US 97 Parkway Plan Phase 2

Technical Memorandum #6 – First Level Alternatives Evaluation

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1.0 ALTERNATIVES EVALUATION PROCESS

In the previous memorandum[1], potential projects were developed to address the deficiencies in operations and safety identified in the Existing Conditions[2] and Future Conditions[3] Memoranda. The purpose of this memorandum is to begin the process of evaluating and screening these projects (Level 1 Evaluation).

Evaluation criteria were previously developed that reflect the goals and objectives[4] established to guide this planning effort. The evaluation will take place in two steps. The objective of the first step, "Level 1" evaluation is to screen the field of individual projects to be advanced as two bundles of projects for a more detailed analysis in the Level 2 Evaluation. The Level 1 evaluation will use a simplified, qualitative version of the project evaluation criteria.

The Level 2 evaluation will be completed in the next task. It will include a more comprehensive assessment of potential benefits and trade-offs associated with the alternatives using quantified analysis and evaluation criteria. The projects will be assembled into two bundles that will be run as two alternatives using the Bend-Redmond Travel Demand model and more detailed traffic analysis. The results will be discussed with project stakeholders, leading to the identification of the best projects to be combined into a final, Preferred Alternative.

LEVEL 1 EVALUATION PROCESS

In order to evaluate each project identified in Technical Memorandum #5, groups were created based on location or because they addressed similar needs. For example, projects located in the same area, such as Butler Market Road, were evaluated against each other. Similarly, TSMO projects that have similar approaches throughout the corridor are evaluated against each other.

Each group was evaluated individually using the qualitative evaluation criteria. Note that many of the projects considered are complementary and would be appropriate to include in both project bundles.

The groups include:

- Transportation Systems Management and Operations Projects
- Right-In/Right-Outs Closures
- Ramp Metering
- Preferred Alternatives from US 97 Bend North Corridor FEIS
- Butler Market Road @ US 97 Improvements
- Revere Avenue @ US 97 Improvements
- Colorado Avenue @ US 97 Improvements
- Reed Market Road @ US 97 Improvements
- Powers Road @ US 97 Improvements

[1] US 97 Parkway Plan Phase 2: Technical Memorandum #5 Preliminary Alternatives, January 31, 2019
[2] US 97 Parkway Plan Phase 2: Revised Technical Memorandum #2 Existing Conditions, August 14, 2018
[3] US 97 Parkway Plan Phase 2: Technical Memorandum #4 Future Conditions, November 9, 2018
[4] US 97 Parkway Plan Phase 2: Methodology Memorandum, January 4, 2019

- China Hat Road @ US 97 Improvements
- Other Projects
- Congestion Pricing

Following the Level 1 evaluation process, the projects with the highest ranking based on the evaluation criteria will be recommended to be grouped together to form the two bundled alternatives for further analysis (Table 15). The projects, Level 1 evaluation criteria, and the process of developing the two project bundles will be discussed further in the following sections.

EVALUATION CRITERIA

Project goals, objectives and evaluation criteria are defined in the Methodology Memorandum[5]. Many of the evaluation criteria presented in the Methodology Memorandum are quantitative and require a more detailed analysis. They are the criteria that will be used in Level 2 screening.

Since the Level 1 screening is qualitative, the original evaluation criteria were modified for use in a high-level qualitative screening. For example, a Level 1 screening criteria might be "potential to reduce crashes" (qualitative) instead of the Level 2 screening criteria of "reduction in crash frequency" (quantitative). For comparison purposes, the Level 1 screening criteria are presented in Table 2 below alongside the goals, objectives, and Level 2 evaluation criteria.

[5] US 97 Parkway Plan Phase 2: Technical Memorandum #4 Future Conditions, November 9, 2018

Table 2: Level 1 Screening Evaluation Criteria

Goal	Objectives	Qualitative Evaluation Criteria (Level 1)	Evaluation Criteria (Level 2)
1. Improve safety for all modes	Reduce the frequency and severity of crashes for all modes with an emphasis on severe and fatal injuries	Potential to reduce crashes	Reduction in crash frequency (all modes)
		N/A	Reduction in crash severity (all modes)
2. Support economic development throughout the region and state	Support efficient movement of people, goods and services, and recreational traffic to, within and through the City of Bend	Ability to improve travel time reliability on US 97	Travel Time Reliability measures on the Bend Parkway (planning time index)
		N/A	Percent through traffic on congested segments (modeled demand/capacity ratio $\geq$ 1.0) of the Bend Parkway
	Develop strategies to accommodate planned growth through provision of transportation options now, and into the future	Enhances travel for multiple modes	Degree to which the alternative enhances travel for multiple modes (qualitative assessment)
3. Manage transportation mobility into the future	Evaluate the ability to achieve ODOT volume/capacity (V/C) targets and develop alternative mobility measures and targets, where appropriate	Would reduce or better manage congestion on US 97	Ability to meet ODOT v/c targets
	Assess impacts on local system	Would reduce or better manage congestion on City streets	Ability to meet Bend mobility standards (v/c ratios and LOS)
4. Consider accessibility to key destinations now and in the future	Evaluate and assess reliable travel times between key destinations during peak periods	N/A	Travel Time Reliability measures (planning time index) for specific routes during PM peak hour
			Peak Hour VMT by street classification
5. Facilitate the use of multimodal travel options	Enhance transit, bicycle and pedestrian facilities along, parallel to, and across, US 97	Supports implementation of low-stress pedestrian and bicycle crossings of US 97	Number of bike and pedestrian crossing locations on the Bend Parkway with low Level of Traffic Stress (LTS 2 or lower)
		Supports implementation of a parallel low-stress walking and biking network along the US 97 corridor	Miles of north-south bike and pedestrian facilities with low Level of Traffic Stress within 0.25 miles of the Bend Parkway
	Look for transportation demand management opportunities	Supports travel demand management strategies (or supports the transit system)	Does the alternative allow for transportation demand management strategies?
6. Enhance the environment	Reduce emissions through reduction of vehicular delay, improved connections in the local system, and the use of alternative modes	N/A	Total PM peak hour vehicle delay (vehicle hours)
		Potential to reduce Vehicle Miles Traveled (VMT)	Total PM peak hour vehicle miles traveled (regional measure)
	Minimize right of way impacts	Would impact property	Approximate degree of right of way impacts (order of magnitude costs)
	Design projects to avoid, mitigate and minimize impacts	Would impact the environment	
7. Identify cost effective solutions	Prioritize low cost, high benefit solutions	Order of magnitude cost	Total cost
			Reduction in delay and crashes
	Prioritize solutions that that leverage existing planned projects and programs	N/A	Does alternative leverage existing planned projects and programs?
8. Develop an implementation plan	Consider available funding sources and existing planned project and programs	Ability to construct in reasonably affordable phases	Can the alternative be separated into reasonably fundable and constructible phases?
	Recommend potential future funding sources	N/A	
	Include partner commitments to short term actions	N/A	Does the alternative have local agency support?

Additional Criteria (from Scope of Work)		Can be constructed to comply with design standards (geometric feasibility) Would impact freight movement Substantial conflicts with ODOT, City, or County policies and regulations	

Each candidate project was scored on each of the above criteria to assess its positive, negative, or neutral impacts compared to the Future No-Build alternative, unless otherwise indicated. This assessment is qualitative and high-level since the full impacts of each project are unknown at this point in the process. To represent this qualitative evaluation, a value of +1, 0 or -1 is applied, as appropriate. This Level 1 qualitative scoring will be used to inform the selection of the projects to bundle into two (Project Bundle A and Project Bundle B) analysis alternatives for the detailed, quantitative analysis to be performed for the Level 2 evaluation.

To better understand how projects were evaluated, the basis of scoring against the criteria is described in Table 3. Given the qualitative nature of this evaluation, engineering judgement and experience from similar projects were used to develop reasonable assumptions for the performance of each project.

Table 3: Level 1 Evaluation Criteria – Basis of Scoring

Qualitative Evaluation Criteria (Level 1)	Evaluation Score		
	1	0	-1
Potential to reduce crashes	Would likely reduce crashes (based on Crash Modification Factors)	No impact or impact unknown	Would likely increase crash frequency
Ability to improve travel time reliability on US 97	Improves access management on US 97; decreases impact of incidents	No impact or impact unknown	Degrades access management on US 97
Enhances travel for multiple modes	Would likely provide safer and more efficient travel for bikes, peds, or transit	No impact or impact unknown	Would likely decrease the safety and efficiency of travel for certain modes
Would reduce or better manage congestion on US 97	Would likely enhance capacity of US 97	No impact or impact unknown	Would likely degrade capacity of US 97
Would reduce or better manage congestion on City streets	Would likely enhance capacity of City streets	No impact or impact unknown	Would likely degrade capacity of City streets
Supports implementation of low-stress ped. and bike crossings of US 97	Would likely decrease Level of Traffic Stress (LTS) at US 97 crossings	No impact or impact unknown	Would likely increase LTS at US 97 crossings
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	Would likely provide or improve safety and efficiency on parallel facility for active modes	No impact or impact unknown	Would likely decrease safety and efficiency on parallel facility for active modes
Support travel demand management (TDM) strategies	Is part of a TDM strategy or supports transit	No impact or impact unknown	Would preclude a TDM strategy
Potential to reduce Vehicle Miles Traveled (VMT)	Would likely decrease out of direction travel	No impact or impact unknown	Would likely increase out of direction travel
Would impact property	Existing right-of-way available	Minor to no property impacts required/ impact unknown	Significant property impacts
Would impact the environment	Significant positive environmental impacts (major VMT reduction)	No impact or impact unknown	Potential conflicts with natural features or resources, including VMT increase
Order of magnitude cost	Cost is lower relative to projects in the same group	Cost is average for projects in the same group	Cost is higher relative to projects in the same group
Ability to construct in reasonable affordable phases	Can likely construct in phases	Phasing feasibility unknown	Cannot likely construct in phases
Can be constructed to comply with design standards (geometric feasibility)	Is likely geometrically feasible	Geometric feasibility unknown	Is not likely to be geometrically feasible
Would impact freight	Would likely reduce freight delay	No impact or impact unknown	Would likely have negative impacts on freight operations

Substantial conflicts with ODOT, City, or County policies and regulations	(not applicable – this criterion used to flag fatal flaws or issues to resolve)	No known conflicts with policies	Conflicts with policies (such as the Bend TSP)

2.0 Level 1 Project Evaluation

As described above, many projects identified in Technical Memorandum #5 are complementary with one another. However, some are competing projects where no more than two will be advanced for further detailed analysis as part of the two project bundles. Using the Level 1 screening criteria, as described in the previous section, projects were evaluated and ranked to screen out less feasible solutions for further study. Projects were determined to advance to level two evaluation, not advance, or be deferred to other studies. Projects within each group were scored against one another. The projects are grouped by category, described briefly, and evaluated, below. For more details on the projects and why they were considered, see Technical Memorandum #5.

For each of the projects evaluated, planning level costs are included. Cost estimates were developed based on a conceptual level of project definition. Major cost elements were identified, and order of magnitude costs were determined with contingencies. Right-of-way costs are not included.

