Klamath Falls Fine Particulate Matter (PM2.5) Attainment Plan

Revision to Section 4.62 of the State Implementation Plan

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Quality

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State Implementation Plan Revision

KLAMATH FALLS FINE PARTICULATE MATTER ($PM_{2.5}$) ATTAINMENT PLAN SECTION 4.62 OF THE STATE IMPLEMENTATION PLAN

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Executive Summary

Klamath Falls has a lengthy history of identifying and successfully working to solve problems with particulate air pollution. In the late 1980s Klamath Falls had particulate pollution that violated federal standards by more than five times. By January 1991 the community's particulate reduction strategies achieved federal standards, and the area was designated as "in attainment" in 2003.

In September 2006, the U.S. Environmental Protection Agency (EPA) revised the PM standard by establishing a daily (24-hr) $PM_{2.5}$ (fine particulate) standard of 35 $\mu g/m^3$ and retaining the annual $PM_{2.5}$ standard of 15 $\mu g/m^3$. Areas in violation of the $PM_{2.5}$ standard, based on the most recent three years of federal reference monitoring data, are designated as a "nonattainment area" by the EPA. Because high winter air pollution levels violated the daily $PM_{2.5}$ standard, EPA designated Klamath Falls as a nonattainment area in December 2009.

Fine particulate matter ($PM_{2.5}$) is a mixture of extremely small particles and droplets in the air and is known to cause or contribute to respiratory disease, asthma attacks, heart problems, and premature death. Unhealthy accumulation of $PM_{2.5}$ continues to be a wintertime phenomena in the Klamath Falls basin due to cold air inversions trapping emissions near the ground. The predominant source of particulate in Klamath Falls in the winter has been and continues to be residential wood heating. DEQ and Klamath Falls were required to develop an attainment plan to bring air quality into compliance with the standard as soon as possible, and submit this plan to EPA. EPA must approve the plan and publish its findings in the Federal Register. The proposed plan adoption will amend the State Clean Air Act Implementation Plan (SIP).The deadline for reducing pollution sufficiently to meet the standard is December 2014.

Attainment Plan Overview

The Klamath Air Quality Advisory Committee and Klamath County Commissioners have collaborated with DEQ to develop and recommend a plan to attain the $PM_{2.5}$ standard. The plan describes the proposed $PM_{2.5}$ reduction strategies, including what action will be taken, who will conduct the work, and when and how it will be done. It is a comprehensive mixture of emission reduction strategies consisting of local ordinances, DEQ regulations, interagency agreements and non-regulatory elements including incentives and education. The plan also includes additional strategies recommended by the advisory committee that, while not needed for $PM_{2.5}$ compliance, will benefit air quality in general. Based on its analysis, DEQ fully expects that the attainment plan will achieve the $PM_{2.5}$ standard by December 2014. However, should the community fail to meet the standard; automatic contingency measures identified in this plan will take effect.

DEQ will determine whether the attainment plan accomplishes its objective of meeting the federal PM2.5 standard deadline by tracking particulate monitoring data at the Peterson School monitor in Klamath Falls. This monitor is the established federal reference monitor and is located in an area where the highest levels of PM 2.5 accumulate in Klamath Falls. If the area does not meet the federal standard by the deadline, DEQ will continue to evaluate monitoring data for progress during implementation of the contingency measures. Designation back to attainment is possible only after Klamath Falls meets the standards for three consecutive years and a maintenance plan is drafted, adopted by the Environmental Quality Commission (EQC) and approved by EPA. EPA may re-designate Klamath Falls back into attainment in the Federal Register.

Elements of the Attainment Plan

The Klamath Falls $PM_{2.5}$ attainment plan consists of early reduction strategies the community adopted between 2007 and 2009, and new strategies developed by DEQ and the advisory committee in 2012. Both sets of strategies are included in the attainment plan proposed for adoption. Because residential wood burning emissions continue to make up the majority of harmful particulate in Klamath Falls, the most significant proposed particulate reductions are from enhancements to the community's woodstove curtailment program. The curtailment program is one of the key elements in ensuring Klamath Falls will attain the $PM_{2.5}$ standard. DEQ performed an analysis of the reductions expected from the attainment plan using a proportional mathematical analysis or "rollback model". This model demonstrated that by continuing to implement the early reduction strategies Klamath Falls will meet the $PM_{2.5}$ standard by 2014 and that the new strategy reductions will provide an additional protective buffer to ensure compliance.

Current reduction strategies

Klamath County Clean Air Ordinance

In November 2007, Klamath County revised their Clean Air Ordinance to implement early particulate reductions, including:

- Revised woodstove curtailment levels to increase the number of days when burning is restricted or prohibited;
- Tightening enforcement of wood stove curtailment;
- Requiring removal of an uncertified woodstove upon sale of a home;
- Reducing by half the number of residential open burning days;
- Prohibiting use of burn barrels.

Woodstove changeouts

Utilizing funding from the EPA, city of Klamath Falls and federal American Recovery and Reinvestment Act (ARRA) stimulus money, 584 uncertified woodstoves were replaced with new, cleaner burning heating units such as certified woodstoves, pellet stoves, heat exchangers, and natural gas furnaces.

New reduction strategies

Additional $PM_{2.5}$ emission reduction measures recommended by the Klamath Air Quality Advisory Committee and approved by Klamath County Commissioners include residential wood burning, industrial and agricultural and forest burning measures.

Residential wood burning

Strategies to reduce emissions from residential wood burning include:

- Pursuing funds to continue offering woodstove change outs and fireplace conversions within the nonattainment area;
- A continued focus of enforcement on individuals habitually violating curtailment requirements;
- Amending the county building code to set a new residential construction requirement for installation of clean fireplaces that emit 5.1 g/kg or less as determined by ASTM International;
- Expansion of educational efforts to reduce $PM_{2.5}$ from wood smoke.

Industrial emissions

Although industrial emissions make up a smaller percentage of $PM_{2.5}$ measured in Klamath Falls, there are several proposed particulate reduction measures that are reasonably available:

- In DEQ rules, limit industrial boiler emissions to 20% opacity, a measure of particulate density;
- In DEQ rules for wood products and other major industrial facilities require controls on fugitive emissions, or particulates that escape from windows, doors, storage piles and roadways;
- In DEQ rules require industrial facilities to use best operations and maintenance practices to prevent breakdowns and ensure proper operation of pollution control equipment.
- Allowing woodstove offsets for new and expanding industrial facilities

Designation of the Klamath Falls area as nonattainment for $PM_{2.5}$ activated existing state and federal regulations for major industrial sources. These requirements, known as New Source Review rules, require strict $PM_{2.5}$ pollution controls on new and expanding industry, as well as the requirement that facilities offset $PM_{2.5}$ increases with decreases obtained from other area industrial facilities. An additional element of the attainment plan provides regulatory flexibility for new and expanding industry by allowing them to obtain particulate emission offsets and reduce air pollution by working with homeowners to remove and destroy dirty uncertified wood stoves. Facilities would be able to increase their emissions one ton for every one ton of particulate reduced through woodstove removal. This measure provides the dual benefit of further removing dirty uncertified woodstoves from the community and providing an additional opportunity for economic growth.

Elements of the Contingency Plan

In the event that the attainment measures fail to realize sufficient emission reductions to meet the $PM_{2.5}$ standard by December 2014, the Clean Air Act requires contingency measures to be fully adopted rules or control measures that are ready to be implemented quickly and take effect automatically. The contingency measures function as a backstop until such time as the plan can be reevaluated and corrected.

Residential wood burning

The attainment plan contingency strategies to reduce $PM_{2.5}$ emissions from wood burning would

- Prohibit the use of non-ASTM international certified fireplaces in the Klamath Falls area at all times.

Industrial emissions

The attainment plan includes two contingency strategies to reduce $PM_{2.5}$ from industrial facilities:

- Further limiting industrial emissions by decreasing the grain loading limit, a measurement of particulate density. The proposal would decrease the grain loading standard from 0.2 to 0.1 grains per standard cubic foot.
- Requiring installation and use of continuous emission monitoring equipment for wood –fired boilers.

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Background

Introduction

In September 2006, the U.S. Environmental Protection Agency (EPA) strengthened the daily (24-hr) $PM_{2.5}$ (fine particulate) standard by lowering the level from 65 μg/m3 to 35 μg/m3 and retained the annual $PM_{2.5}$ standard of 15 μg/m3. Fine particulate matter ($PM_{2.5}$) is a mixture of extremely small particles and droplets in the air and is known to cause or contribute to respiratory disease, asthma attacks, heart problems, and premature death. Areas in violation of the $PM_{2.5}$ standard (based on the most recent three years of federal reference monitoring data) are designated as a "nonattainment area" by the EPA. Klamath Falls has been designated as nonattainment for the daily $PM_{2.5}$ standard. DEQ and Klamath Falls must develop an attainment plan that will bring air quality into compliance by December 2014, and submit this plan to EPA.

What Is PM2.5?

This plan addresses the 24-hour ambient air quality standard for $PM_{2.5}$. Particulate matter (PM) is the general term used for a mixture of solid particles or liquid droplets found in the air. Some particles are large or dark enough to be seen as soot or smoke. Others are so small they can be detected only with an electron microscope. These particles come in a wide range of sizes ("fine" particles are less than $_{2.5}$ micrometers in diameter, $PM_{2.5}$, and coarser-sized particles, PM10, are larger than $_{2.5}$ micrometers), and originate from many different sources.

Fine particulate matter ($PM_{2.5}$) in the atmosphere is composed of a complex mixture of particles: sulfate, nitrate, and ammonium particles; particle-bound water; elemental carbon; a great variety of organic compounds (or volatile organic compounds (VOCs)); and crustal material. Fine particulate matter, also known as $PM_{2.5}$, is referred to as "primary" if it is directly emitted into the air as a solid or liquid particle and its chemical form is stable. $PM_{2.5}$ formed near its source by condensation processes in the atmosphere is also considered primary $PM_{2.5}$. Primary $PM_{2.5}$ includes soot from diesel engines, fuel combustion from residential fireplaces and woodstoves, pile and forest burning.

$PM_{2.5}$ that is formed by chemical reactions of gases in the atmosphere is referred to as "secondary" $PM_{2.5}$. These reactions form condensable matter that either form new particles or condense onto other particles in the air. Most of the sulfate and nitrate and a portion of the organic particles in the atmosphere are formed by such chemical reactions. As such, sulfur dioxide (SO2), oxides of nitrogen (NOx), some VOC, and ammonia can be considered $PM_{2.5}$ precursors. Secondary $PM_{2.5}$ formation depends on numerous factors including the concentrations of precursors; the concentrations of other gaseous reactive species, and the interactions of the precursors and pre-existing particles with cloud or fog droplets or with the liquid film on solid particles. EPA has established a policy regarding $PM_{2.5}$ precursors for planning and regulatory purposes in its 2007 $PM_{2.5}$ Implementation Rule that states must address SO2 and NOx as a $PM_{2.5}$ precursor and evaluate reasonable controls for these pollutants.

Health Effects of $PM_{2.5}$

$PM_{2.5}$ can accumulate in the respiratory system and are associated with numerous health effects. Sensitive groups that are at greatest risk include the elderly, individuals with cardiopulmonary disease such as asthma, and children. Both long- and short-term exposures to $PM_{2.5}$ cause adverse health effects. Long-term exposure to fine particulates, which is based on an annual standard, is linked to premature death, especially related to heart disease, cardiovascular effects, such as heart attacks and strokes; reduced lung development and chronic respiratory diseases, such as asthma, in children; and some studies suggest that long-term exposure to $PM_{2.5}$ may be linked to cancer and to harmful developmental and reproductive effects, such as infant mortality and low birth weight. Short-term exposure to fine particulates, which is

based on a daily standard, include premature death, especially death related to heart and lung diseases; increased hospital admissions and emergency department visits for cardiovascular effects, such as non-fatal heart attacks and strokes. Short-term $PM_{2.5}$ exposures also are linked to increased hospital admissions and emergency department visits for respiratory effects, such as asthma attacks, as well as increased respiratory symptoms, such as coughing, wheezing and shortness of breath. In addition, short-term $PM_{2.5}$ exposures are linked to reduced lung function, especially in children and people with lung diseases, such as asthma.

National Ambient Air Quality Standards for $PM_{2.5}$

EPA has established National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ as a mass-based concentration of airborne particulate matter with aerodynamic diameters less than 2.5 microns. The EPA standard is 35 micrograms per cubic meter ($\mu g/m^3$) for a daily (24-hour) average and 15 $\mu g/m^3$ as an annual average.

Annual $PM_{2.5}$ Standard

The annual standard for $PM_{2.5}$ is met whenever the three year average of the annual mean$PM_{2.5}$ concentrations for designated monitor is less than or equal to 15.0 $\mu g/m^3$. Klamath Falls has met this standard since the monitoring started at Peterson School, as shown below in Figure 1.

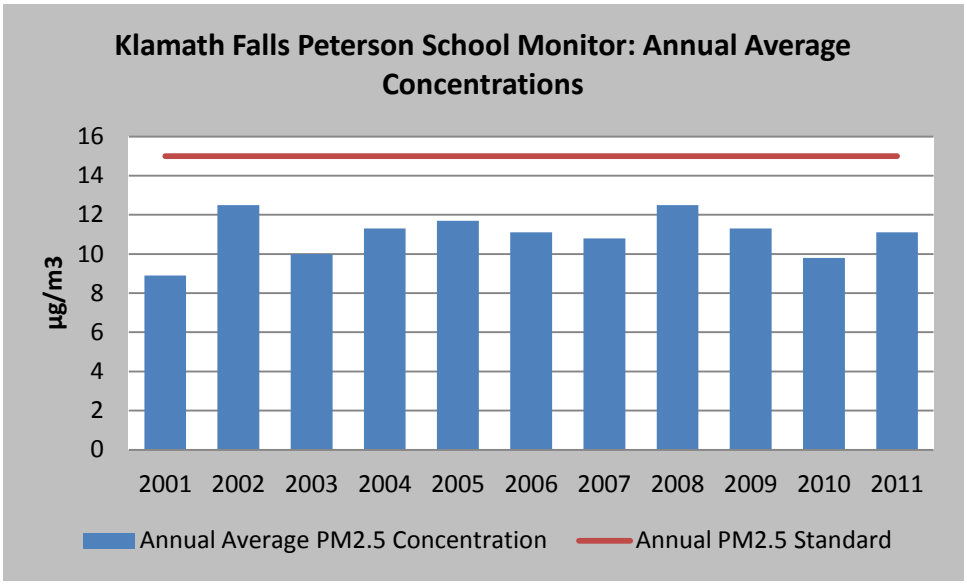

Figure 1: Average annual PM2.5 concentrations measured at Peterson School monitor

24 Hour $PM_{2.5}$ Standard

The 24 hour standard for $PM_{2.5}$ is met whenever the three year average of the annual 98th percentile of values at monitoring sites is less than or equal to 35 µg/m3. Figure 2shows the 98th percentile concentrations for each year from 2001 through 2011. After the $PM_{2.5}$ standard was revised to a more protective concentration in 2006, measurements at the Peterson School monitor indicated that Klamath Falls was not in compliance with the 24 hour standard.

