Guidelines for
Soil and Vegetation Analysis
And
Visibility Analysis

December 2015

1. Introduction

1.1 Scope

This document explains the requirements for performing a soil and vegetation analysis and a visibility analysis for the Santa Barbara County Air Pollution Control District (District). It is assumed that the reader has some modeling experience with AERMOD, AERSCREEN and VISCREEN. This document is not intended as a user's guide for AERMOD, AERSCREEN or VISCREEN. User's guides for these models are noted in the reference section of this document and should be consulted for troubleshooting or when background information is needed on a topic. The purpose of this document is to clarify the requirements for the soil and vegetation analysis and a visibility analysis. The District's guidance for the air dispersion models is a separate document and available here: http://www.ourair.org/wp-content/uploads/aqia.pdf

1.2 Applicability

Per District's Rule 803, Prevention of Significant Deterioration, any new or modified stationary source which emits, in its entirety, more than any emission level shown in Table 2 of any attainment pollutant must complete a soil and vegetation analysis and a visibility analysis. The entire project's emissions must be included in the analyses. Project is defined to include all Authority to Constructs issued within the last three years and other related project emissions.

Table 2: Prevention of Significant Deterioration Monitoring Thresholds

Pollutant	Pounds/day
Particulate Matter	120
PM_{10}	80
All other attainment pollutants	240

2. Soil and Vegetation Analysis

2.1 EPA's Seven-Step Screen

A screening analysis for soil and vegetation impacts should be conducted by using EPA's *Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals* (EPA's Screening Procedure). The document is available on the District's website: http://www.ourair.org/wp-content/uploads/EPA-Soil-Plant-Screen.pdf. Before using EPA's seven step screening methodology, you must first determine your project's criteria and toxics emissions. The toxic emissions may be calculated using source test results or District-approved emission factors.

If you completed air dispersion modeling for some other aspect of your project (e.g., Air Quality Impact Analysis), then you will combine the modeled ground level concentrations with the ambient background concentrations and compare the results with the most stringent limits for each Class I and Class II area. Background concentrations can be obtained from the District for NOx, CO and SO_2 for certain areas in Santa Barbara County. Background concentrations for lead are found in Appendix C of EPA's Screening Procedure for Santa Barbara County.

Step 1 Evaluating Maximum Concentrations

If the ground level concentration (GLC) is already known for these pollutant (i.e., air dispersion modeling was required for some other aspect of the project), then continue to Step 2. If the GLCs have not yet been determined, then use EPA's Significant Emission Rate (SER) methodology by comparing the project's potential emissions against the SER thresholds in Tables 5.6 and 5.7 of EPA's Screening Procedure (tables are reproduced below). **If your project emissions (in tons/year) for all pollutants are less than the SER thresholds in Tables 5.6 and 5.7, no further action is required for the soil and vegetation impacts analysis.**

Significant Emission Rate Methodology

EPA defines the SER as the minimum emission rate which would cause the source's impact to just equal the screening concentration. Your project's emissions are compared to the SER thresholds in Table 5.6 and 5.7. The SER thresholds are based on generic stack parameters and may be adjusted to reflect different stack parameters. EPA's Screening Procedure Table 5.8 provides different stack configurations with the corresponding adjustment factor, called the Emission Rate Increase Factor. In addition, it may be necessary to adjust for a different project lifetime. EPA's Table 5.7 is based on a project lifetime of 10 years. To adjust for a different project lifetime, use EPA's Screening Procedure Equation 5.9 (shown below).

