A

Appendix A
Raw 2004 Traffic Count and Overlap Data

- 2004 Raw Traffic Count Data
- I-81 / I-77 Overlap Traffic Data

2004 Raw Traffic Count Data

I-81 Northbound

				Link Start:	Tennessee State Line		I-77 Fort Chiswell		I-581		US 220		I-64 near Lexington		I-64 near Staunton		I-66; Warren County Line	
				Link End:	I-77 Wytheville (0-81)		I-581 (81-143		US 220 (143-150)		I-64 (150-191)		I-64 near Staunton (191-221)		66; Frederick County Line (221-29		West Virginia State Line (296-WV	
FactorGroupTypeDescription	FactorGroupLabel	FactorDate	Month	Day	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	SUN	10181	1.2857505	20350	1.2507912	20181	1.2742495	20234	1.1057749	80254	1.1019768	80234	1.2535331	80373	1.4213843
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	MON	10181	1.2072437	20350	1.2833669	20181	1.2273558	20234	1.4588715	80254	1.4752081	80234	1.3180269	80373	1.2091572
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	TUE	10181	1.1213412	20350	1.2136101	20181	1.1642788	20234	1.3763186	80254	1.6336064	80234	1.204882	80373	1.1712778
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	WED	10181	1.0946311	20350	1.1905766	20181	1.1354381	20234	1.3073637	80254	1.3364914	80234	1.1760542	80373	1.1356995
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	THU	10181	1.0885165	20350	1.1602372	20181	1.1055018	20234	1.2704559	80254	1.289454	80234	1.1421794	80373	1.1054957
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	FRI	10181	1.1095538	20350	1.2057603	20181	1.1177927	20234	1.3326207	80254	1.3436791	80234	1.1692353	80373	1.0909451
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	SAT	10181	1.2864851	20350	1.4684899	20181	1.4301734	20234	1.493699	80254	1.5268002	80234	1.4565097	80373	1.3196816
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	SUN	10181	1.2374672	20350	1.1782243	20181	1.2336214	20234	1.0443658	80254	1.0484882	80234	1.1788748	80373	1.3082006
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	MON	10181	1.1238285	20350	1.1892152	20181	1.1466866	20234	1.3229838	80254	1.3346849	80234	1.1881358	80373	1.1659181
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	TUE	10181	1.0785524	20350	1.1447109	20181	1.1325906	20234	1.280216	80254	1.3048704	80234	1.1685404	80373	1.1158057
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	WED	10181	1.1048959	20350	1.1235572	20181	1.1244541	20234	1.2580163	80254	1.2983346	80234	1.1356373	80373	1.0921141
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	THU	10181	1.0506506	20350	1.1165103	20181	1.058358	20234	1.1629241	80254	1.1939087	80234	1.0668777	80373	1.053845
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	FRI	10181	1.0456633	20350	1.1006517	20181	0.99934702	20234	1.1333244	80254	1.1523757	80234	1.0391544	80373	1.0213793
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	SAT	10181	1.2334753	20350	1.3511111	20181	1.3583157	20234	1.4039873	80254	1.4610724	80234	1.3169234	80373	1.2067181
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	SUN	10181	1.1382196	20350	0.99772785	20181	1.0687876	20234	0.8752015	80254	0.88521301	80234	1.0297661	80373	1.1489291
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	MON	10181	1.0794716	20350	1.0466102	20181	1.0335022	20234	1.1102243	80254	1.1802504	80234	1.0531155	80373	1.061938
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	TUE	10181	1.0452318	20350	1.0870283	20181	1.0712814	20234	1.1791369	80254	1.2313402	80234	1.0996458	80373	1.0594441
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	WED	10181	1.0094138	20350	1.0389064	20181	1.0113812	20234	1.0967679	80254	1.1590096	80234	1.0472724	80373	1.0449609
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	THU	10181	0.95689126	20350	0.96409055	20181	0.93478113	20234	0.99869459	80254	1.0861617	80234	0.96657108	80373	0.93956569
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	FRI	10181	0.96284683	20350	0.94581658	20181	0.86913175	20234	0.9151759	80254	0.97599661	80234	0.95530002	80373	0.88813581
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	SAT	10181	1.115662	20350	1.2136101	20181	1.2264815	20234	1.2035038	80254	1.2621424	80234	1.230328	80373	1.0948516
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	SUN	10181	1.0424897	20350	0.92813527	20181	0.95470456	20234	0.77287964	80254	0.77544686	80234	0.89919585	80373	1.0003999
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	MON	10181	0.96887699	20350	0.95532779	20181	0.94624395	20234	1.0010111	80254	0.98154021	80234	0.91318652	80373	0.91907418
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	TUE	10181	0.98964743	20350	1.0026894	20181	1.0010902	20234	1.0979842	80254	1.089815	80234	0.99426886	80373	0.97010506
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	WED	10181	0.96961868	20350	0.98254686	20181	0.97212224	20234	1.0410713	80254	0.96549958	80234	0.96776046	80373	0.95244358
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	THU	10181	0.92759063	20350	0.93110923	20181	0.91664726	20234	0.97452377	80254	0.9814473	80234	0.92630835	80373	0.89740412
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	FRI	10181	0.9368095	20350	0.93419062	20181	0.87331981	20234	0.916821	80254	0.91606662	80234	0.88749295	80373	0.84132322
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	SAT	10181	1.0886919	20350	1.1071889	20181	1.1243623	20234	1.0604209	80254	1.1020354	80234	1.0721134	80373	0.95283934
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	SUN	10181	0.97827766	20350	0.8804527	20181	0.90469622	20234	0.7240074	80254	0.72043496	80234	0.84821685	80373	0.92997634
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	MON	10181	0.99294463	20350	0.98200974	20181	0.96126736	20234	0.98565238	80254	0.98757024	80234	0.96958987	80373	0.95004316
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	TUE	10181	0.97705139	20350	0.97662235	20181	0.945984	20234	0.99175063	80254	1.0118571	80234	0.97977659	80373	0.97841778
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	WED	10181	0.95194701	20350	0.9814732	20181	0.92641916	20234	0.96913687	80254	0.99730679	80234	0.95988609	80373	0.93719774
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	THU	10181	0.91288288	20350	0.92091159	20181	0.89247416	20234	0.90572028	80254	0.9218493	80234	0.91392935	80373	0.88896786
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	FRI	10181	0.90964585	20350	0.91325045	20181	0.8585676	20234	0.88523642	80254	0.88283878	80234	0.87136684	80373	0.84569286
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	SAT	10181	1.0722184	20350	1.1247723	20181	1.1126459	20234	1.0520033	80254	1.0728439	80234	1.0912539	80373	1.0245355
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	SUN	10181	0.94537482	20350	0.85797403	20181	0.9458216	20234	0.77100321	80254	0.73056192	80234	0.88960109	80373	0.97370935
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	MON	10181	0.92122369	20350	0.94315307	20181	0.93199811	20234	0.96171647	80254	0.94932247	80234	0.95650059	80373	0.96048866
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	TUE	10181	0.9476736	20350	0.97565793	20181	0.95869149	20234	1.0454037	80254	1.0319996	80234	1.0010182	80373	0.96618798
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	WED	10181	0.92118182	20350	0.94740375	20181	0.91802186	20234	0.9956226	80254	0.96630941	80234	0.9432695	80373	0.92488152
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	THU	10181	0.88940578	20350	0.88534433	20181	0.8656904	20234	0.9002942	80254	0.88977087	80234	0.89050764	80373	0.86974936
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	FRI	10181	0.8743259	20350	0.84455272	20181	0.8364862	20234	0.83936764	80254	0.8191586	80234	0.85170746	80373	0.81119005
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	SAT	10181	0.99709717	20350	0.98030461	20181	1.063383	20234	0.97379079	80254	0.93624994	80234	1.0444907	80373	0.95264142

				Link Start:	Tennessee State Line		I-77 Fort Chiswell		I-581		US 220		I-64 near Lexington		I-64 near Staunton		I-66; Warren County Line	
				Link End:	I-77 Wytheville (0-81)		I-581 (81-143		US 220 (143-150)		I-64 (150-191)		I-64 near Staunton (191-221)		66; Frederick County Line (221-29		West Virginia State Line (296-WV	
FactorGroupTypeDescription	FactorGroupLabel	FactorDate	Month	Day	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value
Month&Day of Week Factor	Single Source Factor	07/01/2002	JULY	SUN	10181	0.92937724	20350	0.81676518	20181	0.87883622	20234	0.70780941	80254	0.66770776	80234	0.8368744	80373	0.95485617
Month&Day of Week Factor	Single Source Factor	07/01/2002	JULY	MON	10181	0.94378988	20350	0.92944497	20181	0.91034665	20234	0.94412969	80254	0.92600697	80234	0.9402997	80373	0.94827527
Month&Day of Week Factor	Single Source Factor	07/01/2002	JULY	TUE	10181	0.96559939	20350	0.96663732	20181	0.93240819	20234	0.99922821	80254	1.0017874	80234	0.9756037	80373	0.95851475
Month&Day of Week Factor	Single Source Factor	07/01/2002	JULY	WED	10181	0.91477837	20350	0.91485717	20181	0.91351638	20234	0.94418265	80254	0.94284805	80234	0.93545318	80373	0.92128963
Month&Day of Week Factor	Single Source Factor	07/01/2002	JULY	THU	10181	0.88439887	20350	0.85797403	20181	0.89258983	20234	0.89383962	80254	0.87490507	80234	0.87317272	80373	0.86203872
Month&Day of Week Factor	Single Source Factor	07/01/2002	JULY	FRI	10181	0.86459044	20350	0.84908903	20181	0.82560614	20234	0.82174592	80254	0.81302439	80234	0.83985334	80373	0.80328108
Month&Day of Week Factor	Single Source Factor	07/01/2002	JULY	SAT	10181	0.98040733	20350	0.95514308	20181	1.034317	20234	0.94180516	80254	0.90310078	80234	1.014883	80373	0.92363978
Month&Day of Week Factor	Single Source Factor	08/01/2002	AUGUST	SUN	10181	0.81612436	20350	0.79223799	20181	0.88778601	20234	0.6622467	80254	0.64935024	80234	0.80415815	80373	0.91131276
Month&Day of Week Factor	Single Source Factor	08/01/2002	AUGUST	MON	10181	0.95132141	20350	0.97411881	20181	0.93465427	20234	0.97951464	80254	0.94685174	80234	0.94206428	80373	0.95901582
Month&Day of Week Factor	Single Source Factor	08/01/2002	AUGUST	TUE	10181	0.95738851	20350	1.0036061	20181	0.97487437	20234	1.0319436	80254	1.0328734	80234	0.98604146	80373	0.9693191
Month&Day of Week Factor	Single Source Factor	08/01/2002	AUGUST	WED	10181	0.91556359	20350	0.91502663	20181	0.93136791	20234	0.95903134	80254	0.97279167	80234	0.92182067	80373	0.92497479
Month&Day of Week Factor	Single Source Factor	08/01/2002	AUGUST	THU	10181	0.86930039	20350	0.87152119	20181	0.87501191	20234	0.88780462	80254	0.88767604	80234	0.87739392	80373	0.86591774
Month&Day of Week Factor	Single Source Factor	08/01/2002	AUGUST	FRI	10181	0.85449256	20350	0.85290055	20181	0.86211429	20234	0.85349899	80254	0.83931679	80234	0.84992795	80373	0.8115489
Month&Day of Week Factor	Single Source Factor	08/01/2002	AUGUST	SAT	10181	0.98560451	20350	0.94904183	20181	1.039155	20234	0.93458826	80254	0.92386171	80234	0.99301347	80373	0.92450865
Month&Day of Week Factor	Single Source Factor	09/01/2002	SEPTEMBER	SUN	10181	1.035353	20350	0.9509601	20181	1.0173573	20234	0.84932129	80254	0.81302439	80234	0.95325441	80373	1.0658868
Month&Day of Week Factor	Single Source Factor	09/01/2002	SEPTEMBER	MON	10181	1.0072565	20350	1.030831	20181	1.0161189	20234	1.1360016	80254	1.1132167	80234	1.0329218	80373	1.0209624
Month&Day of Week Factor	Single Source Factor	09/01/2002	SEPTEMBER	TUE	10181	1.0297764	20350	1.0354766	20181	1.0549939	20234	1.1737099	80254	1.1657859	80234	1.0558489	80373	1.0322218
Month&Day of Week Factor	Single Source Factor	09/01/2002	SEPTEMBER	WED	10181	0.9722702	20350	0.98074251	20181	0.97439162	20234	1.0949841	80254	1.1073908	80234	1.0130093	80373	0.9890734
Month&Day of Week Factor	Single Source Factor	09/01/2002	SEPTEMBER	THU	10181	0.94313105	20350	0.93032015	20181	0.93567013	20234	1.0147715	80254	1.0191174	80234	0.967443	80373	0.94942037
Month&Day of Week Factor	Single Source Factor	09/01/2002	SEPTEMBER	FRI	10181	0.92750572	20350	0.91148116	20181	0.86033729	20234	0.88616859	80254	0.88092608	80234	0.89653076	80373	0.88630508
Month&Day of Week Factor	Single Source Factor	09/01/2002	SEPTEMBER	SAT	10181	1.1321155	20350	1.2057603	20181	1.2473625	20234	1.1941961	80254	1.1658515	80234	1.1959045	80373	1.1038549
Month&Day of Week Factor	Single Source Factor	10/01/2002	OCTOBER	SUN	10181	1.0098161	20350	0.89209932	20181	0.88069054	20234	0.71399482	80254	0.70743356	80234	0.83429986	80373	0.98996295
Month&Day of Week Factor	Single Source Factor	10/01/2002	OCTOBER	MON	10181	1.0195191	20350	1.0701327	20181	1.0005811	20234	1.0510179	80254	1.0533347	80234	1.0001272	80373	0.9875471
Month&Day of Week Factor	Single Source Factor	10/01/2002	OCTOBER	TUE	10181	1.0073065	20350	1.0599152	20181	1.0237847	20234	1.1543896	80254	1.1568759	80234	1.0557072	80373	1.0278265
Month&Day of Week Factor	Single Source Factor	10/01/2002	OCTOBER	WED	10181	0.96624392	20350	0.99366388	20181	0.97885798	20234	1.0682958	80254	1.0812347	80234	1.0042564	80373	0.97974152
Month&Day of Week Factor	Single Source Factor	10/01/2002	OCTOBER	THU	10181	0.94745208	20350	0.92957614	20181	0.92319035	20234	0.98617215	80254	0.9949621	80234	0.93341773	80373	0.92603311
Month&Day of Week Factor	Single Source Factor	10/01/2002	OCTOBER	FRI	10181	0.9290364	20350	0.8955765	20181	0.86913175	20234	0.91304112	80254	0.90404569	80234	0.88317425	80373	0.87322692
Month&Day of Week Factor	Single Source Factor	10/01/2002	OCTOBER	SAT	10181	1.1297174	20350	1.1556231	20181	1.1031997	20234	1.092142	80254	1.1159124	80234	1.0922642	80373	1.0761409
Month&Day of Week Factor	Single Source Factor	11/01/2002	NOVEMBER	SUN	10181	1.101413	20350	1.0075464	20181	1.0041188	20234	0.77914082	80254	0.84723811	80234	1.005669	80373	1.1574343
Month&Day of Week Factor	Single Source Factor	11/01/2002	NOVEMBER	MON	10181	1.03843	20350	1.0440664	20181	1.0323016	20234	1.1778167	80254	1.0900442	80234	1.0721134	80373	1.0449609
Month&Day of Week Factor	Single Source Factor	11/01/2002	NOVEMBER	TUE	10181	1.0411508	20350	0.94144552	20181	0.96167004	20234	1.1437211	80254	1.0462136	80234	1.1053643	80373	0.96459619
Month&Day of Week Factor	Single Source Factor	11/01/2002	NOVEMBER	WED	10181	1.0190064	20350	1.0136452	20181	1.0134275	20234	1.1333244	80254	1.175034	80234	1.047133	80373	1.0653916
Month&Day of Week Factor	Single Source Factor	11/01/2002	NOVEMBER	THU	10181	0.98897131	20350	0.9673945	20181	0.91533759	20234	1.0522663	80254	1.0153251	80234	0.97334983	80373	0.97291755
Month&Day of Week Factor	Single Source Factor	11/01/2002	NOVEMBER	FRI	10181	0.95378389	20350	0.95486614	20181	0.86979035	20234	0.98542155	80254	0.92708333	80234	0.90735684	80373	0.92407401
Month&Day of Week Factor	Single Source Factor	11/01/2002	NOVEMBER	SAT	10181	1.137964	20350	1.1929486	20181	1.2361678	20234	1.3238163	80254	1.2443444	80234	1.1997966	80373	1.1407843
Month&Day of Week Factor	Single Source Factor	12/01/2002	DECEMBER	SUN	10181	N/A	20350	1.0502817	20181	1.1333361	20234	0.9567417	80254	0.98061191	80234	1.0940876	80373	1.3345296
Month&Day of Week Factor	Single Source Factor	12/01/2002	DECEMBER	MON	10181	N/A	20350	1.0136972	20181	1.0042286	20234	1.0979126	80254	1.1029732	80234	1.016063	80373	0.99253381
Month&Day of Week Factor	Single Source Factor	12/01/2002	DECEMBER	TUE	10181	N/A	20350	1.038688	20181	1.0175452	20234	1.135312	80254	1.1543643	80234	1.0450921	80373	1.0091683
Month&Day of Week Factor	Single Source Factor	12/01/2002	DECEMBER	WED	10181	N/A	20350	1.0432395	20181	0.88941982	20234	0.92886313	80254	0.97124256	80234	0.95930067	80373	1.0654329
Month&Day of Week Factor	Single Source Factor	12/01/2002	DECEMBER	THU	10181	N/A	20350	0.93680368	20181	0.88658599	20234	0.92640907	80254	0.96838517	80234	0.92536377	80373	0.96068985
Month&Day of Week Factor	Single Source Factor	12/01/2002	DECEMBER	FRI	10181	N/A	20350	0.97700865	20181	0.96544473	20234	0.94758473	80254	0.97165214	80234	1.0092826	80373	1.1323814
Month&Day of Week Factor	Single Source Factor	12/01/2002	DECEMBER	SAT	10181	N/A	20350	1.0617377	20181	1.1174753	20234	1.041329	80254	1.1037952	80234	1.0702168	80373	1.2604434

Northbound Seasonal

				Link Start:	Tennessee State Line		I-77 Wytheville		I-77 Fort Chiswell		US 220		I-64 near Lexington		I-64 near Staunton		I-66	
				Link End:	I-77 Wytheville		I-77 Fort Chiswell		I-581		I-64 near Lexington		I-64 near Staunton		I-66		West Virginia State Line	
FactorGroupTypeDescription	FactorGroupLabel	FactorDate	Month	Day	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value	Factor Group #	Factor Value
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	SUN	110025	1.6117234	10005	1.5931238	120015	1.5510576	120001	1.3585182	180011	1.3366867	180022	1.4324144	180005	1.5207965
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	MON	110025	1.246264	10005	1.489554	120015	1.3479518	120001	1.4975819	180011	1.5448849	180022	1.3281347	180005	1.2499318
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	TUE	110025	1.0943499	10005	1.3146133	120015	1.168477	120001	1.3110153	180011	1.3001652	180022	1.1302285	180005	1.1036808
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	WED	110025	1.0706631	10005	1.2832904	120015	1.1645156	120001	1.2754176	180011	1.2860285	180022	1.1320728	180005	1.0914576
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	THU	110025	1.0416516	10005	1.2271539	120015	1.109669	120001	1.2038877	180011	1.2037179	180022	1.0826602	180005	1.0681792
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	FRI	110025	0.97234535	10005	1.1266413	120015	1.0585532	120001	1.0340733	180011	1.036418	180022	0.97398737	180005	1.0096203
Month&Day of Week Factor	Single Source Factor	01/01/2002	JANUARY	SAT	110025	1.1647045	10005	1.3680246	120015	1.2961075	120001	1.0221896	180011	1.2034347	180022	1.188722	180005	1.2100515
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	SUN	110025	1.5476994	10005	1.4213172	120015	1.4920744	120001	1.6546606	180011	1.3943441	180022	1.4748656	180005	1.485949
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	MON	110025	1.1958995	10005	1.3612144	120015	1.3050927	120001	1.4104251	180011	1.4338168	180022	1.2417877	180005	1.1664192
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	TUE	110025	1.0621546	10005	1.2340309	120015	1.152723	120001	1.2720219	180011	1.3058073	180022	1.1313669	180005	1.0971191
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	WED	110025	1.0951812	10005	1.260154	120015	1.1554441	120001	1.2499626	180011	1.2844947	180022	1.1138972	180005	1.0631404
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	THU	110025	1.024571	10005	1.153593	120015	1.0817127	120001	1.1136863	180011	1.1713321	180022	1.0667481	180005	1.0213967
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	FRI	110025	0.93021755	10005	0.98816568	120015	0.99099054	120001	1.0095997	180011	0.9896977	180022	0.93636869	180005	0.9599218
Month&Day of Week Factor	Single Source Factor	02/01/2002	FEBRUARY	SAT	110025	1.1141658	10005	1.2100272	120015	1.2377671	120001	1.2585234	180011	1.3008264	180022	1.2134883	180005	1.169943
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	SUN	110025	1.3369104	10005	1.1145801	120015	1.2875838	120001	1.1083714	180011	1.1392461	180022	1.3115201	180005	1.359909
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	MON	110025	1.1436505	10005	1.1959531	120015	1.2279084	120001	1.3658417	180011	1.3319013	180022	1.182821	180005	1.1239832
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	TUE	110025	1.0383824	10005	1.1524709	120015	1.1189279	120001	1.2318232	180011	1.230797	180022	1.1076728	180005	1.0792056
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	WED	110025	1.0040297	10005	1.1005794	120015	1.0652919	120001	1.1307817	180011	1.1368409	180022	1.0512969	180005	1.0277726
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	THU	110025	0.89419584	10005	0.95049467	120015	0.95498	120001	0.99169731	180011	0.98129676	180022	0.94393758	180005	0.93469762
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	FRI	110025	0.81645698	10005	0.79328594	120015	0.82898637	120001	0.81376223	180011	0.7980188	180022	0.80945028	180005	0.8492973
Month&Day of Week Factor	Single Source Factor	03/01/2002	MARCH	SAT	110025	1.0255602	10005	0.95472509	120015	1.1089776	120001	1.0831012	180011	1.1059345	180022	1.1339775	180005	1.1009409
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	SUN	110025	1.3148739	10005	1.047044	120015	1.2472289	120001	1.1047103	180011	1.1226819	180022	1.2688398	180005	1.3010315
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	MON	110025	1.0606475	10005	1.0340342	120015	1.123938	120001	1.2064065	180011	1.1804546	180022	1.0716427	180005	1.0774717
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	TUE	110025	0.99228084	10005	1.0600239	120015	1.0599285	120001	1.1404992	180011	1.1533085	180022	1.0352409	180005	1.0298513
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	WED	110025	0.98684661	10005	1.0514684	120015	1.0321033	120001	1.1073439	180011	1.1078506	180022	1.0037018	180005	0.99938211
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	THU	110025	0.92151043	10005	0.96043693	120015	0.95048303	120001	1.0400547	180011	0.97591453	180022	0.92961576	180005	0.93756607
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	FRI	110025	0.8296814	10005	0.84138094	120015	0.84254239	120001	0.80398096	180011	0.77873344	180022	0.78538372	180005	0.81719024
Month&Day of Week Factor	Single Source Factor	04/01/2002	APRIL	SAT	110025	1.0075383	10005	0.88722099	120015	1.0661621	120001	0.98341567	180011	1.01287	180022	1.0292334	180005	1.0067001
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	SUN	110025	1.2389956	10005	1.0072458	120015	1.1925326	120001	1.0602333	180011	1.0465426	180022	1.197472	180005	1.1917992
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	MON	110025	1.0596451	10005	1.1018953	120015	1.1149137	120001	1.1988816	180011	1.1567641	180022	1.0941602	180005	1.0367242
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	TUE	110025	0.98984747	10005	1.0628764	120015	1.0476216	120001	1.0819099	180011	1.0963352	180022	1.034696	180005	1.0008008
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	WED	110025	0.96219309	10005	1.0361872	120015	0.99532306	120001	1.045844	180011	1.0374163	180022	0.98369475	180005	0.96844181
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	THU	110025	0.90701542	10005	0.93823762	120015	0.91124453	120001	0.9402834	180011	0.92663708	180022	0.9066764	180005	0.91391345
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	FRI	110025	0.82733459	10005	0.80350685	120015	0.82333894	120001	0.77599889	180011	0.75208586	180022	0.77874616	180005	0.82013959
Month&Day of Week Factor	Single Source Factor	05/01/2002	MAY	SAT	110025	0.987426	10005	0.99178923	120015	1.0639604	120001	1.0421938	180011	1.048473	180022	1.0511095	180005	1.0355919
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	SUN	110025	1.1394535	10005	0.92902479	120015	1.0508829	120001	0.92642659	180011	0.9318275	180022	1.1158467	180005	1.1002801
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	MON	110025	0.99408925	10005	1.0525358	120015	1.0379029	120001	1.0893101	180011	1.0641772	180022	1.0308526	180005	0.98499015
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	TUE	110025	0.94688937	10005	1.0313342	120015	0.98283219	120001	1.0143152	180011	1.0367856	180022	0.99932218	180005	0.97427539
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	WED	110025	0.92675759	10005	0.98181029	120015	0.94767667	120001	0.93964936	180011	0.97829413	180022	0.96727765	180005	0.94951309
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	THU	110025	0.8689774	10005	0.86486393	120015	0.87857303	120001	0.85784641	180011	0.90069548	180022	0.89008377	180005	0.90186303
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	FRI	110025	0.78928432	10005	0.70694358	120015	0.76188808	120001	0.71740529	180011	0.70996843	180022	0.76749634	180005	0.78857405
Month&Day of Week Factor	Single Source Factor	06/01/2002	JUNE	SAT	110025	0.91648881	10005	0.73064952	120015	0.90184247	120001	0.86985019	180011	0.85579256	180022	0.97058097	180005	0.94090271

