Preliminary Air Quality Related Screening Values for the James River Face Wilderness, a Class I Area in Virginia.

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Work is currently underway to assist applicants of Prevention of Significant Deterioration (PSD) permits determine if a new source of pollution will have an adverse impact on any air quality related value in James River Face Wilderness located near Natural Bridge, VA. Table 1 lists the red line and green line screening values for several types of pollutants which have the potential to adversely impact the air quality related values. The red line values indicates a total pollution level (new source plus ambient) where at least one air quality related value has a high likelihood of having an adverse impact; whereas the green line value indicates a total pollution level where there is a low likelihood of an adverse impact to the air quality related values. Values that are between the red line value and green line value are classified as the yellow zone. The yellow zone is an area where there is uncertainty that one or more air quality related values will have an adverse impact.

The user of the information needs to understand that the values presented are used by people at the George Washington and Jefferson National Forests to assess the risk of a new source of air pollution. The exceeding of a red line value by current monitored or estimated values does not mean the Federal Land Manger will issue an adverse impact determination to the air regulatory authority. Neither does a value between the red and green line values (i.e. the yellow zone) mean that an adverse impact determination will not be recommended to the air regulatory agency. Other data are often used, which are not presented here, before issuing an adverse impact determination. For example, the applicant may want to collect acidic deposition information near the Class I area to estimate the total deposition of sulfate and nitrates for a particular year. Furthermore, an applicant could recommend ways to mitigate, or offset the new emissions of one or more air pollutants.

The sections following Table 1 briefly describe each of the pollutants which have the potential to have an adverse impact on the air quality related values. Another document will be released at a future date which will provide greater detail on how the pollutants impact the resources and how the screening level values were selected.

Table 1. Red line and green line screening values for the Class I area, and current monitored or estimated values.

Pollutant Name	Red Line Value	Green Line Value	Unit of Measure	Averaging Period	Current Values James River Face
Ozone	> 23.7	<5.9	W126 (ppm-hrs.)	April - October	41.9
Ozone	>50	<6	# hrs. >= 0.10 ppm	April - October	7
Sulfate	>=60	<15	kg/ha/yr	Annual	55
Nitrate	>=44	<13	kg/ha/yr	Annual	32
Sulfate + Nitrate	<25.0	>=25.0	ANC, ueq/L	Spring	3
Sulfate + Nitrate	<0	>0	ANC, ueq/L	Episodic	ND
Sulfate + Nitrate	<=6.0	>6.0	pH units	Spring	5.7
Sulfate + Nitrate	<=5.5	>5.5	pH units	Episodic	ND
Paticulates and NO_2	>=2.0	<2.0	ΔE	Hourly	NA
Paticulates and NO_2	>=0.05	<0.05	contrast	Hourly	NA
PM 2.5	>= 5%	< 5%	b_{ext}	Daily	*

NA = not applicable
ND = no data available at this time
* Current visibility values are expressed as b_{ext} in inverse megameters (Mm^{-1}). See Table 2 for values.

Ozone: A high seasonal exposure and frequent occurrence of peak hourly ozone concentrations (>= 0.10 ppm) are needed to reduce the growth of tree species found in the southern Appalachians (Lefohn et al. 1997, and SAMAB 1996). Therefore, a dual parameter screening level value is used to determine if ground level ozone will cause an adverse impact to the vegetation resources at the Class I area. An adverse impact is likely to occur when the W126, a measure of the seasonal exposure (Lefohn and Runeckles 1987), is greater than 23.7 ppm-hours; and there are more than 50 hours during the growing season (April through October) when the average hourly ozone concentration is 0.10 ppm or greater. Currently, there is no EPA approved method to estimate ozone increases from a single source. The preferred method for addressing ground-level ozone is to reduce emissions on a regional scale. The air regulatory agencies and applicants will be informed early in the application process if ozone exposures are believed to be causing an adverse impact to terrestrial resources. Table 1 shows that the W126 value exceeds the red line value. The frequency of peak hourly ozone concentrations are below the red line value, but above the green line value. These results do not clearly demonstrate that ozone exposures are having an adverse impact on the vegetation. Therefore, other data and/or published results will be used to determine if an adverse impact is occurring to the terrestrial resources at the Wilderness.

Sulfate: Deposition of sulfates from the atmosphere occur in wet (rainfall), dry, and cloudwater forms. Increases in sulfates have the potential to have an adverse impact on soil chemistry, which could lead to adverse impacts to soil and vegetation air quality related values. Sulfate deposition at the three Class I areas was estimated using the sulfate modeling results reported in the Southern Appalachian Assessment (SAMAB 1996, Lynch and others 1996). The numbers reported represent sulfate from only rainfall which

underestimates the total sulfate deposition. Studies conducted at the Great Smoky Mountains National Park have demonstrated that dry sulfate deposition is equivalent to sulfate from rainfall. Sulfate from cloudwater is approximately twice the rainfall plus dry sulfate deposition (Johnson and Lindberg 1992). The total deposition results in Table 1 were obtained by doubling the modeled sulfate results presented in the Southern Appalachian Assessment (SAMAB 1996). The values presented in Table 1 do not include cloudwater.

