



Final US97 Multi-Use Path Technical Memorandum

Knott Road/Baker Road to Lava Butte

October 5, 2020



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1 Project Background and Purpose

Deschutes County and the City of Bend have experienced continued population growth and economic development, resulting in additional demands on the transportation infrastructure from a variety of uses – freight, residential, and commercial development, industrial activity, tourism, and active recreation. The project area serves as an interface between the City of Bend’s southern urban fringe and recreational opportunities provided on the Deschutes National Forest, specifically the Newberry National Volcanic Monument, the associated Lava Lands Visitor Center, and the private, nonprofit High Desert Museum. The project area also has significant potential to provide bicycle and pedestrian connections between the trail systems of the Bend Parks and Recreation District and Deschutes National Forest.

The *Deschutes National Forest Alternative Transportation Study* identified an opportunity for a Multi-Use Path (MUP) to connect southwest Bend to southern destinations. In an effort to connect recreational areas, a 5.5-mile paved path connecting Sunriver, Benham East Trailhead and Lava Lands Visitor Center was constructed. With the construction of that paved path, a significant gap in the regional trail network exists between the Knott/Baker Road and the Lava Lands Visitor Center. Closing the 6-mile trail gap will accommodate access to destinations south of Baker/Knott Road and provide additional multi-modal options for growing demand in bicycle and pedestrian travel.

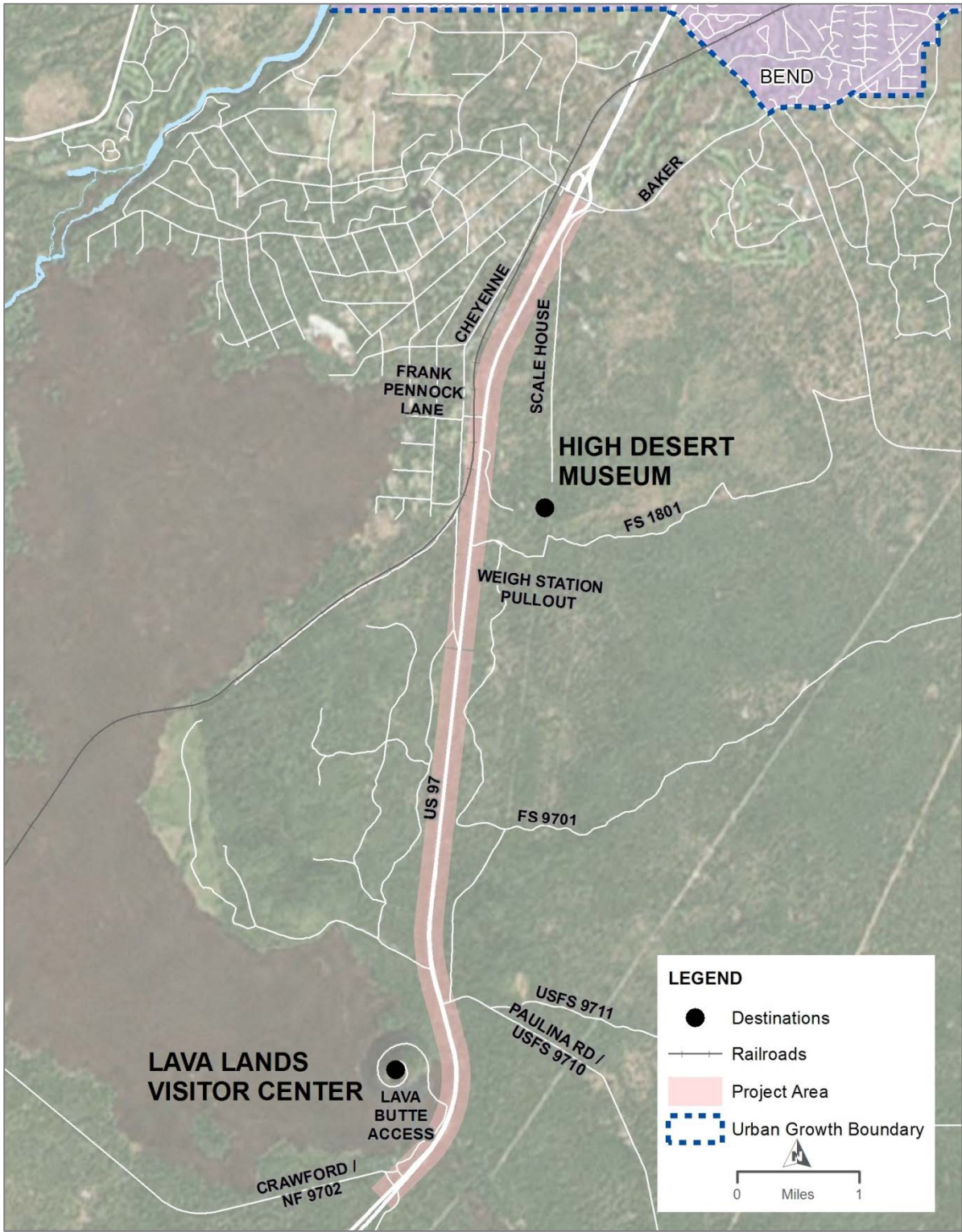
The U.S. 97 Bend to Lava Butte Refinement Plan (completed June 2017) was developed to address the safety and operations of U.S. 97 between Baker Road and Lava Butte and the missing connections between the trail systems of the Bend Park and Recreation District and the Deschutes National Forest. In the plan, three alternatives were analyzed to compare the benefits of the varying MUP alignments.