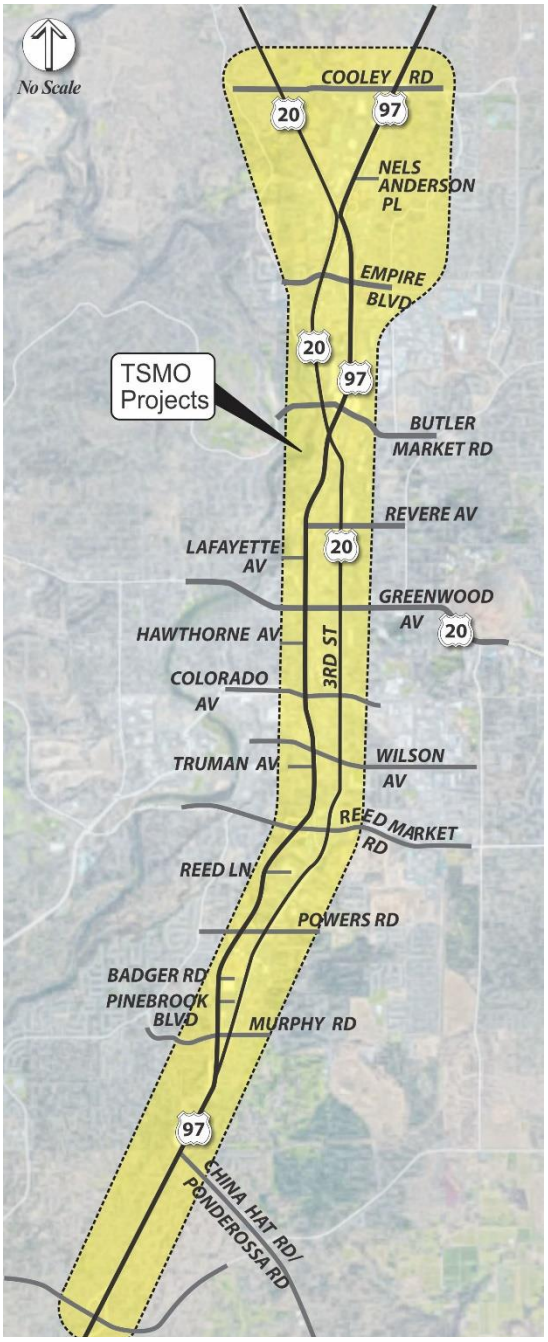


Figure 1: TSMO Projects

Transportation Systems Management and Operations Projects

Transportation System Management and Operations (TSMO) Projects includes a set of strategies that focus on operational improvements and maintenance that have the potential to restore and even increase the performance of existing facilities before capacity enhancement projects are required. These projects generally do not conflict with one another and multiple strategies may be included in both alternative bundles. The following projects were included in the TSMO group (Figure 1):

- **Shoulders Built to Standard Widths ($2,000,000 - $10,000,000):** provide needed lateral support for the pavement and serve

many safety and operational functions. They provide space for law enforcement activity, disabled vehicles to pull over, bicycle travel, passage around incidents, opportunities for improved freight operations, potential transit use, and partial storage for snow removal.

- **Weather Warning System ($5,000 - $450,000 per sign):** includes a variety of applications that activate warnings regarding weather (e.g., roadway flooding, fog, snow, or ice) to inform drivers of potentially hazardous conditions. Weather warning systems are often tied to variable speed signs.
- **Variable Speed Signs ($500,000 - $1,500,000 per sign)**: used to manage congested corridors and/or weather impacted events by displaying advisory speeds according to the conditions ahead. They provide a flexible restriction on the rate at which motorists can drive on a given stretch of road and can help to reduce crashes.
- **Incident Management ($50,000 - $500,000 per year):** focuses the coordination of responses to clear incidents that impact safe and efficient travel. Strategies include: dedicated incident response programs and strategies, incident response vehicles, and staged/dry run towing.
- **Freeway and Arterial Integrated Corridor Management (ICM) ($2,000,000 - $10,000,000)**: focuses on route or mode diversion to parallel facilities, providing real-time information, and real-time adjustments for signals, ramp meters, etc.
- **Enhanced Traffic Signal Operations at Ramp Terminals ($50,000 - $100,000):** includes improving existing signals through re-timing/optimization, adaptive systems, or better/increased detection. Improvements to signal timing may result in improved mobility and a reduction in fuel consumption and emissions. Enhanced traffic signal operations may need to be combined with geometric and lane utilization improvements to be fully effective.
- **Traffic Signal Priority for Freight at Signalized Intersections on US 97 ($8,000 - $35,000 per signal):** provides extra green, yellow, or red time at traffic signals for freight in the dilemma zone to improve safety.
- **Traffic Signal Priority for Transit at Signalized Intersections on US 97 ($8,000 - $35,000 per signal):** provides extra green time and in some cases shrink or skip opposing phases at traffic signals to reduce delay and/or improve safety for transit. Along US 97 (or at US 97 ramp terminals), transit priority could reduce delay and improve reliability for mass transit users. It should be noted that traffic signal priority for transit is often paired with geometric improvements, such as wider shoulders, for queue jump opportunity.
- **Traveler Information Signing ($2,000 - $30,000):** static signing that guides travelers along a certain path.
- **Roadside Traveler Information Dissemination ($50,000 - $500,000)**: uses variable message signs (VMS) on roadways or highway advisory radio to disseminate traveler information.

The results of the evaluation are as follows (Table 4).

Table 4: Evaluation Results for the TSMO Projects

Qualitative Evaluation Criteria (Level 1)	Evaluation Score									
	Shoulders Built to Standard	Weather Warning System	Variable Speed Signs	Incident Mgmt.	Integrated Corridor Mgmt.	Enhanced Signal Ops. at Ramp Terminals	Transit Signal Priority	Freight Signal Priority	Travel Info. Signing	Roadside Traveler Info. Dissemination
Potential to reduce crashes	1	1	1	0	0	0	0	1	0	1
Ability to improve travel time reliability on US 97	1	0	1	1	1	1	1	0	0	1
Enhances travel for multiple modes	0	0	0	0	0	0	0	0	0	0
Would reduce congestion on US 97	0	0	0	0	0	1	0	0	0	0
Would reduce congestion on City streets	0	0	0	0	-1	1	0	0	0	-1
Supports implementation of low-stress ped. and bike crossings of US 97	0	0	0	0	0	0	0	0	0	0
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	0	0	0	0	0	0	0	0	0	0
Support travel demand management strategies	0	0	0	0	0	0	1	0	0	0
Potential to reduce Vehicle Miles Traveled (VMT)	0	0	0	0	0	0	0	0	0	0
Would impact property	0	0	0	0	0	0	0	0	0	0
Would impact the environment	0	0	0	0	0	0	0	0	0	0
Order of magnitude cost	-1	0	0	0	-1	1	1	1	1	0
Ability to construct in reasonable affordable phases	1	1	1	1	1	1	1	1	1	1
Can be constructed to comply with design standards (geometric feasibility)	1	1	1	1	1	1	1	1	1	1
Would impact freight	0	0	0	0	0	0	0	1	0	0
Substantial conflicts with ODOT, City, or County policies and regulations	0	0	0	0	0	0	0	0	0	0
Total Evaluation Score	**3**	**3**	**4**	**3**	**1**	**6**	**5**	**5**	**3**	**3**

The scoring evaluation resulted in the following findings and recommendations for the TSMO projects:

- ***Shoulders Built to Standard Widths*** – this project was assumed to reduce secondary crashes by providing space for vehicles to pull off the road and out of traffic during an incident. This project is expected to provide safety and travel time benefits to the corridor. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**
- ***Weather Warning System*** – this project is expected to provide safety benefits, particularly during the winter months. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**
- ***Variable Speed Signs*** – this project is expected to provide safety and travel time benefits to the corridor. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**
- ***Incident Management*** – this project is expected to provide safety benefits on the corridor year-round. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**
- ***Freeway and Arterial Integrated Corridor Management (ICM)*** – this project would require a more system wide approach to provide meaningful benefits. For example, 3rd Street, Wall Street, and potentially Hwy 20 (Greenwood) should also be included to better coordinate system management. While this project could be limited to a timing management plan to support incidents and events on the Parkway only, the real benefit would be implementation across the entire system, which is beyond the scope of this study. *Recommendation:* **Project to be deferred**
- ***Enhanced Traffic Signal Operations at Ramp Terminals*** – this project was assumed to reduce congestion on US 97 by decreasing the probability of queue spillback onto the main facility. This project could provide significant relief to US 97 by allowing treatments such as ramp queue dumps and scored particularly well due to relatively low cost combined with likely congestion relief and safety benefits. However, it should be noted that there may be locations where the local system queueing onto the ramp terminal is the main issue, as opposed to the ramp terminal itself. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**
- ***Traffic Signal Priority for Freight at Signalized Intersections on US 97*** – this project provides extra green time at traffic signals for freight to reduce delay and/or improve safety. Pairing with the Enhanced Traffic Signal Operations at Ramp Terminals could significantly mitigate the cost of this project, which is expected to have both safety and freight travel time reliability benefits. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**
- ***Traffic Signal Priority for Transit at Signalized Intersections on US 97*** - this project provides extra green time and, in some cases, can shrink or skip opposing phases at traffic signals to reduce delay and/or improve safety for transit. Along US 97 (or at US 97 ramp terminals), transit priority could reduce delay and improve reliability for mass transit users. Pairing with the Enhanced Traffic Signal Operations at Ramp Terminals could significantly mitigate the cost of this project. This project would support the Bend TSP objectives to develop both north-south and east-west high capacity transit corridors and scored well due to low cost and benefits to multiple modes of travel. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**
- ***Traveler Information Signing*** – this project could assist unfamiliar drivers (especially common during the summer in Bend) with correct routing to regional destinations. A relatively low-cost project likely to be implemented with other project on or adjoining the US 97 corridor. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**

- ***Roadside Traveler Information Dissemination*** – this project provides some safety (crash warning) and travel time reliability benefits. Note that without route choice this could potentially lead to worse operations. With the proliferation of private data sources (smart phone applications) and limited route choice, the independent utility of this strategy may be limited. However, since roadside traveler information may use the same infrastructure as other strategies such as variable speed signs or weather warning systems, it is still recommended for advancement if bundled with one of these other strategies. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**

RIGHT-IN/RIGHT-OUT CLOSURES ($50,000 - $250,000 PER LOCATION)

A right-in/right-out (RIRO) refers to a type of intersection where the turning movements are restricted to right turns only. On US 97, this refers to minor street stop-controlled intersections of a local road with the US 97 Parkway, where only right turns to and from the local road are allowed.

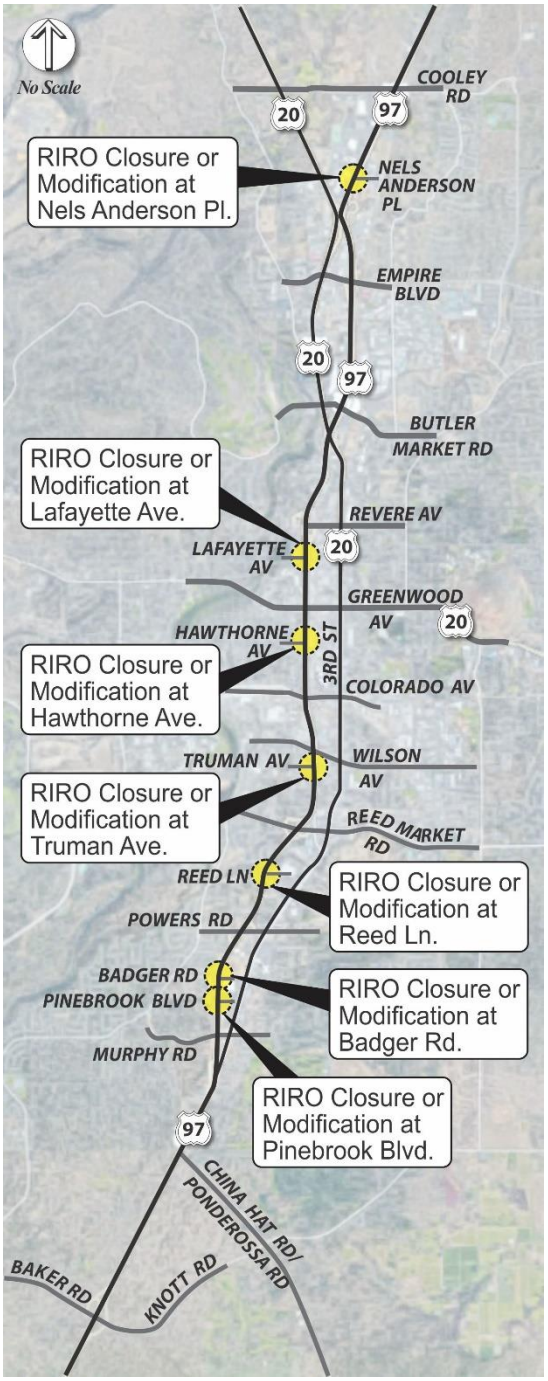
Several RIROs with operational and safety issues were identified along the US 97 corridor (Figure 2). The RIRO access points likely have significant influence on each other, where closing one might significantly increase traffic either at an adjacent RIRO or on the local system. The Bend-Redmond Travel Demand model will be used to analyze these impacts in the Level 2 evaluation, focusing on study intersections that receive at least an additional 50 PM peak hour trips under each RIRO closure scenario compared to future no-build conditions. The following RIRO scenarios will be analyzed initially:

- Closure of Lafayette Avenue
- Closure of Hawthorne Avenue
- Conversion of Lafayette or Hawthorne to right-in only
- Closure of Truman Avenue, Reed Lane, and Nels Anderson Place
- Closure of Pinebrook Boulevard and Badger Road (evaluate in coordination with Powers Road alternatives)
- Closure of all intersections listed above

Conversion to right-out only at Lafayette Avenue and Hawthorne Avenue was not considered because constructing acceleration lanes at these locations was determined to be infeasible in Technical Memorandum 5.[6] The results from the RIRO closure scenario analysis, combined with input from project stakeholders regarding local business access and previous work identifying the improvements necessary to make the RIROs meet ODOT design standards will be used to develop the preferred RIRO scenario, which could then be recommended for inclusion in both project bundles in the Level 2 evaluation.

