

RH SIP Technical Support Documentation – Visibility Modeling

February 20, 2015

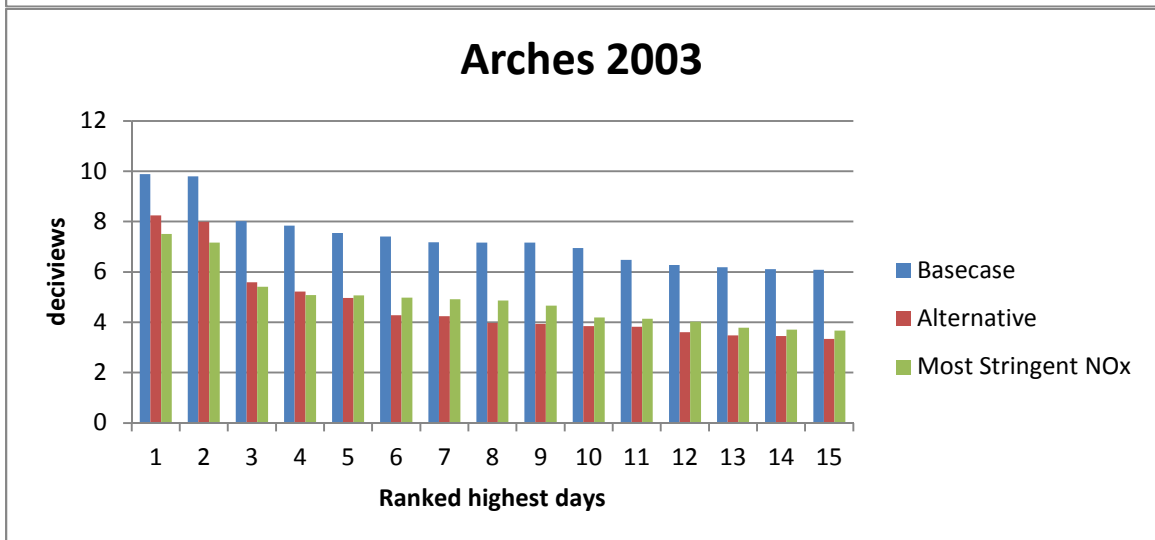
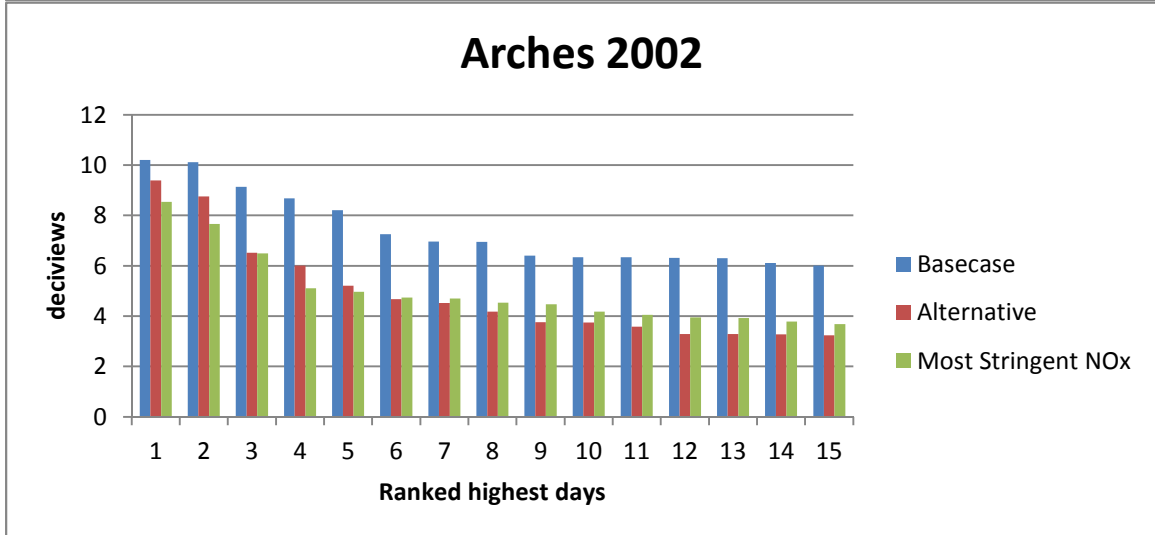
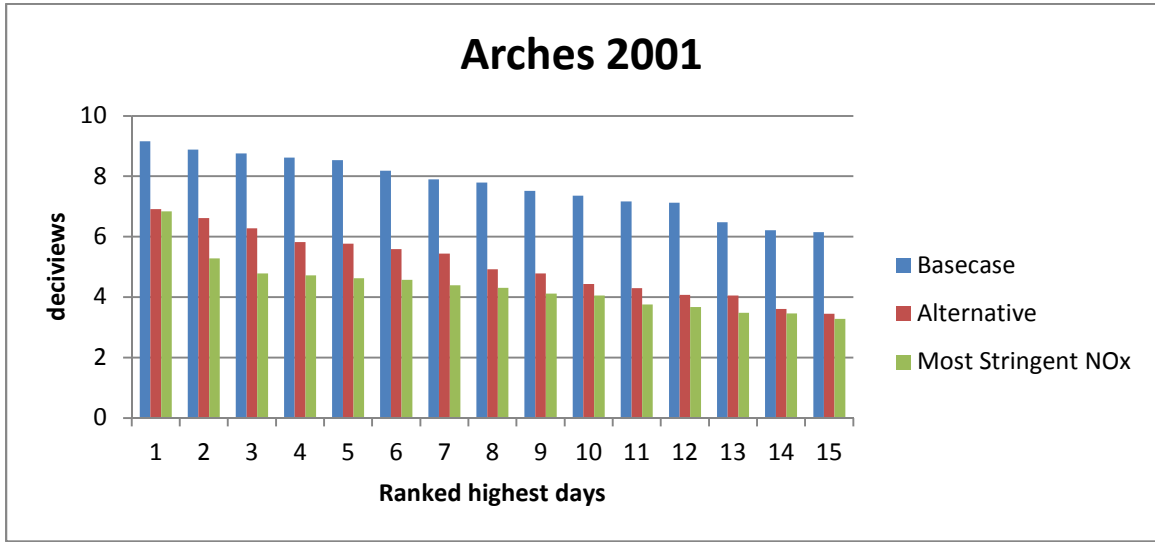
The Division of Air Quality has performed CALPUFF Modeling to compare an alternative to BART to the most stringent technology available to reduce NOx. The modeling evaluated three alternative scenarios that included all units at the Hunter, Huntington, and Carbon power plants.