An example using the SER method is available at: http://www.ourair.org/wp-content/uploads/Example-SER-Method.xlsx

Table 5.6 Significant Emission Rates for Direct Acting Pollutants[a]

	Significant Emission Rate (T/yr)																
	Pollutant and Averaging Time[b]																
	SO_2				NO_2				CO			H_2S	Ethylene		Fluoride	Beryllium	Lead
Screening Criterion	1	3	24	A	4	8	M	A	1	8	W	4	3	24	240	M	3M
AQRV Screening Concentration	160	170	-	171	840	950	3,200	950	-	-	760,000	6,400	10.0	0.36	0.23	0.057	11
NAAQS	-	290	110	760	-	-	-	950	7,000	2,500	-	-	-	-	-	-	11
PSD Increment I	-	5.3	1.5	19	-	-	-	-	-	-	-	-	-	-	-	-	-
II	-	110	28	190	-	-	-	-	-	-	-	-	-	-	-	-	-
III	-	150	55	380	-	-	-	-	-	-	-	-	-	-	-	-	-
Variance	-	69	28	190	-	-	-	-	-	-	-	-	-	-	-	-	-
NESHAP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.057	-

[a]Based on 30 m release height and no background.

[b]Numerals: hours
W: 1 week
M: 1 month
A: Annual

Table 5.8. Summary of Representative Stacks

Stack	Stack Parameters			Emission Rate Increase Factor
	Height (m)	Temperature (°K)	Flow (m^3/sec)	
30 m release	30	293	0	1.00
10 m cold	10	350	4	0.96
10 m hot	10	550	4	4.07
30 m cold	30	350	4	3.43
30 m hot	30	550	4	8.93

$$\begin{pmatrix}\text{Significant}\\ \text{emission}\\ \text{rate for}\\ \text{N year}\\ \text{lifetime}\end{pmatrix} = \begin{pmatrix}\text{Tabulated}\\ \text{significant}\\ \text{emission rate}\end{pmatrix} \times (10/N). \qquad (5.9)$$

Table 5.7 Significant Emission Rates for Trace Elements[a]

Trace Element	Significant Emission Rate (T/yr) Criterion			
	Soils	Plant Tissue	Animals	10% of Endogenous Soil Concentration[b]
Arsenic	.40	.24	2.8	.08
Boron	.067	.28	-	.13
Cadmium	.33	.037	.19	.00080
Chromium	1.1	6.7	-	1.3
Cobalt	-	23[c]	1.2	.11
Copper	5.3	.21	5.7	.27
Fluoride	53[c]	1400[c]	440[c]	2.7
Lead	130[d]	37[d]	24[d]	.13
Manganese	.33	810[c]	1000[c]	11[c]
Mercury	61[c]	-	-	-
Nickel	67[c]	170[c]	3000[c]	.53
Selenium	1.7	13[c]	.67	.0067
Vanadium	.33	-	130[c]	1.3
Zinc	-	63[c]	100[c]	.67

[a]Based on a 30 m release height, no background, and a source lifetime of 10 years. For a lifetime of N years, divide the tabulated values by (N/10).

[b]For use as a supportive indicator only; based on a 10% increase over the average values in Table 3.5.

[c]Exceeds the significant emission level for TSP of 10 T/yr established for PSD (Ref. 3).

[d]Exceeds the significant emission level for lead of 1 T/yr established for PSD (Ref. 3).

If any of the SER thresholds are exceeded, estimate the maximum ambient concentration for the appropriate averaging times. This may be done in AERSCREEN or AERMOD. You must include background concentrations (if available). Table 5.2 of EPA's Screening Procedure (shown below) gives the correspondence between pollutants and the averaging times to be considered.

Table 5.2 Pollutants and Averaging Times

	Required Averaging Times									
Pollutant	1 hr	3 hr	4 hr	8 hr	24 hr	1 wk	10 days	1 mo	3 mo	1 yr
SO_2	X	X			X[a]					X[b]
NO_2			X	X				X		X[b]
CO	X[a]			X[a]		X				
H_2S	X[a]		X							
Ethylene		X			X					
Fluoride					X[a]		X			
Be								X[a]		
Pb									X[b]	X[c]
Trace Elements[d]										X[e]

[a] For comparison with criteria not necessarily related to impacts on plants, animals, or soils (NAAQS, NESHAP's, PSD increments).