For this first level screening, the RIRO closure scenario was analyzed as a general concept. The results from the evaluation are presented in Table 5.

Figure 2: RIRO Projects



[6] Technical Memorandum 5: Preliminary Alternatives

Table 5: Evaluation Results for the RIRO Closure/Modification Scenario

Qualitative Evaluation Criteria (Level 1)	Evaluation Score
Potential to reduce crashes	1
Ability to improve travel time reliability on US 97	1
Enhances travel for multiple modes	0
Would reduce congestion on US 97	0
Would reduce congestion on City streets	-1
Supports implementation of low-stress ped. and bike crossings of US 97	0
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	0
Support travel demand management strategies	1
Potential to reduce Vehicle Miles Traveled (VMT)	0
Would impact property	0
Would impact the environment	0
Order of magnitude cost	1
Ability to construct in reasonable affordable phases	1
Can be constructed to comply with design standards (geometric feasibility)	1
Would impact freight	0
Substantial conflicts with ODOT, City, or County policies and regulations	0
Total Evaluation Score	**5**

The scoring evaluation resulted in the following findings and recommendations for the as yet to be determined RIRO Closure Scenario:

- ***RIRO Closure/Modification Scenario*** – This project would likely reduce the frequency of crashes at the locations identified for closure by controlling access. It will also be likely to increase congestion on City streets due to reduced access to US 97. The RIRO closure/modification scenario is expected to provide significant safety and travel time reliability benefits to the corridor, decreasing conflicts on US 97 and reducing deceleration and acceleration in the main lanes. In cases where the RIRO or Right-in only access are preserved, these locations would be considered for improvements to meet ODOT standards. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**

Ramp Metering ($100,000 - $300,000, per location)

Ramp meters are used to control the traffic flow from on-ramps onto freeways to forestall merge congestion and maximize the capacity of the mainline. This results in increased travel speeds, improves safety, and enhanced reliability for longer trips in the corridor.

The general locations of ramp metering on this corridor are shown in Figure 3. Note that, for the ramp metering project to provide maximum operational benefit, at a minimum the Right-Out movements onto US 97 would need to be closed as a significant amount of traffic could be diverted to them otherwise. Therefore, this project was identified as a unique group because, if passed through the first level evaluation, all analysis would need to include the RIRO closures. The results from the evaluation can be seen below in Table 6.

Figure 3: Ramp Meter Project

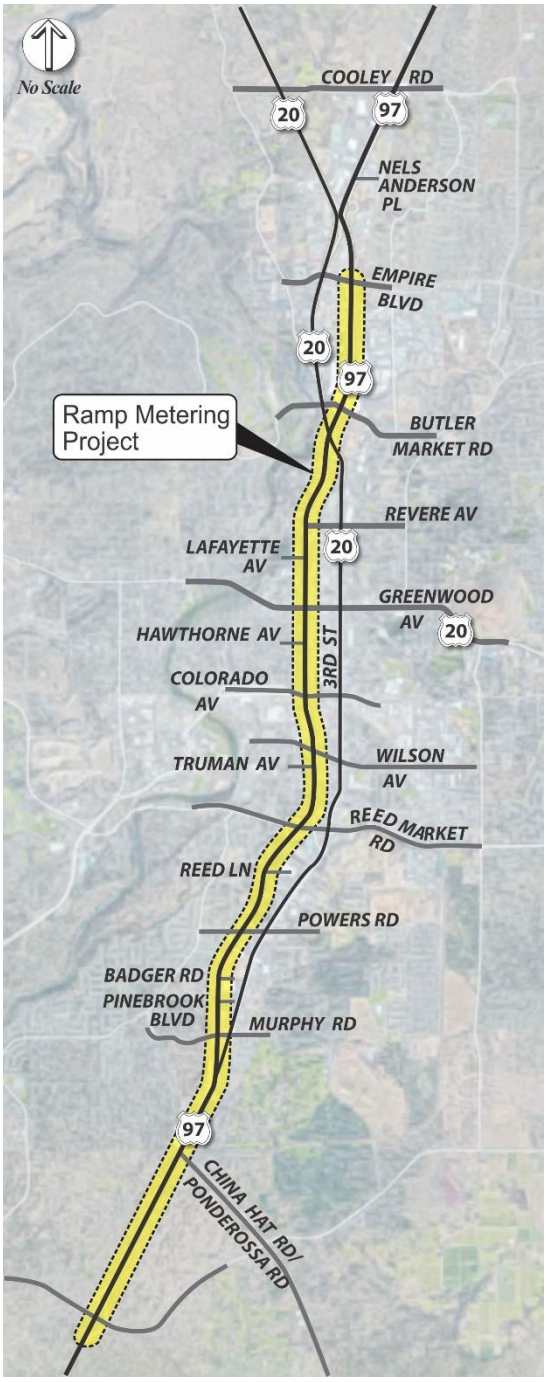


Table 6: Evaluation Results for the Ramp Metering Project

Qualitative Evaluation Criteria (Level 1)	Evaluation Score
Potential to reduce crashes	1
Ability to improve travel time reliability on US 97	1
Enhances travel for multiple modes	0
Would reduce congestion on US 97	1
Would reduce congestion on City streets	-1
Supports implementation of low-stress ped. and bike crossings of US 97	0
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	0
Support travel demand management strategies	1
Potential to reduce Vehicle Miles Traveled (VMT)	0
Would impact property	1
Would impact the environment	0
Order of magnitude cost	1
Ability to construct in reasonable affordable phases	0
Can be constructed to comply with design standards (geometric feasibility)	0
Would impact freight	1
Substantial conflicts with ODOT, City, or County policies and regulations	0
Total Evaluation Score	**6**

The scoring evaluation resulted in the following findings and recommendations for the ramp meter project:

- ***Ramp Metering*** – This project was assumed to have the potential to improve travel time reliability on US 97 by metering the flow of traffic onto the facility. Ramp meters were also assumed to have the potential to cause queue spillback onto City streets during congested periods. The scoring for property impacts assumed no property impacts, essentially, assuming that the existing ramps would provide sufficient storage for queuing vehicles and sufficient acceleration distance. The validity of this assumption will be tested in the next phase of this project and may be modified. Furthermore, this assumption implies that ramp meters would only be turned on when mainline speeds are significantly below the facility design speed. This strategy is employed by ODOT in Region 1 at locations with existing ramp constraints. If the ramps need to be extended to comply with design standards, impacts to properties could increase costs.

  Given the preliminary findings concerning the impacts of ramp metering on US 97 identified in the Bend TSP, this project should be included in both project bundles and compared against No-Build during the Level 2 evaluation. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**

Preferred Alternative from US 97 Bend North Corridor FEIS ($150,000,000 - $200,000,000)

Under future conditions, there will be several operational and safety issues with the forecasted demand at the north portion of US 97 in Bend. The US 97 Bend North Corridor study is assessing some coordinated projects to address queueing and operational issues around Empire Boulevard, Robal Road, and Cooley Road (Figure 4).

This project was identified as its own group as it will affect only the north portion of the corridor and is compatible with all other projects. The results from the evaluation are as follows (Table 7).

Figure 4: North Corridor FEIS Projects

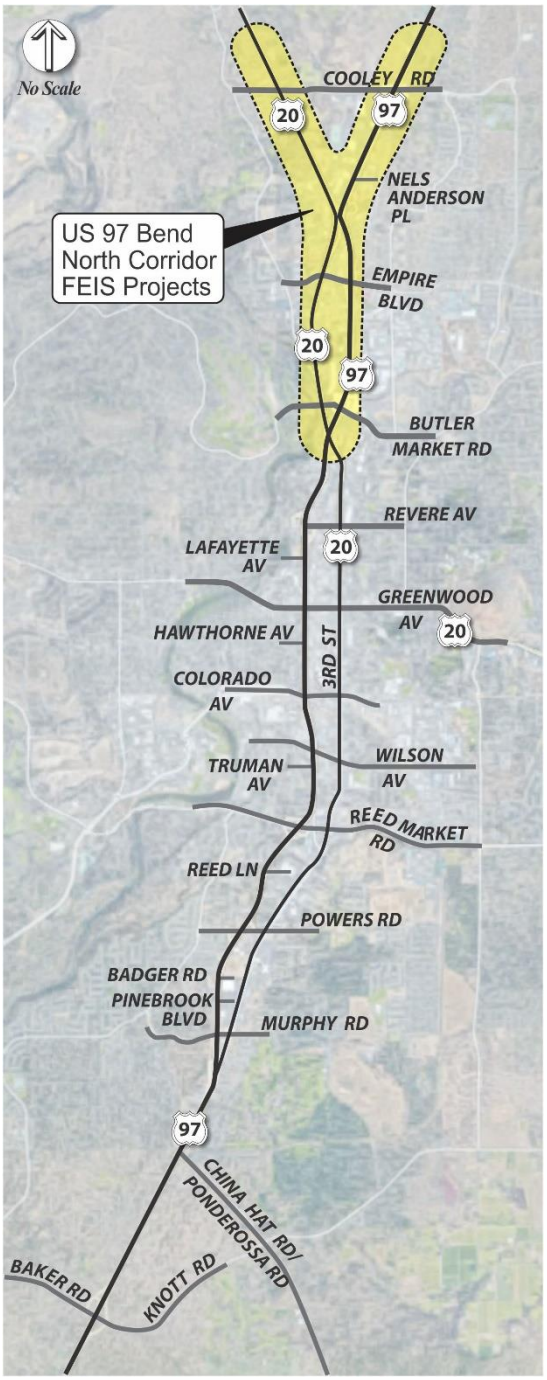


Table 7: Evaluation Results for the FEIS Project

Qualitative Evaluation Criteria (Level 1)	Evaluation Score
Potential to reduce crashes	1
Ability to improve travel time reliability on US 97	1
Enhances travel for multiple modes	1
Would reduce congestion on US 97	1
Would reduce congestion on City streets	1
Supports implementation of low-stress ped. and bike crossings of US 97	1
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	1
Support travel demand management strategies	0
Potential to reduce Vehicle Miles Traveled (VMT)	-1
Would impact property	-1
Would impact the environment	0
Order of magnitude cost	-1
Ability to construct in reasonable affordable phases	1
Can be constructed to comply with design standards (geometric feasibility)	1
Would impact freight	1
Substantial conflicts with ODOT, City, or County policies and regulations	0
Total Evaluation Score	**7**