Building on the recommendations of the refinement plan, a formal evaluation of three MUP concepts was performed using a combination of stakeholder input, project goals and objectives, and the existing trail network within the proximity of the project area. As a result, the preferred alignment is a MUP on the east side of U.S. 97 crossing under U.S. 97 at the USFS Boundary and continuing south on the west side of U.S. 97.

1.1 Project Area

The project area includes U.S. 97 from the Baker Road interchange (northbound off-ramp and southbound on-ramp) south to Lava Lands Visitors Center. The project area is shown in Figure 1.

Figure 1. Project Area



Two alternative alignments were considered for the MUP. One entirely on the west side of U.S. 97 (red and black alignment in Figure 2) and one on the east side of U.S. 97 starting at Baker Road, crossing under U.S. 97 to the west (blue alignment in Figure 2) at the USFS boundary and continuing on the west side of U.S. 97, see Figure 2. Because the center portion of the MUP is the same for both alternatives (black alignment in Figure 2), the concepts were divided into a north and south concept. The north concept (Detail A in Figure 2) has an east alternative and two west alternatives (Detail A in Figure 2) and the south concept, at Lava Butte, has two alternatives, one adjacent to U.S. 97 (magenta alignment in Figure 2) and one through the lava (orange alignment) (Detail B in figure 2).

The northern alignment begins at Baker Road/Knott Road and extends two miles south to the north boundary of USFS land. Two alignment alternative were considered for the north concept, one on the west side of U.S. 97 and one on the east side. The west side alternative had two options at the north end, one adjacent to U.S. 97 and one adjacent to BNSF railroad. Both alternatives utilize a proposed bicycle/pedestrian connection under U.S. 97 adjacent to the High Desert Museum.

2.1.1 East Alternative – Knott Road to USFS Boundary

The East Alternative begins at Knott Road and runs on the east side of U.S. 97 within ODOT right of way to the High Desert Museum. The connection at Knott Road provides linkages to the City of Bend's existing/proposed low-stress bicycle/pedestrian systems and provides an opportunity to collaborate with Bend Parks and Recreation District for connectivity to a future trailhead. Between Knott Road and the proposed undercrossing near the High Desert Museum, the path alignment is adjacent to U.S. 97 near the ODOT right-of-way line, roughly 100 feet to 150 feet offset from the highway. At the proposed undercrossing the path splits; one leg continues south to the High Desert Museum while another section connects users under U.S. 97 to the south concept on USFS land to the Lava Lands Visitor Center.