[b] Applies to both impacts on plants, animals, soils and other criteria.

[c] Also included in trace element analysis.

[d] Trace elements: As, B, Cd, Cr, Co, Cu, F (as fluoride), Pb, Mn, Hg, Ni, Se, V, Zn.

[e] Required for use in estimating amount of deposition.

Step 2 Screening for Direct Impacts

Compare the maximum concentration determined in Step 1 against the corresponding screening concentrations in EPA's Screening Procedure Table 3.1 (reproduced below) or against the corresponding NAAQS, NESHAP or PSD increments (shown in EPA's Screening Procedure Table 5.3), whichever applicable standard is most restrictive. In addition, check for synergistic impacts by comparing the GLCs to Table 3.3 in EPA's Screening Procedure. If your project concentrations (plus background) are less than the most restrictive standard, then **no further action is required for the soil and vegetation impacts analysis.** If any pollutants exceed the most restrictive standard or if there is no standard for the trace element of interest (e.g., arsenic), go to Step 3.

Table 3.1 Screening Concentrations for Exposure to Ambient Air Concentrations[a,b]

Pollutant	Averaging Time	Minimum Reported Level (ppmv)[c] Vegetation Sensitivity: Sensitive[d]	Intermediate	Resistant	Reference
SO_2	1 hr	.35(917)	-	-	14
	3 hrs	.30(786)	.80(2096)	5.0(13100)	16
	1 yr	.007(18)			17
O_3[e]	1 hr	.20(392)	.35(686)	.55(1078)	18
	4 hrs	.10(196)	.15(294)	.35(686)	18
	8 hrs	.06(118)	.15(294)	.30(588)	18
NO_2	4 hrs	2.0(3760)	5.0(9400)	9.0(16920)	19
	8 hrs	2.0(3760)	4.0(7520)	8.0(15040)	19
	1 mo	.30(564)			f
	1 yr	.05-.10(94-188)			20
COS	1 wk	1000 (1,800,000)	-	10,000 (18,000,000)	21
H_2S	4 hrs	20.0-60.0 (28,000-84,000)	-	400 (560,000)	22
Ethylene[h]	3-4 hrs	.04(47)			24
	24 hrs	.001(1.2)			25
Fluorine	10 days	(0.5-10)			26
Beryllium[i]	1 mo	(0.01)			27
Lead[j]	3 mo	(1.5)			28

[a]All values except beryllium and lead refer to effects on vegetation.

Table 3.3 Synergisms of Gaseous Pollutants (Plants)[a]

Pollutants	Concentrations (ppmv)	Exposure	Reference
SO_2	.05	1 hr	30
NO_2	.05		
SO_2[b]	.30	1 hr	31
O_3	.10		
SO_2[b]	.05	4 hr	32
O_3	.05		
SO_2	.14	6 hr/day	33
O_3	.05	for 28	
NO_2	.10	days	

[a]The same criteria were used in selecting these values from Ref. 15 as were used in developing Table 3.1.

[b]Antagonism, as well as synergism, has been reported for mixutes of SO_2 and O_3 (Ref. 18).

Table 5.3 Ambient Screening Concentrations

Screening Criterion	Ambient Concentration ($\mu g/m^3$) — Pollutant and Averaging Time[a]																
	SO_2				NO_2				CO			H_2S	Ethylene		Fluoride	Beryllium	Lead
	1	3	24	A	4	8	M	A	1	8	W	4	3	24	240	M	3M
AQRV Screening Concentration[b]	917	786	-	18	3,760[b]	3760[b]	564	(100)	-	-	1,800,000[b]	28,000[b]	47	(1.2)	(0.5)	(.01)	(1.5)
NAAQS[c,d]	-	1,300	365	80	-	-	-	(100)	40,000	(10,000)	-	-	-	-	-	-	(1.5)
PSD Increment																	
I[e,f]	-	25	(5)	2	-	-	-	-	-	-	-	-	-	-	-	-	-
II[e,f]	-	512	91	20	-	-	-	-	-	-	-	-	-	-	-	-	-
III[e,f]	-	700	182	40	-	-	-	-	-	-	-	-	-	-	-	-	-
Variance[e,g]	-	325	91	20	-	-	-	-	-	-	-	-	-	-	-	-	-
NESHAP[f,h]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(.01)	-

Note: Circled values expected to be controlling; see text.