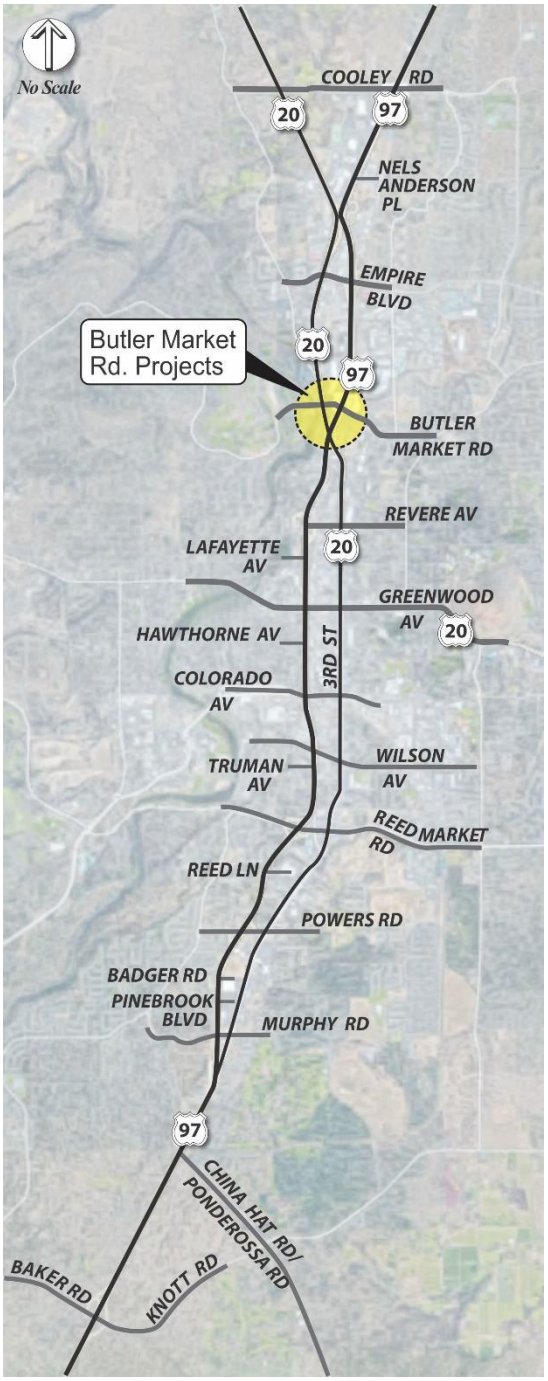
The scoring evaluation resulted in the following findings and recommendations for the FEIS project:

- ***US 97 North Corridor FEIS*** – This project has the potential be built in phases. Individual pieces have been broken out into subprojects. For example, the current US 20 Empire to Greenwood includes parts of the FEIS. The work already completed to establish the FEIS project indicated numerous operational and safety benefits from the project. While this project is outside the main study area for this project, it is the current preferred plan for the portion of US 97 north of Empire Boulevard and south of Grandview. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**

BUTLER MARKET ROAD PROJECTS

Improvement projects were identified at both ramp terminuses along Butler Market Road (Figure 5). In the future, the intersection at the terminus of the southbound off-ramp at the Butler Market Road interchange will experience demand that exceeds the intersection capacity. In addition, queuing issues at the intersections of US 20 (3rd Street) at Division Street and Butler Market Road will impact operations at the US 97 ramps. The Butler Market and US 97 southbound off-ramp intersection was also identified as a safety concern under existing conditions. Furthermore, an extension project to the northbound off-ramp was identified due to the lack of existing connectivity from US 97 to Butler Market in the northbound direction.

Figure 5: Butler Market Road Projects



The following projects were included in the Butler Market Road Projects group:

- **Northbound Off-Ramp Connecting US 97 to Butler Market Road ($5,000,000 - $10,000,000)**: There is no existing direct connection from northbound US 97 to Butler Market Road. A driver must exit at Revere Avenue and travel north via US 20 to reach Butler Market. By directly connecting US 97 to Butler Market Road, some of the traffic currently taking an out of direction route to northeastern Bend using Empire Avenue could use a more direct connection via Butler Market Road. Two possible intersection improvements would be considered:
  - Signal
  - Roundabout
- **Southbound Frontage Road at Butler Market Road Interchange ($7,250,000)**: Currently, queuing and congestion issues at the southbound off-ramp are exacerbated by the nearby Butler Market Road/US 20 (3rd Street) and Division Street/ US 20 (3rd Street) intersections. Constructing a frontage road extending from the US 97 southbound off-ramp to the US 20 (3rd Street) ramp would help redirect traffic and reduce demand at the nearby intersections. The US 97 southbound off-ramp would be either signalized or have a roundabout, and the signal at US 20 (3rd Street) and Division Street intersection would be realigned to the new four-legged intersection.
- **Formalized Two-Stage Left at Butler Market Road Interchange ($765,000)**: Currently the US

97 southbound off-ramp at Butler Market Road is stop controlled. The demand for this movement will exceed the existing capacity in the future. In addition, the unprotected left turns increase safety risks. A potential solution for this safety and operations issue would be to create a formalized two-stage left turn at this location. This would include a barrier created by flexible delineators to clearly mark the center turn lane as a refuge for left turns until they can safely merge into traffic. It should be noted that a two-stage left may be impacted by queueing from the 3rd Street/Butler Market Road signal.

- **Single Point Urban Interchange at Butler Market Road ($20,000,000)**: Another option to address the future capacity and safety issues at the Butler Market Road interchange is to construct a single point urban interchange (SPUI) at this location. This project would involve adding a northbound off-ramp and a southbound on-ramp to the interchange.
- **Intersection Improvement at US 97 southbound Off-Ramp and Butler Market Road ($1,100,000)**: In the future, this intersection will not have sufficient capacity to serve the demand from the off ramp. To improve operations and safety at this intersection, a possible solution is to either signalize this intersection or implement a roundabout. This improvement would allow for increased capacity at the intersection, minimizing queues on the ramp and allowing large gaps for turning vehicles. It should be noted that whichever intersection improvement is selected will be used at both off-ramps.

The results of the evaluation are as follows (Table 8).

Table 8: Evaluation Results for the Butler Market Road Projects

Qualitative Evaluation Criteria (Level 1)	Evaluation Score						
	New NB Off-Ramp w/ Signal	New NB Off-Ramp w/ RAB*	New SB Frontage Road	Formalized Two-Stage Left (SB Ramp)	SPUI**	Signalize SB Off-Ramp	RAB* at SB Off-Ramp
Potential to reduce crashes	0	1	0	1	0	0	1
Ability to improve travel time reliability on US 97	0	0	0	0	0	0	0
Enhances travel for multiple modes	0	0	0	0	0	0	0
Would reduce congestion on US 97	1	1	0	1	1	1	1
Would reduce congestion on City streets	0	0	1	0	1	0	0
Supports implementation of low-stress ped. and bike crossings of US 97	1	1	1	0	1	1	1
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	0	0	0	0	0	0	0
Support travel demand management strategies	0	0	0	0	0	0	0
Potential to reduce Vehicle Miles Traveled (VMT)	1	1	1	0	0	0	0
Would impact property	-1	-1	-1	1	-1	0	-1
Would impact the environment	0	0	0	0	0	0	0
Order of magnitude cost	-1	-1	0	1	-1	1	1
Ability to construct in reasonable affordable phases	0	0	0	1	-1	1	1
Can be constructed to comply with design standards (geometric feasibility)	0	0	0	1	-1	1	0
Would impact freight	0	0	0	0	0	0	0
Substantial conflicts with ODOT, City, or County policies and regulations	0	0	0	0	0	0	0
Total Evaluation Score	**1**	**2**	**2**	**6**	**-1**	**5**	**4**

*RAB = Roundabout; **SPUI = Single Point Urban Interchange

Some of the Butler Market Road projects conflict with each other (i.e. cannot both be built). For example, a roundabout and a signal cannot both be constructed at the same intersection. The scores from the evaluation were used to develop recommendations of two mutually exclusive sets of projects (where necessary) to be analyzed in the next task.

Some key assumptions used in the qualitative scoring against the evaluation criteria include:

- All projects involving construction of new roadways assume that new facilities will be designed to include facilities for walking and biking. Therefore, any new construction is assumed to provide an enhancement to the walking and biking network (including crossings).
- Adding signals and roundabouts to existing unsignalized intersections is assumed to reduce stress for walking and biking by providing designated crossings.

The findings and recommendations for the projects at Butler Market Road are summarized as follows:

- Conflicting at Butler Market Road and US 97 Northbound On-Ramp
    - ***Northbound Off-Ramp Connecting US 97 to New Signal at Butler Market Road*** – This project scored poorly due mainly to property impacts and cost. *Recommendation:* **Not Recommended for Advancement**
    - ***Northbound Off-Ramp Connecting US 97 to New Roundabout at Butler Market Road*** – This project scored poorly due mainly to property impacts and cost. *Recommendation:* **Not Recommended for Advancement**
- Conflicting at Butler Market Road and US 97 Southbound Off-Ramp
    - ***Formalized Two-Stage Left at Butler Market Road Interchange*** –The safety benefits, low cost, and low property impacts of this project lead to the highest score against evaluation criteria. However, the operational benefits of this project are already captured in the Future No-Build analysis. Therefore, this project is recommended as likely an interim improvement at this location. *Recommendation:* **Advance, No-Build**
    - ***Southbound Frontage Road at Butler Market Road Interchange*** – This project scored well due to both operational benefits to US 97 and pedestrian and bicycle improvements to Butler Market Road. *Recommendation:* **Advance, Project Bundle A**
    - ***Signal at US 97 southbound Off-Ramp and Butler Market Road*** – This project scored well due to both likely operational benefits to US 97 and pedestrian and bicycle improvements to Butler Market Road. However, this project does not need to be evaluated individually as it is also included in the Southbound Frontage Road Project. *Recommendation:* **Project to be deferred**
    - ***Roundabout at US 97 southbound Off-Ramp and Butler Market Road*** – This project scored moderately well due mainly to operational benefits on US 97, partially offset by property impacts and cost. *Recommendation:* **Advance, Project Bundle B**
- Conflicting with all other projects at Butler Market Road
    - ***Single Point Urban Interchange (SPUI) at Butler Market Road*** – This project had the lowest score due to high cost, high property impacts, phasing constraints, and design feasibility constraints. *Recommendation:* **Not Recommended for Advancement**

Revere Avenue Lane Rechannelization ($500,000 - $2,000,000)

To improve bicycle and pedestrian facilities on Revere Avenue, a lane rechannelization project is proposed from 4th Street to Wall Street, converting the existing roadway cross section from four to three lanes (varying at the signalized intersections). The lane rechannelization will allow for better sidewalks and buffered bike lanes within the existing right of way (Figure 6). Furthermore, the project may provide mobility, operational, and safety benefits, including:

- Dedicated left turn lanes at Division Street and Revere Avenue
- The ability to separate left turn phases at Division Street and Revere Avenue during railroad closures to the east
- Crash reduction benefits at Division Street and Revere Avenue, as well as at Wall Street/US 97 SB off-ramp and Revere Avenue

This project was identified as its own group as it is only expected to impact the Revere Avenue interchange and is therefore compatible with all other projects. The results from the evaluation are as follows (Table 9).