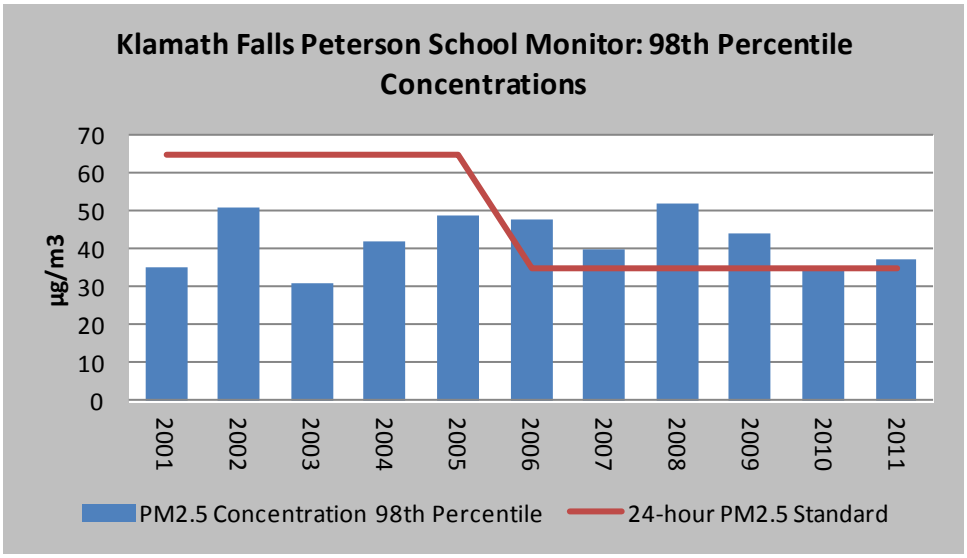

Figure 2: 98th percentile concentrations measured at Peterson School monitor[1]

Klamath Falls Area Description

Klamath Falls is located in south central Oregon at an elevation of 4,105 feet. The Klamath Falls nonattainment area as established by EPA and shown in figure 3 was estimated to have a population of 46,588 in 2008. Based on the long-range forecast, the Klamath Falls nonattainment area population is expected to grow to approximately 48,097 by 2014 (0.54 percent per year non-lineal compounded average growth). The City of Klamath Falls serves as an important commercial center for south central Oregon. The Klamath Basin is a relatively flat area of an old high elevation lake-bed that is drained by the Klamath River. Occasional hills and a system of elongated ridges confine the basin and the greater Klamath Falls area to the east and west. Most of the Klamath Falls residential area, especially the south suburban area, is located on the lower elevation area. Because of these features, Klamath Falls can experience very strong and shallow nighttime inversions that break up with daytime solar heating. In the wintertime, frigid arctic air masses frequently move down Upper Klamath Lake and invade the Klamath Basin. Temperatures can remain well below freezing for several weeks at a time. Under these conditions, these strong inversions occur over the Klamath Basin concentrating emissions in the south suburban area of Klamath Falls.

[1] Current 98th percentile for 2011 is 37.1 µg/m3; however Klamath County Commissioners have requested the exceedance of 37.8 µg/m3 on December 14, 2011 be looked at as an exceptional event due to a hay fire started by spontaneous combustion that caused the exceedance. Should that exceedance be considered an exceptional event, the 2011 98th percentile would become 35.5 µg/m3.

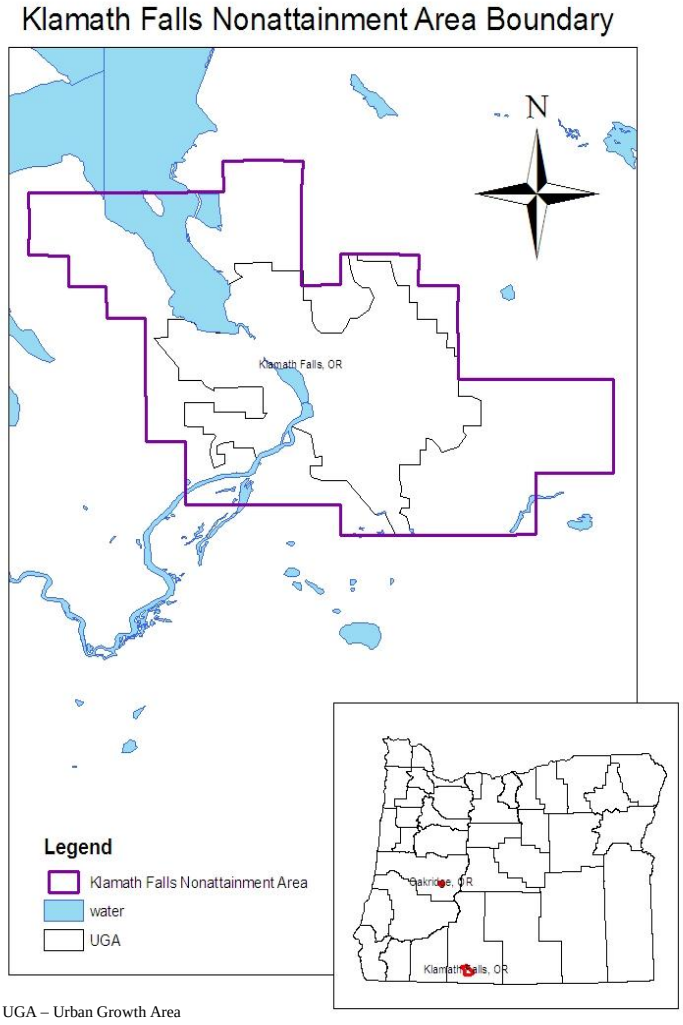

Figure 3: Klamath Falls Nonattainment Area Boundary

History of Efforts to Address Particulate Matter in Klamath Falls

This is not the first time Klamath Falls has struggled to meet air quality standards. In 1987, Klamath Falls was designated a nonattainment area by the Environmental Protection Agency (EPA) for PM_{10} – particulate matter 10 microns and smaller. A PM_{10} attainment plan was developed for the Klamath Falls Urban Growth Boundary (UGB) by 1991, however, at that time the area still had not met the standard. DEQ subsequently revised the PM_{10} plan and submitted an addendum to EPA in 1995. EPA approved both the attainment plan and the addendum on April 14, 1997. In 2002, DEQ submitted a maintenance plan for PM_{10}. The PM_{10} maintenance plan was approved by EPA and Klamath Falls was redesignated to attainment for PM_{10} on October 21, 2003. Both the attainment plan and maintenance plan included a key strategy of a mandatory woodstove curtailment program and a large woodstove change-out program. This was accomplished through citizen involvement in Klamath Falls and the citizenry addressing it at a local level both through ordinance and education of neighbor to neighbor. As a result, the area was able to meet and continues to meet the PM_{10} standards.

In 1997, EPA revised the particulate standard to include $PM_{2.5}$ and established a daily standard of 65 $\mu g/m^3$. The original PM_{10} strategies included in the attainment plan were so successful in maintaining clean air that Klamath Falls met the fine particulate ($PM_{2.5}$) standard. By 2006, however, EPA modified the $PM_{2.5}$ standard again based on the latest health effects data, lowering it to 35 $\mu g/m^3$. Klamath Falls has struggled to meet this new daily $PM_{2.5}$ standard. DEQ has measured particulate at the same location in the Klamath Falls UGB (Peterson School on Clinton Street) since 1996 and conducted numerous saturation surveys to confirm Peterson School is still the appropriate location for the monitor.

Purpose of the Attainment Plan

This document provides a pathway to return the Klamath Falls Nonattainment Area (NAA) to attainment for $PM_{2.5}$ (state classification will be "maintenance"). It also is a plan to ensure Klamath Falls meets the 24-hour and annual National Ambient Air Quality Standards for $PM_{2.5}$ and maintains these standards into the future. The attainment plan provides information on the emissions contributing to the area, emission reduction strategies, and a technical demonstration (rollback analysis) of how the strategies will ensure Klamath Falls meets the $PM_{2.5}$ standards by December 2014. A non attainment area can demonstrate attainment by meeting the standard for three consecutive years based on collected monitoring data. Should the community fail to meet the standard by 2014, automatic contingency measures will take effect and are clearly identified in this plan. This plan will be adopted by the state and then submitted for approval to EPA.

DEQ relied on the involvement of the local Klamath Air Quality Advisory Committee, the Klamath County Commissioners, and the Oregon Department of Transportation (ODOT) to develop the $PM_{2.5}$ attainment plan. The Advisory Committee prepared a report that was submitted to the Klamath County Commissioners and to DEQ for input into developing the plan.

Monitoring and Emission Inventory

Ambient Air Quality Monitoring in Klamath Falls

The Klamath Falls area has one particulate ($PM_{2.5}$) monitoring site with the sampler located at 4856 Clinton Street, also known as Peterson School. DEQ has monitored at the Peterson School site since 1987 for PM_{10} and since 1999 for $PM_{2.5}$. The Peterson School represents one of the higher $PM_{2.5}$ concentration areas and is a representative area of where people live, work, and play. After rigorous quality assurance, the data from the Peterson School site is transferred to EPA's database. The data from the Peterson School monitor was used as the basis for the nonattainment determination and for determining compliance with the standard.

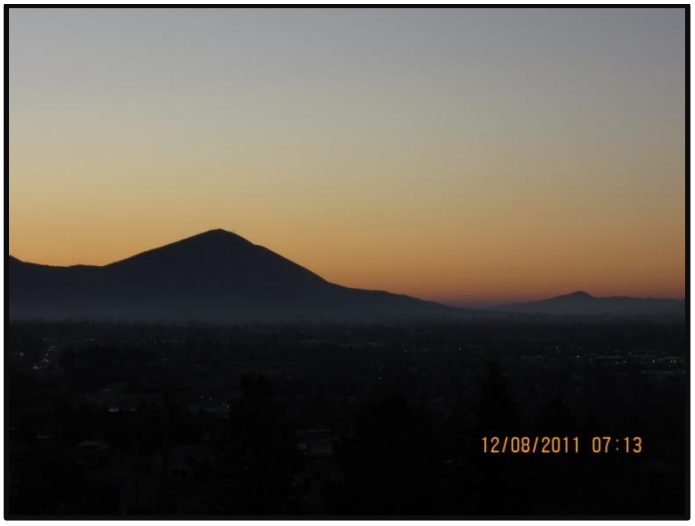

Figure 4: Smoke inversion over south suburbs where Peterson School is located. Inversion showing particulate matter on the morning of December 8th, 2011

Verification of Monitoring Location

DEQ has conducted field studies to verify that the location of the $PM_{2.5}$ monitor generally represents peak level $PM_{2.5}$ concentrations within the nonattainment area boundary. DEQ conducted three saturation surveys, one in 1996-1997, and another in 2000-2001, and most recently in 2010-2011. DEQ wanted to survey areas to the northwest of the Peterson School site to see if fine particulate was being transported into southeast Klamath Falls (referred to in this report as the Valley) from sources in that area or upwind of northwest Klamath Falls. Sources from northwest Klamath Falls were suspected because on days with elevated levels of $PM_{2.5}$, the wind was light but was from the northwest. The 2010-2011 $PM_{2.5}$ saturation survey results are shown in Figure 5 while methods and maps of the 1996-1997 survey and 2000-2001 survey are described in Appendix A-1 and A-2.

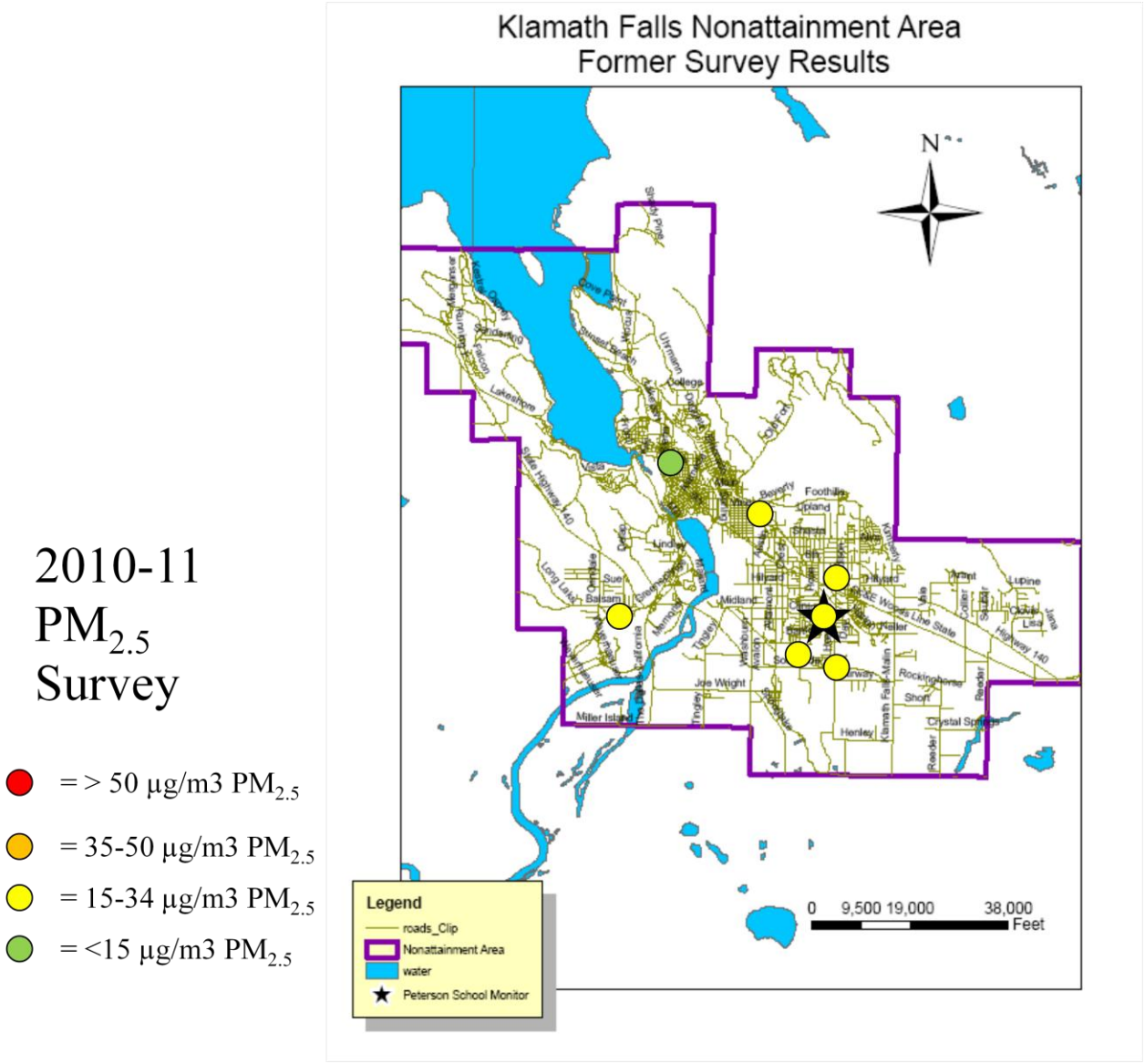

Figure 5: Klamath Falls 2010-2011 Saturation Survey

The survey results showed that the neighborhood in the Valley to the southeast of Klamath Falls had higher levels than the northwest part of the Klamath Falls. Within the valley the highest levels were at Peterson School, therefore it was confirmed that this site represents peak levels of $PM_{2.5}$ concentrations in Klamath Falls. In addition, the Peterson School monitor also represents an area where people live, work, and play, reconfirming the monitor location is the most appropriate for Klamath Falls. Details of the 2010-2011 Saturation Survey are available in A3-1 and A3-2.