Baseline	Baseline (2001-3) Conditions for Hunter 1,2,3 and Huntington 1,2; Carbon 1,2 (2012-13)
Alternative	2008 SIP controls Hunter 1,2 and Huntington 1,2; Low NOx burners Hunter 3; Carbon 1,2 shut down
Most stringent NOx control	SCR Hunter 1,2 and Huntington 1,2; Hunter 3 and Carbon 1,2 baseline

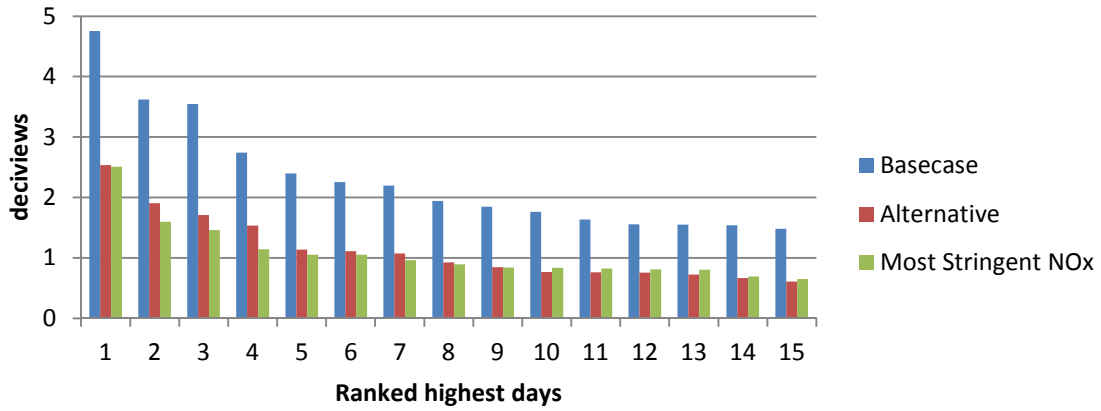
The visibility impact is typically evaluated using three metrics: the number of days with greater than 0.5 dV impact, the number of days with greater than 1.0 dV impact, and the 98th percentile impact. The results of these metrics show that the number of days impacted are lower under the alternative scenario while the 98th percentile is lower under the most stringent NOx control scenario. Looking closer at the data, it can be seen that the results for the two control alternatives varied by day, by year, and by Class I area because different pollutants were reduced at different locations. For this reason, it is necessary to look at a number of different metrics when comparing the different alternatives.

All Class I areas	Basecase	Alternative	Most stringent NOx
# Days > 0.5 dV impact ¹	784	441	499
# Days > 1.0 dV impact ¹	511	258	264
Average 98th percentile (Δ dV)	4.25	2.39	2.25
average (Δ dV)	0.55	0.28	0.29

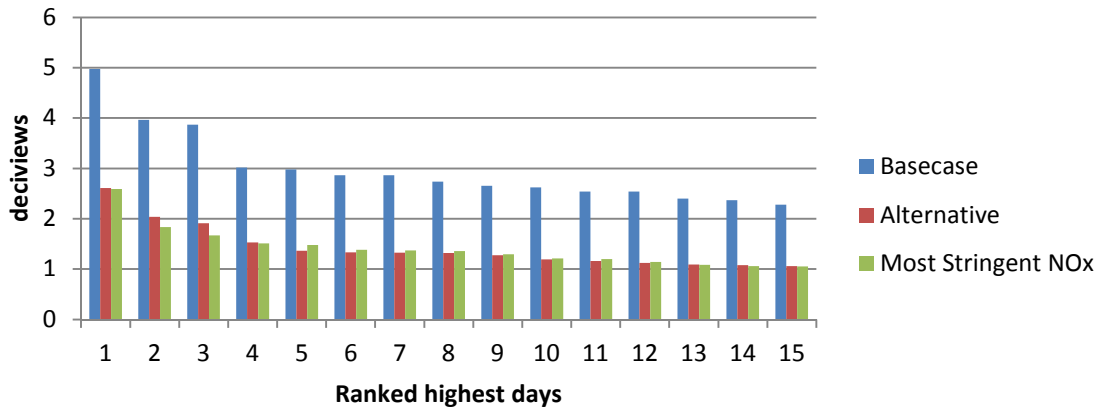
Appendix A shows the results for the highest 15 days for each year for each Class I area. As can be seen, the results vary between the two alternatives, with some days showing better results under the most stringent NOx scenario while others show better results under the alternative scenario. Appendix B through D contain averages, number of days impacted, 90th percentile, and 98th percentile values.