Figure 6: Revere Avenue Project

Table 9: Evaluation Results for the Revere Avenue Lane Rechannelization Project

Qualitative Evaluation Criteria (Level 1)	Evaluation Score
Potential to reduce crashes	0
Ability to improve travel time reliability on US 97	0
Enhances travel for multiple modes	1
Would reduce congestion on US 97	0
Would reduce congestion on City streets	-1
Supports implementation of low-stress ped. and bike crossings of US 97	1
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	0
Support travel demand management strategies	0
Potential to reduce Vehicle Miles Traveled (VMT)	0
Would impact property	0
Would impact the environment	0
Order of magnitude cost	1
Ability to construct in reasonable affordable phases	1
Can be constructed to comply with design standards (geometric feasibility)	1
Would impact freight	0
Substantial conflicts with ODOT, City, or County policies and regulations	0
Total Evaluation Score	**4**

The scoring evaluation resulted in the following findings and recommendations for the Revere Avenue Lane Rechannelization project:

- ***Revere Avenue Lane Rechannelization*** – This project scored well due to bicycle and pedestrian crossing enhancements coupled with low cost. While promising at a conceptual level, a more detailed investigation of potential negative impacts to motor vehicle travel is recommended to fully understand the net benefit of the lane reduction. *Recommendation:* **Advance, Project Bundle A**

COLORADO AVENUE PROJECTS

Under future conditions, the US 97 northbound and southbound ramps at Colorado Avenue will not provide enough capacity to serve the forecasted demand at this interchange. In addition, the US 97 southbound ramp intersection at Colorado Avenue was flagged for safety issues under existing conditions. The following projects were included in the Colorado Avenue Project group (Figure 7):

- **Intersection Improvement at US 97 northbound Ramps and Colorado Avenue ($500,000 - $1,500,000)**: To improve mobility and reduce queueing, a possible solution is to either signalize or implement a roundabout at the US 97 northbound ramp terminal at Colorado Avenue. Sight distance requirements would have to be met for this project.
- **Diamond Interchange at Colorado Avenue ($20,600550,000):** To mitigate the safety and operational issues, a possible solution is to reconstruct the interchange as a complete diamond configuration.

The Colorado Avenue Projects were grouped together based on their shared location and because they are mutually exclusive. The evaluation results are as follows (Table 10).

Figure 7: Colorado Avenue Projects

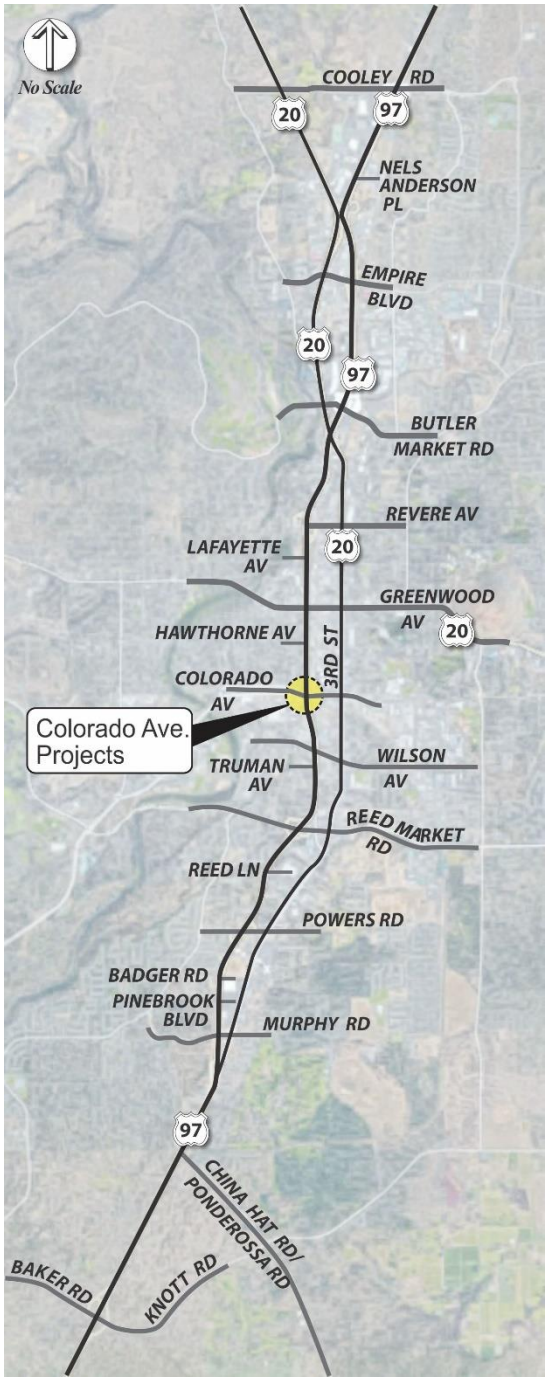


Table 10: Evaluation Results for the Colorado Avenue Projects

Qualitative Evaluation Criteria (Level 1)	Evaluation Score		
	Diamond Interchange	Signalize NB Ramps	Roundabout at NB Ramps
Potential to reduce crashes	1	0	1
Ability to improve travel time reliability on US 97	0	0	0
Enhances travel for multiple modes	0	0	0
Would reduce congestion on US 97	1	1	1
Would reduce congestion on City streets	1	1	1
Supports implementation of low-stress ped. and bike crossings of US 97	1	1	1
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	0	0	0
Support travel demand management strategies	0	0	0
Potential to reduce Vehicle Miles Traveled (VMT)	0	0	0
Would impact property	-1	0	-1
Would impact the environment	0	0	0
Order of magnitude cost	-1	0	0
Ability to construct in reasonable affordable phases	-1	1	1
Can be constructed to comply with design standards (geometric feasibility)	-1	0	0
Would impact freight	0	0	0
Substantial conflicts with ODOT, City, or County policies and regulations	0	0	0
Total Evaluation Score	**0**	**4**	**4**

All the Colorado Avenue projects conflict with each other (i.e. cannot be built together). For example, a roundabout and a signal cannot both be constructed at the same intersection. The scores from the evaluation were used to develop recommendations two mutually projects to be analyze in the next task. Some key assumptions used in the qualitative scoring against the evaluation criteria:

- All three Colorado Avenue projects would likely reduce congestion on US 97.
- Adding signals and roundabouts to existing unsignalized intersections is assumed to reduce stress for walking and biking by providing designated crossings.

The findings and recommendations for the conflicting projects at Colorado Avenue are summarized as follows:

- ***Signal at US 97 northbound Ramps and Colorado Avenue*** – the congestion benefits to both US 97 and local streets, and low property impacts of this project lead to the highest score against evaluation criteria. *Recommendation:* **Advance, Project Bundle B**
- ***Roundabout at US 97 northbound Ramps and Colorado Avenue*** – the congestion benefits to both US 97 and local streets of this project lead to a good score against evaluation criteria. However, as the signal project at this location is already recommended for advancement to Level 2 Evaluation, this project is redundant. Note that if the signal project is the recommended solution after the Level 2 evaluation, a roundabout would still be considered as a solution in design. *Recommendation:* **Project to be deferred**

- ***Diamond Interchange at Colorado Avenue*** – This project would likely have significant property impacts and would be difficult to construct in one phase. This project scored lowest of the three projects at Colorado Avenue due to high costs, property impacts, phasing constraints, and geometric feasibility concerns. However, if the other projects at Colorado Avenue do not provide sufficient future capacity, this project could be revisited in the future as it represents a large-scale solution at this location. *Recommendation:* **Advance, Project Bundle A**

Reed Market Road Projects

In the future, the Reed Market Road Interchange is forecasted to experience the worst operating conditions along US 97 in Bend. The future demand at the US 97 northbound ramps/Reed Market Road intersection far exceeds the available capacity. Furthermore, this intersection was also flagged as a safety focus location under existing conditions due to a high observed crash rate. The following projects were included in the Reed Market Road Projects group (Figure 8):

- **Widen northbound Off-Ramp at Reed Market Road Interchange ($2,400,000)**: The northbound off-ramp is striped as a single lane until 130 feet before the intersection, where it then splits into exclusive left and right turn lanes. To minimize queuing onto the US 97 mainline, which is both a safety and operational concern, a potential solution would extend the length of the exclusive left and right turn lanes by widening the northbound off-ramp.
- **Intersection Improvement at US 97 northbound Ramps and Reed Market Road ($700,000-$2,000,000)**: To improve mobility and mitigate this operational issue, a possible solution is to either signalize or implement a roundabout at the US 97 northbound ramp terminal at Reed Market Road. This would allow for increased capacity at the intersection, minimizing queues on the ramp and would reduce safety issues by allowing larger gaps for turning vehicles.
- **Single Point Urban Interchange at Reed Market Road Interchange ($38,400,000)**: To mitigate this operational issue, a possible solution is to construct a single point urban interchange (SPUI) at this interchange. The interchange type would consolidate the conflicting left turn movements on and off the US 97 mainline into one signalized intersection, increasing the efficiency of ramp terminal operations.

Figure 8: Reed Market Road Projects

The Reed Market Road Projects were grouped together based on their shared location and because some are mutually exclusive. The lowest scoring projects will be considered for removal from the next level of screening. The results are as follows (Table 11).

Table 11: Evaluation Results for the Reed Market Road Projects

Qualitative Evaluation Criteria (Level 1)	Evaluation Score			
	Widen NB Off-Ramp	Signalize NB Ramps	Roundabout at NB Ramps	SPUI*
Potential to reduce crashes	1	0	1	0
Ability to improve travel time reliability on US 97	0	0	0	0
Enhances travel for multiple modes	0	0	0	0
Would reduce congestion on US 97	1	1	1	1
Would reduce congestion on City streets	0	0	0	1
Supports implementation of low-stress ped. and bike crossings of US 97	0	1	1	1
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	0	0	0	0
Support travel demand management strategies	0	0	0	0
Potential to reduce Vehicle Miles Traveled (VMT)	0	0	0	0
Would impact property	-1	0	-1	-1
Would impact the environment	0	0	0	0
Order of magnitude cost	0	1	1	-1
Ability to construct in reasonable affordable phases	1	1	1	-1
Can be constructed to comply with design standards (geometric feasibility)	-1	1	0	0
Would impact freight	0	0	0	0
Substantial conflicts with ODOT, City, or County policies and regulations	0	0	0	0
Total Evaluation Score	**1**	**5**	**4**	**0**

*SPUI = Single Point Urban Interchange

Some of the Reed Market Road projects conflict with each other (i.e. cannot both be built). For example, a roundabout and a signal cannot both be constructed at the same intersection. The scores from the evaluation were used to develop recommendations of two mutually exclusive sets of projects (where necessary) to be analyze in the next task. Some key assumptions used in the qualitative scoring against the evaluation criteria:

- All projects involving construction of new roadways assume that new facilities will be designed to include facilities for walking and biking. Therefore, any new construction is assumed to provide an enhancement to the walking and biking network (including crossings).
- Adding signals and roundabouts to existing unsignalized intersections is assumed to reduce stress for walking and biking because it would provide designated crossings.