Additional Monitoring

In addition, between January 2009 and October 2010, a background sampler was located at Stateline road on the California-Oregon border a couple of miles west of Merrill, Oregon. This monitor was put in place to provide comparison concentrations outside of the nonattainment area. The background sampler confirms emissions from far outside the nonattainment area as being low. From the results, DEQ

concludes the bulk of the emissions affecting exceedance events are generated inside the nonattainment area. For more information about the background sampler results, please see Appendix A-4.

$PM_{2.5}$ and Precursor Emission Estimates

The analysis of $PM_{2.5}$ levels begins with an assessment of $PM_{2.5}$ and its precursor emissions occurring in Klamath Falls. Emissions are estimated for a wide variety of sources, and are summarized into four major categories. These include major point sources (industrial facilities), on-road mobile sources (e.g. car and truck exhaust, road dust), non-road mobile sources (e.g., construction equipment, recreational off road vehicles, lawn and garden equipment), and area sources (e.g., fugitive dust sources, outdoor burning, woodstoves).

$PM_{2.5}$ emissions are estimated using many sources of information, including industrial permits, population, housing, employment information, and estimates of motor vehicle travel in the nonattainment area. A "base year" emissions inventory (EI) was created to estimate actual $PM_{2.5}$ emissions occurring in the airshed. For the Klamath Falls area, the $PM_{2.5}$ base-year EI is 2008. The base year EI serves as the foundation for the 2014 future emissions forecast to help determine whether Klamath Falls will be in attainment with the standard.

An emission inventory consists of emission estimates from all sources that emit $PM_{2.5}$ or precursors within the Klamath Falls nonattainment area boundary. The emissions inventory data is essential in developing the attainment demonstration, as it helps identify the sources contributing to the air quality problem and the emission reduction strategies that will reduce pollution levels below the standard.

In addition to direct emissions, particulate matter is formed in the atmosphere from precursors. Sulfur oxides (SOX), nitrogen oxides (NOX), volatile organic compounds (VOC), and ammonia (NH3) all contribute to the formation of particulate matter. Under the EPA's implementation rule for $PM_{2.5}$, SO2 must be evaluated and there is the presumption that NOx should be evaluated as part of the SIP for control measures, whereas ammonia and VOC are not required to be evaluated for strategies that will reduce $PM_{2.5}$ unless a state demonstrates that either or both of these pollutants are significant contributors to the $PM_{2.5}$ problem in an area (72 FR 20589-20597).

DEQ conducted an analysis of the $PM_{2.5}$ precursors in Klamath Falls to determine their contribution to the $PM_{2.5}$ nonattainment area and whether specific strategies needed to be developed to address precursor emissions. Although there is some contribution through secondary formation, analysis of filter samples and modeling shows on average that secondary formation is relatively small compared to the direct $PM_{2.5}$ emissions. DEQ focused its strategy development on those controls that directly address $PM_{2.5}$ emissions; however, many of these strategies also address precursor emissions. For more information on these strategies please refer to Section 5, Emission Reduction Measures.

Filter Sample and Modeling Analysis of Precursors

Speciated $PM_{2.5}$ samples were collected at Peterson School for the period 2007-to present. The samples showed the dominance of organic and elemental carbon, with secondary inorganic aerosol nitrate and sulfate comprising relatively minor concentrations of total $PM_{2.5}$. DEQ looked at the role of secondary organic aerosols (SOAs) as components of total organic carbon, and an additional analysis was conducted by a research scientist at Portland State University (PSU) in collaboration with DEQ to better understand the magnitude of these aerosols. The results of this analysis showed that the contributions from both biogenic and anthropogenic sources were minor (less than 1% and 3%, respectively, of total design value $PM_{2.5}$. Because all secondary aerosols were determined to be minor contributors to total $PM_{2.5}$, and their emissions are expected to decline from 2008 to 2014, these components and their concentrations are held constant in the rollback model and assigned a Relative Response Factor (RRF) of 1.0. NOx and SO2

strategies were analyzed but shown not to be needed as part of the modeling/attainment demonstration. The precursor emissions to secondary aerosols, including NOx, SO2, ammonia, and biogenic and anthropogenic VOCs, are not used in the attainment demonstration.

In addition to the study of secondary aerosols, a positive matrix factorization (PMF) study based on the speciated data from Peterson School was conducted by EPA Region 10 to identify likely sources of speciated $PM_{2.5}$. The study showed the importance of residential woodsmoke to the high levels of organic carbon, an estimated 60-70% of total PM concentrations.

The SANDWICH (Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbonaceous Material Balance Approach) speciation formulation, based on adjusted and corrected Peterson School speciation data, is used to speciate the measured design value (DV) for use in the rollback model. The SANDWICH approach uses a combination of speciation measurements and modeled estimates to represent $PM_{2.5}$ measurements. The goal is to reconstruct the measured speciated components so that they add up to the measured $PM_{2.5}$ mass. The SANDWICH analysis provides additional design value profile information by describing the components that contribute to $PM_{2.5}$ exceedances. This profile is shown in Figure 6 and shows that over 80% of total particulate matter is from organic and elemental carbon with smaller amounts of secondary inorganic aerosols, such as sulfate (2%) and nitrate (10%). The SOA study by Portland State University, the SANDWICH analysis, and the PMF study by EPA Region 10 are described in more detail in Appendix A-5, A-6-1, A-6-2, and A-7. Based on the evidence cited above, the primary sources contributing to nonattainment in Klamath Falls, are considered to be those that emit direct emissions of $PM_{2.5}$.

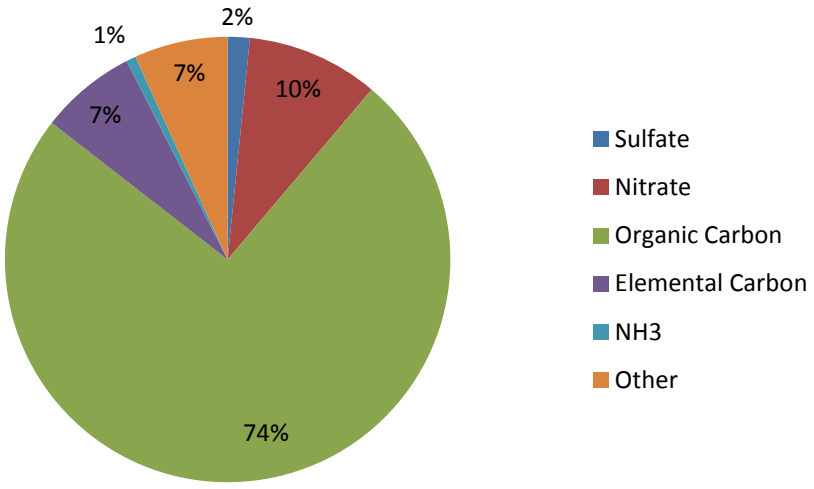

Figure 6: Speciated Components of PM2.5 (using SANDWICH analysis)

Base Year Emission Inventory (2008)

The base year emission inventory is used as the starting point for the attainment demonstration and serves as the foundation for the future emissions forecast (2014) to determine attainment with the standard. This inventory includes all sources in the nonattainment area and represents emissions from one of three years on which the area was designated nonattainment. DEQ analyzed a number of factors to determine the appropriate year for the base emission inventory.

Determining the Base Year Emission Inventory

DEQ selected 2008 as the base year for the Klamath Falls emission inventory. 2008 is a year for which DEQ completed the National Emission Inventory (NEI) and this information provided the most recent and robust data for Klamath Falls. In addition, 2008 is also the most recent of the three years used in evaluating whether Klamath Falls was nonattainment by EPA. The base year inventory is the primary inventory from which the modeling and attainment year (2014) inventories are derived.
DEQ also assessed meteorological and economic conditions for 2008. DEQ evaluated winter wind speeds, temperatures, and foggy days that might contribute to stagnation events and economic conditions might have an effect on emissions such as residential wood combustion. For more information about meteorological conditions and DEQ's analysis of economic factors, please see Appendix A-8 and A-9.

Source Category Distribution of 2008 Emission Inventory

Sources of $PM_{2.5}$ in Klamath Falls include major industry, on-road mobile sources (e.g. car and truck exhaust, road dust), non-road mobile sources (e.g., construction equipment), and area sources (e.g., woodstoves). The following sources represent the main emission sources in Klamath Falls.

Residential Wood Combustion

Residential wood combustion is a common way to heat homes in Oregon. To estimate emissions from wood burning, DEQ conducted a survey in 2007/2008 heating season in Klamath Falls area (See Appendix A-10-1, A-10-2, A-10-3, A-10-4). The survey provided DEQ with information on how many homes use a wide range of wood-heating devices, what species of wood residents burn, and the amount of wood burned.

Mobile and Nonroad Sources

Road dust and tailpipe emissions of $PM_{2.5}$ from motor vehicles were calculated by applying emission factors from the EPA MOVES computer program to total vehicle miles traveled in the nonattainment area. Estimated vehicle miles traveled are from the Oregon Department of Transportation's travel demand model. Emissions from rail, aircraft, construction and other non-road sources are estimated using the EPA NONROAD2008a emissions model.

Industrial Point Sources

DEQ maintains data on industrial point source emissions for all sources emitting 5 or more tons of criteria pollutants per year. Emissions information is compiled from each source's operating permit issued by DEQ. All permitted point sources within the one-mile buffer around the non-attainment area are included in the emissions inventory and shown in Figure 7.

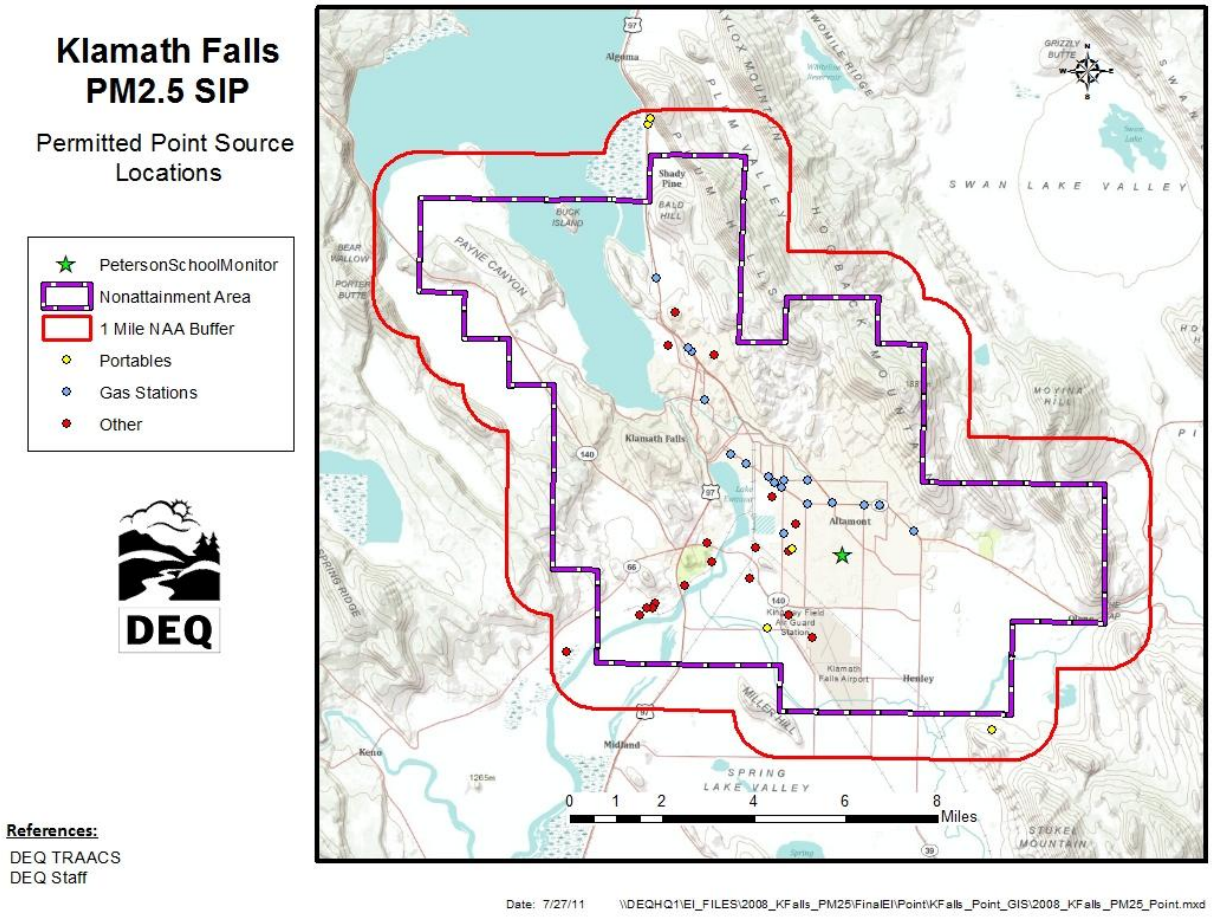

Figure 7: Permitted Point Locations

Emission estimates are developed for both annual and daily $PM_{2.5}$ emissions. Annual emissions are reported as tons per year (tpy), whereas typical season and worst-case day emissions are reported as pounds per day (lbs/day). A "worst-case" day is a day during the season when the maximum amount of emissions per day could occur. Daily emissions are adjusted to reflect a typical season and worst-case day during the year. The typical season and worst-case days occur in the winter (November through February). Historically, this is the time period when the daily $PM_{2.5}$ standard is most likely to be exceeded. For DEQ to run the attainment model, the goal is to develop an emissions inventory that closely matches the conditions under which the design value concentrations are measured. The design value is what is used to determine attainment, and the concentrations are calculated following EPA methodology and described in more detail in Section 5, "Attainment Demonstration".

