Alaska Department of Environmental Conservation

Amendments to State Air Quality Control Plan

Vol. III: Appendix III.D.3.4

PM_{10} Design Values for Juneau's Mendenhall Valley 2nd 10-year PM-10 Limited Maintenance Plan

DRAFT

April 24, 2020

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Governor

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Appendix to Volume II., Section III.D.3.4

PM_{10} Design Values for Juneau's Mendenhall Valley and Qualification for Second 10-year Limited Maintenance Plan

<u>Computation of 24-hr Design Value</u>

Computational methods for determining the 24-hour design value (DV) are outlined in the *PM_{10} SIP Development Guideline (EPA-450/2-86-001, June 1987).* The empirical frequency distribution approach (see Section 6.3.3. of the guidance) was used to determine the site-specific PM_{10} concentration that would be expected to be exceeded at a frequency of once every 365 days.

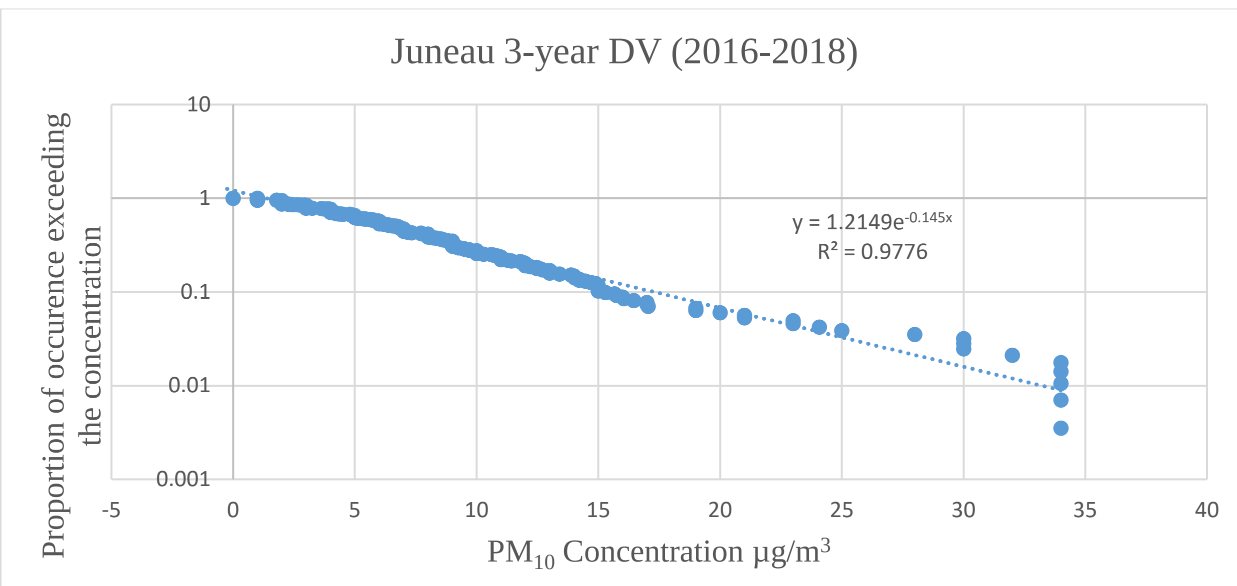
All observations by PM_{10} concentration were ranked for each 3-year block during the 2010 – 2018 period in descending order. Since PM_{10} concentrations were monitored generally on a one-in-six-days basis, each 3-year block had approximately 180 observations. Thus, the lowest concentration measured in each 3-year block had a rank order approximately 180.

Next, for a concentration ranked (*i*), the proportion of PM_{10} observations that exceed that concentration is calculated as:

i / total number of observations

The empirical frequency distribution for each 3-year block was then graphed by plotting the proportion of occurrence against PM_{10} concentrations. Figure 1 below shows an example of 2016-2018 period.

Figure 1
Example – Determination of 24-hr DV for 2016-2018



Total number of observations = 285. For this particulate period, DV was determined to be 42 μg/m³.

Table 1 below shows the calculated DVs for 2010-2018, all seven 3-year blocks. The average DV during the last 5-year period (2013-2018) was 49 μg/m³, which is below the LMP criteria of 98 μg/m³.

Table 1
Computation of Average DV for Floyd Dryden Site in Mendenhall Valley, Juneau

3-yr Period	**Equation of Line Describing Empirical Frequency Distribution**	R^2	**DV(computed from previous 3 years data using empirical frequency distribution** (μg/m³)
2010-2012	$y = 1.4639e^{-0.170x}$	0.9863	37
2011-2013	$y = 1.3749e^{-0.169x}$	0.9898	37
2012-2014	$y = 1.2576e^{-0.137x}$	0.9875	45
2013-2015	$y = 1.2581e^{-0.134x}$	0.9771	46
2014-2016	$y = 1.0327e^{-0.100x}$	0.9531	59
2015-2017	$y = 0.9613e^{-0.112x}$	0.9631	52
2016-2018	$y = 1.2149e^{-0.145x}$	0.9776	42
	Average DV 2013-2018 =		**49** μg/m³
	LMP Qualification Criteria		**< 98** μg/m³

Note: 2009 data points were removed from time series because of data completeness issue.
In this equation y is the proportions of concentrations exceeding a particular PM10 concentrations and x is the concentration of interest. If y is set = 1/365 = 0.0027, the equation can be used to solve for x, the concentration that would be expected to be exceeded once per year.

