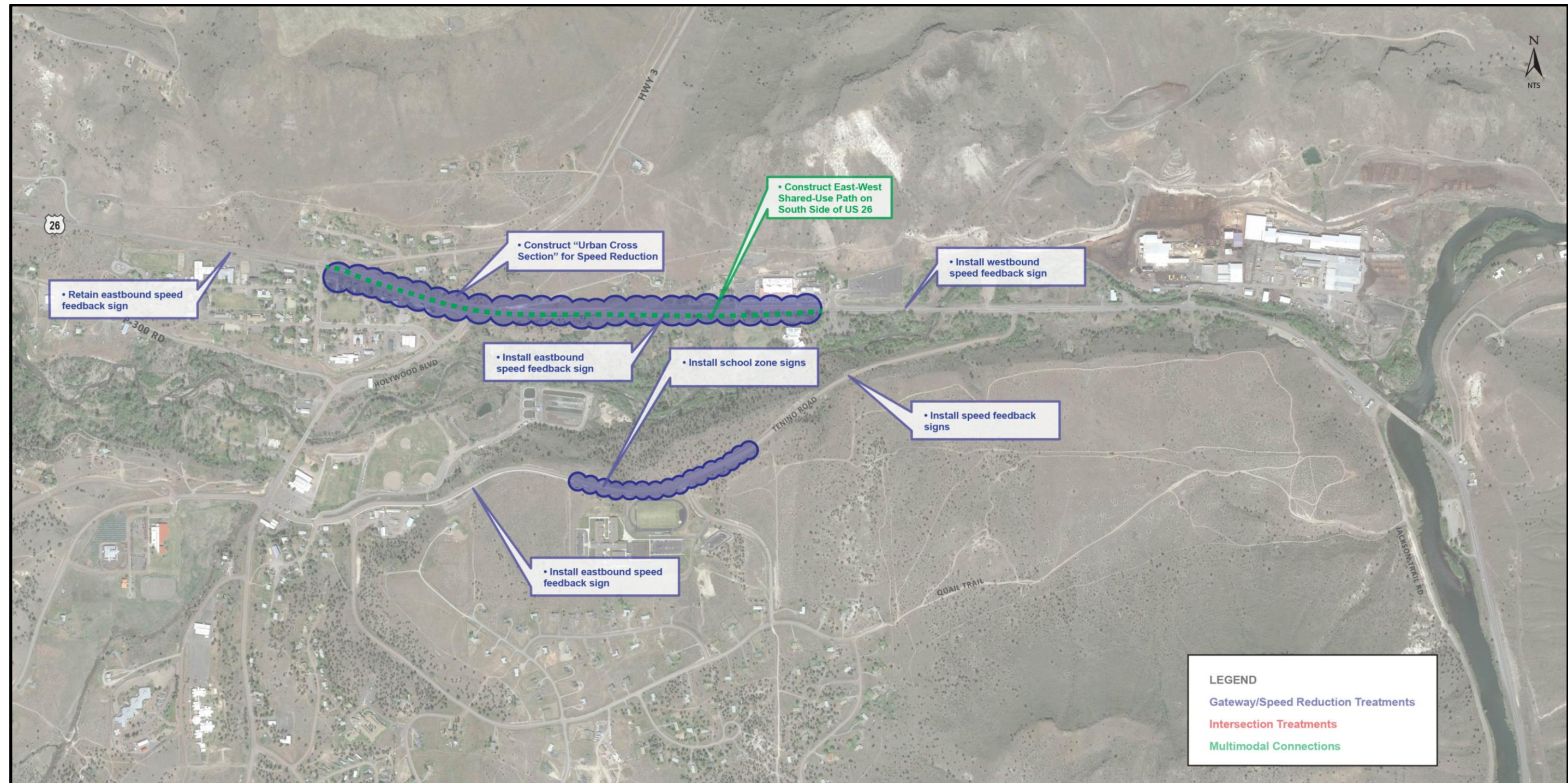


Figure 2. Immediate-Term Recommended Projects

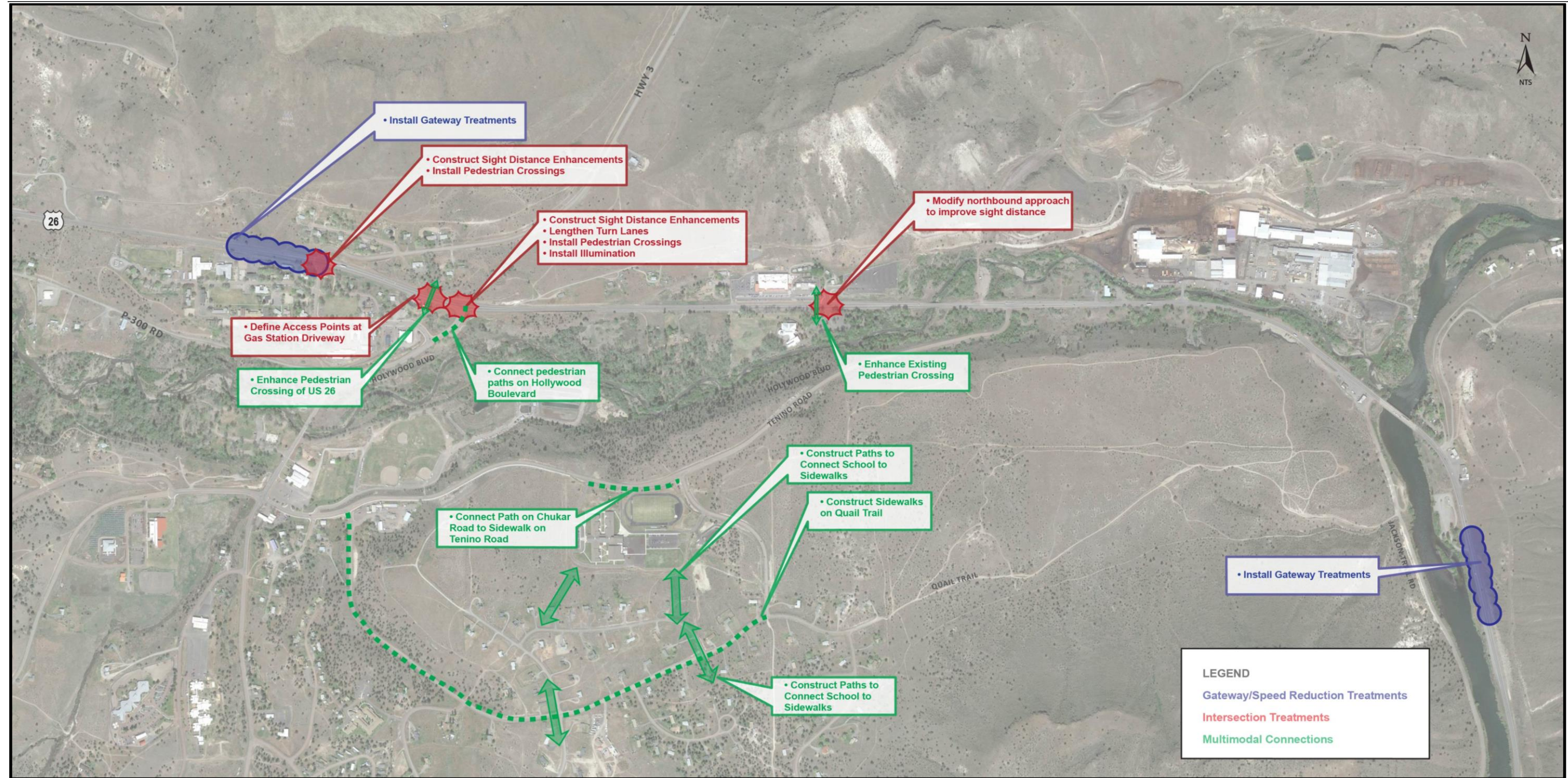


Figure 3. Near-Term Recommended Projects

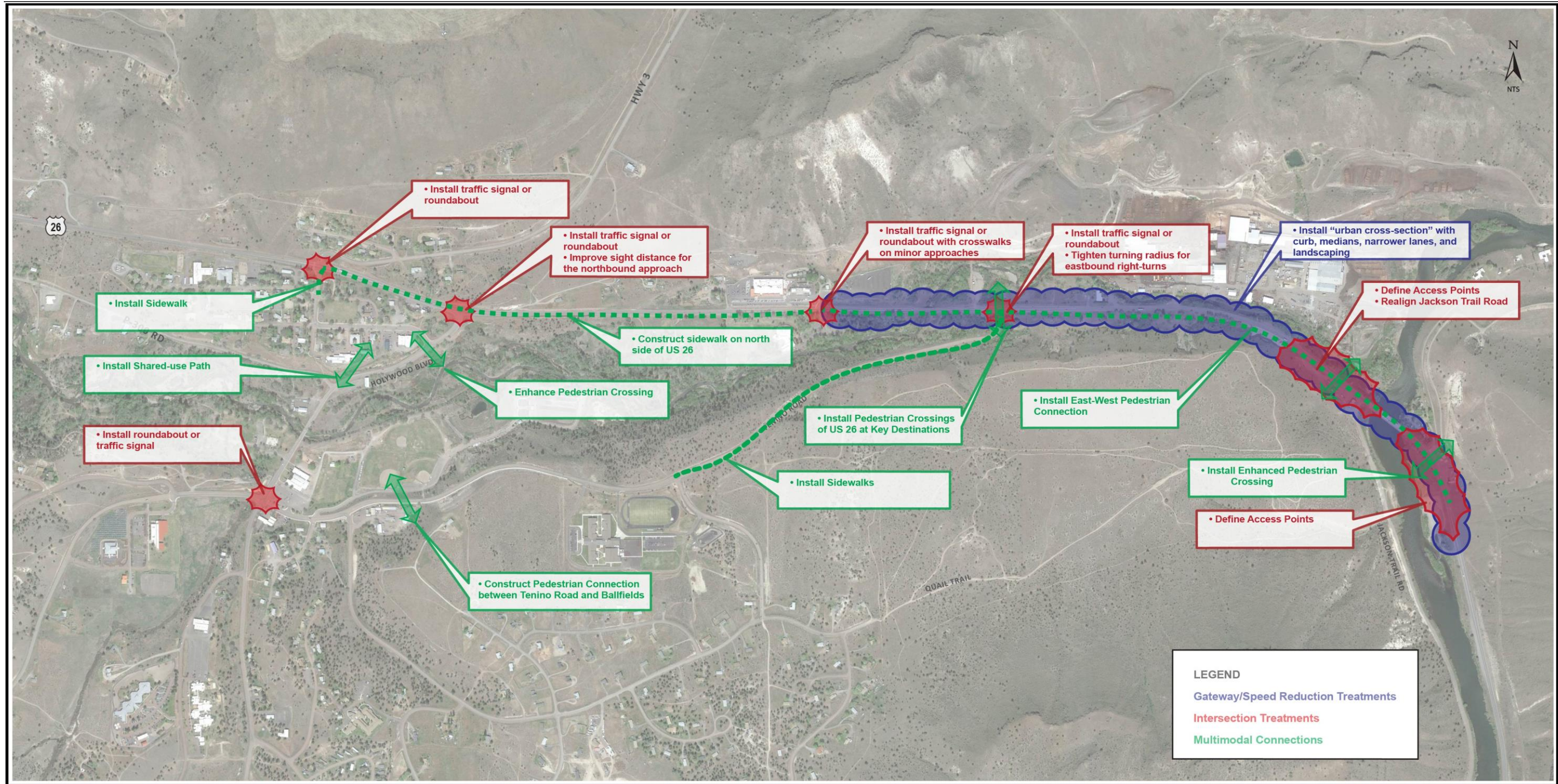


Figure 4. Long-Term Recommended Projects

Key characteristics of the safety plan at specific locations are discussed in the following sections. The intersection concept graphics shown at some locations are intended to illustrate concepts, not the specific final recommended design for the location. Additional collaboration with project stakeholders, combined with more design level detail about engineering needs at each location, will be needed to define specific project recommendations.

