APPENDIX K

Rollback Methodology

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INTRODUCTION

The approach Clark County used to demonstrate attainment of the 24-hour and annual average PM_{10} National Ambient Air Quality Standards (NAAQS) is referred to as "rollback modeling" or using the "rollback method." The methodology, the reasons for its use, and justification for the use of this model are described in this appendix. Concerns raised by the United States Environmental Protection Agency (U. S. EPA) with the method and potential uncertainties will be discussed throughout the appendix.

SELECTION OF THE ROLLBACK MODEL

The rollback approach is not one of U. S. EPA's preferred methods for demonstrating attainment of the PM_{10} NAAQS. Preferred methods include dispersion modeling, source/receptor models such as the Chemical Mass Balance (CMB) models, and advanced regional models (e.g., the Urban Airshed Model). However, these nominally more sophisticated models do not offer significant improvements in demonstrating attainment under the conditions that prevail in the Las Vegas, Nevada area.

In the early 1990's, attainment demonstrations were based on proportional rollback of an emission inventory, usually in conjunction with receptor modeling (CMB). For nonattainment areas where the principal contribution to PM_{10} is fugitive dust, standard receptor modeling does not give enough information on which to base an attainment demonstration, since the many source types cannot be distinguished. In a study Desert Research Institute (DRI) conducted during 1995 for the Clark County nonattainment area,[1] CMB receptor modeling showed that fugitive dust accounted for 80-90 percent of the PM_{10} contribution. However, CMB receptor modeling depends on the relative chemistry of one source to distinguish it from another. The CMB receptor model cannot distinguish between soil entrained from construction activities versus soil entrained from vehicles or wind erosion.

More recently, plume and regional dispersion models have been applied in PM_{10} State Implementation Plans (SIPs). Because of the acknowledged uncertainties in PM_{10} emission factors and activity levels, dispersion modeling is somewhat suspect, though application to a micro-scale area may give a better idea of relative source contributions than proportional rollback based only on the emission inventory. However, dispersion models require substantially more resources and time than rollback models, including development of meteorological inputs. Due to the uncertainties associated with emission factors

[1] Chow, J. et al, *Middle- and Neighborhood-Scale Variations of PM_{10} Source Contributions in Las Vegas, Nevada,* Journal of Air & Waste Management Association, **49**:641-654[1999].

and activity levels, the potential for more information regarding source contributions from dispersion modeling is largely offset, making the extra resources required for dispersion modeling economically impractical.

Based on these considerations, the U. S. EPA, Clark County Comprehensive Planning, and the Clark County Health District settled on the proportional rollback model using micro-scale inventories for the attainment demonstration. It is assumed that those sources within a relatively short distance (1 to 2 kilometers) will have the greatest contribution to the ambient concentration measured at a monitor. It is for this reason that, for the most part, the inventories prepared for the proportional rollback modeling included sources within a square, centered on a monitoring station, having a two-kilometer radius.

There are drawbacks to the proportional rollback model. One is that sources outside the micro-scale area may contribute to the PM_{10} concentrations measured at the monitoring site despite the generally short-range PM_{10} source contributions. There is a “regional” component to PM_{10} that would include secondary particulate and other fine particles in addition to some larger primary or coarse particles. Unfortunately, there is no clear way of separating this regional component from the local one. For this reason 24-hour valley-wide proportional rollback modeling and attainment demonstration was completed for third highest value of the highest value measured in each year of the three-year base line period (1997 through 1999). For the annual attainment demonstration, the percent reductions that were projected for the J. D. Smith annual attainment demonstration were applied to the 1998 annual valley-wide emissions inventory to establish a valley-wide emissions budget.

Additionally, the micro-scale areas are considered representative of the significant PM_{10} sources located throughout the nonattainment area. Control strategies for sources within the micro-scale area will be applied throughout the nonattainment area. Therefore, the sources outside the micro-scale area will also be controlled. In the proportional rollback model, these sources are not addressed and neither will the potential reduction in emissions from these sources. The background concentration will remain constant although control strategies may reduce background concentrations. Therefore, the actual reduction in contributions may be greater than what is projected using the rollback modeling.

Another drawback of the proportional rollback model is that the contribution from secondary particulate is not addressed. It is assumed they remain constant and contribute the same amount regardless of the changes in emissions of primary particulate. Therefore, they are treated the same as background in the proportional rollback modeling. The attainment of the NAAQS must be demonstrated despite the contribution from secondary particulate.

