



City of Oakridge
Smoke Safety Plan

Oakridge Smoke Sensitive
Receptor Area

May 2021



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Acronyms

COPD	Chronic Obstructive Pulmonary Disease
DEQ	Oregon Department of Environmental Quality
DSPG	Data Science for Public Good
EPA	Environmental Protection Agency
EQC	Oregon Environmental Quality Commission
HEPA	High-Efficiency Particulate Air
HWH	Home Wood Heating
LRAPA	Lane Regional Air Protection Agency
NAAQS	National Ambient Air Quality Standards
OAR	Oregon Administrative Rule
ODF	Oregon Department of Forestry
OSU	Oregon State University
PM _{2.5}	Particulate Matter (2.5 micrometers or smaller)
SIP	State Implementation Plan
SMP	Smoke Management Plan
SPZ	Special Protection Zone
SSP	Smoke Safety Plan
SSRA	Smoke Sensitive Receptor Area
SWFC	Southern Willamette Forest Collaborative
TAG	Targeted Airshed Grant
UGB	Urban Growth Boundary
WUI	Wildland-Urban Interface

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I. Executive Summary

The City of Oakridge, in coordination with the Lane Regional Air Protection Agency (LRAPA), has developed the following Smoke Safety Plan (SSP) for the Oakridge Smoke Sensitive Receptor Area (hereafter referred to as the Oakridge SSRA SSP) consistent with OAR 629-048-0180.

Goal 1: Smoke Intrusion Exemption

The primary goal of this project is for the Smoke Safety Plan to assist with an eventual request to the Oregon Department of Forestry (ODF) and Oregon Department of Environmental Quality (DEQ) for an exemption from the 1-hour smoke intrusion threshold in accordance with the 2019 Oregon prescribed fire Smoke Management Plan (SMP). The SSP will enhance coordination, communication, and notification of residents and visitors of Oakridge and Westfir about planned prescribed fire, wildfire and winter time smoke events, potential smoke and air quality impacts, and recommendations to reduce exposure and mitigate the health impacts of smoke from all sources. Moreover, an exemption from the smoke intrusion threshold will increase opportunities to accomplish critical prescribed fire treatments in the wildland-urban interface (WUI) to improve forest health, reduce the risk of extreme wildfires, and increase community and firefighter safety when wildfires do occur.

Goal 2: A Plan for the Community

The secondary goal of this project is to convene a local group of stakeholders collectively known as the Oakridge Air partners to craft a shared strategy to provide year round smoke messaging and mitigations to protect smoke-vulnerable populations in the Oakridge-Westfir area. This plan combines multiple agency and partner efforts in one place for the community.

The outcome and deliverables of this project include a shared community outreach platform, key messages, and coordination for how to disseminate information regarding fire, smoke, and public health impacts. Central to the strategy is the new Oakridge Air brand and website www.oakridgeair.org, which serves as the leading voice and a "one-stop-shop" for all information on prescribed fire, wildfire, and wintertime smoke and related public health impacts.

II. Partners and Background

Oakridge Air

A sense of wellbeing, healthy environment, and high quality of life are reasons why people choose to live in and visit Oakridge, Oregon. Yet, for the last three decades, the health of residents in Oakridge has been compromised due to poor air quality from high concentrations of particulate matter (PM_{2.5}) from home wood heating smoke and wildfire smoke. The local climate and topography make the Oakridge area prone to inversions caused by stagnant air, low wind speeds, and poor atmospheric dispersion. Inversions, where cooler air pockets sit low in the valley for extended periods in the winter months, may trap wintertime smoke from uncertified wood stoves and improper burning techniques. Summertime wildfire smoke is also trapped in the valleys due to stagnant air or excessive wildfire smoke in the area.

Particulate matter is measured by its size in micrometers. “PM_{2.5}” is particulate matter that is less than 2.5 micrometers. The concentration of PM_{2.5} is measured in terms of micrograms (µg) per cubic meter (m³) of air.

At this size, particulates are small enough that people can inhale them, which can cause respiratory and health hazards by entering into the lungs and penetrating the body’s circulatory system.

The City of Oakridge and community stakeholders have worked together the past two decades to improve air quality and meet the Environmental Protection Agency (EPA) PM_{2.5} threshold. In 2020, the EPA awarded a \$4.9 million Targeted Airshed Grant (TAG) to LRAPA on behalf of the City of Oakridge. This grant provided funding to formally launch Oakridge Air, a project that will span five years between 2019 and 2024 to establish the infrastructure and programs that sustain smoke reductions into the future. The Oakridge Air program is designed with the expressed goal to permanently reduce and sustain the average 24-hour PM_{2.5} concentration to be below 30 µg/m³. After 2024, the Oakridge Air website and communications will be managed by the City of Oakridge and LRAPA.

Developing the Oakridge Smoke Safety Plan

The City of Oakridge, LRAPA, and Oakridge Air partners developed the Oakridge Smoke Safety Plan with assistance from DEQ. The SSP was developed in accordance

with the 2019 smoke management rule, adopted by the Oregon Board of Forestry and Oregon Environmental Quality Commission, which adjusted the thresholds for community smoke impacts.

The following community partners met regularly to develop the SSP from June 2020 to March 2021.