US 26 CORRIDOR TREATMENTS

Gateway and Speed Reduction Treatments on the US 26 Corridor

The goal of gateway and speed reduction treatments is to make drivers aware of changes in the roadway environment and encourage them to reduce travel speeds within the Warm Springs commercial corridor along US 26. There are many ways to accomplish this, with some of the more common options including speed feedback signs, curb bulb-outs, transverse rumble strips, median islands, landscaping, urban cross sections with curb and sidewalks, landmark signs, and enforcement.

Of these options, KAI identified speed feedback signs and urban cross sections, with marked or raised medians, curb, lighting, and sidewalks/paths, as treatments appropriate within the study area. The treatments would begin approximately a half-mile in advance of the study area to provide drivers with the opportunity to transition to a lower speed prior to reaching the core area. If treatments are provided too far in advance of the location of interest, drivers will not realize they are entering an urban area at the same time that they are experiencing the gateway treatments. The median, curb, sidewalk, illumination, landscaping, and possibly narrower travel lanes provide visual cues to the driver that they are approaching a more urban community and should expect non-motorized users and more activity at public roads and driveway access points.

KAI does not recommend reducing the posted speed alone under current roadway conditions. The effectiveness of reducing the posted speed limit without changing the roadway environment is limited. Speed discrepancy between drivers who do slow and those who do not can increase the risk of crashes. KAI recommends these changes to the roadway environment to create a more urbanized feel and encourage drivers to travel at slower speeds. ODOT could consider lowering the posted speed limit as part of implementing the physical cross section changes.

Speed feedback signs provide drivers with real-time feedback about their travel speeds, relative to the posted speed limit. Speed feedback signs have been proven effective when used in conjunction with a posted speed limit sign. In addition, speed feedback signs can be relatively easy and cost-effective to install. Warm Springs currently has one sign, located on the eastbound approach into Warm Springs. Community stakeholders shared a perception that the signs work well at reducing speeds. KAI recommends retaining this sign and installing additional signs on the east approach to Warm Springs as well as within the corridor on both sides of the Casino/Museum to encourage slow speeds throughout the corridor.

Gateway treatments to illustrate the transition area are proposed on both the east and west end of the study area, as shown in Figure 5 and Figure 6. The urban cross-section is proposed throughout the corridor to maintain slower speeds within the 3-mile section in Warm Springs. An example of a shift between urban and rural cross section is shown in Figure 7 and Figure 8.



Figure 5. Conceptual Example of Potential Gateway Treatments on West End of Study Area



Figure 6. Conceptual Example of Potential Gateway Treatments on East End of Study Area



Figure 7. Example of Transition from Rural to Urbanized Cross-Section



Figure 8. Example of Transition from Urbanized to Rural Cross-Section

Implementation Phasing of Gateway and Speed Reduction Treatments

Immediate-Term Treatments:

- Speed feedback signs are relatively easy to implement and highly effective. Therefore, KAI proposes these as immediate recommendations.
- Speed reduction treatments throughout the corridor should be phased, based on the segment's context. The segment from Paiute Avenue to the Casino/Museum driveway is recommended for immediate implementation. This segment exhibits the highest pedestrian/bicycle traffic. The lack of existing facilities results in pedestrians walking along US 26, with high traffic volumes, truck percentages, and speeds. An urbanized cross-section through this section would assist in calming traffic. This may include a sidewalk/path, curb, illumination enhancements, lane narrowing, and/or a marked or raised median. For efficiency, these features could be completed in conjunction with the pedestrian/bicycle path along US 26.

Near-Term Treatments:

- KAI proposes the gateway treatments as near-term improvements. While the final design would be determined at the time of implementation, these treatments are expected to include marked or raised median, curb, illumination enhancements, and/or lane narrowing.

Long-Term Treatments:

- KAI recommends constructing an urban cross-section from the Museum/Casino Driveway east to the end of the study area to assist with speed reduction in the long-term. This section exhibits lower pedestrian traffic than the western section. However, if the mill site redevelops, the priority for this section may elevate. Future development along the eastern section of the corridor should include frontage improvements to meet the goal of an urban cross-section. To the extent possible, backage roads should be considered to reduce conflicts on US 26.

US 26 Multimodal Connections

The US 26 corridor is the most direct east-west connection between the Warm Springs campus/downtown area, residential areas, and employment areas such as the casino, museum, and former mill site. As such, pedestrian traffic is common along US 26. Under current conditions, there are no sidewalks or paths for pedestrians to travel east-west along the corridor. Pedestrians walk along the highway shoulder, adjacent to motorized traffic. With the exception of the major intersections along the corridor, there is no street lighting along the majority of the corridor.

Because of these conditions and the volume of pedestrians using this route, a pedestrian path or sidewalk is recommended as an immediate-term project for the western section of the corridor between Paiute Avenue and the Casino/Museum. The highest priority section is that between the

intersection of Paiute Avenue and the Casino/Museum driveway because it is the most heavily used connection. The section east of there, between the Casino/Museum driveway and the Deschutes River recreational areas is also recommended but is a lower priority than the western section noted. Pedestrians continue to use US 26 to access the market and recreational areas at the end of the corridor. If redevelopment of the former mill site occurs or new development on the eastern end of the corridor occurs, the priority for that section may increase.

The pedestrian connection may take the form of a 6 foot sidewalk or shared-use path. The sidewalk, adjacent to or offset by a 2 to 5 foot buffer from the road, supports the speed reduction treatments to create a relatively urban feel and assist in traffic calming. However, a shared-use path, is typically 10 to 12 feet wide to also accommodate bicyclists, may be further offset from the highway and have its own unique alignment. While this may decrease the effectiveness of creating an urban environment, it provides the benefit of further separation between pedestrians/bikes and vehicles. The US 26 cross section should include a raised curb regardless of where the multi-use path is located. Roadway and crosswalk illumination is recommended for both options. Active crossing treatments such as rapid flashing beacons or hybrid beacons are supplements that should be considered during design activities.