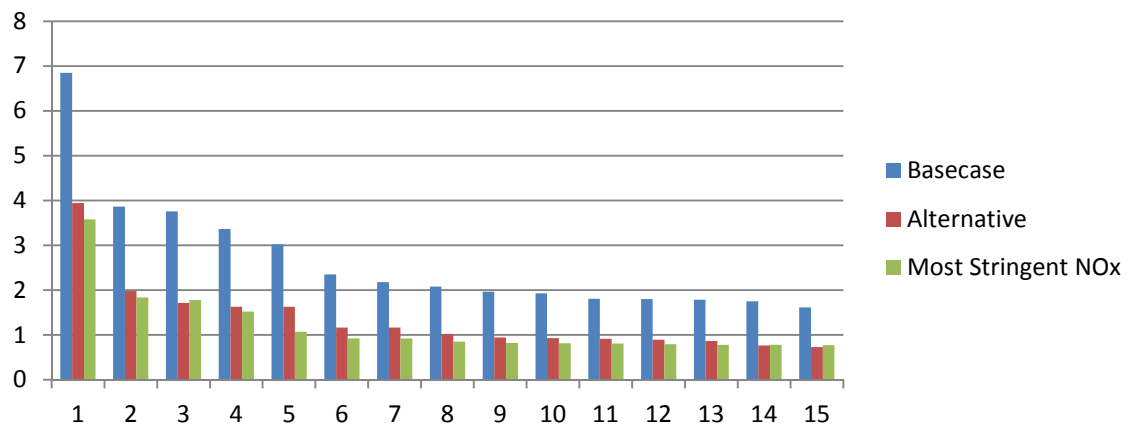
Black Canyon of the Gunnison 2001



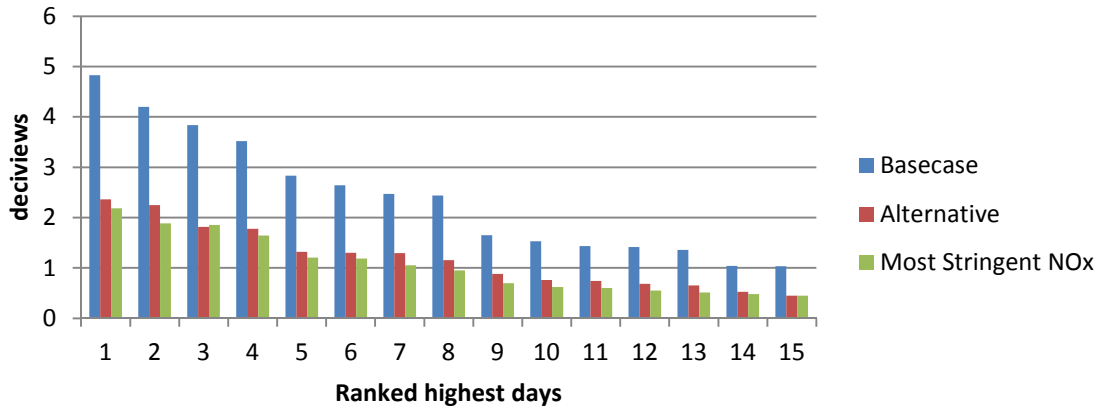
Black Canyon of the Gunnison 2002



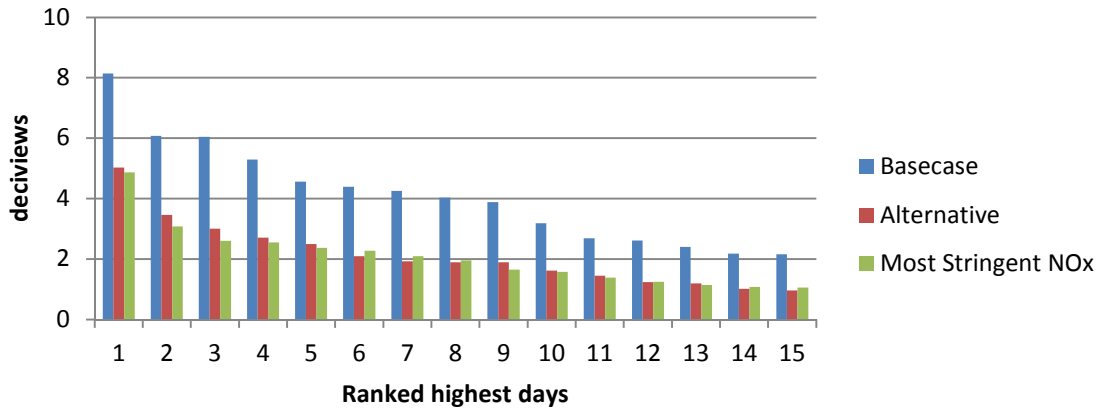
Black Canyon of the Gunnison 2003



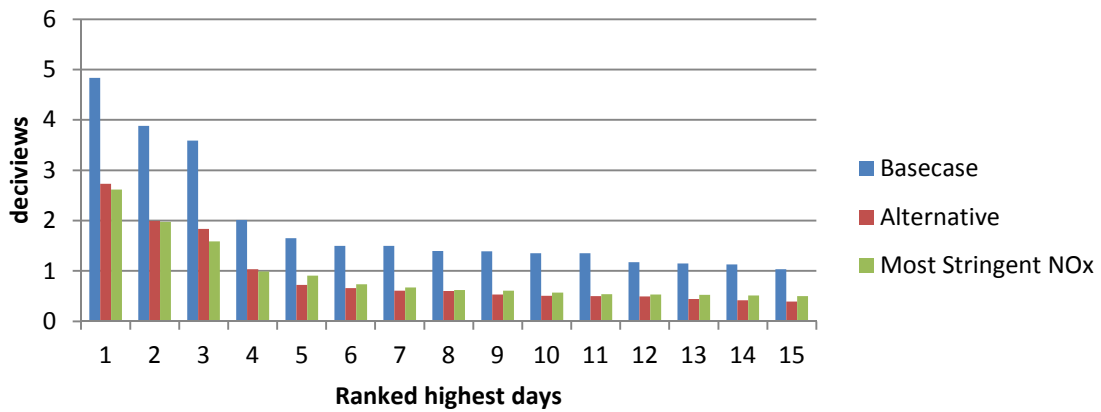
Bryce 2001



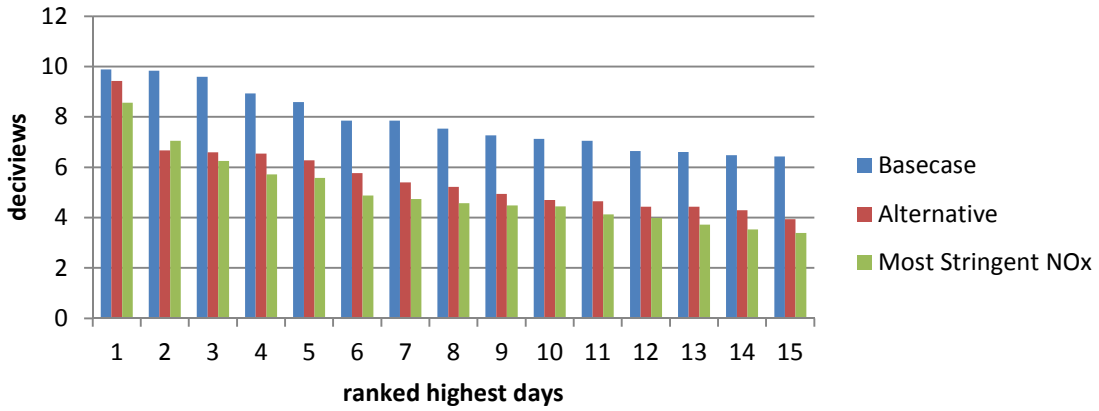
Bryce 2002