The concentration added to the background made by secondary particulate was determined using the Chemical Mass Balance (CMB) receptor modeling results from 1995 and 1996. As shown in Table 4-2, the average concentration of secondary particulate was higher at the East Charleston site than at Craig Road. Although the PM_{10} concentrations measured at the East Charleston site were below the NAAQS, the average values from this site were used for the secondary particulate because they were higher. Using the average data from the East Charleston site, a total of 3.47 $\mu g/m^3$ of secondary particulate was modeled. For purposes of rollback modeling, 3.5 $\mu g/m^3$ was added to the background concentration for each design day.

Background for the 24-hour inventories was based on the design day. For each design day, the natural background PM_{10} concentration was determined by comparing the PM_{10} concentrations measured at the monitoring stations generally upwind of the area and using the lowest 24-hour concentration. For most design days the concentration measured at the Jean station was the lowest and the station is not only generally upwind, but also not located within the nonattainment area.

For the base year, 1998, the natural background PM_{10} concentration was determined by comparing the annual average PM_{10} concentration at the sites most frequently upwind of the nonattainment area. The site that most often had the lowest 24-hour PM_{10} concentration of any sites was used as the background monitoring site. For 1998, that site was the Jean monitoring station with an annual average 24-hour concentration of 13 $\mu g/m^3$.

The background concentration will remain constant for the rollback modeling, even in future years. The measured background may be expected to increase with additional vehicle miles traveled. The U. S. EPA guidance for estimating paved road dust emissions utilizes a formula that gives PM_{10} emissions in units such as pounds per vehicle miles traveled (VMT). The empirical formula is partially based on the road surface silt loading. As VMT grows, even in the background areas, the impacts from paved road dust would be expected to increase. The vast majority of emissions affecting silt loading on paved roads comes from wind erosion of vacant land, wind erosion of construction sites, unpaved roads, unimproved shoulders, track out from construction sites and transition points between unpaved and paved roads. Control measures are being implemented to reduce emissions from each of these sources. The overall reduction in these emissions is assumed to lead to a corresponding reduction in silt loading on paved roads. The reduced silt loading in later years are expected to offset the potential increase in emissions from growth in VMT.

ROLLBACK MODEL

The proportional rollback model assumes a linear relationship is present between PM_{10} emissions from sources and their contribution to measured PM_{10} levels in the ambient air. For example, if 25 percent of the emissions (measured in tons) in an area come from wind erosion of vacant land, it is assumed 25 percent of the ambient concentration measured (minus the background which remains constant throughout the modeling) by a monitor (in $\mu g/m^3$) in the area was contributed by wind-entrained soil. Likewise, the proportional rollback model assumes any reduction or increase in emissions will have a corresponding reduction or increase in the ambient concentration measured at the monitoring station. If emissions from a source are reduced by 10 percent, the relative contribution from that source measured at the monitoring station will be reduced by 10 percent. For example, construction activities emissions were calculated to be 20 tons on a day the monitor in the area recorded an ambient concentration of 120 $\mu g/m^3$. The total inventory for the area was 100 tons, so construction activities represented 20 percent. Using the proportional rollback model approach, the relative contribution from construction activities to the ambient concentration measured of 120 $\mu g/m^3$ is 24 $\mu g/m^3$ (20 percent). If emissions from construction activities were reduced by control measures by 50 percent, the proportional rollback model assumes the relative contribution from construction activities will also be reduced by 50 percent to 12 $\mu g/m^3$. The anticipated ambient concentration would be reduced by the same amount to 108 $\mu g/m^3$.

The basic steps for the rollback model are as follows:

1. Determine representative monitoring station(s) and the design value;
2. Determine background as the lowest PM_{10} value recorded at an upwind monitoring location on the same day or during the same time period;
3. Prepare a micro-scale inventory of the sources that emit PM_{10} for the time period the monitor measured;
4. Calculate the percentage for each source based upon the entire inventory;
5. Calculate the relative contribution from each source to the concentration measured for the time period;
6. Estimate the anticipated increase or decrease in emissions from each source;
7. Apply the same percentage of increase or decrease in emissions from each source to the relative contribution calculated for the same source; and
8. Calculate the anticipated ambient concentration after source emissions change.

The selection of representative monitoring stations is described in detail below. The design value determinations are described in Appendix A. Appendices B and D describe in detail the development of the base line emission inventories while appendices E and L describe, respectively, the increases in emissions due to growth and decreases from adopted controls.

SELECTION OF REPRESENTATIVE MONITORING STATIONS

The representative monitoring stations selected for this State Implementation Plan (SIP) were those stations where exceedances of the 24-hour and/or annual NAAQS were measured. The 24-hour NAAQS was exceeded at five monitoring stations: Craig Road, East Flamingo, Green Valley, J. D. Smith and Pittman. All five sites were modeled. The annual NAAQS was exceeded at only one station: J. D. Smith. An annual inventory as well as a design day inventory was prepared for this site. This is a conservative selection process as these stations are also where the highest concentrations of PM_{10} were measured in the nonattainment area.

