Appendix 5-2: Estimate of Natural Visibility Conditions

APPENDIX 5–2: ESTIMATE OF NATURAL VISIBILITY CONDITIONS

5.1 INTRODUCTION

Title 40 CFR §51.308(d)(2)(iii) states that the ultimate responsibility for calculating natural conditions lies with the state. Even though the EPA "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program" (Sept 2003) provides "default" estimates of natural visibility, it, too, emphasizes the state's right to derive "refined" estimates.

Exercising its right and responsibility under 40 CFR §51.308(d)(2)(iii), the state of Texas has analyzed available monitoring information, and, using the analysis detailed here and in the appendices referenced herein, derived refined estimates of natural visibility conditions for its Class I areas: Big Bend National Park (NP) and Guadalupe Mountains NP.

5.2 REASON FOR THE ESTIMATE

As detailed in *Dust Storms as Natural Events for Regional Haze and Particulate Matter in West Texas* (Appendix 5–2a), Big Bend NP and, to an even greater degree, Guadalupe Mountains NP are heavily impacted by large long range dust storms, that originate from dry desert and dry lake bed areas with little or no human activity, almost all of which are situated in the Chihuahuan Desert. Additionally, *Estimating Natural Conditions Based on the Revised IMPROVE Algorithm* (Appendix 5–2b) shows that both fine soil (Soil) and coarse mass (CM) are consistent with Trijonis' estimates of natural conditions over the entire western region (even using the EPA designation of this region).

Furthermore, as can be seen from Table 5–1: *Land cover classifications and their relative percentage of dust sources*, of the 122 dust storm source points identified in the analysis of ten major Chihuahuan Desert synoptic-scale dust outbreaks from 2002–2006 in the report "Investigation of Dust Emission Hotspots in Chihuahuan Desert Playa Basins" (Gill et al. 2005), only between five and eleven source points could be potentially attributed to agricultural activity. The majority of the source points were clearly identified as shrub/scrubland. In fact, Gill et al. state the additional conclusion that "Field campaigns revealed that … the vast majority of source points were natural desert landscapes."

This corresponds quite closely with the work of Kavouras et al. (2007), "Classification of sources of atmospheric dust in Class I areas of the western United States". Their analysis of erodible soils along with land use show that the primary source regions appear to be highly erodible soils in scrub/scrublands. This is especially apparent when one couples this with their earlier work expounded in Kavouras et al. (2006), "Assessment of the Principal Causes of Dust-Resultant Haze at IMPROVE Sites in the Western United States," final report prepared for the Western Regional Air Partnership (WRAP). This shows that the wind direction/speed coefficients associated with what they term "local"[1]

[1] It must be pointed out that "local", as used in the Kavouras work does not correspond with any distance measure, but with how well the dust dominated days in the 20 percent worst measured visibility days correlated with local wind speed and direction.

windblown dust are quite consistent with highly erodible soils in scrub/scrublands around Big Bend and Guadalupe Mountains.

Table 5–1: Land cover classifications and their relative percentage of dust sources[2]

Land Cover Classes	Class Title/Description	# of Locations	Relative % of Sources
1	Forest, Deciduous	0	0
2	Forest, Evergreen	0	0
3	Shrub/Scrub	65	53.28
4	Grassland (> 10% ground cover)	10	8.2
5	Barren/Minimal Vegetation (< 10% ground cover)	18	14.75
6	Urban/Built-Up	0	0
7	Agriculture, General	5	4.1
8	Agriculture Rice/Paddy	0	0
9	Wetland, Permanent/Herbaceous	3	2.46
10	Wetland, Mangrove	0	0
11	Water	0	0
12	Permanent or Nearly Permanent Ice and/or Snow	0	0
13	Cloud/Cloud Shadow/No Data	0	0
3 and/or 4	Shrub/Scrub and/or Grassland (> 10% ground cover)	11	9.02
3 and/or 7	Shrub/Scrub and/or Agriculture, General	3	2.46
3 and/or 5	Shrub/Scrub and/or Barren/Minimal Vegetation (< 10% ground cover)	1	0.82
4 and/or 5	Grassland (> 10% ground cover) and/or Barren/Minimal Vegetation (< 10% ground cover)	2	1.64
3, 4, and/or 5	Shrub/Scrub, Grassland (> 10% ground cover), and/or Barren/Minimal Vegetation (< 10% ground cover)	1	0.82
Out of Classes	Undetermined	3	2.46
Total		122	100