City of Oakridge	Orchid Health
City of Westfir	Oregon Department of Environmental Quality
Good Company	Oregon Department of Forestry
Hazeldell Rural Fire District	Oregon State University
Lane Council of Governments	Saint Vincent De Paul
Lane County	Southern Willamette Forest Collaborative
Lane County Public Health	Sustainable Northwest
Lane Regional Air Protection Agency	Umpqua National Forest
Oakridge Air	University of Oregon
Oakridge Fire Dept.	Willamette National Forest
Oakridge School District	Willamette National Forest, Middle Fork Ranger District
Oakridge Volunteer Fire Department	

Table 1: Oakridge Air partners

Smoke and Prescribed Fire

Healthy, resilient forests and communities are critical to resist catastrophic wildfire and climate change. Research consistently shows that prescribed fire, when used in conjunction with mechanical thinning and applied across the landscape, can significantly reduce the intensity and severity of future wildfire across the western United States.

Oakridge is one of only a few communities completely surrounded by National Forest. The Lane County Community Wildfire Protection Plan (CWPP) designates Oakridge as a WUI with high wildfire risk. Figure 1 (below) shows the severity of risk surrounding Oakridge.

Oakridge Smoke Sensitive Receptor Area

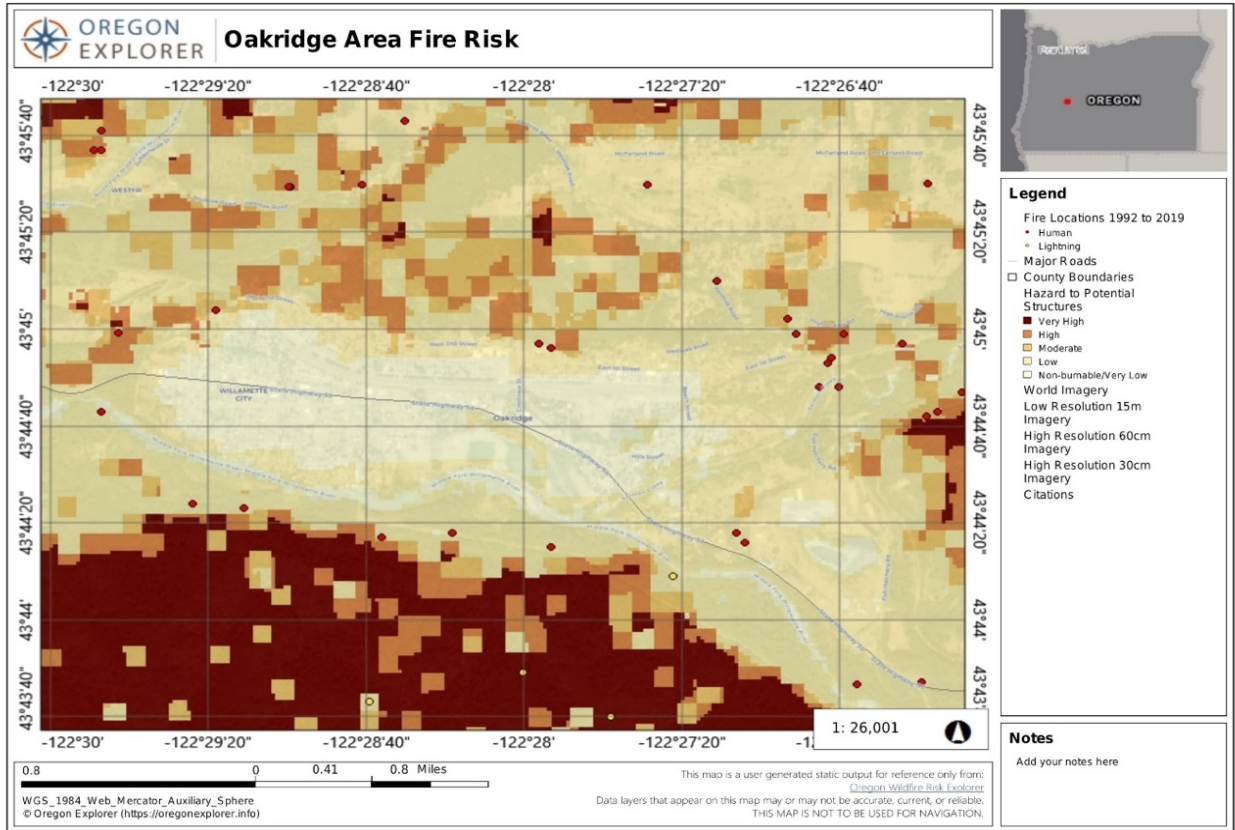


Figure 1: Map showing Oakridge fire risk (Source: Oregon Explorer)

Under the previous smoke management guidelines, prescribed burns were allowed only when conditions were not expected to result in any community smoke impacts. Land managers surrounding Oakridge were severely limited in the number of days that prescribed fire was permissible, anecdotally about five to six days a year, creating a growing backlog of untreated acres.