In addition, each of the five sites were chosen to represent a typical range of likely nonattainment scenarios and to reflect valley-wide worst case scenarios. The five micro-scale sites selected for modeling to demonstrate the attainment of the 24-hour NAAQS include some of the highest emitting sources in the nonattainment area. The Craig Road micro-scale area includes large tracts of vacant land, a desert area used as a motorcycle race track, and PM_{10}-emitting stationary sources such as a cinder block manufacturing plant and an aggregate plant. The East Flamingo site includes a portion of Tropicana Avenue from Paradise Road to Las Vegas Boulevard. This link of roadway has the highest traffic volume of any non-freeway roadway in the county (Clark County Comprehensive Planning, Tranplan Modeling, 2000) being largely impacted by tourist traffic between McCarran International Airport and the resort corridor commonly referred to as the “Las Vegas Strip.” Of the 669 acres of vacant land in the Green Valley micro-scale area, 356 acres (53 percent) were under active construction. The area also includes two areas referred to as “race tracks” where motorcycles are routinely ridden. The J. D. Smith site represents a developed urban area. There are 4.5 miles of freeway, 13 stationary sources made up largely of boilers, and only 250 acres of vacant land, including 48 acres of active construction sites, within the micro-scale area. The Pittman area includes two of the seven major PM_{10} stationary sources, unpaved parking areas, and 13 miles of unpaved roads. The area also includes the only off-road bicycle riding area identified in the inventorying process including satellite images and aerial photographs.

Despite the variation of the sources within the micro-scale areas, the source contributions in the valley-wide inventory are within the range of those in the micro-scale areas. Table K-1 shows the percent contribution of source categories to the 1998 valley-wide base year emissions inventory and the range of the percent contribution for the same or similar source category for the micro-scale inventories. Therefore, the overall attainment area is represented by the micro-scale inventories.

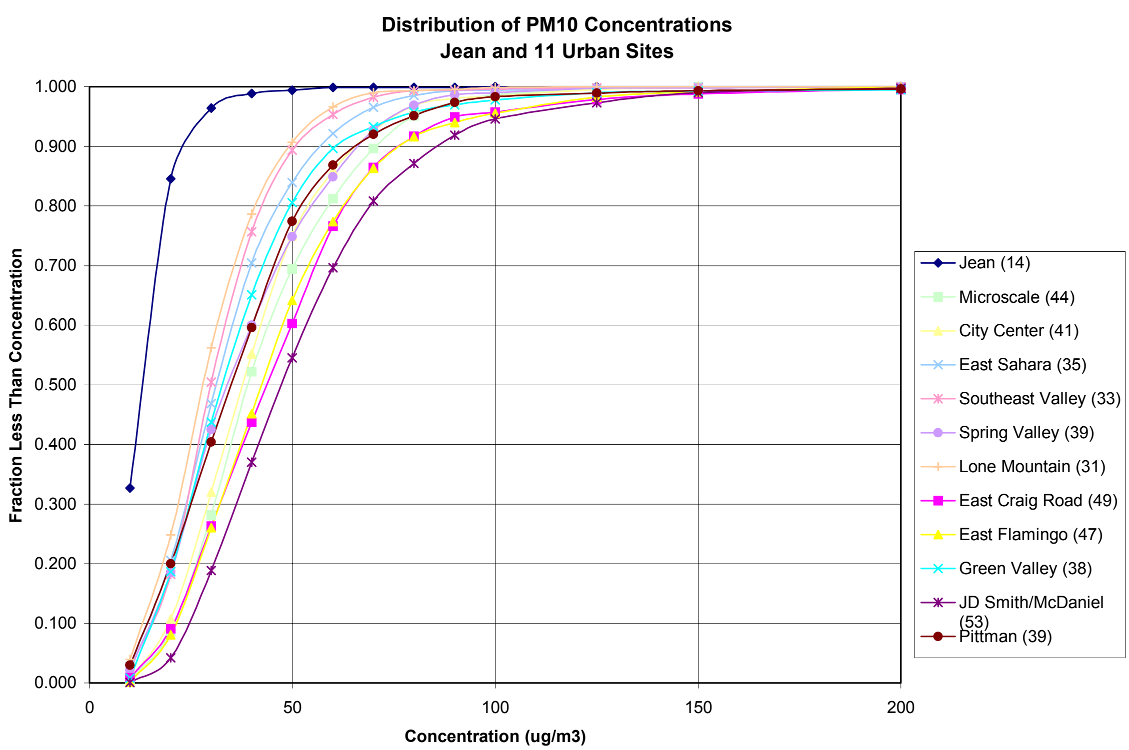
Table K-1
Comparison of Emissions Inventories for Annual Average PM_{10} and 24-Hour PM_{10} Attainment Demonstrations.