Number/File	Loc_ID	Loc_Name	Count_Date	ADT	ADT_Truck	AM_Total	AM_Truck	PM_Total	PM_Truck
I81 14EB	414	I-81 Exit 001 - NB On-ramp From EB Rt. 58	04/19/04	916	73	115	9	76	7
I81 14WB	415	I-81 Exit 001 - NB On-ramp From WB Rt 421	04/19/04	1,887	102	68	8	200	4
I81 12EB	412	I-81 Exit 001 - SB On-ramp From EB Rt 58/421	04/19/04	1,090	69	68	3	105	2
I81 12WB	413	I-81 Exit 001 - SB On-ramp From WB Rt 58/421	04/19/04	440	31	57	2	35	1
I81 013	313	I-81 Exit 001 NB Off-ramp @ Rts 58 WB and 421	03/16/04	1,765	122	100	4	175	7
I81 014	314	I-81 Exit 001 NB On-ramp @ Rts 58 EB and 421	03/16/04	2,690	125	176	8	239	12
I81 011	310	I-81 Exit 001 SB Off-ramp @ Rts 58/421 WB	03/16/04	916	68	50	5	93	6
I81 012 OFF	312	I-81 Exit 001 SB Off-ramp @ Rts 58/421(On) and Rt 421 EB(Off)	03/16/04	1,456	60	94	5	138	4
I81 012 ON	311	I-81 Exit 001 SB On-ramp @ Rts 58/421(On) and Rt 421 EB(Off)	03/16/04	1,591	129	121	8	128	4
3NBOFF	281	I-81 Exit 003 NB Off-ramp to I381 SB--Westbound	03/17/04	423	53	47	7	50	8
3NBON	284	I-81 Exit 003 NB On-ramp from I381 NB--Westbound	03/17/04	6,938	588	555	64	786	38
3SBOFF	282	I-81 Exit 003 SB Off-ramp to I381 SB--Westbound	03/17/04	6,869	528	652	50	624	47
3SBON	283	I-81 Exit 003 SB On-ramp from I381 NB--Westbound	03/17/04	807	103	58	0	107	8
I81 052	32	I-81 Exit 005 NB Off-ramp @ Rts 11 and 19	03/15/04	4,051	396	294	45	327	21
I81 053	17	I-81 Exit 005 NB On-ramp @ Rts 11 and 19	03/15/04	3,006	149	216	9	296	8
I81 054	15	I-81 Exit 005 SB Off-ramp @ Rts 11 and 19	03/15/04	2,513	213	236	16	255	18
I81 051	16	I-81 Exit 005 SB On-ramp @ Rts 11 and 19	03/15/04	4,575	488	303	32	394	32
I81 071	18	I-81 Exit 007 NB Off-ramp @ Old Airport Rd, Bristol	03/15/04	5,765	662	309	52	505	36
I81 072	19	I-81 Exit 007 NB On-ramp @ Old Airport Rd, Bristol	03/15/04	5,095	311	257	21	438	15
I81 073	20	I-81 Exit 007 SB Off-ramp @ Old Airport Rd, Bristol	03/15/04	4,757	459	346	37	436	33
I81 074	21	I-81 Exit 007 SB On-ramp @ Old Airport Rd, Bristol	03/15/04	4,206	253	232	23	334	12
I81 101	24	I-81 Exit 010 NB Off-ramp @ Rt 11	03/15/04	2,250	223	165	15	158	18
I81 102	25	I-81 Exit 010 NB On-ramp @ Rt 11	03/15/04	957	129	85	9	86	8
I81 103	22	I-81 Exit 010 SB Off-ramp @ Rt 11	03/15/04	934	106	66	4	84	8
I81 104	23	I-81 Exit 010 SB On-ramp @ Rt 11	03/15/04	2,119	214	206	12	172	14
I81 131	27	I-81 Exit 013 NB Off-ramp @ Rt 611	03/15/04	1,288	82	85	4	119	2
I81 132	28	I-81 Exit 013 NB On-ramp @ Rt 611	03/15/04	1,832	148	165	3	167	7
I81 133	29	I-81 Exit 013 SB Off-ramp @ Rt 611	03/15/04	1,942	161	151	13	135	9
I81 134	26	I-81 Exit 013 SB On-ramp @ Rt 611	03/15/04	1,123	76	75	4	138	2
I81 141	34	I-81 Exit 014 NB Off-ramp @ Rts 140 and 647	03/15/04	4,695	506	300	36	434	20
I81 142	33	I-81 Exit 014 NB On-ramp @ Rts 140 and 647	03/15/04	2,851	478	189	24	290	22
I81 143	31	I-81 Exit 014 SB Off-ramp @ Rts 140 and 647	03/15/04	3,241	449	287	42	245	22
I81 144	30	I-81 Exit 014 SB On-ramp @ Rts 140 and 647	03/15/04	4,931	445	379	32	394	29
I81 171	35	I-81 Exit 017 NB Off-ramp @ Rts Alt 58 and 75	03/15/04	4,137	487	303	24	349	46
I81 172	36	I-81 Exit 017 NB On-ramp @ Rts Alt 58 and 75	03/15/04	4,346	236	238	13	408	9
I81 173	37	I-81 Exit 017 SB Off-ramp @ Rts Alt 58 and 75	03/15/04	4,244	212	394	15	348	9
I81 174	38	I-81 Exit 017 SB On-ramp @ Rts Alt 58 and 75	03/15/04	4,236	193	294	10	376	15
I81 191 ON	40	I-81 Exit 019 NB Off-ramp @ Rts 11 and 58	03/15/04	5,598	570	313	22	563	22
I81 191 OFF	39	I-81 Exit 019 NB On-ramp @ NB Rts 11 and 58	03/16/04	1,819	94	129	13	189	1
I81 192	41	I-81 Exit 019 NB On-ramp @ Rts 11 and 58	03/15/04	641	204	43	13	39	7
I81 193 OFF	43	I-81 Exit 019 SB Off-ramp @ Rts 11 and 58	03/15/04	2,734	255	254	17	211	12
I81 193 ON	42	I-81 Exit 019 SB On-ramp @ Rts 11 and 58	03/15/04	3,367	350	338	28	239	18
I81 194	44	I-81 Exit 019 SB On-ramp @ Rts 11 and 58	03/15/04	2,329	122	179	9	174	6
I81 221	45	I-81 Exit 022 NB Off-ramp @ Rt 704	03/16/04	1,518	279	164	20	92	7
I81 224	46	I-81 Exit 022 NB On-ramp @ Rt 704	03/16/04	580	101	34	3	52	2
I81 223	47	I-81 Exit 022 SB Off-ramp @ Rt 704	03/17/04	642	89	80	7	37	5
I81 222	48	I-81 Exit 022 SB On-ramp @ Rt 704	03/16/04	1,668	268	112	21	160	15
I81 241	49	I-81 Exit 024 NB Off-ramp @ Rt 80	03/16/04	927	69	51	4	104	4
I81 244	50	I-81 Exit 024 NB On-ramp @ Rt 80	03/16/04	589	57	63	5	43	3
I81 242	51	I-81 Exit 024 SB Off-ramp @ Rt 80	03/16/04	654	53	100	5	55	5
I81 243	52	I-81 Exit 024 SB On-ramp @ Rt 80	03/16/04	1,016	59	134	3	77	5
I81 261	53	I-81 Exit 026 NB Off-ramp @ Rt 737	03/17/04	1,247	53	77	5	132	2
I81 262	54	I-81 EXit 026 NB On-ramp @ Rt 737	03/17/04	485	31	30	2	35	1
I81 263	55	I-81 Exit 026 SB Off-ramp @ Rt 737	03/17/04	556	46	39	2	51	3
I81 264	56	I-81 Exit 026 SB On-ramp @ Rt 737	03/17/04	1,220	63	107	2	84	5
I81 291	57	I-81 Exit 029 NB Off-ramp @ Rt 91	03/17/04	3,662	822	189	51	325	36
I81 292	58	I-81 Exit 029 NB On-ramp @ Rt 91	03/30/04	2,122	904	145	79	120	38
I81 293	59	I-81 Exit 029 SB Off-ramp @ Rt 91	03/17/04	1,916	656	80	20	167	40

I-81 / I-77 Overlap Traffic Count Data

I-77 Weekend Traffic Volumes

Volume Comparisons in the I-77 Overlap Area

	mid-week PM Peak		Friday PM Peak		Sunday PM Peak		Average of Counts		Balanced Volumes	
	All Vehs.	HV%	All Vehs.	HV%	All Vehs.	HV%	All Vehs.	HV%	All Vehs.	HV%
Exit 72										
I-81 SB Off-ramp (to I-77 NB)	671	34.6%	1289	15.3%	1349	9.9%	1103	17.0%	1000	38.0%
I-81 SB On-ramp (from I-77 SB)	172	38.4%	229	19.2%	226	9.7%	209	21.1%	400	22.5%
I-81 NB Off-ramp (to I-77 NB)	202	28.2%	297	13.5%	286	8.0%	262	15.3%	400	22.5%
I-81 NB On-ramp (from I-77 SB)	597	32.3%	1424	12.1%	1476	8.9%	1166	14.2%	900	39.4%
Exit 73										
I-81 SB Off-ramp	340	6.5%	370	8.6%	274	5.8%	328	7.0%	350	4.3%
I-81 SB On-ramp*	141	8.5%	184	3.3%	155	1.3%	160	4.4%	200	2.5%
I-81 NB Off-ramp	113	7.1%	189	5.8%	177	6.8%	160	6.3%	100	10.0%
I-81 NB On-ramp	383	4.4%	353	4.0%	305	2.3%	347	3.7%	400	3.8%
Exit 77										
I-81 SB Off-ramp	225	70.7%	244	30.3%	180	27.8%	216	43.5%	300	63.3%
I-81 SB On-ramp	245	48.2%	218	11.5%	243	16.9%	235	26.0%	300	33.3%
I-81 NB Off-ramp	292	41.1%	277	28.5%	297	24.6%	289	31.5%	300	31.7%
I-81 NB On-ramp	174	50.0%	283	7.8%	331	26.6%	263	25.1%	200	47.5%
Exit 80										
I-81 SB Off-ramp	257	37.4%	417	18.0%	331	16.0%	335	22.4%	350	21.4%
I-81 SB On-ramp	234	23.9%	337	19.3%	342	13.7%	304	18.4%	300	26.7%
I-81 NB Off-ramp	253	17.8%	296	10.5%	265	17.0%	271	14.8%	250	20.0%
I-81 NB On-ramp	177	28.8%	224	24.1%	284	28.9%	228	27.2%	200	30.0%
Exit 81										
I-81 SB Off-ramp (to I-77 SB)	476	30.5%	688	20.9%	631	14.7%	598	21.2%	750	35.3%
I-81 SB On-ramp (from I-77 NB)	895	34.0%	1392	17.0%	1437	11.0%	1241	18.8%	1150	48.3%
I-81 NB Off-ramp (to I-77 SB)	802	22.9%	1382	12.5%	1626	10.3%	1270	13.8%	1100	31.8%
I-81 NB On-ramp (from I-77 NB)	387	42.1%	493	18.5%	575	19.8%	485	25.4%	650	41.5%

* Weekend count did not begin until Saturday afternoon.

Transportation
Land Development
Environmental
Services

Vanasse Hangen Brustlin, Inc.

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Memorandum

To: Steve Aldrich
Dick Lockwood

Date: August 5, 2004

Project No.: 31698.00

From: Rich Clifton

Re: Comparison of Traffic Counts in the I-77 Overlap Area

As you requested, I have compared the original weekday traffic counts at the two I-77/I-81 interchanges (I-81 Exit 72 and I-81 Exit 81) with the new weekend traffic counts at these interchanges. The original 12-hour counts were taken on Tuesday, March 23, 2004 (Exit 72) and Wednesday, March 24, 2004 (Exit 81). The new counts were conducted in the afternoon of Friday, July 23, 2004 and the afternoon of Sunday, July 25, 2004 at both interchanges. Raw afternoon peak hour volumes from each count were used for this comparison. Seasonal factors were not applied to the counts; therefore, there is some inherent error in these calculations since the counts were taken four months apart.

In a nutshell, the total volumes for all movements at both interchanges are considerably higher for the weekend counts than for the mid-week counts; however, the heavy vehicle and tractor-trailer volumes are higher for the mid-week counts. Therefore, the heavy vehicle percentages are considerably higher for the mid-week counts. The peak hour total volumes collected on the Friday afternoon ranged from 127.4% to 238.5% of the mid-week peak hour total volumes and the Sunday afternoon peak hour total volumes ranged from 131.4% to 247.2% of the mid-week peak hour volumes. The Friday afternoon and Sunday afternoon counts were very similar for all eight of the movements with Sunday afternoon having the higher volumes for five of the movements and Friday afternoon having the higher volumes for the other three movements. The following table compares the peak hour volumes for the three counts of each movement.

	mid-week PM Peak		Friday PM Peak		Sunday PM Peak	
	All Vehs.	HV%	All Vehs.	HV%	All Vehs.	HV%
Exit 72						
I-81 NB to I-77 NB	202	**28.22%**	**297**	13.47%	286	8.04%
I-77 SB to I-81 NB	597	**32.33%**	1424	12.08%	**1476**	8.88%
I-81 SB to I-77 NB	671	**34.58%**	1289	15.28%	**1349**	9.86%
I-77 SB to I-81 SB	172	**38.37%**	**229**	19.21%	226	9.73%
Exit 81						
I-77 NB to I-81 SB	895	**33.97%**	1392	16.95%	**1437**	11.00%
I-77 NB to I-81 NB	387	**42.12%**	493	18.46%	**575**	19.83%
I-81 NB to I-77 SB	802	**22.94%**	1382	12.52%	**1626**	10.33%
I-81 SB to I-77 SB	476	**30.46%**	**688**	20.93%	631	14.74%

As shown in the above table, heavy vehicles make up between 23% and 42% of the peak hour traffic during the week while they make up only 8% to 21% of the peak hour traffic on the weekend.

On average, the afternoon peak hour occurs earlier on Sunday than on the other days. The peak hour generally occurred between 2:00 PM and 3:00 PM at both interchanges during the Sunday afternoon count. The peak hour began at about 3:00 PM at Exit 81 and at 3:15 PM at Exit 72 during the Friday afternoon count. During the mid-week counts, the afternoon peak hour began at about 2:45 PM at Exit 81 and at 3:15 PM at Exit 72.

The spreadsheet I used to compare the counts is attached for your use. Please let me know if you have any questions.

cc: Craig Eddy
Larry Moore

Direction	MP	MP	Volume	V/C Ratio	Density	$LOS_{Density}$
I-81N	72	73	5500	0.63	25.9	C
I-81N	73	77	6000	0.68	25.8	C
I-81N	77	80	5750	0.65	24.7	C
I-81N	80	81	5750	0.65	25.7	C

Direction	MP	MP	Volume	V/C Ratio	Density	$LOS_{Density}$
I-81S	73	72	5250	0.60	23.8	C
I-81S	77	73	5850	0.66	25.5	C
I-81S	80	77	5800	0.66	25.3	C
I-81S	81	80	5750	0.65	26	C

B

Appendix B
Safety and Geometric Deficiencies

- Safety and Geometric Deficiencies

Safety and Geometric Deficiencies

I-81 North

LinkID	StartMP	EndMP	Slice Num	Fat	Inj	PDO	Total Crashes	Deaths	Injuries	Deaths and Injuries	RearEnd	Angle	HeadOn	SideSwipe Same	SideSwipe Opposite	Object In road	Train	Non Collision	Object Off road	Deer	Other Animal	Pedestrian	Bicyclist	Motor Cycle	Backed Into	Misc	Not Stated
IS00081N	72	73	2	0	8	13	21	0	16	16	2	0	0	6	0	0	0	2	10	1	0	0	0	0	0	0	0
IS00081N	73	74	3	0	11	29	40	0	18	18	3	2	0	9	1	0	0	3	22	0	0	0	0	0	0	0	0
IS00081N	74	75	4	0	4	12	16	0	9	9	0	0	0	8	0	0	0	1	5	2	0	0	0	0	0	0	0
IS00081N	75	76	5	0	1	7	8	0	1	1	1	0	0	3	0	0	0	0	4	0	0	0	0	0	0	0	0
IS00081N	76	77	6	0	4	4	8	0	13	13	1	0	0	0	0	2	0	1	3	1	0	0	0	0	0	0	0
IS00081N	77	78	7	0	4	13	17	0	5	5	4	3	0	3	0	0	0	2	5	0	0	0	0	0	0	0	0
IS00081N	78	79	8	0	3	5	8	0	3	3	1	0	0	1	0	0	0	2	4	0	0	0	0	0	0	0	0
IS00081N	79	80	9	0	3	4	7	0	3	3	0	0	0	2	0	0	0	0	4	1	0	0	0	0	0	0	0
IS00081N	80	81	10	0	7	15	22	0	16	16	4	3	0	7	0	0	0	0	6	1	0	0	0	0	1	0	0
					45		147		84		16	8	0	39	1	2	0	11	63	6	0	0	0	0	1	0	0

I-81 South

LinkID	StartMP	EndMP	Slice Num	Fat	Inj	PDO	Total Crashes	Deaths	Injuries	Deaths and Injuries	RearEnd	Angle	HeadOn	SideSwipeSame	SideSwipeOpposite	Object In road	Train	Non Collision	Object Off road	Deer	Other Animal	Pedestrian	Bicyclist	Motor Cycle	Backed Into	Misc	Not Stated
IS00081S	72	73	1	0	7	12	19	0	10	10	3	0	0	7	0	0	0	1	7	1	0	0	0	0	0	0	0
IS00081S	73	74	2	0	7	10	17	0	7	7	2	0	0	3	0	0	0	2	9	1	0	0	0	0	0	0	0
IS00081S	74	75	3	0	4	12	16	0	7	7	0	0	0	4	1	0	0	0	9	2	0	0	0	0	0	0	0
IS00081S	75	76	4	0	9	12	21	0	12	12	1	0	0	6	0	0	0	1	13	0	0	0	0	0	0	0	0
IS00081S	76	77	5	0	6	8	14	0	8	8	0	0	0	1	0	0	0	1	11	1	0	0	0	0	0	0	0
IS00081S	77	78	6	0	2	9	11	0	3	3	2	0	0	2	0	0	0	1	5	1	0	0	0	0	0	0	0
IS00081S	78	79	7	0	4	4	8	0	5	5	1	1	0	0	1	0	0	1	3	0	0	0	0	0	0	1	0
IS00081S	79	80	8	0	5	3	8	0	6	6	1	0	0	2	1	0	0	0	3	0	0	0	0	0	0	1	0
IS00081S	80	81	9	0	5	8	13	0	8	8	5	0	0	4	0	0	0	0	4	0	0	0	0	0	0	0	0
					49		127		66		15	1	0	29	3	0	0	7	64	6	0	0	0	0	0	2	0
Total					94		274		150		31	9	0	68	4	2	0	18	127	12	0	0	0	0	1	2	0

2003-2007

I-81 North

LinkID	StartMP	EndMP	SliceNum	Fat	Inj	PDO	Total Crashes	Deaths	Injuries	Deaths and Injuries	RearEnd	Angle	HeadOn	SideSwipeSame	SideSwipeOpposite	ObjectInroad	Train	NonCollision	ObjectOffroad	Deer	Other Animal	Pedestrian	Bicyclist	MotorCycle	Backed Into	Misc	Not Stated	Total Crashes
IS00081N	72	73	1	0	5	10	15	0	9	9	2	0	0	4	0	0	0	2	6	1	0	0	0	0	0	0	0	15
IS00081N	73	74	2	0	8	19	27	0	15	15	3	2	0	6	1	0	0	2	13	0	0	0	0	0	0	0	0	27
IS00081N	74	75	3	0	3	7	10	0	8	8	0	0	0	5	0	0	0	0	4	1	0	0	0	0	0	0	0	10
IS00081N	75	76	4	0	1	5	6	0	1	1	0	0	0	2	0	0	0	0	4	0	0	0	0	0	0	0	0	6
IS00081N	76	77	5	0	2	1	3	0	5	5	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	3
IS00081N	77	78	6	0	3	7	10	0	4	4	3	1	0	2	0	0	0	1	3	0	0	0	0	0	0	0	0	10
IS00081N	78	79	7	0	3	5	8	0	3	3	1	0	0	1	0	0	0	2	4	0	0	0	0	0	0	0	0	8
IS00081N	79	80	8	0	2	0	2	0	2	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2
IS00081N	80	81	9	0	6	12	18	0	14	14	3	3	0	6	0	0	0	0	4	1	0	0	0	0	1	0	0	18
				0	33	66	99		61		13	6	0	27	1	0	0	8	40	3	0	0	0	0	1	0	0	99

I-81 South

LinkID	StartMP	EndMP	SliceNum	Fat	Inj	PDO	Total Crashes	Deaths	Injuries	Deaths and Injuries	RearEnd	Angle	HeadOn	SideSwipeSame	SideSwipeOpposite	ObjectInroad	Train	NonCollision	ObjectOffroad	Deer	Other Animal	Pedestrian	Bicyclist	MotorCycle	Backed Into	Misc	Not Stated	Total Crashes
IS00081S	72	73	1	0	5	11	16	0	8	8	2	0	0	7	0	0	0	1	5	1	0	0	0	0	0	0	0	16
IS00081S	73	74	2	0	5	4	9	0	5	5	2	0	0	1	0	0	0	2	3	1	0	0	0	0	0	0	0	9
IS00081S	74	75	3	0	3	9	12	0	6	6	0	0	0	3	0	0	0	0	7	2	0	0	0	0	0	0	0	12
IS00081S	75	76	4	0	6	7	13	0	8	8	1	0	0	5	0	0	0	0	7	0	0	0	0	0	0	0	0	13
IS00081S	76	77	5	0	5	3	8	0	7	7	0	0	0	1	0	0	0	1	5	1	0	0	0	0	0	0	0	8
IS00081S	77	78	6	0	2	4	6	0	3	3	2	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	6
IS00081S	78	79	7	0	2	2	4	0	2	2	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	4
IS00081S	79	80	8	0	3	2	5	0	4	4	1	0	0	0	1	0	0	0	2	0	0	0	0	0	0	1	0	5
IS00081S	80	81	9	0	3	3	6	0	4	4	3	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	6
				0	34	45	79		47		11	1	0	18	1	0	0	6	34	6	0	0	0	0	0	2	0	79
			Total	0	67	111	178		108		24	7	0	45	2	0	0	14	74	9	0	0	0	0	1	2	0	178

2005-2007

Between	And	2003 AADT	2005 AADT	2006 AADT	2007 AADT	MVM
Exit 70	Exit 72	29000				
Exit 72	Exit 73	49000	49000	46000	45000	51100000
Exit 73	Exit 77	52000	51000	52000	51000	56210000
Exit 77	Exit 80	50000	50000	52000	44000	53290000
Exit 80	Exit 81	51000	51000	52000	48000	55115000
Exit 81	Exit 84	37000				

Between	And	Dir. Factor (NB)	Dir. Factor (SB)
Exit 70	Exit 72		
Exit 72	Exit 73	0.5	0.5
Exit 73	Exit 74	0.454	0.546
Exit 74	Exit 75	0.461	0.539
Exit 75	Exit 76	0.468	0.532
Exit 76	Exit 77	0.475	0.525
Exit 77	Exit 78	0.481	0.519
Exit 78	Exit 79	0.481	0.519
Exit 79	Exit 80	0.481	0.519
Exit 80	Exit 81	0.498	0.502

2003-2007

StartMP	EndMP	Crashes	AADT	Crash Rate	
72	73	145	49000	162.15	111.40
73	74	183	52000	192.83	
74	75	88	52000	92.73	
75	76	99	52000	104.32	
76	77	92	52000	96.94	
77	78	70	50000	76.71	
78	79	65	50000	71.23	
79	80	71	50000	77.81	
80	81	119	51000	127.85	

*per 100 million vehicle miles

2005-2007

StartMP	EndMP	NB Crashes	SB Crashes	Combined Crashes	MVM	NB Crash Rate*	SB Crash Rate*	Combined Crash Rate
72	73	50	51	101	51100000	195.69	199.61	197.65
73	74	83	44	127	56210000	325.24	143.37	225.94
74	75	31	33	64	56210000	119.63	108.92	113.86
75	76	13	55	68	56210000	49.42	183.92	120.97
76	77	17	43	60	56210000	63.67	145.71	106.74
77	78	31	20	51	53290000	120.94	72.31	95.70
78	79	29	18	47	53290000	113.14	65.08	88.20
79	80	16	26	42	53290000	62.42	94.01	78.81
80	81	60	27	87	55115000	218.60	97.59	157.85
						*per 100 million vehicle miles		
				647	490925000			131.79

Interstate	2007 Crashes	2007 PDO	2007 Injuries	2007 Fatalities		
64	4039	2871	1146	22		
66	1512	993	513	6		
77	336	228	104	4		
81	2254	1510	725	19		
85	328	210	112	6		
95	4393	3038	1327	28		
264	1207	848	355	4		
195	107	80	27	0		
295	388	252	132	4		
395	563	372	189	2		
464	89	54	34	1		
564	80	63	17	0		
581	94	62	32	0		
664	402	275	127	0		
	15792	10856	4840	96		
Weight		1	8	20		
		10856	38720	1920	51496	**Crash Rate = 211.58**

***DVMT = 66,683,000 on Interstates**

AVMT =	24339295000
	4923850000
	163641667
Interstate fatality rate:	0.394424
I-81 fatality rate:	0.399142

Juris.	DVMT
Wash Co	980390
Smyth Co	639078
Wythe Co	1461476
Pulaski Co	736326
Montgomery Co	1162782
Roanoke Co	982166
Botetourt Co	1047608
Rockbridge Co	1427448
Augusta Co	1884889
Rockingham Co	917236
Shenandoah Co	1408441
Frederick Co	1183886
Bristol	369581
Harrisonburg	318612
Roanoke	352152
Salem	23079
Winchester	4222

14899372 DVMT
5438270780 AVMT

Executive Summary

The Virginia Department of Transportation is currently conducting a corridor improvement study along the I-81 Corridor between the Virginia state lines. The following summarizes the findings of crash analyses performed for the project area.

I-81 Crash Data

Accident data has been reviewed for a 3-year period from January 1, 2000 through December 31, 2002, 5746 crashes were reported on I-81 during this time. Seventy-six of these crashes involved fatalities. In addition to the fatal crashes there were 3095 persons injured in 2098 of the other crashes. Secondary crashes total approximately 4% of the total.

The total reported crashes are broken down into several major crash types. These include 41% as a collision with a fixed object; 19% due to one vehicle rear ending another; 18% were sideswipe between two vehicles traveling in the same direction and more than 8% were collisions with deer or other animals.

The major contributing factor reported is some fault of the driver (74%). These factors include driver error (46%), speed related (16%), driver handicap and fatigue (9%) and drugs or alcohol related crashes (4%). Weather conditions were identified as major factors for 8% of the crashes and no major factor was identified in nearly 19% of the crashes.

Roadway surface conditions were reported as dry pavement in 71% of the crashes and wet pavement and snowy or icy pavement conditions in 29% of the reported crashes. Weather conditions were recorded in a similar fashion; clear conditions (50%), cloudy (25%), inclement conditions combined equaled 27%.

Time of day reporting for the crashes is summarized by more than 63% occurred during daylight hours, while less than 5% occurred at dusk or at dawn. Of the crashes reported at night, 94% occurred in areas where there is no street lighting.

Crashes were fairly evenly distributed throughout each day of the week; however, more crashes did occur on Sundays than any other day of the week for both directions of I-81.

Crash Rates

Daily traffic volumes were averaged over the three year period to determine average annual vehicle miles of travel on each direction of I-81 for the three year study period. Crash rates for each direction were developed based on several categories. VDOT's weighting system was applied to the data so that segments could be directly compared with each other and with other facilities across the state.

Comparison with Other Virginia Interstates

The average crash rates for I-81 for the three year period from 2000 to 2002 were compared to the statewide crash rates for 2002 to determine if I-81 is more hazardous than similar facilities. Despite terrain and traffic composition differences, I-81 appears to be fairly representative of an interstate facility in Virginia.

There were nearly 23 billion vehicle miles traveled on interstates in Virginia in 2002 including 4.75 billion miles of travel on 325 miles of I-81 in 2002. In 2002, the I-81 corridor average annual total crash rate had 47% less crashes per 100 million vehicle miles of travel as compared to other facilities within the state. Application of the weighting system also revealed the statewide weighted crash rate on interstates in 2002 was 118 points per 100 million vehicle miles of travel higher than that of I-81 from 2000 to 2002.

The statewide rates far exceed the I-81 average annual rates in every category except for fatal crashes. The data shows that, in general, motorists are less likely to be involved in a crash on I-81 than they are on other interstates in Virginia. It also shows that crashes on I-81 tend to be more severe and that motorists are as likely to be killed in a crash on I-81 as they are on more hazardous interstates in Virginia.

Comparison with Other States

Limited data was available to compare I-81 and Virginia interstate crash rates with crash rates from Maryland, West Virginia, Pennsylvania and Tennessee. Comparison shows that interstate crash rates in Virginia are similar to the interstate crash rates for neighboring states in the I-81 corridor.

Segmental Analysis

To determine specific problem areas that may be unusually hazardous, the data was evaluated under smaller one mile, one way segments. Annual vehicle miles of travel for each segment were estimated using annual average daily traffic volumes from various studies that have been performed in the I-81 corridor.

Each mile of the I-81 corridor was compared with the statewide average weighted crash rate to identify specific problem areas. VDOT's highway safety corridors program uses 125% of the regional average as a threshold to qualify segments into the program. I-81 is entirely in the western region and accounts for a little more than two-thirds of the interstate mileage in the region. A number of segments were found to have rates that are more than 125% of the statewide average, northbound included twenty-four segments and southbound had twenty-one. Review of the data shows that there are seven northbound segments and one southbound segment with weighted rates that are more than double the statewide average. One of the northbound segments, from milepost 162 to 163, has a weighted average more than three times the statewide average.

Segments having weighted crash rates greater than 125% of the statewide average for Virginia interstates are identified as high crash segments. Approximately 21% of all of the crashes on I-81 in Virginia occurred in the forty-five high crash segments and a little more than one-third of the fatal crashes occurred in these segments. Overall the data reveals the same general distribution when comparing the high crash segments to the entire corridor. Although more crashes occurred on curves and speeding was the major factor in a significantly greater percentage of incidents.

Reviewing the grades of the segments with high crash rates did not show a good correlation between grades and crash rates so the entire corridor was checked for such a correlation. The review shows that crashes are more likely to occur on segments with a negative grade; however,

the data still does not show a very good correlation between the grade of the segment and the crash rate.

The crash data was also reviewed to determine if there was any correlation between the crash rate of a segment and the presence of an interchange. Ten of the forty-five high crash segments include an interchange and twenty-one more of these segments are adjacent to a segment that includes an interchange. A good correlation between the crash rate of a segment and the presence of an interchange in that segment or an adjacent segment could not be identified.

High Crash Segments

A detailed review was conducted for those segments where the weighted crash rates are more than double the statewide average for Virginia interstates. The data was reviewed to determine if there were any identifiable patterns. The data was also compared with data from the previous Preliminary Engineering studies conducted on I-81 to determine if the crash patterns were consistent with any deficiencies identified in those reports. Recommendations for improving safety in these areas are also included in this report.

Large Vehicle Involvement

I-81 carries a very high volume of large vehicle traffic, making up as much as 40% of all of the traffic in some segments. Large vehicles account for nearly 29% of all of the vehicle travel miles on I-81 in Virginia. There is a perception that this high amount of truck traffic is a primary cause of crash problems. A review of crash data shows that large vehicles are not disproportionately involved in crashes on I-81 in Virginia. Large vehicles were involved in approximately 29% of all of the crashes in the corridor from 2000 to 2002.