Additionally, while Appendix 5–2a is able to obtain an estimate of natural visibility for Guadalupe Mountains that is actually in excess of that used within this SIP, the situation at Big Bend is a little more uncertain because the dust impact is less from major dust storms. However, the area of the park is approximately 801 thousand acres, about 80

[2] Gill, T. et al. 2005. Investigation of Dust Emission Hotspots in Chihuahuan Desert Playa Basins. SCERP project number A-05-03. (Available at <http://www.scerp.org/new/det_research_pub.asp?IdInvestigacion=7727>.)

percent of Rhode Island, and broad restrictions on human use of the park are in place to minimize human impact on its desert environment. Furthermore, the Big Bend IMPROVE monitoring site is surrounded by the park, with the closest park boundary approximately ten miles away, while land use and soil erodibility indicates the landscape surrounding the park is overwhelmingly dominated by highly erodible soils in scrub/scrubland areas.

Unfortunately, while the Gill et al. and Kavouras et al. works suggest that the relative contribution of agricultural and/or other anthropogenic activities to suspended dust are only a very small portion of the source points/regions, they are not able to quantify the actual percentage of source load, let alone receptor concentrations. However, while some dust (CM and Soil) at both of Texas' Class I areas must be from some human activity, the times when human caused dust is likely to be more important at these sites are on days with less visibility impairment than on the worst dust impaired days, since the most dust impaired days are dominated by dust storms and other blowing dust from the surrounding desert landscape. So the TCEQ has chosen, for the sake of the most and least impaired natural visibility estimates, to treat 100 percent of the CM and Soil concentrations measured at each of its Class I areas as natural.

There are also substantial questions and uncertainties pertaining to the portion of the organic carbon (OC) species that contribute to natural visibility conditions. However, since this issue remains unresolved, the state of Texas will, for this initial Regional Haze SIP, simply use an estimate of natural organic carbon calculated from monitoring data using the same methodology as other species that are significantly more impacted by human caused pollution, namely sulfate, elemental (light absorbing) carbon, and nitrate. However, to the extent to which the 100 percent natural CM and Soil estimate is an over estimate, the TCEQ expects this low OC estimate to more than compensate, at this time.

The data used for this is the IMPROVE summary data available through 2004 (updated March 6, 2006) using the revised (new) IMPROVE algorithm (IMPROVE 2006). For calculations that follow, only actual non-patched/non-substituted observations, within "good years"[3] from 2000 through 2004, are used.

5.3 METHODOLOGY OF THE ESTIMATE

Since the methodology proposed within Appendix 5–4 has met with objection by FLMs, and since it makes a small difference in the Haze Index, this initial Regional Haze SIP will calculate surrogate natural concentrations of all species besides fine soil and coarse mass in a manner very similar to that used by the Natural Conditions II (NC II) committee (Pitchford et al. 2006).[4] The only difference between the method used by the state of Texas and the NC II approach is that the same scale is used for each year in the period, rather than rescaling each year separately. This is simpler and it may enhance preservation of the year-to-year variability that may be expected of natural processes and conditions. Because the measure of interest is an average of three or more years of least and most impaired days, precise year-to-year variation is not explicitly used.

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[3] A good year is determined from the 'good_year' flag within the IMPROVE dataset.

[4] Just as with the NC II work, sea-salt (Ss) is treated as consistent with natural conditions, and not adjusted.

For each species that is not determined to be consistent with natural conditions—ammonium sulfate (ASO4), elemental carbon (EC), ammonium nitrate (ANO3), and organic mass (OMC)—if the average of the yearly average concentration, for complete years in the period 2000 through 2004, is greater than Trijonis' estimate of the regional multi-annual mean natural concentration (RAM-NC) for that species, then all measurements of that species are rescaled such that the average of the yearly average concentration is set equal to Trijonis' estimate of the RAM-NC for that species. The process of obtaining the data scaling factors is illustrated in Table 5–1: *Calculating Data Scale Factors*.

Table 5–2: Calculating Data Scale Factors

	ASO_4	EC	ANO_3	OMC	Ss	Soil	CM
Present Multi-Annual Mean Concentration, 2000–2004 (μg/m^3)							
Big Bend NP	2.71	0.13	0.26	1.26	0.03	1.32	6.72
Guadalupe Mountains NP	1.69	0.11	0.40	1.17	0.02	1.78	11.40
Trijonis' RAM-NC estimates	0.12	0.02	0.1	0.6			
Data Scale Factor ‡							
Big Bend NP	0.044	0.16	0.38	0.48	1	1	1
Guadalupe Mountains NP	0.071	0.19	0.25	0.51	1	1	1

ASO_4 stands for ammonium sulfate, EC for elemental carbon, ANO_3 for ammonium nitrate, OMC for organic mass, Ss for sea-salt, Soil for fine soil, and CM for coarse mass.