For most source categories, this emissions inventory used for modeling purposes (referred to as design day emissions), are best represented by typical season day emissions. For some, such as residential wood burning, worst case day is a more representative choice. The design day emissions for area, on-road, and non-road sources are shown in Table 1.

Table 1: 2008 Design Day $PM_{2.5}$ Emissions for Area, On-Road, and Non-Road sources

	Design Day (lbs/day)
Stationary Area Sources	
Residential Wood Combustion: Fireplace(1)	989
Residential Wood Combustion: Non-Certified Woodstove/Insert(2)	869
All Other Res Wood Combustion(1)	315
Wildfire/Prescribed Burning	459
All Other Stationary Area Sources	172
On-Road Sources	
On-Road: Exhaust, Brake, Tire	364
Re-Entrained Road Dust	165
Nonroad Sources	
All Nonroad Vehicles & Equipment	79
Total, All Sources, lbs/day	**3,411**

(1) Design day = Advisory controlled

Design day emissions for point sources are estimated using data submitted in 2008 annual reports for all permitted facilities. The actual annual emissions are adjusted based on operating schedules or EPA temporal data specific to the process to estimate typical season day emissions for a facility. Design day emissions for point sources are used in modeling for 2008 are shown in Table 2.

Table 2: 2008 Estimated Design Day $PM_{2.5}$ Emissions for Permitted Point Sources

Permitted Point Source	**Design Day** (lbs/day)
Klamath Cogeneration	93
Jeld-Wen	106
Columbia Forest Products	268
Industrial Oil	17
Klamath Generation	0
Klamath Energy	3
Kingsley Field	3
Collins Products	265
Total All	------- **755**

For a detailed emission inventory report please refer to Appendix A-11.

The relative level of emissions for some source categories, as a percent of total emissions, did not correlate well with their estimated relative contribution to the measured concentrations at the Peterson School. Two of the categories that did not correlate well were point sources and prescribed fires. DEQ conducted an additional analysis (Appendix A-12) to assess the impacts of forest burning at the Peterson School monitor. DEQ concluded that prescribed burning has a minimal impact at Peterson School. For both prescribed burning and point sources, DEQ applied modeling to better evaluate the actual contributions of these sources to the monitored concentration, and the emissions were adjusted to establish an Effective Emission rate. Additional discussion about the effective emissions is described in Section 6, "Attainment Demonstration" and in Appendix A-12.

Attainment Year Emission Forecast (2014)

The attainment year inventory is an estimation of emissions for the year that the area is expected to attain the $PM_{2.5}$ standard. It includes projected emissions for the attainment year based on a number of different factors. Growth rates for population, employment, and VMT through 2014 were used to estimate 2014 emissions. DEQ also took credit for emissions reductions as a result of current strategies (or control measures) already being implemented but not accounted for in the 2008 emission inventory. As mentioned previously, these strategies were not included in the 2008 emission inventory because they had recently been adopted or implemented within the past few years. As a result, DEQ could determine if Klamath Falls would reach attainment with the $PM_{2.5}$ standard based on its estimated emissions and if not, what strategies it should develop in order to ensure compliance.

Determining the Attainment Year Emission Inventory

Growth Rates

Growth is expected to be low to moderate in Klamath Falls nonattainment area through 2014. Population, housing, and employment forecasts are expected to increase gradually. Oregon Executive Order 97-22 directs key state agencies such as DEQ and ODOT to use population and employment forecasts developed or approved by the Oregon Office of Economic Analysis (OEA). OEA county growth rates

better suit the nonattainment area rather than Klamath Falls city growth rates since the city is expected to grow in part by annexation. OEA states that between 2008 and 2024 an estimated growth of 0.54 percent per year is anticipated. A similar population growth is expected between 2008 and 2014. DEQ will be using expected population growth to estimate number of households in Klamath Falls Nonattainment Area. Employment was also assessed by OEA. Overall employment growth is predicted at 0.85 percent per year. However, 2008 was a recession year and the years between 2008 and 2014 are likely to expand only by 0.03 percent per year. Due to the recession, the growth rate between 2008 and 2014 is predicted to be relatively flat. However, growth between 2014 and 2024 is predicted to be higher. Because Klamath Falls must continue to meet the standard into the future, DEQ has used the longer term growth rate from 2008 to 2024 that OEA provided. Employment growth will be used as estimated growth for industrial sources. OEA also recommended that DEQ utilize the Oregon Department of Transportation methodology to determine Vehicle Miles Traveled (VMT). VMT projections will be used to determine growth in transportation. VMT is expected to grow at 1.29 percent per year. Growth rates used to forecast future $PM_{2.5}$ emissions are shown in Table 3.

Table 3: Growth Rates Used in Estimating 2014 Emissions

Growth	Average Annual Growth Rate (AAGR)	Data Used to Establish Growth Rate
Population And Household	0.54%	OEA County estimate
Employment	0.03% 0.85%	2008-2014 2008-2024
VMT	1.29	Estimated by ODOT to 2014

A summary of emission projections and how the growth rate is applied to each source category is described in the Future Year Emission Inventory (2014) section in Appendix A-11.

Existing Control Measures (Strategies)

There are several existing strategies and regulations which will reduce emissions by 2014. Adjustments were made to the 2014 emission inventory to account for these strategies which are already in place, but were not fully implemented in time to affect the 2008 emission inventory. They include:

- Klamath County Clean Air Ordinance
- Woodstove Changeout Program in Klamath Falls
- Heat Smart: Statewide Stove Removal upon Sale of Home
- Maximum Achievable Control Technology (MACT) reductions
- Transportation and Fuel-Related Emissions
- Road Paving

These existing control measures are discussed in more detail in Section 5.

Source Category Distribution of the 2014 Emission Inventory

In order to demonstrate attainment, future year anticipated ambient concentrations must be lower than the National Ambient Air Quality Standards. Future year concentrations are based on the 2014 emission

inventory that was developed using 2008 emissions, expected growth rates, and emission control measures that were or are being implemented between 2008 and 2014. As mentioned previously, DEQ applied growth factors to the 2008 inventory to forecast likely emissions in 2014; more specific information on emission growth for each source category are available in the emission inventory located in Appendix A-11. Similar to 2008, design day emissions were developed for 2014. The 2014 design day emissions from area, nonroad mobile and on-road mobile area are summarized in Table 4.

Table 4: 2014 Estimated Design Day $PM_{2.5}$ Emissions for Area, On-Road, and Non-Road sources

	Design Day (lbs/day)
Stationary Area Sources	
Residential Wood Combustion: Fireplace(1)	736
Residential Wood Combustion: Non-Certified Woodstove/Insert(1)	421
All Other Res Wood Combustion(1)	232
Wildfire/Prescribed Burning	459
All Other Stationary Area Sources	169
On-Road Sources	
On-Road: Exhaust, Brake, Tire	199
Re-Entrained Road Dust	156
Nonroad Sources	
All Nonroad Vehicles & Equipment	66
Total, All Sources, lbs/day	**2,437**

(1) Design day = Advisory controlled

For permitted point sources, the design day inventory is estimated using one of the following scenarios: actual emissions estimated from source annual reports, potential emissions (PTE) using 100% of the source permitted daily operating capacity, or permitted plant site emission limits (PSEL). DEQ developed these multiple emission scenarios representing the range of possible future activity. The design day emissions for point sources are based on the permitted plant site emission limits. Different future emission possibilities for point sources are shown in Table 5.

Table 5: 2014 Estimated Design Day, PSEL, and 100% Capacity $PM_{2.5}$ Emissions for Permitted Point Sources

Permitted Source	**Actual** **2014** TSD Emissions lbs/day	**PTE** **2014** WCSD (100% Capacity) lbs/day	**PSEL** **2014** Permitted Limit lbs/day
Klamath Bioenergy(1)	98	122	137
Klamath Cogeneration	93	210	327

Jeld-Wen	67[(2)]	161	130
Columbia Forest Products	268	647	361
Industrial Oil	17	20	77
Klamath Generation	0	0	0
Klamath Energy	3	77	92
Kingsley Field	3	3	77
Collins Products	170[(2)]	400	532
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Total All	**717**	**1,642**	**1,732**

(1) Klamath Bioenergy is a new facility, expected to be built and permitted by 2014. Actual emissions information is from the facility's construction permit.

(2) Reduction due to impact of MACT regulations on Hardboard and Particleboard Manufacturers

Comparison of 2008 to 2014 Emissions

The emission inventory shows an overall decrease in emissions for the attainment year (2014) based on the effectiveness of the existing strategies[2] listed above. The decrease in emissions for the design day is the most significant in residential wood combustion emissions. The ongoing implementation of existing strategies is expected to continue to reduce concentrations from wood combustion. Increased enforcement of the county ordinance and continued education will provide the reductions necessary to ensure Klamath Falls attains the standard. Figure 8 shows distribution of emission inventory for 2008 and for 2014 by source category.

The residential wood combustion reductions are primarily due to the required provisions in the county ordinance such as the mandatory compliance whenever an advisory call is issued and woodstove burning prohibitions. Appendix A-14 provides additional information on emissions reductions as a result of the county ordinance. The ordinance and other existing strategies provide the basis for the attainment demonstration.

The annual emissions also decreased from 2008 to 2014, as a result of the current strategies targeting the worst case day. Although the community did not violate the annual NAAQS, further reductions in the annual emission inventory will provide a larger margin of safety to the public with reduced $PM_{2.5}$ emissions.

Actual permitted point source emissions decreased between 2008 and 2014 because of the hardboard and particle board Maximum Achievable Control Technology (MACT) requirements on Collins Products and Jeld-Wen. However, the point source emissions increased due to addition of the Klamath Falls Bioenergy facility that has been permitted and projected to be built by 2014.

[2] Strategies currently implemented and effective as of December 31, 2011.

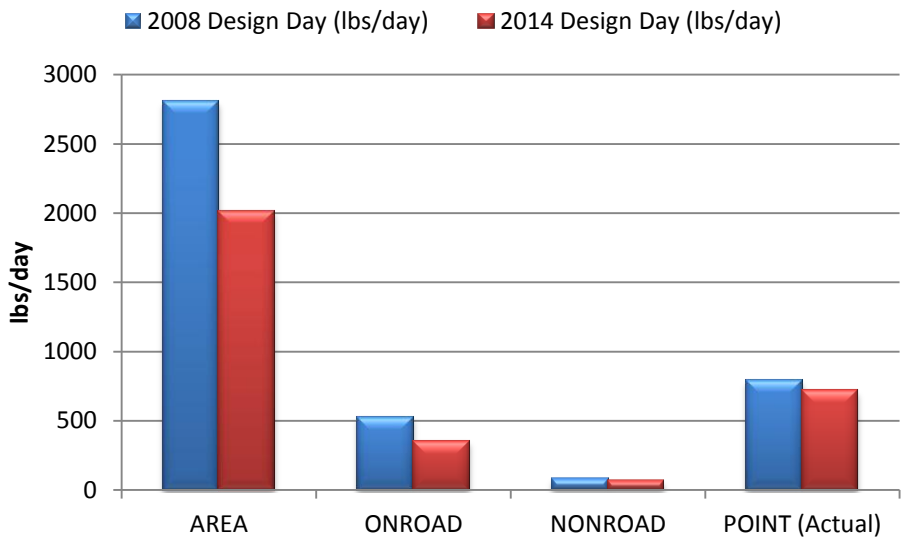

Figure 8: Comparison of 2008 Base Year and 2014 Forecast Year Design Day PM2.5 Emissions

Attainment Strategies: Emission Reduction Measures

Over the years Klamath County and DEQ have developed effective strategies to manage particulate matter air pollution concentrations in the Klamath Falls area, based in part on its history of dealing with particulate pollution from the mid-1980s. The emission reduction measures identified in this section include actions to address residential wood smoke, emission limits on industries, transportation and fuel related controls and regulations, restrictions on residential open burning, and public education.

The $PM_{2.5}$ emission reduction measures identified are currently being implemented, or will be implemented at the local (Klamath County), state and federal level to achieve compliance with the 24 hour $PM_{2.5}$ standard. DEQ often uses the term "strategies" interchangeably with the terms Reasonable Available Control Measures (RACM) and Reasonably Available Control Technology (RACT). RACM will be implemented for a wide range of emission sources, whereas RACT is implemented for stationary or industrial sources (e.g., equipment to control emissions from polluting sources such as boilers).

The identified emission reduction measures (or strategies) are grouped in three categories:

1. Past strategies adopted and implemented before 2007 that were accounted for in the 2008 base year inventory. These strategies form the basis for the current and new strategies (or RACT/RACM) that were developed for Klamath Falls.
2. Current strategies adopted and implemented after 2007, that were not included in the 2008 base year inventory but provide benefits post 2007.
3. New strategies to be implemented ensuring Klamath Falls reaches attainment by 2014.

Table 6 provides a summary of these emission reduction measures that will ensure attainment of the standard.

