"Using Highway Economic Requirements System: Telling the Story"

This was a test project to see how HERS-ST could be used at the Traffic Analysis Level for Project Development.

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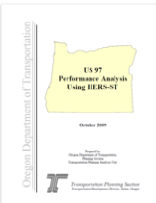
Project: Evaluate project scenarios that could result in corridor alternatives.



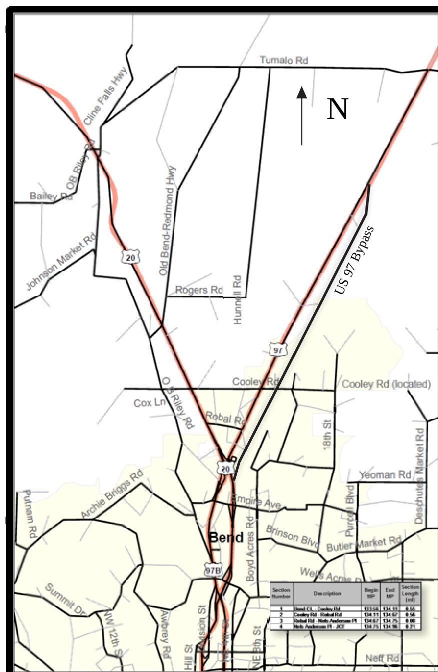
Over the past decade, the northern area of the City of Bend has undergone considerable business growth and change. The area known locally as the "Cooley Triangle" has been the location of choice for many retail organizations moving into this Central Oregon community. With growth comes traffic and associated congestion and this area is a source of current congestion issues. The location makes it extremely attractive for future retail development, which will result in greater congestion in the future. Traffic analysis of this area is important for planning how the area develops, grows, and flows.

To simplify the analysis, each scenario dataset was run independently. The analysis assumed that the scenario already exists. The post-processing compared performance and cost measures for the two build scenarios against the no-build scenario to evaluate the potential benefits associated with each scenario. Keeping the timeframe identical for all three scenarios reduced the need to discount the improvement benefits back to different implantation time periods, and facilitated the post-process analysis of the results.

US 97 Bend North Corridor

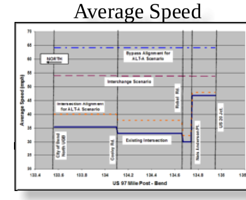
#1) **Existing Intersection Scenario**: Intersection scenario is the existing roadway system. This is the "no build" condition and the base case against which the "build" scenarios are compared.
#2) **Intersection Scenario**: Interchange scenario replaced the existing Cooley Road signalized intersection with a full interchange and removed all other signal and access points to US 97. *This is an Access Management Scenario.*
#3) **Alt-A (Bypass) Scenario**: Bypass scenario made no changes to the existing alignment, but added a "new" bypass alignment to the east of the analysis area.

Note that for the Alt-A Scenario, two alignments, the existing US 97 alignment with intersections and the US97 Bypass, were evaluated separately within HERS-ST and the results were combined.

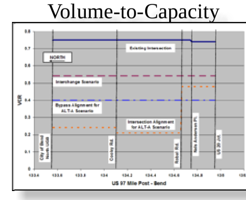


The ALT-A Scenario has two average speed flow curves that reflect the dual alignments within the scenario. The additional of the high speed, access controlled bypass alignment attracts a large number of trips to shift onto the bypass alignment, resulting in a slight increase in speed on the existing intersection alignment. The "shifted" trips are considered "pass through" trips because they begin and end outside the study area.

Average Speed



Volume-to-Capacity



The v/c on the segments north of Robal Road is half the value for the segments located south of Robal Road. This is probably due to the traffic flow from the southern area accessing retail development in the "Cooley Triangle".

These are future performance measure forecasts depicting system condition at the end of the 20-year analysis period, and represent a reasonable expectation of the long-range impacts for each scenario. The purpose of this analysis is to compare relative change between performance measures.