2.1.2 West Alternative 1 – Baker Road to USFS Boundary (Adjacent to US97)

West Alternative 1 begins at Baker Road and travels on the west side of U.S. 97 within ODOT right of way for approximately ½ mile south of Baker Road. At this point, the West Alternative 1 will veer away from U.S. 97 to approximately 150 feet from the edge of U.S. 97 and continue south to the USFS boundary. At the proposed undercrossing the path splits; one leg connects users under U.S. 97 to the High Desert Museum and the other leg continues south to the south concept on USFS land to the Lava Lands Visitor Center.

2.1.3 West Alternative 2 – Baker Road to USFS Boundary (Adjacent to RR)

West Alternative 2 begins at Baker Road and travels on the west side of U.S. 97 adjacent to the BNSF railroad for approximately ½ mile south of Baker Road. At this point, West Alternative 2 will veer away from U.S. 97 to approximately 150 feet from the edge of U.S. 97 and continue south to the USFS boundary. At the proposed undercrossing the path splits; one leg connects users under U.S. 97 to the High Desert Museum and the other leg continues south to the south concept on USFS land to the Lava Lands Visitor Center.

2.2 South Concept – USFS Boundary to Lava Lands Visitor Center

The southern alignment begins at the northern USFS boundary, traverses four miles through USFS land, through the National Volcanic Monument, then ends at the Lava Lands Visitor Center. The preferred alternative was developed by USFS trails staff and provided to the project team. A field visit was conducted in September 2019 with USFS, ODOT, and consultant staff to vet and walk the preferred alternative. A GIS map of the trail was provided by the USFS to be used as the basis for the design on USFS land.

Through the lava flow on the National Volcanic Monument there are two alignment alternatives (See detail B, Figure 2). South Alternative 1 travels along the eastern edge of the lava flow between the flow and US97, while South Alternative 2 goes through the lava flow before converging again. From that point, the MUP continues adjacent to the existing Lava Butte Road for the remaining ½ mile to the Lava Lands Visitor Center.

2.2.1 South Alternative 1 – Adjacent to US97

The objective of South Alternative 1 is to avoid impacts to the lava flow. South Alternative 1 avoids impacts to the lava flow by traveling through the limited space between the flow and U.S. 97. From the divergence point, South Alternative 1 travels 600 feet between the lava flow and U.S. 97 before intersecting Lava Butte Road. Grades within this area are flat and will easily meet standards. Approximately 325 feet of the path is adjacent to U.S. 97 to avoid impacts to the lava flow. This section will likely require barrier or another means of separation between the MUP and the highway to users from highway traffic.

2.2.2 South Alternative 2 – Through Lava Flow

South Alternative 2 does not avoid impacts to the lava flow and provides a unique user experience, instead it travels through the lava flow while still meeting the maximum grade of 5%. From the point of divergence, South Alternative 2 travels 575 feet through the lava flow before intersecting Lava Butte Road. The project team envisions that this section of the paved path that crosses through the lava flow would also be a paved path. Only 40 feet of this alternative is adjacent to U.S. 97 and will not likely require barrier to shield users from highway traffic.

2.3 Preferred Alignment

A design criteria matrix was developed with ODOT and USFS staff to help determine the preferred alternative, See Appendix A. Design characteristics were selected and a description of each characteristic was included in the matrix. The following characteristics were included in the matrix:

- Disturbed area - a smaller footprint results in less impact
- Private property impacts – properties with right-of-way impacts
- User experience - The uniqueness of the trail and less distance of trail adjacent to U.S. 97, the more pleasant the user experience
- Accessibility - % trail that is greater than 5%, the lower the %, the more accessible
- Trailhead access and network connectivity - Direct access to trailhead and connection to local sidewalks/paths/low stress networks
- Cost – cost of each alternative

The data for each alternative was calculated and input into the matrix. The project team ranked each alternative based on the criteria; low, medium and high. The alternative with the highest rating was selected as the preferred. The preferred alignment, See Appendix B, based on the matrix, was the east alternative and the south alternative through the lava flow.