Table 6: Summary of Emission Reduction Measures

Emission Reduction Measure	Sector	Pollutant Addressed
Past Strategies (mid-1980s to 2006), accounted for in the 2008 base year emission inventory		
Residential Wood Combustion		
Klamath Woodstove Curtailment Program (Clean Air Ordinance)	Area	$PM_{2.5}$
Certification of Woodstoves	Area	$PM_{2.5}$
Open Burning		
Prohibition on Burning except for Green Days (Klamath Clean Air Ordinance)	Area	$PM_{2.5}$
Road Dust		
Highway Road Sanding practices	Area	$PM_{2.5}$

Current Strategies (2007 – present), currently implemented but not accounted for in the 2008 base year EI		
Residential Wood Combustion		
Klamath Woodstove Curtailment Program – revised with lower thresholds & increased enforcement (Clean Air Ordinance)	Area	$PM_{2.5}$
Woodstove Changeout Programs	Area	$PM_{2.5}$
Heat Smart program removal of uncertified woodstoves upon sale of home	Area	$PM_{2.5}$
Open Burning		
Shortened Open Burning Window (Klamath Clean Air Ordinance)	Area	$PM_{2.5}$
Fuel and Transportation Related		
Low Emission Vehicle Program	Mobile	SOx, NOx
Road Paving	Area	$PM_{2.5}$
Diesel Retrofits	Mobile	$PM_{2.5}$
Fuel Economy	Mobile	SOx
Industrial Point Sources		
Maximum Achievable Control Technology (MACT) - hardboard and particleboard facilities	Point	$PM_{2.5,}$ SOx
New Strategies (post 2012), strategies on the way		
Residential Wood Combustion		
Fireplace Standard	Area	$PM_{2.5}$
Public Awareness	Area	$PM_{2.5}$
Woodstove Changeouts and Fireplace Conversions[(1)]	Area	$PM_{2.5}$
Industrial Point Sources		
Opacity, Operation and Maintenance Plan Requirements	Point	$PM_{2.5}$
Offset Requirements[(a)]	Point	$PM_{2.5}$
Road Dust		
Highway Road Sanding practices	Area	$PM_{2.5}$

[(1)]DEQ is not taking credit for these strategies as they are dependent upon funding or industry interest.

Past Strategies (mid 1980s -2006)

Since the mid-1980s, DEQ and Klamath County developed strategies to address particulate matter in Klamath Falls, specifically to address PM10 pollution. These strategies were effective in reducing particulate levels in the area and provided a level of protection in addressing $PM_{2.5}$ pollution. The past strategies also formed the basis for current and future emission reduction measures that the county and DEQ could implement to ensure Klamath Falls reached attainment of the $PM_{2.5}$ standard by 2014. The reductions from these past strategies were accounted for in the 2008 base year inventory.

Residential Wood Combustion Strategies

Beginning in the mid-1980s the Klamath County Air Quality Task Force, DEQ, and Klamath County identified emission control measures or strategies for the Klamath Falls area. These strategies included

measures that were implemented by the county, through a county clean air ordinance to reduce emissions from residential wood burning. During this time, the state of Oregon also began requiring the certification of woodstoves, which reduced the amount of $PM_{2.5}$ pollution emitted from new wood burning devices.

The Klamath County Clean Air Ordinance

When Klamath Falls was nonattainment for PM10, Klamath County established a 1991 ordinance to help the area meet the PM10 standard. The ordinance has been effective in significantly reducing emissions from woodstoves in Klamath Falls. The key piece of the ordinance was the woodstove curtailment program. Citizens were required to curtail all their residential wood combustion on red days (high pollution, high health risk days) and curtail their uncertified woodstove use on yellow days (moderate pollution days). In 2001, the ordinance was revised to update their curtailment program to meet the 1997 particulate standards. The main provisions of the ordinance include:

- Woodstove Curtailment - During the winter, advisory calls are made on a daily basis to alert the public as to the level of pollution and whether burning must be curtailed;
- Opacity standard - With the exception of startup, all emissions from woodstoves must meet a 20% opacity limitation when burning wood;
- Exemptions - Low income and sole source homeowners are allowed to burn even on yellow and red days[3].

Statewide Certification of Woodstoves

In 1986, the Oregon Legislature required the emissions certification of any new woodstove sold in Oregon. This requirement was subsequently adopted by EPA on a national basis in 1990. Additionally, the State Building Code Agency prohibits the installation of uncertified woodstoves. The dual effect of this certification and installation requirement resulted in reducing the amount of wood smoke pollution that was emitted from uncertified stoves.

Open Burning Strategies

The 1991 Klamath County Ordinance also included provisions to address open burning. The ordinance prohibited open burning on yellow and red days and prohibited any agricultural burning within the nonattainment area.

Road Dust Strategies

The Oregon Department of Transportation (ODOT), the County Public Works Department, and the City of Klamath Falls Public Works Department made significant strides to reduce the amount of winter road sanding material placed on the roadway. All these agencies have utilized de-icing agents and salt instead of sand, increased plowing of roads and sweeping up of cinders during storms, and reduced sanding to intersections only. In addition, the area has made use of local geothermal energy to keep portions of streets free of ice in the winter.

[3] The sole source exemption terminated on December 31, 1992. Currently there are very few to no low income exemptions issued.

Reasonably Available Control Technology (RACT)

Oregon's $PM_{2.5}$ reasonably available control technology (RACT) analysis was conducted pursuant to 42 U.S.C. § 7502(c)(1) (Section 172(c)(1) of the Clean Air Act), which requires states with nonattainment areas to submit State Implementation Plans (SIPs) implementing all reasonably available control measures (including such reductions in emissions from existing sources in the area as may be obtained through the adoption, at a minimum, of reasonably available control technology) as expeditiously as practicable to attain the NAAQS. Oregon's RACT analysis demonstrates that reductions of direct $PM_{2.5}$ emissions and its precursors, SO2 and NOx, from several major industrial source categories, including hardboard and particleboard manufacturers and boiler operators are reasonable. Oregon's full RACT analysis is included in Appendix A-15-1.

Reasonably Available Control Measures (RACM) Analysis

A Reasonably Available Control Measure, or RACM, is defined by the EPA as any potential control measure for application to point, area, onroad, and nonroad emission source categories that is technologically and economically feasible, does not cause "substantial widespread and long-term adverse impacts", and is not "absurd, unenforceable, or impracticable". Oregon's $PM_{2.5}$ RACM analysis was conducted to fulfill the requirements of Section (c)(1) of the Clean Air Act. A total of 102 potential control measures were compiled and reviewed to determine whether or not any of these measures could be considered a RACM. DEQ and a local advisory committee evaluated the potential measures, and identified many that did not meet all the RACM criteria; those that did meet the criteria are identified below ("Current Strategies" and "New Strategies"). These reasonable measures that met the criteria do not result in severely disruptive socioeconomic impacts, particularly when addressing residential heating. For a description of the full RACM analysis please see Appendix A-15-1.

Current Strategies (2007 – Present)

In 2007, DEQ in conjunction with Klamath County identified "early emission reduction strategies" or RACM that targeted wood stove emissions just after the County became aware they were identified as a potential nonattainment area. There are a number of strategies and regulations recently implemented that will reduce $PM_{2.5}$ emissions and as described in Section 6, "Attainment Demonstration", show that the Klamath Falls area will reach attainment with the standard by 2014. These current strategies are a continuum of past strategies developed over the years that have been adjusted and updated to address the current $PM_{2.5}$ standard. Local efforts include revisions to the existing Klamath County clean air ordinance and woodstove changeouts. One of the most effective strategies has been the implementation of the revised Klamath County clean air ordinance, and in particular, the tighter levels and enhanced enforcement of the woodstove curtailment program. In addition, State and federal regulations recently implemented affect industrial sources, woodstoves, and transportation emissions. These strategies were not in place to affect the base year 2008 emission inventory but were accounted for in the 2014 emission inventory, as they are currently being implemented. All these current strategies provided emissions reductions for 2014. These strategies are permanent and enforceable; they are currently implemented and enacted by county ordinance, state, or federal rules. There are penalties for violating these ordinances or rules. Table 7 describes the emissions reductions anticipated from these strategies between 2008 and 2014.

Table 7: Reductions from Current Strategies, 2008 to 2014

Current Strategies (2007 – present), currently implemented but not accounted for in the 2008 base year EI	Source Category	Pollutant	2014 Projected Design Value Reduction at the Peterson School Monitor

Klamath Clean Air Ordinance (updated) • Woodstove curtailment – lower thresholds and increased enforcement • Shorter open burning window	Area	$PM_{2.5}$	9.2
Woodstove Changeout Programs	Area	$PM_{2.5}$	1.0
Heat Smart- changeout of uncertified stove upon sale of home	Area	$PM_{2.5}$	0.3
Maximum Achievable Control Technology (MACT) for particleboard and hardboard facilities	Point	$PM_{2.5,}$	0.2
Transportation and Fuel Related Emissions	Mobile and Nonroad	$PM_{2.5}$	minimal
• Diesel Retrofits			
• Low Emission Vehicle Program			
• Fuel Economy			
Road Paving	Area	$PM_{2.5}$	minimal

Residential Wood Combustion Strategies

The Klamath County Clean Air Ordinance

As mentioned previously, the Klamath County Board of Commissioners established a clean air ordinance for Klamath Falls that has been in effect since the 1990s. While the ordinance had been updated in the years since, a major revision occurred in 2007 to further existing strategies and address the revised $PM_{2.5}$ standard. (See Appendix A-17-1 for a copy of the 2007 ordinance.) All of the changes to the ordinance were fully implemented by 2009 and continue many of the existing requirements in place since the original ordinance was developed. The elements in the revised county ordinance are strategies or Reasonable Available Control Measures (RACM) that will bring the Klamath Falls nonattainment area back into compliance. The updated and more stringent requirements in the ordinance, specifically the woodstove curtailment program, provide the greatest emission reductions in Klamath Falls. Because woodstoves are the predominant source of particulate in Klamath Falls, the curtailment program is an effective tool to ensure Klamath Falls reaches attainment by 2014.

Woodstove Curtailment & Tightened enforcement

The existing residential woodburning advisory is calculated daily by assessing particulate concentrations and trends measured by the local nephelometer (located at Peterson School). Nephelometer data is used in combination with the local ventilation index and weather forecast to derive a predicted $PM_{2.5}$ value for the next 24 hours. Thresholds for the woodburning advisory are as follows:

Green day: Predicted $PM_{2.5}$ level less than 16 µg/m3
Yellow day: Predicted $PM_{2.5}$ level less than 30 µg/m3
Red day: Predicted $PM_{2.5}$ level greater than 30 µg/m3

In Klamath Falls, advisory calls are made more frequently to address poor air quality days (red and yellow days). The daily advisory is made by Klamath County health and environment staff. The advisory is provided to the public every day during the wood heating season (October 15 – March 15). The county also maintains a phone number, website, and electronic message board at the County Fairgrounds so the public can call, look up, or see the daily advisory.

Klamath County has one full-time program staff person and two part time staff people who are responsible for providing the advisory calls, conducting patrols to see if anyone is not complying with the advisory, and enforcing the ordinance. The revised ordinance included provisions for tightened enforcement, which includes more patrols and following up with repeat violators through letters and home visits. The ordinance included the potential for court citations and fines if the homeowner continued to violate the woodstove curtailment. Existing resources were also reallocated to employ a full-time program staff person (who was previously part-time) to ensure the enforcement of the curtailment program.

There have already been some reductions in the design value from 2008-2012. These reductions have been a result of better compliance with the ordinance, and while the overall design values are going down, the reductions are not as great as might be expected. A number of factors have affected the effectiveness of the program including the recession in 2008 (causing more people to heat with wood to save money on energy costs), colder than average winter temperatures, and the need for continued education of the community regarding the provisions of the revised ordinance.

Since the 2007 ordinance went into effect, Klamath County has been issuing warning letters to residents who violated the woodstove curtailment program. There is similar program for open burning violations. When the warning letters didn't work, a County Health Official visit was made to the home of the violator. After the initial home visit, those violators did not continue to repeat, with only a few exceptions. In more recent years, compliance improved and there were fewer first time offenders who violated the woodstove curtailment. Beginning in 2011, the violator who receives a warning letter is required to contact the Environmental Health Program to discuss the violation. Now, if an initial offender receives one warning any additional offenses are referred directly to the codes enforcement officer. The county has the authority to cite and fine an individual by a codes enforcement officer. There was one fine issued in 2010-2011 and one in 2011-2012. If a fine is issued, it is adjudicated in the Justice Court (small claims and civil court). As shown in Table 8, compliance has improved over the years.

Table 8: Violations and Compliance with Woodstove Curtailment Program

Heating Season	Red Days	Violations	Repeat	Citations
2007-2008	22	138	4	0
2008-2009	33	158	3	0
2009-2010	29	77	0	0
2010-2011	39	62	1	1
2011-2012	38	42	1	1
Average per season	**32**	**95**	**2**	

Enforcement of and compliance with the ordinance is expected to continue to show better resolve and compliance over the next few years. For the upcoming wood heating season (2012-2013) Klamath County plans to conduct enforcement patrols on all red advisory days. For violators, the County plans to provide added awareness including how to burn properly in their wood stove. Increased awareness will also occur, as the electronic message board announcing the advisory was recently installed for the 2011-2012 season and will continue to be in place. Klamath County has also recently focused on new public outreach for the curtailment program. This effort includes the recent addition of an Air Quality Advisory flag program at the local elementary schools within the nonattainment area. The flag program involves hanging a red, yellow, or green flag in front of the school to notify the public of the local advisory. This provides

additional awareness of the curtailment advisory in addition to the regular notification through the website, electronic message board, and phone. The County has received funding from Jeld-Wen to implement the program.

Funding for the program remains the same, although recent budget cuts in the county have led DEQ to commit $50,000 per biennium to ensure continued maintenance of the program. As part of this commitment, DEQ and the County have established targets for enforcement to ensure a low level of violators per month, and will identify steps to ensure better compliance if these targets are not met. These commitments are identified in the Interagency Agreement between Klamath County and DEQ, and are included as Appendix A-18.

Uncertified Stove Removal upon Sale of Home

The Klamath Clean Air Ordinance also included a provision to require the removal of an uncertified stove when a home is sold. This requirement facilitates the turnover of old uncertified stoves by ensuring any uncertified stove on the property being sold (including garages and outbuildings) is removed.

Rental Units and Woodstoves

Under the revised ordinance, rental units in Klamath Falls cannot have just wood heating as the sole source of heat for the home. The units must have alternate sources of heat.

