Technical Paper:

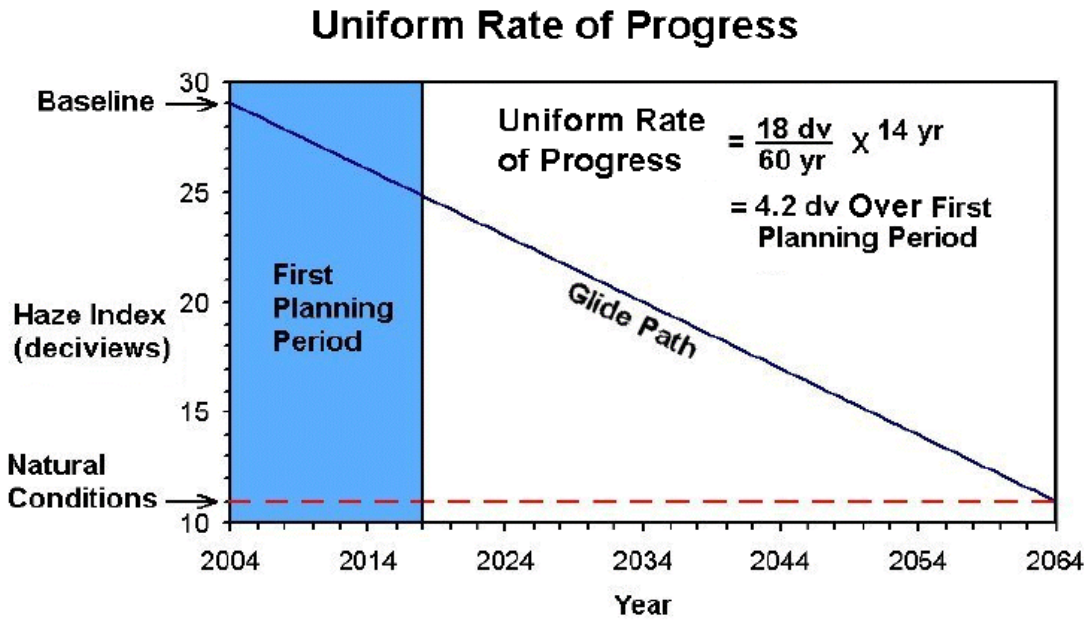
Uniform Rates of Progress and
The Projected 2018 Reasonable Progress Goals

In preparing a regional haze state implementation plan (SIP) each state must "analyze and determine the uniform rate of progress (glide path) needed to attain natural visibility conditions by the year 2064." (40 Code of Federal Regulations (CFR) §51.308(d)(1)(i)(B)) Each state with one or more Class I areas must set a reasonable progress goal (measured in deciviews) for each of its Class I areas and compare the reasonable progress goal to the glide slope for the Class I area.

"The reasonable progress goals must provide for an improvement for the most impaired days [the worst 20 percent of monitored days] over the period of the implementation plan and ensure no degradation in visibility for the least impaired days [the best 20 percent of monitored days] over the same period." (40 CFR §51.308(d)(1))

The period of the first regional haze SIP is from its adoption to 2018. The uniform rate of progress line is a straight line from the 2000 through 2004 base period impairment for the worst 20 percent of monitored days plotted from 2004 to natural conditions plotted for 2064. The following graph (Figure 1) shows the generic example from EPA's June 1, 2007, guidance for setting reasonable progress goals:

Figure 1 From "Guidance for Setting Reasonable Progress Goals Under the Regional Haze Program"



The EPA's default methodology projects only 22 percent of the improvement needed to reach the glide slope line in 2018 at Big Bend, even though the reductions in Texas emissions affecting regional haze are larger than that percentage.

One reason that the projected improvement at Big Bend is not larger is that CENRAP modeling calculates that foreign pollution impacts on Big Bend cause close to half the visibility impairment at the park, and those impacts are beyond the control of Texas, other states, and the federal government. The preamble to the regional haze rule states, "The EPA does not expect states to restrict emissions from domestic sources to offset the impacts of international transport of pollution" (43 FR 35736, column 3). However, the EPA requires the 2018 projection to include all factors contributing to regional haze even if they are beyond state and federal control.