‡ The scale factors for all components except Soil and CM are essentially the same as for the NC II estimate.

5.4 RESULTS[5]

The result of applying each site's data scaling factors to all the measured data for that site and for the period produces the surrogate natural conditions dataset that can be used in conjunction with the revised IMPROVE algorithm to obtain the haze indices for the least and most impaired days under this approximation to natural conditions for the site. The results are shown in Table 5-2: *Estimate of Natural Visibility Conditions*.

[5] The SAS program and IMPROVE/VIEWS data used is available as a ZIP file named <TXNC.zip> and provided as Appendix 5–2c.

Table 5–3: Estimate of Natural Visibility Conditions

Class I Area	Site ID	Year	Haze Index (deciviews)	
			Most Impaired	Least Impaired
Big Bend NP †	BIBE1	2001	10.99	2.68
		2002	11.03	2.03
		2003	10.09	2.27
		2004	8.27	1.80
		Average	10.09	2.19
Guadalupe Mountains NP	GUMO1	2000	12.03	1.90
		2001	11.82	2.30
		2002	13.86	2.56
		2003	13.31	2.30
		2004	10.27	1.42
		Average	12.26	2.10

† The fourth quarter of 2000 for Big Bend was not sufficiently complete for use in calculating an average for regulatory purposes: The fourth quarter had only ten complete days.

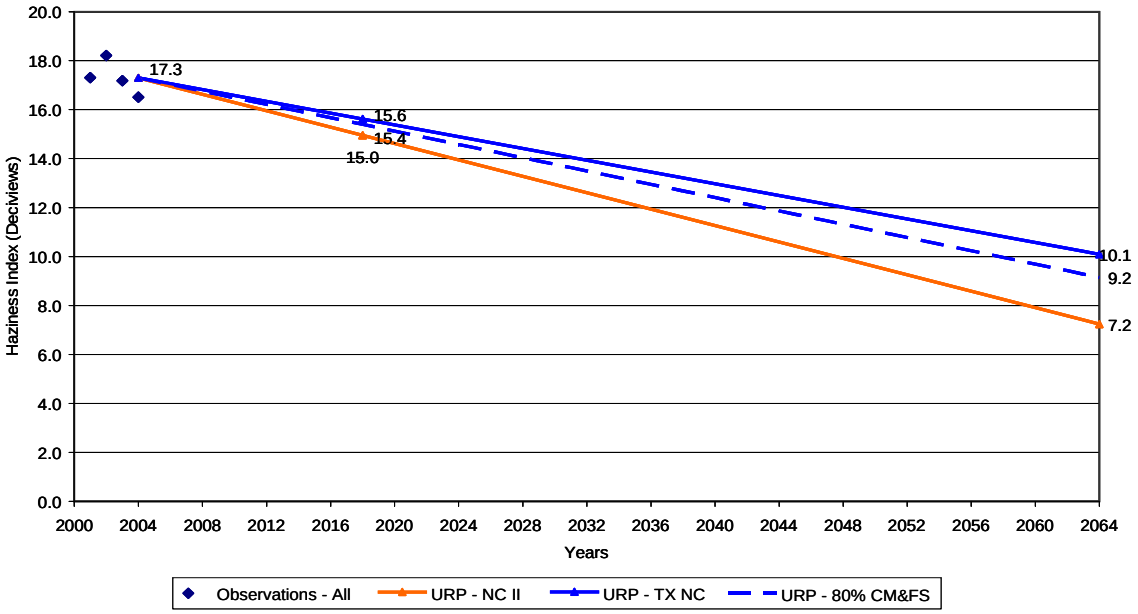

Figure 5–1: Big Bend NP URP

TX NC is Texas' estimate of natural conditions; 80% CM&FS is a comparison where 80 percent of CM & Soil is taken as natural; NC II is a comparison using the Natural Conditions II (NC II) committee's estimate.