The 2009 data point were removed from time series because of data completeness issue, which was addressed in the letter submitted by DEC to EPA, dated January 6, 2010 (a copy of the letter can be found in the Appendix to III.D.3.3).

Computation of a Site-Specific Design Value

Attachment B of the Limited Maintenance Plan guidance (Wegman memo, EPA, August 9, 2001) outlines the procedure for computing a site-specific value (called a critical design value or CDV) that may serve as alternative to the 98 μg/m³ value used to determine whether an area qualifies for LMP option or meets the Motor Vehicle Regional Emissions Analysis Test. The computation is described below:

$$CDV = NAAQS/(1+tcCV)$$

Where:

CDV = the critical design value

CV = the coefficient of variation of the annual design values (the ratio of standard deviation divided by the mean design value in the past)

t_c = the critical one-tail t-value corresponding to a given probability of exceeding the NAAQS in the future and the degree of freedom in the estimate for the CV.

The Tables below illustrate the guidance received from EPA Region 10 staff. CDV was calculated based on 3-yr DVs from tabular ADV, the ADV for all empirical data, and ADV for upper 10% tail distribution, using 10% to determine the appropriate critical one-tail t value (t_c) in the computation.

Table 2
3-Year Average Design Values (ADVs) Data

Years	**3-Yr OBS**	**Tabular-ADV = lower**		**Empirical - ADV**	**Upper 10% Tail Dist - ADV**
		upper	lower		
2012-2014	185	0	38	45	38
2013-2015	183	0	38	46	40
2014-2016	188	0	38	59	44
2015-2017	187	0	34	52	54
2016-2018	285	0	34	42	45

Table 3
Critical Design Value Calculation

CDV = NAAQS/(1+t_CCV)			
Parameter	**Tabular**	**Empirical (all)**	**U10% Tail Distribution**
St. Dev	2.2	7.0	6.2
Mean	36.4	48.8	44.2
CV	0.060	0.143	0.140
n	5	5	5
df	4	4	4
NAAQS	150.0	150.0	150.0
t_C (10%, one-tail)	1.533	1.533	1.533
Critical Design Value	**137.3**	**123.0**	**123.5**

With the 5-year ADV (49 µg/m^3) for this monitoring station, less than the CDV (123.0 µg/m^3), this CDV provides additional evidence that the Mendenhall Valley Maintenance area continues to remain eligible for a Limited Maintenance Plan. Hence, there is less than 10% probability of violating the PM_{10} 24-hr standard in the future at the Floyd Dryden site in the Juneau's Mendenhall Valley PM_{10} maintenance area.

Alaska Department of Environmental Conservation

Amendments to State Air Quality Control Plan

Vol. III: Appendix III.D.3.5

2017 PM_{10} Emission Inventory for Mendenhall Valley 2nd 10-year PM-10 Limited Maintenance Plan

DRAFT

April 24, 2020

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Before developing the second 10-year LMP, DEC met with the Environmental Protection Agency (EPA) to discuss the development plan, issues of concern, and questions relating to projected emission inventories. Below is the response provided by the EPA;

"A maintenance plan typically contains an emission or modeling demonstration that shows how the area will stay in compliance through the 10-year maintenance period. This demonstration requires a projected emissions inventory usually. However, an area meeting the LMP qualification criteria is at little risk of violating the standard because emissions are not expected to grow sufficiently to threaten the maintenance of the standard. As stated in Section V.b. Maintenance Demonstration of the Wegman memo, "if the tests described in Section IV are met, we will treat that as a demonstration that the area will maintain the NAAQS. Consequently, there is no need to project emission over the maintenance period."

Thus, for this second 10-year LMP, emissions inventory report was only developed for 2017, which was selected as the base year. Also, the feedback and the clarifications received from EPA, particularly on the method of calculation of the Average Design Value (ADV) and the need for the computation of the Critical Design Value to further justify eligibility, were helpful in the development of the Appendix documents.

As shown in the 2017 inventory, the most significant source of PM_{10} in the Mendenhall Valley Maintenance area is the fugitive dust stirred up by vehicle traffic traveling on paved roadways. The on-road, non-road, and point source categories represent a trivial portion of the overall inventory.

Although there was an increase in on-road, non-road, and residential (wood) emissions in 2017, the analysis of the emission inventory indicates that the PM_{10} emissions in the maintenance area declined by about 78% between 2004 and 2017. The on-road and non-road emission estimates for 2017 were higher than 2014 because the latest EPA's mobile source emission factor model, MOVES2014b, which has higher emission factors were used was used to generate the emissions. In contrast, the 2014 on-road and non-road emission were based on MOBILE6.2 and were calculated using local data. The small increase in residential (wood) emissions can be attributed to increase in the number of households. The analysis of the emission inventory (2017) for the second 10-year LMP indicates that paved roads remain the most significant sources of fugitive dust (particularly during the summer) in the maintenance area. Fugitive dust from paved roads accounted for 46.2% of the overall inventory; fugitive dust from unpaved roads accounted for 0.53%; and emissions from wood burning accounted for 8.4% of the overall inventory.