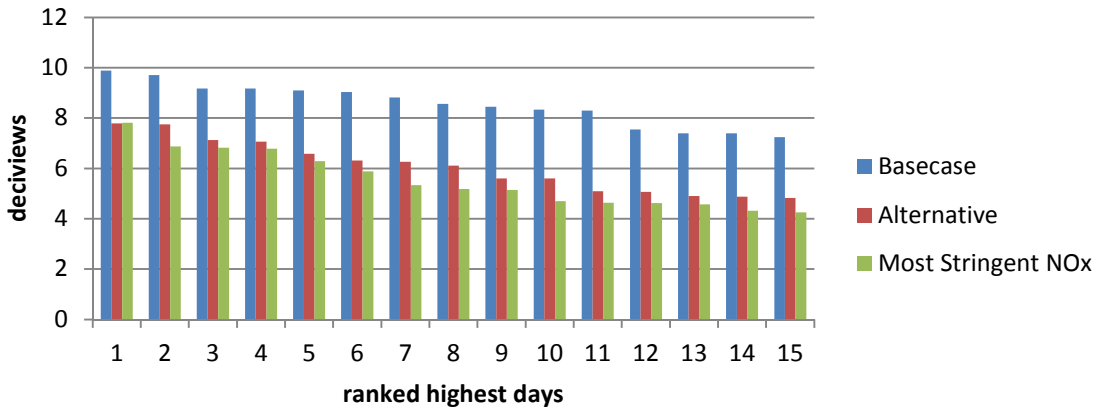
Bryce 2003



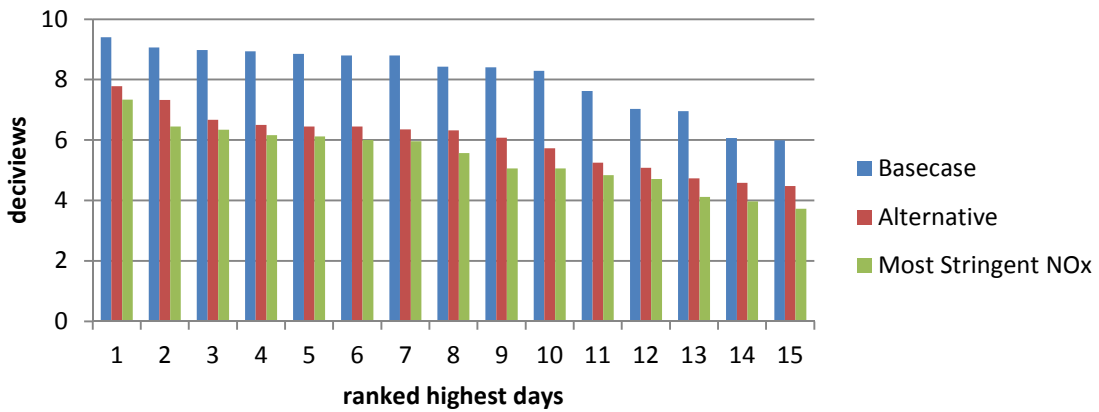
Canyonlands 2001



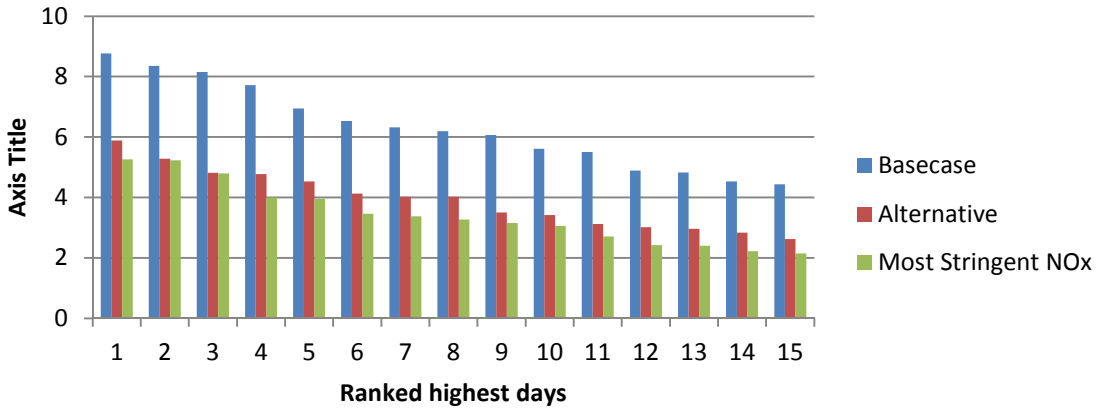
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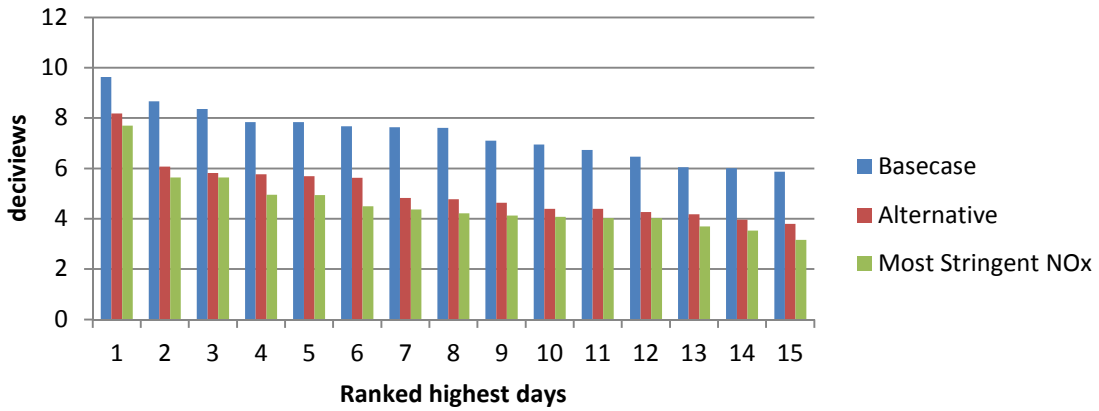
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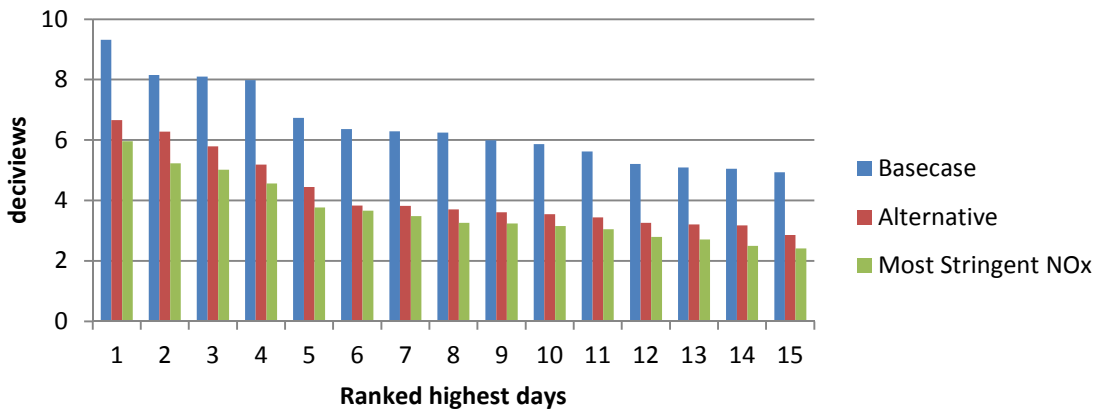
Capitol Reef 2001