[a] Numerals: hours
W: 1 week
M: 1 month
A: Annual

[b] Ambient concentrations this high are unlikely.

[c] 40 CFR 50.

[d] Based on maximum impact of source plus background.

[e] Ref. 1.

[f] Based on maximum impact of source alone.

[g] Includes the source together with all other sources.

[h] 40 CFR 61.

Step 3 Calculating Deposited Soil Concentrations

Use EPA's Screening Procedure Equation 5.1 (shown below) to estimate the maximum concentration in the soil:

$$DC(ppmw) = 21.5\ (N/d)X \qquad (5.1)$$

where:

DC = deposited concentration (ppmw),

N = expected lifetime of source (yr),

d = depth of soil through which deposited material is distributed (cm), and

X = maximum annual average ambient concentration from the source ($\mu g/m^3$).

Per EPA's guidance, d = 3 cm. N is set to the same value used for the SER method in Step 1.

Step 4 Calculate Increase over Endogenous Soil Concentration

An increase over the endogenous concentration of more than 10% over the lifetime of the source could be taken as a possible cause for concern. The percentage increase is calculated from EPA's Screening Procedure Equation 5.4 (shown below):

$$(\%\ \text{Increase}) = [DC(ppmw) \times 100)]/[\text{Endogenous Concentration (ppmw)}] \qquad (5.4)$$

Obtain the endogenous concentrations from EPA's Screening Procedure Table 3.5 (shown below).

Table 3.5 Range of Endogenous Soil Contentrations of Selected Elements[a]

Element	Range (ppmw)	Average Soil Concentration (ppmw)
Arsenic	0.1-40	6.0
Beryllium	1-40	6.0
Boron	2-100	10.0
Cadmium	0.01-7.0	0.06
Chromium	5-3000	100
Cobalt	1-40	8
Copper	2-100	20
Fluoride	30-300	200
Lead	2-100	10
Manganese	100-4000	850
Mercury	0.01-4.0(?)	-
Nickel	10-1000	40
Selenium	0.01-80	0.5
Vanadium	20-500	100
Zinc	10-300	50

[a]Based on Ref. 8.

Step 5 Calculate Potential Concentrations in Plant Tissue

Estimate the plant tissue concentration using EPA's Screening Procedure Equation 5.5 (shown below):

[Tissue concentration (ppmw)] =

[Deposited concentration (ppmw)] x [Concentration ratio]

or

$$TC\ (ppmw) = DC\ (ppmw) \times CR \qquad (5.5)$$

The soil concentration ratios, CR, may be obtained from EPA's Screening Procedure Table 3.6 (shown below):

Table 3.6. Plant: Soil Concentration Ratios

Element	Recommended Value[a]	Comparative Value[b]
Arsenic	0.14	4.2
Boron	5.3	-
Cadmium	10.7	222
Chromium	0.02	250
Cobalt	0.11	87
Copper	0.47	1000
Fluoride	0.03	-
Lead	0.45	2
Manganese	0.066	3000
Mercury	0.02-0.5	26
Nickel	0.045	331
Selenium	1.0	4
Vanadium	0.01	1
Zinc	0.64	40

[a]Based on Ref. 8.

[b]Based on Ref. 12. Based on non-standard methods involving solution cultures. See discussion in text.