The efforts by City and Borough of Juneau and the State to pave sections of unpaved roads in the Valley, as well as the woodsmoke control program, have continued to lead to significant reduction in the PM_{10} emissions.

Similar to the first 10-year LMP, four main source categories were inventoried for the second 10-year LMP. These include (1) On-Road; (2) Non-Road; (3) Area Sources; and (4) Point Sources. This document describes the assumptions and methods used to develop the 2017 base year PM_{10} emission inventory from the four sources.

Table 1 shows the summary of 2017 (base year for the second 10-year LMP) and 2014 Mendenhall Valley PM10 emissions by season and source category, as well as the percentage decrease in emissions.

Table III.D.3-5
Summary of Mendenhall Valley PM_{10} Emissions by Season and Source Category (tons/day)

Source Category	2017 (tons/day)	2004 (ton/day)	Percent Decrease (%)
Winter PM_{10} Emissions			
On-road	0.044	0.022	+50
Non-road	0.044	0.027	+38.6
Area			
Residential - wood	0.094	0.091	+3.2
Residential - Pellet	0.006	0.006	0
Residential - Oil	0.002	0.002	0
Residential Burn Barrels	N/A	0.000	N/A
Paved Road Fugitive Dust	0.116	1.478	92.2
Unpaved Road Fugitive Dust	0.004	0.161	97.5
Other Area Sources	0.182	0.182	0
Area Subtotal	0.404	1.920	79
Point	0.000	0.000	0
Total All sources	0.492	1.969	75
Summer PM_{10} Emissions			
On-road	0.042	0.021	50
Non-road	0.042	0.049	14.3
Area			
Residential - wood	0.033	0.031	+6.1
Residential - Pellet	0.002	0.002	0
Residential Burn Barrels	N/A	0.057	N/A
Residential - Oil	0.001	0.001	0
Paved Road Fugitive Dust	0.584	4.135	85.9
Unpaved Road Fugitive Dust	0.004	0.190	97.9
Other Area Sources	0.182	0.182	0
Area Subtotal	0.806	4.598	82.5
Point	0.133	0.155	14.2
Total All Sources	1.023	4.823	78.8
Annual Average	0.758	3.400	77.7

Note: + denotes percent increase in PM_{10} emissions

(1) On-road Emissions

On-Road Vehicle 2017 Emissions including Emissions from Exhaust, Tire and Break Wear

The estimates of exhaust, tire, and brake wear emissions for the first 10-year LMP were prepared for 2004 and 2018, using the EPA's vehicle emission factor model, MOBILE6. The EPA's latest vehicle emission factor model, MOVES2014b, was used to estimate the on-road exhaust, tire, and brake wear emissions for the calendar year 2017 for the Mendenhall Valley PM_{10} second 10-year LMP.

The county-level on-road vehicle emissions (Table 2) were developed from the local fleet data submitted to EPA for the 2017 NEI and the 2010 U.S. Census block level populations, using ArcGIS and the planning area map. The on-road emissions for the Mendenhall Valley Maintenance area in Table 3 were calculated by scaling the data in Table 2 by a factor of 0.4654 (see Appendix B for details). Separate inventories were prepared for summer (April to September) and winter (October to March).

Table 2
County-Level MOVES2014b On-road Vehicle 2017 PM_{10} Emissions (tons/day)
Based on DEC's 2017 NEI MOVES Inputs

	Summer	Winter
Vehicle Regulatory Type	April - September	October - March
Motorcycles	0.000	0.000
Light Duty Vehicles	0.011	0.013
Light Duty Trucks	0.037	0.042
Class 2b Trucks with 2 Axles and 4 Tires (8,500 lbs < GVWR <= 10,000 lbs)	0.007	0.006
Class 2b Trucks with 2 Axles and at least 6 Tires or Class 3 Trucks (8,500 lbs < GVWR <= 14,000 lbs)	0.004	0.004
Class 4 and 5 Trucks (14,000 lbs < GVWR <= 19,500 lbs)	0.004	0.004
Class 6 and 7 Trucks (19,500 lbs < GVWR <= 33,000 lbs)	0.006	0.005
Class 8a and 8b Trucks (GVWR > 33,000 lbs)	0.021	0.018
Urban Bus (see CFR Sec 86.091_2)	0.000	0.000
On-Road Fleet Totals	**0.090**	**0.094**

Table 3
Estimation of Mendenhall Valley On-road Vehicle 2017 PM_{10} Emissions (tons/day)
Using Scaling Factor of 0.4654

	Summer	Winter
Vehicle Regulatory Type	April - September	October - March
Motorcycles	0.000	0.000

Light Duty Vehicles	0.005	0.006
Light Duty Trucks	0.017	0.020
Class 2b Trucks with 2 Axles and 4 Tires (8,500 lbs < GVWR <= 10,000 lbs)	0.003	0.003
Class 2b Trucks with 2 Axles and at least 6 Tires or Class 3 Trucks (8,500 lbs < GVWR <= 14,000 lbs)	0.002	0.002
Class 4 and 5 Trucks (14,000 lbs < GVWR <= 19,500 lbs)	0.002	0.002
Class 6 and 7 Trucks (19,500 lbs < GVWR <= 33,000 lbs)	0.003	0.002
Class 8a and 8b Trucks (GVWR > 33,000 lbs)	0.010	0.009
Urban Bus (see CFR Sec 86.091_2)	0.000	0.000
On-Road Fleet Totals	**0.042**	**0.044**