In the near-term, the shared-use path is recommended on the southern side of the highway. In the long-term, a sidewalk is also recommended on the north side of the highway to serve pedestrians that access the connection from informal paths to the north.

Implementation Phasing of US 26 Multimodal Connections

Immediate-Term Treatments:

- Install an east-west shared-use path along the south side of US 26 between Paiute Avenue and the Casino/Museum driveway.

Long-Term Treatments:

- Install an east-west sidewalk connection or shared-use path along US 26 between the Casino/Museum driveway and the Deschutes River Recreation area on the eastern end of the study area. This section includes two bridge crossings with limited width. The preferred option for addressing those connections should be determined in cooperation with project stakeholders before the initiation of final design. This treatment may increase in priority if new development occurs or if there is redevelopment of the former mill site.
- Install sidewalk along the length of the study corridor on US 26 on the north side of the highway.

US 26 / Paiute Avenue

US 26/Paiute Avenue is the first intersection vehicles encounter when approaching Warm Springs on US 26 from the west. There have been eight reported intersection crashes over the past five years, including one severe crash. There is a trend of angle crashes and rear-end crashes. Angle crashes are associated with turning movements while rear-end crashes are likely associated with turning vehicles decelerating or accelerating near the intersection.

The gateway and speed reduction treatments are expected to have a direct, positive impact to this location. As such, the intersection improvements at US 26/Paiute Avenue are included in the conceptual drawing for the gateway treatments on the west end of the study, as shown in Figure 5.

In addition to the speed reduction treatments, several additional treatments are recommended at this location. These include the following items.

- **Enhanced crosswalks:** KAI recommends enhanced crossings at this location. There is one existing, continental crosswalk located on the west side of the intersection. The crossing currently contains school crossing warning signs with an overhead warning signal. Enhanced crossings may contain reflective signing, raised pedestrian medians, pedestrian-scale illumination, and/or flashing beacons. Such enhancements will increase pedestrian visibility to drivers. The crosswalks should connect to ADA-compliant pedestrian ramps and sidewalks so as not to lead a pedestrian to a point without pedestrian facilities. Therefore, the crossings should not be installed until sidewalk or shared-use path facilities are completed on the approaches.
- **Intersection Control Modifications:** In the long-term, intersection control such as a traffic signal or roundabout may be needed at this location. An intersection evaluation should be completed at that time to consider the safety and operational trade-offs between traffic signals and roundabouts. For example, traffic signals may reduce angle crashes but increase rear-end crashes. The analysis should also consider whether the intersection meets signal warrants according to the Manual on Uniform Traffic Control Devices (MUTCD).
- **Intersection Geometry Modifications to Improve Sight Distance:** Westbound traffic in the right-turn lane restricts the view of oncoming traffic for vehicles queued at the southbound approach. Bringing the stop bar forward will assist in improving sight distance for southbound vehicles at the intersection. However, the stop bar should be placed in advance of any future crosswalk locations. Lengthening the left and right turn storage allows drivers to access turn lanes farther in advance of the intersection. This aids side street drivers by differentiating between through and turning vehicles when selecting a gap in traffic. Other treatments could include increasing the separation between through and right turning vehicles via striping. Separating the right turning traffic could increase the view for side street drivers looking for a gap in through traffic on US 26.