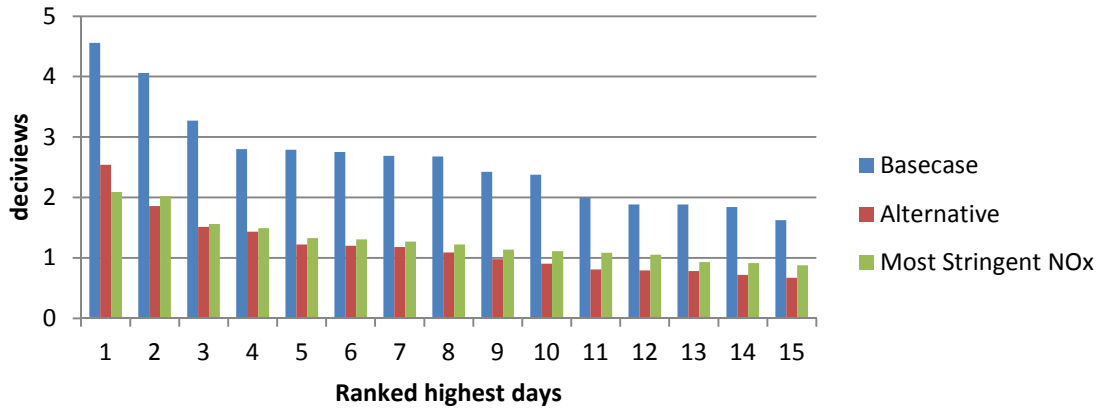
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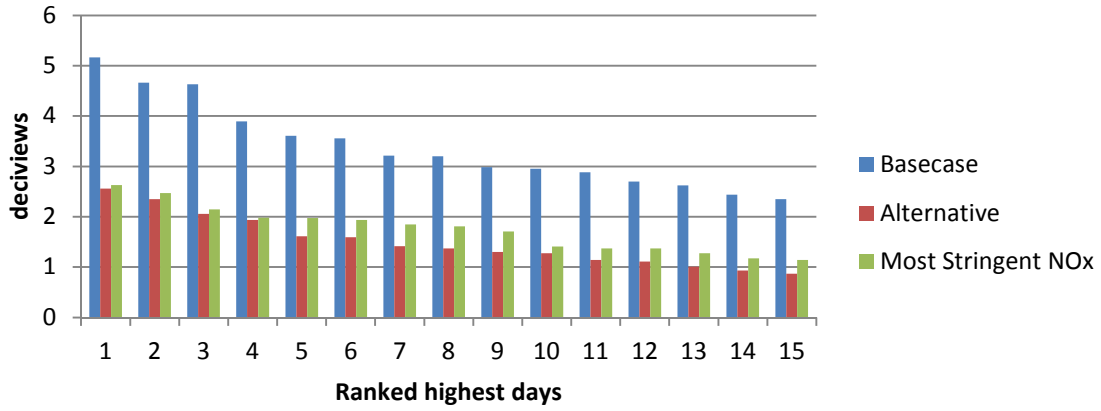
Capitol Reef 2003