Current sulfate deposition at James River Face Wilderness is estimated to be 55 kg/ha/yr (i.e. in the yellow zone) which is below the red line of 60 kg/ha/yr. Applicants will need to follow Section 5.1.3 of the Interagency Workgroup on Air Quality Modeling guidelines (EPA, 1993) when converting the screening model (Level 1) values for sulfate deposition. If the screening model values are predicted to be greater than or equal to 0.03 kg/ha (see Appendix A) then the applicant should use the CalMet and CalPuff models for subsequent analysis.

Nitrate: Deposition of nitrates from the atmosphere occur in wet (rainfall), dry, and cloudwater (SAMAB 1996). As with sulfates, an increase in nitrates has the potential to adversely impact soils, and vegetation air quality related values (Peterjohn and others 1996). The nitrate values in Table 1 were obtained by doubling the wet nitrate estimates found in the Southern Appalachian Assessment data (SAMAB 1996, and Lynch and others 1996). The Class I area value falls within the yellow zone, which means other information is needed to determine if an adverse impact is likely to occur. Excessive amounts of nitrates have been found to be present at the Great Smoky Mountains National Park (Nodvin and others 1995). There is a possibility that nitrogen saturation could also be occurring at James River Face. Applicants will need to follow Section 5.1.3 of the Interagency Workgroup on Air Quality Modeling guidelines (EPA, 1993) when converting the screening model (Level 1) values for nitrate deposition. If the screening model values are predicted to be greater than or equal to 0.03 kg/ha (see Appendix A) then the applicant should use the CalMet and CalPuff models for subsequent analysis.

Sulfate + Nitrate: The red values for sulfate and nitrate numbers presented in Table 1 are given as an indicator where soil and vegetation air quality related values could be adversely impacted. Acidic deposition can also have an adverse impact on water air quality related values because the acidified rainwater or soil water moves into the stream. Adverse effects can occur to water quality and aquatic organisms (especially some fish and aquatic insects) if the acidified soil water is not neutralized. The acid neutralizing capacity (ANC) is a water chemistry measurement which reflects the ability of a watershed to offset the acid inputs. Aquatic biota are at risk of adverse impacts if the spring stream ANC values are less than 25.0 ueq/l. Furthermore, aquatic biota are at risk if the ANC values are less than 0 ueq/l following a rain storm (i.e. episodic event). Water is an air quality related value at James River Face Wilderness, and spring time water chemistry samples have been collected. The lowest ANC recorded over the past five years is 3 ueg/l, which is well below the red line value. The CalMet and CalPuff models should be used if the steady state ANC levels are predicted to decrease equal to or greater than 0.1 ueq/l.

pH is another important water chemistry measurement used to indicate the status of the water as an air quality related value. Streams with a pH value of less than or equal to 6.0 in the spring time could have adverse impacts to the stream biota. Adverse impacts can also occur if the pH is less than or equal to 5.5 following a rain storm. The lowest spring time pH measurement for James River Face Wilderness is 5.7, which is below the red line value. The CalMet and CalPuff model should be used if the pH levels are predicted to decrease less than or equal to 0.01 units.

Particulates and NO_2: Some facilities which emit particulates, nitrogen dioxide (NO_2), and sometimes hydrogen sulfides (H_2SO_4) can produce a plume that can be seen in or outside of the Class I area. The EPA has recommended a method to assess impacts from coherent plumes from sources less than 50 km from the Class I area. The VISCREEN (EPA, 1988) and PLUVUE-II (EPA, 1995) models are recommended to conduct plume blight analysis. These two models calculate the change in color (ΔE) and contrast between the plume and the viewing background. Sources should perform the analysis using the existing emissions plus any additional emissions proposed. The model results are significant if the ΔE value is 2.0 or greater, and/or the contrast value is 0.05 or greater.

PM2.5: New sources emission increases can result in plume blight if they are 50 km or less from the Class I areas, but all sources have the potential to contribute to regional haze. The main type of visibility reductions at Class I areas is regional haze (SAA 1996), and any PSD analysis needs to focus on what a new source's contributions will be to regional haze. Fine particles (2.5 microns or smaller) are primarily responsible for reducing visibility at the Class I areas. The most important types of fine particles are: sulfates, organics, nitrates, elemental carbon and soil. In addition, coarse particles (between 2.5 and 10 microns) contribute somewhat to visibility impairment. The Environmental Protection Agency (EPA) has published a document with recommendations for modeling impacts on regional haze (EPA 1993), but the following steps should be followed instead of the guidance given by the EPA (1993):

1. Use the 24-hour modeling results for NO_x and SO_x concentrations for one year. Assume all NO_x forms ammonium nitrate and all SO_x forms ammonium sulfate. (Multiply the mass concentration of SO_4^{-2} by 1.375 to obtain $(NH_4)_2SO_4$. Likewise, multiply the mass concentration of NO_3^- by 1.29 to obtain NH_4NO_3.)