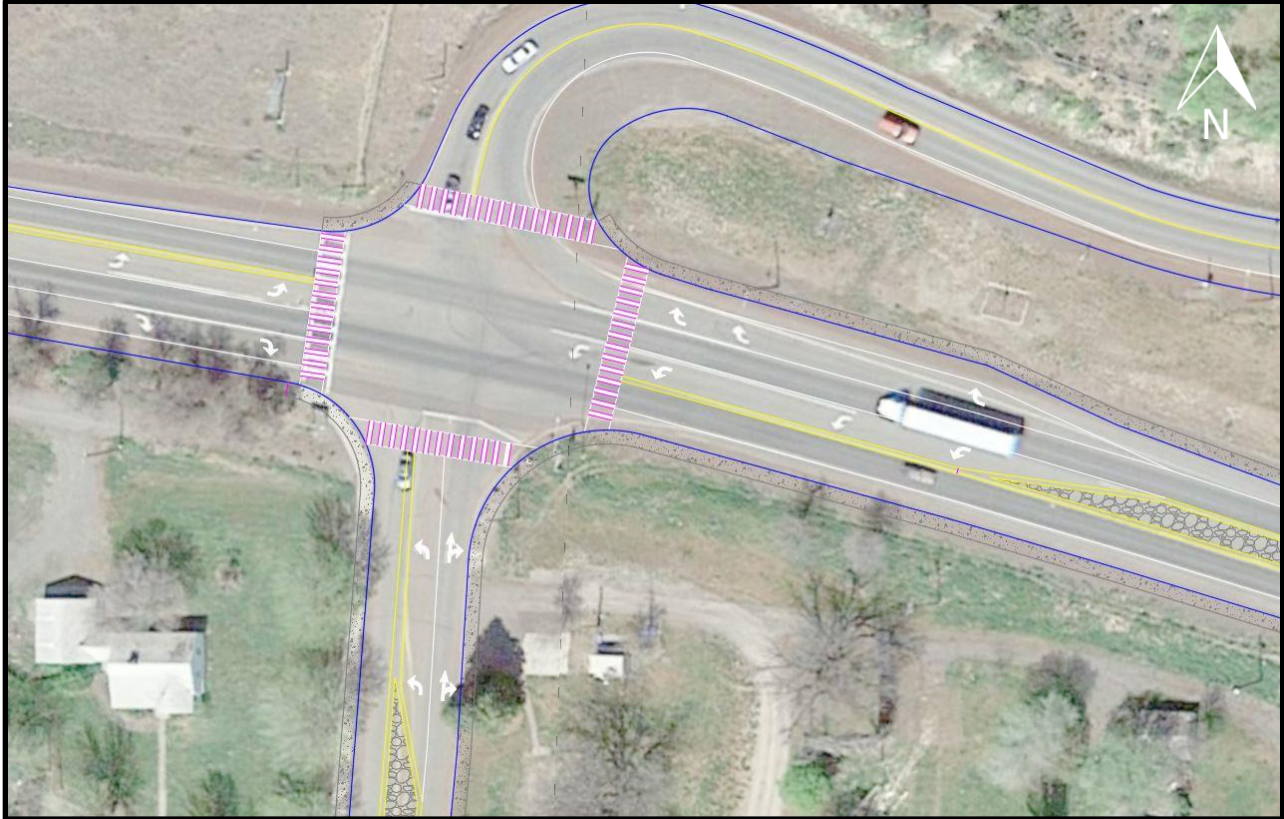


Figure 9. Example of Potential Treatments at US 26/Paiute Avenue

Implementation Phasing of Treatments at US 26 / Paiute Avenue

As summarized in the previous section, the gateway treatments are recommended as a **near-term project**. The crosswalks should be phased based on the installation of connecting pedestrian treatments, including ADA ramps and sidewalks. The crossing on the southern leg of the intersection may be completed when the sidewalk project between Paiute and the Casino/Museum driveway is completed. Sight distance enhancements are also recommended for installation in conjunction with the gateway treatments. KAI recommends the traffic control change as a long-term improvement.

US 26 / Hollywood Boulevard

There are several recommended components at the US 26/Hollywood Boulevard intersection. For continuity and because of close proximity, the gas station is included as part of this discussion. There were four reported as rear end or angle crashes in this section of US 26. The two rear-end crashes occurred at the Hollywood Boulevard intersection, and the two angle crashes occurred in front of the gas station, according to crash report information. However, the crash report location information is often slightly off from the true crash location.

KAI recommends access management treatments at the gas station. This could include reducing and better defining the number of access points in and out of the gas station, adding curbs to better

define access points, adding signage to direct vehicles to access points or restrict directions at access points, and creating defined facilities for pedestrians/bicyclists.

Creating specific access points into and out of the gas station would reduce the number of conflict points between through vehicles on US 26 and vehicles entering/exiting the gas station. Further study and coordination with the gas station owners is needed to determine the recommended design of access. Observations indicate that vehicles frequently queue in the eastbound approach to the gas station. The design of access improvements should consider this to prevent queuing from overflowing onto US 26. Figure 10 illustrates one potential concept for access modifications at the gas station.

In addition to access management along the gas station frontage, KAI recommends an enhanced pedestrian crossing near the gas station. Informal paths connect the gas station up hill to BIA Route 3, and pedestrians are reported to frequently cross US 26 at this location to access the gas station. The enhanced crossing could include a refuge island, a Rectangular Rapid Flashing Beacon (RRFB), and illumination in addition to appropriate signage to increase visibility and awareness of the crossing. This crossing should be installed in conjunction with the gateway/speed reduction treatments in the area.

Elements to the Hollywood Boulevard intersection should include creating turn lanes of appropriate length, modifying the eastbound right turn radius, enhancing crosswalks, and modifying geometry to provide adequate sight distance for northbound vehicles. These recommendations are further discussed below.

- Reducing the westbound right turn radius will reduce speeds for vehicles turning onto Hollywood Boulevard. The radius should accommodate truck traffic as this intersection is part of the alternate route to US 26 (formed by Hollywood Boulevard and Tenino Road) in the event of a highway closure.
- Along with reducing the turning radius, a channelization island would provide a pedestrian refuge area and reduce the crossing distance for pedestrians.
- Redefining and extending the eastbound left turn lane will provide longer storage distance for vehicles and separate them from through traffic.
- As a means of increasing intersection sight distance triangles from Hollywood Boulevard KAI recommends conducting a design evaluation to adjust approach grades of Hollywood Boulevard at US 26 to better match into the grades along US 26. This could potentially include reducing the superelevation on US 26 to minimize the grade break to Hollywood Boulevard and create more of a platform on the Hollywood Boulevard approach. Under the existing configuration, the Hollywood Boulevard approach is lower than US 26, making it difficult for vehicles to see approaching US 26 traffic. The grade break creates an awkward driving experience for northbound to west bound drivers.
- KAI recommends medians be installed as part of the gateway and speed reduction treatments proposed for this section of the US 26 corridor. The design of medians through this section

should accommodate turn lanes, access points to the gas station, and pedestrian refuge areas where appropriate.

Figure 10 illustrates an example concept of potential treatments at the gas station driveway and Hollywood Boulevard. The preferred design should be developed in collaboration with the gas station owner, project stakeholders, and rely on additional traffic data from the gas station to accommodate necessary queues and fuel tanker truck service.