To reduce risk of a catastrophic, large wildfire in the Oakridge-Westfir area, the Willamette National Forest’s Middle Fork Ranger District worked cooperatively with the City of Oakridge, Emergency Services Department, the Hazeldell Rural Fire Protection District, the City of Westfir, and ODF to design and implement a thinning and fuels reduction project on the Forest Service lands surrounding the communities. The main objective of this project was to reduce long-term potential fire behavior in the WUI of Oakridge and Westfir. Treatments conducted as part of this project include commercial thinning, non-commercial understory thinning, and prescribed fire. Since 2010, approximately 2,000 acres have been completed, and hundreds of acres of prescribed fire activities are still underway.

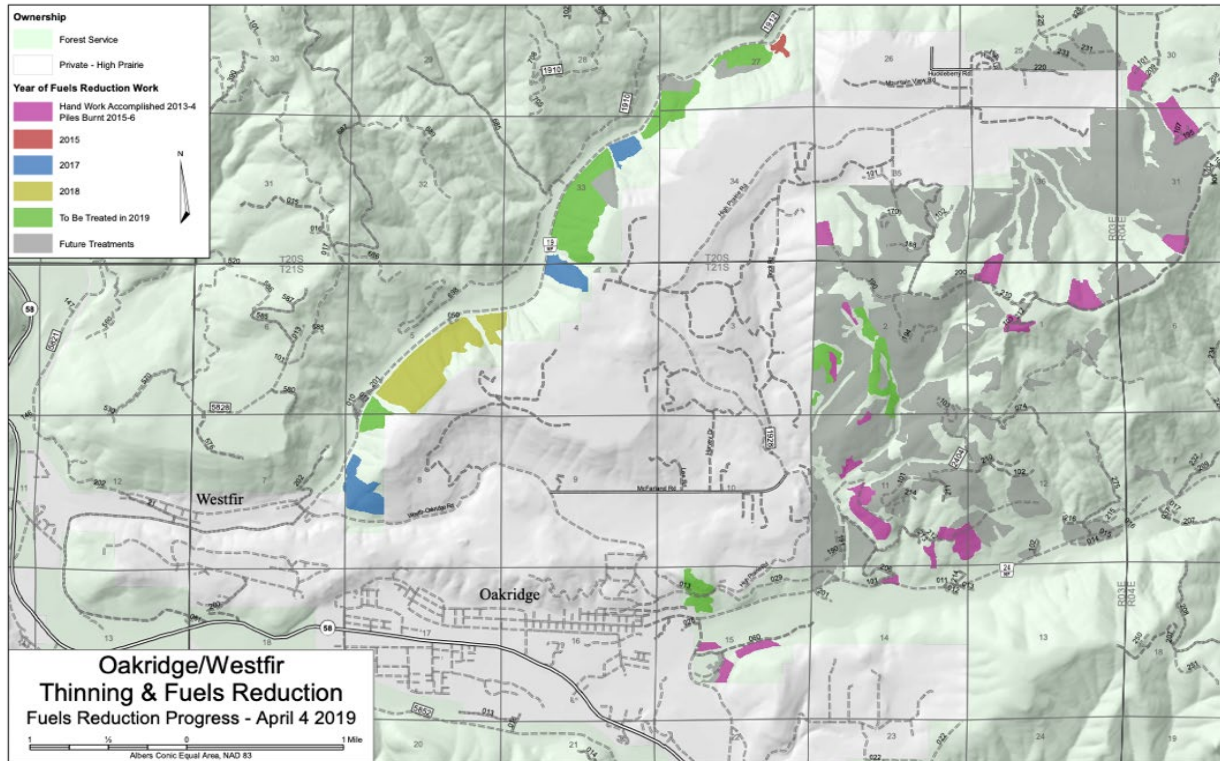


Figure 2: Map of Oakridge-Westfir Thinning and Fuels Reduction projects

State-Required Components of Community Response Plans

As the 2019 Oregon prescribed fire SMP states, ODF and DEQ "recommend communities that are SSRAs and have experienced repeated smoke incidents and/or intrusions in the past collaboratively develop a [Smoke Safety Plan]¹ and program." Within the SMP, OAR 629-048-0180, Section 2 spells out the following required components of such a plan:

1. A description of populations in an SSRA community that are vulnerable to the health effects of short-term smoke
2. Adequate means by which the public, especially vulnerable populations in the SSRA community, will be notified in a clear and reliable way of anticipated smoke impacts in a timely manner

¹ The SMP refers to this type of report as a "Community Response Plan." Oakridge Air calls its Community Response Plan a "Smoke Safety Plan" to specify the types of events for which this information is intended. In particular, the "Smoke Safety Plan" terminology clarifies that this is not a community response plan for all types of emergencies and does not include response information for non-smoke wildfire impacts, winter storms, or other events that are likely to affect the Oakridge-Westfir area.

Oakridge Smoke Sensitive Receptor Area

3. Adequate options for protecting the health of vulnerable populations (or helping such populations to protect themselves) from short-term exposure to smoke
4. A plan and program for communications between the entities that conduct prescribed fire, the local public health authority, and the community's public and vulnerable populations who may be impacted by smoke

Per the 2019 SMP, once Oakridge is in “attainment” for PM_{2.5}, the Oakridge SSRA can be eligible for an exemption from the 1-hour prescribed fire smoke intrusion threshold if the public is adequately notified and a community response plan is in place. This policy change is intended to expand opportunities for prescribed burning and, over time, reduce the risk of catastrophic wildfires and their severe and widespread smoke impacts.