(2) Non-road Emissions

The non-road emissions for the first the 10-year LMP were developed using EPA's NONROAD model. MOVES2014b was also used for developing the 2017 non-road emissions for this second 10-year LMP. However, unlike the on-road emissions, which were developed from the county-level NEI data, the non-road estimates were based on MOVES defaults. The non-road emissions for the Mendenhall Valley maintenance area, presented in Table 4, like the on-road emissions, were calculated from the county-level data by using a scaling factor of 0.4654 (see attached Appendix C for details).

Table 4
Estimation of Mendenhall Valley Non-road Equipment 2017 PM_{10} Emissions (tons/day)

Non-Road Equipment Sector	Summer April - September	Winter October - March	Annual
Recreational	0.0055	0.0452	0.0253
Construction	0.0069	0.0055	0.0062
Industrial	0.0004	0.0016	0.0004
Lawn/Garden	0.0025	0.0000	0.0021
Agriculture	0.0000	0.0000	0.0000
Commercial	0.0013	0.0013	0.0013
Airport Support	0.0000	0.0000	0.0000
Oil Field	0.0000	0.0000	0.0000
Pleasure Craft	0.0000	0.0000	0.0000
Railroad	0.0000	0.0000	0.0000
Non-Road Totals	**0.0420**	**0.0437**	**0.0428**

(3) Area Sources

Small sources that individually emit a small quantity of emissions but collectively impact the regional air quality are called area sources. In Mendenhall Valley, combustion sources generally used for heating and cooking, residential wood burning, propane, coal, fuel oil, natural gas combustion, and structural fires constitute the area sources.

Residential Fuel Use

Similar to what Sierra Research did in 2005, the Department of Environmental Conservation calculated the 2017 emissions from residential and commercial facilities by using the 2017 population estimates to adjust the results of the 2005 home heating survey. Juneau's population data for 2017 (32,269) was derived from the Research and Analysis (R&A) Section of the Alaska Department of Labor and Workforce Development (DLWD). The R&A section also contains the most current population growth forecast (2017 to 2045) for the State and individual Boroughs. As shown in Table 4, the 2017 Mendenhall Valley population and household estimates were derived by proportion using the 2004 data and the 2017 CBJ population estimate.

Table 5

Population and Housing Estimates for City and Borough of Juneau and Mendenhall Valley Maintenance Area

Year	City and Borough Juneau		Mendenhall Valley	
	Population	Households	Population	Households
2004	30,966		13,327	4,888
2017	32,269		**13,888**	**5,094**

Table 6 shows the allocation of survey fuel use to summer and winter seasons.[1] Since the 2005 survey collected data for winter heating season (defined to last a total of 243 days from October to May), the data was modified to match the 182-day winter season (October – March) and 183-day summer season (April – September). Annual and seasonal PM_{10} emissions were computed based on the activity data and EPA's AP-42 emission factors.

[1] Sierra Research Draft Report of Mendenhall Valley PM_{10} Emission Inventory For Alaska Department of Environmental Conservation (2006)

Table 6

*Allocation of Survey Fuel Use to Summer & Winter Seasons (fuel use by participating households)					
Survey		Winter		Summer	
Season	Fuel Use	Adjustment	Fuel Used	Adjustment	Fuel Used
Wood (cords)					
Oct. – May	133	0.85	113.05	0.15	19.95
June – Sept.	19	-	-	1.00	19.00
Annual	1	0.72	0.72	0.28	0.28
Total	-	-	113.77	-	39.23
Fuel Use/Household		127 homes	0.90	127 homes	0.31
Pellets (40 lb bags)					
Oct. – May	1,291	0.85	1,097	0.15	194
June – Sept.	181	-	-	1.00	181
Annual	0	-	-	-	-
Total	-	-	1,097	-	375
Fuel Use/Household		22 homes	49.86	22 homes	17.05
Fuel Oil (gallons)					
Oct. – May	148,891	0.85	126,557	0.15	22,334
June – Sept.	51,944	-	-	1.00	51,944
Annual	35,403	0.72	25,420	0.28	9,984
Total	-	-	151,977	-	84,261
Fuel Use/Household		390 homes	389.68	390 homes	224.96

* Data was extracted from the Sierra Research Draft Report of Mendenhall Valley PM_{10} Emission Inventory for Alaska Department of Environmental Conservation (2006)

As shown in the Table 6 above, Sierra adjusted the winter survey data, which covered October to May, by 85%, to compute the amount of fuel used during the period of October to March. They allocated the remaining 15%, which covered April and May, to summer season. The summer survey data, which covered the period of June to September, was fully allocated (100%) to the summer season. Sierra allocated the annual survey data on the basis of winter (71.85) and summer (28.2%) heating degree-day splits recorded over a 12-month period. The computed seasonal fuel-use values were then divided by the number of homes that reported wood, pellet, and fuel oil use in the survey to estimate fuel use per household.