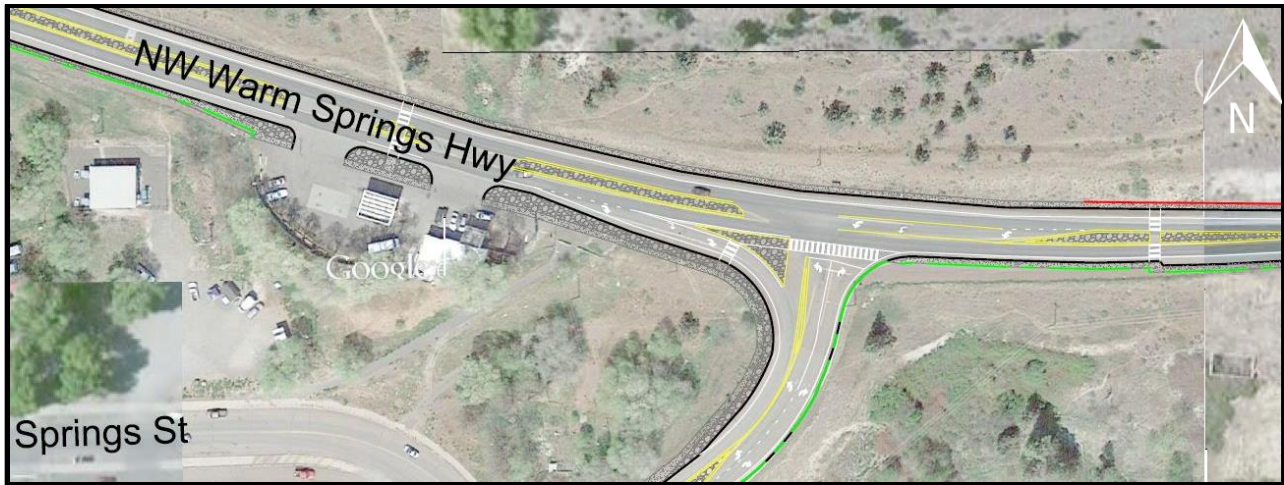


Figure 10. Example of Potential Treatments at the US 26/Hollywood Boulevard Intersection

Implementation Phasing of Treatments at US 26 / Hollywood Boulevard Intersection

While these treatments can be organized and constructed as separate projects with independent timelines and requirements, the initial design for these project elements should be done in tandem to ensure continuity along the corridor and cost effectiveness in construction.

The proposed timelines of the projects are shown below.

Immediate-Term Treatments:

- Install continental crosswalk across Hollywood Boulevard to connect the east-west pedestrian connection (shared-use path) when the east-west connection is installed.

Near-Term Treatments:

- Complete the following enhancements in conjunction with the gateway and speed reduction treatments:
 - Modify the Hollywood Boulevard approach and US 26 superelevation to improve intersection sight distance to and from US 26.
 - Reduce the eastbound right-turn radius to reduce travel speeds.
 - Install a channelized right-turn island and accompanying continental pedestrian crossing.

- Install illumination at the intersection and pedestrian crossings.
- Add curbing and driveways to define access at the gas station driveway.
- Install enhanced crossing with RRFB, pedestrian refuge island, and illumination at the gas station to connect to informal paths to the north.
- Install pedestrian path or sidewalk on Hollywood Boulevard between the new sidewalk on US 26 and the existing sidewalk and crosswalk at the Hollywood Boulevard/Warm Springs Street intersection.
- Lengthen the westbound left-turn lane on US 26.

Long-Term Treatments:

- Install a traffic signal or roundabout, pending further analysis to confirm the preferred treatment and satisfaction of traffic control warrants.
- Install enhanced pedestrian crossing across Hollywood Boulevard at Warm Springs Street. This may include enhanced signage, lighting, and pavement markings.

US 26 / Casino / Museum Driveway

This intersection had fewer reported crashes than other locations along the corridor but had a higher expected crash rate, indicating the potential for future crashes. Limited sight distance from the side street approaches and lack of adequate multimodal connections are observed issues at this intersection.

This intersection will benefit from the speed reduction treatments along the corridor as well. The lower speeds will help to reduce the potential for rear-end crashes and pedestrian crashes.

Sight distance at this intersection is a two-fold attribute caused by lower grades on the museum intersection approach compared to US 26. This is compounded by trucks parking along the US 26 corridor that block the view of US 26 traffic for drivers who are departing the museum parking lot. KAI recommends, in the near-term, to install No Parking signs along US 26 to restrict trucks from parking along the road. While this is a relatively simple treatment, it would only be effective with proper enforcement and an alternative location for trucks to load/unload. A more extensive but beneficial long-term treatment is adjusting and raising the approach grades on the museum leg to improve sight distance on that approach.

Because this intersection serves the casino and the museum, pedestrian crossing traffic is relatively high compared to other locations on the corridor. KAI recommends high visibility, continental crosswalks on each intersection approach, with appropriate ADA ramps and sidewalk connections. Figure 11 illustrates the potential near-term treatments at the intersection.

In the long-term, this intersection may benefit from a roundabout or traffic signal. Further study is needed to determine the appropriate treatment at this location.



Figure 11. Example of Potential Treatments at US 26 and Casino/Museum Driveway

Implementation Phasing of Treatments at US 26 / Casino / Museum Driveway

Immediate-Term Treatments:

- Restrict truck parking along US 26 and install no-parking signs. Enforcement is needed for the success of this treatment. Truck drivers need to be provided with information and wayfinding about alternative locations for loading or resting.

Near-Term Treatments:

- Install high-visibility continental crosswalks on all intersection legs, pending the completion of pedestrian connections (sidewalks or paths) and ADA ramps.

Long-Term Treatments:

- Raise the northbound (museum) approach to improve intersection sight distance.
- Install a traffic signal or roundabout, pending further analysis to confirm the preferred treatment and satisfaction of warrants

US 26 / Tenino Road

Several long-term treatments are recommended at the intersection of US 26 and Tenino Road. The intersection is not as heavily traveled as other intersections in the study segment. However, the intersection serves as a connection for the alternate route to US 26 in the event that US 26 is closed or congested. If the mill site redevelops or new development occurs in the area, these treatments may increase in priority because of increased traffic volumes.

When the pedestrian connection along US 26 is completed for this section of US 26, KAI recommends adding a continental crosswalk across Tenino Road. In addition, the eastbound right-turn radius should be reduced to reduce traffic speeds. However, the design modifications should ensure that trucks can continue to use this route. Figure 12 illustrates a potential concept of these improvements.

If and when the mill site redevelops, an enhanced crossing may be considered at this location. In addition, the redevelopment of that site may result in realigning the US 26 access points to the mill site. It may be appropriate to align the driveway with Tenino Road to minimize conflict points along the corridor and provide a single, well defined intersection serving each side of US 26.