III. Air Quality and Smoke

Clean, breathable air is essential to the health and enjoyment of Oakridge residents and visitors. Knowing what impacts clean air is key to prevention. Three types of smoke are common in the Oakridge area: wood stove smoke, wildfire, and prescribed fire. Wood stove smoke from home heating arises in the wintertime, whereas wildfire is the primary concern in the summertime. Prescribed fire smoke rarely impacts the airshed, but the frequency of prescribed fire has declined as smoke regulations have increased.

A “Red Advisory” is issued when predicted PM levels for the upcoming 24-hour period, beginning at 16:00 hours meet the following criteria. PM₁₀ levels are forecast by LRAPA to be $\geq 125 \mu\text{g}/\text{m}^3$, or when PM_{2.5} levels are forecast by LRAPA to be $\geq 25 \mu\text{g}/\text{m}^3$.

Source: City of Oakridge Ordinance No. 920

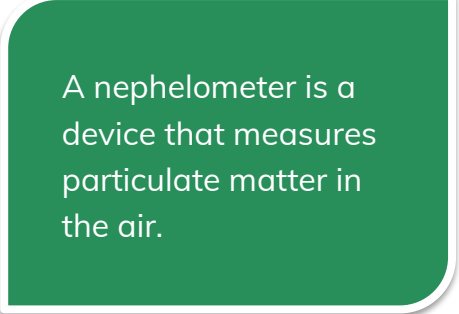
Home Wood Heating Woodsmoke

Many homes in Oakridge use wood as the sole, primary, or secondary heat source. As a result, home wood heating has been the major contributor to the historical PM_{2.5} air pollution, especially on stagnant winter days when temperature inversions form over the small valley.

An inversion means a warm air layer traps polluted air. These inversion layers and the correlated poor air quality led to Yellow and Red Day designations issued by LRAPA's Home Wood Heating (HWH) advisory program (<https://www.lrapa.org/181/Home-Wood-Heating-Program>). On Yellow Days, voluntary curtailment of home wood heating is requested. On Red Days home wood heating is banned to maintain PM_{2.5} below the EPA threshold. On average, Oakridge will have 13 Yellow and six Red Day designations a HWH season.

Prescribed Fire Smoke

Prescribed fire is an important tool to reduce the community risk of wildfire. Prescribed burns in the area surrounding the Oakridge-Westfir SSRA rarely cause smoke impacts to residents. Detailed analysis of air quality data from the Oakridge nephelometer did not find smoke impacts from prescribed fire from 2015-2019. Prescribed fire is a key tool in restoring forest health, and a major goal of this plan is to provide opportunities for more prescribed fire.



A nephelometer is a device that measures particulate matter in the air.

Wildfire Smoke

In recent years, wildfire has been a primary contributor to the poorest air quality in the Oakridge-Westfir SSRA throughout the entire year. Wildfire smoke is now the largest PM_{2.5} source, and undoubtedly impacting the health and wellbeing of the community. Wildfires are unpredictable, but the frequency and severity of wildfires on the Willamette National Forest has increased in the past two decades. The effects of climate change are anticipated to continue this trend.

Oakridge “Nonattainment Area” for 24-hour PM_{2.5} Standard

The federal Clean Air Act requires the U.S. EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health. Areas in violation of either of the PM_{2.5} standards² (based on the most recent three years of federal reference monitoring data) are designated as “nonattainment areas” by the EPA. Oakridge was designated

² EPA adopted a 35 µg/m³ 24-hour PM_{2.5} standard in 2006 and a 12 µg/m³ annual PM_{2.5} standard in 2012.

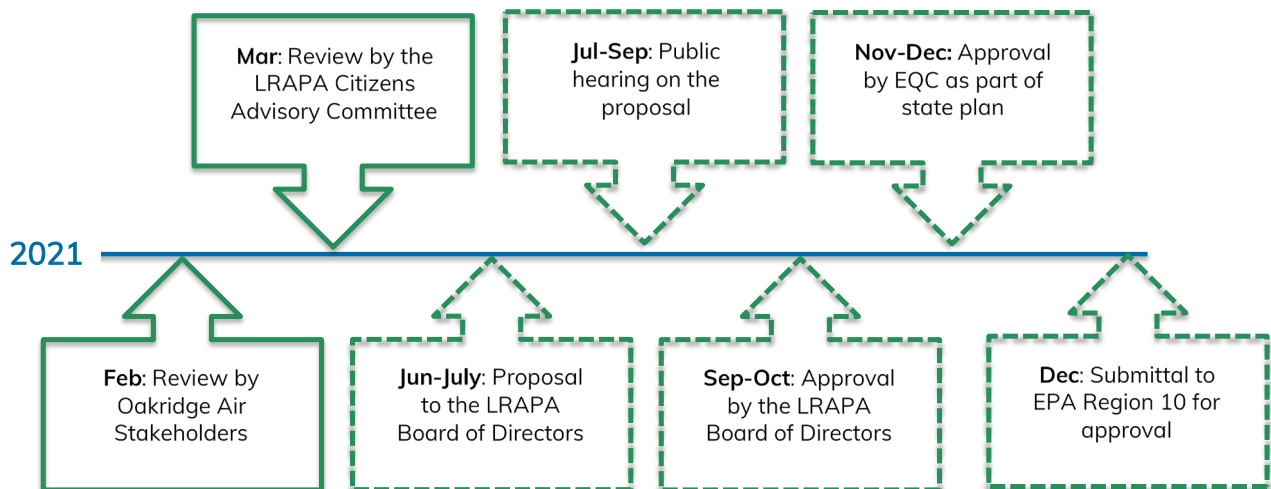
Oakridge Smoke Sensitive Receptor Area

as a nonattainment area for the daily PM_{2.5} standard in 2009 based on a comparison of Oakridge data from 2006-2008 with the 2006 standard of 35 µg/m³.