Step 6 Screen for Potential Adverse Impacts from Trace Elements

In this step, three comparisons are made:

1. The deposited concentration (DC) is compared to the soil screening concentration in EPA's Screening Procedure Table 3.4 (shown below);
2. The tissue concentration (TC) is compared to the tissue screening concentration in Table 3.4; and
3. The tissue concentration (TC) is compared to the dietary screening concentration for animals in EPA's Screening Procedure Table 3.7.

A calculated concentration in excess of any one of the three screening concentrations is an indication that a more detailed evaluation may be required and/or that the Federal Land Managers will be notified, since there are indication(s) of potential adverse impacts to plant, soils, or animals. **If none of the screening concentrations of Table 3.4 are exceeded, no further action is required for the soil and vegetation impacts analysis.**

Table 3.4 Screening Concentrations for Exposure of Vegetation to Pollutant Concentrations in Soil and Tissue

	Minimum Reported Level (ppmw)		
	Pollutant Source		
Pollutant	Soil	Tissue	Reference
Arsenic	3	0.25	9
Boron	0.5	11	9
Cadmium	2.5	3	9
Chromium	8.4	1	9,35
Cobalt[a]	-	19	9
Copper	40	0.73	9
Fluoride[a]	400	310	9
Lead[a]	1000	126	9
Manganese	2.5	400	9,36
Mercury	455	-	9
Nickel	500	60	9
Selenium[a]	13	100	9,37
Vanadium	2.5	-	38
Zinc	-	300	9

[a]Tissue concentrations may affect animals before affecting plants. Compare to toxic levels for animals in Table 3.7.

Step 7 Consider Effects of Solubilities

If a screen indicates that a further action is needed on a source because its emissions will cause a trace element screening concentration to be exceeded, an attempt may be made to look at the possible effect of reduced solubility on that indication by considering the solubility of the deposited material. This additional consideration can only be used as a supportive indicator; it can only increase confidence in the decision to take further action; it cannot reverse such a decision based on the screens in Step 6.

Calculate the tissue concentration corrected for the solubility of the pollutant, TC_{corr}, using EPA's Screening Procedure Equations 5.7 and 5.8 (shown below). Then compare TC_{corr} to the concentrations in EPA's Screening Procedure Table 3.4. Additional review may be required if it is known that solubility effects may be important, even if none of the screening concentrations of Table 3.4 are exceeded using TC_{corr}.

If the solubility of a particular trace element is S%, the amount actually available for uptake (AA) by plants is

$$\begin{pmatrix}\text{Amount}\\ \text{available}\\ \text{for uptake}\end{pmatrix} = DC \times (S/100)$$

or

$$AA = DC \times (S/100). \qquad (5.7)$$

$$TC_{corr.} = AA \times CR = DC \times (S/100) \times CR = TC \times (S/100) \qquad (5.8)$$

where $TC_{corr.}$ stands for the tissue concentration corrected for the solubility of the deposited material. The new values of $TC_{corr.}$ could be compared with the screening concentrations for plant tissues and animals given in Tables 3.4 and 3.7, respectively.

3.0 Visibility Impact Analysis

A visibility impact analysis begins with a Level-1 plume visual impact screening analysis conducted for the nearest Class I area using the *United States Environmental Protection Agency (EPA) Workbook for Plume Visual Impact Screening and Analysis* Revised October 1992 (EPA Workbook) http://www.epa.gov/scram001/userg/screen/WB4PlumeVisualOCR.pdf and VISCREEN model version 13190 (available at: http://www.epa.gov/scram001/dispersion_screening.htm). A VISCREEN Level-1 analysis uses emission rates, distances, and background visual range data to predict whether a plume has the potential to be perceptible under reasonable worst case conditions.

3.1 Level-1 Screening

For most sources, only the total particulates and NOx emission rates are required to be evaluated. The District will notify you if must include primary NO_2, soot, and/or sulfate emissions in VISCREEN.