The findings and recommendations for the projects at Reed Market Road are summarized as follows:

- Conflicting at Reed Market Road and US 97 Northbound Off-Ramp
    - ***Signal at US 97 Northbound Ramps and Reed Market Road*** – This project scored well due to likely congestion relief, bicycle and pedestrian level of stress improvement, and low cost. *Recommendation:* **Advance, Project Bundle A**
    - ***Roundabout at US 97 Northbound Ramps and Reed Market Road*** – This project scored well due to safety benefits and likely congestion relief, and bicycle and pedestrian level of stress improvement, partially offset by potential property impacts. However, as the

signal project at this location is already recommended for advancement to Level 2 Evaluation, this project is redundant. Note that if the signal project is the recommended solution after the Level 2 evaluation, a roundabout would still be considered as a solution in design. *Recommendation:* **Project to be deferred**

- Project does not conflict with the US 97 Northbound Off-Ramp
    - ***Widen northbound Off-Ramp at Reed Market Road Interchange*** – this project would be geometrically feasible but will also increase the crossing distance for pedestrian and bicyclists. The safety benefits and potential congestion relief of this project are partially offset by geometric feasibility constraints caused by likely property impacts. However, combining this project with an intersection improvement at US 97 Northbound Ramps and Reed Market Road could indicate whether the existing interchange has the long-term capacity to serve future demand. This project could also be part of a short-term interim solution at this location *Recommendation:* **Advance, Project Bundle A**
- Conflicting with all other projects at Reed Market Road and US 97
    - ***Single Point Urban Interchange (SPUI) at Reed Market Road Interchange*** – This project is assumed to be geometrically feasible based on the relatively large amount of right-of-way available. The SPUI was the lowest scoring project at this location due mainly to cost, limited phasing opportunities (likely need to remove existing interchange for most of the construction). However, the Reed Market Interchange was identified as a significant pinch point for congestion in existing and future conditions analysis. Therefore, the intersection improvements at the US 97 Northbound Ramps and Reed Market Road may not provide enough capacity to relieve the forecasted demand. A more comprehensive analysis and a larger interchange capacity enhancement project (such as a SPUI) may be necessary. *Recommendation:* **Advance, Project Bundle B**

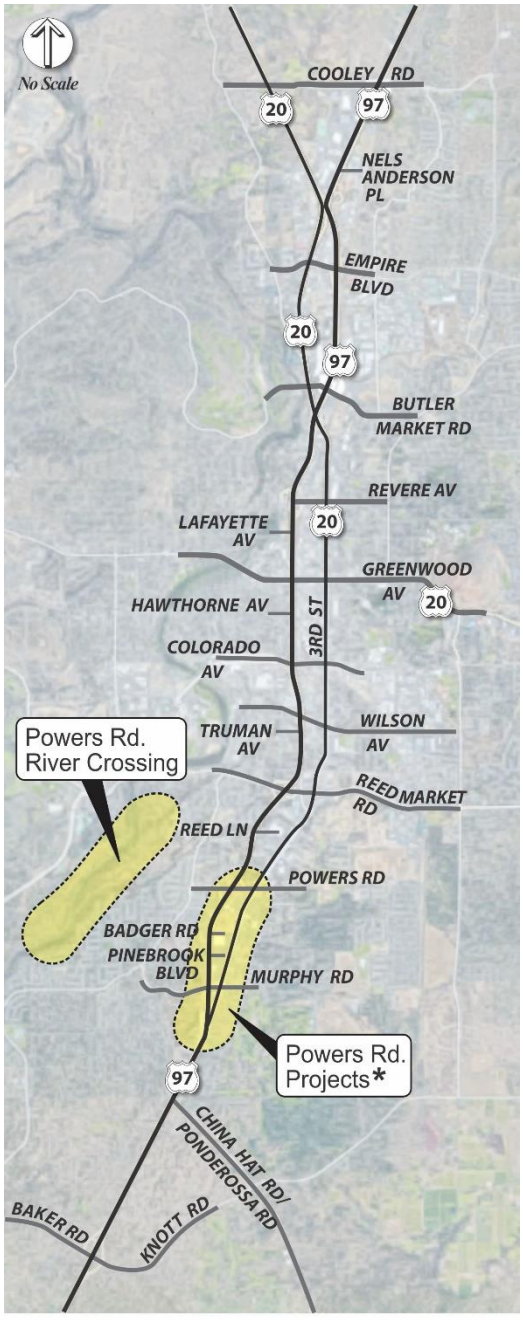
POWERS ROAD PROJECTS

Under future conditions, the Powers Road intersection will fail to provide sufficient capacity for the northbound and southbound movements on US 97. Several projects were identified to address this issue (Figure 9). Since these are competing projects and will have differing impacts, the screening process will be used to select two mutually exclusive projects to analyze. Note that an additional analysis focused on the Powers Road improvements will be completed as a separate task. The following projects were included in the Powers Road Projects groups:

- **Powers Road Overcrossing ($15,000,000)**: Construct an overcrossing at the Powers Road/US 97 intersection to maintain east-west connectivity if the RIRO intersections are closed. Grade separation allows traffic to move freely with fewer interruptions and at higher overall speeds. Furthermore, with fewer conflicts between movements, the risk of crashes is reduced.
- **Replace Powers Road At-Grade Intersection with an Interchange ($21,700,000)**: To mitigate the capacity issue at this location without closing the intersection altogether and restricting access to US 97, a compact diamond interchange could be constructed at this intersection. This interchange would allow for full access on and off US 97. This project would also address some of the safety issues with the current at grade intersection configuration.
- **Southern River Crossing near Powers Road (TBD)**[7]: To improve east-west connectivity and relieve some of the demand on Reed Market Road, a new river crossing at Powers Road is proposed under this project.

The Powers Road Projects were grouped together based on their shared location and because they are mutually exclusive. The lowest scoring projects will be considered for removal from the next level of screening. The results are as follows (Table 12).

Figure 9: Powers Road Projects



[7] Cost and Scope of project is unknown and would have to be determined in a future study.

Table 12: Evaluation Results for the Powers Road Projects

Qualitative Evaluation Criteria (Level 1)	Evaluation Score		
	Overcrossing	River Crossing	Interchange
Potential to reduce crashes	1	0	1
Ability to improve travel time reliability on US 97	1	0	1
Enhances travel for multiple modes	1	1	1
Would reduce congestion on US 97	1	0	1
Would reduce congestion on City streets	1	1	1
Supports implementation of low-stress ped. and bike crossings of US 97	1	0	1
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	0	0	0
Support travel demand management strategies	0	0	0
Potential to reduce Vehicle Miles Traveled (VMT)	-1	1	0
Would impact property	-1	-1	-1
Would impact the environment	0	-1	0
Order of magnitude cost	0	-1	0
Ability to construct in reasonable affordable phases	-1	-1	-1
Can be constructed to comply with design standards (geometric feasibility)	1	0	0
Would impact freight	0	0	0
Substantial conflicts with ODOT, City, or County policies and regulations	0	0	0
Total Evaluation Score	**4**	**-1**	**4**

Some of the Powers Road projects conflict with each other (i.e. cannot be built together). For example, while an overcrossing could be built as a first phase of an interchange project, the impacts for an overcrossing versus an interchange are very different. The scores from the evaluation were used to develop recommendations for two mutually exclusive projects to be analyze in the next task. Some key assumptions used in the qualitative scoring against the evaluation criteria:

- All three projects have the potential to reduce congestion along the City streets due the improved east-west connectivity.
- With controlled access (interchange and overcrossing only), crash frequency may decrease.

The findings and recommendations for the projects at Powers Road are summarized as follows:

- Conflicting at Powers Road and US 97
    - ***Powers Road Overcrossing*** – This project has the potential to reduce congestion along US 97 by removing the signal from the facility and controlling access. The overcrossing is assumed to be geometrically feasible based on the ease of design at the location. This project scored well due to likely improvements to US 97 operations and bicycle and pedestrian crossing enhancements. *Recommendation:* **Advance, Project Bundle A**
    - ***Replace Powers Road At-Grade Intersection with an Interchange*** – This project has the potential to reduce congestion along US 97 by removing the signal from the facility and controlling access. This project scored well due to likely improvements to US 97

operations and bicycle and pedestrian crossing enhancements. *Recommendation:* **Advance, Project Bundle B**

- Non-conflicting projects
    - ***Southern River Crossing near Powers Road –*** This project had the lowest score due to environmental impacts, cost, property impacts and limited phasing opportunities. However, the impacts of this project should be considered as part of any long-term solution at the Powers Road and US 97 intersection. *Recommendation:* **Project to be deferred**

China Hat Road Projects

A previously identified project is to close the RIRO at China Hat Road/Ponderosa Street. Closing the RIRO at China Hat Road and US 97 would provide both safety and operational improvements but would also restrict east-west connectivity. Furthermore, in the future, there will be heavy demand on US 97 and shorter trips may shift off US 97 to parallel alternatives routes, where available. Therefore, additional solutions to address these issues are proposed (Figure 10). The following projects were included in the China Hat Road Project group:

- **China Hat Road Overcrossing ($12,500,000)**: This project includes closing the existing RIRO intersections and building an overcrossing to maintain east-west connectivity. Grade-separating this intersection should greatly improve the operations and safety issues projected in the future. Grade separation allows traffic to move freely with fewer interruptions and at higher speeds.
- **Complete Southern Frontage System from China Hat Road to Baker Road ($5,000,000 - $10,000,000)**: To provide a parallel route to US 97 and support development in southern Bend, a frontage road could be constructed from China Hat Road to Baker Road. This frontage road would tie into the frontage road proposed for Phase 3 of the Murphy Interchange.

The China Hat Road Projects were grouped together based on their shared location. The results are as follows (Table 13).

Figure 10: China Hat Road Projects

Table 13: Evaluation Results for the China Hat Road Projects

Qualitative Evaluation Criteria (Level 1)	Evaluation Score	
	Overcrossing	New Frontage Road
Potential to reduce crashes	1	0
Ability to improve travel time reliability on US 97	0	0
Enhances travel for multiple modes	1	1
Would reduce congestion on US 97	1	1
Would reduce congestion on City streets	1	1
Supports implementation of low-stress ped. and bike crossings of US 97	1	0
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	0	1
Support travel demand management strategies	0	0
Potential to reduce Vehicle Miles Traveled (VMT)	-1	0
Would impact property	-1	-1
Would impact the environment	0	0
Order of magnitude cost	0	1
Ability to construct in reasonable affordable phases	-1	0
Can be constructed to comply with design standards (geometric feasibility)	0	0
Would impact freight	0	0
Substantial conflicts with ODOT, City, or County policies and regulations	0	0
Total Evaluation Score	**2**	**4**

The findings and recommendations for the projects at China Hat Road are summarized as follows:

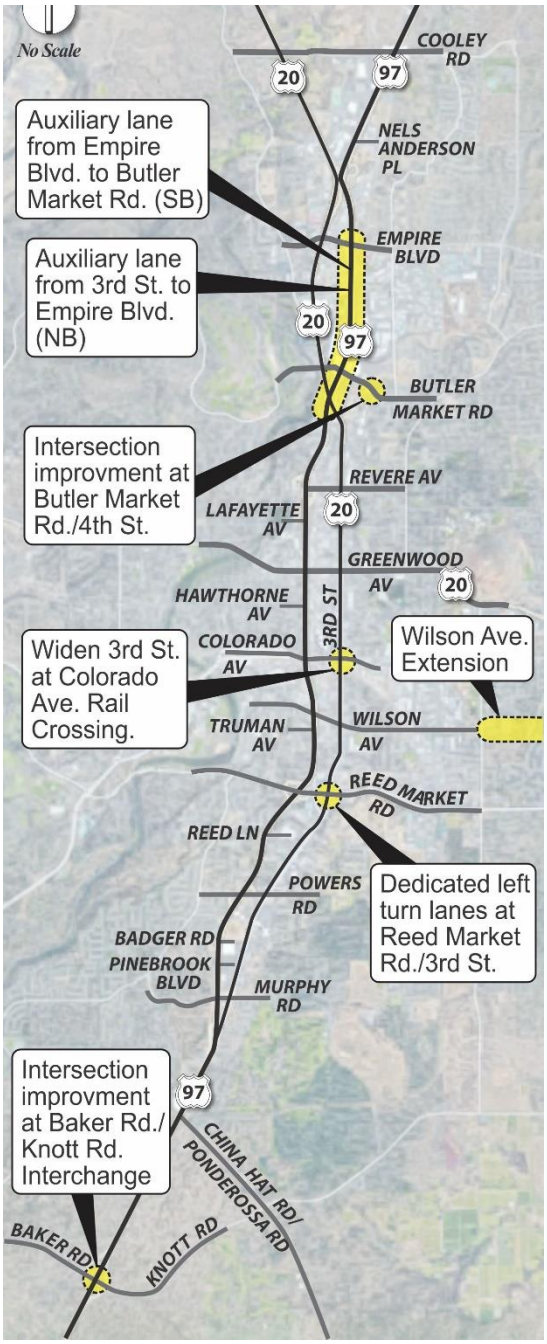
- ***China Hat Road Overcrossing*** – This project is assumed to be geometrically feasible based on the relative ease of design to the location. A new overcrossing would provide a new low stress pedestrian and bicycle connection across US 97. This project is expected to enhance multiple modes of travel and ease congestion on US 97. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**
- ***Complete Southern Frontage System from China Hat Road to Baker Road*** – This project is assumed to promote a parallel low-stress bicycle and pedestrian network along the US 97 corridor. This project is expected to enhance multiple modes of travel and ease congestion on US 97. *Recommendation:* **Advance, Project Bundle A**