In response, LRAPA, the City of Oakridge, and other stakeholders developed the [Oakridge 2016 PM_{2.5} Attainment Plan](http://www.lrapa.org/DocumentCenter/View/2108/Updated-Oakridge-Westfir-PM25-Attainment-Plan-EQC?bidId=) (“2016 Plan” available at <http://www.lrapa.org/DocumentCenter/View/2108/Updated-Oakridge-Westfir-PM25-Attainment-Plan-EQC?bidId=>) to bring air quality in Oakridge into compliance with the standard by December 31, 2016. The 2016 Plan was adopted by the LRAPA Board of Directors on November 10, 2016 and approved and incorporated into the State of Oregon Clean Act Implementation Plan, referred to as the State Implementation Plan (SIP), by the Oregon Environmental Quality Commission (EQC) on January 18, 2017.

As of the writing of this report, the Oakridge-Westfir airshed remains in nonattainment (<https://www3.epa.gov/airquality/greenbook/rbtc.html>). LRAPA is in the process of finalizing a “Redesignation request” and “Maintenance Plan” for PM_{2.5} as well as PM₁₀ to submit to EPA, which is outlined below.

Once EPA approves the request, Oakridge will be in attainment and enter the “maintenance” phase. This is a phase of two, 10-year maintenance plans that LRAPA and the City of Oakridge will follow to assure Oakridge remains in “attainment.” After the first 10-year maintenance plan, LRAPA will submit a second 10-year maintenance plan. This 20-year clock begins with EPA approval of Oakridge’s “attainment.”



The above timetable is approximate and specific to Oakridge-Westfir PM_{2.5} Redesignation Request and PM_{2.5} Maintenance Plan for 2015-2035. A PM₁₀ Redesignation Request and PM₁₀ Maintenance Plan will move near-consecutively with PM_{2.5} plan through this process.

Oakridge Smoke Sensitive Receptor Area and Special Protection Zone

A Smoke Sensitive Receptor Area (SSRA) is a designated area provided the highest level of protection under the Oregon Smoke Management Plan. This designation is determined per past history of smoke incidents, density of population, or other special legal status. The Oakridge SSRA, shown in Figure 5, remains the Oakridge Urban Growth Boundary (UGB) as listed in Oregon Administrative Rules [629-048-0140](#).