VISCREEN Inputs:

- Emission rates of (maximum short-term rates)
  - Particulate matter
  - Nitrogen oxides (NOx)
  - Nitrogen dioxide (NO_2), primary sulfate (SO_4^{2-}), soot – If notified by District to include.
- Distance between the emission source and (1) the observer, (2) the closest Class I area boundary, and (3) the most distant Class I area boundary.
- Background visual range appropriate for the region in which the Class I area (San Rafael Wilderness) is located.

The following three distances must be determined for VISCREEN (See EPA Workbook Figure 7, shown below):

- Minimum distance between the emission source and observer (parameter d)
- Nearest Class I area boundary based on a 22.5º wide sector (parameter Xmin)
- Most distant Class I area boundary based on a 22.5º wide sector (parameter Xmax)

An example showing the three distances on an aerial photo is shown below.

VISCREEN requires the background visual range of the region in which the Class I area is located. Based on the EPA Workbook Figure 9 (shown below), use a default value of 25 kilometers for the background visual range.

A Level-1 plume visual impact screening analysis must be conducted for any parks (e.g. city, county, state, or federal) within 20 kilometers of the facility boundary using the same methodology as for the nearest Class I area. The Class II visibility analysis is for informational purposes as there is no established criterion for Class II areas.

Results from VISCREEN are compared to two separate screening criteria specified by the EPA for Class I areas to see if the plume might be perceptible under reasonable worst case conditions:

1. a total color contrast (ΔE) value of 2.0
2. a green (0.55 um) contrast value of 0.05

If the results of the Level-1 screening are below the screening criteria for a Class 1 area, no additional analysis is required. If the results exceed the screening criteria for a Class 1 area, a Level-2 screening is required.