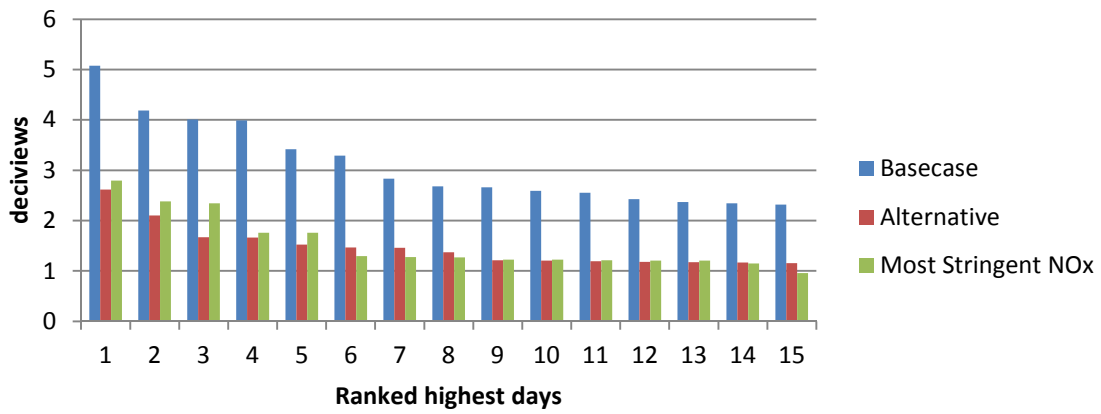
Flat Tops 2001



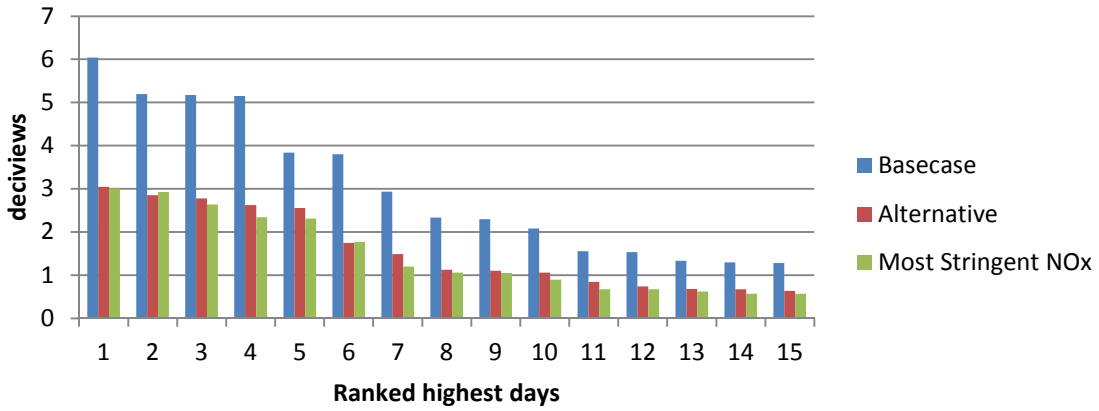
Flat Tops 2002



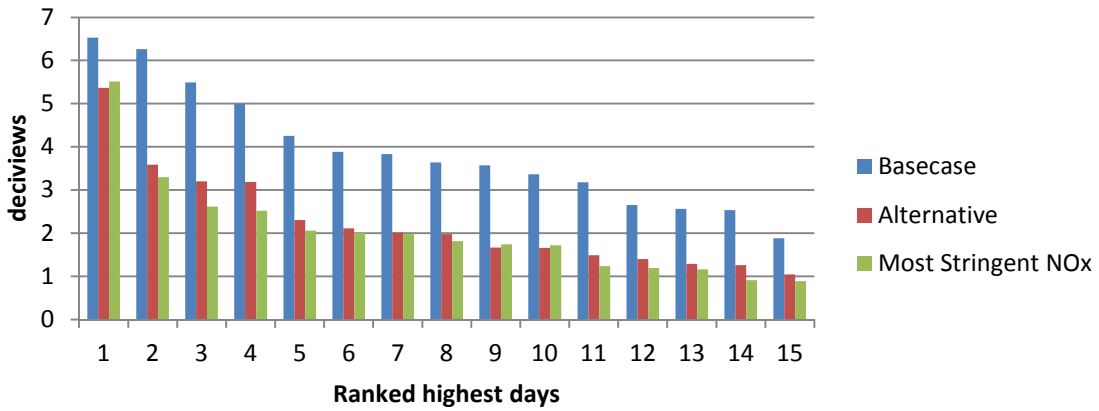
Flat Tops 2003



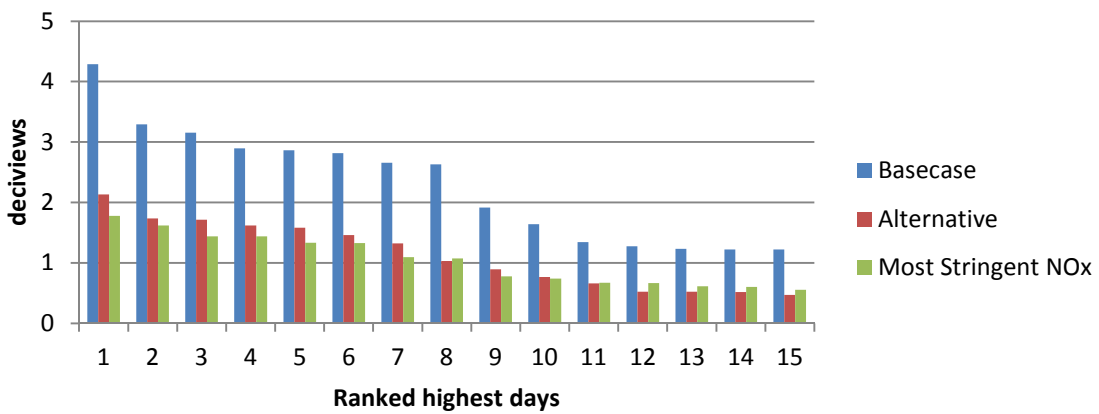
Grand Canyon 2001



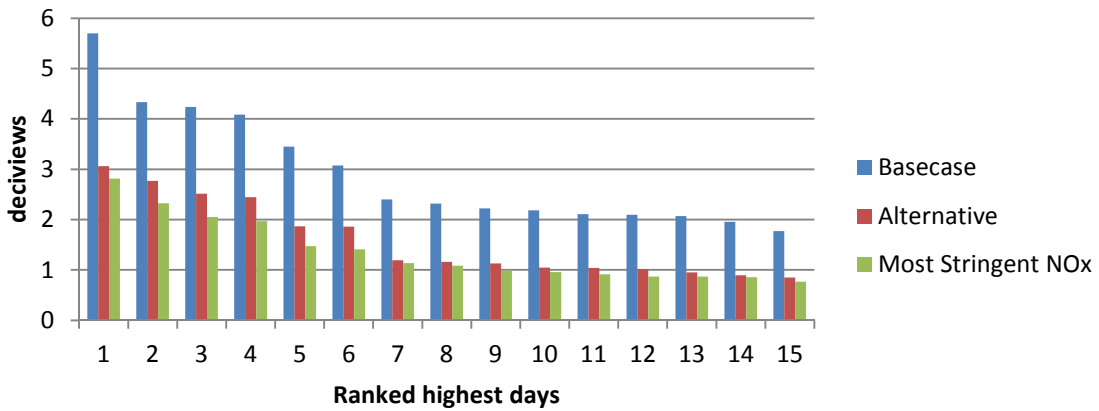
Grand Canyon 2002



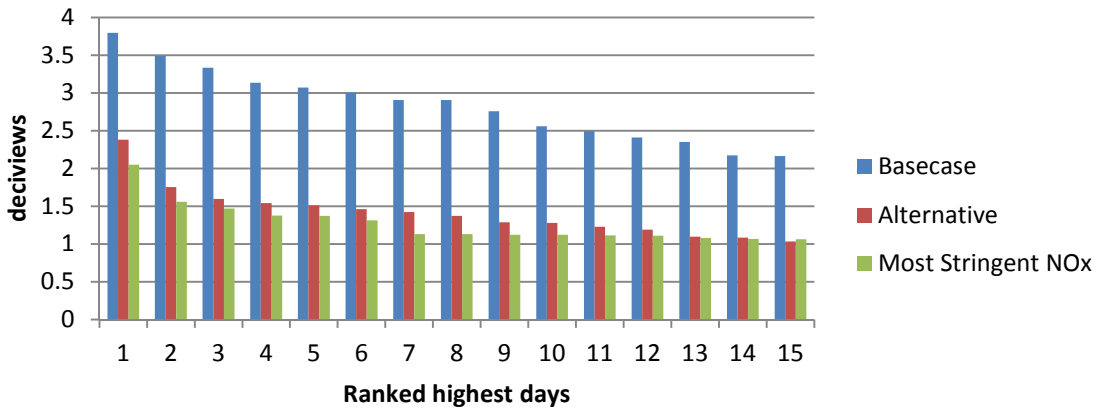
Grand Canyon 2003



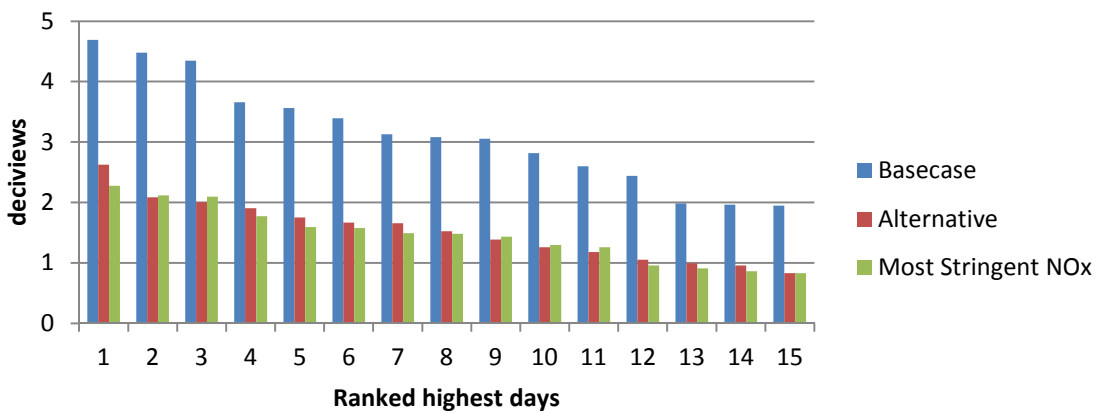
Mesa Verde 2001



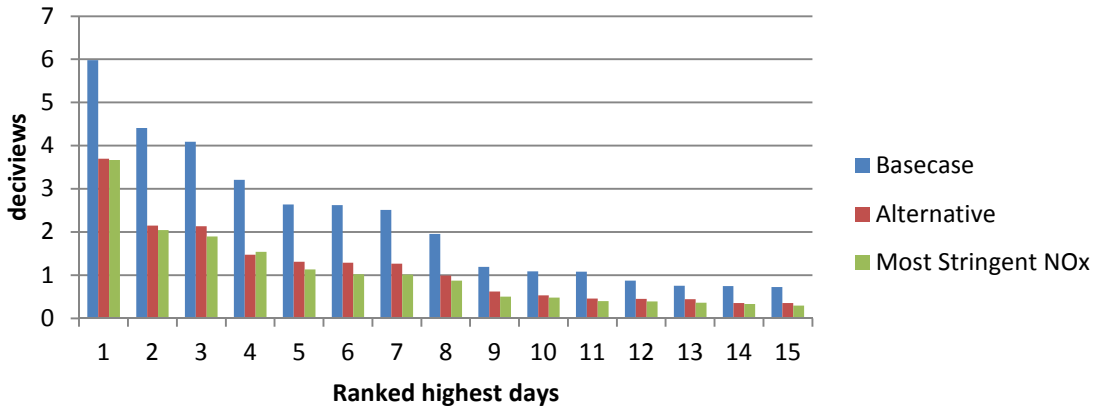
Mesa Verde 2002



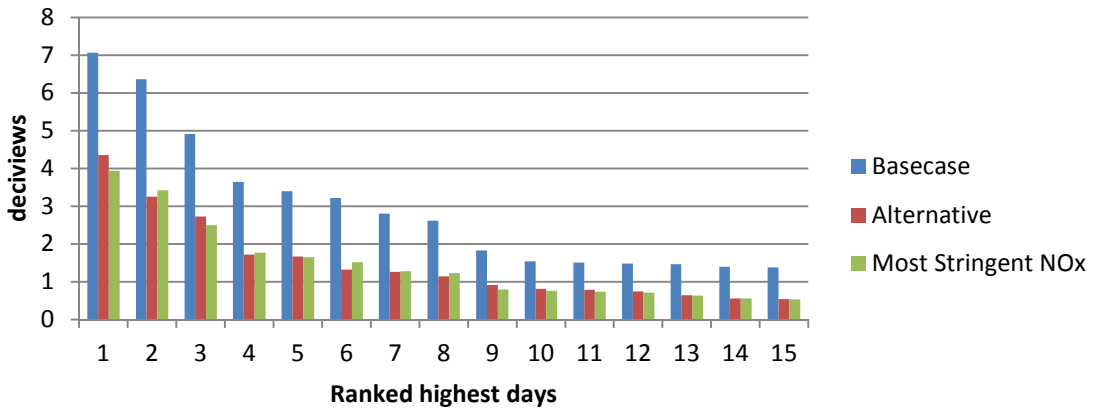
Mesa Verde 2003



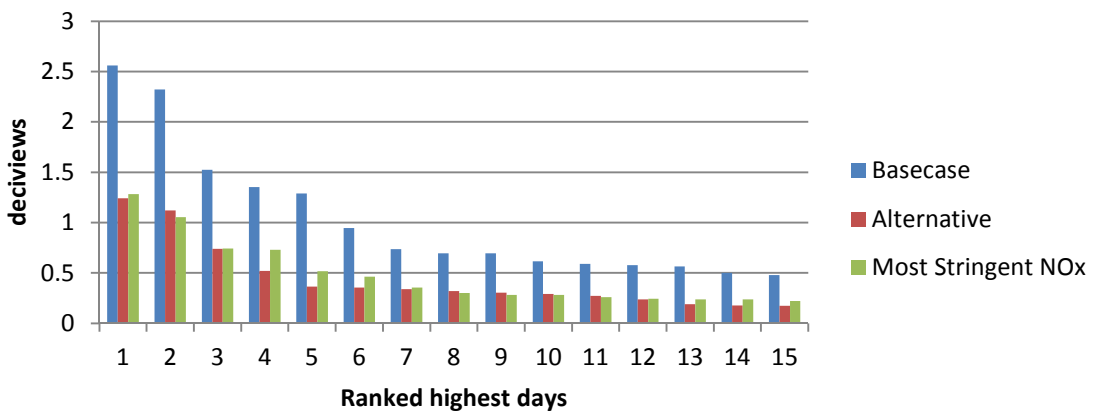
Zion 2001



Zion 2002



Zion 2003



Appendix B

Average all days

Basecase

	2001	2002	2003	Average
Arches	1.076	1.442	1.189	1.236
Black Canyon of the Gunnison	0.250	0.430	0.322	0.334
Bryce Canyon	0.152	0.284	0.141	0.192
Canyonlands	1.190	1.650	1.329	1.389
Capitol Reef	0.541	0.889	0.728	0.719
Flat Tops	0.322	0.479	0.481	0.427
Grand Canyon	0.182	0.288	0.164	0.211
Mesa Verde	0.275	0.402	0.337	0.338
Zion	0.119	0.178	0.061138	0.119
Average	0.456	0.671	0.528	0.552

Alternative

	2001	2002	2003	Average
Arches	0.562	0.699	0.586	0.616
Black Canyon of the Gunnison	0.105	0.174	0.133	0.137
Bryce Canyon	0.072	0.133	0.062	0.089
Canyonlands	0.693	0.930	0.750	0.791
Capitol Reef	0.298	0.506	0.389	0.398
Flat Tops	0.124	0.182	0.195	0.167
Grand Canyon	0.089	0.144	0.074	0.102
Mesa Verde	0.129	0.171	0.144	0.148
Zion	0.059	0.083	0.024848	0.056