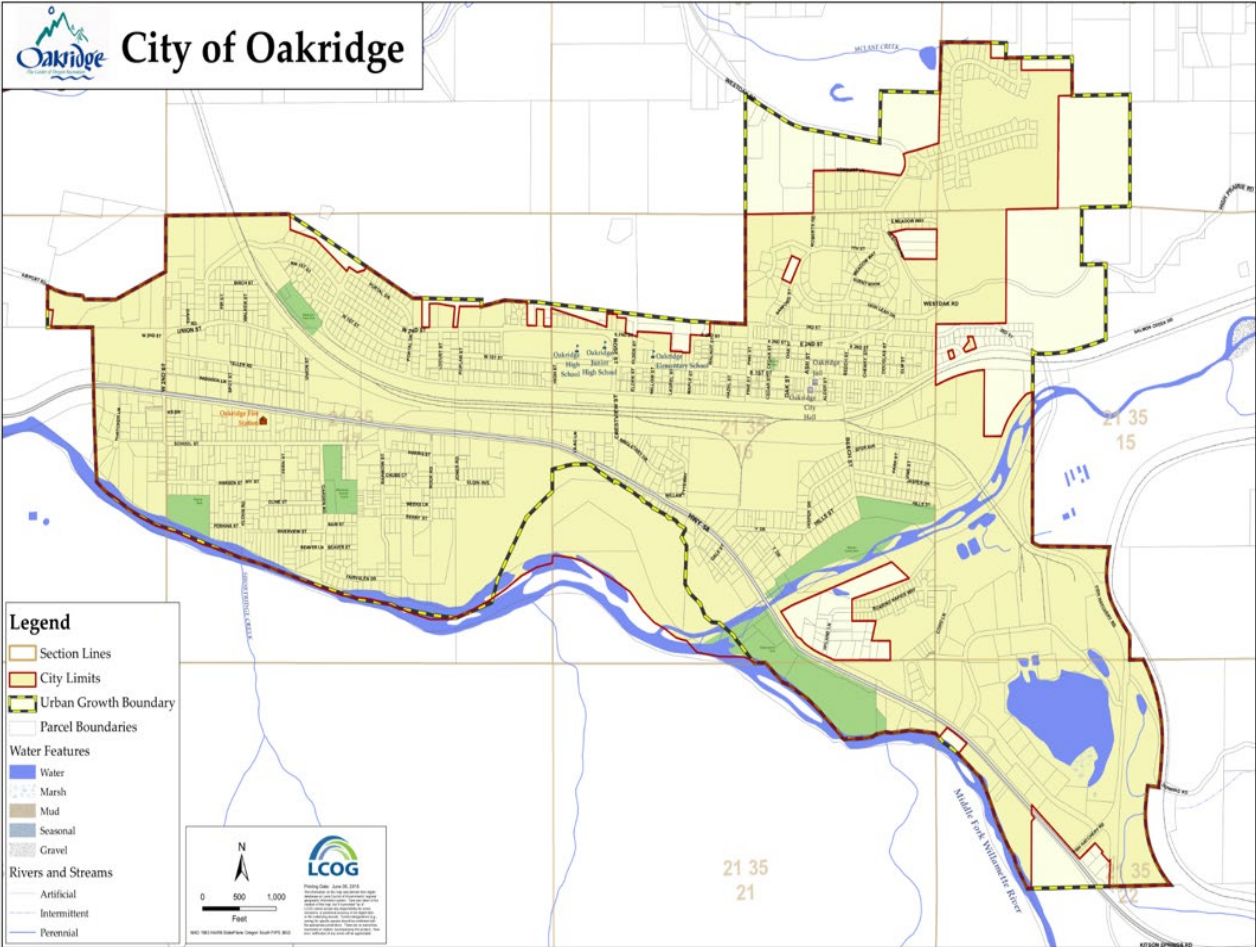


Figure 3: Oakridge SSRA boundary

Oakridge Smoke Sensitive Receptor Area

Special Protection Zones (SPZ) have been established by the State around certain communities requiring additional protection from particulates. Any prescribed fire in an SPZ, during its protection period, must have the approval of the State meteorologist. Specific control strategy restrictions for these areas adopted by the Department of Environmental Quality (DEQ) and Oregon Department of Forestry (ODF) are found in OAR 629-048-0135 and OAR 629-048-0137. The Oakridge SPZ is shown in Figure 5.

