MARVIN & ASSOCIATES 1300 N. Transtech Way Billings, MT 59102

Bridger Canyon Property Owners Association
Attn: Tom Fiddaman
1070 Bridger Woods Rd
Bozeman MT 59715

December 5, 2006

Re: Bridger Canyon Partners Base Area Development
TIS Review

Dear Tom:

I have reviewed the information you provided relative to the Bridger Canyon Partners' Base Area Development Traffic Impact Study (TIS). I also inspected pertinent transportation sections of the Bridger Bowl Master Plan EIS. Although my review was not extensive, I am able to provide you with my general impressions of the study's composition and value in assessing transportation impacts on the Highway 86 corridor in the following narratives.

The trip generation characteristics of the proposed development appear to be consistent with accepted standards and the assumptions regarding internal capture trips seem to be reasonable, if not conservative. The principal of providing on-site accommodations to reduce the number of external trips on Highway 86 to Bozeman is representative of good Transportation Demand Management practices and is well accounted for within the TIS report. Even though a wealth of information on trip generation is provided in the report, the actual traffic volume assignment on the Highway 86 corridor was not entirely clear. From the trip generation and distribution discussions in the report I was able to calculate that there would be approximately 1,765 external trips to and from the development on the average weekday (AWT), with 149 during the peak pm hour. Of those external trips, approximately 1,660 AWT and 140 pm hour trips would be directed to and from the south on Highway 86. South of Jackson Creek Road, to and from Bozeman, there would be approximately 1,465 AWT and 124 pm hour trips. Since the average annual daily traffic (AADT) on Highway 86 is currently about 2,000, the development would have significant volume impacts on the AADT, if not on the peak pm hour winter volumes.

Because of the number and variety of traffic data sources quoted and extrapolated upon within the TIS study, it was not clear what existing and planned traffic volume conditions were being analyzed as a part of the study. I could not find a statement or figure that clearly stated the exact volume numbers being analyzed. I can only assume that the study based all traffic growth on a 4% annual rate, which may be a valid assumption considering the time lag experienced in planned developments and the highly variable nature of historic traffic growth. Site development traffic assignment numbers would have then been added to background traffic increases. A check of capacity calculations for

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the 2015 peak pm hour traffic volumes at the Jackson Creek Road – Highway 86 intersection, appears to support my assumptions.

Capacity calculation summaries for 4 intersections on Highway 86 were presented within the report and mitigation measures were presented for the movements that would be substantially impacted. One thing that was missing from the analysis was the two-lane highway capacity calculations for Highway 86. This would appear to be a critical issue considering that current design hour volumes for weekend ski days are approximately 35% of the AADT. Having performed impact studies for several ski areas in Montana, I know that this is a critical issue and I fully expected to see a very detailed summary of capacity variations along the corridor. I was also surprised to see that the Bridger Bowl EIS did not contain highway capacity calculations for the corridor either.

In order to determine if this would have been a critical issue, I completed HCS Two-lane Highway Capacity calculations for existing and year 2012 traffic volumes. Existing design hour volumes are 700 vph and calculated 2012 volumes used in the capacity analysis were 1,000 vph. The MDT documented peak pm hour directional split for this traffic was 24%/76% and MDT's records indicated that trucks traffic is approximately 6%. Without the benefit of other documented data, assumptions were made to complete the analysis (attached). It was determined that the existing level of service (LOS) would be "C" and that the year 2012 traffic conditions would result in LOS "D" on the highway corridor.

Generally, my only concerns with the study deal with the report's lack of clarity and the fact that no attempt was made to address operations along the entire Highway 86 corridor. If additional information or evaluation is required, feel free to contact me.

Respectfully Submitted,

Robert R. Marvin, P.E., P.T.O.E.

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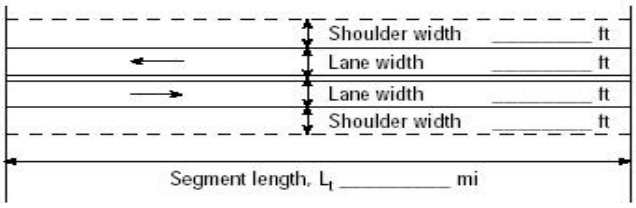
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	K Marvin	Highway	MT 55
Agency or Company	Marvin & Associates	From/To	Average Conditions
Date Performed	4/5/2007	Jurisdiction	MT
Analysis Time Period	Peak PM Winter Day	Analysis Year	2005

Project Description: Bridger Canyon Base Area Development

Input Data



☐ Class I highway ☑ Class II highway	
Terrain: ☐ Level ☑ Rolling	
Two-way hourly volume	200 veh/h
Directional split	65/35
Peak hour factor, PHF	0.80
No passing zone	60
% Trucks and Buses, P_T	6 %
% Recreational vehicles, P_R	2 %
Access points/mi	5

Average Travel Speed

Grade adjustment factor: f_g (Exhibit 20-7)	0.93
Passenger car equivalents for trucks: E_T (Exhibit 20-8)	1.9
Passenger car equivalents for RVs: E_R (Exhibit 20-9)	1.1
Heavy vehicle adjustment factor: $f_{HV} = 1/(1 + P_T(E_T - 1) + P_R(E_R - 1))$	0.847
Two-way flow rate: v_p (pc/h) $= V/PHF \times f_g \times f_{HV}$	333
v_p = highest directional split proportion (pc/h)	67

Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed, S_{FM} mi/h	Base free-flow speed, BFFS: S_{FM} 60.0 mi/h
Observed volume, V_f veh/h	Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-6): 2.5 mi/h
Free-flow speed, FFS = $S_{FM} + 0.00776(V/f_{HV})$ mi/h	Adj. for access points, f_A (Exhibit 20-6): 1.3 mi/h
	Free-flow speed, FFS = BFFS - f_{LS} - f_A: 56.2 mi/h