A comparison at the statewide level shows that large vehicle involved crash rates on I-81 are significantly lower than the statewide rates in Virginia for all categories.

Large vehicle involved crash rates on I-81 are well below statewide crash rates for large vehicle involved crashes on interstates; however, 143 (68 northbound and 75 southbound) of the 650 one-mile long segments on I-81 have weighted crash rates in excess of the statewide weighted crash rate for interstates. 96 of these segments have weighted crash rates that are more than 125% of the statewide interstate rate and twenty-three segments are more than double the statewide interstate rate. One segment in the southbound direction and four in the northbound direction have weighted crash rates for truck involved crashes that are more than triple the statewide rate.

Large Vehicle Involved Crash Data

Approximately 52% of the crashes that involved a large vehicle were on the northbound lanes. These crashes occurred most often on Sundays (18%) and least often on Saturdays (9%). Southbound crashes involving a large vehicle occurred most often on Thursdays (18%) and least often on Sundays (10%).

Sideswipes were the most common crash type (40%), followed by rear end collisions and fixed object crashes at 23% each. Driver error or inattention was the primary cause of most of the reported crashes.

Approximately 23% of the large vehicle involved crashes occurred during foul weather, either fog, mist, rain, sleet or snow. The pavement was recorded as wet, snowy or icy for 26% of the crashes; however, the slick pavement was recorded as the major factor in only fifty-eight of the reported crashes. Approximately 65% of the crashes involving a large vehicle occurred during daylight conditions.

Large Vehicle Involvement in the High Crash Segments

Large vehicles were involved in 32% of the total crashes; 27% of the crashes involving an injury; and 27% of the fatal crashes in all of the high crash segments. 64% of the forty-five high crash segments are also high crash segments for large vehicle involved crashes. Seven of the eight segments that have overall crash rates that are more than double the statewide crash rate for interstates also have large vehicle involved crash rates that are more than double the statewide large vehicle crash rate. The high volume of trucks in the traffic mix seemed to impact safety in only two of these segments, the northbound lanes between MP 179.75 and MP 181.25 and the northbound lanes between MP 167.75 and MP 169.25. Both of these segments have geometric deficiencies that most significantly impact large vehicles.

I-81 CRASH DATA SUMMARY REPORT

I-81 Crash Data

From January 1, 2000 through December 31, 2002, there were 9024 vehicles involved in 5746 reported crashes on I-81 in Virginia. This amounts to approximately 5 crashes each day in the 325 mile long corridor. Seventy-six of these crashes involved fatalities, killing a total of eighty-four people (approximately 1 fatal crash every 14 days). Six of the fatalities were pedestrians killed in six separate crashes. Forty-two of the fatal crashes also included injuries to eighty-eight other drivers and/or passengers. In addition to the fatal crashes there were 3095 other drivers and/or passengers and 17 pedestrians injured in 2098 of the other crashes (approximately 2 crashes involving an injury each day). The other crashes only include property damage. Approximately 381 of the crashes (4%) appear to be secondary crashes, occurring within an hour after another crash and within 5 miles upstream of the original crash.

Approximately 41% of the total reported crashes were classified as a collision with a fixed object off from the roadway. Approximately 19% of the reported crashes were due to one vehicle rear ending another while 18% were classified as a sideswipe between two vehicles traveling in the same direction. More than 8% of the reported crashes were collisions with deer or other animals in the road.

The major factor in 4274 of the 5746 reported crashes (74%) was classified as some fault of the driver, including 2629 crashes (46%) reported as driver error, 908 crashes (16%) reported due to speeding, 543 crashes (9%) due to driver handicap, including fatigue, and 204 crashes (4%) due to drivers under the influence of alcohol or other drugs. Weather, visibility or road conditions were reported as the major factor in 445 of the reported crashes (8%). A major factor was not identified in nearly 19% of the reported crashes.

A driver under the influence of alcohol or drugs was reported as the major factor in only 204 crashes; however, 221 crashes were reported to involve one or more drivers that were clearly impaired by the use of alcohol and the use of alcohol by one or more drivers was recorded in 297 of the reported crashes. One or more drivers were reported to be ill, fatigued or “apparently asleep” in 585 of the reported crashes (10%).

The roadway surface was recorded as dry for 71% of the reported crashes and wet for 19% of the reported crashes. The roadway surface was reported as snowy or icy in the other 10% of the reported crashes.

Weather conditions at the time of the crash were recorded as clear in about half of the reported crashes and cloudy in about a quarter of the crashes. Fog or mist was reported in 3% of the crashes, rain was recorded as the weather condition for 14% of the reported crashes, and snow or sleet was reported for the other 9% of the crashes.

More than 63% of the reported crashes occurred during daylight conditions while less than 5% were reported to have occurred at dusk or at dawn. Of the 1899 crashes that were reported at night, nearly all (1794) occurred in areas where there is no street lighting.

Crashes were fairly evenly distributed throughout each day of the week; however, more crashes did occur on Sundays than any other day of the week for both directions of I-81 (19% NB and 18% SB) followed by Fridays (15% NB and 16% SB). The least number of crashes occurred on Tuesdays in both directions (13% NB and 11% SB).

Crash Rates

VDOT provided daily traffic volumes for I-81 for each year of the study period. The volumes were averaged over the three year period to determine average annual vehicle miles of travel on each direction of I-81 for the three year study period. The average volumes were used to develop crash rates for each direction of I-81 for several categories, including:

- total number of crashes;
- total number of property damage only (PDO) crashes;
- total number of crashes with one or more class 3 (minor) injuries;
- total number of crashes with one or more class 2 (major) injuries; and
- total number of crashes that included one or more fatalities.

A severity weighting system was applied to the data so that segments could be directly compared with each other and with other facilities across the state. The weighting system used by VDOT is 1 point for PDO crashes; 8 points for crashes involving injuries of either class; and 20 points for crashes involving a fatality. Crash rates for I-81 in Virginia from 2000 to 2002 are presented in Table 1. Crash rates are expressed as the number of crashes per 100 million miles of vehicle travel.

Table 1: 2000-2002 Summary Crash Data for I-81

	Crash Data					VMT	Crash Rates per 100 million miles of travel				
	Total	PDO	Injury	Fatal	Weighted	(millions)	Total	PDO	Injury	Fatal	Weighted
I-81 NB	2859	1784	1038	37	10828	6,837	41.82	26.09	15.18	0.54	158.38
I-81 SB	2887	1787	1061	39	11055	6,871	42.02	26.01	15.44	0.57	160.89

Comparison with Other Virginia Interstates

The average crash rates for I-81 for the three year period from 2000 to 2002 were compared to the statewide crash rates for 2002 to determine if I-81 is more hazardous than similar facilities. I-81 is somewhat unique from other Virginia interstates in that most segments have rolling terrain and some segments would be considered mountainous. Most other interstate segments in Virginia are nearly level or have moderately rolling terrain. Traffic on many portions of I-81 also includes a higher percentage of large vehicle traffic than most other interstate segments in Virginia. Despite these differences, I-81 appears to be fairly representative of an interstate facility in Virginia. Most of the roadway is considered rural with low to moderate volumes; however, several portions lie within or near urbanized areas and are highly congested in the peak periods. The same statement would be true about interstates in general in Virginia; most segments are in rural areas and have low to moderate volumes while many segments, such as I-95 in northern Virginia, are highly congested with frequent interchanges. Therefore, it is reasonable to use statewide interstate crash data for comparison with I-81.

There were nearly 23 billion vehicle miles traveled on 1,118 miles of interstate in Virginia in 2002 including 4.75 billion miles of travel on 325 miles of I-81 in 2002. There were 17,776 crashes on interstates in Virginia in 2002 for a total crash rate of 78 crashes per 100 million vehicle miles of travel as compared to an average annual total crash rate of 42 crashes per 100 million vehicle miles of travel on I-81. Using the weighting system described above, the statewide weighted crash rate on interstates in 2002 was 277.32 points per 100 million vehicle miles of travel while the weighted crash rate on I-81 from 2000 to 2002 was 159.64 points per 100 million vehicle miles of travel.

The statewide rates far exceed the I-81 average annual rates in every category except for fatal crashes. The statewide fatal crash rate in 2002 and the I-81 average annual rate for fatal crashes were both 0.52 crashes per 100 million vehicle miles of travel. The data shows that, in general, motorists are less likely to be involved in a crash on I-81 than they are on other interstates in Virginia. It also shows that crashes on I-81 tend to be more severe and that motorists are as likely to be killed in a crash on I-81 as they are on more hazardous interstates in Virginia. The 2002 statewide crash rates are presented in Table 2.

Table 2: 2002 Statewide (Virginia) Crash Data

	Crash Data					VMT	Crash Rates per 100 million miles of travel				
	Total	PDO	Injury	Fatal	Weighted	(millions)	Total	PDO	Injury	Fatal	Weighted
Interstates	17,776	11,468	6,190	118	63,348	22,843	77.82	50.20	27.10	0.52	277.32
Primaries	37,466	22,334	14,791	341	147,482	23,999	156.12	93.06	61.63	1.42	614.54
Secondaries	33,334	20,327	12,760	247	127,347	14,422	231.13	140.94	88.47	1.71	882.99

Comparison with Other States

As noted above, I-81 is fairly representative of interstate facilities in Virginia and the comparison with statewide data is fair and reasonable; however, it is also appropriate to compare I-81 in Virginia with interstate facilities in neighboring states. Limited data was available to compare I-81 and Virginia interstate crash rates with crash rates from Maryland, West Virginia, Pennsylvania and Tennessee.

Table 3: Statewide Interstate Crash Rates[1] (States Along I-81 Corridor)

State	Crash Rate by Type[2]			
	Property Damage Only	Personal Injury	Fatal	Total
Tennessee	N/A	N/A	0.76	N/A
West Virginia	52	26	0.84	79
Maryland	N/A	N/A	0.46	55
Pennsylvania	N/A	N/A	0.47	44

Notes: 1. All data included in table is listed for the latest year available (2000-2002).
2. Crashes per hundred million vehicle miles traveled.

Comparing Table 2 with Table 3 shows that interstate crash rates in Virginia are similar to the interstate crash rates for neighboring states in the I-81 corridor. Total crash rates, PDO crash rates and injury crash rates for Virginia and West Virginia are nearly identical. Fatal crash rates for Virginia interstates are significantly less than for interstates in Tennessee and West Virginia and only slightly higher than for interstates in Maryland and Pennsylvania.

Segmental Analysis

Comparing crash data for I-81 with crash data for other interstates in and around Virginia does not support the perception that I-81 is a hazardous roadway. However, it is important to breakdown the data into smaller segments to determine if there are specific problem areas that may be unusually hazardous. For this analysis, I-81 was broken into 650 one mile, one way segments with the mile markers designating the boundary of each segment. Annual vehicle miles of travel for each segment were estimated using annual average daily traffic volumes from various studies that have been performed in the I-81 corridor over the past 10 years.

Each mile of the I-81 corridor was compared with the statewide average weighted crash rate to find any specific problem areas. Tables 4 and 5 list all of the data for the one mile segments that have weighted crash rates greater than the statewide average for Virginia interstates for 2002. In the northbound direction there are forty-four of these segments including twenty-four segments that have rates that are more than 125% of the statewide average. In the southbound direction there are fifty-one of these segments including twenty-one that have rates that are more than 125% of the statewide average. Segment crash rates in excess of the 2002 statewide average for interstates are highlighted in yellow on Tables 4 and 5. Cells highlighted in red on these tables are segment crash rates in excess of 125% of the 2002 statewide average for interstates. VDOT's highway safety corridors program uses 125% of the regional average as a threshold for qualifying for the program. (VDOT has split the state into three regions for the highway safety corridors program. I-81 is entirely in the western region and accounts for a little more than two-thirds of the interstate mileage in the region.) Reviewing the data in Tables 4 and 5 shows that there are seven northbound segments and one southbound segment with weighted rates that are more than double the statewide average. One of the northbound segments, from milepost 162 to 163, has a weighted average more than three times the statewide average.

Segments having weighted crash rates greater than 125% of the statewide average for Virginia interstates will be referred to as high crash segments. Crashes occurring within a quarter mile of a high crash segment will be included in the analyses performed for the high crash segment, effectively making each high crash segment 1.5 miles long. As noted above, there are forty-five high crash segments which is a little more than 10% of the entire length of I-81 in Virginia.

Table 4: 2000-2002 Crash Data for I-81 NB Segments with Weighted Crash Rates Greater Than the 2002 Statewide Weighted Crash Rate for Interstates

Segment		Crash Data					Average	Crash Rates per 100 million miles of travel				
Beg. MP	End MP	Total	PDO	Injury	Fatal	Weighted	ADT	Total	PDO	Injury	Fatal	Weighted
162	163	38	22	15	1	162	16,343	212.34	122.94	83.82	5.59	905.25
73	74	33	21	11	1	129	15,370	196.08	124.78	65.36	5.94	766.48
94	95	26	13	12	1	129	16,379	144.96	72.48	66.91	5.58	719.25
292	293	40	27	13	0	131	17,931	203.72	137.51	66.21	0.00	667.19
180	181	24	12	12	0	108	15,829	138.47	69.23	69.23	0.00	623.11
314	315	50	35	14	1	167	25,277	180.65	126.45	50.58	3.61	603.37
168	169	16	6	9	1	98	16,365	89.29	33.48	50.22	5.58	546.87
7	8	29	16	13	0	120	22,453	117.95	65.08	52.87	0.00	488.07
195	196	20	9	11	0	97	19,247	94.90	42.70	52.19	0.00	460.25
45	46	23	16	7	0	72	14,495	144.91	100.81	44.10	0.00	453.64
223	224	28	15	13	0	119	24,582	104.02	55.73	48.30	0.00	442.10
189	190	16	6	10	0	86	19,379	75.40	28.27	47.12	0.00	405.27
181	182	14	7	6	1	75	16,970	75.34	37.67	32.29	5.38	403.61
296	297	16	7	9	0	79	17,931	81.49	35.65	45.84	0.00	402.35
49	50	9	2	7	0	58	13,562	60.60	13.47	47.14	0.00	390.56
213	214	17	9	7	1	85	20,369	76.22	40.35	31.38	4.48	381.09
156	157	12	7	3	2	71	17,082	64.15	37.42	16.04	10.69	379.57
23	24	9	2	6	1	70	16,862	48.74	10.83	32.50	5.42	379.13
80	81	18	8	9	1	100	24,098	68.21	30.32	34.11	3.79	378.96
16	17	18	11	6	1	79	19,755	83.21	50.85	27.74	4.62	365.20
105	106	17	9	8	0	73	18,274	84.96	44.98	39.98	0.00	364.82
109	110	16	8	8	0	72	18,248	80.08	40.04	40.04	0.00	360.34
298	299	19	13	5	1	73	19,373	89.57	61.28	23.57	4.71	344.12
252	253	14	7	6	1	75	20,711	61.73	30.87	26.46	4.41	330.71
92	93	11	5	5	1	65	18,287	54.93	24.97	24.97	4.99	324.61
141	142	28	17	11	0	105	29,649	86.25	52.36	33.88	0.00	323.42
69	70	8	3	5	0	43	12,278	59.50	22.31	37.19	0.00	319.84
120	121	14	6	7	1	82	23,607	54.16	23.21	27.08	3.87	317.22
19	20	19	12	7	0	68	20,436	84.91	53.62	31.28	0.00	303.87
262	263	15	9	6	0	57	17,747	77.19	46.31	30.88	0.00	293.32
65	66	11	7	4	0	39	12,149	82.69	52.62	30.07	0.00	293.16
196	197	13	6	7	0	62	19,371	61.29	28.29	33.00	0.00	292.30
173	174	10	4	6	0	52	16,389	55.72	22.29	33.43	0.00	289.76
273	274	10	4	6	0	52	16,471	55.44	22.18	33.27	0.00	288.31
26	27	9	3	6	0	51	16,222	50.67	16.89	33.78	0.00	287.11
235	236	13	6	7	0	62	19,763	60.07	27.73	32.35	0.00	286.50
193	194	10	3	7	0	59	19,053	47.93	14.38	33.55	0.00	282.79
137	138	32	24	8	0	88	28,554	102.35	76.76	25.59	0.00	281.45
66	67	9	5	4	0	37	12,149	67.65	37.59	30.07	0.00	278.13
97	98	7	1	6	0	49	16,306	39.21	5.60	33.60	0.00	274.44
274	275	20	15	5	0	55	18,341	99.59	74.69	24.90	0.00	273.86
310	311	18	11	7	0	67	22,536	72.94	44.58	28.37	0.00	271.51
14	15	12	5	7	0	61	20,521	53.40	22.25	31.15	0.00	271.47
318	319	18	11	7	0	67	22,820	72.03	44.02	28.01	0.00	268.13

Table 5: 2000-2002 Crash Data for I-81 SB Segments with Weighted Crash Rates Greater Than the 2002 Statewide Weighted Crash Rate for Interstates

Segment		Crash Data					Average	Crash Rates per 100 million miles of travel				
Beg. MP	End MP	Total	PDO	Injury	Fatal	Weighted	ADT	Total	PDO	Injury	Fatal	Weighted
49	48	30	18	12	0	114	15,227	179.93	107.96	71.97	0.00	683.73
275	274	23	13	10	0	93	17,177	122.29	69.12	53.17	0.00	494.46
285	284	21	10	11	0	98	18,246	105.11	50.05	55.06	0.00	490.50
315	314	30	18	12	0	114	21,640	126.60	75.96	50.64	0.00	481.09
122	121	20	8	11	1	116	22,255	82.07	32.83	45.14	4.10	476.00
203	202	17	7	9	1	99	19,868	78.14	32.18	41.37	4.60	455.05
170	169	20	12	8	0	76	15,559	117.39	70.43	46.96	0.00	446.09
197	196	25	15	10	0	95	19,631	116.30	69.78	46.52	0.00	441.94
35	34	13	4	9	0	76	16,251	73.05	22.48	50.58	0.00	427.08
95	94	19	10	9	0	82	18,037	96.20	50.63	45.57	0.00	415.18
8	7	26	16	10	0	96	21,735	109.24	67.23	42.02	0.00	403.36
206	205	17	7	10	0	87	19,868	78.14	32.18	45.96	0.00	399.89
171	170	7	2	3	2	66	15,105	42.32	12.09	18.14	12.09	399.04
44	43	9	4	3	2	68	15,563	52.81	23.47	17.60	11.74	399.03
249	248	32	22	10	0	102	23,496	124.38	85.51	38.87	0.00	396.45
247	246	22	13	8	1	97	22,917	87.67	51.81	31.88	3.99	386.55
300	299	25	19	5	1	79	20,313	112.40	85.42	22.48	4.50	355.17
68	67	11	6	5	0	46	11,889	84.50	46.09	38.41	0.00	353.34
151	150	26	17	8	1	101	26,872	88.36	57.77	27.19	3.40	343.24
319	318	21	11	10	0	91	24,334	78.81	41.28	37.53	0.00	341.52
74	73	17	11	6	0	59	16,372	94.83	61.36	33.47	0.00	329.11
311	310	14	7	6	1	75	20,857	61.30	30.65	26.27	4.38	328.40
317	316	24	14	10	0	94	26,142	83.84	48.91	34.93	0.00	328.38
138	137	26	16	10	0	96	27,097	87.63	53.92	33.70	0.00	323.55
16	15	15	7	8	0	71	20,420	67.08	31.31	35.78	0.00	317.53
169	168	16	10	6	0	58	16,986	86.02	53.77	32.26	0.00	311.84
229	228	17	8	9	0	80	23,440	66.23	31.17	35.07	0.00	311.69
23	22	11	4	7	0	60	17,690	56.79	20.65	36.14	0.00	309.75
136	135	22	13	9	0	85	25,134	79.94	47.23	32.70	0.00	308.84
298	297	13	7	5	1	67	20,029	59.27	31.92	22.80	4.56	305.49
297	296	12	6	5	1	66	19,928	54.99	27.50	22.91	4.58	302.45
281	280	17	11	6	0	59	17,903	86.72	56.11	30.61	0.00	300.97
202	201	16	9	7	0	65	19,729	74.06	41.66	32.40	0.00	300.89
185	184	12	6	6	0	54	16,575	66.12	33.06	33.06	0.00	297.52
182	181	12	8	3	1	52	15,980	68.58	45.72	17.14	5.71	297.18
106	105	15	9	6	0	57	17,520	78.19	46.91	31.28	0.00	297.12
238	237	18	11	7	0	67	20,652	79.60	48.64	30.95	0.00	296.28
130	129	21	13	8	0	77	23,773	80.67	49.94	30.73	0.00	295.80
2	1	11	5	6	0	53	16,382	61.32	27.87	33.45	0.00	295.46
259	258	11	5	5	1	65	20,574	48.83	22.19	22.19	4.44	288.53
39	38	6	2	3	1	46	14,746	37.16	12.39	18.58	6.19	284.88
177	176	13	8	5	0	48	15,440	76.89	47.32	29.57	0.00	283.92
271	270	11	5	6	0	53	17,072	58.84	26.75	32.10	0.00	283.51
302	301	14	8	6	0	56	18,163	70.39	40.23	30.17	0.00	281.58
159	158	13	7	6	0	55	17,924	66.24	35.67	30.57	0.00	280.23
140	139	25	15	10	0	95	31,038	73.56	44.14	29.42	0.00	279.52
133	132	15	7	8	0	71	23,773	57.62	26.89	30.73	0.00	272.75
72	71	7	3	4	0	35	11,801	54.17	23.22	30.96	0.00	270.86
121	120	12	6	5	1	66	22,255	49.24	24.62	20.52	4.10	270.83
163	162	18	13	5	0	53	17,924	91.71	66.24	25.48	0.00	270.04
194	193	9	5	3	1	49	16,698	49.22	27.35	16.41	5.47	267.98
47	46	10	5	5	0	45	15,445	59.13	29.56	29.56	0.00	266.08
145	144	29	21	8	0	85	29,187	90.74	65.71	25.03	0.00	265.96
150	149	17	10	6	1	78	26,872	57.77	33.98	20.39	3.40	265.08

Approximately 21% of all of the crashes on I-81 in Virginia occurred in the forty-five high crash segments and a little more than one-third of the fatal crashes occurred in these segments, accounting for one-third of all of the fatalities on I-81 between 2000 and 2002. Approximately 22% of the total injuries and 22% of the crashes that involved one or more injuries occurred in the high crash segments. The distribution of crash types in the high crash segments is similar to the distribution for all of I-81. In fact, the data for the forty-five high crash segments compares well to the overall data, except that a slightly higher percentage of the crashes in the high crash segments occurred on curves that are on a grade and speeding was the major factor in a significantly greater percentage of the crashes that occurred in the high crash segments. Wet pavement was also more of a factor in the crashes in the high crash segments.

Topographic mapping of the corridor was used to estimate the average grade of each segment to determine if there is a correlation between grade and crash rate. Approximately 58% of the 45 high crash segments have average grades between -1% and +1% (level); 29% of the segments have average slopes between -1% and -3% and the remaining 13% have average slopes between +1% and +3% (rolling). Reviewing the grades of the segments with high crash rates did not show a good correlation between grades and crash rates so the entire corridor was checked for such a correlation. Approximately 5.8% of the segments having average grades between -1% and +1% had crash rates in excess of 125% of the statewide average while 14.3% of the segments having grades between -1% and -3% had high crash rates and 6.6% of the segments having grades between +1% and +3% had high crash rates. None of the segments with grades steeper than 3% had high crash rates. This review shows that crashes are more likely to occur on segments with a negative grade; however, the data still does not show a very good correlation between the grade of the segment and the crash rate. It must be noted that grade data used for this level of analysis was an average for the segment and was determined by comparing the elevation at the beginning milepost with the elevation at the end milepost. This review does not account for hills or dips that may be included in the segment. More specific grade data was considered in the detailed analyses of the segments with the highest crash rates.

The crash data was also reviewed to determine if there was any correlation between the crash rate of a segment and the presence of an interchange. 180 of the 650 one-mile long segments include an interchange (27.7%). 43.7% of the segments are adjacent to a segment that includes an interchange either upstream, downstream or both. Ten of the forty-five high crash segments include an interchange (22.2%) and twenty-one more of these segments are adjacent to a segment that includes an interchange (46.7%). Based on this information there does not appear to be a good correlation between the crash rate of a segment and the presence of an interchange in that segment or an adjacent segment.

High Crash Segments

A more detailed review was conducted on the crash data for those segments where the weighted crash rates are more than double the statewide average for Virginia interstates. The data was reviewed to determine if there were any identifiable patterns. The data was also compared with data from the previous Preliminary Engineering studies conducted on I-81 to determine if the crash patterns were consistent with any deficiencies identified in those reports.

NBL from MP 161.75 to MP 163.25 – There is a slight curve to the left approaching the ramp to Exit 162. The rest of the segment is primarily straight. There is a hill crest just past the bridge over Mill Creek and immediately prior to the deceleration lane for Exit 162. The rest of the segment has an average down grade of more than 1%. The deficiency report compiled from the previous studies noted that the tapers, acceleration lanes and deceleration lanes for the interchange at Exit 162 are shorter than current design standards. The deceleration lane for the northbound exit begins immediately past the bridge over Mill Creek, approximately one-twelfth of a mile past the milepost. The on-ramp merges into I-81 NB approximately a half mile past milepost 162.

The crash data shows that there were three rear end collisions, four sideswipes and thirty-four run off the road incidents in this segment, with the run-off the road incidents evenly split to the right side and the left side. Eight crashes (2 rear end, 2 sideswipes, 3 collisions with a fixed object off of the road and 1 collision with a deer) occurred upstream of the exit ramp. Thirty-one crashes occurred between the exit ramp and the end of the acceleration lane for the on-ramp. One of these crashes was a rear-end collision, one was classified as an angle crash and one was a sideswipe, the other twenty-eight incidents involved one or more vehicles leaving the roadway. The collision types are not consistent with the roadway geometry unless drivers are being forced off the roadway or maneuvering to avoid a collision with merging traffic. Unfortunately, the crash data does not adequately report the reason why a vehicle left the roadway except to note that driver inattention or error was sited as the major factor in nearly half of all of the reported crashes. A driver was listed as fatigued or "apparently asleep" in eight of the crashes and it was noted that a driver was exceeding the maximum safe speed in about one-third of all of the reported crashes. Weather was listed as a major factor in about 20% of the crashes. Alcohol was involved in less than 10% of the reported crashes. If the assumptions as to why vehicles are leaving the roadway are correct then the crash data is consistent with expectations at an interchange with substandard acceleration and deceleration lanes.

The VDOT has recently completed improvements to the interchange at Exit 162 including widening the bridges over Mill Creek and extending the acceleration and deceleration lanes. The changes to the interchange should improve safety in this segment; however, additional modifications to flatten the hill crest at the beginning of the exit ramp would also be beneficial.

NBL from MP 72.75 to MP 74.25 – Except for a sharp curve to the right at the beginning, this segment is primarily straight with an average down grade of close to 3%. The loop ramp from I-81 NB to I-77 NB is at the end of this segment, followed by a long sweeping curve to the right. The deficiency report compiled from the previous studies noted safety concerns with the low design speed of the ramp to I-77 NB. This loop has a radius of approximately 250'. With a maximum superelevation of 8%, the design speed on this ramp is between 30 and 35 mph. The deceleration lane serving this ramp should have a minimum length of 612'; however, the existing lane is only approximately 500' long.

More than 60% of the reported crashes in this segment involve a vehicle running off from the road and nearly 20% of the crashes were sideswipes. This crash pattern is consistent with the deficiency report in that it appears that exiting vehicles are required to slow significantly in order to exit the highway and that many are unable to safely make the exit. Due to the grade of the

road, thru traffic may also be having difficulty slowing sufficiently to avoid collisions with exiting traffic. Rear end collisions have not been significant but it appears that thru traffic may be making abrupt lane changes or running off from the road to avoid collisions with slowing traffic. Unfortunately, the crash data is not detailed enough to determine whether or not any of the crashes are associated with exiting vehicles; however, this relationship can be assumed based on the roadway geometry and collision types.

Significant modifications to the ramp from I-81 NB to I-77 NB are recommended to improve safety in this segment.

NBL from MP 93.75 to MP 95.25 – This segment includes a slight curve to the left at the beginning of the segment and a slight curve to the right at the end of the segment. Between these curves is a half cloverleaf interchange with Route 99 (the cloverleaf loops serve I-81 NB). The deficiency report notes that the weaving distance between the loops does not meet current standards. Approximately half of the crashes in this segment occurred in the vicinity of the loop ramps. These crashes include rear end collisions, sideswipes and run off the road incidents, all consistent with a pattern expected in an area with inadequate weaving space.

The deficiency report also notes that the sight distance across the bridge for the interchange (I-81 crosses over the secondary road) does not meet current design standards; however, a hill crest was not recorded as a visibility obstruction on any of the reported crashes. The segment has a grade of -2.5% approaching the interchange, -1.5% through the interchange and -4% downstream of the interchange. There is a dip at the end of the segment followed by +1% grade.