In the long-term, as traffic increases, a roundabout or traffic signal may be needed at this location.



Figure 12. Example of Potential Treatments at the US26/Tenino Road Intersection

Implementation Phasing of Treatments at the US 26 / Tenino Road Intersection.

Long-Term Treatments

- Reduce the eastbound right-turn radius to lower traffic speeds on this movement. Verify the design of the radius accommodates truck movements.
- Install continental crosswalk across Tenino Road in conjunction with the east-west pedestrian path or sidewalk along this section of the corridor. The project should include appropriate ADA ramps.

Development-Driven Treatments

- Install an enhanced crossing across US 26.
- Consider realigning the driveway to the former mill site at Tenino Road.
- Install a traffic signal or roundabout, pending additional operations, safety, and warrant analysis.

US 26 / Deschutes River Area

The length of US 26 between Jackson Trail area and the Warm Springs State Park, described here as the Deschutes River Area, is also another section with long-term recommendations. Priority for this intersection will increase if development occurs in the area or if Jackson Trail becomes realigned away from the Deschutes River bridge. KAI recommends access management at these locations to reduce potential conflict points. In addition, KAI recommends realigning Jackson Trail Road as a long-term project to increase intersection sight distance, which is currently limited by the bridge parapets. Relocating the intersection to the west would allow for a possible left turn pocket to Jackson Trail Road. A turn lane is not possible on the Deschutes River bridge.

Figure 13 and Figure 14 show an example of potential access management and multimodal connections along the corridor. KAI recommends a pedestrian crossing be installed to connect the commercial areas to the river recreation areas. The pedestrian crossing should be completed in conjunction with or after the gateway and speed reduction treatments in this area.



Figure 13. Example of Potential Treatments in Deschutes River Area



Figure 14. Example of Potential Treatments in Deschutes River Area

Implementation Phasing of Treatments at US 26 / Deschutes River Area

The treatments for this section of the study area are prioritized as **long-term improvements**. However, if development occurs in the eastern section of the corridor, these project elements may increase in priority.

OFF-HIGHWAY TREATMENTS

Hollywood Boulevard / Tenino Road

The existing Hollywood Boulevard/ Tenino Road intersection is an all-way stop-controlled intersection, as shown in Figure 15. It operates well under existing conditions. However, it is a junction along the alternate route to US 26 and therefore is recommended to be configured as a roundabout or traffic signal in the long-term.



Figure 15. Existing Intersection Configuration of Hollywood Boulevard/Tenino Road

Source: Google Maps

Implementation Phasing of Treatments at the Hollywood Boulevard / Tenino Road Intersection

The traffic control changes are recommended as **long-term treatments**.

Campus Area Treatments

The campus area includes the area immediately south of US 26 and west of Hollywood Boulevard. This area includes several commercial establishments and experiences pedestrian traffic. The campus area is planned for redevelopment in the future.

KAI recommends two pedestrian-focused, **long-term projects** for the campus area:

- Install sidewalks on Paiute Avenue between US 26 and Wasco Street. Pedestrian connections are provided from US 26 to Hollywood Boulevard via Paiute Avenue and Warm Springs Street. However, the eastern side of Paiute Avenue is missing sidewalks along one block. This block will connect with the future pedestrian path along US 26, forming an important connection.
- Enhance existing shared-use path with illumination between Warm Springs Street and Hollywood Boulevard. According to project stakeholders, the existing informal path is heavily used by pedestrians. Enhancements such as illumination would increase the comfort and security along the path.

School Area Treatments

The new school opened on the corner of Tenino Road and Chukar Road. Several projects, including new sidewalks along Tenino Road from the school to Hollywood Boulevard, have been completed. However, there are remaining concerns raised by stakeholders about speed along Tenino Road and multimodal connections between the school and residential areas. The recommendations for this area are focused on addressing these issues.

Implementation Phasing of School Area Treatments

Immediate-Term Treatments (See Figure 16)

- Install speed feedback signs on Tenino Road in both directions.
- Install school zone signs on Tenino Road.

Near-Term Treatments (See Figure 17)

- Connect the existing path on Chukar Road to the existing sidewalk on Tenino Road at the school by constructing a new sidewalk or path.
- Install sidewalks on Quail Trail. Install pedestrian crossings where the residential streets connect.
- Construct new shared-use paths to connect residential areas to schools. Students currently use these routes informally. Pathways should include a gravel or paved surface, appropriate crossing treatments, and lighting.

Long-Term Treatments (See Figure 18)

- Install sidewalks on Tenino Road between Chukar Road and US 26.
- Install a pedestrian connection between the ball fields and Tenino Road. This connection will may include a staircase down the hill or enhancements at the intersection of Victory Lane. Crossing treatments on Tenino Road will be needed in either location.