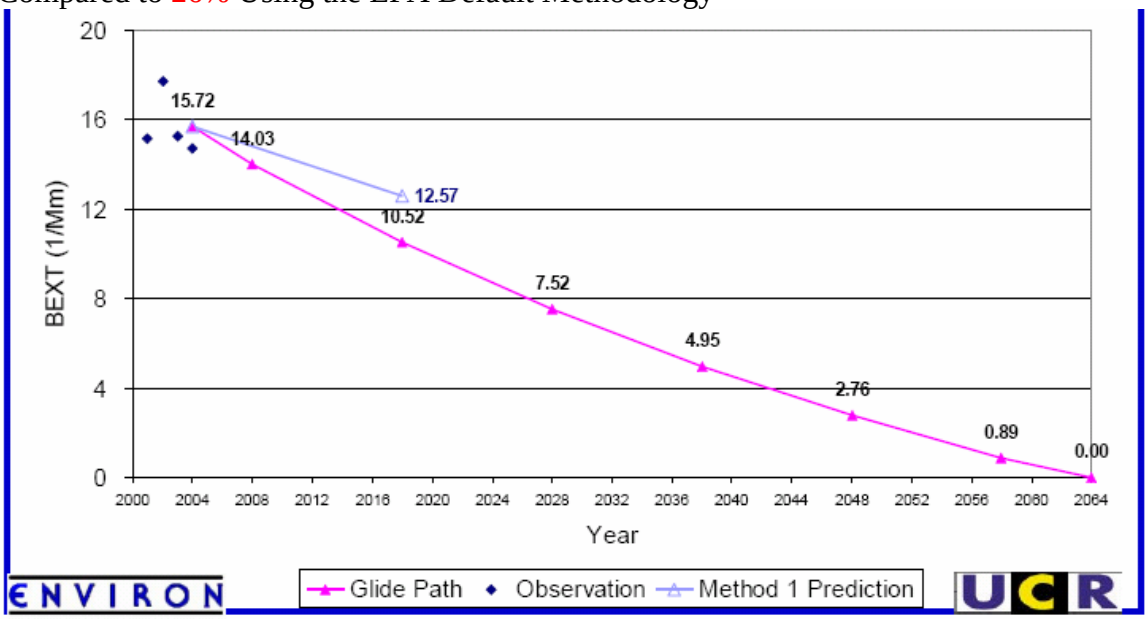
Another reason is that the National Park Service and the EPA have substantially underestimated the impact of natural blowing dust on natural conditions for the Class I areas in West Texas and nearby states.

To see whether Texas and other states are making reasonable efforts to reduce their regional haze impacts on Class I areas, it helps to look separately the U.S. anthropogenic impacts at each Class I area. To show this change, we have to separate U.S. anthropogenic impacts from foreign and natural impacts.

Since the deciview scale is a logarithmic scale, we have to convert the glide slope graph to a linear scale before separating the U.S. anthropogenic impacts from all other impacts. The following graph (Figure 2) still contains the incorrect assumption that roughly half the coarse mass and fine soil comes from human activity. The corrected modeling post processing that will assign the soil to natural sources is not yet available. When it is, the progress in reducing Texas and other U.S. anthropogenic impacts will be larger than the following graph shows.

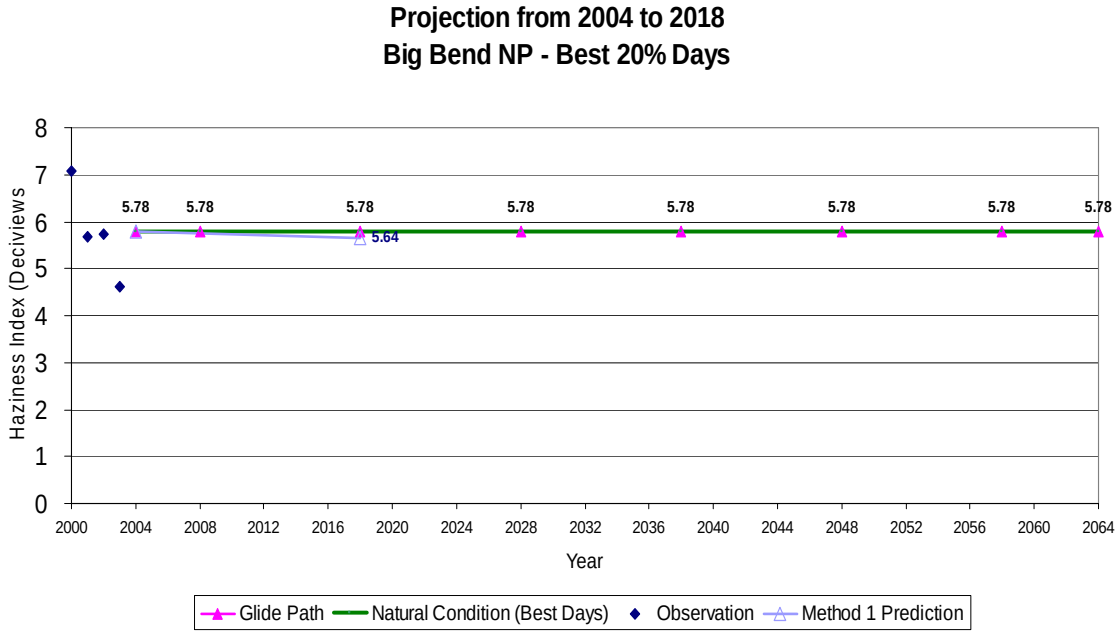
To produce a linear reduction in the visibility impairment measured in deciviews, the pollutant and light extinction (b_{ext}) reductions must be larger in the earlier years of the program. In Figure 2, the left end of the uniform rate of progress line for U.S. anthropogenic impairment is set in 2004 at the average U.S. anthropogenic impact for 2000-2004. The right end is set at zero in 2064, the target date to reduce human impacts on visibility impairment to zero at all Class I areas.