There is no discernable pattern for the crashes outside of the weave area. Most of the crashes are run off the road incidents with most vehicles going off the right side of the roadway. There is no obvious reason as to why vehicles are leaving the roadway in this area unless they are losing control by traveling too fast of the steep downgrade at the end of this segment.

The weaving distance between the loops should be extended to improve safety in this segment. The recommendation in the I-81 Improvement Study offers a reasonable and economical solution to the weaving problem in this area. The study recommends that improvements be made to Possum Hollow Road (F-047) at Route 99 so that the exit ramp can provide access to westbound Route 99 and the exit loop can be closed. Additional improvements may be necessary on the exit ramp to provide adequate storage and stopping distance for the additional traffic that will use this ramp after closure of the loop.

NBL from MP 291.75 to MP 293.25 – This segment begins in the middle of the acceleration lane for the on ramp from Exit 291. The mainline is a long flat curve to the left for two-thirds of the segment followed by a long flat curve to the right. The terrain is rolling throughout the segment. There is a dip near milepost 292.2 and a hill crest near milepost 292.6. The grade leading to the dip is -1.5% followed by a grade of +1.5%. The grade over the crest of the hill is -2.5%. There is another soft dip in the alignment just beyond the segment where I-81 crosses South Fork Creek and Battlefield Road. The deficiency report compiled from the previous I-81 studies identifies limited sight distance and substandard superelevation in this segment for the southbound lanes but does not identify any problems for the northbound lanes. The report also mentions safety

problems with ramp geometrics and heavy truck traffic in the Exit 291 interchange; however, the report does not provide any details about this safety problem.

Of the fifty-six crashes reported in this segment, thirty-six were run off the road incidents, nine were rear end collisions, six were sideswipes and five were collisions with a deer. Thirty-six of the crashes in this segment (64%) occurred between the dip and the hill crest. Only four (7%) occurred before the dip and sixteen (29%) occurred after the hill crest. The hill crest was not identified as a sight obstruction in any of the crash reports.

More than two-thirds of the crashes in this segment occurred when it was raining or misting and the pavement was wet. The pavement was recorded as dry for all of the other crashes. Rain on the windshield was noted as a visibility obstruction in only two of the crashes. Slick pavement was not recorded as the major factor nor was it noted as a road defect on any of the crash reports.

Speeding was identified as the major factor in thirty-one of the crashes (55%) and driver inattention or error was recorded as the major factor in fourteen crashes (25%). Drivers in two crashes were noted to be "apparently asleep" and two other drivers were recorded as "obviously drunk."

There does not appear to be any geometric problems with this segment. The addition of rumble strips along the shoulders may help to prevent vehicles from leaving the roadway and, therefore, reduce crashes. More than 80% of the fixed object crashes involved a collision with guardrail so there appears to be adequate guardrail protection in the segment. This is also reflected in the fact that this segment has the second highest number of crashes but has no fatalities and relatively few injury crashes. Since a large portion of the crashes occurred during rain the area should be checked to ensure that there is not a drainage problem in the segment. While the road may not be slick enough to create a hazard, it may be holding enough water to cause excess splash and spray, especially from large vehicles. Speeding appears to be the biggest problem in this segment. Increased enforcement of the speed limit may help to reduce crashes in this area.

NBL from MP179.75 to MP 181.25 – The segment is mostly straight except for a long, soft curve to the left in the middle of the segment. The segment includes all of the interchange for Exit 180. This interchange includes a single northbound exit ramp onto Route 11 and an on ramp and loop onto I-81 NB. The segment begins near a hill crest with a downstream grade of -3%. There is a dip near MP 180.5 a short distance upstream of the merge point with the interchange loop. The upgrade after the dip is 1.5%. The deficiency report compiled from the previous I-81 studies notes that the tapers and the acceleration and deceleration lanes for the interchange ramps are not in compliance with current design standards. There is no mention of vertical deficiencies.

Sideswipes and rear end collisions are the most typical crash types in areas near interchanges with substandard merging and/or weaving conditions; however, of the twenty-eight crashes reported in this segment, only one was classified as a rear end collision and only two were classified as sideswipes. Three-quarters of the reported crashes were run off the road incidents with three-quarters of those being to the right side of the roadway. This crash pattern might not be unexpected if vehicles are having difficulty making the exit due to the improper taper or the short deceleration lane; however, only one of the run off the road incidents occurred upstream of

the exit ramp. All of the other crashes occurred within one of the two merging areas in the segment. The crash pattern is not consistent with the deficiencies reported in this segment; however, the crash pattern is consistent with another problem that VDOT has recently identified in this segment. Past resurfacings in this area have made the inside lane flat and has caused the outside lane to slope to the outside of the curve, thereby lowering the design speed on the curve. As noted above, the curve is soft, making drivers believe that they can take the curve at a higher speed than can be negotiated due to the improper cross slopes. The change in the vertical alignment also occurs in the middle of the curve so traffic is nearing its maximum speed while still in the curve. This is especially a problem for trucks and other large vehicles. More than half of the reported crashes in this segment involved a large vehicle including a fatality and nine crashes with injuries. Nearly half of the reported crashes occurred at night. There is no lighting on this portion of I-81.

Driver error was recorded as the major factor in nearly half of the crashes and driver condition (ill, fatigued, drunk, etc.) was cited as the major factor in nearly all of the other half of the reported crashes. Inattention was recorded as the driver's action in two-thirds of the reported crashes and the driver was recorded as "apparently asleep" in half of those crashes.

VDOT is preparing to make bridge and pavement modifications (UPC# 70066 – Draft Six-Year Improvement Program 2005-2010) to correct the cross slope problem in this area. The project will reconstruct the pavement with a 2% superelevation which should significantly improve safety in this segment. Based on the crash patterns and the driver actions cited in the crash reports, the addition of rumble strips on the shoulders would also improve safety in this area. Lighting in this segment may also be helpful but may not be necessary with the proposed improvements to the cross slope.

NBL from MP313.75 to MP 315.25 – This segment is between the interchanges for Exit 313 and Exit 315 in Winchester. The segment includes the merge area for the on ramp from Exit 313 and the diverge area for the off ramp at Exit 315. The segment includes a moderate curve to the right between the interchanges. There is also a crest vertical curve at this same point in the segment. The approach to the crest vertical curve is a 3.0% grade followed by downgrade of 2.5%. The deficiency report compiled from the previous I-81 studies identifies a safety problem with the I-81 NB ramp for Exit 313 during peak traffic hours. The report does not elaborate on the nature of the safety problem; however, it is likely caused by too short of an acceleration lane for traffic merging onto I-81 NB. The taper for this lane currently ends at the abutment for the bridge over Abram's Creek. The report also notes that the ramp radii at Exit 313 do not meet current standards.

This segment has more crashes than any other segment in the corridor. It does not rank higher on the list of high crash segments because it carries a very large volume of traffic and there have been relatively few injuries and fatalities in this segment. Unlike most of the high crash segments, this segment includes few single car crashes (less than 20%) and has the second highest number of vehicles involved per crash. More than three quarters of the crashes in this segment were rear end collisions or sideswipes. Run off the road incidents accounted for all but one of the reported single car crashes in this segment.

Speeding or exceeding a safe speed was sited in less than 20% of the reported crashes. Cutting in, following too close and failure to yield the right of way were the actions that precipitated most of the crashes (half). Fatigue was a factor in only three incidents and alcohol was not reported as a factor in any of the crashes. More than a quarter of the crashes occurred in the afternoon peak period (5:00 PM to 7:00 PM) and half of the crashes occurred in the dark. Large vehicles were involved in a little more than half of the reported crashes including the only fatal crash and half of the crashes that involved an injury.

The pattern of crashes in this segment is as expected for a highly congested segment between two congested interchanges in an urban area. The VDOT is currently preparing plans to widen the bridge over Abram's Creek (near MP 314) and extend the acceleration lane onto I-81 NB at Exit 313 (UPC# 56388 – Draft Six-Year Improvement Program 2005-2010). A lower cost alternative also being considered is to extend the acceleration lane by reconstructing the on ramp with a lower design speed (smaller radii) so that it can tie into the mainline further south, thereby allowing a longer acceleration lane without adding a new bridge or widening the existing bridge. VDOT is also preparing plans to widen the exit ramp at Exit 115 from 1 lane to 2 lanes (UPC# 67915 – Draft Six-Year Improvement Program 2005-2010) to increase the capacity of the ramp and to provide more storage so as to try to prevent the ramp queue from extending onto the mainline of I-81 NB. These modifications should improve safety in this area; however, additional capacity improvements such as the addition of a Collector-Distributor system or reconstruction of Exits 313 and 315 as single-point diamond urban interchanges (as recommended in the previous I-81 study conducted for this area) may be necessary to move this segment off from the list of high crash segments. Providing lighting in and between the interchanges at Exits 313 and 315 may also help to reduce the number of night time collisions.

NBL from MP167.75 to MP 169.25 – This segment begins in the middle of a sharp curve to the left where Route 11 crosses I-81 near Purgatory Creek. The curve to the left is followed by a sharp curve to the right, then a moderate curve to the left and a soft curve to the right. The deficiency report compiled from the previous I-81 studies identifies this segment as having substandard reversing horizontal curves for the high speed conditions.

The segment includes the entrance ramp from Route 11 (Exit 167) and all of the interchange at Exit 168 (Arcadia Road). The deficiency report notes that the tapers and the acceleration and deceleration lanes for the interchange ramps at Exit 167 are not in compliance with current design standards.

The crash pattern in this segment appears to be consistent with the geometric deficiencies identified in the previous reports. Fifteen of the twenty-four crashes reported in this segment from 2000 to 2002 were run off the road type incidents and six more were sideswipes. Eight of the incidents involved a vehicle running off the right side of the road and the other seven involved running off the road to the left. Foul weather or slick pavement was a factor in about 40% of the reported crashes in this segment. Speeding, exceeding a safe speed and cutting in were identified as causal maneuvers in a third of the crashes. One driver was reported to be fatigued, three were reported as "apparently asleep" and one driver was reported as "obviously drunk." A large vehicle was involved in more than half of the crashes in this segment.

The recommendation from the previous study includes realigning I-81 in this segment to soften the curve at the beginning of the segment and to eliminate the sharp reverse curves in the middle of the segment. It also eliminates the partial interchange at Exit 167 and extends the acceleration and deceleration lanes for Exit 168. These changes should significantly reduce crashes in this segment; however, this requires total reconstruction of more than a mile of I-81. Safety could be improved on the current alignment by adding rumble strips on the shoulders and by extending the guardrail in the segment. The additional guardrail may not help to reduce the number of crashes in the segment but may reduce injuries. Of the seven crashes into existing guardrail, only 1 involved an injury. Two vehicles left the roadway and crashed into an embankment or ledge and two others hit trees. All four of these crashes involved injuries. Additional signing to warn of the maximum safe speed for the horizontal curves may also help to improve safety by slowing traffic through this segment.

SBL from MP 49.25 to MP 47.75 – This segment is tangent at both ends but includes a large reverse curve (to the right then to the left) from approximately MP 48.75 to MP 47.75. The exit ramp for Exit 48 begins near MP 48.3, at the end of the first curve. Previous studies performed on I-81 identify the location of this exit ramp as a safety problem. The crash data indicates that the ramp placement may be a problem as stated. Half of the thirty-five crashes reported in this segment occurred between the beginning of the ramp deceleration lane and the end of the ramp gore. One-quarter of the crashes occurred beyond the ramp gore and the other quarter occurred upstream of the deceleration lane.

The ramp placement may be contributing to the safety problems in this segment; however, weather appears to have a bigger impact. Nearly 60% of the crashes in this segment occurred during foul weather (rain or sleet). Wet or icy pavement was recorded for nearly 70% of the reported crashes. The slick pavement was recorded as the major factor in more than a quarter of the crashes in the segment. 80% of the reported crashes involved a vehicle running off the road. Most of these were single car incidents.

As at most sights, some type of driver error was reported for most incidents. Drivers in nineteen crashes were reported to be speeding or exceeding the maximum safe speed for the area and for the conditions. Driver inattention was cited in eight other crashes, with one driver reported as "apparently asleep" and two drivers impaired by the use of alcohol.

An investigation needs to be made to determine if surface treatments in this segment will improve coefficients of friction during inclement weather. Pavement marking improvements may also be necessary to ensure that lane markings are visible during inclement weather. Modifications such as these should significantly improve safety in this area; however, the addition of rumble strips along the edge of the shoulder should also help to warn motorists when they begin to leave the roadway.

Large Vehicle Involvement

I-81 carries a very high volume of large vehicle traffic. At times, large vehicles make up as much as 40% of all of the traffic on I-81 and large vehicles account for nearly 29% of all of the vehicle travel miles on I-81 in Virginia. There is a perception that this high amount of truck traffic is a primary cause of crash problems on I-81; therefore, it is necessary to look specifically

at the crashes involving large vehicles to determine if there is a disproportionate number of large vehicle involved crashes. For the purposes of this study, the following vehicles are considered to be large vehicles: single-unit trucks, tractor-trailer trucks (single or double trailers), motor homes, oversized vehicles, and buses (school, transit, and commercial).

Table 6 shows that large vehicles are not disproportionately involved in crashes on I-81 in Virginia. Large vehicles were involved in 1674 crashes on I-81 from 2000 to 2002. This is approximately 29% of all of the crashes in the corridor. Large vehicles were also involved in twenty-one fatal crashes in this period, approximately 29% of all of the fatal crashes on I-81 during this period. Comparing the data in Table 6 with the data in Table 1 shows that large vehicle crash rates on I-81 are very similar to overall crash rates on I-81.

Table 6: Large Vehicle Crash Data on I-81 (2000-2002)

	Crash Data					VMT	Crash Rates per 100 million miles of travel				
	Total	PDO	Injury	Fatal	Weighted	(millions)	Total	PDO	Injury	Fatal	Weighted
I-81 NB	873	568	291	14	3176	2,229	39.17	25.49	13.06	0.63	142.50
I-81 SB	801	507	287	7	2943	2,082	38.47	24.35	13.78	0.34	141.33

Table 7 provides statewide data for large vehicle involved crashes on interstates in Virginia. Comparing Table 6 to Table 7 shows that large vehicle involved crash rates on I-81 are significantly lower than the statewide rates in Virginia for all categories.

Table 7: Large Vehicle Crash Data on Virginia Interstates (2000-2002)

	Crash Data					VMT	Crash Rates per 100 million miles of travel				
Area*	Total	PDO	Injury	Fatal	Weighted	(millions)	Total	PDO	Injury	Fatal	Weighted
Region 1	2,057	1,297	729	31	8,509	5,289	38.89	24.52	13.78	0.59	160.89
Region 2	2,325	1,511	784	30	9,197	3,062	75.93	49.35	25.60	0.98	300.36
Region 3	2,597	1,743	838	16	8,767	2,343	110.84	74.39	35.77	0.68	374.18
Statewide	6,979	4,551	2,351	77	24,899	9,766	65.26	42.56	21.98	0.72	232.83

* Region 1 includes the Bristol, Salem and Staunton Districts; Region 2 includes the Hampton Roads, Richmond and Lynchburg Districts; and Region 3 includes the Culpepper, Fredericksburg and Northern Virginia Districts

Large vehicle involved crash rates on I-81 are well below statewide crash rates for large vehicle involved crashes on interstates; however, 143 (68 northbound and 75 southbound) of the 650 one-mile long segments on I-81 have weighted crash rates in excess of the statewide weighted crash rate for interstates. As shown in **Tables 8 and 9**, 96 of these segments have weighted crash rates that are more than 125% of the statewide interstate rate and twenty-three segments are more than double the statewide interstate rate. One segment in the southbound direction and four in the northbound direction have weighted crash rates for truck involved crashes that are more than triple the statewide rate.

Table 8: 2000-2002 Large Vehicle Involved Crash Data for I-81 NB Segments with Weighted Crash Rates Greater Than the 125% of the Statewide Weighted Crash Rate for Interstates

Segment		Crash Data					Average	Crash Rates per 100 million miles of travel				
Beg. MP	End MP	Total	PDO	Injury	Fatal	Weighted	ADT	Total	PDO	Injury	Fatal	Weighted
314	315	25	18	6	1	86	6,820	334.75	241.02	80.34	13.39	1151.54
73	74	16	10	6	0	58	4,726	309.18	193.24	115.94	0.00	1120.78
180	181	13	5	8	0	69	6,385	185.94	71.51	114.42	0.00	986.90
292	293	9	4	5	0	44	5,672	144.91	64.40	80.50	0.00	708.44
58	59	4	1	3	0	25	3,323	109.93	27.48	82.45	0.00	687.06
168	169	8	4	3	1	48	6,602	110.66	55.33	41.50	13.83	663.97
30	31	2	0	1	1	28	4,476	40.81	0.00	20.40	20.40	571.33
94	95	7	3	4	0	35	5,607	114.01	48.86	65.15	0.00	570.06
14	15	5	1	4	0	33	5,610	81.39	16.28	65.11	0.00	537.17
258	259	6	2	4	0	34	6,075	90.20	30.07	60.13	0.00	511.11
66	67	4	2	2	0	18	3,320	110.02	55.01	55.01	0.00	495.08
93	94	4	0	4	0	32	6,239	58.55	0.00	58.55	0.00	468.38
195	196	8	4	4	0	36	7,372	99.10	49.55	49.55	0.00	445.97
164	165	6	4	1	1	32	6,564	83.48	55.65	13.91	13.91	445.21
80	81	8	5	2	1	41	8,434	86.62	54.14	21.66	10.83	443.93
121	122	6	3	2	1	39	8,107	67.59	33.79	22.53	11.26	439.33
318	319	8	5	3	0	29	6,155	118.71	74.19	44.51	0.00	430.31
98	99	7	4	3	0	28	5,946	107.51	61.44	46.08	0.00	430.05
120	121	5	2	2	1	38	8,107	56.32	22.53	22.53	11.26	428.06
172	173	4	2	1	1	30	6,612	55.24	27.62	13.81	13.81	414.34
162	163	9	6	3	0	30	6,616	124.23	82.82	41.41	0.00	414.11
33	34	3	1	2	0	17	3,840	71.34	23.78	47.56	0.00	404.26
89	90	4	1	3	0	25	5,652	64.64	16.16	48.48	0.00	403.97
181	182	4	2	1	1	30	6,841	53.40	26.70	13.35	13.35	400.47
49	50	2	0	2	0	16	3,708	49.25	0.00	49.25	0.00	394.03
10	11	5	2	3	0	26	6,126	74.53	29.81	44.72	0.00	387.58
105	106	5	2	3	0	26	6,272	72.80	29.12	43.68	0.00	378.58
92	93	5	2	3	0	26	6,280	72.71	29.09	43.63	0.00	378.11
316	317	7	4	3	0	28	6,935	92.18	52.67	39.51	0.00	368.72
198	199	3	1	1	1	29	7,417	36.94	12.31	12.31	12.31	357.09
83	84	4	3	0	1	23	5,919	61.71	46.28	0.00	15.43	354.85
5	6	10	8	2	0	24	6,254	146.03	116.83	29.21	0.00	350.48
26	27	3	1	2	0	17	4,432	61.82	20.61	41.21	0.00	350.30
173	174	4	1	3	0	25	6,612	55.24	13.81	41.43	0.00	345.28
311	312	3	2	0	1	22	5,925	46.24	30.83	0.00	15.41	339.09
234	235	3	0	3	0	24	6,595	41.54	0.00	41.54	0.00	332.32
61	62	5	4	1	0	12	3,320	137.52	110.02	27.50	0.00	330.05
189	190	7	4	3	0	28	7,817	81.78	46.73	35.05	0.00	327.12
263	264	6	4	2	0	20	5,615	97.59	65.06	32.53	0.00	325.29
266	267	1	0	0	1	20	5,624	16.24	0.00	0.00	16.24	324.75
131	132	6	3	3	0	27	7,781	70.42	35.21	35.21	0.00	316.88
197	198	4	1	3	0	25	7,417	49.25	12.31	36.94	0.00	307.83
7	8	6	4	2	0	20	6,141	89.23	59.49	29.74	0.00	297.44
144	145	6	3	3	0	27	8,291	66.09	33.04	33.04	0.00	297.39
135	136	6	3	3	0	27	8,404	65.20	32.60	32.60	0.00	293.39
109	110	6	4	2	0	20	6,259	87.54	58.36	29.18	0.00	291.80

Table 9: 2000-2002 Large Vehicle Involved Crash Data for I-81 SB Segments with Weighted Crash Rates Greater Than the 125% of the Statewide Weighted Crash Rate for Interstates

Segment		Crash Data					Average	Crash Rates per 100 million miles of travel				
Beg. MP	End MP	Total	PDO	Injury	Fatal	Weighted	ADT	Total	PDO	Injury	Fatal	Weighted
285	284	8	3	5	0	43	5,319	137.36	51.51	85.85	0.00	738.29
249	248	17	12	5	0	52	6,852	226.59	159.95	66.64	0.00	693.10
68	67	4	2	2	0	18	2,893	126.28	63.14	63.14	0.00	568.28
122	121	8	3	5	0	43	7,193	101.57	38.09	63.48	0.00	545.96
72	71	3	1	2	0	17	2,871	95.44	31.81	63.63	0.00	540.82
94	93	6	2	4	0	34	5,755	95.21	31.74	63.47	0.00	539.50
203	202	4	0	3	1	44	7,554	48.36	0.00	36.27	12.09	531.94
41	40	3	2	0	1	22	3,812	71.87	47.91	0.00	23.96	527.05
300	299	8	6	1	1	34	5,929	123.23	92.42	15.40	15.40	523.73
27	26	3	0	3	0	24	4,373	62.65	0.00	62.65	0.00	501.17
121	120	4	1	2	1	37	7,193	50.79	12.70	25.39	12.70	469.78
312	311	3	0	3	0	24	4,711	58.16	0.00	58.16	0.00	465.28
49	48	4	2	2	0	18	3,699	98.76	49.38	49.38	0.00	444.44
319	318	9	6	3	0	30	6,250	131.51	87.68	43.84	0.00	438.38
238	237	8	5	3	0	29	6,056	120.65	75.40	45.24	0.00	437.34
17	16	8	6	2	0	22	4,718	154.86	116.15	38.72	0.00	425.87
85	84	4	1	3	0	25	5,383	67.86	16.96	50.89	0.00	424.11
95	94	6	3	3	0	27	5,831	93.97	46.98	46.98	0.00	422.85
304	303	3	2	0	1	22	4,791	57.18	38.12	0.00	19.06	419.36
47	46	3	1	2	0	17	3,750	73.06	24.35	48.71	0.00	414.00
97	96	6	3	3	0	27	5,964	91.87	45.94	45.94	0.00	413.42
37	36	2	0	2	0	16	3,586	50.93	0.00	50.93	0.00	407.47
247	246	8	5	3	0	29	6,716	108.79	67.99	40.80	0.00	394.36
35	34	3	1	2	0	17	3,948	69.40	23.13	46.26	0.00	393.24
30	29	3	1	2	0	17	3,983	68.78	22.93	45.85	0.00	389.75
185	184	6	3	3	0	27	6,346	86.34	43.17	43.17	0.00	388.53
273	272	7	5	2	0	21	4,943	129.33	92.38	36.95	0.00	387.98
317	316	6	3	3	0	27	6,708	81.68	40.84	40.84	0.00	367.57
275	274	6	4	2	0	20	4,984	109.93	73.29	36.64	0.00	366.44
260	259	3	0	3	0	24	5,983	45.79	0.00	45.79	0.00	366.31
74	73	4	2	2	0	18	4,595	79.50	39.75	39.75	0.00	357.74
302	301	5	3	2	0	19	4,936	92.50	55.50	37.00	0.00	351.51
148	147	5	4	0	1	24	6,261	72.93	58.35	0.00	14.59	350.09
11	10	3	0	3	0	24	6,264	43.74	0.00	43.74	0.00	349.90
10	9	3	0	3	0	24	6,264	43.74	0.00	43.74	0.00	349.90
163	162	12	10	2	0	26	6,865	159.63	133.03	26.61	0.00	345.87
159	158	5	2	3	0	26	6,865	66.51	26.61	39.91	0.00	345.87
126	125	5	2	3	0	26	7,193	63.48	25.39	38.09	0.00	330.12
123	122	5	2	3	0	26	7,193	63.48	25.39	38.09	0.00	330.12
293	292	6	4	2	0	20	5,600	97.85	65.23	32.62	0.00	326.16
18	17	3	1	2	0	17	4,911	55.78	18.59	37.19	0.00	316.11
14	13	3	1	2	0	17	4,937	55.49	18.50	36.99	0.00	314.44
206	205	5	2	3	0	26	7,554	60.45	24.18	36.27	0.00	314.33
133	132	5	2	3	0	26	7,676	59.48	23.79	35.69	0.00	309.32
211	210	4	1	3	0	25	7,390	49.43	12.36	37.07	0.00	308.93
177	176	6	4	2	0	20	5,919	92.57	61.71	30.86	0.00	308.56
58	57	2	1	1	0	9	2,735	66.79	33.40	33.40	0.00	300.56
152	151	8	6	2	0	22	6,748	108.27	81.20	27.07	0.00	297.74
315	314	11	10	1	0	18	5,536	181.47	164.97	16.50	0.00	296.95
106	105	4	2	2	0	18	5,644	64.72	32.36	32.36	0.00	291.24

Large Vehicle Involved Crash Data

Approximately 52% of the crashes that involved a large vehicle were on the northbound lanes. More of these crashes occurred on a Sunday than any other day of the week (18%) and the least occurred on Saturdays (9%). Crashes involving a large vehicle occurred on the southbound lanes most often on Thursdays (18%) and least often on Sundays (10%).

Sideswipes were the most common crash type (40%), followed by rear end collisions (23%) and fixed object crashes (23%). More than 2% of the reported crashes involving large vehicles involved hitting deer or other animals. Approximately one quarter of all of the crashes involved one or more vehicles leaving the roadway.

Driver error or inattention was the primary cause of most of the reported crashes. Speeding or exceeding the maximum safe speed was reported in more than 17% of the crash reports. Cutting in or other improper passing was cited in 12% of the crash reports and following too close was cited in 8% of the crashes. Drivers in ninety-four of the reported crashes were listed as "apparently asleep" and twenty-four others were recorded as ill or fatigued. Alcohol was cited as a factor in less than 2% of all of the crashes involving a large vehicle.

Approximately 390 of the 1674 crashes that involved a large vehicle (23%) occurred during foul weather, either fog, mist, rain, sleet or snow. The pavement was recorded as wet, snowy or icy for 430 of the crashes (26%); however, the slick pavement was recorded as the major factor in only fifty-eight of the reported crashes. Approximately 65% of the crashes involving a large vehicle occurred during daylight conditions and approximately 30% of the crashes occurred after dark on an unlit segment.

Large Vehicle Involvement in the High Crash Segments

Large vehicles were involved in 32% of the total crashes; 27% of the crashes involving an injury; and 27% of the fatal crashes in all of the high crash segments. Twenty-nine of the forty-five high crash segments are also high crash segments for large vehicle involved crashes. Seven of the eight segments that have crash rates that are more than double the statewide crash rate for interstates also have large vehicle involved crash rates that are more than double the statewide large vehicle crash rate. Large vehicles were involved in 37% of all crashes; 38% of the injury crashes; and 40% of the fatal crashes in those segments. The high volume of trucks in the traffic mix seemed to impact safety in only two of these segments, the northbound lanes between MP 179.75 and MP 181.25 and the northbound lanes between MP 167.75 and MP 169.25. Both of these segments have geometric deficiencies that most significantly impact large vehicles.

VDOT provided a database (Microsoft Access) of all crashes that were reported on I-81 in 2000, 2001 and 2002. This list included 2859 crashes in the northbound lanes and 2887 crashes in the southbound lanes. The crashes were broken down by severity type as follows:

Northbound:	
Property Damage Only crashes:	1784
Crashes involving an injury:	1038
Crashes involving a fatality:	37
Total crashes:	2859

Southbound:	
Property Damage Only crashes:	1787
Crashes involving an injury:	1061
Crashes involving a fatality:	39
Total crashes:	2887

The VDOT severity weighting system was applied to this data. The weighting system assigns 1 point for PDO crashes, 8 points for crashes involving injuries and 20 points for crashes involving one or more fatalities. Using this system, there was a total of 21,883 points scored on I-81 from 2000 to 2002.

According to data provided by VDOT, there were a total of 13,707,767,720 vehicles miles of travel on I-81 from 2000 to 2002. The crash rate for a roadway is typically reported as the number of crashes per 100 million vehicles miles of travel. The severity points are often used in place of the number of crashes so that particularly hazardous locations are appropriately inflated. Based on the numbers presented above, the crash rate on I-81 from 2000 to 2002 can be determined with the following formula:

21,883 / 137.07767720 = 159.64 crash points per 100 million vehicle miles of travel.