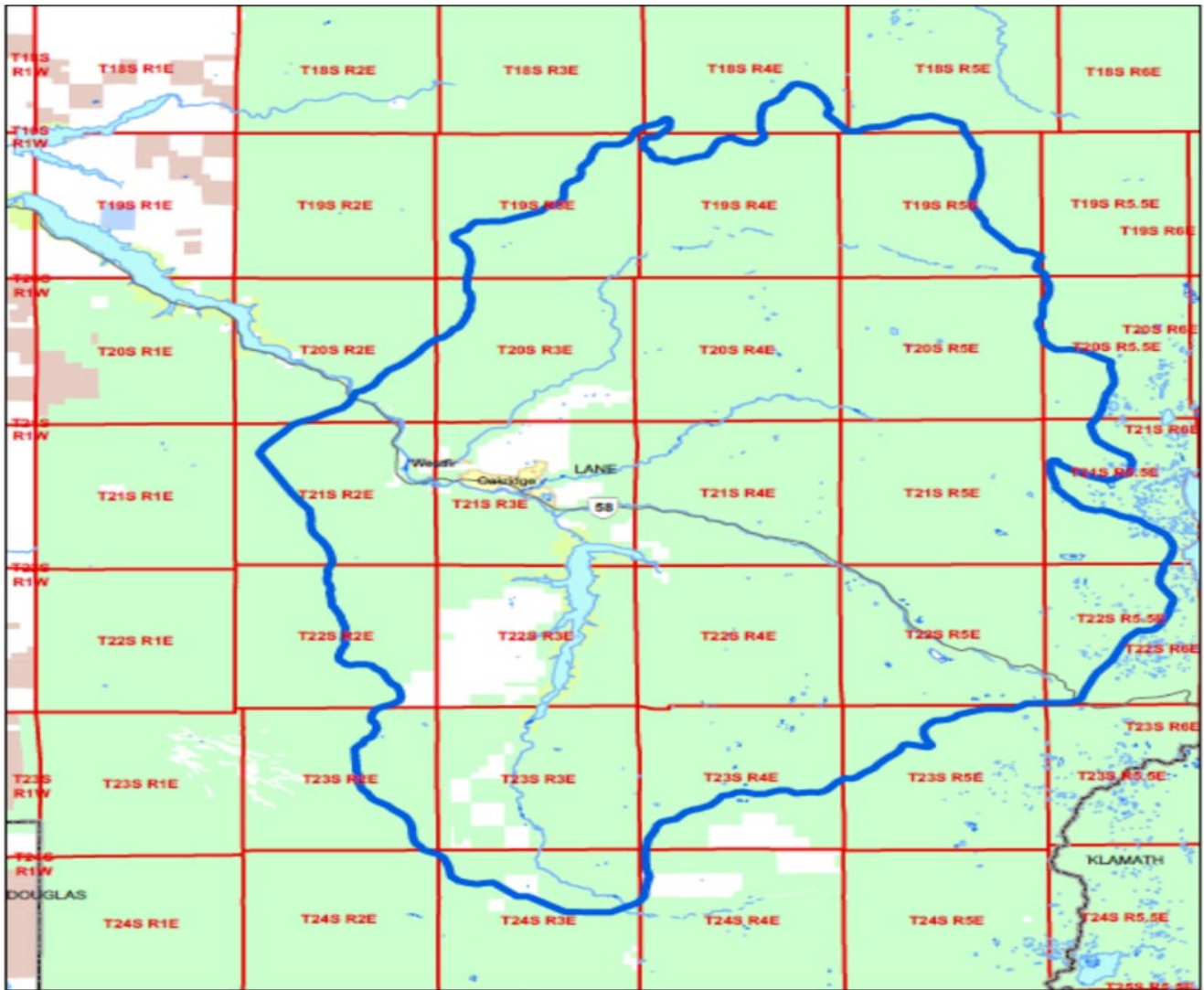


Figure 4: Map of Oakridge Special Protection Zone (Source: Oregon Smoke Management Program Directive, p. 43)

IV. Smoke, Health and Safety

Health Effects of Smoke

Smoke vapors contain particulate matter and gas droplets that may be dangerous if inhaled. People with chronic heart disease or lung disease, such as asthma or chronic obstructive pulmonary disease (COPD), or those with or recovering from COVID-19, who have compromised health/lung function, may be more likely to experience serious health complications from smoke. PM_{2.5} is specifically linked to both respiratory and cardiac diseases, whereas PM₁₀ is more commonly linked to respiratory diseases.

Symptoms of short-term smoke exposure can include:

- Watery or dry eyes
- Persistent cough, phlegm, wheeze, scratchy throat, or irritated sinuses
- Headaches
- Shortness of breath, asthma attack, or lung irritation
- Irregular heartbeat, chest pain, or fatigue
- Heart attack

The following diseases are the common health impacts lined to smoke:

Respiratory Diseases: Acute bronchitis, asthma, COPD, pneumonia, upper respiratory infection

Cardiovascular Diseases: Arrhythmia, heart attack, cardiac arrest, deep vein thrombosis, heart failure, hypertension, ischemic heart disease, peripheral vascular disease, pulmonary embolism

Cerebrovascular Diseases: stroke

Smoke-Vulnerable Populations

Many factors influence a person's sensitivity to smoke, including severity and duration of smoke exposure and a person's health. Smoke may worsen symptoms for people who have pre-existing health conditions and those who are particularly sensitive to air pollution. These smoke-vulnerable populations include:

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- Persons with asthma or other chronic respiratory diseases, such as COPD and emphysema
- Persons with cardiovascular disease
- Persons 65 years of age or older
- Infants and children
- Pregnant women
- Smokers, especially those who have smoked for several years
- Persons without housing or access to closed-loop air conditioning

Oakridge-Westfir social and economic demographics

- Community members below poverty level (2017):
 - All families, 25.0%,
 - All people 34.5%,
 - Under 18 years 82.7%,
 - 65 years and over 16.8%.
- Number of veterans 15.1%³
- 26.6% of the population has a disability⁴
- Infants and children under the age of 15: 15.5% of the population⁵
- Adult smokers 18.5% of population⁶
 - 26.5% of 11th graders used e-cigarettes in 2019

Data Analysis of Air Quality Impacts to Public Health

Given the long-term exposure to smoke after decades of being out of attainment for PM_{2.5} standards, Oakridge Air partners are attempting to better understand the connection between smoke exposure and health visits (all medical claims and pharmaceuticals) associated with respiratory and cardiac issues to better serve the community. As part of the Smoke Safety Plan development, Oakridge received data analysis support from Lane Council of Governments (LCOG) and the Data Science for Public Good (DSPG) program at Oregon State University (OSU).

Health Claims Data Analysis

LGOG analyzed five years of LRAPA nephelometer data and Oregon Health Authority (OHA) Oregon All Payer All Claims Reporting Program (APAC) data to investigate the following questions:

³ Source: Census, 2019

⁴ Ibid

⁵ Ibid

⁶ Source: Lane County, 2017

Since 2015, how have public health impacts (overall claims and pharmaceuticals for select respiratory/cardiac issues) been impacted by PM_{2.5} exposure from winter woodsmoke in the Oakridge/Westfir airshed using LRAPA data? How have these claims and pharmaceutical counts shifted following significant wildfire events?

Overall, the analysis showed a significant correlation between PM_{2.5} and health claims. The total APAC claims and the number of claims per person significantly increased in both the winter and summer when PM_{2.5} concentrations were above a yellow threshold (>20ug/m³). The cost of treatment (visits/pharmaceuticals), number of visits, and claims per person were all increased when air quality was above the yellow and red thresholds. There is a higher significance connecting increases in visits and claims following significant wildfire events.

The same results repeat in both Oakridge and diagnosis and pharmacy data. There is strong evidence in the LRAPA and APAC data to support that PM_{2.5}, particularly during summertime wildfire seasons, negatively impacts public health. The public is very likely more susceptible to both cardiovascular and respiratory diseases with a longer period of yellow-warning outdoor air quality.

DSPG Study

DSPG researchers analyzed five years of Oakridge nephelometer data prescription compared to data from the Oakridge Postal Pharmacy. Through this analysis, DSPG researchers determined that there are, on average, six days a year when the daily PM_{2.5} concentration is above the EPA threshold of 35 µg/m³. Additionally, data showed that around a quarter of the prescriptions filled (24%) between 2015 and 2019 were prescriptions specifically used to treat smoke-related cardiac and respiratory conditions.