OTHER IMPROVEMENT PROJECTS

This group of projects includes improvements that can be implemented in conjunction with any of the other groups (Figures 11 and 12). It should be noted that some of the projects below are on facilities owned by the City of Bend and will directly impact Parkway operations. The following projects are included in the Other Improvement Project group:

- **Auxiliary Lanes**: An auxiliary lane is defined by AASHTO as the portion of the roadway adjoining the traveled way for speed change, turning, weaving, truck climbing, maneuvering of entering and leaving traffic, and other purposes supplementary to through-traffic movement.[8]
    - **Auxiliary Lane from Empire Boulevard to Butler Market Road (Southbound) ($1,000,000 - $2,000,000)**: In the future, traffic demand from the Empire Avenue southbound on-ramp to US 97 is forecasted to exceed the capacity of the current ramp merge configuration. A southbound auxiliary lane from the Empire Avenue southbound off-ramp to the Butler Market southbound off-ramp would provide a significant capacity boost for this movement, smoothing the combined impacts of vehicles merging onto US 97 from Empire Avenue and vehicles exiting the Parkway at Butler Market Road.
    - **Auxiliary Lane from 3rd Street to Empire Boulevard (Northbound) ($1,000,000 - $3,000,000)**: In the future, congestion levels will lead to capacity issues and congestion at the 3rd Street on-ramp to northbound US 97. An auxiliary lane connecting 3rd Street to Empire Boulevard would provide additional capacity for traffic entering northbound US 97 at both 3rd Street and Butler Market Road and exiting northbound US 97 at Empire Boulevard and isolating

Figure 11: Other Improvement Projects

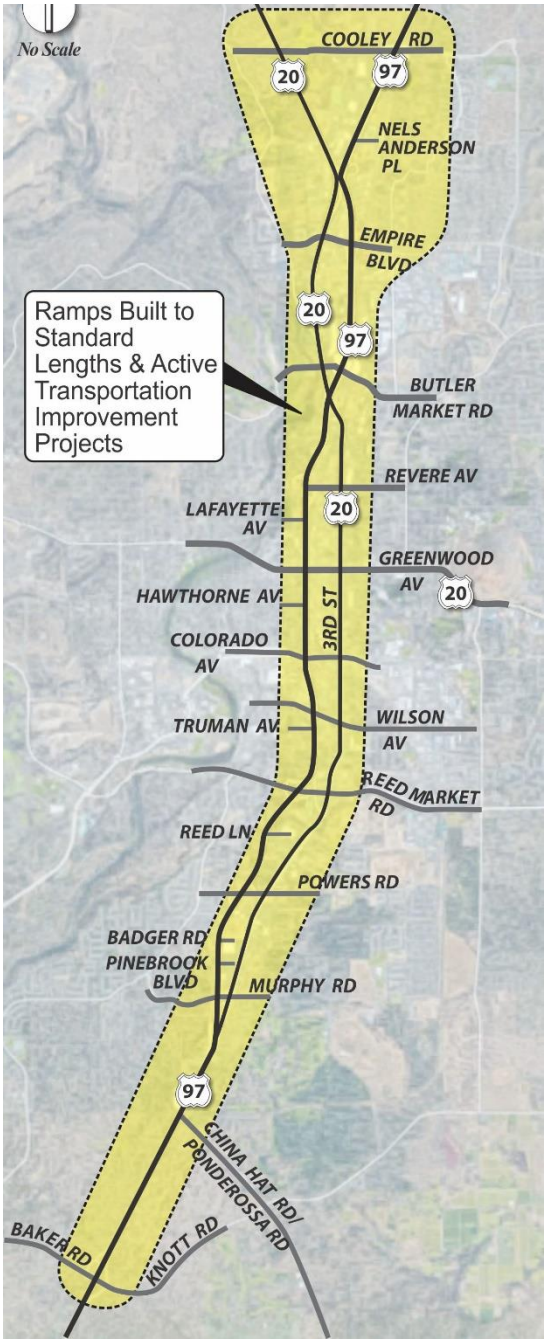


[8] *A Policy on Geometric Design of Highways and Streets,* American Association of State Highway and Transportation Officials, Washington, D.C. 2001

weaving movements from the mainline traffic stream.

- **Intersection Improvement at US 97 Ramps at Baker Road/Knott Road Interchange ($1,000,000 - $2,000,000)**: Under future conditions, the ramp terminal intersections at Baker Road/Knott Road will not have sufficient capacity to effectively serve forecasted demand. Since both intersections are currently stop-controlled, a possible solution to improve mobility and safety would be to either implement a roundabout or signalize these intersections.
- **Dedicated Left Turn Lanes at Reed Market Road and 3rd Street ($1,000,000 - $2,000,000)**: Under future conditions, the Reed Market Road Interchange has the worst operating conditions along US 97 in Bend. This leads to extensive queueing along Reed Market Road, impacting nearby intersections. The left turn movements at Reed Market Road and 3rd Street contribute to these queues since there is no separate storage lane for left turning vehicles. Adding dedicated left turn lanes on Reed Market Road for vehicles turning onto 3rd Street would help prevent the left turning vehicles from queuing onto Reed Market Road through lanes. Furthermore, adding left turn lanes here may lessen queue spillback that impacts the US 97 NB ramps.
- **Wilson Avenue Extension to the East ($15,000,000 - $25,000,000)**: In the future, there will be heavy demand along US 97 in Bend, especially in the central region around Reed Market Road. As mentioned previously, Reed Market Road is a localized area of failure that impacts the whole corridor. Part of the issue is the demand on Reed Market Road, which is exacerbated by a lack of east-west routes connecting across the river. To improve east-west connectivity and relieve some of the demand on Reed Market Road, an extension of Wilson Avenue, just north of Reed Market Road, is proposed as a possible solution.
- **Widen 3rd Street Railroad Undercrossing ($5,000,000 - $10,000,000):** As traffic increases on US 97 in the future, so will the need for a reliable alternate route. 3rd Street may provide an alternate route as it runs parallel to US 97 with four lanes for most of its length. However, at the rail crossing near the US 97 Colorado Avenue interchange, 3rd Street narrows down to two lanes. A possible solution would be to widen 3rd Street from two to four lanes at the Colorado Avenue rail crossing. This would

Figure 12: Other Improvements Projects, Part 2



improve operations on US 97 by allowing 3rd Street to provide more effective alternate routing and also serve some short distance local trips that might otherwise use US 97.

- **Intersection Improvement at Butler Market Road and 4th Street ($500,000 - $1,000,000):** In the future, Butler Market Road at 4th Street will not have sufficient capacity to serve the forecasted demand. Queue spillback from this intersection could impact operations at the US 97 ramp terminal intersections on Butler Market Road. The intersection is currently all-way stop-controlled and already operates near capacity. An intersection improvement such as a signal or roundabout would be a possible solution to address the operations issues at this intersection. It should be noted that the improvement will be influenced by the railroad crossing proximity and the intersection control types at the NB and SB US 97 ramps.
- **Ramps (Acceleration/Deceleration Lanes) Built to Standard Lengths ($1,000,000 - $5,000,000):** Acceleration and deceleration lanes provide drivers with an opportunity to speed up or slow down outside the high-speed through traffic stream while entering or exiting the mainline facility. In Technical Memorandum #2 – Existing Conditions, locations along US 97 within the study area were identified where geometric conditions represented a safety risk due to substandard acceleration/deceleration lane lengths. Constructing ramps to standard is recommended, where feasible, to improve safety on US 97.
- **Active Transportation Improvements (Variable)**: This category of projects, developed by the Parkway Plan's Bicycle and Pedestrian Working Group, aims to improve multimodal access around US 97 by improving crossing locations and parallel routes.

The results of the evaluation are as follows (Table 14).

Table 14: Evaluation Results for the Other Improvement Projects

Qualitative Evaluation Criteria (Level 1)	Evaluation Score										
	Aux. Lane Empire Blvd. to Butler Market Rd. (SB)	Aux. Lane 3rd St. to Empire Blvd. (NB)	Signalize Baker Rd./ Knott Rd.	RAB* at Baker Rd./ Knott Rd.	Dedicated Left-turn at Reed Market Rd./3rd St.	Wilson Ave. Ext.	Widen 3rd St. Rail Xing	Signalize Butler Market Rd./ 4th St.	RAB* at Butler Market Rd./ 4th St.	Active Trans.	Ramps Built to Std.
Potential to reduce crashes	0	0	0	1	1	0	0	0	1	1	1
Ability to improve travel time reliability on US 97	1	1	0	0	0	0	1	0	0	0	0
Enhances travel for multiple modes	0	0	0	0	0	1	0	0	0	1	0
Would reduce congestion on US 97	1	1	1	1	0	0	1	0	0	0	0
Would reduce congestion on City streets	0	0	0	0	1	1	1	1	1	0	0
Supports implementation of low-stress ped. and bike crossings of US 97	0	0	1	1	0	1	0	0	1	1	0
Supports implementation of a parallel low-stress walking/ biking network along the US 97 corridor	0	0	0	0	0	0	0	0	0	1	0
Support travel demand management strategies	0	0	0	0	0	0	0	0	0	0	0
Potential to reduce Vehicle Miles Traveled (VMT)	0	0	0	0	0	1	0	0	0	0	0
Would impact property	0	0	0	0	0	-1	-1	0	-1	0	0
Would impact the environment	0	0	0	0	0	-1	0	0	0	0	0
Order of magnitude cost	0	0	0	0	0	-1	-1	1	1	1	1
Ability to construct in reasonable affordable phases	1	1	1	1	1	-1	0	1	1	0	0
Can be constructed to comply with design standards (geometric feasibility)	0	0	1	1	1	-1	0	1	0	0	0
Would impact freight	0	0	0	0	0	0	0	0	0	0	0
Substantial conflicts with ODOT, City, or County policies and regulations	0	0	0	0	0	0	0	0	1	1	1
Total Evaluation Score	**3**	**3**	**4**	**5**	**4**	**-1**	**1**	**4**	**5**	**5**	**3**

*RAB = Roundabout

- ***Auxiliary Lane from Empire Boulevard to Butler Market Road (Southbound)*** – This project has the potential to improve travel time reliability by decreasing delay caused by weaving movements and can be constructed in reasonable phases because construction will not significantly impact daily functions of the facility. This project scored well due to expected travel time reliability and congestion relief benefits. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**
- ***Auxiliary Lane from 3rd Street to Empire Boulevard (Northbound)*** – This project has the potential to improve travel time reliability by decreasing delay caused by weaving movements and can be constructed in reasonable phases because construction will not significantly impact daily functions of the facility. This project scored well due to expected travel time reliability and congestion relief benefits. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**
- ***Signals at US 97 Ramps at Baker Road/Knott Road Interchange*** – This project scored well due to traffic operations benefits and enhancements to alternate modes of travel. *Recommendation:* **Advance, Project Bundle A**
- ***Roundabouts at US 97 Ramps at Baker Road/Knott Road Interchange*** – This project scored well due to traffic operations benefits and enhancements to alternate modes of travel. *Recommendation:* **Advance, Project Bundle B**
- ***Dedicated Left Turn Lanes at Reed Market Road and 3rd Street*** – This project scored well as this project is likely to provide congestion relief to the local system and safety benefits on a key east-west corridor. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**
- ***Wilson Avenue Extension to the East*** – This project scored poorly due to expected residential property impacts, potential environment impacts, and high cost. *Recommendation:* **Project to be deferred**
- ***Widen 3rd Street at Colorado Avenue Rail Crossing*** – This project scored poorly due to expected commercial property impacts and high cost. However, it should be noted that if this project is advanced by the City it is expected to provide some positive benefit to US 97, mainly by providing more capacity to local trips forecasted to use the Parkway. *Recommendation:* **Project to be deferred** ***Signal at Butler Market Road and 4th Street*** – This project is likely to provide local system congestion relief and safety benefits, resulting in a high score. *Recommendation:* **Advance, Project Bundle A**
- ***Roundabout at Butler Market Road and 4th Street*** – This project is likely to provide local system congestion relief and safety benefits, resulting in a high score. *Recommendation:* **Advance, Project Bundle B**
- ***Ramps (Acceleration/Deceleration Lanes) Built to Standard Lengths*** – This project is expected to provide key safety benefits and compliance with adopted standards. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**

  Active Transportation Improvements (Variable) – This package of improvements is expected to provide enhancement to active transportation modes along the entire corridor and therefore score well against the evaluation criteria. *Recommendation:* **Advance, Project Bundle A and Project Bundle B**

VALUE PRICING (VARIABLE PRICING)

Due to future travel demand on US 97 exceeding the facility capacity, other strategies such as value pricing could be considered to influence trip-taking behavior on US 97 (Figure 13). Value pricing is a dynamic pricing strategy to manage the volume of vehicles using a facility by varying the cost to use the facility based on demand, as well as an innovative financing strategy for facility improvements.