3 Typical Section

The proposed typical section for the multi-use path consists of a 10-foot bi-directional asphalt path with 2-foot aggregate shoulders on both sides. The pavement section is 4 inches of asphalt pavement concrete (ACP) over 6 inches of aggregate base with subgrade geotextile.

4 Design Standards

The Agency design standards that apply to this Project are:

- ODOT *Highway Design Manual*, 2012
- ODOT *Hydraulics Manual*, April 2014
- ODOT *Sign Policy and Guidelines*, Rev. 7-2014
- ODOT *Traffic Sign Design Manual*, 3rd Edition
- ODOT *Traffic Line Manual*, June 2011
- ODOT *Traffic Control Plans Design Manual*, 12th Edition – May 1, 2016
- *Manual on Uniform Traffic Control Devices*, 2009 Edition
- American Association of State Highway and Transportation Officials (AASHTO) *Roadside Design Guide*, 4th Edition
- American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities*, 4th Edition

5 Design Criteria

- Design Standard: Multi-Use Path
- Design Speed: 20 mph
- Maximum Grade: 5%
- Minimum Radius: 50'
- Cross Slope: 2%
- Cut/Fill Slopes: 1h: 3v max.
- Stopping Sight Distance: Per *Guide for the Development of Bicycle Facilities*, 4th Edition
- Paved Width: 10 feet
- Aggregate Shoulder Width: 2 feet

6 Structural Components

A bicycle/pedestrian undercrossing connection be used to connect the alternatives to the High Desert Museum. The concept structure is assumed to provide a 14 foot wide by 10 foot high clearance envelope for pedestrian use. An exact location for the undercrossing structure has not been identified, but for planning level cost estimating purposes it has been assumed to be 125 feet long. It was also assumed for planning level cost estimating purposes that the undercrossing structure would be a corrugated metal culvert structure, but a more robust structure type alternatives analysis should be completed. Without specific geotechnical information available, it has been assumed that excavation for installation of the undercrossing will be easy and not require ripping or blasting and that the structure does not require deep foundations. Depending on the prefabricated structure type selected, the profile grade of the pathway within the undercrossing will need to be between 15 and 20 feet below the U.S. 97 grade.



Retaining walls will be needed at all four corners of the undercrossing structure to retain the soil on each side of the path as it approaches the undercrossing structure. A specific location for the undercrossing has not been identified and without specific topography it has been assumed that each wall will be 50 feet long with a maximum height of 17 feet tapering down to a minimum height of 0 feet. For cost estimating purposes, it was assumed these walls would be a type allowing for top-down construction such as a soldier pile wall. Once an undercrossing site is selected and geotechnical information is available a retaining wall alternatives analysis should be completed to select the appropriate wall type.