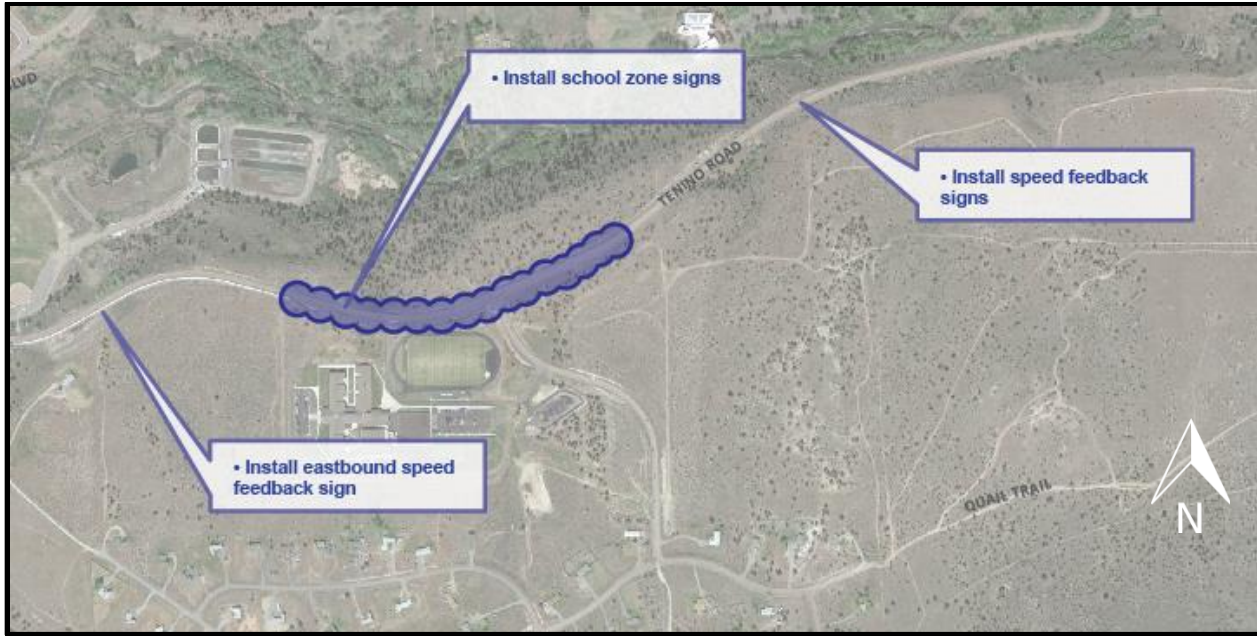


Figure 16. Immediate-Term School Area Treatments

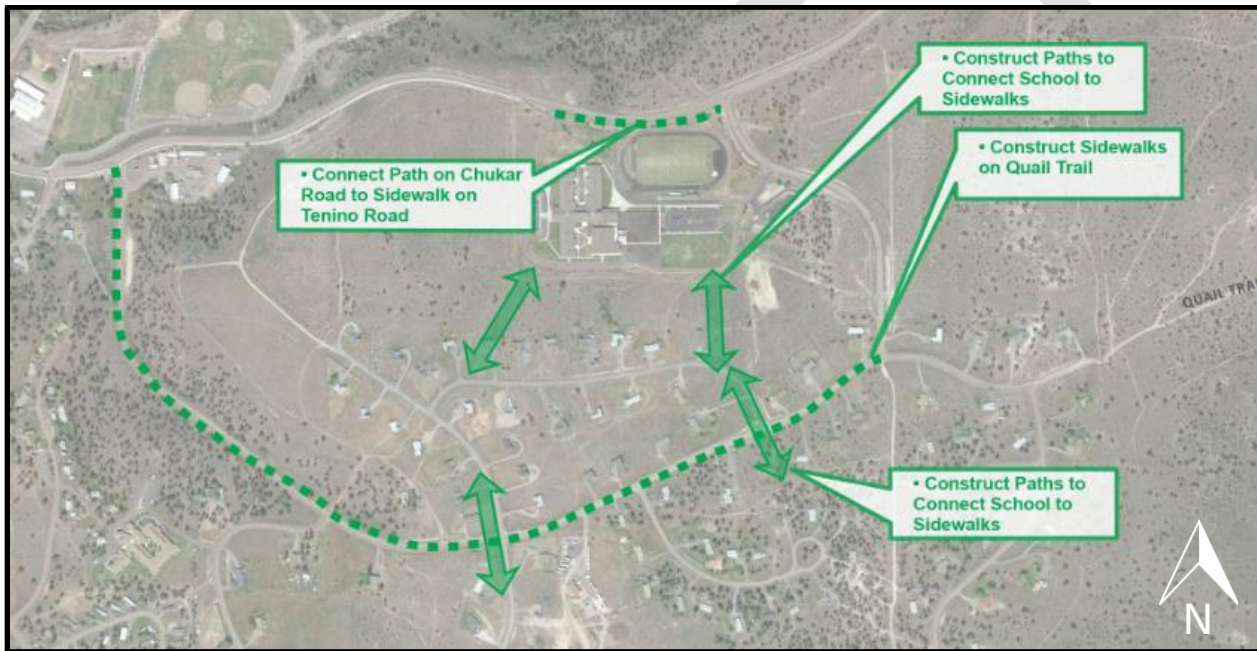


Figure 17. Near-Term School Area Treatments



Figure 18. Long-Term School Area Treatments

PRELIMINARY PROGRAMMATIC RECOMMENDATIONS

In addition to the numerous projects recommended for the study area, KAI recommends several programmatic and policy related strategies be implemented. Topics include:

- **Data Collection:** Crash data records were limited within the study area, particularly off the state highway. The Project Advisory Committee (PAC) noted reported crash data did not fully represent the crashes that had occurred within the reservation. The CTWS should develop a consistent method of gathering data for crashes and reporting the data to the state. ODOT stores reported crash data and relies heavily on the reported crash data to identify safety issues and award grant funding for projects. This data would assist the CTWS in being competitive for future project grants.
- **Education:** Education for students at the school should address safe crossing practices, appropriate side of the road for traveling as a pedestrian when sidewalks are not present, and best practices for skateboarding. Although Tenino Road has new sidewalks on one side of the road, a common concern dealt with skateboards on the sidewalk. On downhill sections, the skateboarders should walk on the sidewalk to avoid injuring another pedestrian.
- **Enforcement:** Many of the recommended projects recommended will not be successful without effective enforcement. For example, truck parking along the highway was noted as an issue. Even with "No Parking" signs installed, the issue may continue if it is not enforced.

Similarly, speed is a concern in the corridor. Enforcement should focus on ensuring that speeds remain low through the 45 mph zone.

- **Development Standards:** KAI recommends the CTWS adopt development standards that require new developments to install frontage improvements along their roadway, consistent with the cross-section for the specific location. This will help the CTWS build towards the community's vision.

NEXT STEPS

These recommendations will be reviewed with the Project Advisory Committee at the meeting on November 17, 2016. The input received from the PAC will be incorporated into a revised set of draft recommendations which will ultimately inform the Draft Safety Plan.

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