VDOT also provided statewide crash data for 2002. The following crashes were reported on interstates in Virginia in 2002:

Crash Type	Number	Points
Property Damage Only crashes:	11,468	11,468
Crashes involving an injury:	6,190	49,520
Crashes involving a fatality:	118	2360
Total crashes:	17,776	63,348

According to VDOT there were 22,843,000,000 vehicle miles of travel on interstates in Virginia in 2002; therefore, the interstate crash rate in Virginia in 2002 can be determined with the following formula:

63, 348 / 228.43 = 277.32 crash points per 100 million vehicle miles of travel.

Interstate 81 Corridor Improvement Study
Existing I-81Geometric Deficencies

STUDY AREA	M.P.	EXIT NO.	SIDE ROAD	HORIZONTAL DEFICIENCY	VERTICAL DEFICIENCY
1	8.8				Sight Distance on Vertical Curves on Sag curves NB &SB, less than current design standards
1		10	Rte. 11		Rte. 11 Overpass Vertical Clearance less than 16.5', and does not meet current design standard
1	10.8				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1	11.1		Rte.808		Sight Distance on Vertical Curves on Sag curves NB &SB, less than current design standards
1	11.8				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1	12.5				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1		13	Rte 611		I-81Bridge Vertical Clearance less than 14.5' over 611 and does not meet current design standard
1	13.1		Rte. 611		Sight Distance on Vertical Curves on Sag curves NB &SB, less than current design standards
1		14	Rte. 647	Safety problem with weaving distance between loops NBL,less than current standards.	I-81Bridges Vertical Clearance less than 14.5' over 647 and does not meet current design standard
1	15.0		Rte140/647		Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1	15.4				Sight Distance on Vertical Curves on Sag curves NB &SB, less than current design standards
1	15.8				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1	16.2		Rte.794		Sight Distance on Vertical Curves on Sag curves NB &SB, less than current design standards
1	16.6				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1	17.1		Rte.58/75		Sight Distance on Vertical Curves on Sag curves NB &SB, less than current design standards
1	17.4				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1	18.5		Rte.793		Sight Distance on Vertical Curves on Sag curves NB &SB, less than current design standards
1	19.6		Rte.58/11		Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1		19	Rte.58/11		I-81 SB BridgeVerticalClearance over 58 less than 14.5'and does not meet current designstandard
1	20.1				Sight Distance on Vertical Curves on Sag curves NB &SB, less than current design standards
1	20.5				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1	20.9				Sight Distance on Vertical Curves on Sag curves NB &SB, less than current design standards
1	21.3				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1	21.8				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1	22.8				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
1	23.1				Sight Distance on Vertical Curves on Sag curves NB &SB, less than current design standards
2 2		24,26 29,32		Interchange ramp terminii spacing on side road is less than current design standard	
2 2	35.4	35	Rte.107	Interchange ramp terminii spacing on side road is less than current design standard Ramp geometric less than current design standards	
2 2	39.2	39	Rte.11/645	Interchange ramp terminii spacing on side road is less than current design standard Ramp and cross road geometrics less than current design standard.	
2 2	42 to 44.8				Several I-81 NB & SB Bridge Vertical Clearance over sideroads below 14.5',less thancurrentstandard
2	Revised	45	Rte. 16	Interchange ramp terminii spacing on side road is less than current design standard	NB exit ramp has steep grade and geometrics less than current design standard.
2 2	46.0 to 54				Several Overpass Vertical Clearances below 16.5',less than current design standard
2 2	47.9	47	Rte. 11	Safety problem with SB exit gore location at beginning of mainline curve. Inadequate space between ramp terminal on Route 11, less than current standards..	
2 2	50.2	50 60	Rte. 11/622 Rte. 90/680	Interchange ramps have geometrics less than current design standards. Interchange ramp terminii spacing on side road is less than current design standard	
2 2	67.5	67	Rte.11	Geometrics and length NB Exit Ramp are less than current design standard. Exit Ramp Stopping Sight Distance, less than current standards.	
2 2	70.8	70	Rte.11	Geometrics NB Exit Ramp are less than current design standard. Geometrics SB Exit Ramp are less than current design standard.	
3		72	I.-77	Safety concerns of low design speed ramp I-77SB to I-81 SB	
3		72	I-77	Safety concerns of low design speed ramp I-77SB to I-81 NB	
3		72	I-77	NBL& SBL 81 Bridges over I-77 have substandard horizontal clearance.	
3		41	Rte. 610	Safety concerns low design speed of ramps and tight loop.	
3	74.5				Sight Distance on Vertical Curves on NB &SB 81, less than current design standards
3	75 to 76			Mainline horizontal curves do not meet current design standards	
3		80	Rte.52	Interchange ramp terminii spacing on side road is less than current design standard	
3				Short Ramps do not meet current design standards.	
3	81.5		I-77	I-77 NBL overpass Bridge over I-81 has substandard horizontal clearance.	
3		81	I-77	Safety concerns of low design speed ramp I-77NB to I-81 NB.	
3	81.5 to 83				Sight Distance on Vertical Curves on NB &SB 81, less than current design standards

Interstate 81 Corridor Improvement Study
Existing I-81Geometric Deficencies

STUDY AREA	M.P.	EXIT NO.	SIDE ROAD	HORIZONTAL DEFICIENCY	VERTICAL DEFICIENCY
4	83 to 97			Median narrow for current Rural Interstate Design standards, approx. 40'	
4		84	Rte.619	Interchange ramp terminii spacing on side road is less than current design standard	
4	85				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
4	85.7				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
4		86	Rte.618	Interchange ramp terminii spacing on side road is less than current design standard	
4	88.4				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
4	89		Rte.11&100		NB & SB 81 Bridge Vertical Clearance over Rte. 11 below 16.5',less than current design standard
4	90.6				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
4		92	F 064/067	Interchange ramp terminii spacing on side road is less than current design standard	SB 81 Bridge Vertical Clearance over Rte. 99 below 16.5',less than current design standard
4	92.7				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
4	93.5				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
4		94	Rte. 99	Short Weaving distance NBL between loops does not meet current standards.	
4	94.4				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
4	95.5				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
4	96		Rte.644		NB & SB 81 Bridge Vertical Clearance over 644 below 14.5',less than current design standard
4	96.3				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
4	97		Rte.611		NB & SB 81 Bridge Vertical Clearance over 611 below 14.5',less than current design standard
4	98		Rte.100		NB & SB 81 Bridge Vertical Clearance over 100 below 16.5',less than current design standard
4	103.6				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
4	104		Rte.799		SB 81 Bridge Vertical Clearance over 799 below 14.5',less than current design standard
4	105.9				Sight Distance on Vertical Curves on Crest curves NB , less than current design standards
4	106.6				Sight Distance on Vertical Curves on Crest curves NB , less than current design standards
4	107.5				Sight Distance on Vertical Curves on Crest curves NB, less than current design standards
4	108		Rte. 787		Rte. 787 Overpass Vertical Clearance less than 16.5', and does not meet current design standard
4	108.2				Sight Distance on Vertical Curves on Crest curves NB &SB, less than current design standards
4		109	Rte.177	Safety problems with ramp terminii onto Route 177,less than current design standard.	
4	115		S. Franklin		S. Franklin St. Overpass Vertical Clearance below 16.5',less than current design standard
5	120.5				Substandard Vertical Curve in sag condition provided NBL..
5	122 to 123.9				Sight Distance on Vertical Curves on Crest curve NB, less than current design standards
5	126	126	Rte.603	Geometrics NB on, NB off, SB off ramps less than current design standards	
5	128.5				Sight Distance on Vertical Curves on Crest curve NB, less than current design standards
5	127.8 to	129.9			Existing profile grades have substandard clearance over hydraulic gradient on N.Fork Roanoke River
5	129.3		Rest Area	Geometrics NBL Exit and Entrance Ramp are less than current design standard.	Portions of Rest Area lie within Hydraulic Grade line and Flood Plain of N. Fork of Roanoke River.
5		132	Rte.647	Interchange ramps have tapers, acceleration and deceleration	
5				lanes less than current design standards	Sight Distance on Vertical Curves on Sag curve NB, less than current design standards
5	132.6				Sight Distance on Vertical Curves on Crest curve NB, less than current design standards
5	135.2				Substandard Vertical Curve in sag condition provided NBL..
5	136.3				Substandard Vertical Curve in crest condition provided NBL..
5		137	Rte. 112	Interchange ramps have tapers, acceleration and deceleration	
5				lanes less than current design standards	
5		141	Rte.419	Interchange ramps have tapers, acceleration and deceleration	
5				lanes less than current design standards	
5	142.4				Substandard Vertical Curve in sag condition provided NBL..
5		143	I-581	Interchange ramps have tapers, acceleration and deceleration, sight distance	
5				lanes less than current design standards	
5	145.6				Substandard Vertical Curve in crest condition provided NBL..
5		146	Rte.115	Interchange ramps have tapers, acceleration and deceleration	Substandard Vertical Curve in crest condition provided NBL..
5				lanes less than current design standards	
5	149.9				Sight Distance on Vertical Curves on Crest curve NB, less than current design standards
5	Added	150	Rte.220	Safety problem noted with accidents and backups on ramps designed less than current standard.	
5		156	Rte.670	Interchange ramps have tapers, acceleration and deceleration	
5				lanes less than current design standards	
5	156.1				Sight Distance on Vertical Curves on Crest curve NB, less than current design standards
5	158.9 to 159.4				Substandard Vertical Curve in crest condition provided NBL..
5	161.3		Rte.11,636		Sight Distance on Vertical Curves on Crest curve NB, less than current design standards
5		162	Rte. 606	Interchange ramps have tapers, acceleration and deceleration	
5			Rest Area	lanes less than current design standards	

Interstate 81 Corridor Improvement Study
Existing I-81Geometric Deficencies

STUDY AREA	M.P.	EXIT NO.	SIDE ROAD	HORIZONTAL DEFICIENCY	VERTICAL DEFICIENCY
6	165.7 to	166.8		Median narrow for current Rural Interstate Design standards, approx. 40'	Long runs of maximum NB profile grades require climbing lanes to meet current design standards.
6	166.5 to	167.5		Median narrow for current Rural Interstate Design standards, approx. 40'	Long runs of maximum SB profile grades require climbing lanes to meet current design standards.
6		167	Rte.11	Interchange ramps have tapers, acceleration and deceleration, sight distance	
6				lanes less than current design standards	
6	167.7 to	168.7		NBL & SBL has substandard reversing horizontal curves and high speed conditions.	Long runs of maximum SB profile grades require climbing lanes to meet current design standards.
6		168	Rte.614	Interchange ramp terminii spacing on side road is less than current design standard	
6	168.7			SB horizontal curve does not meet current design standards	
6	168.7 to	174.1			Long runs of maximum NB profile grades require climbing lanes to meet current design standards.
6	168.6		Rte.614		Rte. 614 Overpass Vertical Clearance less than 16.5', and does not meet current design standard
6	170.3				Sight Distance on Vertical Curves on Crest curve NB, less than current design standards
6	170.5				Sight Distance on Vertical Curves on Crest curve NB, less than current design standards
6	171.8		Rte 623		Rte. 623 Overpass Vertical Clearance less than 16.5', and does not meet current design standard
6	171.9				Sight Distance on Vertical Curves on Crest curve NB, less than current design standards
6	172.4				Sight Distance on Vertical Curves on Crest curve NB & SB, less than current design standards
6	172.6				Sight Distance on Vertical Curves on Sag curve NB, less than current design standards
6	172.9				Sight Distance on Vertical Curves on Crest curve NB & SB, less than current design standards
6	175.2 to	175.8		SB 81 Acceleration lane substandard and Median Narrow for currrent design standards,approx. 40'.	
6	179.3		Rte.690		Rte. 690 Overpass Vertical Clearance less than 16.5', and does not meet current design standard
7		180	Rte. 11	Interchange ramps have tapers, acceleration and deceleration	NB 81 Bridge Vertical Clearance less than 16.5' and does not meet current design standard
7				lanes less than current design standards.	
7	184				Sight Distance on Vertical Curves on Crest curves less than current design standards
7	185				Sight Distance on Vertical Curves on Sag curves less than current design standards
7	185 to				Long runs of maximum NB profile grades require climbing lanes to meet current design standards.
7	186				
7		188	Rte. 60		Sight Distance on Vertical Curves on Crest curves less than current design standards
7	190				Sight Distance on Vertical Curves on Crest curves, less than current design standards
7	190.3		Maury River		Long runs of maximum NB profile grades require climbing lanes to meet current design standards.
7		191	I-64	Safety concerns with NBL left Hand exit ramps.	
7	191.7 to				Long runs of maximum NB profile grades require climbing lanes to meet current design standards.
7	202				
7	195				Sight Distance on Vertical Curves on Crest curves, less than current design standards
7	198.7		Rte. 712		Rte. 712 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
7		205	Rte.606	Interchange ramp terminii spacing on side road is less than current design standard	
7				Delays with heavy truck traffic on interchange off ramps causes safety problem.	
7	207		Rte. 620		Rte. 620 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
7	220 to		Rte.250	SB entrance and exit ramp spacing does not meet current design standards, creating	
7	222		I-81	a safety problem with weaving.	
7	221.1		Rte. 635		Rte. 635 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
7	224.3		Rte. 254		Rte. 254 Ovepass Vertical Clearance less than 16.5' and does not meet current design standard

Interstate 81 Corridor Improvement Study
Existing I-81Geometric Deficencies

STUDY AREA	M.P.	EXIT NO.	SIDE ROAD	HORIZONTAL DEFICIENCY	VERTICAL DEFICIENCY
8	234.5				Sight Distance on Vertical Curves on Crest curves, less than current design standards
8 8	234.6 to 236.4				Long runs of maximum SB profile grades require climbing lanes to meet current design standards.
8	238				Sight Distance on Vertical Curves on Crest curves, less than current design standards
8	240			Median narrow for current Rural Interstate Design standards, approx. 40'	Sight Distance on Vertical Curves on Crest curves, less than current design standards
8		243		Interchange ramp terminii spacing on side road is less than current design standard	
8	243.5				Sight Distance on Vertical Curves on Sag curves, less than current design standards
8 8		245		Interchange ramp terminii spacing on side road is less than current design standard causing Safety concerns and traffic backups during events..	
8	245.1		Rte. 726		Sight Distance on Vertical Curves on Crest curves, less than current design standards
8 8		247 247	Rte.33	Safety problems with ramp weaves on I-81 and Rte 33 in interchange. Safety concern of traffic backups during peak hour caused by substandard weaving.	Sight Distance on Vertical Curves on Crest curves, less than current design standards
8	248			Median narrow for current Rural Interstate Design standards, approx. 40'	Sight Distance on Vertical Curves on Crest curves, less than current design standards
8		251		Tight radius loop on NB off ramp does not meet current design standards.	
8	259				Sight Distance on Vertical Curves on Crest curves, less than current design standards
8	261				Sight Distance on Vertical Curves on Crest curves, less than current design standards
8	262				Sight Distance on Vertical Curves on Crest curves, less than current design standards
9		269	Rte.730	Interchange ramp terminii spacing on side road is less than current design standard	
9		269			Sight Distance of Exit ramps at Rte. 730 does not meet current design standards.
9		270	Rte. 720	Rte.720 Overpass bridge has substandard load rating less than 36 tons.	
9		271	N-S Rwy		I-81Overpass Vertical Clearance less than 23.0' and does not meet current design standard
9		272	Rte. 263	Substandard superelevation NBL & SBL Bridges.	
9		273	Rte.292/703	Interchange ramp terminii spacing on side road is less than current design standard	
9		273	Rte.292/703		Sight Distance of Exit ramps at Rte. 703 does not meet current design standards.
9	273		Rte. 292		Rte. 292 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
9	274		Rte. 796		Rte. 796 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
9	275		Rte.707		Rte. 707 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
9	282		Rte.605		Rte. 605 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
9	284		Rte.816		Rte. 816 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
9	285		Rte. 604		Rte. 604 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
9	295		Rte.638	Rte. 638 Overpass bridge has substandard load rating less than 36 tons.	
9	296		Pugh's Run	Substandard cross slope NBL & SBL Bridges	
9	287		Rte. 600		I-81 Overpass Vertical Clearance less than 14.5' and does not meet current design standard
9	288		Rte.625		I-81 NB Overpass Vertical Clearance less than 14.5' and does not meet current design standard
9	290		Rte.655,653		Rte. 655,653 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
9		291	Rte. 651	Safety problems with ramp geometrics and heavy truck traffic in interchange.	Rte. 651 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
9	292.5				Sight Distance on SB Vertical Curves does not meet current design standards
9	293		Rte.601	Substandard superelevation SBL Bridge.	
9	296				Sight Distance on SB Vertical Curves does not meet current design standards
9		296	Rte.55	Ramp sight distance at Rte. 55 less than current design standard.	Rte. 55 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
9		298	Rte. 11		Rte. 11 Overpass Vertical Clearance less than 16.5' and does not meet current design standard
9	298		I-81		Sight Distance on NB Vertical Curves does not meet current design standards
9	300		I-81	SBL has horizontal curves that do not meet current design standards.	
9	300		I-66	I-66 WB overpass Bridge over I-81 has substandard load rating less than 36 tons.	
9		300	I-66	Safety concerns with left hand exits and ramps .	Long runs of maximum NB profile grades and 66 exit ramp causes safety problem.
9		302	Rte.627	Interchange ramp terminii spacing on side road is less than current design standard.	
9			Rte. 627	Ramp sight distance at Rte. 627 less than current design standard.	
10		307	Rte. 277	Interchange ramp terminii spacing on side road is less than current design standard	
10		313	Rte.50/17	Safety problems with 81 NB Ramp and Rte 50 during peak hour traffic.	Overpass Vertical Clearance less than 16.5' and does not meet current design standard
10		313	Rte. 50/17	Existing Ramp Radii do not meet current design standards.	
10		317	Rte. 11		81 Bridges Vertical Clearance less than 14.5' and does not meet current design standard
10	318		Conrail		Sight Distance on NB & SB Vertical Curves on Crest does not meet current design standards
10		321	Rte.672		Overpass Vertical Clearance less than 16.5' and does not meet current design standard
10		321		Bridge Parapet Walls and substandard shoulders restrict sight distance.	
10 10		323 323	Rte. 669 Rte. 669	Bridge substandard sight distance caused by narrow shoulders, parapets. Deceleration lanes NB and SB exit ramps substandard.	

C

Appendix C
Existing, No Build, and Build Traffic Analysis

- Mainline Inputs for Analysis
- Mainline Analysis Calculations
- Merge Inputs for Analysis
- Merge Analysis Calculations
- Diverge Inputs for Analysis
- Diverge Analysis Calculations
- Weave Inputs for Analysis
- Weave Analysis Calculations

Mainline Inputs for Analysis

I-77/I-81 Overlap Transportation Study
31698.02

I-77/I-81 Basic Freeway Segment - Analysis Inputs

Direction	From Exit	To Exit	Volume	PHF	lanes by direction	f_p	P_T	P_R	grade	length grade (mi)	BFFS	Right Lat Clear	Int/mile	Lane Width
Existing Conditions														
I-81N	72	73	1750	0.90	3	1.00	0.23	0	4	1	70	10	1.00	12
I-81N	73	77	2050	0.90	3	1.00	0.20	0	2.2	4	70	10	0.25	12
I-81N	77	80	1950	0.90	3	1.00	0.21	0	1.4	3	70	10	0.33	12
I-81N	80	81	1900	0.90	3	1.00	0.22	0	0	1	70	10	1.00	12
I-81S	81	80	1800	0.90	3	1.00	0.29	0	0	1	70	10	1.00	12
I-81S	80	77	1750	0.90	3	1.00	0.30	0	2.5	3	70	10	0.33	12
I-81S	77	73	1750	0.90	3	1.00	0.25	0	4	4	70	10	0.25	12
I-81S	73	72	1600	0.90	3	1.00	0.26	0	2.8	1	70	10	1.00	12
2015 No-Build Conditions														
I-81N	72	73	2550	0.90	3	1.00	0.23	0	4	1	70	10	1.00	12
I-81N	73	77	2800	0.90	3	1.00	0.20	0	2.2	4	70	10	0.25	12
I-81N	77	80	2650	0.90	3	1.00	0.21	0	1.4	3	70	10	0.33	12
I-81N	80	81	2650	0.90	3	1.00	0.22	0	0	1	70	10	1.00	12
I-81S	81	80	2750	0.90	3	1.00	0.29	0	0	1	70	10	1.00	12
I-81S	80	77	2800	0.90	3	1.00	0.30	0	2.5	3	70	10	0.33	12
I-81S	77	73	2800	0.90	3	1.00	0.25	0	4	4	70	10	0.25	12
I-81S	73	72	2500	0.90	3	1.00	0.26	0	2.8	1	70	10	1.00	12
2015 Widening Conditions														
I-81N	72	73	2550	0.90	4	1.00	0.23	0	4	1	70	10	1.00	12
I-81N	73	77	2800	0.90	4	1.00	0.20	0	2.2	4	70	10	0.25	12
I-81N	77	80	2650	0.90	4	1.00	0.21	0	1.4	3	70	10	0.33	12
I-81N	80	81	2650	0.90	4	1.00	0.22	0	0	1	70	10	1.00	12
I-81S	81	80	2750	0.90	4	1.00	0.29	0	0	1	70	10	1.00	12
I-81S	80	77	2800	0.90	4	1.00	0.30	0	2.5	3	70	10	0.33	12
I-81S	77	73	2800	0.90	4	1.00	0.25	0	4	4	70	10	0.25	12
I-81S	73	72	2500	0.90	4	1.00	0.26	0	2.8	1	70	10	1.00	12
2035 No-Build Conditions														
I-81N	72	73	3750	0.90	3	1.00	0.25	0	4	1	70	10	1.00	12
I-81N	73	77	4150	0.90	3	1.00	0.23	0	2.2	4	70	10	0.25	12
I-81N	77	80	3950	0.90	3	1.00	0.24	0	1.4	3	70	10	0.33	12
I-81N	80	81	3950	0.90	3	1.00	0.24	0	0	1	70	10	1.00	12
I-81S	81	80	4050	0.90	3	1.00	0.30	0	0	1	70	10	1.00	12
I-81S	80	77	4100	0.90	3	1.00	0.30	0	2.5	3	70	10	0.33	12
I-81S	77	73	4150	0.90	3	1.00	0.24	0	4	4	70	10	0.25	12
I-81S	73	72	3700	0.90	3	1.00	0.26	0	2.8	1	70	10	1.00	12
2035 Widening Conditions														
I-81N	72	73	3750	0.90	4	1.00	0.25	0	4	1	70	10	1.00	12
I-81N	73	77	4150	0.90	4	1.00	0.23	0	2.2	4	70	10	0.25	12
I-81N	77	80	3950	0.90	4	1.00	0.24	0	1.4	3	70	10	0.33	12
I-81N	80	81	3950	0.90	4	1.00	0.24	0	0	1	70	10	1.00	12
I-81S	81	80	4050	0.90	4	1.00	0.30	0	0	1	70	10	1.00	12
I-81S	80	77	4100	0.90	4	1.00	0.30	0	2.5	3	70	10	0.33	12
I-81S	77	73	4150	0.90	4	1.00	0.24	0	4	4	70	10	0.25	12
I-81S	**73**	**72**	**3700**	**0.90**	**4**	**1.00**	**0.26**	**0**	**2.8**	**1**	**70**	**10**	**1.00**	**12**
2015 Alternative C1-81 Existing Alignment														
I-81/77 N	72	73	1450	0.90	3	1.00	0.25	0	4	1	70	10	1.00	12
I-81/77 N	73	77	1700	0.90	3	1.00	0.23	0	2.2	4	70	10	0.25	12
I-81/77 N	77	80	1600	0.90	3	1.00	0.24	0	1.4	3	70	10	0.33	12
I-81/77 N	80	81	1600	0.90	3	1.00	0.24	0	0	1	70	10	1.00	12
I-81/77 S	81	80	1500	0.90	3	1.00	0.30	0	0	1	70	10	1.00	12
I-81/77 S	80	77	1500	0.90	3	1.00	0.30	0	2.5	3	70	10	0.33	12
I-81/77 S	77	73	1550	0.90	3	1.00	0.24	0	4	4	70	10	0.25	12
I-81/77 S	73	72	1250	0.90	3	1.00	0.26	0	2.8	1	70	10	1.00	12
2015 Alternative C1-81 New Alignment														
I-81 N	Seg 1		1,000	0.90	3	1.00	0.30	0	4.14	1	70	10	0.11	12
I-81 N	Seg 2		1,000	0.90	3	1.00	0.30	0	5.36	1	70	10	0.11	12
I-81 N	Seg 3		1,000	0.90	3	1.00	0.30	0	4.10	1	70	10	0.11	12
I-81 N	Seg 4		1,000	0.90	3	1.00	0.30	0	4.96	1	70	10	0.11	12
I-81 N	Seg 5		1,000	0.90	3	1.00	0.30	0	4.59	1	70	10	0.11	12
I-81 S	Seg 5		1100	0.90	3	1.00	0.23	0	4.59	1	70	10	0.11	12
I-81 S	Seg 4		1100	0.90	3	1.00	0.23	0	4.96	1	70	10	0.11	12
I-81 S	Seg 3		1100	0.90	3	1.00	0.23	0	4.1	1	70	10	0.11	12
I-81 S	Seg 2		1100	0.90	3	1.00	0.23	0	5.36	1	70	10	0.11	12
I-81 S	Seg 1		1100	0.90	3	1.00	0.23	0	4.14	1	70	10	0.11	12
2035 Alternative C1-81 Existing Alignment														
I-81/77 N	72	73	2250	0.90	3	1.00	0.25	0	4	1	70	10	1.00	12
I-81/77 N	73	77	2650	0.90	3	1.00	0.23	0	2.2	4	70	10	0.25	12
I-81/77 N	77	80	2450	0.90	3	1.00	0.24	0	1.4	3	70	10	0.33	12
I-81/77 N	80	81	2450	0.90	3	1.00	0.24	0	0	1	70	10	1.00	12
I-81/77 S	81	80	2450	0.90	3	1.00	0.30	0	0	1	70	10	1.00	12
I-81/77 S	80	77	2500	0.90	3	1.00	0.30	0	2.5	3	70	10	0.33	12
I-81/77 S	77	73	2550	0.90	3	1.00	0.24	0	4	4	70	10	0.25	12
I-81/77 S	73	72	2100	0.90	3	1.00	0.26	0	2.8	1	70	10	1.00	12
2035 Alternative C1-81 New Alignment														
I-81 N	Seg 1		1,500	0.90	3	1.00	0.30	0	4.14	1	70	10	0.11	12
I-81 N	Seg 2		1,500	0.90	3	1.00	0.30	0	5.36	1	70	10	0.11	12
I-81 N	Seg 3		1,500	0.90	3	1.00	0.30	0	4.10	1	70	10	0.11	12
I-81 N	Seg 4		1,500	0.90	3	1.00	0.30	0	4.96	1	70	10	0.11	12
I-81 N	Seg 5		1,500	0.90	3	1.00	0.30	0	4.59	1	70	10	0.11	12
I-81 S	Seg 5		1600	0.90	3	1.00	0.23	0	4.59	1	70	10	0.11	12
I-81 S	Seg 4		1600	0.90	3	1.00	0.23	0	4.96	1	70	10	0.11	12
I-81 S	Seg 3		1600	0.90	3	1.00	0.23	0	4.1	1	70	10	0.11	12
I-81 S	Seg 2		1600	0.90	3	1.00	0.23	0	5.36	1	70	10	0.11	12
I-81 S	Seg 1		1600	0.90	3	1.00	0.23	0	4.14	1	70	10	0.11	12

Source: Based on methodology presented in the 2000 Highway Capacity Manual (HCM)

Notes:

Volume = hourly volume (veh/hr)
PHF = peak-hour factor
Lanes by Direction (N)
f_p = driver population factor; f_p = 1.00 for a commuter facility

P_T = proportion trucks
P_R = proportion recreational vehicles
Grade, Length Grade
BFFS = base free-flow speed; BFFS = 70 mph for urban and 75 mph for rural facilities
Right Lat Clear = right shoulder lateral clearance (feet)
Int/Mile = interchange density
Lane Width (feet) (NOTE: assumed to be 12 feet for all segments of this facility)