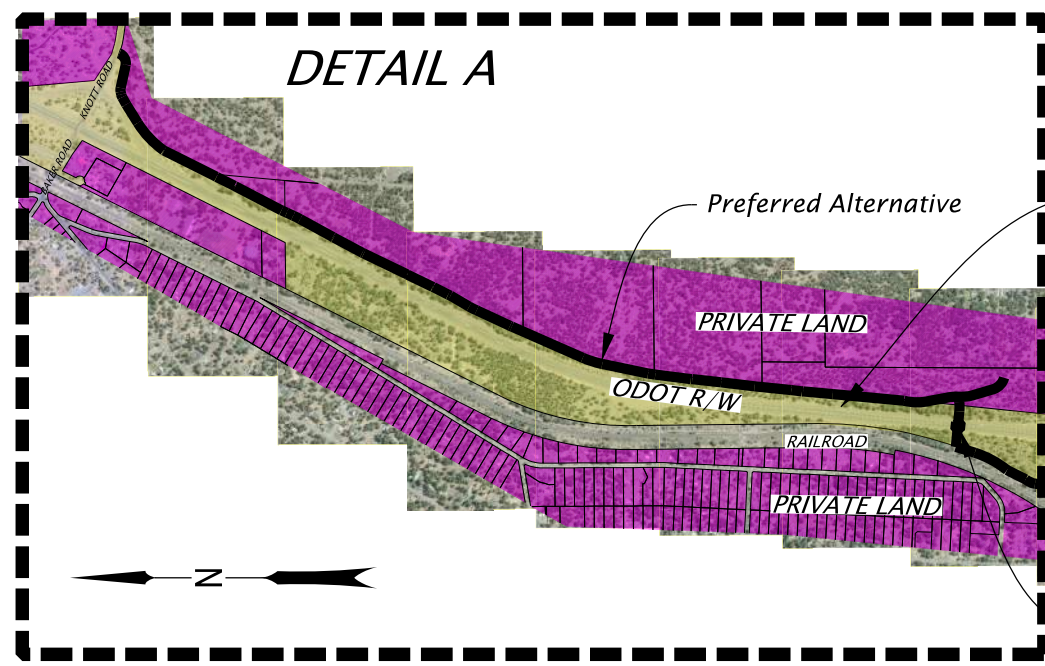
Appendix A. Design Characteristic Matrix

US97: S. Century Drive - USFS Boundary Project												
Multi-Use Path Design Characteristics												
Design Option	Disturbed Area		Private Property Impacts		User Experience		Accessibility		Trailhead Access and Network Connectivity		Estimated CN Cost	
	A smaller footprint results in less impact.		Properties with R/W Impacts		The uniqueness of the trail and lower the amount of trail adjacent to US97, the more pleasant the user experience		% trail that is greater than 5% The lower the %, the more accessible.		Direct access to trailhead and connection to local sidewalks/paths/low stress networks.		Base cost for alg on USFS property = \$3M	
NORTH ALIGNMENT ALTERNATIVES												
East Alternative East side of US97 within ODOT right of way, pedestrian crossing under US97 near HDM and continue on west to USFS boundary	7.68 AC	●	0	●	570 ft of the 11,343 ft trail alternative (5%) is adjacent to US97	●	0	●	Connects to existing or proposed low-stress system. Preferred from a Trails perspective. Preferred due to proximity to City connections	●	\$2.53 M	
West Alternative 1 West side of US97 within ODOT right of way from Baker Rd then approx 150' from edge of roadway to USFS boundary	7.57 AC	●	0	●	1,540 ft of the 11,000 ft trail alternative (14%) is adjacent to US97	●	0	●	Connects to existing or proposed low-stress system.	●	\$2.59M	
West Alternative 2 West side of US97 adjacent to RR from Baker Rd then approx 150' from edge of roadway to USFS boundary	7.64 AC	●	4	●	888 ft of the 11,100 ft trail alternative (8%) is adjacent to US97	●	0	●	Preferred from a Pedestrian Connectivity perspective.	●	\$2.6M	
SOUTH ALIGNMENT ALTERNATIVES												
South Alternative 1 West side of US97 within ODOT right of way adjacent to Lava Butte	0.41 AC	●	0	●	324 ft of the 600ft trail alternative (54%) is adjacent to US97	○	0	●	Both trails connect to Lava Butte Rd	●	\$46k	
South Alternative 2 West side of US97 on Lava Butte through lava flow	0.37 AC	●	0	●	40 ft of the 572 ft of trail alternative (7%) is adjacent to US97	●	0	●		●	\$55k	