This project was identified as its own group as it will affect the entire corridor and is compatible with all other projects. Furthermore, this transportation demand strategy would have citywide impacts and would require further consideration of many complex issues that are outside the scope of this analysis. The results from the first round of evaluation can be seen in Table 15.

Figure 13: Value Pricing Project

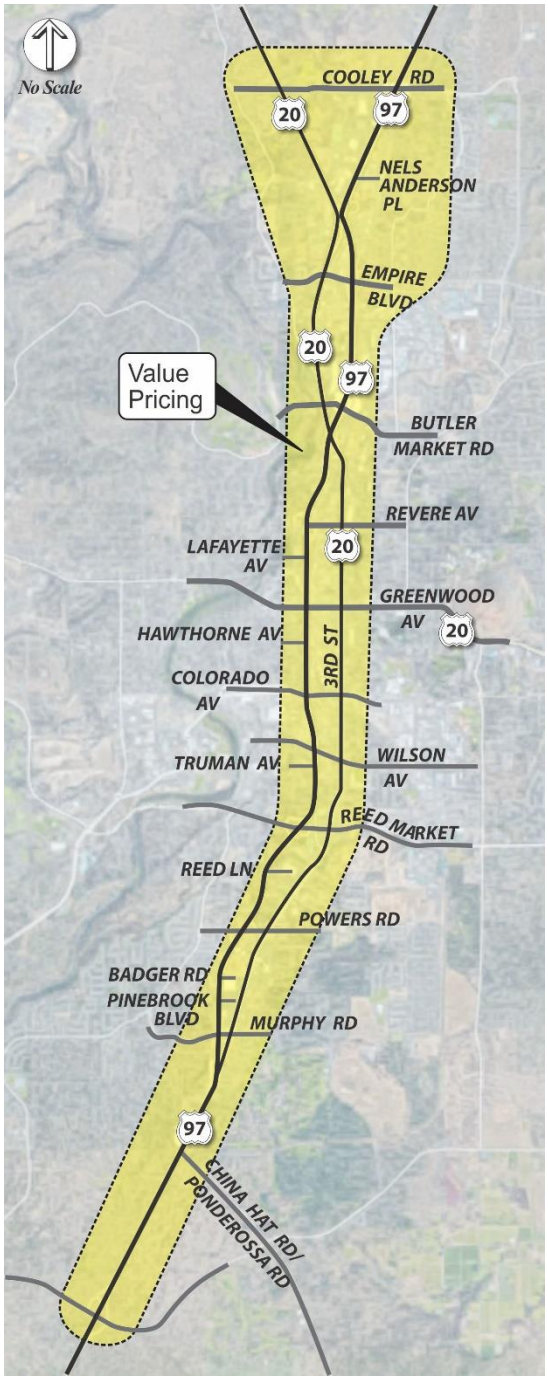


Table 15: Evaluation Results for the Congestion Pricing Project

Qualitative Evaluation Criteria (Level 1)	Evaluation Score
Potential to reduce crashes	0
Ability to improve travel time reliability on US 97	1
Enhances travel for multiple modes	0
Would reduce congestion on US 97	1
Would reduce congestion on City streets	-1
Supports implementation of low-stress ped. and bike crossings of US 97	0
Supports implementation of a parallel low-stress walking/biking network along the US 97 corridor	-1
Support travel demand management strategies	1
Potential to reduce Vehicle Miles Traveled (VMT)	0
Would impact property	0
Would impact the environment	0
Order of magnitude cost	-1
Ability to construct in reasonable affordable phases	0
Can be constructed to comply with design standards (geometric feasibility)	0
Would impact freight	0
Substantial conflicts with ODOT, City, or County policies and regulations	0
Total Evaluation Score	**0**

The scoring evaluation resulted in the following findings and recommendations for the Value Pricing project:

- ***Value Pricing*** - Under a value pricing scenario, some drivers would likely reroute to City streets to avoid tolls. Therefore, congestion might decrease along US 97 but increase along City streets. Increased traffic along City streets would increase pedestrian and bicycle stress on parallel routes. Based on the evaluation criteria, the Value Pricing project scored zero points due mainly to the likely negative congestion and bicycle and pedestrian impacts to the local system. A more comprehensive study of the benefits and impacts of value pricing in Bend would be needed to fully develop and evaluate various value pricing scenarios and their specific implications. *Recommendation:* **Project to be deferred**

3.0 CONCLUSION

The following section summarizes the results of the Level 1 evaluation into two project bundles (A and B) and describes the next steps in the evaluation process. The two project bundles recommended for advancement to Level 2 evaluation are summarized as follows (Table 16).

Table 16: Level 2 Project Bundles

Group	Project Bundle A	Project Bundle B
TSMO	Shoulders built to standard	Shoulders built to standard
TSMO	Weather warning system	Weather warning system
TSMO	Variable speed signs	Variable speed signs
TSMO	Incident management	Incident management
TSMO	Enhanced signal operations at ramp terminals	Enhanced signal operations at ramp terminals
TSMO	TSP for freight on US 97	TSP for freight on US 97
TSMO	TSP for transit on US 97	TSP for transit on US 97
TSMO	Travel information signing	Travel information signing
TSMO	Traveler Information Dissemination	Traveler Information Dissemination
Ramp Meters	Ramp Meters	Ramp Meters
RIRO	Preferred RIRO Closure Scenario	Preferred RIRO Closure Scenario
FEIS	FEIS projects	FEIS projects
Butler Market Rd*	SB frontage road to interchange	Roundabout (or signal) at SB off ramp
Revere Ave	Lane Rechannelization	--
Colorado Ave	Diamond interchange	Signal (or roundabout) at NB ramp
Reed Market Rd	Widen NB off ramp	Interchange (SPUI)
Reed Market Rd	Signal (or roundabout) at NB off ramp	--
Powers Rd	Overcrossing	Interchange
China Hat Rd	Overcrossing	Overcrossing
China Hat Rd	Frontage system	--
Other	Auxiliary lane Empire Blvd to Butler Market Rd SB	Auxiliary lane Empire Blvd to Butler Market Rd SB
Other	Auxiliary lane 3rd St to Empire Blvd NB	Auxiliary lane 3rd St to Empire Blvd NB
Other	Ramps Built to Standard	Ramps Built to Standard
Other	Signal at Baker Rd/Knott Rd	Roundabout at Baker Rd/Knott Rd
Other	Dedicated left turn lane Reed Market Rd and 3rd St	Dedicated left turn lane Reed Market Rd and 3rd St
Other	Signal at Butler Market Rd/4th St	Roundabout at Butler Market Rd/4th St
Other	Active transportation improvements	Active transportation improvements
**No-Build will assume formalized two-stage left (SB)*		

NEXT STEPS

The next step in the evaluation process is detailed quantitative analysis of the two recommended alternatives using the criteria highlighted in Table 17. Based on input from the Technical Advisory Committee each goal will be weighted equally, except for safety, which will be weighted twice as high. Within each goal, performance measures would be scored equally. For example, for Goal 1 (Safety) the reduction in predicted crash frequency will provide 50% of the Goal 1 score, and the reduction in predicted severe crashes will provide the remaining 50%.

Table 17: Level 2 Screening Evaluation Criteria

Goal	Objectives	Evaluation Criteria (Level 2)	Weighting	
			By Criteria	By Goal
1. Improve safety for all modes	Reduce the frequency and severity of crashes for all modes with an emphasis on severe and fatal injuries	Reduction in crash frequency (all modes)	50%	20%
		Reduction in crash severity (all modes)	50%	
2. Support economic development throughout the region and state	Support efficient movement of people, goods and services, and recreational traffic to, within and through the City of Bend	Travel Time Reliability measures on the Bend Parkway (planning time index)	33%	10%
		Percent through traffic on congested segments (modeled demand/capacity ratio $\geq$ 1.0) of the Bend Parkway	33%	
	Develop strategies to accommodate planned growth through provision of transportation options now, and into the future	Degree to which the alternative enhances travel for multiple modes (qualitative assessment)	33%	
3. Manage transportation mobility into the future	Evaluate the ability to achieve ODOT volume/capacity (V/C) targets and develop alternative mobility measures and targets, where appropriate	Ability to meet ODOT v/c targets	50%	10%
	Assess impacts on local system	Ability to meet Bend mobility standards (v/c ratios and LOS)	50%	
4. Consider accessibility to key destinations now and in the future	Evaluate and assess reliable travel times between key destinations during peak periods	Travel Time Reliability measures (planning time index) for specific routes during PM peak hour	50%	10%
		Peak Hour VMT by street classification	50%	
5. Facilitate the use of multimodal travel options	Enhance transit, bicycle and pedestrian facilities along, parallel to, and across, US 97	Number of bike and pedestrian crossing locations on the Bend Parkway with low Level of Traffic Stress (LTS 2 or lower)	33%	10%
		Miles of north-south bike and pedestrian facilities with low Level of Traffic Stress within 0.25 miles of the Bend Parkway	33%	
	Look for transportation demand management opportunities	Does the alternative allow for transportation demand management strategies?	33%	
6. Enhance the environment	Reduce emissions through reduction of vehicular delay, improved connections in the local system, and the use of alternative modes	Total PM peak hour vehicle delay (vehicle hours)	33%	10%
		Total PM peak hour vehicle miles traveled (regional measure)	33%	
	Minimize right of way impacts	Approximate degree of right of way impacts (order of magnitude costs)	33%	
	Design projects to avoid, mitigate and minimize impacts	NA (design criteria; a applies to all project)	33%	
7. Identify cost effective solutions	Prioritize low cost, high benefit solutions	Total cost	33%	10%
		Reduction in cost of delay and crashes	33%	
	Prioritize solutions that that leverage existing planned projects and programs	Does alternative leverage existing planned projects and programs?	33%	
8. Develop an implementation plan	Consider available funding sources and existing planned project and programs	Can the alternative be separated into reasonably fundable and constructible phases?	33%	10%
	Recommend potential future funding sources	NA (funding sources to be recommended in implementation plan)	33%	
	Include partner commitments to short term actions	Does the alternative have local agency support?	33%	
Additional Criteria (from Scope of Work)	N/A	Can be constructed to comply with design standards (geometric feasibility)	33%	10%
		Would impact freight movement	33%	
		Substantial conflicts with ODOT, City, or County policies and regulations	33%	