Mainline Analysis Calculations

I-77/I-81 Overlap Transportation Study
31698.02

I-77-I-81 Basic Freeway Segment - Analysis Inputs

Direction	From Exit	To Exit	Volume	f_{LW}	f_{LC}	f_N	f_{ID}	FFS	V_{MAX}	E_T	E_R	f_{HV}	V_p	Density	$LOS_{Density}$	V/C Ratio	$LOS_{v/c\ ratio}$
Existing Conditions																	
I-81N	72	73	1750	0.0	0	3.0	2.5	64.5	2345	3	2	0.68	946	14.7	B	0.40	B
I-81N	73	77	2050	0.0	0	3.0	0.0	67.0	2370	2	1.2	0.83	911	13.6	B	0.38	B
I-81N	77	80	1950	0.0	0	3.0	0.0	67.0	2370	1.5	1.2	0.90	798	11.9	B	0.34	B
I-81N	80	81	1900	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.90	781	12.1	B	0.33	B
I-81S	81	80	1800	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.87	763	11.8	B	0.33	B
I-81S	80	77	1750	0.0	0	3.0	0.0	67.0	2370	2	1.2	0.77	843	12.6	B	0.36	B
I-81S	77	73	1750	0.0	0	3.0	0.0	67.0	2370	3	2	0.67	972	14.5	B	0.41	B
I-81S	73	72	1600	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.88	670	10.4	A	0.29	A
2015 No-Build Conditions																	
I-81N	72	73	2550	0.0	0	3.0	2.5	64.5	2345	3	2	0.68	1379	21.4	C	0.59	C
I-81N	73	77	2800	0.0	0	3.0	0.0	67.0	2370	2	1.2	0.83	1244	18.6	C	0.52	C
I-81N	77	80	2650	0.0	0	3.0	0.0	67.0	2370	1.5	1.2	0.90	1085	16.2	B	0.46	B
I-81N	80	81	2650	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.90	1089	16.9	B	0.46	B
I-81S	81	80	2750	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.87	1166	18.1	C	0.50	C
I-81S	80	77	2800	0.0	0	3.0	0.0	67.0	2370	2	1.2	0.77	1348	20.1	C	0.57	C
I-81S	77	73	2800	0.0	0	3.0	0.0	67.0	2370	3	2	0.67	1556	23.3	C	0.66	C
I-81S	73	72	2500	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.88	1046	16.2	B	0.45	B
2015 Widening Conditions																	
I-81N	72	73	2550	0.0	0	1.5	2.5	66.0	2360	3	2	0.68	1034	15.7	B	0.44	B
I-81N	73	77	2800	0.0	0	1.5	0.0	68.5	2385	2	1.2	0.83	933	13.6	B	0.39	B
I-81N	77	80	2650	0.0	0	1.5	0.0	68.5	2385	1.5	1.2	0.90	813	11.9	B	0.34	B
I-81N	80	81	2650	0.0	0	1.5	2.5	66.0	2360	1.5	1.2	0.90	817	12.4	B	0.35	B
I-81S	81	80	2750	0.0	0	1.5	2.5	66.0	2360	1.5	1.2	0.87	875	13.3	B	0.37	B
I-81S	80	77	2800	0.0	0	1.5	0.0	68.5	2385	2	1.2	0.77	1011	14.8	B	0.42	B
I-81S	77	73	2800	0.0	0	1.5	0.0	68.5	2385	3	2	0.67	1167	17.0	B	0.49	B
I-81S	73	72	2500	0.0	0	1.5	2.5	66.0	2360	1.5	1.2	0.88	785	11.9	B	0.33	B
2035 No-Build Conditions																	
I-81N	72	73	3750	0.0	0	3.0	2.5	64.5	2345	3	2	0.67	2083	35.0	D	0.89	D
I-81N	73	77	4150	0.0	0	3.0	0.0	67.0	2370	2	1.2	0.81	1891	29.3	D	0.80	D
I-81N	77	80	3950	0.0	0	3.0	0.0	67.0	2370	1.5	1.2	0.89	1639	24.6	C	0.69	C
I-81N	80	81	3950	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.89	1639	25.5	C	0.70	C
I-81S	81	80	4050	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.87	1725	27.0	D	0.74	D
I-81S	80	77	4100	0.0	0	3.0	0.0	67.0	2370	2	1.2	0.77	1974	31.2	D	0.83	D
I-81S	77	73	4150	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	2275	40.6	E	0.96	E
I-81S	73	72	3700	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.88	1549	24.0	C	0.66	C
2035 Widening Conditions																	
I-81N	72	73	3750	0.0	0	1.5	2.5	66.0	2360	3	2	0.67	1563	23.7	C	0.66	C
I-81N	73	77	4150	0.0	0	1.5	0.0	68.5	2385	2	1.2	0.81	1418	20.7	C	0.59	C
I-81N	77	80	3950	0.0	0	1.5	0.0	68.5	2385	1.5	1.2	0.89	1229	17.9	B	0.52	B
I-81N	80	81	3950	0.0	0	1.5	2.5	66.0	2360	1.5	1.2	0.89	1229	18.6	C	0.52	C
I-81S	81	80	4050	0.0	0	1.5	2.5	66.0	2360	1.5	1.2	0.87	1294	19.6	C	0.55	C
I-81S	80	77	4100	0.0	0	1.5	0.0	68.5	2385	2	1.2	0.77	1481	21.6	C	0.62	C
I-81S	77	73	4150	0.0	0	1.5	0.0	68.5	2385	3	2	0.68	1706	25.3	C	0.72	C
I-81S	73	72	3700	0.0	0	1.5	2.5	66.0	2360	1.5	1.2	0.88	1161	17.6	B	0.49	B
2015 Alternative C1-81 Existing Alignment																	
I-81/77 N	72	73	1450	0.0	0	3.0	2.5	64.5	2345	3	2	0.67	806	12.5	B	0.34	B
I-81/77 N	73	77	1700	0.0	0	3.0	0.0	67.0	2370	2	1.2	0.81	774	11.6	B	0.33	B
I-81/77 N	77	80	1600	0.0	0	3.0	0.0	67.0	2370	1.5	1.2	0.89	664	9.9	A	0.28	A
I-81/77 N	80	81	1600	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.89	664	10.3	A	0.28	A
I-81/77 S	81	80	1500	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.87	639	9.9	A	0.27	A
I-81/77 S	80	77	1500	0.0	0	3.0	0.0	67.0	2370	2	1.2	0.77	722	10.8	A	0.30	A
I-81/77 S	77	73	1550	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	850	12.7	B	0.36	B
I-81/77 S	73	72	1250	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.88	523	8.1	A	0.22	A
2015 Alternative C1-81 New Alignment																	
I-81 N	Seg 1	0	1000	0.0	0	3.0	0.0	67.0	2370	3	2	0.63	593	8.9	A	0.25	A
I-81 N	Seg 2	0	1000	0.0	0	3.0	0.0	67.0	2370	3	2	0.63	593	8.9	A	0.25	A
I-81 N	Seg 3	0	1000	0.0	0	3.0	0.0	67.0	2370	3	2	0.63	593	8.9	A	0.25	A
I-81 N	Seg 4	0	1000	0.0	0	3.0	0.0	67.0	2370	3	2	0.63	593	8.9	A	0.25	A
I-81 N	Seg 5	0	1000	0.0	0	3.0	0.0	67.0	2370	3	2	0.63	593	8.9	A	0.25	A
I-81 S	Seg 5	0	1100	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	595	8.9	A	0.25	A
I-81 S	Seg 4	0	1100	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	595	8.9	A	0.25	A
I-81 S	Seg 3	0	1100	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	595	8.9	A	0.25	A
I-81 S	Seg 2	0	1100	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	595	8.9	A	0.25	A
I-81 S	Seg 1	0	1100	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	595	8.9	A	0.25	A

Direction	From Exit	To Exit	Volume	f_{LW}	f_{LC}	f_N	f_{ID}	FFS	V_{MAX}	E_T	E_R	f_{HV}	V_p	Density	$LOS_{Density}$	V/C Ratio	$LOS_{v/c\ ratio}$
2035 Alternative C1-81 Existing Alignment																	
I-81/77 N	72	73	2250	0.0	0	3.0	2.5	64.5	2345	3	2	0.67	1250	19.4	C	0.53	C
I-81/77 N	73	77	2650	0.0	0	3.0	0.0	67.0	2370	2	1.2	0.81	1207	18.0	B	0.51	B
I-81/77 N	77	80	2450	0.0	0	3.0	0.0	67.0	2370	1.5	1.2	0.89	1016	15.2	B	0.43	B
I-81/77 N	80	81	2450	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.89	1016	15.8	B	0.43	B
I-81/77 S	81	80	2450	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.87	1044	16.2	B	0.45	B
I-81/77 S	80	77	2500	0.0	0	3.0	0.0	67.0	2370	2	1.2	0.77	1204	18.0	B	0.51	B
I-81/77 S	77	73	2550	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	1398	20.9	C	0.59	C
I-81/77 S	73	72	2100	0.0	0	3.0	2.5	64.5	2345	1.5	1.2	0.88	879	13.6	B	0.37	B
2035 Alternative C1-81 New Alignment																	
I-81 N	Seg 1	0	1500	0.0	0	3.0	0.0	67.0	2370	3	2	0.63	889	13.3	B	0.38	B
I-81 N	Seg 2	0	1500	0.0	0	3.0	0.0	67.0	2370	3	2	0.63	889	13.3	B	0.38	B
I-81 N	Seg 3	0	1500	0.0	0	3.0	0.0	67.0	2370	3	2	0.63	889	13.3	B	0.38	B
I-81 N	Seg 4	0	1500	0.0	0	3.0	0.0	67.0	2370	3	2	0.63	889	13.3	B	0.38	B
I-81 N	Seg 5	0	1500	0.0	0	3.0	0.0	67.0	2370	3	2	0.63	889	13.3	B	0.38	B
I-81 S	Seg 5	0	1600	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	865	12.9	B	0.36	B
I-81 S	Seg 4	0	1600	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	865	12.9	B	0.36	B
I-81 S	Seg 3	0	1600	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	865	12.9	B	0.36	B
I-81 S	Seg 2	0	1600	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	865	12.9	B	0.36	B
I-81 S	Seg 1	0	1600	0.0	0	3.0	0.0	67.0	2370	3	2	0.68	865	12.9	B	0.36	B

Source: Based on methodology presented in the 2000 Highway Capacity Manual (HCM)

Notes:

f_{LW} = Adjustment to BFFS for Lane Width
f_{LC} = Adjustment to BFFS for Lateral Clearance
f_N = Adjustment to BFFS for Number of Lanes
f_{ID} = Adjustment to BFFS for Interchange Density
FFS = Calculated free-flow speed

V_{MAX} = Maximum Service Flow (pc/hr/ln)
E_T = Passenger-car equivalent for trucks (based on terrain)
E_R = Passenger-car equivalent for recreational vehicles (based on terrain)
f_{HV} = Heavy vehicle adjustment factor
V_p = 15-min passenger car equivalent flow rate (pc//h/ln)

Density = v_p / Speed (pc/mi/ln)
$LOS_{Density}$ = level of service based on segment density
V/C Ratio = volume to capacity ratio
$LOS_{v/c\ ratio}$ = level of service based on v/c ratio; if v/c ratio > 1, LOS = F
Speed = average passenger car speed (mph)

Merge Inputs for Analysis

I-77/I-81 Merge - Analysis Inputs

																	UPSTREAM OFF-RAMP					DOWNSTREAM OFF_RAMP					
Scenario	Direction	Exit	$V_{FREEWAY}$	V_{RAMP}	$PHF_{FREEWAY}$	PHF_{RAMP}	P_{FM}	L_A	f_p	$PT_{(ramp)}$	$PT_{(mainline)}$	grade	length grade	FFS	Lanes/dir	S_{FR}	L_{UP}	$P_{FM\ (2)}$	$L_{EQ(2)}$	L_{DOWN}	$P_{FM\ (3)}$	V_{DOWN}	PHF_{DOWN}	$PT_{(down)}$	$f_{HV\ (down)}$	V_D	$L_{EQ(3)}$
Existing Condtions																											
Existing	NB	72	850	900	0.90	0.90	0.555	1700	1.00	0.39	0.2257	4	1	70	3	25	1531	0.625	334	2640	0.625	100	0.90	0.10	0.83	133	457
Existing	NB	73	1,650	400	0.90	0.90	0.610	1150	1.00	0.04	0.1951	2.2	4	70	3	25	1426	0.610	-17	17107	0.610	300	0.90	0.32	0.76	440	1891
Existing	NB	77	1,750	200	0.90	0.90	0.611	1190	1.00	0.48	0.2051	1.4	3	70	3	25	1373	0.611	-49	12302	0.611	250	0.90	0.20	0.91	306	1290
Existing	NB	80	1,700	200	0.90	0.90	0.614	1300	1.00	0.30	0.2158	0	1	70	3	25	1478	0.614	-15	5755	0.614	1100	0.90	0.32	0.86	1417	5696
Existing	NB	81	800	650	0.90	0.90	0.621	1560	1.00	0.42	0.2274	3	3	70	3	25	3485	0.621	105	8870	0.621	150	0.90	0.27	0.71	234	847
Existing	SB	81	650	1,150	0.90	0.90	0.628	1800	1.00	0.48	0.2861	0	1	70	3	25	3802	0.628	220	2957	0.628	350	0.90	0.21	0.90	431	1425
Existing	SB	80	1,450	300	0.90	0.90	0.607	1050	1.00	0.27	0.2971	2.5	3	70	3	25	1742	0.607	-91	11880	0.607	350	0.90	0.63	0.61	634	2856
Existing	SB	77	1,450	300	0.90	0.90	0.610	1175	1.00	0.33	0.2457	4	4	70	3	25	1531	0.610	59	15523	0.610	350	0.90	0.04	0.93	420	1785
Existing	SB	73	1,400	200	0.90	0.90	0.627	1775	1.00	0.03	0.2625	2.8	1	70	3	25	1901	0.627	118	5067	0.627	1000	0.90	0.38	0.84	1322	4414
Existing	SB	72	600	400	0.90	0.90	0.630	1880	1.00	0.23	0.1300	2.1	2	70	3	25	2482	0.630	18	8395	0.630	200	0.90	0.08	0.93	240	772
2015 No Build																											
2015 NB	NB	72	900	1,650	0.90	0.90	0.555	1700	1.00	0.39	0.2257	4	1	70	3	25	1531	0.625	669	2640	0.625	200	0.90	0.10	0.83	267	915
2015 NB	NB	73	2,350	450	0.90	0.90	0.610	1150	1.00	0.04	0.1951	2.2	4	70	3	25	1426	0.610	195	17107	0.610	500	0.90	0.32	0.76	733	3152
2015 NB	NB	77	2,300	350	0.90	0.90	0.611	1190	1.00	0.48	0.2051	1.4	3	70	3	25	1373	0.611	140	12302	0.611	350	0.90	0.20	0.91	428	1806
2015 NB	NB	80	2,300	350	0.90	0.90	0.660	1300	1.00	0.30	0.2158	0	1	70	3	25	1478	0.614	184	5755	0.660	1900	0.90	0.32	0.86	2447	9839
2015 NB	NB	81	750	1,100	0.90	0.90	0.621	1560	1.00	0.42	0.2274	3	3	70	3	25	3485	0.621	263	8870	0.621	200	0.90	0.27	0.71	312	1129
2015 NB	SB	81	650	2,100	0.90	0.90	0.628	1800	1.00	0.48	0.2861	0	1	70	3	25	3802	0.628	500	2957	0.628	400	0.90	0.21	0.90	492	1628
2015 NB	SB	80	2,350	450	0.90	0.90	0.607	1050	1.00	0.27	0.2971	2.5	3	70	3	25	1742	0.607	232	11880	0.607	400	0.90	0.63	0.61	724	3264
2015 NB	SB	77	2,400	400	0.90	0.90	0.610	1175	1.00	0.33	0.2457	4	4	70	3	25	1531	0.610	436	15523	0.610	500	0.90	0.04	0.93	600	2550
2015 NB	SB	73	2,300	200	0.90	0.90	0.662	1775	1.00	0.03	0.2625	2.8	1	70	3	25	1901	0.627	360	5067	0.662	1650	0.90	0.38	0.84	2182	7284
2015 NB	SB	72	950	350	0.90	0.90	0.630	1880	1.00	0.23	0.1300	2.1	2	70	3	25	2482	0.630	97	8395	0.630	200	0.90	0.08	0.93	240	772
2015 Widening																											
2015 Widening	NB	72	900	1,650	0.90	0.90	0.209	1700	1.00	0.39	0.2257	4	1	70	4	60											
2015 Widening	NB	73	2,350	450	0.90	0.90	0.826	1510	1.00	0.04	0.1951	2.2	4	70	4	25											
2015 Widening	NB	77	2,300	350	0.90	0.90	0.831	1510	1.00	0.48	0.2051	1.4	3	70	4	25											
2015 Widening	NB	80	2,300	350	0.90	0.90	0.835	1510	1.00	0.30	0.2158	0	1	70	4	25											
2015 Widening	NB	81	750	1,100	0.90	0.90	0.555	1560	1.00	0.42	0.2274	3	3	70	3	40											
2015 Widening	SB	81	650	2,100	0.90	0.90	0.209	1800	1.00	0.48	0.2861	0	1	70	4	25											
2015 Widening	SB	80	2,350	450	0.90	0.90	0.812	1510	1.00	0.27	0.2971	2.5	3	70	4	25											
2015 Widening	SB	77	2,400	400	0.90	0.90	0.799	1510	1.00	0.33	0.2457	4	4	70	4	25											
2015 Widening	SB	73	2,300	200	0.90	0.90	0.863	1510	1.00	0.03	0.2625	2.8	1	70	4	25											
2015 Widening	SB	72	950	350	0.90	0.90	1.000	1880	1.00	0.23	0.1300	2.1	2	70	2	50											
2015 Widening	SB	72	400	1,550	0.90	0.90	1.000	610	1.00	0.23	0.1000	2	1	50	2	30											
2035 No Build																											
2035 NB	NB	72	1,300	2,450	0.90	0.90	0.555	1700	1.00	0.34	0.2453	4	1	70	3	25	1531	0.625	1099	2640	0.625	250	0.90	0.06	0.89	312	1070
2035 NB	NB	73	3,500	650	0.90	0.90	0.610	1150	1.00	0.06	0.2265	2.2	4	70	3	25	1426	0.610	600	17107	0.610	750	0.90	0.40	0.71	1167	5015
2035 NB	NB	77	3,400	550	0.90	0.90	0.611	1190	1.00	0.40	0.2380	1.4	3	70	3	25	1373	0.611	495	12302	0.611	550	0.90	0.25	0.89	689	2908
2035 NB	NB	80	3,400	550	0.90	0.90	0.722	1300	1.00	0.25	0.2430	0	1	70	3	25	1478	0.614	536	5755	0.722	2850	0.90	0.40	0.83	3800	15279
2035 NB	NB	81	1,100	1,600	0.90	0.90	0.621	1560	1.00	0.40	0.2889	3	3	70	3	25	3485	0.621	581	8870	0.621	250	0.90	0.52	0.56	494	1788
2035 NB	SB	81	950	3,100	0.90	0.90	0.628	1800	1.00	0.42	0.2963	0	1	70	3	25	3802	0.628	855	2957	0.628	600	0.90	0.29	0.87	764	2528
2035 NB	SB	80	3,450	650	0.90	0.90	0.607	1050	1.00	0.29	0.2951	2.5	3	70	3	25	1742	0.607	633	11880	0.607	550	0.90	0.40	0.71	856	3855
2035 NB	SB	77	3,550	600	0.90	0.90	0.610	1175	1.00	0.40	0.2410	4	4	70	3	25	1531	0.610	934	15523	0.610	700	0.90	0.04	0.93	840	3570
2035 NB	SB	73	3,450	250	0.90	0.90	0.709	1775	1.00	0.04	0.2622	2.8	1	70	3	25	1901	0.627	682	5067	0.709	2300	0.90	0.42	0.83	3092	10324
2035 NB	SB	72	1,400	500	0.90	0.90	0.630	1880	1.00	0.42	0.1526	2.1	2	70	3	25	2482	0.630	292	8395	0.630	250	0.90	0.08	0.93	300	965
2035 Widening																											
2035 Widening	NB	72	1,300	2,450	0.90	0.90	0.209	1700	1.00	0.34	0.2453	3.9	1	70	4	60											
2035 Widening	NB	73	3,500	650	0.90	0.90	0.683	1510	1.00	0.06	0.2265	2.2	4	70	4	30											
2035 Widening	NB	77	3,400	550	0.90	0.90	0.687	1510	1.00	0.40	0.2380	1.4	3	70	4	30											
2035 Widening	NB	80	3,400	550	0.90	0.90	0.693	1510	1.00	0.25	0.2430	0	1	70	4	30											
2035 Widening	NB	81	1,600	1,600	0.90	0.90	0.555	1560	1.00	0.40	0.2889	3	3	70	3	40											
2035 Widening	SB	81	950	3,100	0.90	0.90	0.209	1800	1.00	0.42	0.2963	0	1	70	4	30											
2035 Widening	SB	80	3,450	650	0.90	0.90	0.486	1000	1.00	0.29	0.2951	2.5	1	70	4	30											
2035 Widening	SB	77	3,550	600	0.90	0.90	0.473	1000	1.00	0.40	0.2410	3	1	70	4	30											
2035 Widening	SB	73	3,450	250	0.90	0.90	0.744	1510	1.00	0.04	0.2622	2.8	1	70	4	30											
2035 Widening	SB	72	1,400	500	0.90	0.90	1.000	1880	1.00	0.42	0.1526	2.1	2	70	2	50											
2035 Widening	SB	72	600	2,300	0.90	0.90	1.000	610	1.00	0.23	0.1000	2	1	50	2	30											
2015 Build Condition																											
2015 Build Alt C1-81	SB	72	1200	350	0.90	0.90	0.555	1880	1.00	0.23	0.1300	2.1	2	70	3	50	2482	0.630	1473	8395	0.630	200	0.90	0.08	0.96	231	744
2015 Build Alt C1-81	SB	73	1,300	400	0.90	0.90	0.620	1510	1.00	0.08	0.2692	2.2	4	70	3	25	1426	0.620	-425	17107	0.620	450	0.90	0.33	1.50	334	1230
2015 Build Alt C1-81	SB	77	1,250	350	0.90	0.90	0.620	1510	1.00	0.43	0.1840	1.4	3	70	3	25	1373	0.620	-425	12302	0.620	350	0.90	0.23	1.30	300	1106
2015 Build Alt C1-81	SB	80	1,250	350	0.90	0.90	0.620	1510	1.00	0.26	0.2400	0	1	70	3	25	1478	0.620	-425	5755	0.620	150	0.90	0.27	1.36	122	451
2015 Build Alt C1-81	NB	80	1,200	400	0.90	0.90	0.620	1510	1.00	0.30	0.3083	2.5	3	70	3	25	1742	0.620	-425	11880	0.620	350	0.90	0.80	5.00	78	287
2015 Build Alt C1-81	NB	77	1,250	400	0.90	0.90	0.620	1510	1.00	0.38	0.1680	4	4	70	3	25	1531	0.620	-425	15523	0.620	450	0.90	0.07	1.07	467	1721
2015 Build Alt C1-81	NB	73	1,200	150	0.90	0.90	0.620	1510	1.00	0.03	0.2750	2.8	1	70	3	25	1901	0.620	-425		0.620		0.90				
81-1-M 2015 Build Alt C1-81	NB	81	150	1100	0.90	0.90	1.000	580	1.00	0.40	0.2889	3	3	70	2	50											
New Exit 72 & 81	From	To																									
72-5-M 2015 Build Alt C1-81	I-81 NB	I/77-81 NB	1,300	150	0.90	0.90	1.000	580	1.00	0.27	0.2462	2	1	70	2	40											
72-4-M 2015 Build Alt C1-81	I-81 NB	I-77 NB	1,250	380	0.90	0.90	1.000	580	1.00	0.34	0.2417	2	1	70	2	40											
72-2-M 2015 Build Alt C1-81	I-77 SB	New I-81NB	950	50	0.90	0.90	1.000	580	1.00	0.20	0.2526	2	1	70	2	50											
72-9-M 2015 Build Alt C1-81	New I-81SB	I-77 NB	1,200	50	0.90	0.90	1.000	580	1.00	0.20	0.2000	2	1	70	2	50											
72-10-M 2015 Build Alt C1-81	I-77-81 NB	I-81 SB	1,050	150	0.90	0.90	1.000	580	1.00	0.25	0.2500	2	1	70	2	50											
81-4-M 2015 Build Alt C1-81	I-81 SB	I-77-81 SB	1,500	100	0.90	0.90	1.000	580	1.00	0.30	0.3000	2	1	70	2	60											
2035 Build Conditions																											
2035 Build Alt C1-81	SB	72	1730	500	0.9	0.9	0.555	1880	1.00	0.42	0.1526	2.1	2	70	3	50	2482	0.630	1815	8395	0.630	250	0.90	0.08	0.93	300	965
2035 Build Alt C1-81	SB	73	2,000	650	0.90	0.90	0.620	1510	1.00	0.07	0.2650	2.2	4	70	3	25	1426	0.620	-425	17107	0.620	750	0.90	0.29	1.41	589	2173
2035 Build Alt C1-81	SB	77	1,900	550	0.90	0.90	0.620	1510	1.00	0.40	0.1842	1.4	3	70	3	25	1373	0.620	-425	12302	0.620	550	0.90	0.22	1.28	478	1762
2035 Build Alt C1-81	SB	80	1,900	550	0.90	0.90	0.620	1510	1.00	0.25	0.2368	0	1	70	3	25	1478	0.620	-425	5755	0.620		0.90		1.00	0	0
2035 Build Alt C1-81	NB	80	1,850	650	0.90	0.90	0.620	1510	1.00	0.29	0.3081	2.5	3	70	3	25	1742	0.620	-425	11880	0.620	550	0.90	0.82	5.49	111	410
2035 Build Alt C1-81	NB	77	1,950	600	0.90	0.90	0.620	1510	1.00	0.40	0.1590	4	4	70	3	25	1531	0.620	-425	15523	0.620	700	0.90	0.06	1.06	733	2705
2035 Build Alt C1-81	NB	73	1,850	250	0.90	0.90	0.620	1510	1.00	0.04	0.2757	2.8	1	70	3	25	1901	0.620	-425		0.620		0.90				
81-1-M 2035 Build Alt C1-81	NB	81	100	1600	0.90	0.90	1.000	580	1.00	0.10	0.2889	3	3	70	2	50											
New Exit 72 & 81	From	To																									
72-5-M 2035 Build Alt C1-81	I-81 NB	I/77-81 NB	2,000	250	0.90	0.90	1.000	580	1.00	0.27	0.2462	2	1	70	2	40											
72-4-M 2035 Build Alt C1-81	I-81 NB	I-77 NB	1,970	600	0.90	0.90	1.000	580	1.00	0.34	0.2417	2	1	70	2	40											
72-2-M 2035 Build Alt C1-81	I-77 SB	New I-81NB	1,450	50	0.90	0.90	1.000	580	1.00	0.20	0.2526	2	1	70	2	50											
72-9-M 2035 Build Alt C1-81	New I-81SB	I-77 NB	1,900	50	0.90	0.90	1.000	580	1.00	0.20	0.2000	2	1	70	2	50											
72-10-M 2035 Build Alt C1-81	I-77-81 NB	I-81 SB	1,530	200	0.90	0.90	1.000	580	1.00	0.25	0.2500	2	1	70	2	50											
81-4-M 2035 Build Alt C1-81	I-81 SB	I-77-81 SB	2,300	150	0.90	0.90	1.000	580	1.00	0.30	0.3000	2	1	70	2	60											

Source: Based on methodology presented in the 2000 Highway Capacity Manual (HCM)

Notes:

$V_{FREEWAY}$ = freeway flow-rate immediately upstream of merge (veh/h)
V_{RAMP} = on-ramp flow-rate (veh/h)
$PHF_{FREEWAY}$= peak-hour factor on freeway(NOTE: assumed to be 0.90 for this facility)
PHF_{RAMP}= peak-hour factor on ramp (NOTE: assumed to be 0.90 for this facility)
P_{FM} = proportion of approaching freeway flow remaining in Lanes 1 and 2 immediatelty upstream of merge
L_A = length of acceleratin lane (ft)
f_p = driver population factor; f_p = 1.00 for a commuter facility (NOTE: assumed to be a commuter facility)
$PT_{(ramp)}$ = proportion trucks on ramp

$PT_{(mainline)}$ = proportion trucks on mainline
Grade, Length Grade
FFS = free-flow speed
S_{FR} = free-flow speed of ramp at point of merge area (mph)
L_{UP} = distance to adjacent upstream ramp (ft)
$P_{FM\ (2)}$ = proportion of approaching freeway flow remaining in Lanes 1 and 2 immediatelty upstream of merge based on Equation 2 of Exhibit 25-5 of HCM
$L_{EQ(2)}$ = equilibrium distance for Equation 25-2 of HCM
L_{DOWN} = distance to adjacent downstream ramp (ft)
$P_{FM\ (3)}$ = proportion of approaching freeway flow remaining in Lanes 1 and 2 immediatelty upstream of merge based on Equation 3 of Exhibit 25-5 of HCM
V_{DOWN} = downstream ramp flow-rate (veh/h)
PHF_{DOWN} = peak-hour factor on downstream ramp (NOTE: assumed to be 0.90 for this facility)
$PT_{(down)}$ = proportion trucks on downstream ramp
$f_{HV\ (down)}$ = Heavy vehicle adjustment factor for downstream ramp

V_D = demand flow on adjacent downstream ramp (pc/h)
$L_{EQ(3)}$ = equilibrium distance for Equation 25-3 of HCM