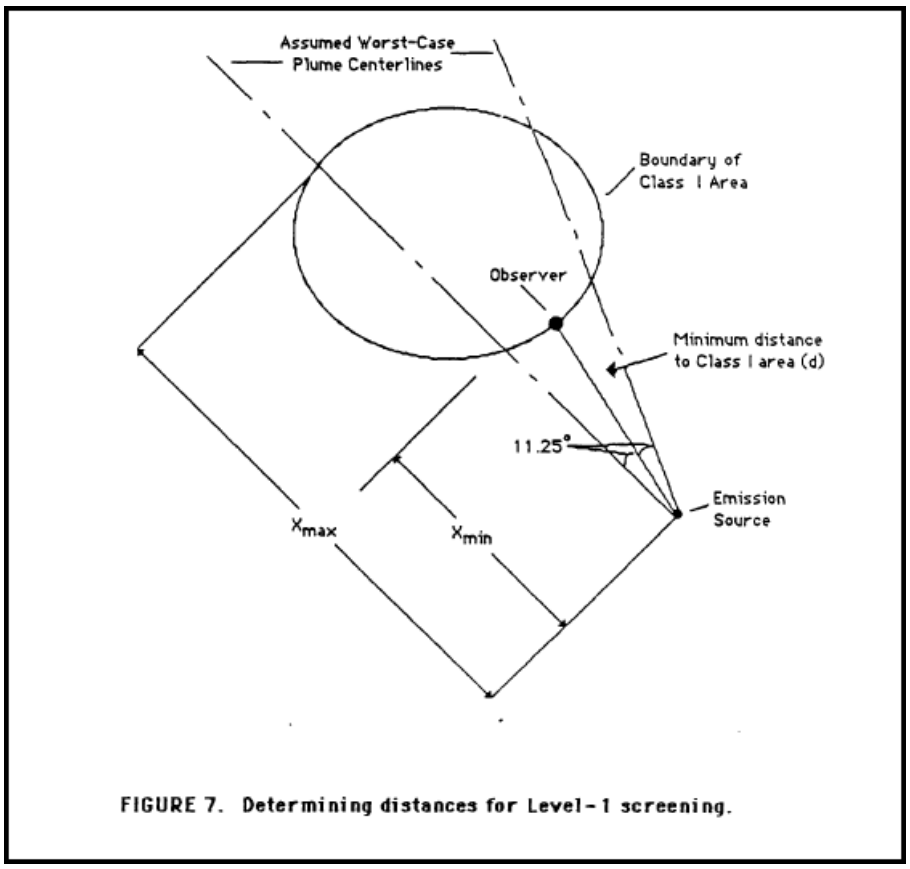
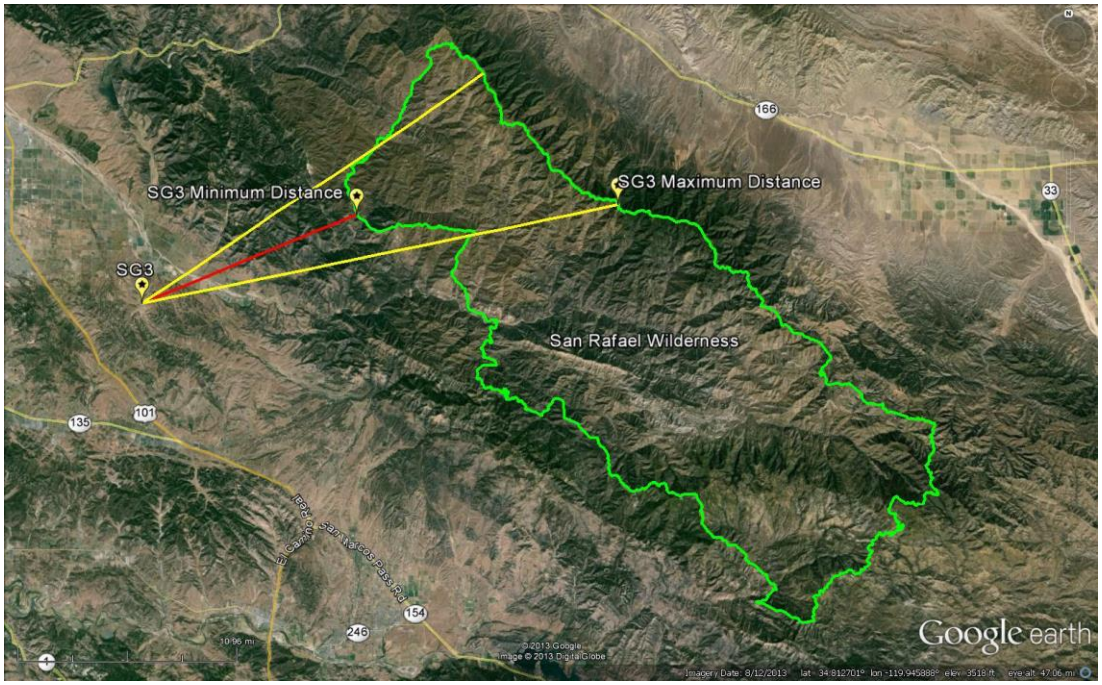


FIGURE 7. Determining distances for Level-1 screening.