Figure 2: U. S. Anthropogenic B_{ext} (extinction) Glide Path and Visibility Projections for Big Bend National Park Achieves 61% of 2018 Uniform Rate of Progress Goal Compared to 26% Using the EPA Default Methodology



For the best 20 percent of visibility days at Big Bend and at Guadalupe National Parks the CENRAP modeling projects slight visibility improvement for the 2004 to 2018 period based on current emission inventory projections and modeling. Based on these projections both areas meet the non-degradation requirement for the best 20 percent days.

Figure 3 Big Bend National Park Projection from 2004 to 2018 for Best 20 Percent Days



Additional Technical Details

A deciview is a measure of visibility impairment. In the regional haze rule definition of deciview the EPA states: "A deciview is a haze index derived from calculated light extinction, such that uniform changes in haziness correspond to uniform incremental changes in perception across the entire range of conditions, from pristine to highly impaired" (40 CFR §51.301). The deciview haze index is defined so that one deciview is approximately the smallest amount of change in visibility impairment that a person can detect visually.

The regional haze rule specifies that the visibility for the worst 20 percent of monitored days and the best 20 percent of monitored days is calculated by taking the average of the impairment measured in deciviews for the 20 percent worst monitored days and 20 percent best monitored days, respectively. Since the rule requires measured particulate matter components to be used to calculate the visibility impairment, only days with IMPROVE data, which is scheduled to be collected every third day, can be used to determine the 20 percent worst and 20 percent best days.

The TCEQ has participated in the Central Regional Air Planning Association (CENRAP), which has carried out extensive modeling to project the amount of visibility improvement expected by 2018. These projections include the benefit from both state and federal requirements to reduce emissions contributing to regional haze.

Following EPA guidance, CENRAP and its contractor Environ have used relative response factors (RRFs) to adjust the raw, future-case modeling results to provide the best estimates available for the predicted future-case concentrations of each particulate matter component. The procedure is to calculate a RRF for each site for each particulate matter component contributing to regional haze. The RRF is the modeled future concentration for a component divided by the modeled base-case concentration of that component at a specific site. The procedure to calculate the future concentration of a particulate matter component is to multiply its measured base-case concentration by its RRF.

For the $PM_{2.5}$ components that the emission inventory represents adequately, the RRF procedure works well. The RRF procedure does not do an acceptable job of projecting future concentrations of the $PM_{2.5}$ components that the inventory does capture well. Coarse mass and fine soil from dust storms are $PM_{2.5}$ components that emission inventories do not represent adequately. The TCEQ staff has documented the large wind blown dust impacts at both Big Bend and Guadalupe Mountains National Parks. These impacts are much larger than EPA's suggested default levels of dust impacts at these parks and at the Class I areas in nearby states. ("Dust Storms as Natural Events for Regional Haze and PM in West Texas," June 2007)

CENRAP analysis of Class I area data on coarse mass and fine soil together with data on population and motor vehicle support the conclusion that coarse mass and fine soil are largely independent of human activity. The Western Regional Air Partnership (WRAP) has already decided to assume that coarse mass (soil) will continue to be the same in the future as it is during the base period. Considering the analysis and evidence, the TCEQ staff recommends (1) projecting both coarse mass and fine soil to the future as unchanged from the base period and (2) treating both coarse mass and fine soil as natural for Big Bend and Guadalupe Mountains National Parks.