Merge Analysis Calculations

I-77/I-81 Merge - Analysis Calculations

	Scenario	Direction	Exit	$f_{HV\ (mainline)}$	$f_{HV\ (ramp)}$	E_T	E_R	V_F	V_R	V_{12}	$V_{FO\ Merge}$	$V_{R12\ Merge}$	V	M_s	S_r	D_R	LOS
	Existing Condtions																
	Existing	NB	72	0.69	0.56	3		1371	1780	761	3151	2541	7200	0.29	62	13.7	B
	Existing	NB	73	0.84	0.96	2		2191	462	1336	2653	1798	7200	0.29	62	12.1	B
	Existing	NB	77	0.91	0.81	1.5		2144	276	1310	2419	1585	7200	0.28	62	10.2	B
	Existing	NB	80	0.90	0.87	1.5		2093	256	1285	2348	1540	7200	0.27	62	9.2	A
	Existing	NB	81	0.75	0.61	2.5		1192	1177	741	2369	1918	7200	0.27	62	10.1	B
	Existing	SB	81	0.87	0.81	1.5		826	1584	518	2410	2103	7200	0.26	63	9.8	A
	Existing	SB	80	0.77	0.79	2		2090	423	1268	2513	1692	7200	0.29	62	11.9	B
	Existing	SB	77	0.67	0.60	3		2403	553	1467	2956	2020	7200	0.29	62	13.6	B
	Existing	SB	73	0.88	0.99	1.5		1760	226	1104	1985	1329	7200	0.25	63	4.6	A
	Existing	SB	72	0.88	0.81	2		753	547	475	1300	1021	7200	0.24	63	1.4	A
	2015 No Build																
	2015 NB	NB	72	0.69	0.56	3		1451	3263	806	4715	4069	7200	0.46	57	24.9	C
	2015 NB	NB	73	0.84	0.96	2		3121	520	1903	3641	2423	7200	0.31	61	16.9	B
	2015 NB	NB	77	0.91	0.81	1.5		2818	482	1721	3300	2203	7200	0.30	62	15.0	B
	2015 NB	NB	80	0.90	0.87	1.5		2831	447	1870	3279	2317	7200	0.30	62	15.2	B
	2015 NB	NB	81	0.75	0.61	2.5		1118	1992	694	3110	2686	7200	0.30	62	15.7	B
	2015 NB	SB	81	0.87	0.81	1.5		826	2893	518	3719	3412	7200	0.35	60	19.4	B
	2015 NB	SB	80	0.77	0.79	2		3387	635	2055	4022	2690	7200	0.33	61	19.6	B
	2015 NB	SB	77	0.67	0.60	3		3977	738	2428	4715	3165	7200	0.35	60	22.4	C
	2015 NB	SB	73	0.88	0.99	1.5		2891	226	1913	3117	2139	7200	0.27	63	10.9	B
	2015 NB	SB	72	0.88	0.81	2		1193	478	752	1671	1230	7200	0.24	63	3.0	A
	2015 Widening																
	2015 Widening	NB	72	0.69	0.56	3		1451	3263	303	4715	3567	9600	0.26	63	21.0	C
	2015 Widening	NB	73	0.84	0.96	2		3121	520	2578	3641	3098	9600	0.33	61	19.9	B
	2015 Widening	NB	77	0.91	0.81	1.5		2818	482	2341	3300	2824	9600	0.31	61	17.8	B
	2015 Widening	NB	80	0.90	0.87	1.5		2831	447	2365	3279	2812	9600	0.31	61	17.7	B
	2015 Widening	NB	81	0.75	0.61	2.5		1118	1992	620	3110	2612	7200	0.25	63	15.1	B
	2015 Widening	SB	81	0.87	0.81	1.5		826	2893	173	3719	3066	9600	0.31	61	16.7	B
	2015 Widening	SB	80	0.77	0.79	2		3387	635	2750	4022	3385	9600	0.36	60	22.1	C
	2015 Widening	SB	77	0.67	0.60	3		3977	738	3178	4715	3916	9600	0.44	58	26.2	C
	2015 Widening	SB	73	0.88	0.99	1.5		2891	226	2495	3117	2721	9600	0.30	61	17.1	B
	2015 Widening	SB	72	0.88	0.81	2		1193	478	1193	1671	1671	4800	0.15	66	6.5	A
	2015 Widening	SB	72	0.95	0.90	1.5		467	1920	467	2387	2387	4500	0.33	47	19.3	B
	2035 No Build																
	2035 NB	NB	72	0.67	0.60	3		2153	4573	1195	6726	5768	7200	1.48	28	37.5	F
	2035 NB	NB	73	0.82	0.94	2		4770	766	2908	5535	3674	7200	0.42	58	26.5	C
	2035 NB	NB	77	0.89	0.83	1.5		4227	733	2582	4961	3315	7200	0.37	60	23.5	C
	2035 NB	NB	80	0.89	0.89	1.5		4237	688	3060	4924	3747	7200	0.42	58	26.2	C
	2035 NB	NB	81	0.70	0.63	2.5		1752	2844	1088	4596	3933	7200	0.44	58	24.9	C
	2035 NB	SB	81	0.87	0.83	1.5		1212	4168	761	5380	4929	7200	0.77	48	30.5	F
	2035 NB	SB	80	0.77	0.78	2		4965	932	3013	5896	3945	7200	0.47	57	29.2	D
	2035 NB	SB	77	0.67	0.56	3		5846	1200	3568	7046	4768	7200	0.72	50	34.7	F
	2035 NB	SB	73	0.88	0.98	1.5		4336	283	3074	4619	3358	7200	0.34	60	20.4	C
	2035 NB	SB	72	0.87	0.70	2		1793	789	1130	2582	1919	7200	0.25	63	8.3	A
	2035 Widening																
	2035 Widening	NB	72	0.80	0.75	2		1799	3648	376	5447	4024	9600	0.34	61	24.4	C
	2035 Widening	NB	73	0.82	0.94	2		4770	766	3259	5535	4025	9600	0.45	57	27.0	C
	2035 Widening	NB	77	0.89	0.83	1.5		4227	733	2906	4961	3639	9600	0.38	59	24.0	C
	2035 Widening	NB	80	0.89	0.89	1.5		4237	688	2936	4924	3624	9600	0.38	59	23.9	C
	2035 Widening	NB	81	0.70	0.63	2.5		2548	2844	1414	5393	4259	7200	0.47	57	27.5	C
	2035 Widening	SB	81	0.87	0.83	1.5		1212	4168	253	5380	4421	9600	0.54	55	26.6	C
	2035 Widening	SB	80	0.87	0.87	1.5		4399	827	2138	5226	2965	9600	0.34	61	21.9	C
	2035 Widening	SB	77	0.81	0.71	2		4895	933	2314	5828	3248	9600	0.36	60	24.1	C
	2035 Widening	SB	73	0.88	0.98	1.5		4336	283	3224	4619	3507	9600	0.36	60	23.2	C
	2035 Widening	SB	72	0.87	0.70	2		1793	789	1793	2582	2582	4800	0.18	65	13.4	B
	2035 Widening	SB	72	0.95	0.90	1.5		700	2849	700	3549	3549	4500	0.42	47	27.9	C
	2015 Build Condition																
	2015 Build Alt C1-81	SB	72	0.88	0.81	2		1507	478	836	1985	1315	7200	0.15	66	3.7	A
	2015 Build Alt C1-81	SB	73	0.79	0.93	2		1833	478	1136	2311	1614	7200	0.27	63	8.4	A
	2015 Build Alt C1-81	SB	77	0.92	0.82	1.5		1517	472	940	1989	1412	7200	0.26	63	6.8	A
	2015 Build Alt C1-81	SB	80	0.89	0.89	1.5		1556	439	964	1994	1403	7200	0.26	63	6.7	A
	2015 Build Alt C1-81	NB	80	0.76	0.77	2		1744	578	1081	2322	1659	7200	0.27	63	8.7	A
	2015 Build Alt C1-81	NB	77	0.75	0.57	3		1856	778	1150	2633	1928	7200	0.27	62	10.7	B
	2015 Build Alt C1-81	NB	73	0.88	0.98	1.5		1517	169	940	1686	1109	7200	0.26	63	4.6	A
	2015 Build Alt C1-81	NB	81	0.70	0.63	2.5		239	1956	239	2194	2194	4800	0.30	62	18.0	B
	New Exit 72 & 81	From	To														
72-5-M	2015 Build Alt C1-81	I-81 NB	I/77-81 NB	0.89	0.88	1.5		1622	189	1622	1811	1811	4800	0.30	62	15.9	B
72-4-M	2015 Build Alt C1-81	I-81 NB	I-77 NB	0.89	0.85	1.5		1557	494	1557	2051	2051	4800	0.30	61	17.6	B
72-2-M	2015 Build Alt C1-81	I-77 SB	New I-81NB	0.89	0.91	1.5		1189	61	1189	1250	1250	4800	0.28	62	11.6	B
72-9-M	2015 Build Alt C1-81	New I-81SB	I-77 NB	0.91	0.91	1.5		1467	61	1467	1528	1528	4800	0.28	62	13.7	B
72-10-M	2015 Build Alt C1-81	I-77-81 NB	I-81 SB	0.89	0.89	1.5		1313	188	1313	1500	1500	4800	0.28	62	13.4	B
81-4-M	2015 Build Alt C1-81	I-81 SB	I-77-81 SB	0.87	0.87	1.5		1917	128	1917	2044	2044	4800	0.28	62	17.7	B
	2035 Build Conditions																
	2035 Build Alt C1-81	SB	72	0.87	0.70	2		2216	789	1230	3004	2019	7200	0.16	65	9.0	A
	2035 Build Alt C1-81	SB	73	0.79	0.93	2		2811	773	1742	3584	2515	7200	0.29	62	15.2	B
	2035 Build Alt C1-81	SB	77	0.92	0.83	1.5		2306	733	1429	3039	2162	7200	0.28	62	12.5	B
	2035 Build Alt C1-81	SB	80	0.89	0.89	1.5		2361	689	1463	3050	2152	7200	0.28	62	12.5	B
	2035 Build Alt C1-81	NB	80	0.76	0.77	2		2689	933	1667	3622	2600	7200	0.30	62	15.8	B
	2035 Build Alt C1-81	NB	77	0.76	0.56	3		2856	1200	1770	4056	2970	7200	0.32	61	18.6	B
	2035 Build Alt C1-81	NB	73	0.88	0.98	1.5		2339	283	1450	2622	1733	7200	0.27	63	9.4	A
	2035 Build Alt C1-81	NB	81	0.70	0.87	2.5		159	2044	159	2204	2204	4800	0.30	62	18.0	B
	New Exit 72 & 81	From	To														
72-5-M	2035 Build Alt C1-81	I-81 NB	I/77-81 NB	0.89	0.88	1.5		2496	315	2496	2811	2811	4800	0.34	60	23.6	C
72-4-M	2035 Build Alt C1-81	I-81 NB	I-77 NB	0.89	0.85	1.5		2453	781	2453	3234	3234	4800	0.37	60	26.7	C
72-2-M	2035 Build Alt C1-81	I-77 SB	New I-81NB	0.89	0.91	1.5		1815	61	1815	1876	1876	4800	0.29	62	16.4	B
72-9-M	2035 Build Alt C1-81	New I-81SB	I-77 NB	0.91	0.91	1.5		2322	61	2322	2383	2383	4800	0.31	61	20.4	C
72-10-M	2035 Build Alt C1-81	I-77-81 NB	I-81 SB	0.89	0.89	1.5		1913	250	1913	2163	2163	4800	0.30	62	18.6	B
81-4-M	2035 Build Alt C1-81	I-81 SB	I-77-81 SB	0.87	0.87	1.5		2939	192	2939	3131	3131	4800	0.34	60	26.2	C

Source: Based on methodology presented in the 2000 Highway Capacity Manual (HCM)

Notes:

$f_{HV\ (mainline)}$ = Heavy vehicle adjustment factor for mainline
$f_{HV\ (ramp)}$ = Heavy vehicle adjustment factor for ramp
E_T = Passenger-car equivalent for trucks (based on terrain)
E_R = Passenger-car equivalent for recreational vehicles (based on terrain)
V_F = freeway demand flow-rate immediately upstream of merge (pc/h)
V_R = on-ramp demand flow-rate (pc/h)
V_{12} = flow rate in Lanes 1 and 2 immediatelty upstream of merge (pc/h)
$V_{FO\ Merge}$ = maximum total flow departing from a merge area on the freeway
$V_{R12\ Merge}$ = maximum total flow entering the merge influence area on the freeway
V = maximum downstream freeway flow (pc/h)
M_s = intermediate speed determination variable for merge area
S_r = space mean speed of vehicles within ramp influence area (mph); for merge areas, this includes all vehicles in v_{R12}
D_R = density of merge influence area (pc/mi/ln)

Diverge Inputs for Analysis

I-77/I-81 Diverge - Analysis Inputs

	Scenario	Direction	Exit	$V_{FREEWAY}$	V_{RAMP}	$PHF_{FREEWAY}$	PHF_{RAMP}	L_D	F_P	$PT_{(ramp)}$	$PT_{(mainline)}$	grade	length grade	FFS	Lanes/dir	P_{FD}	S_{FR}	UPSTREAM ON-RAMP L_{UP}	$P_{FD\ (6)}$	V_{UP}	PHF_{UP}	$PT_{(up)}$	$f_{HV\ (up)}$	V_U	$L_{EQ(6)}$	L_{DOWN}	$P_{FD\ (7)}$
	Existing Condtions																										
	Existing	NB	72	1,250	400	0.90	0.90	800	1.00	0.23	0.10	0	2	70	3	0.701	25	12461	0.70	300	0.90	0.07	0.97	345	5159		0.70
	Existing	NB	73	1,750	100	0.90	0.90	1225	1.00	0.10	0.23	4	1	70	3	1.016	25	2640	1.02	900	0.90	0.39	0.56	1789	14179		0.68
	Existing	NB	77	2,050	300	0.90	0.90	950	1.00	0.32	0.20	2.2	4	70	3	0.671	25	17107	0.67	400	0.90	0.04	0.96	461	4592		0.67
	Existing	NB	80	1,950	250	0.90	0.90	900	1.00	0.20	0.21	1.4	3	70	3	0.686	25	12302	0.69	200	0.90	0.48	0.81	276	2679		0.69
	Existing	NB	81	1,900	1,100	0.90	0.90	1570	1.00	0.32	0.22	0	1	70	3	0.450	25	5755	0.65	200	0.90	0.30	0.87	256	14905		0.64
	Existing	SB	81	1,400	750	0.90	0.90	950	1.00	0.35	0.16	1.2	3	70	3	0.673	25	11933	0.67	100	0.90	0.45	0.82	136	3864		0.67
	Existing	SB	80	1,800	350	0.90	0.90	900	1.00	0.21	0.29	0	1	70	3	0.951	25	2957	0.95	1150	0.90	0.48	0.81	1584	17409		0.68
	Existing	SB	77	1,750	300	0.90	0.90	925	1.00	0.63	0.30	2.5	3	70	3	0.672	25	11880	0.67	300	0.90	0.27	0.79	422	4807		0.67
	Existing	SB	73	1,750	350	0.90	0.90	800	1.00	0.04	0.25	4	4	70	3	0.668	25	15523	0.67	300	0.90	0.33	0.60	553	5212		0.67
	Existing	SB	72	1,600	1,000	0.90	0.90	1850	1.00	0.38	0.26	2.8	1	70	3	0.666	25	5069	0.67	200	0.90	0.03	0.99	226	13494		0.65
	2015 No Build Conditions																										
	2015 NB	NB	72	1,300	400	0.90	0.90	800	1.00	0.23	0.10	0	2	70	3	0.699	25	12461	0.70	350	0.90	0.07	0.97	403	5900		0.70
	2015 NB	NB	73	2,550	200	0.90	0.90	1225	1.00	0.10	0.23	4	1	70	3	1.306	25	2640	1.31	1650	0.90	0.39	0.56	3279	22481		0.64
	2015 NB	NB	77	2,800	500	0.90	0.90	950	1.00	0.32	0.20	2.2	4	70	3	0.633	25	17107	0.63	450	0.90	0.04	0.96	519	5129		0.63
	2015 NB	NB	80	2,650	350	0.90	0.90	900	1.00	0.20	0.21	1.4	3	70	3	0.659	25	12302	0.66	350	0.90	0.48	0.81	482	4255		0.66
	2015 NB	NB	81	2,650	1,900	0.90	0.90	1570	1.00	0.32	0.22	0	1	70	3	0.450	25	5755	0.57	350	0.90	0.30	0.87	447	-11196		0.57
	2015 NB	SB	81	1,800	1,150	0.90	0.90	950	1.00	0.35	0.16	1.2	3	70	3	0.647	25	11933	0.65	200	0.90	0.45	0.82	272	41406		0.64
	2015 NB	SB	80	2,750	400	0.90	0.90	900	1.00	0.21	0.29	0	1	70	3	1.172	25	2957	1.17	2100	0.90	0.48	0.81	2893	25348		0.65
	2015 NB	SB	77	2,800	400	0.90	0.90	925	1.00	0.63	0.30	2.5	3	70	3	0.626	25	11880	0.63	450	0.90	0.27	0.79	633	5812		0.63
	2015 NB	SB	73	2,800	500	0.90	0.90	800	1.00	0.04	0.25	4	4	70	3	0.616	25	15523	0.62	400	0.90	0.33	0.60	738	5558		0.62
	2015 NB	SB	72	2,500	1,550	0.90	0.90	1850	1.00	0.38	0.26	2.8	1	70	3	0.587	25	5069	0.59	200	0.90	0.03	0.99	226	-17953		0.59
	2015 Widening Condition																										
	2015 Widening	NB	72	1,300	400	0.90	0.90	800	1.00	0.23	0.10	0	2	70	4	0.436	25										
	2015 Widening	NB	73	2,550	200	0.90	0.90	1225	1.00	0.10	0.23	4	1	70	4	0.436	25										
	2015 Widening	NB	77	2,800	500	0.90	0.90	950	1.00	0.32	0.20	2.2	4	70	4	0.436	25										
	2015 Widening	NB	80	2,650	350	0.90	0.90	900	1.00	0.20	0.21	1.4	3	70	4	0.436	25										
	2015 Widening	NB	81	2,650	1,900	0.90	0.90	1570	1.00	0.32	0.22	0	1	70	4	0.260	25										
	2015 Widening	SB	81	1,800	1,150	0.90	0.90	950	1.00	0.35	0.16	1.2	3	70	4	0.260	25										
	2015 Widening	SB	80	2,750	400	0.90	0.90	900	1.00	0.21	0.29	0	1	70	4	0.436	25										
	2015 Widening	SB	77	2,800	400	0.90	0.90	925	1.00	0.63	0.30	2.5	3	70	4	0.436	25										
	2015 Widening	SB	73	2,800	500	0.90	0.90	800	1.00	0.04	0.25	4	4	70	4	0.436	25										
	2015 Widening	SB	72	2,500	1,550	0.90	0.90	1850	1.00	0.38	0.26	2.8	1	70	4	0.436	25										
	2035 No Build Condition																										
	2035 NB	NB	72	1,900	600	0.90	0.90	800	1.00	0.35	0.15	0	2	70	3	0.667	25	12461	0.67	500	0.90	0.10	0.95	583	9154		0.67
	2035 NB	NB	73	3,750	250	0.90	0.90	1225	1.00	0.08	0.25	4	1	70	3	1.525	25	2640	1.52	2450	0.90	0.34	0.59	4589	24234		0.59
	2035 NB	NB	77	4,150	750	0.90	0.90	950	1.00	0.29	0.23	2.2	4	70	3	0.569	25	17107	0.57	650	0.90	0.06	0.94	767	6422		0.57
	2035 NB	NB	80	3,950	550	0.90	0.90	900	1.00	0.22	0.24	1.4	3	70	3	0.606	25	12302	0.61	550	0.90	0.40	0.83	733	5539		0.61
	2035 NB	NB	81	3,950	2,850	0.90	0.90	1570	1.00	0.29	0.24	0	1	70	3	0.470	25	5755	0.47	550	0.90	0.25	0.89	689	-7541		0.47
	2035 NB	SB	81	2,650	1,700	0.90	0.90	950	1.00	0.36	0.19	1.2	3	70	3	0.577	25	11933	0.58	300	0.90	0.37	0.85	394	-16330		0.58
	2035 NB	SB	80	4,050	600	0.90	0.90	900	1.00	0.30	0.30	0	1	70	3	1.368	25	2957	1.37	3100	0.90	0.42	0.83	4172	31712		0.60
	2035 NB	SB	77	4,100	550	0.90	0.90	925	1.00	0.82	0.30	2.5	3	70	3	0.561	25	11880	0.56	650	0.90	0.29	0.77	933	7640		0.56
	2035 NB	SB	73	4,150	700	0.90	0.90	800	1.00	0.06	0.24	4	4	70	3	0.549	25	15523	0.55	600	0.90	0.40	0.56	1200	7409		0.55
	2035 NB	SB	72	3,700	2,300	0.90	0.90	1850	1.00	0.39	0.26	2.8	1	70	3	0.503	25	5069	0.50	250	0.90	0.04	0.98	283	-5233		0.50
	2035 Widening Condition																										
	2035 Widening	NB	72	1,900	600	0.90	0.90	800	1.00	0.35	0.15	0	2	70	4	0.436	25										
	2035 Widening	NB	73	3,750	250	0.90	0.90	1225	1.00	0.08	0.25	4	1	70	4	0.436	25										
	2035 Widening	NB	77	4,150	750	0.90	0.90	950	1.00	0.29	0.23	2.2	4	70	4	0.436	25										
	2035 Widening	NB	80	3,950	550	0.90	0.90	900	1.00	0.22	0.24	1.4	3	70	4	0.436	25										
	2035 Widening	NB	81	3,950	2,850	0.90	0.90	1570	1.00	0.29	0.24	0	1	70	4	0.260	25										
	2035 Widening	SB	81	2,650	1,700	0.90	0.90	950	1.00	0.36	0.19	1.2	3	70	4	0.260	25										
	2035 Widening	SB	80	4,050	600	0.90	0.90	900	1.00	0.30	0.30	0	1	70	4	0.436	25										
	2035 Widening	SB	77	4,100	550	0.90	0.90	925	1.00	0.82	0.30	2.5	3	70	4	0.436	25										
	2035 Widening	SB	73	4,150	700	0.90	0.90	800	1.00	0.06	0.24	4	4	70	4	0.436	25										
	2035 Widening	SB	72	3,700	2,300	0.90	0.90	1850	1.00	0.39	0.26	2.8	1	70	4	0.436	25										
	2015 Build Conditions																										
	2015 Build Alt C1-81	SB	73	1,450	150	0.90	0.90	1225	1.00	0.07	0.02	4	1	70	3	0.450	25										
	2015 Build Alt C1-81	SB	77	1,700	450	0.90	0.90	950	1.00	0.33	0.22	2.2	4	70	3	0.672	25										
	2015 Build Alt C1-81	SB	80	1,600	350	0.90	0.90	900	1.00	0.23	0.24	1.4	3	70	3	0.690	25										
	2015 Build Alt C1-81	NB	80	1,600	400	0.90	0.90	900	1.00	0.28	0.30	0	1	70	3	0.686	25										
	2015 Build Alt C1-81	NB	77	1,600	350	0.90	0.90	925	1.00	0.80	0.31	2.5	3	70	3	0.670	25										
	2015 Build Alt C1-81	NB	73	1,650	450	0.90	0.90	800	1.00	0.07	0.22	4	4	70	3	0.668	25										
	New Exit 72 and 81	From	To																								
72-2-D	2015 Build Alt C1-81	I-77 SB	New I-81NB	1,350	50	0.90	0.90	340	1.00	0.35	0.25	2	1	70	2	1.000	50										
72-5-D	2015 Build Alt C1-81	I-81 NB	I-77/81 NB	1,330	150	0.90	0.90	440	1.00	0.27	0.28	2	1	70	3	0.450	40										
72-7-D	2015 Build Alt C1-81	New I-81SB	I-77 NB	1,050	50	0.90	0.90	340	1.00	0.00	0.30	2	1	70	2	1.000	50										
72-6-D	2015 Build Alt C1-81	I-77/81 SB	I-81 SB	1,200	50	0.90	0.90	340	1.00	0.33	0.24	2	1	70	2	1.000	50										
81-5-D	2015 Build Alt C1-81	I-77/81 NB	I-81 NB	1,450	150	0.90	0.90	340	1.00	0.27	0.24	2	1	70	2	1.000	50										
81-1-D	2015 Build Alt C1-81	I-77 NB	I-81 NB	2,600	1,100	0.90	0.90	440	1.00	0.39	0.30	2	1	70	3	0.450	40										
81-4-D	2015 Build Alt C1-81	I-81 SB	I-77/81 SB	1,750	100	0.90	0.90	950	1.00	0.36	0.30	2	1	70	2	0.000	25										
	2035 Build Conditions																										
	2035 Build Alt C1-81	SB	73	2,250	250	0.90	0.90	1225	1.00	0.08	0.24	4	1	70	3	0.450	25										
	2035 Build Alt C1-81	SB	77	2,650	750	0.90	0.90	950	1.00	0.29	0.22	2.2	4	70	3	0.621	25										
	2035 Build Alt C1-81	SB	80	2,450	550	0.90	0.90	900	1.00	0.22	0.23	1.4	3	70	3	0.653	25										
	2035 Build Alt C1-81	NB	80	2,450	600	0.90	0.90	900	1.00	0.30	0.31	0	1	70	3	0.646	25										
	2035 Build Alt C1-81	NB	77	2,500	550	0.90	0.90	925	1.00	0.82	0.30	2.5	3	70	3	0.618	25										
	2035 Build Alt C1-81	NB	73	2,550	700	0.90	0.90	800	1.00	0.06	0.22	4	4	70	3	0.619	25										
	New Exit 72 and 81	From	To																								
72-2-D	2035 Build Alt C1-81	I-77 SB	New I-81NB	2,000	50	0.90	0.90	340	1.00	0.20	0.25	2	1	70	2	1.000	50										
72-5-D	2035 Build Alt C1-81	I-81 NB	I-77/81 NB	2,300	250	0.90	0.90	440	1.00	0.27	0.28	2	1	70	3	0.450	40										
72-7-D	2035 Build Alt C1-81	New I-81SB	I-77 NB	1,530	70	0.90	0.90	340	1.00	0.00	0.30	2	1	70	2	1.000	50										
72-6-D	2035 Build Alt C1-81	I-77/81 SB	I-81 SB	1,900	200	0.90	0.90	340	1.00	0.33	0.24	2	1	70	2	1.000	50										
81-5-D	2035 Build Alt C1-81	I-77/81 NB	I-81 NB	2,300	150	0.90	0.90	340	1.00	0.27	0.24	2	1	70	2	1.000	50										
81-1-D	2035 Build Alt C1-81	I-77 NB	I-81 NB	3,900	1,600	0.90	0.90	440	1.00	0.39	0.30	2	1	70	3	0.450	40										
81-4-D	2035 Build Alt C1-81	I-81 SB	I-77/81 SB	1,750	150	0.90	0.90	950	1.00	0.36	0.30	2	1	70	2	0.000	25										

Source: Based on methodology presented in the 2000 Highway Capacity Manual (HCM)

Notes:

$V_{FREEWAY}$ = freeway flow-rate immediately upstream of diverge (veh/h)
V_{RAMP} = on-ramp flow-rate (veh/h)
$PHF_{FREEWAY}$= peak-hour factor on freeway (NOTE: assumed to be 0.90 for this facility)
PHF_{RAMP}= peak-hour factor on ramp (NOTE: assumed to be 0.90 for this facility)
L_D = length of deceleratin lane (ft)
f_p = driver population factor; f_p = 1.00 for a commuter facility (NOTE: assumed to be a commuter facility)
$PT_{(ramp)}$ = proportion trucks on ramp
$PT_{(mainline)}$ = proportion trucks on mainline
Grade, Length Grade (NOTE: assumed level terrain - short grades of no more than 2% - for this facility)
FFS = free-flow speed
P_{FD} = proportion of approaching freeway flow remaining in Lanes 1 and 2 immediatelty upstream of diverge
S_{FR} = free-flow speed of ramp at point of diverge area (mph)
L_{UP} = distance to adjacent upstream ramp (ft)