Example Distances to Class I Areas

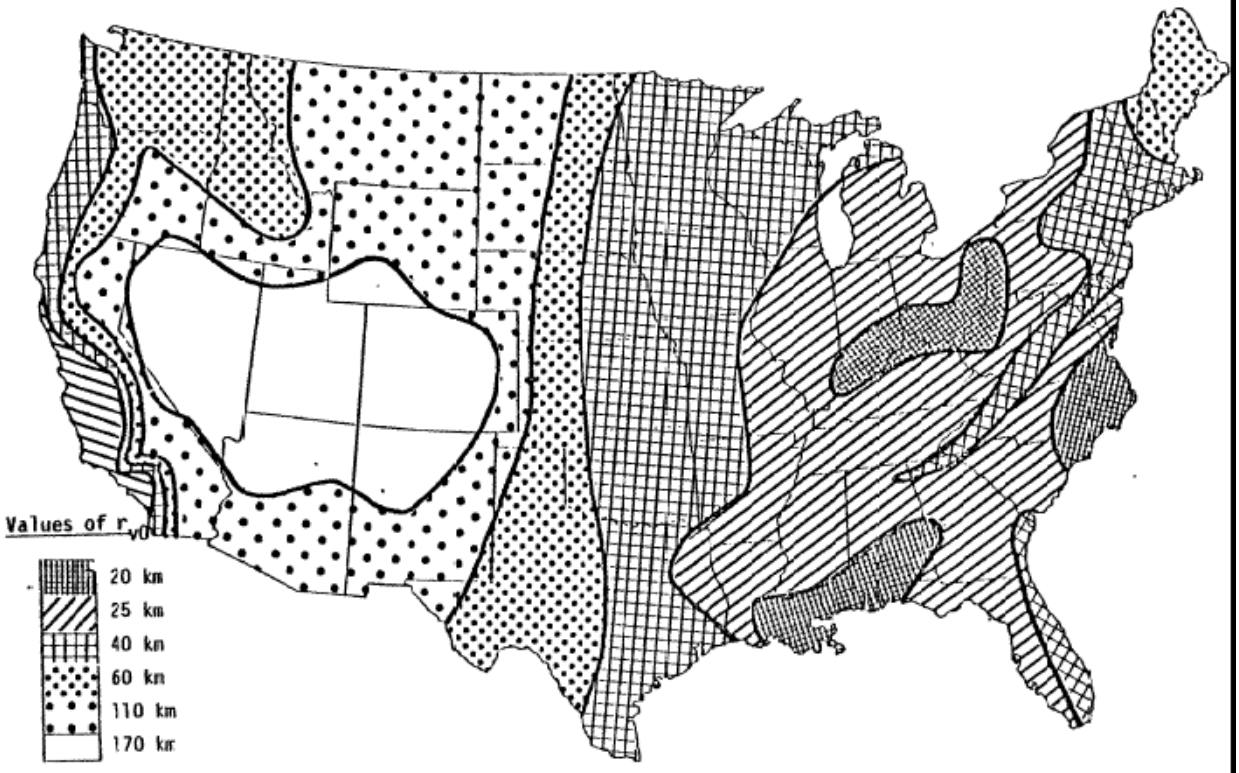


FIGURE 9. Regional background visual range values (r_{v0}) for use in level-1 visibility screening analysis procedure.

3.2 Level-2 Screening & Level-3 Analysis

If the results of the Level-1 screening exceed the screening criteria for a Class 1 area, a Level-2 screening must be done using more representative inputs. For example, meteorological data and topography representative of the surrounding area are used in a Level-2 screening. The procedure for the Level-2 screening is described on page 39 of the EPA Workbook.

If the results of the Level-2 screening exceed the screening criteria for a Class 1 area, a Level-3 analysis is done. A Level-3 analysis in not considered a screening and is intended to be a comprehensive analysis of the magnitude and frequency of occurrence of plume visual impacts as observed at a Class I area. A Level-3 analysis is described on page 51 of the EPA Workbook.

All assumptions and non-default inputs must be clearly documented and may require the approval of the Federal Land Managers in addition to the District.

4.0 References

- Santa Barbara County Air Pollution Control District Rule 803. http://www.sbcapcd.org/rules/download/rule803.pdf
- EPA's *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals* (EPA 450/2-81-078)
- http://www.ourair.org/wp-content/uploads/EPA-Soil-Plant-Screen.pdf
  United States Environmental Protection Agency (EPA) Workbook for Plume Visual Impact Screening and Analysis (Revised October 1992)
  http://www.epa.gov/ttn/scram/userg/screen/WB4PlumeVisualOCR.pdf
- EPA's *User's Guide for the AMS/EPA Regulatory Model -AERMOD*
  http://www.epa.gov/scram001
- EPA's *AERSCREEN User's Guide*
  http://www3.epa.gov/ttn/scram/models/screen/aerscreen_userguide.pdf