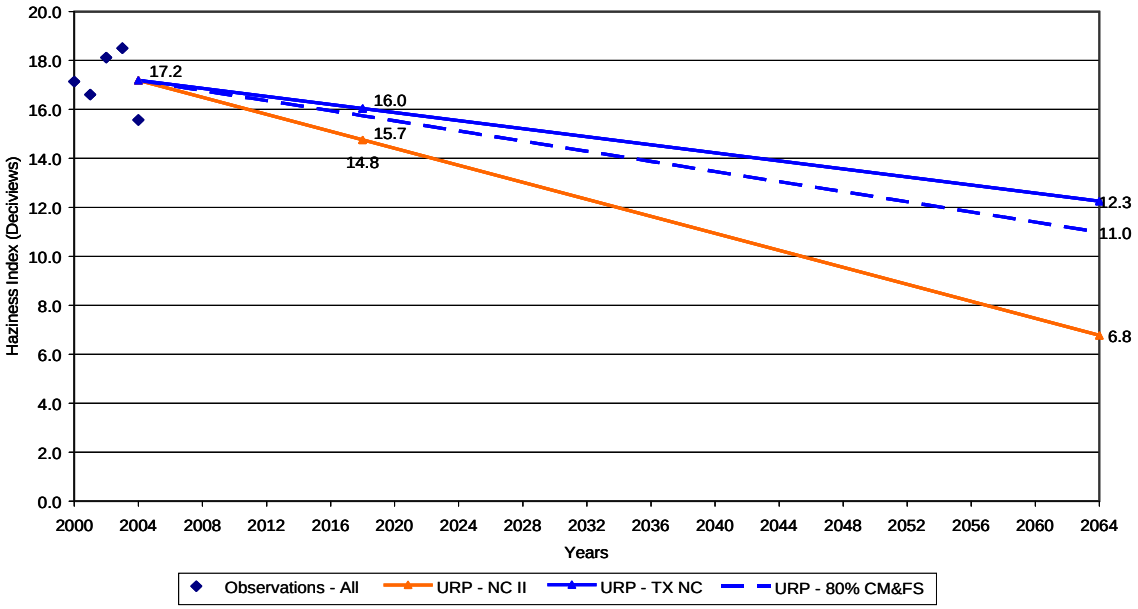

Figure 5–2: Guadalupe Mountains NP URP

Since this estimate has some degree of uncertainty, just as there is uncertainty in the estimates used by the NC II, and in order to provide the reader with a comparison of Texas' natural conditions estimate to the "default" estimate provided by the NC II, the TCEQ provides here (Figure 5–1: *Big Bend NP URP* and Figure 5–2: Guadalupe Mountains NP URP) graphs of the Uniform Rate of Progress (URP) for the 20 percent Worst Days both with the estimate approximating 100 percent Soil and CM as natural (TX NC) with a calculation treating only 80 percent Soil and CM as natural (80% CM&FS), along with the NC II estimate, for both Texas Class I areas. This 80 percent calculation is displayed only as an illustration of how little sensitivity this natural visibility estimate has to approximating 100 percent of the Soil and CM as natural; there is no other significance to this 80 percent assumption for this SIP. Similarly, the NC II estimate is displayed here only for comparison purposes and has no other significance for this SIP.

NATURAL VISIBILITY CONDITIONS, AN ONGOING EFFORT

Texas makes no claim that the present natural condition estimates are the final word for its Class I areas. The natural condition visibility values provided herein are simply the best estimates available at this time. Since the natural concentrations and statistics of all components important for Regional Haze have significant uncertainties, the TCEQ will be continuing to evaluate data, modeling, and any other sources of information, as well as potentially devising additional monitoring, sampling and/or analysis schemes, in order to further improve these estimates. Furthermore, the TCEQ plans to work with the EPA, Federal Land Managers (FLMs), and other experts and researchers to refine natural conditions estimates for future five-year reports and major regional haze SIP revisions.

At this point, it is anticipated that the component that most likely needs improved estimation is OC.[6] Improved sampling and/or analysis techniques are likely methods in the pursuit of an improved characterization of the natural contributions to this component. However, the application of such methods will depend upon available resources and estimates of potential benefits.

[6] Additionally, there is significant regulatory uncertainty with regard to what prescribed fires should or should not be considered as "natural". Hopefully when the EPA revises the Interim Air Quality Policy on Wildland and Prescribed Fires such issues will be clarified.

Appendix 5–2 Appendices

5–2a Dust Storms as Natural Events for Regional Haze and Particulate Matter in West Texas (online: http://www.tceq.state.tx.us/implementation/air/sip/bart/haze_sip.html)

5–2b Estimating Natural Conditions Based on the Revised IMPROVE Algorithm (online: http://www.tceq.state.tx.us/implementation/air/sip/bart/haze_sip.html)

5–2c <TXNC.zip>