PM_{10} Emissions Inventory Category	Annual Valley-Wide 1998 Base Year Emissions Inventory		24-Hour 1999 Design Day Micro-Inventory Range	
	(TPY)	(%)	Min. %	Max. %
Stationary Point Sources Total	**1,201**	**0.70**	**0.08**	**1.83**
Small Point Sources	184	0.11	-	-
Residential Firewood	75	0.04	-	-
Residential Natural Gas	67	0.04	-	-
Commercial Natural Gas	33	0.02	-	-
Industrial Natural Gas	14	0.01	-	-
NG - Purchased at the source – Carried by SWG	210	0.12	-	-
Structural/Vehicle Fires/Wild Fires	17	0.01	-	-
Charbroiling/Meat cooking	750	0.44	-	-
Soil Microbial Activity/Biological Sources	-	-	-	-
Disturbed Vacant Lands/Unpaved Parking Lots	48,500	28.17	21.71	71.41
Unpaved Parking Vehicles	-	-	0.00	0.15
Native Desert Land Dust	11,000	8.42	0.00	2.28
Stabilized Vacant Land Dust	5,410	3.14	0.12	3.19
Construction Activity Fugitive Dust	19,807	11.50	0.97	8.49
Windblown Construction Dust	15,755	9.15	5.71	54.50
Construction Track Out	561	0.33	0.05	0.33
Stationary Area Sources Total	**102,384**	**61.17**	**55.99**	**84.93**
Airport Support Equipment	37.1	0.02	-	-
Commercial Equipment	0.3	0.00	-	-
Construction & Mining Equipment	361	0.21	-	-
Lawn & Garden Equipment	12.4	0.01	-	-
Railroad Equipment	14.5	0.01	-	-
Recreational Equipment	1.0	0.00	-	-
McCarran International Airport	250.2	0.15	-	-
Henderson Executive Airport	5.5	0.00	-	-
North Las Vegas Municipal Airport	22.8	0.01	-	-
Nellis Air Force Base	31.9	0.02	-	-
Race Tracks Wind Erosion	-	-	0.00	10.92
Race Tracks Vehicles	-	-	0.00	4.60
Nonroad Mobile Sources Total	**737**	**0.43**	**0.00**	**15.52**
Paved Road Dust (Excludes Const. Track Out)	44,281	26.05	10.54	42.18
Unpaved Road Dust	15,025	8.73	0.01	3.36
Highway Construction Projects Activities	2,384	1.38	-	-
Highway Construction Projects – Wind Erosion	1,260	0.73	-	-
Vehicular Sulfate PM	408	0.24	-	-
Vehicular Tire Wear	83	0.05	-	-
Vehicular Brake Wear	135	0.08	-	-
Vehicular Exhaust	357	0.21	-	-
Vehicular PM	-	-	0.21	1.09
Onroad Mobile Sources Total	**64,494**	**37.55**	**10.80**	**43.13**
Nominal Background PM_{10}	**16.5**		**19.5**	**45.5**

Lastly, the concentrations measured at the monitoring stations throughout the nonattainment area indicate a general pattern. A comparison of the five sites used for the rollback modeling and six other urban PM_{10} sites that do not violate the PM_{10} standards was performed. There appears to be no large difference between the nonattainment sites and the other six sites. The nonattainment sites generally have more days with high PM_{10} values and higher concentrations of PM_{10}; however, the general distribution of values remains the same for each of the monitoring stations in the Las Vegas Valley. In other words, the representative sites do not show high values due to any anomalies; rather, the sites represent the areas of the valley with the highest impacts. The distribution of measured ambient concentrations for each of the monitoring stations and the background site in Jean is presented in Figure K-1. Although the height of the curve for each monitoring station varies, the shapes of the curves for each of the monitoring stations within the valley are very much the same. This a strong indicator that the PM_{10} concentrations have similar causes because the measured concentrations rise and fall together.

Figure K-1

Distribution of Ambient PM_{10} Concentrations for the Three-Year Period 1997-1999: Jean Background Site and 11 Urban Sites (Five 24-Hour PM_{10} Nonattainment and Six Other Urban Sites).



Therefore, the micro-scale sites are representative of the sources within the nonattainment area. The sites are representative of the nonattainment area as a whole. They also can be considered controlling sites in that the highest ambient concentrations measured in the nonattainment area have been recorded at one of the five chosen sites.