Average	0.237	0.336	0.262	0.278

Most Stringent
NOx

	2001	2002	2003	Average
Arches	0.580	0.825	0.659	0.688
Black Canyon of the Gunnison	0.117	0.206	0.151	0.158
Bryce Canyon	0.066	0.138	0.067	0.090
Canyonlands	0.641	0.894	0.743	0.760
Capitol Reef	0.268	0.467	0.366	0.367
Flat Tops	0.157	0.242	0.232	0.210
Grand Canyon	0.085	0.142	0.074	0.100
Mesa Verde	0.123	0.184	0.153	0.154
Zion	0.054	0.087	0.028394	0.056
Average	0.232	0.354	0.275	0.287

Average all days Summary

	Basecase	Alternative	Most Stringent Nox
Arches	1.236	0.616	0.688
Black Canyon of the Gunnison	0.334	0.137	0.158
Bryce Canyon	0.192	0.089	0.090
Canyonlands	1.389	0.791	0.760
Capitol Reef	0.719	0.398	0.367
Flat Tops	0.427	0.167	0.210
Grand Canyon	0.211	0.102	0.100
Mesa Verde	0.338	0.148	0.154
Zion	0.119	0.056	0.056
Average	0.552	0.278	0.287

Appendix C

Average Number of Days > 0.5 dV impact

	Basecase	Alternative	Most Stringent NOx Control
Arches	176	109	130
Black Canyon of the Gunnison	75	27	34
Bryce Canyon	36	17	19
Canyonlands	178	131	140
Capitol Reef	96	63	65
Flat Tops	93	34	44
Grand Canyon	38	19	20
Mesa Verde	71	32	37
Zion	21	10	10
Total	784	441	499

Average Number of Days > 1.0 dV impact

	Basecase	Alternative	Most Stringent NOx Control
Arches	128	68	77
Black Canyon of the Gunnison	36	10	9
Bryce Canyon	19	9	8
Canyonlands	141	87	87
Capitol Reef	68	42	41
Flat Tops	46	13	15
Grand Canyon	22	11	10
Mesa Verde	40	13	12
Zion	11	6	6
Total	511	258	264