Figures 4 through 6 show measured and modeled 2002 extinction at Texas' two Class I areas and for Caney Creek in Arkansas. The model significantly under predicts most impacts at the two

Class I areas in West Texas. One of the reasons is the model's inability to predict major dust storms and their impacts.

Figure 4

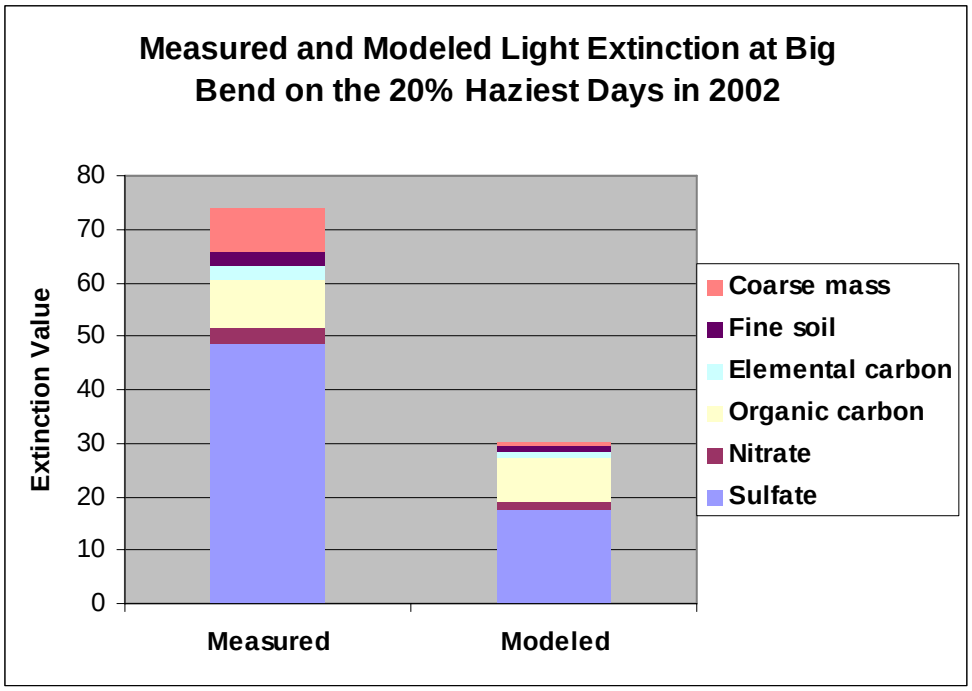


Figure 5

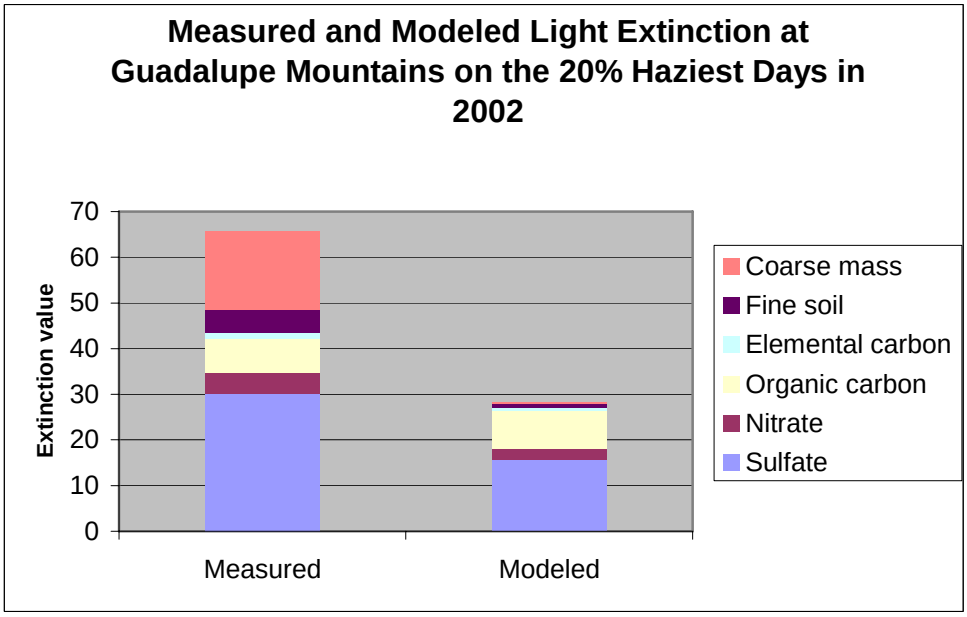
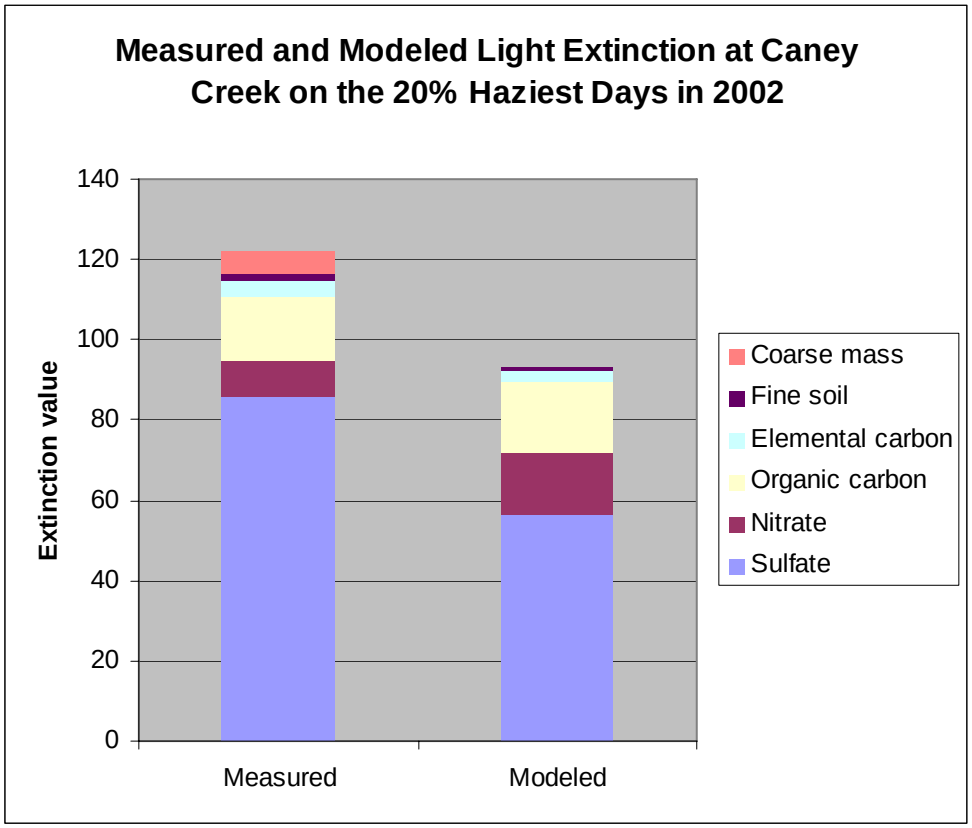


Figure 6



[The preceding three graphs show results for the base-b modeling. When the new modeling results that use a slightly updated 2002 emission inventory become available, they need to replace the base-b modeling shown above.]

EPA guidance allows states to develop more specific information to determine what constitutes natural conditions for each Class I area. Because of the large impact of natural blowing dust and its underestimation in the EPA default calculations on the Class I areas in West Texas and nearby states, TCEQ staff recommends developing more reasonable estimates of natural conditions for each Class I area that Texas impacts.

Development of these more reasonable natural condition estimates for other visibility impairing components of fine particulate matter is the subject of a concurrently developed technical issue paper. These more reasonable estimates add to the estimates of visibility impairment from natural sources, but the correction for coarse mass and fine soil material adds significantly more to the estimate of how much haze is natural than the total of all the other refinements in natural components adds (Natural Conditions, Based on the Revised IMPROVE Algorithm, June 2007).

The full definition of "*Deciview*" in the regional haze rule reads as follows:

"*Deciview* means a measurement of visibility impairment. A deciview is a haze index derived from calculated light extinction, such that uniform changes in haziness correspond to uniform incremental changes in perception across the entire range of conditions, from pristine to highly impaired." The deciview haze index is calculated based on the following equation (for the

purposes of calculating deciview, the atmospheric light extinction coefficient must be calculated from aerosol measurements):
Deciview haze index=10 $\ln_e$ (b_{ext}/10 Mm^{-1}).
Where b_{ext}=the atmospheric light extinction coefficient, expressed in inverse megameters (Mm^{-1})." (40 CFR §51.301)

The uniform rate of progress line in light extinction units (b_{ext}) is calculated using the inverse of the equation used to calculate deciviews from light extinction. The inverse equation is:

$b_{ext} = 10\ e^{(HI/10)}$, where HI is the haze index in deciviews.