Wood-Use Heating

Since wood use in the survey was reported on a per-household and many households reported a mixture of wood burning devices, for the first 10-year LMP, wood use was allocated by type of wood burning devices. The total number of wood heaters was determined first, followed by the number of homes that were equipped with one or more non-pellet type wood heaters. This helped in getting rid of the overlap caused by homes having multiple heaters. The sum total of the wood heaters (162) was then normalized to 127, the sum total of homes equipped with one or more heaters. Based on the percentages calculated by Sierra and using the AP-42 emission factors, DEC, in this second 10-year LMP, extrapolated the data to represent the 2017 emissions (Shown in Tables A and B in Appendix D) for the Mendenhall Valley maintenance area.

Fuel Oil Heating

In the 2005 survey, 390 fuel oil users were recorded. Sierra apportioned the data to Toyo/Monitor-type stoves and central oil furnaces on the basis of the percentage of households that reported the use of each. These percentages were then normalized to 89.7% to account for the households that operate more than one unit. DEC, using these normalized percentages and the 2017 population estimate, calculated the 2017 fuel oil emissions (see Tables C and D in Appendix C) for the maintenance area. Unlike the wood burning sources which have individual emissions factors, only a single emission factor is available for the fuel oil heater.

Used Oil Combustion

There is no available data on used oil combustion in Juneau or the maintenance area. Hence, the source category is excluded from the emissions inventory for the second 10-year LMP.

Propane

The 2005 Mendenhall Valley Heating Survey suggested that annual usage totals for propane are constant. Therefore, the 2017 residential monthly propane use totals were prorated from the Juneau's 2004 data as it was difficult to get the 2017 data from the local distributors. As indicated in Table 7, the 2004 Juneau's totals were apportioned to the Mendenhall Valley using the 2017 population and household data.

Table 7
2017 Mendenhall Valley PM10 Emissions from Propane

Propane Throughput		
	2004 Juneau	2017 Mendenhall
gallons/year	711,392	319,054
gallons/winter	366,321	164,292
gallons/summer	345,071	154,762
PM10 EF (0.4 Ibs/1000 gal)		
2017 Winter (tpd)	0.00018	
2017 Summer (tpd)	0.00017	

Natural Gas

Juneau does not use natural gas as heating source because there is no natural gas service or infrastructure in Juneau.[2]

Coal

Coal is not used as a heating source in Juneau.

Other Area Sources

According to EPA's AP-42 Section 4.5 (Asphalt Paving Operations), particulate emissions from asphalt paving are in the form of condensable hydrocarbons (i.e., TOG or VOC emission factors). Hence, there are no PM_{10} emissions associated with asphalt paving.

Wildfires

According to the Alaska Wildland Fire Coordinating Group Website, there were no incidences of wildfire in the Mendenhall Valley in 2017.

Open Burning (Firefighter Training)

Based on the information collected from the Capital City/Rescue Fire,[3] two trainings were held in 2017 and less than 200 gallons were burned per training. According to the source of information, fuel is no longer burned in training exercises. In total, as shown in Table 8 below, 400 gallons were burned. The seasonal PM_{10} emissions were calculated using the AP-42 emission factor for residential furnaces.

Table 8
Open Burning Emissions Calculations

Gallons burned /exercise	200
Exercise/Year	2
Total Gallons Burned/Year	400
EFs (Ibs/10^3 gal), AP-42 Table 1.3-1	0.4
Summer tons	0.00008
Summer tpd	0.000002

Note: 200 gallons were assumed to be burned; all fuel burned was assumed to be diesel; and training was assumed to take place only in the summer

Structural Fires Calculations

Data from the Capital City/Rescue Fire indicates that there was a total of 42 structural fires in the area in 2017 as shown in Table 9 below.

[2] 2010 CBJ Emissions Inventory
[3] Michel Barte, michel.barte@juneau.org, 9/18/209)

Table 9
Incidence of Structural Fires in 2017

Month	Jan.	Feb	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
# of Fires	3	1	2	5	8	3	4	4	2	4	3	3

For this emission inventory development, winter season is taken as October to March and summer season as April to September. As indicated in Table 10 below, 16 structural fires occurred in the winter while 26 occurred during the summer of 2017.

Table 10
Structural Fires Emissions Calculations

Winter	16/182	0.0879
Summer	26/183	0.1421

Emission Factor (lbs/fire)	13.8
winter tpd	0.0006
summer tpd	0.001

<u>Burn Barrels</u>

The Air Quality Division of Alaska Department of Environmental Conservation gathered from discussion with the City of Borough of Juneau that there is no detailed information on burn permits and that burn permit is not required during burn season in Juneau. Therefore, this source category is excluded from the emissions inventory.

<u>Gasoline Distribution</u>

This area source category is a source of VOC emissions only, and therefore is not included in this emissions inventory.

<u>Surface Coating</u>

This area source category is a source of VOC emissions only, and therefore is not included in this emissions inventory.