Table 4: Summary of Crash Rates (Number of Crashes per 100 Million VMT)

Scenarios			Description
Intersection	Interchange	Bypass	
3132	830	1794	Rate of which crashes occur
1288	341	738	Rate of which injuries occur
9	2	5	Rate of which fatalities occur

Table 5: Summary of All Costs* ($ per 1000 VMT)

Scenarios			Description
Intersection	Interchange	Bypass	
$17,760	$11,574	$12,608	Total Cost to User
$140	$140	$178	Agency Cost**
$138	$146	$156	External Cost
$18,037	$11,860	$12,942	Total Costs
---	$6,178	$5,095	Total Benefit

*Total average 20-year cost
**Maintenance cost converted from "$ per mile" to "$ per 1,000 VMT"

Table 2: Scenario Performance Measure Overview

Scenarios	VCR (avg.)	VMT (million)	Avg. Speed (mph)	Delay (hr/1000 VMT)
Existing Intersection	0.76	24.4	36.3	30.2
Interchange	0.54	24.2	63.9	0.6
ALT-A	0.39	26.3	52.0	20.6
- Existing	0.36	9.2	39.4	20.3
- Bypass	0.40	17.1	64.1	0.2

Table 3: Summary of Total User Costs* ($ per 1,000 VMT)

Scenarios			Description
Intersection	Interchange	Bypass	
$9,382	$6,230	$6,298	Travel Time Costs
$4,418	$4,382	$4,578	Operating Costs
$3,960	$962	$1,732	Cost of Crashes
$17,760	$11,574	$12,608	Total User Costs
---	$6,186	$5,152	Total User Benefit

*Total average 20-year cost

Benefit-Cost Ratio

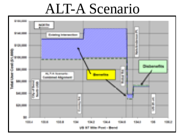
HERS-ST defines the benefit-cost Ratio (BCR) of a highway improvement as the discounted sum of the present value benefits for the user, agency, and environment divided by the implementation costs of the improvement. For BCR analysis, HERS-ST recognizes four broad classes of costs:
- User costs are the costs incurred by the highway user and include Travel Time Costs, Operating Costs, and Safety Costs.
- Agency Costs are roadway maintenance costs borne by the administrative agency responsible for the highway section.
- External Costs (emissions costs) are the social costs passed to the non-users of the highway system.
- Capital Improvement Costs are the estimated construction costs of the improvement.

Average Delay

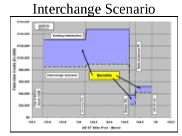
There are three kinds of delays estimated in HERS-ST:
- Zero-Volume Delay is the delay associated with traffic control devices. This is the expected delay that a single vehicle would encounter even if it were the only vehicle on the road. Zero-volume delay only exists for sections controlled with stop signs or traffic signals and is not calculated for uncontrolled sections
- Incident Delay is the delay associated with crashes. HERS-ST estimates delay due to crashes through a secondary (or inferred) process where the HERS-ST model estimates the delay cost of crashes and then back-calculates the delay estimates due to crash incidents from the cost calculations.
- Other Congestion (or Recurring) Delay is the average delay due to non-incident congestion.

The benefits for each variable are defined as a reduction in costs as a result of the implementation of an improvement. Some improvements might show a savings in one variable, such as travel time, while showing an increased cost (disbenefit) in another variable, such as increased fuel consumption. A reduction in the summation of all three costs is defined as the total benefit for the selected improvement.

Total User Costs
ALT-A Scenario

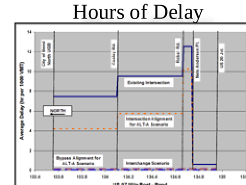


Total User Costs
Interchange Scenario

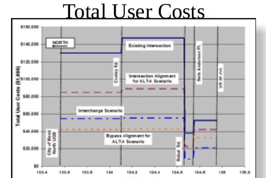


The analysis reflects the average delay for each segment and assumes default stop/start delay associated with a signalized intersection. Although the HERS-ST calculations assume some signalized delay, the model does not specifically evaluate signal delay and averages the effects of the delay across the entire analysis segment. A formal signal delay analysis requires a more detailed analysis approach.

Hours of Delay



Total User Costs



The Total User Costs reflect the travel time, operation and safety costs to the user on the system by scenario. The Total User Costs for the **Existing Intersection Scenario** is the datum. All costs below the datum are considered benefits, while all costs above the datum are disbenefits.

The average segment speed, delay, and volume-to-capacity ratio analyses showed that both "build" scenarios, as compared with the "no build", increased the average speed by about 50 percent, decreased the average delay by over 80 percent (varies by scenario), and improved the VCR by up to 50 percent in the analysis area. Both "build" scenarios showed significant improvements for these performance measures, and the Total User Costs decreases by as much as 45 percent, compared with the "no build" scenario.

This analysis does not address downstream impacts. For example, the Bend Parkway (US 97) segment south of the project area (south of Empire Avenue) is expected to be at capacity in the future. Fixing a bottleneck at one location does not guarantee against creating a problem at other location(s) and additional regional analysis is required to determine additional downstream impacts.