2. Get the Seasonal Clear-day Aerosol Profile data for all the modeling receptors for James River Face Wilderness from Table 2. The numbers in Table 2 are taken from an IMPROVE (Interagency Monitoring of Protected Visual Environments) monitoring site near James River Face Wilderness

Table 2. Seasonal Clear-day Aerosol Profile (background) for James River Face IMPROVE monitoring Site (8/94-9/96).

	Spring ($\mu g/m^3$)	Summer ($\mu g/m^3$)	Autumn ($\mu g/m^3$)	Winter ($\mu g/m^3$)	Extinction Efficiency
Ammonium Sulfate	3.09	5.36	2.46	2.58	3xf(RH)
Ammonium Nitrate	.61	.42	.41	.72	3xf(RH)
Soil	.41	.73	.30	.25	1
Organics	1.78	2.84	2.21	2.43	4
Elemental Carbon	.52	.49	.50	.53	10
Coarse Mass	5.318	4.12	3.48	3.2	0.6
$10^{th}\beta_{ext\ (inverse\ Mm)}$	61	105	62	63	
10th Standard visual range	64	37	63	62	

The following months should be used for each of the seasons listed in Table 2:

Spring: March, April, and May
Summer: June, July, and August
Autumn: September, October, and November
Winter: December, January and February

3. For each day, calculate reconstructed light extinction for background conditions and the new source, using the data in Table 2 for background. This calculation is performed assuming an externally mixed aerosol, so that the total extinction of the aerosols present is equal to the sum of the extinctions of each of the species. Each species' concentration is multiplied by a dry extinction efficiency to determine the amount of extinction it causes. For hygroscopic species (ammonium sulfate and ammonium nitrate), this dry extinction must be multiplied by f(RH) to correct for the effects of relative humidity. The f(RH) curve is in the EPA (1993) document. For computer algorithms, interpolate from values in Table B-1 (EPA, 1993).

Note: It is important to calculate f(RH) for each hour of the day being modeled. These 24 hourly f(RH) values should then be averaged to give a 24-hour average f(RH). **Do not** use the 24-hour average RH to calculate the daily f(RH).

4. Calculate the change in β_{ext} for each day. For the purpose of definition:

$$\Delta\beta_{ext} = \text{source } \beta_{ext} / \text{background } \beta_{ext}$$

The red line value is exceeded when the background β_{ext} change will be greater than or equal to 5 percent for any day during the year (Table 1). Likewise, the atmospheric modeling significance value is also the same as the red line value and the CalMet and CalPuff models should be used if the change in β_{ext} is predicted to be greater than or equal to 5 percent for any day during the year.

The following is for example only:

The modeling results predict the 24-hour average SO_4 concentration will increase by 0.9 $\mu g/m^3$ on December 10th at one of the receptors at James River Face Wilderness. All of the SO_4 increase will be assumed to form ammonium sulfate. Therefore, the increase in ammonium sulfate is predicted to be 1.2375 $\mu g/m^3$. The f(RH) was calculated for each hour on December 10th and the average of the 24 hourly values was 3. Using these values the background β_{ext} is:

[2.58(3(3))]+[.72(3(3))]+[.25(1)]+[2.43(4)]+[.43(10)]+[3.2(0.6)]

23.22 + 6.48 + 0.25 + 9.72 + 4.3 + 1.92 = 45.89 Mm^{-1}

Extinction attributable to the new source (with ammomium sulfate impact of 1.2375 $\mu g/m^3$) would be:

[1.24(3(3))]+[0(3(3))]+[0(1)]+[0(4)]+[0(10)]+[0(0.6)]

11.16 + 0 + 0 + 0 + 0 + 0 = 11.16 Mm^{-1}

Therefore, the percent change in β_{ext} is:

11.16 / 45.89 = .24 or 24 percent

A β_{ext} increase of 24 percent would exceed the red line value of 5 percent. If these were the results from a screening model, then the applicant should proceed to use the CalMet and CalPuff model to see if the SO_x modeled value would decrease. Another option would be to use a better control technology, or seek emissions offsets that would reduce the visibility impact.

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Appendix A

How the minimal nitrate and sulfate detection levels were calculated: According to Jim Lynch (Pennsylvania State University) the minimal detectable levels for sulfate and nitrate in wet deposition collectors is 0.03 mg/liter. To detect an increase in deposition (kg/ha) at a specific location depends upon the amount of rainfall. Rainfall modeling was conducted as a step in order to estimate the annual wet sulfate and nitrate deposition (Lynch and others 1996). The estimated rainfall for the Class I area is 42 inches (1067 mm). The following equation was used to estimate the minimal detectable level of an increase in sulfate or nitrate:

$$D = C * Rain * 0.01$$

where:
D = estimated deposition in kg/ha
C = the concentration of pollutant, which is 0.03 mg/liter
Rain = the rainfall in millimeters, which is 1067

The estimated deposition level for sulfate and nitrate is 0.3 kg/ha based upon using the preceding equation. The George Washington and Jefferson National Forests receives about 5 to 10 PSD applications per year. Therefore, the significant modeling screening value is being reduced to 0.03 kg/ha to provide a margin of protection due to the number of PSD applications received over a 2 year period.