<u>Fugitive Dust</u>

Fugitive Dust from Paved and Unpaved Roads

The equations used for estimating both paved and unpaved road emissions on a per-VMT basis were derived from the U.S. Environmental Protection Agency's (EPA's) AP-42, Fifth Edition, Volume I, Chapter 13 (Miscellaneous Sources). The 2017 VMT estimates for the all the roadways, including the paved and unpaved roads were obtained from the Highway Data Team of Alaska Department of Transportation and Public Facilities (DOT&PF).[4] As shown in the Table 13 below, the total 2017 VMT on paved roads was 165,137.08, while for unpaved roads, it was 296.64. Using a population growth rate of 0.25%, the 2017 VMT estimate was projected to increase to 172,051.0731 in 2033, the last year of the maintenance period (see Appendix E for details).

Table 11
Summary of the 2017 VMT Data by Functional Class for PM_{10}

Functional Class	No. of Segments	Length in Miles	2017 VMT	% of Total VMT
Urban Collector	31	13.37	34,850	21.07%
Urban Minor Arterial	15	4.72	51,874	31.36%
Urban Principal Arterial	7	3.69	68,397	41.34%
Local Road	19	9.05	10,311	6.23%
ALL TOTAL	72	30.83	165,433	100.00%

Table 12
Summary of the 2017 VMT by Facility

	1 One-way	2 Two-Way	4 Ramp
Paved	0.97	28.16	0.16
Unpaved	0.00	1.54	0.00
Total	0.97	29.71	0.16

Table 13
2017 VMT by Pavement

All Facility Types (1,2,4)	
Paved	165,137.08
Unpaved	296.64
Total	165,433.72

Estimating Roadway Particulate Emissions

EPA'S AP-42 is the agency's compilation of emission factors and procedures for estimating emission from a variety of stationary sources.

Unpaved Roads

The equation in AP-42 for estimating particulate emissions from the "dry" (no precipitation), unpaved publicly accessible roads dominated by light-duty vehicles is given in Equation 1 below:

[4] Data obtained from Derrick Grimes (DOT&PF) on September 24, 2019

Equation 1

$$E = \frac{K(s/12)(S/30)^{0.5}}{(M/0.5)^{0.2}} - C$$

Where: E is the dry emission Factor in Ib/VMT;

K is a particle size empirical constant (1.8 for PM_{10}, 0.18 for $PM_{2.5}$);

s is the surface material % silt content;

M is the surface soil % moisture;

S is the mean vehicle speed in miles per hour (mph); and

C is the 1980's motor vehicle articulate emission factor in lb/VMT (0.00047 for PM_{10}, 0.00036 for $PM_{2.5}$).

The same conservative approached used by Sierra for developing the first 10-year Limited Maintenance Plan was used for this second 10-year Limited Maintenance Plan. Alaska-specific factors were used in Equation 1 for estimating unpaved road emissions for the Mendenhall valley. For the surface material silt content, 15% was used, which was the average from samples collected on unpaved streets in the Mendenhall Valley for a 1988 PM_{10} inventory prepared by Engineering Science for EPA. The same soil moisture content of 1.1% was used, and the mean vehicle speed on unpaved roadways was estimated at 25 mph.

Hence, inserting all the values in equation 1 gives:

$$E = \frac{1.8(0.15/12)(25/30)^{0.5}}{(0.011/0.5)^{0.2}} - 0.00047$$

$$E = 0.06937 \text{ Ib/VMT}$$

The fugitive dust emissions estimated using Equation 1 are during the average "dry" conditions of unpaved roads in a given area. Hence, the natural mitigating effect of precipitation would need to be considered since any increase in moisture reduces the level of emissions from the roads. In order to account for the natural precipitation that control fugitive dust in the local areas, the dry emission factor E is adjusted using Equation 2 from AP-42.

Equation 2 $$E_{unpaved} = E[(N-P)/N]$$

Where: $E_{unpaved}$ is the final unpaved roads emission factor adjusted for natural mitigation in Ib/VMT;

N is the total number of days in the study period (182 for summer and 183 for summer and 183 for winter); and

p is the number of days in the study period with measurable amounts (at least 0.01 inch) of precipitation. According to the locality-specific precipitation data on the Western Regional Climate Center (WRCC) website, Juneau receives measurable precipitation for

117 days during winter (October to March) and 106 days during the summer (April to September).

Hence, for winter

$$E_{unpaved} = 0.06937[(183\text{-}117)/183]$$

$$E_{unpaved} = 0.0250\ Ib/VMT$$

And for summer,

$$E_{unpaved} = 0.06937[(182\text{-}106)/182]$$

$$E_{unpaved} = 0.0290\ Ib/VMT$$

Note: No seasonal data are available to reflect any seasonal variation in VMT. Hence, the VMT, calculated as the product of the annual average daily traffic (AADT) and the roadway length in miles (VMT = AADT X Road Length), was used for both summer and winter seasons.

<u>Paved Roads</u>

The VMT estimates from DOT&PF indicate that most of the roadways in Mendenhall Valley are paved. As shown in Table 12 above, about 1.54 miles of the 2 two-way (local) roads are unpaved. The VMT on local paved road, shown in Table 14, was obtained by subtracting the VMT traveled on unpaved road (296.64) from the VMT on local roads (10,311.25).