$P_{FD\ (6)}$ = proportion of approaching freeway flow remaining in Lanes 1 and 2 immediatelty upstream of diverge based on Equation 6 of Exhibit 25-12 of HCM
V_{UP} =upstream ramp flow-rate (veh/h)
PHF_{UP} = peak-hour factor on upstream ramp (NOTE: assumed to be 0.90 for this facility)
$PT_{(up)}$ = proportion trucks on upstream ramp
$f_{HV\ (up)}$ = Heavy vehicle adjustment factor for upstream ramp
V_U = demand flow on adjacent upstream ramp (pc/h)
$L_{EQ(6)}$ = equilibrium distance for Equation 25-8 of HCM
L_{DOWN} = distance to adjacent downstream ramp (ft)
$P_{FD\ (7)}$ = proportion of approaching freeway flow remaining in Lanes 1 and 2 immediatelty upstream of diverge based on Equation 7 of Exhibit 25-12 of HCM
V_{DOWN} = downstream ramp flow-rate (veh/h)
PHF_{DOWN} = peak-hour factor on downstream ramp (NOTE: assumed to be 0.92 for this facility)
$PT_{(down)}$ = proportion trucks on downstream ramp
$f_{HV\ (down)}$ = Heavy vehicle adjustment factor for downstream ramp
V_D = demand flow on adjacent downstream ramp (pc/h)
$L_{EQ(7)}$ = equilibrium distance for Equation 25-9 of HCM

Diverge Analysis Calculations

I-77/I-81 Diverge - Analysis Calculations

	Scenario	Direction	Exit	$f_{HV\ (mainline)}$	$f_{HV\ (ramp)}$	E_T	E_R	V_F	V_R	V_{12}	$V_{FO\ Diverge}$	$V_{R2\ Diverge}$	V	D_s	S_r	D_R	LOS
	Existing Condtions																
	Existing	NB	72	0.95	0.90	1.5		1458	496	1170	963	496	7200	0.60	53	7.1	A
	Existing	NB	73	0.68	0.83	3		2839	133	2881	2706	133	7200	0.57	54	18.0	B
	Existing	NB	77	0.83	0.76	2		2733	440	1980	2293	440	7200	0.60	53	12.7	B
	Existing	NB	80	0.90	0.91	1.5		2394	306	1739	2089	306	7200	0.59	54	11.1	B
	Existing	NB	81	0.90	0.86	1.5		2343	1418	1834	926	1418	7200	0.69	51	5.9	A
	Existing	SB	81	0.93	0.85	1.5		1680	979	1451	701	979	7200	0.65	52	8.2	A
	Existing	SB	80	0.87	0.90	1.5		2290	430	2199	1860	430	7200	0.60	53	15.1	B
	Existing	SB	77	0.77	0.61	2		2528	543	1877	1984	543	7200	0.61	53	12.1	B
	Existing	SB	73	0.67	0.93	3		2917	420	2087	2497	420	7200	0.60	53	15.0	B
	Existing	SB	72	0.88	0.84	1.5		2009	1322	1779	687	1322	7200	0.68	51	2.9	A
	2015 No Build Conditions																
	2015 NB	NB	72	0.95	0.90	1.5		1517	496	1210	1021	496	7200	0.60	53	7.5	A
	2015 NB	NB	73	0.68	0.83	3		4137	267	5321	3870	267	7200	0.58	54	39.0	F
	2015 NB	NB	77	0.83	0.76	2		3733	733	2632	3000	733	7200	0.62	53	18.3	B
	2015 NB	NB	80	0.90	0.91	1.5		3254	428	2290	2826	428	7200	0.60	53	15.8	B
	2015 NB	NB	81	0.90	0.86	1.5		3268	2449	2818	819	2449	7200	0.78	48	14.4	B
	2015 NB	SB	81	0.93	0.85	1.5		2160	1501	1927	659	1501	7200	0.69	51	12.3	B
	2015 NB	SB	80	0.87	0.90	1.5		3499	491	4015	3008	491	7200	0.60	53	30.7	D
	2015 NB	SB	77	0.77	0.61	2		4044	724	2801	3320	724	7200	0.62	53	20.0	B
	2015 NB	SB	73	0.67	0.93	3		4667	600	3104	4067	600	7200	0.61	53	23.7	C
	2015 NB	SB	72	0.88	0.84	1.5		3139	2049	2689	1089	2049	7200	0.74	49	10.7	F
	2015 Widening Condition																
	2015 Widening	NB	72	0.95	0.90	1.5		1517	496	941	1021	496	9600	0.60	53	5.1	A
	2015 Widening	NB	73	0.68	0.83	3		4137	267	1954	3870	267	9600	0.58	54	10.0	A
	2015 Widening	NB	77	0.83	0.76	2		3733	733	2041	3000	733	9600	0.62	53	13.3	B
	2015 Widening	NB	80	0.90	0.91	1.5		3254	428	1660	2826	428	9600	0.60	53	10.4	B
	2015 Widening	NB	81	0.90	0.86	1.5		3268	2449	2662	819	2449	9600	0.78	48	13.0	B
	2015 Widening	SB	81	0.93	0.85	1.5		2160	1501	1673	659	1501	9600	0.69	51	10.1	B
	2015 Widening	SB	80	0.87	0.90	1.5		3499	491	1802	3008	491	9600	0.60	53	11.7	B
	2015 Widening	SB	77	0.77	0.61	2		4044	724	2172	3320	724	9600	0.62	53	14.6	B
	2015 Widening	SB	73	0.67	0.93	3		4667	600	2373	4067	600	9600	0.61	53	17.5	B
	2015 Widening	SB	72	0.88	0.84	1.5		3139	2049	2524	1089	2049	9600	0.74	49	9.3	A
	2035 No Build Condition																
	2035 NB	NB	72	0.93	0.85	1.5		2272	783	1777	1489	783	7200	0.63	52	12.3	B
	2035 NB	NB	73	0.67	0.86	3		6211	322	9300	5889	322	7200	0.59	NA	73.2	F
	2035 NB	NB	77	0.82	0.78	2		5656	1075	3682	4581	1075	7200	0.65	52	27.4	C
	2035 NB	NB	80	0.89	0.90	1.5		4911	678	3244	4233	678	7200	0.62	53	24.0	C
	2035 NB	NB	81	0.89	0.87	1.5		4922	3626	4235	1296	3626	7200	0.88	45	26.5	F
	2035 NB	SB	81	0.91	0.85	1.5		3228	2229	2805	999	2229	7200	0.76	49	19.8	F
	2035 NB	SB	80	0.87	0.87	1.5		5167	767	6785	4400	767	7200	0.63	52	54.5	F
	2035 NB	SB	77	0.77	0.55	2		5900	1112	3800	4788	1112	7200	0.66	52	28.6	D
	2035 NB	SB	73	0.67	0.89	3		6834	871	4145	5963	871	7200	0.64	52	32.7	D
	2035 NB	SB	72	0.88	0.84	1.5		4650	3054	3857	1596	3054	7200	0.83	47	20.8	F
	2035 Widening Condition																
	2035 Widening	NB	72	0.93	0.85	1.5		2272	783	1432	1489	783	9600	0.63	52	9.4	A
	2035 Widening	NB	73	0.67	0.86	3		6211	322	2890	5889	322	9600	0.59	54	18.1	B
	2035 Widening	NB	77	0.82	0.78	2		5656	1075	3072	4581	1075	9600	0.65	52	22.1	C
	2035 Widening	NB	80	0.89	0.90	1.5		4911	678	2524	4233	678	9600	0.62	53	17.9	B
	2035 Widening	NB	81	0.89	0.87	1.5		4922	3626	3963	1296	3626	9600	0.88	45	24.2	C
	2035 Widening	SB	81	0.91	0.85	1.5		3228	2229	2489	999	2229	9600	0.76	49	17.1	B
	2035 Widening	SB	80	0.87	0.87	1.5		5167	767	2685	4400	767	9600	0.63	52	19.2	B
	2035 Widening	SB	77	0.77	0.55	2		5900	1112	3200	4788	1112	9600	0.66	52	23.4	C
	2035 Widening	SB	73	0.67	0.89	3		6834	871	3471	5963	871	9600	0.64	52	26.9	C
	2035 Widening	SB	72	0.88	0.84	1.5		4650	3054	3750	1596	3054	9600	0.83	47	19.9	B
	2015 Build Conditions																
	2015 Build Alt C1-81	SB	73	0.95	0.88	3		1691	189	865	1502	189	7200	0.57	54	0.7	A
	2015 Build Alt C1-81	SB	77	0.82	0.75	2		2311	667	1771	1645	667	7200	0.62	53	10.9	B
	2015 Build Alt C1-81	SB	80	0.89	0.90	1.5		1989	433	1507	1555	433	7200	0.60	53	9.1	A
	2015 Build Alt C1-81	NB	80	0.87	0.88	1.5		2044	506	1561	1539	506	7200	0.60	53	9.6	A
	2015 Build Alt C1-81	NB	77	0.77	0.56	2		2322	700	1786	1622	700	7200	0.62	53	11.3	B
	2015 Build Alt C1-81	NB	73	0.70	0.88	3		2633	566	1947	2067	566	7200	0.61	53	13.8	B
	New Exit 72 and 81	From	To														
72-2-D	2015 Build Alt C1-81	I-77 SB	New I-81NB	0.89	0.85	1.5		1685	65	1685	1619	65	4800	0.24	63	15.7	B
72-5-D	2015 Build Alt C1-81	I-81 NB	I-77/81 NB	0.88	0.88	1.5		1683	189	861	1494	189	7200	0.38	59	7.7	A
72-7-D	2015 Build Alt C1-81	New I-81SB	I-77 NB	0.87	1.00	1.5		1344	56	1344	1288	56	4800	0.24	63	12.8	B
72-6-D	2015 Build Alt C1-81	I-77/81 SB	I-81 SB	0.89	0.86	1.5		1495	65	1495	1430	65	4800	0.24	63	14.0	B
81-5-D	2015 Build Alt C1-81	I-77/81 NB	I-81 NB	0.89	0.88	1.5		1805	189	1805	1616	189	4800	0.25	63	16.7	B
81-1-D	2015 Build Alt C1-81	I-77 NB	I-81 NB	0.87	0.84	1.5		3322	1461	2298	1862	1461	7200	0.49	56	20.1	C
81-4-D	2015 Build Alt C1-81	I-81 SB	I-77/81 SB	0.87	0.85	1.5		2236	131	131	2105	131	4800	0.57	54	0.0	A
	2035 Build Conditions																
	2035 Build Alt C1-81	SB	73	0.67	0.86	3		3722	322	1852	3400	322	7200	0.59	54	9.2	A
	2035 Build Alt C1-81	SB	77	0.82	0.77	2		3578	1078	2630	2500	1078	7200	0.65	52	18.3	B
	2035 Build Alt C1-81	SB	80	0.90	0.90	1.5		3039	678	2219	2361	678	7200	0.62	53	15.2	B
	2035 Build Alt C1-81	NB	80	0.87	0.87	1.5		3139	767	2300	2372	767	7200	0.63	52	15.9	B
	2035 Build Alt C1-81	NB	77	0.77	0.55	2		3622	1111	2664	2511	1111	7200	0.66	52	18.8	B
	2035 Build Alt C1-81	NB	73	0.70	0.90	3		4056	866	2840	3189	866	7200	0.64	52	21.5	C
	New Exit 72 and 81	From	To														
72-2-D	2035 Build Alt C1-81	I-77 SB	New I-81NB	0.89	0.91	1.5		2496	61	2496	2435	61	4800	0.24	63	22.7	C
72-5-D	2035 Build Alt C1-81	I-81 NB	I-77/81 NB	0.88	0.88	1.5		2911	315	1483	2596	315	7200	0.39	59	13.0	B
72-7-D	2035 Build Alt C1-81	New I-81SB	I-77 NB	0.87	1.00	1.5		1958	78	1958	1881	78	4800	0.24	63	18.0	B
72-6-D	2035 Build Alt C1-81	I-77/81 SB	I-81 SB	0.89	0.86	1.5		2367	259	2367	2108	259	4800	0.26	63	21.5	C
81-5-D	2035 Build Alt C1-81	I-77/81 NB	I-81 NB	0.89	0.88	1.5		2864	189	2864	2675	189	4800	0.25	63	25.8	C
81-1-D	2035 Build Alt C1-81	I-77 NB	I-81 NB	0.87	0.84	1.5		4983	2124	3411	2859	2124	7200	0.55	54	29.6	D
81-4-D	2035 Build Alt C1-81	I-81 SB	I-77/81 SB	0.87	0.85	1.5		2236	197	197	2039	197	4800	0.58	54	0.0	A

Source: Based on methodology presented in the 2000 Highway Capacity Manual (HCM)

Notes:

$f_{HV\ (mainline)}$ = Heavy vehicle adjustment factor for mainline
$f_{HV\ (ramp)}$ = Heavy vehicle adjustment factor for ramp
E_T = Passenger-car equivalent for trucks (based on terrain)
E_R = Passenger-car equivalent for recreational vehicles (based on terrain)
VF = freeway demand flow-rate immediately upstream of diverge (pc/h)
V_R = on-ramp demand flow-rate (pc/h)
V_{12} = flow rate in Lanes 1 and 2 immediatelty upstream of diverge (pc/h)
$V_{FO\ diverge}$ = maximum total flow departing from a diverge area on the freeway
$V_{R12\ diverge}$ = maximum total flow entering the diverge influence area on the freeway
V = maximum downstream freeway flow (pc/h)
M_s = intermediate speed determination variable for diverge area
S_r = space mean speed of vehicles within ramp influence area (mph); for diverge areas, this includes all vehicles in v_{12}
D_R = density of diverge influence area (pc/mi/ln)

Weave Inputs for Analysis

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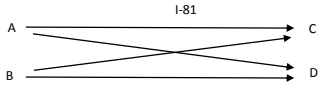
I-81 Weaving Segment - Analysis Inputs **TYPE A**



Scenario	Direction	From Exit	To Exit	Vol A-C	Vol A-D	Vol B-C	Vol B-D	PHF_{A-C}	PHF_{A-D}	PHF_{B-C}	PHF_{B-D}	Lanes	L	F_P	PT_{A-C}	PT_{A-D}	PT_{B-C}	PT_{B-D}	PR	grade	length grade	S_{FF}	S_R
2035 Alt A	NB	72	73	1800	200	200	50	0.90	0.90	0.90	0.90	2	2500	1.00	0.24	0.24	0.24	0.24	0	4	1	70	50
2015 Alt A	NB	72	73	1180	120	120	30	0.90	0.90	0.90	0.90	2	2500	1.00	0.25	0.25	0.25	0.25	0	4	1	70	50

Source: Based on methodology presented in the 2000 Highway Capacity Manual (HCM)

Notes:

Vol A-C = non-weaving freeway flow-rate (veh/h)
Vol A-D = weaving freeway flow-rate (off-ramp volume) (veh/h)
Vol B-C = weaving ramp flow-rate (on-ramp volume - u-turn volume) (veh/h)
Vol B-D = non-weaving ramp flow-rate (u-turn volume) (veh/h)
PHF_{A-C} = peak-hour factor for movement A-C
PHF_{A-D} = peak-hour factor for movement A-D
PHF_{B-C} = peak-hour factor for movement B-C
PHF_{B-D} = peak-hour factor for movement B-D
Lanes = Total number of lanes in weaving area
L = length of weaving area (ft)
f_p = driver population factor; f_p = 1.00 for a commuter facility (NOTE: assumed to be a commuter facility)
PT_{A-C} = proportion trucks on movement A-C
PT_{A-D} = proportion trucks on movement A-D
PT_{B-C} = proportion trucks on movement B-C
PT_{B-D} = proportion trucks on movement B-D
Grade, Length Grade
S_{FF} = average free-flow speed of freeway segments entering and exiting the weaving area (mph)
S_{FR} = free-flow speed of ramps (mph)

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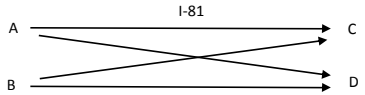
I-81 Weaving Segment (Type B) - Analysis Inputs



Scenario	Direction	From Exit	To Exit	Vol A-C	Vol A-D	Vol B-C	Vol B-D	PHF_{A-C}	PHF_{A-D}	PHF_{B-C}	PHF_{B-D}	Lanes	L	F_p	PT_{A-C}	PT_{A-D}	PT_{B-C}	PT_{B-D}	PR	grade	length grade	S_{FF}	S_{FR}
2035 Alt A	NB	72	41	1340	560	570	100	0.90	0.90	0.90	0.90	3	2000	1.00	0.25	0.25	0.25	0.25	0	3	1	70	50
2015 Alt A	NB	72	41	950	300	330	50	0.90	0.90	0.90	0.90	3	2000	1.00	0.25	0.25	0.25	0.25	0	3	1	70	50

Notes:

Vol A-C = non-weaving freeway flow-rate (veh/h)
Vol A-D = weaving freeway flow-rate (off-ramp volume) (veh/h)
Vol B-C = weaving ramp flow-rate (on-ramp volume - u-turn volume) (veh/h)
Vol B-D = non-weaving ramp flow-rate (u-turn volume) (veh/h)
PHF_{A-C} = peak-hour factor for movement A-C
PHF_{A-D} = peak-hour factor for movement A-D
PHF_{B-C} = peak-hour factor for movement B-C
PHF_{B-D} = peak-hour factor for movement B-D
Lanes = Total number of lanes in weaving area
L = length of weaving area (ft)
f_p = driver population factor; f_p = 1.00 for a commuter facility (NOTE: assumed to be a commuter facility)
PT_{A-C} = proportion trucks on movement A-C
PT_{A-D} = proportion trucks on movement A-D
PT_{B-C} = proportion trucks on movement B-C
PT_{B-D} = proportion trucks on movement B-D
Grade, Length Grade
S_{FF} = average free Referenced from another workbook
S_{FR} = free-flow sp Needs to be updated and/or verified

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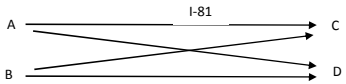
I-81 Weaving Segment (Type C) - Analysis Inputs



Scenario	Direction	From Exit	To Exit	Vol A-C	Vol A-D	Vol B-C	Vol B-D	PHF_{A-C}	PHF_{A-D}	PHF_{B-C}	PHF_{B-D}	Lanes	L	F_p	PT_{A-C}	PT_{A-D}	PT_{B-C}	PT_{B-D}	PR	grade	length grade	S_{FF}	S_R
2035 Widening	NB	72	73	1050	250	2450	0	0.90	0.90	0.90	0.90	4	2500	1.00	0.25	0.25	0.25	0.25	0	4	1	70	25
2015 Widening	NB	72	73	700	200	1650	0	0.90	0.90	0.90	0.90	4	2500	1.00	0.23	0.23	0.23	0.23	0	4	1	70	25

Vol A-D = weaving freeway flow-rate (off-ramp volume) (veh/h)
Vol B-C = weaving ramp flow-rate (on-ramp volume - u-turn volume) (veh/h)
Vol B-D = non-weaving ramp flow-rate (u-turn volume) (veh/h)
PHF_{A-C} = peak-hour factor for movement A-C
PHF_{A-D} = peak-hour factor for movement A-D
PHF_{B-C} = peak-hour factor for movement B-C
PHF_{B-D} = peak-hour factor for movement B-D
Lanes = Total number of lanes in weaving area
L = length of weaving area (ft)
f_p = driver population factor; f_p = 1.00 for a commuter facility
PT_{A-C} = proportion trucks on movement A-C
PT_{A-D} = proportion trucks on movement A-D
PT_{B-C} = proportion trucks on movement B-C
PT_{B-D} = proportion trucks on movement B-D
Grade, Length Grade
S_{FF} = average free-flow speed of freeway segments entering and exiting the weaving area (mph)
S_{FR} = free-flow speed of ramps (mph)

Weave Analysis Calculations

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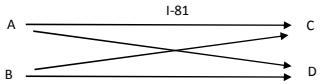
I-81 Weaving Segment - Analysis Calculations **TYPE A**



Scenario	Direction	From Exit	To Exit	E_T	E_R	$f_{HV(A-C)}$	$f_{HV(A-D)}$	$f_{HV(B-C)}$	$f_{HV(B-D)}$	v (A-C)	v (A-D)	v (B-C)	v (B-D)	V_W	V_{NW}	v_{total}	VR	R	$W_{W(U)}$	$W_{W(C)}$	$W_{NW(U)}$	$W_{NW(C)}$	$S_{W(U)}$	N_W	S_W	S_{NW}	S	D	LOS
2035 Alt A	NB	72	73	3	2	0.676	0.676	0.676	0.676	2960	329	329	82	658	3042	3700	0.178	0.500	0.61	1.42	0.34	0.19	52.3	0.61	52.3	59.9	58.39	31.68	D
2015 Alt A	NB	72	73	3	2	0.667	0.667	0.667	0.667	1967	200	200	50	400	2017	2417	0.166	0.500	0.39	0.92	0.19	0.11	58.1	0.56	58.1	65.6	64.23	18.81	B

Source: Based on methodology presented in the 2000 Highway Capacity Manual (HCM)

Notes:

E_T = Passenger-car equivalent for trucks (based on terrain)
$f_{HV\ A-C}$ = Heavy vehicle adjustment factor for movement A-C
$f_{HV\ A-D}$ = Heavy vehicle adjustment factor for movement A-D
$f_{HV\ B-C}$ = Heavy vehicle adjustment factor for movement B-C
$f_{HV\ B-D}$= Heavy vehicle adjustment factor for movement B-D
v (A-C) = demand flow-rate for movement A-C (pc/h)
v (A-D) = demand flow-rate for movement A-D (pc/h)
v (B-C) = demand flow-rate for movement B-C (pc/h)
v (B-D) = demand flow-rate for movement B-D (pc/h)
V_W = total demand flow rate of weaving vehicles (pc/hr)
V_{NW} = total demand flow rate of non-weaving vehicles (pc/hr)
V_{TOTAL} = total demand flow rate in the weaving segment (pc/hr)
VR = volume ratio; the ratio of weaving flow rate to total flow rate in the weaving segment (VR = V_W/V_{TOTAL})
R = weaving ratio; the ratio of the smaller weaving flow rate to the total weaving flow rate (R = V_{W2}/V_W)
$W_{W(U)}$ = weaving intenstiy factor for unconstrained predicition of weaving speed
$W_{W(C)}$ = weaving intenstiy factor for constrained predicition of weaving speed
$W_{NW(U)}$ = weaving intenstiy factor for unconstrained predicition of non-weaving speed
$W_{NW(C)}$ = weaving intenstiy factor for constrained predicition of non-weaving speed
$S_{W(U)}$ = speed of weaving vehicles in an unconstrained weaving segment (mph)
N_W = numbr of lanes that must be used by weaving vehicles to achieve equilibrium or unconstrained operation
S_W= speed of weaving vehicles in a weaving segment (mph)
S_{NW}= speed of non-weaving vehicles in a weaving segment (mph)
S = speed of all vehicles in a weaving segment (mph)
D = density of all vehicles in a weaving segment (pc/mi/ln)

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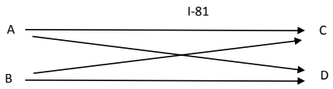
I-81 Weaving Segment (Type B) - Analysis Calculations



Scenario	Direction	From Exit	To Exit	E_T	E_R	$f_{HV(A-C)}$	$f_{HV(A-D)}$	$f_{HV(B-C)}$	$f_{HV(B-D)}$	v (A-C)	v (A-D)	v (B-C)	v (B-D)	V_W	V_{NW}	v_{total}	VR	R	$W_{W(U)}$	$W_{W(C)}$	$W_{NW(U)}$	$W_{NW(C)}$	$S_{W(U)}$	$S_{NW(U)}$	N_W	S_W	S_{NW}	S	D	LOS
2035 Alt A	NB	72	41	2	1.5	0.800	0.800	0.800	0.800	1861	778	792	139	1569	2000	3569	0.440	0.496	0.57	1.06	0.47	0.24	53.3	55.7	1.40	53.3	55.7	54.6	21.8	C
2015 Alt A	NB	72	41	2	1.5	0.800	0.800	0.800	0.800	1319	417	458	69	875	1389	2264	0.387	0.476	0.38	0.71	0.24	0.12	58.5	63.4	1.16	58.5	63.4	61.4	12.3	B

Source: Based on methodology presented in the 2000 Highway Capacity Manual (HCM)

Notes:

E_T = Passenger-car equivalent for trucks (based on terrain)
$f_{HV\ A-C}$ = Heavy vehicle adjustment factor for movement A-C
$f_{HV\ A-D}$ = Heavy vehicle adjustment factor for movement A-D
$f_{HV\ B-C}$ = Heavy vehicle adjustment factor for movement B-C
$f_{HV\ B-D}$= Heavy vehicle adjustment factor for movement B-D
v (A-C) = demand flow-rate for movement A-C (pc/h)
v (A-D) = demand flow-rate for movement A-D (pc/h)
v (B-C) = demand flow-rate for movement B-C (pc/h)
v (B-D) = demand flow-rate for movement B-D (pc/h)
V_W = total demand flow rate of weaving vehicles (pc/hr)
V_{NW} = total demand flow rate of non-weaving vehicles (pc/hr)
V_{TOTAL} = total demand flow rate in the weaving segment (pc/hr)
VR = volume ratio; the ratio of weaving flow rate to total flow rate in the weaving segment (VR = v_W/V_{TOTAL})
R = weaving ratio; the ratio of the smaller weaving flow rate to the total weaving flow rate (R = v_{W2}/V_W)
$W_{W(U)}$ = weaving intenstiy factor for unconstrained predicition of weaving speec
$W_{W(C)}$ = weaving intenstiy factor for constrained predicition of weaving speed
$W_{NW(U)}$ = weaving intenstiy factor for unconstrained predicition of non-weaving speed
$W_{NW(C)}$ = weaving intenstiy factor for constrained predicition of non-weaving speec
$S_{W(U)}$ = speed of weaving vehicles in an unconstrained weaving segment (mph)
N_W = numbr of lanes that must be used by weaving vehicles to achieve equilibrium or unconstrained operatior
S_W= speed of weaving vehicles in a weaving segment (mph)
S_{NW}= speed of non-weaving vehicles in a weaving segment (mph)
S = speed of all vehicles in a weaving segment (mph)
D = density of all vehicles in a weaving segment (pc/mi/ln)

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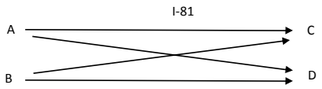
I-81 Weaving Segment (Type C) - Analysis Calculations



Scenario	Direction	From Exit	To Exit	E_T	E_R	$f_{HV(A-C)}$	$f_{HV(A-D)}$	$f_{HV(B-C)}$	$f_{HV(B-D)}$	v (A-C)	v (A-D)	v (B-C)	v (B-D)	V_W	V_{NW}	v_{total}	VR	R	$W_{W(U)}$	$W_{W(C)}$	$W_{NW(U)}$	$W_{NW(C)}$	$S_{W(U)}$	$S_{NW(U)}$	N_W	S_W	S_{NW}	S	D	LOS
2035 Widening	NB	72	73	3	2	0.667	0.667	0.667	0.667	1750	417	4083	0	4500	1750	6250	0.720	0.093	0.91	1.60	1.54	0.77	46.3	38.6	3.33	38.1	48.9	40.6	38.5	E
2015 Widening	NB	72	73	3	2	0.685	0.685	0.685	0.685	1136	324	2677	0	3001	1136	4137	0.725	0.108	0.66	1.16	1.00	0.50	51.1	45.0	3.30	42.8	55.0	45.6	22.7	C

Source: Based on methodology presented in the 2000 Highway Capacity Manual (HCM)

Notes:

E_T = Passenger-car equivalent for trucks (based on terrain)
$f_{HV\ A-C}$ = Heavy vehicle adjustment factor for movement A-C
$f_{HV\ A-D}$ = Heavy vehicle adjustment factor for movement A-D
$f_{HV\ B-C}$ = Heavy vehicle adjustment factor for movement B-C
$f_{HV\ B-D}$= Heavy vehicle adjustment factor for movement B-D
v (A-C) = demand flow-rate for movement A-C (pc/h)
v (A-D) = demand flow-rate for movement A-D (pc/h)
v (B-C) = demand flow-rate for movement B-C (pc/h)
v (B-D) = demand flow-rate for movement B-D (pc/h)
V_W = total demand flow rate of weaving vehicles (pc/hr)
V_{NW} = total demand flow rate of non-weaving vehicles (pc/hr)
V_{TOTAL} = total demand flow rate in the weaving segment (pc/hr)
VR = volume ratio; the ratio of weaving flow rate to total flow rate in the weaving segment (VR = V_W/V_{TOTAL})
R = weaving ratio; the ratio of the smaller weaving flow rate to the total weaving flow rate (R = V_{W2}/V_W)
$W_{W(U)}$ = weaving intenstiy factor for unconstrained predicition of weaving speec
$W_{W(C)}$ = weaving intenstiy factor for constrained predicition of weaving speed
$W_{NW(U)}$ = weaving intenstiy factor for unconstrained predicition of non-weaving speed
$W_{NW(C)}$ = weaving intenstiy factor for constrained predicition of non-weaving speec
$S_{W(U)}$ = speed of weaving vehicles in an unconstrained weaving segment (mph)
N_W = numbr of lanes that must be used by weaving vehicles to achieve equilibrium or unconstrained operatior
S_W= speed of weaving vehicles in a weaving segment (mph)
S_{NW}= speed of non-weaving vehicles in a weaving segment (mph)
S = speed of all vehicles in a weaving segment (mph)
D = density of all vehicles in a weaving segment (pc/mi/ln)