Woodstove Changeout Program

Klamath Falls has had a long history (since the 1990s) of conducting woodstove changeouts by replacing old uncertified stoves with cleaner burning units. Recently, Klamath Falls was able to conduct multiple changeout programs with the assistance of approximately $1.5 million dollars in funds from EPA, the city of Klamath Falls, and federal American Recovery and Reinvestment Act (ARRA) stimulus money. Since 2008, 584 uncertified wood burning devices in Klamath Falls have been removed, destroyed, and replaced with cleaner burning heating units, such as certified woodstoves, pellet stoves, heat exchangers, or natural gas furnaces. The ARRA funding in particular, replaced 246 of the 305 uncertified stoves in low income homes. This effort in particular provided wood smoke reductions because low income wood burning homeowners are more likely to use older, high emitting stoves, have higher fuel consumption because older stoves are less efficient, and can receive a hardship exemption from the county during woodstove advisories. Table 9 shows the number of uncertified stoves changed out since 2008.

Table 9: Klamath Falls Woodstove Changeouts

Year	2008	2009	2010	2011
Number of uncertified wood burning units	2,783	2,599	2,397	2,199
Changeouts		184	202	198

Heat Smart: Stove Removal upon Sale of Home

In 2010, a statewide requirement mandating the removal of an uncertified stove at the time of home sale went into effect. This statewide rule closely mirrored the existing requirement in the Klamath County ordinance. Under the rule, all uncertified devices that are on the property being sold (including

residences, shops, garages, and outbuildings) must be removed at the time of home sale. DEQ estimates that with the Heat Smart requirement and through the natural attrition of people wanting to upgrade or replace their old device on their own, there will continue to be old stoves replaced. Table 10 shows the projected numbers for 2012 through 2014 and details of these calculations are available in Appendix A-11 (Emission Inventory).

Table 10: Klamath Falls Projected Woodstove Changeouts

Year	2012 Projected	2013 Projected	2014 Projected
Number of uncertified wood burning units	2,126	2,063	2,004
Changeouts	73	63	59

Uncertified stoves required to be removed upon sale of home have several built-in mechanisms for compliance. Because it is against the law to sell a home with an uncertified wood stove, realtors, lenders, insurance companies, title companies and others involved in the sale do not want the liability of keeping the uncertified stove in the home and have an incentive to require the removal of the stove upon sale. Realtors will want to ensure their clients comply with the law. Title companies may not be able to verify that the stove has been removed making lenders reluctant to lend. Lenders and insurance agents have a major liability if the illegal uncertified stove causes a fire in the dwelling. In addition to the built-in mechanisms for compliance, DEQ requires every sale with an uncertified wood stove to be documented and that documentation submitted to the department. DEQ can monitor the sales and disclosures in Klamath Falls for compliance with the law. Should a violation be discovered, DEQ has a civil penalty for failure to remove the stove.

Open Burning Strategies

The Klamath County Clean Air Ordinance

The revised ordinance also included updated provisions regarding open burning. Open burning in the Klamath Falls nonattainment area is now restricted to just 15 days in the fall and 15 days in the spring. The county also has the option to not open a fall window at all, if conditions warrant it. In addition, the revised ordinance prohibits the use of burn barrels in the nonattainment area. In addition, the ordinance prohibits any agricultural burning on red and yellow days.

Klamath County's health and environment staff monitor and enforce the open burning regulations as necessary. The open burning program also includes an effort for public outreach and education. Program staff makes field visits to homeowners to provide educational materials, warnings, and citations, as needed.

Industrial Point Source Strategies

Maximum Achievable Control Technology (MACT) reductions

EPA has adopted rules, Maximum Achievable Control Technology (MACT) requirements for certain industrial sources that have Title V permits. Specifically, the MACT requirements require particle board

and hardboard manufacturers to reduce air toxics emissions. In Klamath Falls, Collins Forest Products and Jeld-Wen will need to reduce emissions in order to comply with the MACT requirements. MACT compliance was required by 2007, although both facilities applied for an extension and complied with the MACT by 2009. Although the control technology required under MACT was for toxic emissions, there were also reductions in $PM_{2.5}$ emissions. Under the MACT requirements, Collins will reduce $PM_{2.5}$ by 36 percent, and Jeld-Wen will reduce $PM_{2.5}$ by37 percent. The MACT requirements provide the reasonably available reductions for $PM_{2.5}$ for these sources, so DEQ considers this to be RACT. For additional discussion on the MACT/RACT analysis, please see Appendix A-15-1.

Mobile and Nonroad Vehicle Strategies

Transportation and Fuel-Related Emissions

Federal, state and local transportation regulations and programs recently implemented will reduce mobile and non-road emissions. These include:

- Federal regulations requiring increased fuel economy;
- Oregon regulations requiring low emissions vehicles beginning with model year 2009 and;
- Local programs implementing diesel retrofits of city and county buses.

Road Dust Strategies

Road Paving

$PM_{2.5}$ emissions generated by motor vehicle traffic have been reduced over the years through efforts to pave roads, minimize the use of sanding material, and to control mud and dirt track out from industrial, construction and agricultural operations. Six miles of unpaved road have been paved in the nonattainment area since 2008, resulting in reductions from re-suspended road dust.

New Strategies – Additional Control Measures

While the current strategies in place indicate Klamath Falls will reach attainment with the $PM_{2.5}$ standard by 2014, additional new strategies in Table 11 were identified by a local advisory committee to ensure compliance. For each strategy, a percent reduction is identified and the credit applied to the emission inventory for the future strategies. These strategy reductions are based on reasonably available control measures and EPA guidance on credit taken.

Table 11: Additional control measures

Strategy	Category	Pollutant	Reduction on Design Day µg/m3
Public awareness	Area	$PM_{2.5}$	0.6
New fireplace standards	Area	$PM_{2.5}$	0.2
Industrial requirements[1]	Point	$PM_{2.5}$	0.1

(1) RACT is required for existing sources emitting 10 or more tons of $PM_{2.5}$ per year. While fugitive dust and operation and maintenance plans will likely reduce $PM_{2.5}$ emissions, no credit is taken.

Klamath Air Quality Advisory Committee (KAQAC) Strategy Recommendations

In 2011, DEQ and the County convened an advisory committee to help develop additional "future strategies" or RACM to be implemented as soon as practicable but prior to January 1, 2013. The committee evaluated existing strategies and looked at how to potentially improve upon those strategies. The committee recognized that the current strategies in place (e.g. county ordinance, federal and state regulations) indicated the area will meet the standard by 2014; the KAQAC also identified other strategies to provide a cushion to ensure attainment by 2014. This committee analyzed 79 RACT/RACM measures for its technological and economic feasibility, the amount of reduction achieved, and its implementability. The committee identified and provided its recommendations of RACT/RACM measures that could be adopted to Klamath County and DEQ and is available in Appendix A-16. DEQ also identified separate, additional strategies to provide an additional buffer for Klamath Falls to meet the 2014 attainment date. These control measures are currently being adopted or are in the process of being implemented, as described below. Contingency measures are described in Attainment Demonstration.

Residential Wood Combustion Strategies

Public Awareness

Klamath County plans to continue and expand educational efforts regarding reducing $PM_{2.5}$ emissions from wood smoke. Education has had an impact and reduced wood smoke in the past and the county intends to enhance current educational strategies. DEQ has provided funding to the County, through an interagency agreement, to assist in educating the Klamath Falls community about proper use of woodstoves and reducing woodsmoke. Under the agreement, Klamath County will be required to provide programs such as hands-on demonstration of wood stove use, wood smoke health effects information dissemination, videos on public access and government websites, and outreach to teach homeowners about appropriate wood selection.

New Fireplace Standard

Klamath County plans to adopt a requirement, that fireplaces in new homes are built using the most stringent ASTM standard for fireplaces. Currently, there are no emission certification requirements for fireplaces; EPA does however, have a voluntary certification program in place for fireplace manufacturers who want to have their fireplaces tested. Under EPA's voluntary program, it recommends the use of ASTM test method E2558 to test for emissions and manufacturers that want their fireplace to be qualified under the program must have a fireplace that emits no more than 5.1 g/kg of $PM_{2.5}$. This would be a 2/3 reduction from current fireplace emissions. This requirement will be carried out by the Klamath County building codes department, as they issue permits for fireplace construction in new homes. Appendix A-17-2 includes the proposed changes to the county ordinance to incorporate this requirement.

Industrial Point Source Emissions

Opacity Standards and Operation and Maintenance Plan Requirements

New DEQ rules will require existing sources of industrial $PM_{2.5}$ emissions greater than 10 tons per year to comply with new opacity requirements, and other operating plan requirements. These rules are nonattainment area Reasonably Available Control Technology (RACT) requirements. All RACT control technology must be installed by July 1, 2013. Specifically, these rules require existing sources to retrofit their facilities to meet a 20% opacity limitation. In addition, each facility must have a fugitive emission plan and an operation and maintenance plan prepared during their next permit renewal cycle. These limitations will reduce the industrial contribution to pollution in Klamath Falls. See Appendix A-19-1, A-19-2, and A-19-3 for New Source Review and RACT rules as they relate to nonattainment areas in Oregon.

Additional Strategies for Which DEQ Is Not Taking Credit

DEQ and the Advisory Committee identified additional strategies to adopt as part of this attainment plan, but are not taking credit for these reductions because they are dependent upon funding or interest from the industry for them to be implemented or the emissions reductions are too minimal to quantify (See Table 12). These reductions, if implemented, will provide additional reductions but it will depend on the scope of the funding for woodstove conversions and on the number of conversions industry may choose to obtain offsets. These reductions cannot be quantified.

Table 12: Estimated reductions from additional strategies

Strategy	Category	Pollutant	Reduction on Worst Case Day ($\mu g/m^3$)
Wood stove conversions	Area	$PM_{2.5}$	Varies
Woodstove offsets	Point	$PM_{2.5}$	Varies
Winter road sanding	Area	$PM_{2.5}$	Minimal

Additional Woodstove Change Outs and Fireplace Conversions

Due to the effectiveness of this program in reducing woodstove emissions, the city, county, and DEQ will pursue funds to continue offering woodstove change outs and fireplace conversions within the nonattainment area. Implementation of this strategy will provide substantial reductions of $PM_{2.5}$ in the future. However, DEQ is not applying any emission credit for this strategy to the 2014 inventory as it is dependent upon the acquisition of funding, which in turn, affects the number of stoves that can be changed out.

Woodstove Offsets for Industry

Typically, a new or expanding industry in the Klamath Falls nonattainment area is required to obtain "offsets" if their $PM_{2.5}$ emissions are above a significant level. This has meant buying "offsets" from an industry that is not using them, or paying for emission reductions at another industrial facility. DEQ's rules (OAR 340-240-0550)[4], allow new or expanding industry seeking offsets to have the option of contributing to a woodstove change out program as a one-time cost to purchase offsets. This ratio is one ton of $PM_{2.5}$ offsets to one ton of emissions reduced directly from wood stoves in the airshed due to a change out program. For those offsets obtained directly from wood stove emissions, air dispersion modeling to meet Oregon's net air quality benefit requirements will not need to be conducted.

Highway Sanding

In 2012, the Oregon Department of Transportation (ODOT), the County Public Works Department, and the City of Klamath Falls Public Works Department renewed their commitment to minimize impacts of road dust and winter road sanding material and to utilize de-icing agents and salt instead of sand. The three major public works agencies have also committed to try and purchase highly efficient sweepers to sweep up cinders on roadways after winter storm events are completed. While the expected emissions reduction is minimal and DEQ is not taking credit for this reduction, these efforts will help mitigate the amount of winter road sanding material placed on the roadway. The winter sanding agreement with the agencies and DEQ is available as Appendix A-20.

[4] Subject to EQC approval. EQC consideration of these rules is in December, 2012.

Attainment Plan and Demonstration

Attainment Demonstration

The attainment demonstration shows how Klamath Falls will meet the $PM_{2.5}$ standard by 2014 through the implementation of control measures listed above. DEQ used a "proportional rollback/rollforward analysis" or rollback model to conduct the analysis. The attainment demonstration shows that future concentrations are less than the NAAQS at the Peterson School monitor and other unmonitored parts of the designated nonattainment area. The 2014 attainment demonstration also demonstrates that reasonable further progress (RFP) is achieved (40 CFR 51.1009).

Determination of Baseline Design Value

The demonstration starts with estimating the baseline concentration, or baseline design value, for $PM_{2.5}$. A design value is the mathematically determined pollutant concentration that describes the air quality status of a given area relative to the level of the National Ambient Air Quality Standards (NAAQS). Design values are expressed as a concentration instead of an exceedance count, thereby allowing a direct comparison to the $PM_{2.5}$ standard. The design value is based on data from the DEQ Peterson School monitor at which both the $PM_{2.5}$ federal reference monitor (FRM – the monitor used to determine attainment with the standard) and speciation monitors are located. The base year for the analysis is 2008, and the base monitoring period for constructing the design value includes the years 2006 – 2010. The calculated 2008 baseline design value is 45.1 $\mu g/m^3$, which was developed following the procedures cited in Clean Air Fine Particle Implementation Rule (72 FR 20607). The calculations on which these results are based are provided in the Appendix A-21, and summarized in Table 13, below.

Table 13: $PM_{2.5}$ values used to calculate baseline design value

Year	$PM_{2.5}$ ($\mu g/m^3$)
2006	47.5
2007	39.6
2008	52.2
2009	44.0
2010	34.6
Design Value (2008)	**45.1**

Speciation of the Design Value

Because $PM_{2.5}$ can be formed in the atmosphere from precursor pollutants such as SOx, NOx, ammonia, and volatile organic compounds, DEQ also investigated these components as part of the rollback analysis. Speciation of the measured $PM_{2.5}$ concentration used data from the co-located speciation monitor at Peterson School. The measured speciation data provides information that is used to distribute the total FRM mass into its constituent chemical species. These speciation data were adjusted and modified in the SANDWICH (sulfate, adjusted nitrate, derived water, inferred carbonaceous material balance approach)

procedure. The result is a speciated design value mass that is the basis for speciation in the rollback model. Data used for the SANDWICH approach included all wintertime sample data with total mass greater than 25 $\mu g/m^3$ taken at the Peterson School monitor. Table 14 shows the results as percent contributions of the speciated components (sulfates, nitrates, organic carbon (OC), elemental carbon (EC), ammonia (NH3), and other primary particulate (OPP)).