Table 14
2017 Mendenhall Valley Paved Road VMT

Functional Class	2017 VMT
Urban Collector	34,850
Urban Minor Arterial	51,874
Urban Principal Arterial	68,397
Local Road	10,015
ALL TOTAL	165,433

Equation 3 below, also derived from AP-42, represent the equation for estimating fugitive emissions from paved roads. Similar to unpaved roads, the equation also considers factors such as road surface properties, traffic conditions, and climate for natural mitigation.

Equation 3

$$E = [k(sL/2)^{0.91}(W/3)^{1.02}](1\text{-}P/4N)$$

Where: E is the dry emission Factor for paved road in Ib/VMT;

k is a particle size empirical constant (0.0022 Ibs/VMT for PM_{10}, 0.00054 Ibs/VMT for $PM_{2.5}$);
sL is the road surface silt loading in g/m^2;
W is average weight of vehicle traveling the road in tons, and for Mendenhall valley, it was to 2.0 tons;
N is the total number of days in the study period (182 for summer and 183 for summer and 183 for winter); and
p is the number of days in the study period with measurable amounts (at least 0.01 inch) of precipitation. For Juneau, it is 117 days during winter (October to March) and 106 days during the summer (April to September).

Similar to the approach used for the first 10-year LMP, the silt load values collected from different roadway facility types in Anchorage in 1996 were assumed for this second 10-year LMP since there are no available data for Juneau area. Table 15 shows the seasonal silt loading values (in g/m^2) by roadway facility types.

Table 15
Seasonal Paved Roads Silt Loading (g/m^2) by Facility Type

Facility Type	Winter	Summer
Collector	2.9	9.4
Minor Arterial	1.1	6.7
Interstate/Major Arterial	2.6	20.4
Local Roads	4.7	18.4

The seasonal PM_{10} emission factor (in Ibs/VMT) for paved roads, as shown in Table 16 below, were derived from equation 3.

Table 16
Emission Factors by Season for Paved Roads in Mendenhall Valley

Facility Type	Winter Silt Loading (g/m^2)	Winter PM_{10} Emission Factor (Ibs/VMT)	Summer Silt Loading (g/m^2)	Summer PM_{10} Emission Factor (Ibs/VMT)
Collector	2.9	0.0017	9.4	0.0051
Minor Arterial	1.1	0.0007	6.7	0.0037
Interstate/Major Arterial	2.6	0.0016	20.4	0.0103
Local Roads	4.7	0.0027	18.4	0.0094

Paved road PM_{10} emissions can be readily computed from the emission factor and VMT on each roadway type. Table 17 shows estimated emissions for the winter and summer periods for base year 2017.

Table 17
Estimated PM_{10} 2017 Emissions from Paved Roads in the Mendenhall Valley Maintenance Area

	2017		
Road Type	**VMT**	**Winter PM_{10} Emissions (tons/day)**	**Summer PM_{10} Emissions (tons/day**
Collector	34,850	0.0296	0.0889
Minor Arterial	51,874	0.0182	0.0960
Interstate/Major Arterial	68,397	0.0547	0.3522
Local Roads	10,015	0.0135	0.0471
Total	**165,433**	**0.1160**	**0.5842**

Table 18
2017 Seasonal Road Fugitive Dust Emissions in the Mendenhall Valley Maintenance Area

	PM_{10} (tons/day)		
Source	**Winter**	**Summer**	**Annual Average**
Paved Roads	0.1160	0.5842	0.7002
Unpaved Roads	0.0037	0.0043	0.0080
Total	**0.1197**	**0.5885**	**0.7082**

Wind Blown Dust

Glacial river beds and cleared areas constitute the windblown dust in the Mendenhall Valley. The glacial river beds consist of large sand bars which generate significant emissions during periods of high winds while the cleared areas are open areas which consist of surface material that is susceptible to entrainment by wind. According to the 1988 PM_{10} emissions inventory developed by Engineering Science, the sand bars of the eastern shore of the Mendenhall Lake were estimated to be 41 acres and produce 28.6 tons of PM_{10} per year. Using wind speed data collected from Juneau Airport and silt loading values estimated from local bulk samples, Engineering Science estimated that cleared areas, which were determined to be 154 acres, produced a total of 4.4 tons of PM_{10} per year.

For this emissions inventory category, the same conservative approach used for the development of the first 10-year LMP was assumed.

Table 19
2017 Wind Blown Dust Emissions in the Mendenhall Valley Maintenance Area

	Winter	Summer
Glacial River Beds	0.1808	0.1808
Cleared Areas	0.1808	0.1808
Total	0.3616	0.3616

Table 20
2017 Area Source Emissions for Mendenhall Valley Maintenance Area (tons/day)

	Calendar Year 2017		
Area Sources	Summer	Winter	Annual
Asphalt Production	N/A	N/A	0.0000
Asphalt Paving	0.0000	N/A	0.0000
Gasoline Distribution	N/A	N/A	0.0000
Used Oil Combustion	N/A	N/A	0.0000
Fuel Oil Combustion	0.0010	0.0020	0.0015
Surface Coatings	N/A	N/A	0.0000
Wildfires	0.0000	N/A	0.0000
Open Burning (firefighter training)	0.000002	N/A	0.000001
Burn Barrels (refuse burning)	N/A	N/A	0.0000
Woodstoves/Fireplaces	0.0350	0.1000	0.0675
Propane Use	0.0002	0.0002	0.0002
Natural Gas Heating	N/A	N/A	0.0000
Coal	N/A	N/A	0.0000
Paved Road Fugitive Dust	0.5840	0.1160	0.3500
Unpaved Road Fugitive Dust	0.0040	0.0040	0.0040
Glacial/Cleared Areas Windblown Dust	0.1808	0.1808	0.1808
Structural Fires	0.0010	0.0006	0.0008
Total	0.8060	0.4036	0.6050