Appendix B. Preferred Alternative Exhibit

US97 MULTI-USE PATH
PREFERRED ALTERNATIVE



High Desert
Museum Entrance

Preferred Alternative

PRIVATE LAND

ODOT R/W

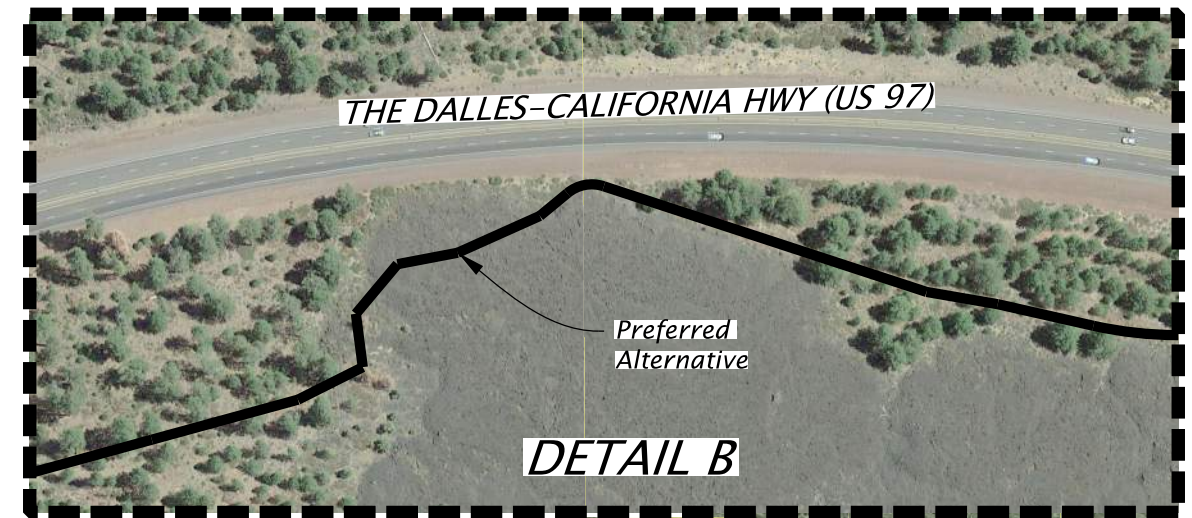
RAILROAD

PRIVATE LAND

USFS LAND

USFS LAND

Proposed Underpass. Actual Crossing
Location To be Determined After
Further Analysis



THE DALLES-CALIFORNIA HWY (US 97)