Table 14: Contribution by speciated components. Results of SANDWICH analysis for winter (Oct-Mar)

% Sulfate	% Nitrate	% OC	% EC	% Water	% NH_3	% OPP
1.6	9.6	74.4	7.0	4.2	0.7	2.6

NO_3 and SO_4 represented small fractions of the speciated samples and it was decided to treat these secondary inorganic aerosols as constants in the rollback analysis, that is, they were given a Relative Response Factor (RRF) of 1.0. This is based on the assumption that total precursor emissions of NO_x and SO_2 decline between 2008 and 2014, which is the case for the Klamath Falls inventory. In addition, a conservatively high amount of nitrate was chosen to account for unlikely but possible increases in secondary nitrate as a result of control strategies. Detailed methods of the SANDWICH procedure and results are included in Appendix A-5.
The attainment demonstration will not take credit for the small emission reductions in primary nitrate and sulfate that are expected to occur. Pollution reduction strategies are focused on organic and elemental carbon. Thus, the attainment demonstration puts focus on these two components of $PM_{2.5}$.

SOA (Secondary Organic Aerosols) and Minor $PM_{2.5}$ Species

In addition to quantifying the species components to the design value mass, attention was paid to the sources of secondary organic aerosol (SOA) precursors to $PM_{2.5}$, and in particular to chemical processes in the atmosphere that might affect the dynamics of $PM_{2.5}$ formation. DEQ partnered with Portland State University (PSU) to examine the formation of these SOAs using a chemical box model. Biogenic precursors were estimated for the vegetative cover in the nonattainment area and adjusted to reflect wintertime temperatures. In the same model, anthropogenic SOA formation was estimated from benzene, toluene, and xylene precursor emissions primarily from on-road mobile sources. The results showed that anthropogenic SOAs contribute 3% and biogenic SOAs 1% of the total measured $PM_{2.5}$ mass, relatively minor components to total $PM_{2.5}$. For the rollback model, these components were assigned RRFs of 1.0 in the same fashion as the secondary inorganic aerosols.

Effective Emissions

As mentioned, DEQ is utilizing a rollback model based on a correlation between emissions and ambient air concentrations that assumes a relatively even distribution of emissions in an air basin with low concentrations gradients of pollutants across the most heavily populated portion of the non-attainment area. In Klamath Falls this assumption is considered generally representative with the exception of three emissions categories: industrial point sources, prescribed burning, and road dust. Two of these emission source categories are located either outside of the nonattainment area (prescribed burning) or at its edge (industrial points), at some distance from the Peterson School monitor which is sited at the approximate center of the nonattainment area. Although these sources may have local high concentrations near their emissions sources, their impact at the monitor is likely to be low with flat concentration gradients. In addition, emissions from road and fugitive dust appear high relative to the fugitive dust component of measured

concentrations based on a Positive Matrix Factorization (PMF) analysis. (See Appendix A-7). The reasons for differences between emissions and concentrations for these three categories can be the result of plume dispersion, inaccurate emissions estimates, use of unrepresentative emission factors, or a combination of these factors.

In order to better provide a correlation between emissions and their contribution to measured concentrations at the monitor from these three source types, PMF and an air dispersion model (AERMOD) were used to develop what is termed "effective emissions." (Please see Appendix A-22 for more information on the AERMOD model.) Effective emissions are defined as those emission rates from a given source category that are considered to proportionately correlate with measured concentrations of that same source category at the monitor For source categories whose emissions are relatively evenly distributed across the domain, effective emissions are considered to be their actual emissions. For source categories that are not evenly distributed, or require other adjustments, effective emissions are estimated using other models.

The contribution of industrial point source and prescribed burning emissions were estimated using the AERMOD air dispersion model. Industrial point sources contribute 1.0% of the baseline design value (45.1 $\mu g/m^3$), or about 0.45 $\mu g/m^3$. Prescribed burning emissions contribute a modeled contribution of 0.694 $\mu g/m^3$, or 1.75% of the baseline design value. Fugitive dust emissions from aggregate storage piles, road sanding operations, and re-entrained road dust were estimated to be about 3.5% (or 1.58 $\mu g/m^3$) using the PMF study conducted by EPA Region 10. These values for prescribed burning, fugitive dust, and industrial point sources have an effective emission rate calculated at a level that, together with the actual emission rates of the other source categories, will result in the percent contributions determined by dispersion and PMF modeling.

A detailed description of effective emissions and the models used in their estimation can be found in Appendix A-13.

Rollback Model

As noted, the method chosen to demonstrate attainment for Klamath Falls is a rollback/roll forward model that assumes a direct linear correlation between emissions and concentrations and that changes in emissions, such as reductions resulting from control strategies, will result in corresponding reductions in concentration. As a result, concentrations in a future year (2014, for the Klamath Falls demonstration) can be predicted based on reductions in emissions, and their corresponding ambient concentrations, from a base year (2008). Rollback is a relatively simple model but depending on the characteristics of the modeling domain and emissions categories it may be just as appropriate as a complex regional grid model.

Rollback/forward was chosen over a regional grid model, such as CMAQ or CAMx, for the following reasons:

1) Photochemistry plays a minor role in $PM_{2.5}$ formation in Klamath Falls which is dominated by organic carbon (OC) primarily the result of winter season residential wood smoke, with highest measure concentrations occurring in evening hours during periods of high burning activity, frequent temperature inversions, and stagnant air,
2) Secondary $PM_{2.5}$, including sulfate, nitrate, and secondary organic aerosols (SOAs), are minor constituents of total PM mass,

3) The nonattainment area is small and bowl shaped – surrounded on three sides by elevated terrain. With low mixing heights and light winds during periods of high concentration, it is assumed pollutants are relatively well-mixed and concentration gradients low within the highly populated portion of the non-attainment area. A typical configuration for CMAQ or CAMx would not resolve the spatial patterns in $PM_{2.5}$ within the non-attainment area much more than the rollback/forward box model.
4) The relative ease of use of the rollback/forward model facilitated troubleshooting, quality control, and sensitivity testing.

The EPA Guideline on Air Quality models (40 CFR Part 51, Appendix W) addresses the choice of models for analyzing $PM_{2.5}$ concentrations, and in 5.2.2.1 a states:

> *Treating secondary components of $PM_{2.5}$, such as sulfates and nitrates, can be a highly complex and resource-intensive exercise. Control agencies with jurisdiction over areas with secondary $PM_{2.5}$ problems are encouraged to use models which integrate chemical and physical processes important in the formation, decay and transport of these species (e.g., Models-3/CMAQ 38 or REMSAD 41). Primary components can be simulated using less resource-intensive techniques.*

This language suggests that for nonattainment areas without secondary $PM_{2.5}$ problems, the attainment demonstration in which primary components are the major component can be made using simpler, less resource-intensive techniques. Though not stated explicitly in this section of the Guideline, this simpler technique could include a proportional rollback/rollforward model. In utilizing the rollback/rollforward model, DEQ can adequately demonstrate attainment with the $PM_{2.5}$ standard utilizing conservative assumptions.

Secondary $PM_{2.5}$, including sulfate, nitrate, and SOAs, will be included in the rollback model but as constants with a RRF of 1.0, that is, the level of secondary $PM_{2.5}$ species will not increase or decrease from the 2008 baseline year to the 2014 future year. As noted above, this approach assumes that precursor emissions will not increase over the attainment timeframe. This is considered a conservative approach as reductions in residential wood smoke with corresponding reductions in organic carbon (the target of control strategies to reach attainment) and reductions in motor vehicle emissions affecting the current fleet of cars from existing rules will also reduce emissions of anthropogenic secondary $PM_{2.5}$ precursors.

Rollback Source Categories

Multiple source categories were used in the rollback reflecting those source types considered to be significant in the analysis. Because residential wood heating is the largest $PM_{2.5}$ emissions source, based on its percentage of emissions from all sources, and because proposed controls of residential wood combustion could be selectively applied by type of wood heating appliance, residential wood heating emissions are defined by specific appliance. Details of residential wood combustion, the type of heating device used, and the methodologies for estimating their emissions are described in the Emissions Inventory section of this report.

Speciation Profiles

The rollback is based on a speciated emissions inventory as described previously. Emissions from source categories in the inventory were initially estimated as total $PM_{2.5}$, and source profiles were used to allocate emissions to individual $PM_{2.5}$ species. Organic Carbon, Elemental Carbon, and Other Primary

Particulate (OPP, or PM Other) are the species identified in the speciation profiles, (EPA Speciate Version 4.2 and 4.3) and are the species used in the rollback model.

Compliance with the $PM_{2.5}$ Standard

Applying the Rollback Model

The speciated rollback as used for Klamath Falls, can predict multiple future year design values based on different modeling scenarios, including changes in the 2008 emissions estimates, and variations in future year emissions as a result of different control reductions and operating scenarios. Applying the current RACT/RACM strategies in place see Table 15 and factoring in emissions from industrial facilities operating at maximum permitted levels (PSELs), the 2014 future year design value is 35 $\mu g/m^3$ at Peterson School using a composite RRF of 0.717 (Table 16). Details of this analysis are available in Appendix A-23-1 and A-23-2.

Table 15: Design Value for 2014, Utilizing Current Strategies

Current Strategies (implemented since 2008)	Emission Reduction ($\mu g/m^3$)
Klamath Clean Air Ordinance (updated) • Woodstove curtailment – lower thresholds and increased enforcement • Shorter open burning window	9.6
Woodstove Changeout Programs	1.0
Heat Smart- woodstove changeout upon sale of home	0.3
Maximum Achievable Control Technology (MACT) particleboard and hardboard	0.1
Transportation and Fuel Related Emissions	minimal
• Diesel Retrofits	
• Low Emission Vehicle Program	
• Fuel Economy	
Road Paving	minimal

Table 16: Design Value for 2008 and 2014 based on Current Strategies

	2008 $\mu g/m^3$	2014 $\mu g/m^3$
Design Value (DV)	**45**	**35**[1]

(1) Using Plant Site Emission Limits (PSELs)

Since the future year 24-hour average concentration levels meet the NAAQS (35 µg/m3) at the Peterson School Monitor, the attainment of the standard is demonstrated at this location with the application of the current strategies in place.

Application of New Strategies

Including current strategies, the rollback model shows that Klamath Falls Area will achieve the standard of 35 $\mu g/m^3$. However at 35 $\mu g/m^3$ the attainment design value does not include much of a buffer for

potential variation while still meeting the standard. To ensure continued compliance, and include a protective buffer, the Klamath Falls Advisory Committee developed and recommended to both DEQ and the County additional strategies to include in the attainment plan. After reviewing the recommendations, the County selected a few strategies, which ultimately will result in additional emission reductions and show further reduction in the attainment demonstration roll back model. The results of the rollback at Peterson School show a cumulative Relative Response Reduction Factor (RRF) of 0.667 with current and immediate strategies recommended by the committee. Table 17 shows how each strategy (RACT/RACM) will bring the area into attainment.

Table 17: New strategies and the 2014 design value

New Strategies	Emission Reduction[1] ($\mu g/m^3$)
Public awareness	0.6
New fireplace standards	0.1
RACT[2]	0.1

(1)Worst case day
(2)RACT is required for existing sources emitting 10 or more tons of $PM_{2.5}$ per year. While fugitive dust and operation and maintenance plans will likely reduce $PM_{2.5}$ emissions, no credit is taken

Once all the strategies are applied, the 2014 future year design value becomes 34 $\mu g/m^3$. Table 18 shows the demonstration design value based on all current and committee recommended attainment strategies:

Table 18: Design value for 2008 and 2014 based on future strategies

	2008 $\mu g/m^3$	2014 $\mu g/m^3$
Design Value (DV)	**45**	**34[1]**

(1) Using PSELs

This demonstrates Klamath Falls will attain the standard by 2014.

Attainment Demonstration in Unmonitored Areas

In addition to the Peterson School location, it was necessary to demonstrate that other areas within the nonattainment area also were in attainment for the future year. A second analysis, or unmonitored area analysis (UMAA), was used to evaluate future year design values in these areas. The UMAA was based on a saturation survey conducted by DEQ, combined with dispersion modeling of industrial point sources. DEQ evaluated the distribution of $PM_{2.5}$ concentrations across broad areas of the nonattainment area, assessed the representativeness of the Peterson School site as a neighborhood monitor for the nonattainment area, and developed representative 2014 background design values (that is, 2014 design values without industrial sources impacts) for areas of the nonattainment area.

In order to estimate the 2014 design value in areas near industrial facilities, AERMOD was run using 2014 permitted emissions (Plant Site Emission Limit, or PSEL) for the industrial facilities. In order to simulate neighborhood scale concentrations, 1.2 km grids were centered on the facilities and modeled concentrations at the corners and center of the grids (five values for each grid) were averaged. The results

of the UMAA, using the approach described above, indicate that the areas surrounding the industrial facilities in Klamath Falls, at a neighborhood monitoring scale, have a maximum concentration of 30 $\mu g/m^3$, and are in attainment for the 2014 Future Year. This supplements the attainment demonstration for the Peterson School monitor that also shows attainment for 2014. A description of the UMAA including the saturation survey and dispersion modeling results is provided in Appendix A-24.

Contingency Plan

The attainment plan must contain contingency measures that would be implemented in the event that the Klamath Falls nonatttainment area fails to meet or violates the standard on or after December 2014. These contingency measures are designed to correct the violation of the $PM_{2.5}$ standards and be implemented immediately. EPA requires that any contingency measures must equal one year's worth of reasonable further progress (RFP). In Klamath Falls, RFP would equal about 2.0 micrograms per cubic meter of further required reduction. In order to achieve reasonable further progress, DEQ, in coordination with the Klamath Air Quality Advisory Committee has identified and adopted the following contingency strategies for Klamath Falls in this plan.

Phase 1: Continuing Violation

If Klamath Falls fails to meet or violates the standard on or after December 2014, the following contingency measures that would be implemented starting March 1, 2015.

Prohibition of Fireplaces

DEQ rules 340-240-0630 prohibits the use of all fireplaces, except those that are ASTM certified (fireplaces that emit less than 5.1 g/kg) inside the AQZ during the winter woodheating season. These devices could not be used unless the homeowner has applied for a short-term exemption allowing use on holidays or special occasions on green advisory days. The prohibition on the use of fireplaces would essentially eliminate the use of non-ASTM certified fireplaces. This addresses background (lingering) smoke in the airshed, particularly when there could be opportunities for a buildup of smoke on poor ventilation days.