(4) **Point Sources**

According to the discussions with the DEC Compliance staff, Asphalt plant, X551 CMI Hot Plant and Industrial D-1 plant of Miller Construction Company Ltd were the sources that operated in the Mendenhall Valley in 2017. Table 21 shows the sources, the full potential to emit (PTE), assessable PTE, and daily emissions.

Table 21
Mendenhall Valley Point Source PM_{10} Emissions Summary

Point Sources	Assessable PTE (tons/year)	Full PTE (tons/year)	Daily Emissions (tons)
Asphalt Plant	22.0	21.9	0.122
Industrial D-1 Plant	11.1	2.0	0.011
Total	33.1	23.9	0.133

Note: The daily value is extremely conservative as it is based on the full PTE, which accounts for emissions controls. Also, for 2017, these sources only operated from April to November.

Appendix

Table A
Winter 2017 Wood burning Emission Calculations

Equipment Description	#Survey Households Equipped	%Survey Households Equipped*	Projected Valley Households Equipped	Cords Burned by Survey Households (cords/season)	Cords Burned by Valley Households (cords/season)	Tons Burned by Valley Households (cords/season)	PM10 (#/ton of wood burned	PM10 (tons/day
Wood Stove	93	16.8%	854	65.3	599	718.8	30.6	0.060
Conventional Fireplace	53	9.6%	487	37.2	341	409.2	23.6	0.026
Modified Fireplace	12	2.2%	110	8.4	77	92.4	23.6	0.006
Other Non-Pellet wood-burning device	4	0.7%	37		26	31.2	23.6	0.002
Total	162	29.2%	1487	113.7	1043	1251.6		
Total # Homes Equipped with One or More Non-Pellet Wood-burning Unit	127	29.2%	1487					0.094
				# 40 Ib Stove Pellet bags	Tons Pellets burned per season	Tons Burned by Valley Households	PM10 (#/ton of Pellets Burned)	PM10 (tons/day)
Pellet Stove	22	5.1%	260	1097	21.9	258.82	8.8	0.006
Total	435	34.3%	5,094					

Note: The percentages were normalized to 29.2% to account for homes with more than one type of unit except the pellet stoves because no detailed information about pellet technology was included in the survey

Table B
Summer 2017 Wood burning Emission Calculations

Equipment Description	#Survey Households Equipped	%Survey Households Equipped*	Projected Valley Households Equipped	Cords Burned by Survey Households (cords/season)	Cords Burned by Valley Households (cords/season)	Tons Burned by Valley Households (cords/season)	PM10 (#/ton of wood burned	PM10 (tons/day
Wood Stove	93	16.8%	854	22.5	207	247.83	30.6	0.021
Conventional Fireplace	53	9.6%	487	12.8	117	140.99	23.6	0.009
Modified Fireplace	12	2.2%	110	2.9	27	31.94	23.6	0.002
Other Non-Pellet wood-burning device	4	0.7%	37	1.0	9	11.01	23.6	0.001
Total	162	29.2%	1487	39.2	360	431.77		
Total # Homes Equipped with One or More Non-Pellet Wood-burning Unit	127	29.2%	1487					0.033
				# 40 Ib Stove Pellet bags	Tons Pellets burned per season	Tons Burned by Valley Households	PM10 (#/ton of Pellets Burned)	PM10 (tons/day)
Pellet Stove	22	5.1%	260	375	7.5	88.64	8.8	0.002
Total	435	34.3%	5,094					

Note: The percentage were normalized to 29.2% to account for homes with more than one type of unit except the pellet stoves because no detailed information about pellet technology was included in the survey

Table C
2017 Fuel Oil Emission Calculations

Equipment Description	#Survey Households Equipped	%Survey Households Equipped*	Projected Valley Households Equipped	Average Winter Fuel Use for Survey Households (gal/hhold/season)	Average Summer Fuel Use for Survey Households (gal/hhold/season)	Total Winter Fuel use for Valley Households ($10^{\wedge 3}$ gallons/year)	Total Winter Fuel use for Valley Households ($10^{\wedge 3}$ gallons/year)
Direct Vent Heater (i.e., Toyo, Monitor)	147	31.5%	1602				
Central Oil Furnace	272	58.2%	2965				
Total	419	89.7%	4567	390	216	1781	986
Total # Homes Equipped with One or More Oil Heating Units	390	89.7%	4567				
Total	435	34.3%	5,094				

Note: The percentage were normalized to 89.7% to account for homes with more than one type of unit

Table D
2017 Seasonal Fuel Oil PM_{10} Emissions

# PM_{10} per 10^3 gallons burned	Winter PM_{10} per Emissions (tons/season)	Summer PM_{10} per Emissions (tons/season)
0.4	0.36	0.20
Tons/day	0.002	0.001