Preferred
Alternative

DETAIL B

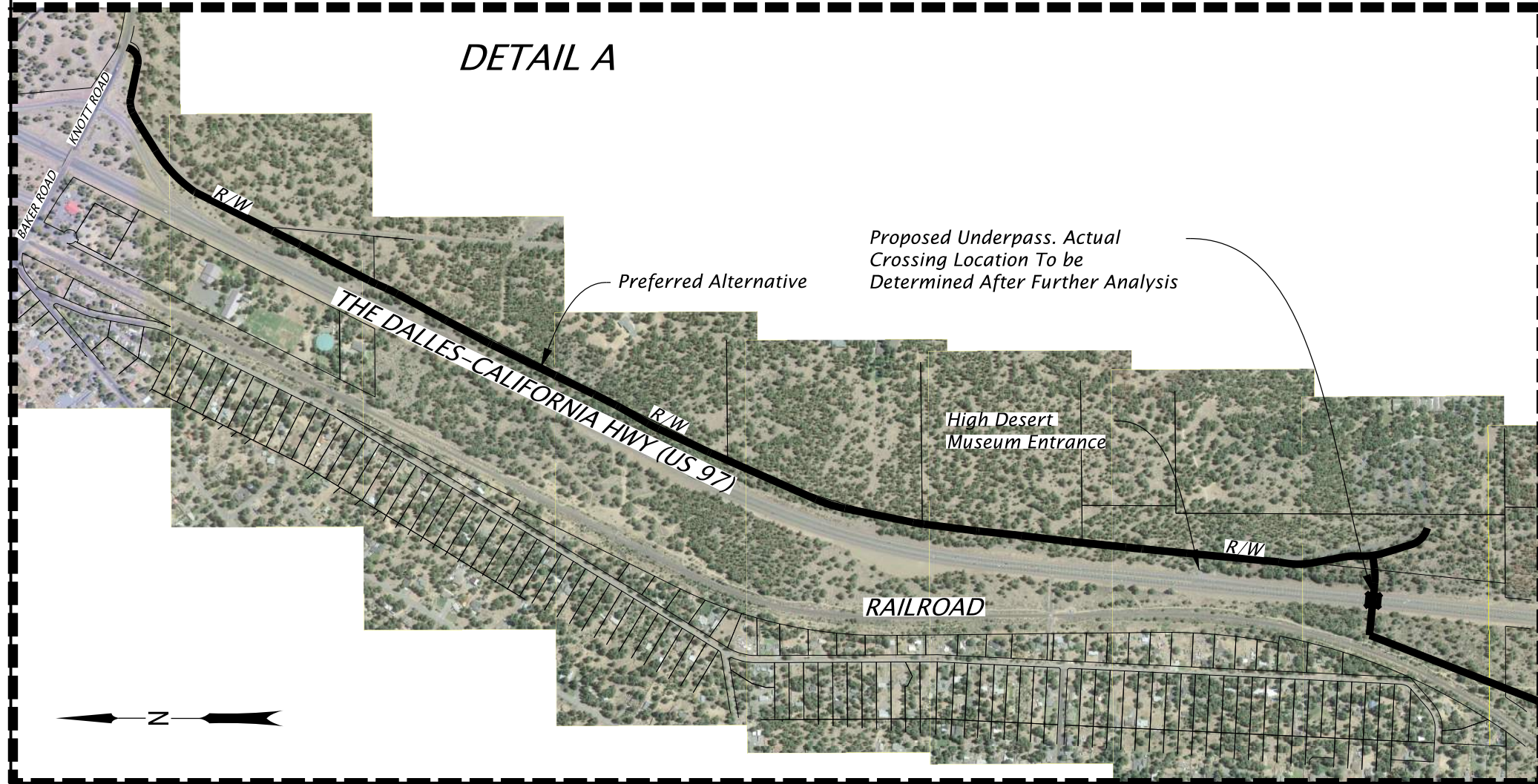
USFS LAND

ODOT R/W

DETAIL B

USFS LAND

Lava Lands
National Historic
Monument



Proposed Underpass. Actual
Crossing Location To be
Determined After Further Analysis

Preferred Alternative

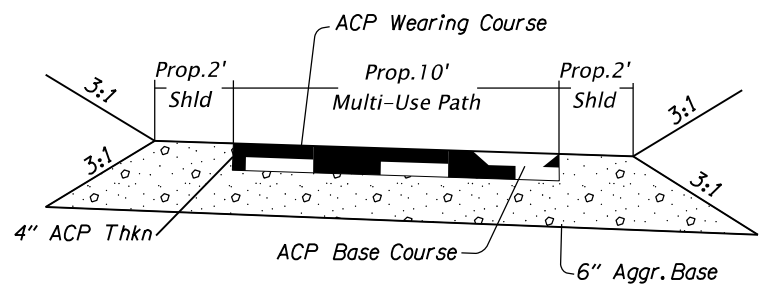
THE DALLES-CALIFORNIA HWY (US 97)

R/W

High Desert
Museum Entrance

RAILROAD

R/W



Typical Section: Proposed Multi-Use Path

Scale 1"=1000'

CONCEPTUAL COPY
INFORMATION ONLY

HDR	HDR ENGINEERING, INC 404 SW COLUMBIA ST., SUITE 240 BEND, OR 97702 541.693.9020		
	US 97: MULTI-USE PATH BAKER ROAD TO LAVA BUTTE		
	HIGHWAY 97 DESCHUTES COUNTY		
	Designer: David Rodriguez	Reviewer: Jason Rahm	
Drafter:		Checker:	SHEET NO. 1 OF 1
Exhibit A			