Table 19 provides the relative reduction achieved from these contingency strategies.

Table 19: Reductions from Contingency Strategies

Contingency Strategy	Rule	Reduction on Worst Case Day Lbs/day	Reduction on Worst Case Day in $\mu g/m^3$
Prohibit use of fireplaces with emissions greater than 5.1 g/kg	Klamath Clean Air Ordinance and DEQ Div 240	528	5.0
Total			5.0

Using this contingency strategy will result in additional emission reductions and show further reduction for reasonable further progress. A reduction of 5.0 $\mu g/m^3$ is anticipated from these contingency strategies; this is above the target needed to meet the reasonable further progress test requested by EPA.

Additional Measures

The following strategies will not be in effect immediately due to the time necessary to install, operate, and show compliance for specific equipment if the contingency requirements were triggered. Therefore DEQ is not claiming credit for these strategies as contingency measures but is still requiring them should Klamath Falls not meet the standard by 2014. The reductions achieved through implementation of these

measures will provide an additional buffer to ensure Klamath Falls achieves the necessary reductions to meet the $PM_{2.5}$ standard.

RACT

DEQ is requiring the following RACT strategy that must be installed and operating with a source demonstration test by December 15, 2016. DEQ is revising Divisions 200, 225, 240 to reflect continuous emission monitors (CEM) or continuous operational monitors (COM) requirements for Title V sources for fuel and refuse burning equipment[5]. As mentioned previously, DEQ is not claiming credit for this strategy in the attainment demonstration.

Table 20: Reductions from Contingency Strategies

Additional Measures	Rule	Reduction on Worst Case Day in µg/m^3
Reasonably Available Control Technologies[1] (RACT) for industry (CEM)	DEQ Div 240	No Credit Taken[2]

(1) RACT is required for existing sources emitting 10 or more tons of $PM_{2.5}$ per year.
If Klamath Falls meets the EPA Clean Air Act 2014 deadline for meeting the standard, the contingency plan will not be enacted.

(2) The emission reduction after all controls are in place will be a minimal reduction. Because it will take a while for the installation of the equipment to meet this reduction, no credit is taken for these RACT.

Phase 2: Significant Continued Violation

DEQ, in consultation with the County, will convene a planning group of City, County and DEQ personnel to develop an action plan if ambient concentrations continue to equal or exceed 110% of the NAAQS concentration of $PM_{2.5}$ (38.5 µg/m^3 for the 24 hour average or 16.5 µg/m^3 for an annual average at a ninety eighth percentile) at Peterson School. The planning group will prepare an action plan that includes a schedule for implementation of additional strategies. The schedule will be presented to the County Commissioners, the City Council and DEQ within one year. The new plan will bring the community back into attainment with the $PM_{2.5}$ standards within three years. The plan will adopt concrete actions that will occur by ordinance or agreement that are permanent and enforceable. The actions will be placed in a schedule for implementation. This schedule will include automatic implementation of more stringent requirements.

[5] These rule revisions are being considered for adoption by the Environmental Quality Commission on December 2012.

Additional Plan Elements and Implementation

Transportation Conformity

Transportation conformity is the regulatory program that links transportation and air quality planning processes together so that emissions from motor vehicles (both now and in the future) do not jeopardize air quality standards. Under conformity, emissions resulting from a transportation plan cannot exceed the allowable emissions level established for transportation in the air quality plan.

DEQ requested EPA to determine that emissions from transportation sources were insignificant for regional emissions analysis. EPA could not make that determination because their policy states that this determination can only be made when an area meets the standards. Therefore, the request has been denied. The request is described in Appendix A-25.

Transportation Emissions Budgets for Conformity

Since regional conformity is required, an emissions budget for on-road motor vehicle emissions in the Klamath Falls nonattainment area is based on emissions from 2014 as they are predicted to 2037. The transportation emissions budgets for selected years are shown in Table 25 and Table 26[6].

Table 21: Motor Vehicle Emissions Budget Through 2037

Klamath Falls Motor Vehicle $PM_{2.5}$ Emissions Budget
Worst Case Winter $PM_{2.5}$ Season (lbs/day)

Pollutant	Pounds per Day
PM2.5	699
NOx	4,834

[6] The motor vehicle emission budget for Klamath Falls is based on the emissions in 2014 because they are the highest emissions of the years 2014 through 2037. DEQ predicts Klamath Falls will meet attainment in 2014. DEQ used the MOVES model that includes Transportation Demand VMT and other criteria for projections to 2037. VMT and other criteria used in the MOVES model can be found in Appendix 11 or by contacting DEQ Technical Services Section of Air Quality. While NOx is not considered a substantive contributor to the PM2.5 problem, DEQ included a budget for NOx only because the addition of a second pollutant is not much more of a workload when running the MOVES model and it satisfies all aspects of EPA's requirements identified in 40CFR93.102(b)(2)(iv).

Table 22: Motor Vehicle Emissions Budget Through 2037

Klamath Falls Motor Vehicle $PM_{2.5}$ Emissions Budget
Annual $PM_{2.5}$ Season (tons/yr)

Pollutant	Tons per Year
PM2.5	60.7
NOx	860.6

The transportation emissions budgets were developed based on the Oregon Department of Transportation (ODOT) travel demand model. The budget amount for each year is the projected on-road mobile emissions for each year as calculated in the emission inventory projections. See Appendix 11a. The emissions are based on vehicle miles traveled (VMT) and other criteria from the transportation demand model then modeled by MOVES as identified the emission in Appendix 11a and 11b. The emission inventory projections include transportation projects in the statewide transportation plan that are funded. The projections do not include projects planned but without funding. DEQ's transportation conformity rules and the transportation conformity process can be found in Oregon Administrative Rule 340, Division 240.

Rules Regulations and Commitments

The following rules and commitments have been adopted to assure the enforceability of the control strategies.

State of Oregon Rules

The Oregon Revised Statutes (ORS) 468.020, 468A, and 468.305 authorize the Oregon Environmental Quality Commission to adopt programs necessary to meet and maintain state and federal standards. The mechanisms for implementing these programs are the Oregon Administrative Rules (OAR). Table 27 lists applicable Oregon regulations.

Table 23: Specific air pollution rules applicable to the Klamath Falls nonattainment area are included in Section 4.62 of the Oregon State Implementation Plan

OAR	**Subject**
340-240-0500	Applicability
340-240-0510	Opacity Standard
340-240-0520	Control of Fugitive Emissions
340-240-0530	Requirement for Operation and Maintenance Plans
340-240-0540	Compliance Schedule for Existing Industrial Sources
340-240-0550	Requirements for New Sources When Using Residential Wood Fuel-Fired Device Offsets
340-240-0560	Real and Permanent $PM_{2.5}$ and PM_{10} Offsets
340-240-0570 to 0630	Klamath Falls Nonattainment Area Contingency Measures
340-225-0090	Air Quality Analysis Requirements
340-262-1000	Wood Burning Contingency Measures for $PM_{2.5}$ Nonattainment Areas
340-264-0078 and 0175	Open Burning

Emergency Action Plan Provisions

OAR 340 Division 206 describes Oregon's Emergency Action Plan. The rule is intended to prevent the excessive accumulation of air contaminants during periods of air stagnation which, if unchecked could result in concentrations of pollutants which could cause significant harm to public health. The rules establish criteria for identifying and declaring air pollution episodes below the significant harm level and were adopted pursuant to requirements of the Clean Air Act. The action levels found in the plan were established by the EPA and subsequently by DEQ.

The 24-hour average emergency action levels for $PM_{2.5}$ are as follows: significant harm level of 350 $\mu g/m^3$, emergency level of 280.5 $\mu g/m^3$; warning level of 210.5 $\mu g/m^3$; and alert level of 140.5 $\mu g/m^3$.

The $PM_{2.5}$ levels, coupled with meteorological forecasts for continuing air stagnation, trigger the Emergency Action Plan. $PM_{2.5}$ concentrations have never been measured at the alert, warning, emergency, or significant harm level in the Klamath Falls nonattainment area.

Authority for the Department to regulation air pollution sources during emergency episodes is provided under Oregon Revised Statute Chapter 468, including emissions from woodstoves.

When there is an imminent and substantial endangerment to public health, ORS 468.115 authorizes the Department, at the direction of the Governor, to enforce orders requiring any person to cease and desist actions causing the pollution. State and local police are directed to cooperate in the enforcement of such orders.

Public Involvement and Administrative Requirements

Public Involvement

Development of the Klamath Falls $PM_{2.5}$ attainment plan included several areas of public involvement including a citizen advisory committee, public participation at hearings on proposed industrial source rules, and attendance at hearings conducted by the Klamath County Boards of Commissioners.

Citizen Advisory Committee

DEQ, in collaboration with Klamath County, convened the Klamath Air Quality Advisory Committee to help develop and recommend strategies to bring Klamath Falls back into attainment with the 24-hour $PM_{2.5}$ standard. The committee met in February 2011 and continued to meet for over a year to consider data, community values, and pollution reduction strategies with the highest chance of success in meeting the $PM_{2.5}$ standard. The committee provided recommendations to the Board of Klamath County Commissioners to include emission reduction measures in ordinances and to DEQ to produce an attainment plan for EPA approval.

The Committee membership includes representatives from the following interests:

- Private citizen
- Local Business
- Klamath County Environmental Health Department
- U.S. Fish and Wildlife
- Klamath County Fire District
- Editor – Chimney Sweep News
- Former Klamath County Commissioner
- Former Klamath Falls City Manager
- Former U.S. Forest Service employee
- Physician

Public Notice

Public notice of proposed rule revisions is done through mailing lists by the Department. This is accomplished through notifications sent by electronic mail, notifications published in local newspapers, and through Department press releases.

Public Hearings

A public hearing was held August 21, 2012 in Klamath Falls to receive public testimony on the proposed attainment plan. Briefings on the draft attainment plan were provided to the Klamath Falls City Council and the Klamath County Board of Commissioners.

Intergovernmental Review

Public hearing notices regarding adoption of this revision to the State Implementation Plan will be distributed for public and state agency review prior to adoption by the Environmental Quality Commission.

Administrative Requirements

The criteria that must be satisfied for a nonattainment area to be redesignated to attainment include several administrative requirements related to compliance with Clean Air Act provisions. Each of these elements is described below.

State Implementation Plan Requirements

The Klamath Falls $PM_{2.5}$ Attainment Plan meets all state implementation requirements specified in Section 110 and Part D of the Clean Air Act. In summary, Section 110 requires that the state submit a plan that becomes part of the SIP, and provides for the implementation, attainment, and enforcement of an air quality standard. Part D of the Clean Air Act outlines specific plan requirements for nonattainment areas.

Approved State Implementation Plan

The 2012 Klamath Falls $PM_{2.5}$ attainment plan contains emission reduction and emission growth management strategies needed to achieve and maintain compliance with the $PM_{2.5}$ standards. The $PM_{2.5}$ plan has been adopted as a revision to the State of Oregon Clean Air Act Implementation Plan (SIP).

1990 Clean Air Act Requirements and Status

The Klamath Falls Nonattainment Area has met the requirements for $PM_{2.5}$ nonattainment areas included in the 1990 Clean Air Act Amendments. The area successfully met the applicable Clean Air Act attainment deadline of December 14, 2012.

Monitoring Network and Commitments

DEQ is responsible for the operation of the permanent ambient $PM_{2.5}$ monitor in the Klamath Falls nonattainment area. DEQ oversees the quality control and quality assurance program for the $PM_{2.5}$ data. DEQ will continue to comply with the air monitoring requirements of Title III, Section 319, of the Clean Air Act. The monitoring site will also continue to be operated in compliance with EPA monitoring guidelines set forth in 40 CFR Part 58. "Ambient Air Quality Surveillance" and Appendices A through G of Part 58. In addition, DEQ will continue to comply with the "Ambient Air Quality Monitoring Program" specified in Volume 2, Section 6 of the SIP. Further, DEQ will continue to operate and maintain the network of state and local air monitoring stations and national air monitoring stations in accordance with the terms of the State/EPA Agreement.

DEQ in consultation with EPA will also periodically conduct saturation studies to verify that existing monitors are recording the appropriate $PM_{2.5}$ concentrations in the area. DEQ will commit to conducting a re-evaluation survey in the event of major changes that may impact $PM_{2.5}$ emissions as practicable after identifying any such changes. Based on $PM_{2.5}$ monitoring data and other considerations such as special project funding availability, DEQ in consultation with EPA may reach agreement that the periodic survey is unnecessary, or should be delayed.

Verification of Continued Compliance

DEQ will analyze on an annual basis the $PM_{2.5}$ air quality monitoring data to verify continued attainment of the $PM_{2.5}$ standard, in accordance with 40 CFR Part 50 and EPA's redesignation guidance. This data, along with the previous year's data, will provide the necessary information for determining whether the Klamath Falls nonattainment area continues to comply with the National Ambient Air Quality Standards for $PM_{2.5}$.

The Clean Air Act requires the state to submit a maintenance plan eight years after the redesignation request is approved by EPA. The revision will provide for continued attainment of standards for an additional ten years following the first ten-year period.

For the interim period between EPA approval of this plan and the required plan update, DEQ will rely on ambient monitoring data to track progress of the attainment plan. Growth projections for Klamath Falls are modest. As long as ambient monitoring data can show a downward trend in concentration, a mid-term emission inventory update or emissions tracking program will not be necessary. If $PM_{2.5}$ concentrations increase over current levels, then an evaluation of growth and other planning assumptions will be necessary.

If Phase 1 of the contingency plan is triggered, DEQ will prepare an analysis of future growth factors to determine if planning assumptions have changed. The analysis will include a review of emission factors, growth rate assumptions, traffic data, and other significant assumptions used to develop the attainment plan. If there are significant changes, DEQ will consult with EPA to determine if a more extensive periodic emission inventory update, or other action, is warranted.

Attainment Plan Commitments

As part of the $PM_{2.5}$ Attainment Plan, DEQ commits to evaluate growth and other planning assumptions if $PM_{2.5}$ concentrations significantly increase over current levels.

Recognition and Acknowledgments

In Memory

This plan is dedicated to Rosemary Bell of Klamath Falls. She enjoyed quilting, sewing, camping and spending time with family and friends. She is survived by her husband and three children, Jennifer, Brian and Michael.

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