Adj. for no-passing zones, f_{np} (mi/h) (Exhibit 20-11)	2.0
Average travel speed, ATS (mi/h) = FFS - $0.00776 v_p - f_{np}$	47.3

Percent Time Spent Following

Grade adjustment factor: f_g (Exhibit 20-8)	0.94
Passenger car equivalents for trucks: E_T (Exhibit 20-10)	1.6
Passenger car equivalents for RVs: E_R (Exhibit 20-10)	1.0
Heavy vehicle adjustment factor: $f_{HV} = 1/(1 + P_T(E_T - 1) + P_R(E_R - 1))$	0.877
Two-way flow rate: v_p (pc/h) $= V/PHF \times f_g \times f_{HV}$	357
v_p = highest directional split proportion (pc/h)	643
Base percent time spent following, BPTSF (%) $= 100(1 - e^{-0.000879 v_p})$	57.7
Adj. for directional distribution and no-passing zone, $f_{d/np}$ (%) (Exhibit 20-17)	12.8
Percent time spent following, PTSF (%) = BPTSF + $f_{d/np}$	69.1

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	C
Volume-to-capacity ratio: $v/c = V_p/3200$	0.28
Peak-hour vehicle-miles of travel, VMT_{15} (veh-mi) = 0.25(V/PHF)	1944
Peak-hour vehicle-miles of travel: VMT_{60} (veh-mi) = VMT_{15}	7000
Peak-hour total travel time, TT_{15} (veh-h) = $VMT_{15}/60$	47.1

Notes

1. If $v_p > 3200$ pc/h, terminate analysis—the LOS is F.
2. If highest directional split vol. > 1,200 veh/h, terminate analysis—the LOS is F.

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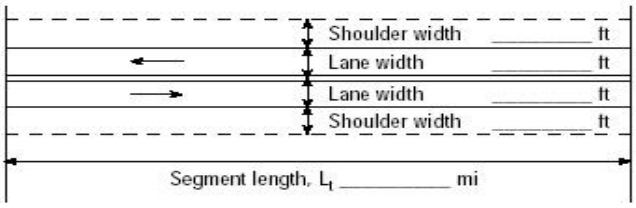
TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	R Marvin	Highway	MP 55
Agency or Company	Marvin & Associates	From/To	Average Conditions
Date Performed	4/5/2007	Jurisdiction	MP
Analysis Time Period	Peak PM Winter Day	Analysis Year	2007 (with base & 45k Arrivals)

Project Description: Bridger Canyon Base Area Development

Input Data



☐ Class I highway ☑ Class II highway

Terrain: ☐ Level ☑ Rolling

Two-way hourly volume	1000 veh/h
Directional split	56 / 44
Peak hour factor, PHF	0.80
No passing zone	60
% Trucks and Buses, P_T	6 %
% Recreational vehicles, P_R	3%
Access points/mi	5

Average Travel Speed

Grade adjustment factor, f_g (Exhibit 20-7)	0.88
Passenger car equivalents for trucks, E_T (Exhibit 20-8)	1.5
Passenger car equivalents for RVs, E_R (Exhibit 20-9)	1.2
Heavy vehicle adjustment factor, $f_{hv} = 1/(1 + P_T(E_T - 1) + P_R(E_R - 1))$	0.869
Two-way flow rate, v_p (pc/h), $v_p = (V \times PHF \times f_g \times f_{hv})$	1108
v_p * highest directional split proportion (pc/h)	550

Free Flow Speed from Field Measurement		Estimated Free Flow Speed	
Field measured speed, S_{FM}	mi/h	Base free flow speed, BFFS	60.0 mi/h
Observed volume, V_f	veh/h	Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5)	-1.5 mi/h
Free flow speed, FFS = $S_{FM} + 0.00776(V/f_{HV})$	mi/h	Adj. for access points, f_A (Exhibit 20-6)	-1.3 mi/h
		Free flow speed, FFS = BFFS - f_{LS} - f_A	57.2 mi/h

Adj. for no-passing zones, f_{np} (mi/h) (Exhibit 20-11)	1.5
Average travel speed, ATS (mi/h) = FFS - $0.00776(v_p + f_{np})$	46.7

Percent Time Spent Following

Grade adjustment factor, f_g (Exhibit 20-8)	1.00
Passenger car equivalents for trucks, E_T (Exhibit 20-10)	1.0
Passenger car equivalents for RVs, E_R (Exhibit 20-10)	1.0
Heavy vehicle adjustment factor, $f_{hv} = 1/(1 + P_T(E_T - 1) + P_R(E_R - 1))$	1.000
Two-way flow rate, v_p (pc/h), $v_p = (V \times PHF \times f_g \times f_{hv})$	1111
v_p * highest directional split proportion (pc/h)	644
Base percent time spent following, BPTSF (%) = $100(1 - e^{-0.000879 v_p})$	67.3
Adj. for directional distribution and no-passing zone, $f_{d/np}$ (%) (Exhibit 20-13)	10.7
Percent time spent following, PTSF (%) = BPTSF + $f_{d/np}$	77.9

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	D
Volume to capacity ratio, v/c = V_p / 3200	0.35
Peak-hour vehicle-miles of travel, VMT_{15} (veh-mi) = 0.25 (V/PHF)	312.5
Peak-hour vehicle-miles of travel, VMT_{60} (veh-mi) = VMT_{15}	1000
Peak-hour total travel time, TT_{15} (veh-h) = VMT_{15} / ATS	6.68

Notes

1. If v/c > 0.700, then terminate analysis: the LOS is F.
2. If highest directional split vol. > 1,700 veh/h, then terminate analysis: the LOS is F.

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