Days Impacted >0.5 dV

Basecase

	2001	2002	2003	Total	Average
Arches	151	203	175	529	176
Black Canyon of the Gunnison	57	95	72	224	75
Bryce Canyon	33	42	32	107	36
Canyonlands	151	206	176	533	178
Capitol Reef	67	122	99	288	96
Flat Tops	69	103	108	280	93
Grand Canyon	31	50	34	115	38
Mesa Verde	52	92	69	213	71
Zion	21	28	14	63	21
Total	632	941	779		

Days Impacted >0.5 dV

Alternative

	2001	2002	2003	Total	
Arches	92	131	104	327	109
Black Canyon of the Gunnison	22	35	24	81	27
Bryce Canyon	14	25	11	50	17
Canyonlands	113	150	130	393	131
Capitol Reef	40	76	72	188	63
Flat Tops	23	36	42	101	34
Grand Canyon	17	25	14	56	19
Mesa Verde	26	40	31	97	32
Zion	10	16	4	30	10
Total	357	534	432	1323	

Days Impacted >0.5 dV

Most stringent NOx

	2001	2002	2003	Total	
Arches	110	151	130	391	130
Black Canyon of the Gunnison	25	46	32	103	34
Bryce Canyon	13	29	15	57	19
Canyonlands	122	163	135	420	140
Capitol Reef	42	77	75	194	65
Flat Tops	30	54	49	133	44
Grand Canyon	16	27	16	59	20
Mesa Verde	27	48	35	110	37
Zion	9	17	5	31	10
Total	394	612	492	1498	

Days Impacted >1.0 dV	Basecase			Total	Average
	2001	2002	2003		
Arches	108	145	130	383	128
Black Canyon of the Gunnison	27	48	33	108	36
Bryce Canyon	15	27	15	57	19
Canyonlands	120	163	139	422	141
Capitol Reef	43	84	77	204	68
Flat Tops	33	51	54	138	46
Grand Canyon	18	31	18	67	22
Mesa Verde	29	53	39	121	40
Zion	11	16	5	32	11
Total	404	618	510		

Days Impacted >1.0 dV	Alternative			Total	Average
	2001	2002	2003		
Arches	57	84	62	203	68
Black Canyon of the Gunnison	7	16	8	31	10
Bryce Canyon	8	14	4	26	9
Canyonlands	80	102	78	260	87
Capitol Reef	31	54	41	126	42
Flat Tops	8	13	17	38	13
Grand Canyon	10	16	8	34	11
Mesa Verde	12	16	12	40	13
Zion	7	8	2	17	6
Total	220	323	232	775	

Days Impacted >1.0 dV	Most stringent NOx			Total	Average
	2001	2002	2003		
Arches	67	93	70	230	77
Black Canyon of the Gunnison	6	17	5	28	9
Bryce Canyon	7	15	3	25	8
Canyonlands	65	104	91	260	87
Capitol Reef	31	51	42	124	41
Flat Tops	12	18	14	44	15
Grand Canyon	9	13	8	30	10
Mesa Verde	8	16	11	35	12
Zion	7	8	2	17	6
Total	212	335	246	793	

Appendix D

90th Percentile Across All 3 Years (110th High)

	Basecase	Alternative	Most Stringent NOx
Arches	3.721	1.859	1.999
Black Canyon of the Gunnison	0.977	0.400	0.465
Bryce Canyon	0.495	0.189	0.227
Canyonlands	4.183	2.447	2.148
Capitol Reef	2.416	1.234	1.150
Flat Tops	1.221	0.466	0.555
Grand Canyon	0.559	0.222	0.241
Mesa Verde	1.124	0.430	0.501
Zion	0.183	0.067	0.089
Average	1.653	0.813	0.819

98th Percentile Across All 3 Years (24th High)

	Basecase	Alternative	Most Stringent NOx
Arches	7.167	4.282	4.469
Black Canyon of the Gunnison	2.366	1.123	1.053
Bryce Canyon	2.401	1.157	1.059
Canyonlands	8.328	5.728	5.057
Capitol Reef	6.364	4.125	3.662
Flat Tops	2.753	1.210	1.292
Grand Canyon	2.814	1.457	1.200
Mesa Verde	2.815	1.287	1.137
Zion	1.464	0.638	0.709
Average	4.052	2.334	2.182

98th Percentile in Highest year

Alternative	Most Stringent NOx	
Arches	4.92	4.87
Black Canyon of the Gunnison	1.32	1.36
Bryce Canyon	1.89	1.96
Canyonlands	6.32	5.56
Capitol Reef	4.78	3.39
Flat Tops	1.37	1.81
Grand Canyon	1.98	1.81
Mesa Verde	1.52	1.48
Zion	1.14	1.22
Average	2.81	2.61

Class I Area	Year	Baseline	Alternative		Most Stringent NOx	
		98th Percentile Visibility Impact above Background (Δ dv)	98th Percentile Value (Δ dv)	Visibility Improvement (Δ dv)	98th Percentile Value (Δ dv)	Visibility Improvement (Δ dv)
Arches	2001	7.797	4.923	2.874	4.304	3.493
	2002	6.948	4.173	2.775	4.531	2.417
	2003	7.167	3.971	3.196	4.867	2.300
Black Canyon	2001	1.942	0.926	1.016	0.892	1.050
	2002	2.736	1.322	1.414	1.358	1.378
	2003	2.076	1.022	1.054	0.85	1.226
Bryce	2001	2.439	1.157	1.282	0.953	1.486
	2002	4.033	1.893	2.140	1.955	2.078
	2003	1.396	0.602	0.794	0.622	0.774
Canyonlands	2001	7.532	5.222	2.310	4.567	2.965
	2002	8.560	6.112	2.448	5.184	3.376
	2003	8.432	6.323	2.109	5.563	2.869
Capitol Reef	2001	6.196	4.020	2.176	3.274	2.922
	2002	7.61	4.78	2.826	4.21	3.391
	2003	6.246	3.707	2.539	3.263	2.983
Flat Tops	2001	2.678	1.087	1.591	1.221	1.457
	2002	3.201	1.373	1.828	1.807	1.394
	2003	2.68	1.373	1.307	1.266	1.414
Grand Canyon	2001	2.334	1.124	1.210	1.058	1.276
	2002	3.635	1.978	1.657	1.813	1.822
	2003	2.629	1.031	1.598	1.075	1.554
Mesa Verde	2001	2.315	1.163	1.152	1.082	1.233
	2002	2.905	1.373	1.532	1.129	1.776
	2003	3.081	1.523	1.558	1.479	1.602
Zion	2001	1.951	0.990	0.961	0.872	1.079
	2002	2.614	1.141	1.473	1.223	1.391
	2003	0.696	0.319	0.377	0.301	0.395
Class I Average	2001	3.909	2.290	1.619	2.025	1.885
	2002	4.693	2.683	2.010	2.579	2.114
	2003	4.156	2.208	1.948	2.143	2.013