DSPG found that around a quarter of the prescriptions filled (24%) between 2015 and 2019 were prescriptions specifically used to treat smoke-related cardiac and respiratory conditions.

Important takeaways from DSPG analysis show that there was a 3% increase in prescription counts within 30 days of a smoke event for every 10 µg/m³ increase in

Oakridge Smoke Sensitive Receptor Area

daily average $PM_{2.5}$ concentration. This means if average daily $PM_{2.5}$ concentration is at $50 \mu\text{g}/\text{m}^3$, then 30 days later, there would be a 15% increase in prescription fills.

Moreover, when poor air quality will affect the community can depend on the season. DSPG researchers found that the average air quality patterns throughout the day vary based on the season and related source of smoke. Figure 5 below demonstrates the hourly, seasonal $PM_{2.5}$ concentration pattern averaged from 2015 to 2019.

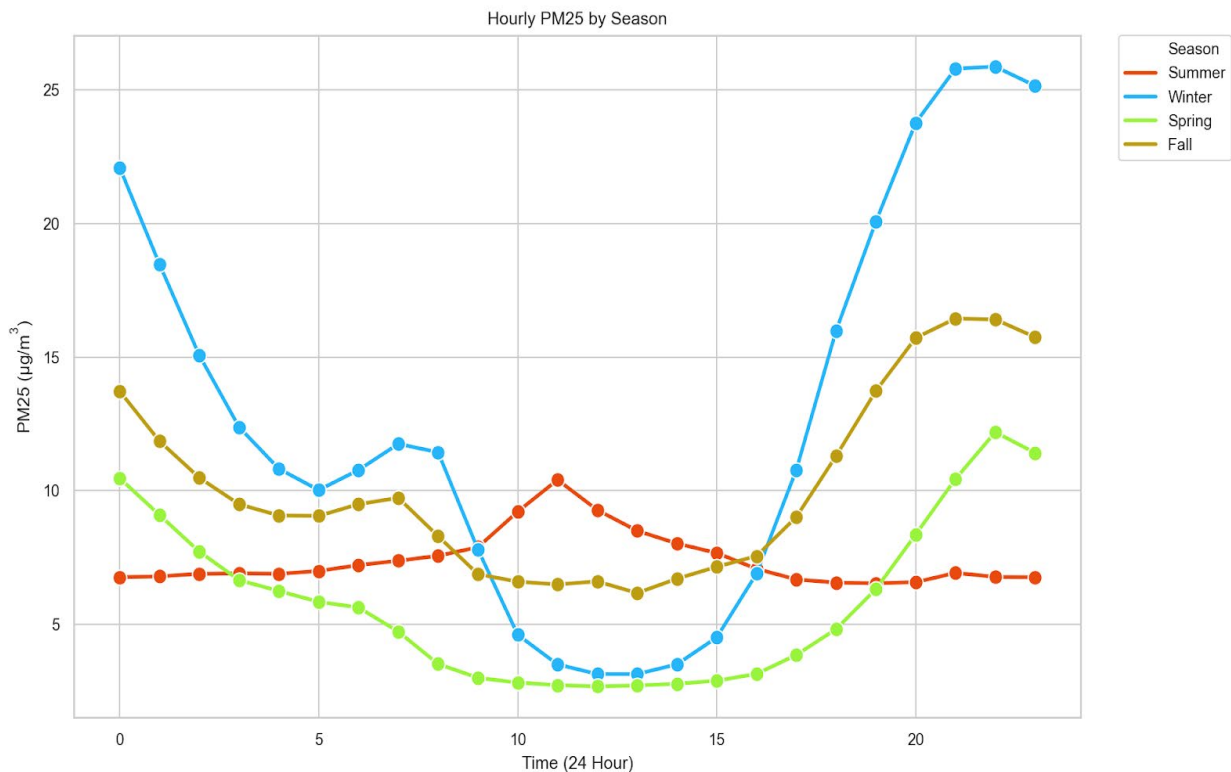


Figure 5: Graph of hourly $PM_{2.5}$ by season

* It is important to note that when averaged, the $PM_{2.5}$ concentrations are not outside the “healthy” range.

Staying safe inside between 10pm and 10am on Red Days is important to avoiding the effects of poor air quality.

The largest spikes in smoke pollution occurred in the winter around 22:00 (10:00 pm), with the concentration dropping by 10:00 (10:00 am). A 10:00 pm spike is consistent throughout spring and fall, when you would expect people are home, burning wood for heat. In the summer, there is a noticeable spike in smoke pollution around 10:00

am, which correlates to diurnal weather patterns. Wildfire smoke tends to settle in valleys overnight as temperatures cool and lift in the morning when warming rise and cause increased atmospheric instability.

For more in-depth details about the data analysis of Oakridge smoke impacts to community health see Appendix D.

V. Smoke Safety Plan Communications

In developing the SSP, the Oakridge Air partners identified different smoke-related events, seasonal timeline, and communications best practices for the Oakridge-Westfir SSRA. The scope of discussions included methods for coordinating and communicating messages in a way that builds credibility and trust with the entire community. Because there are multiple agencies and partners that communicate with the community about smoke, the group determined early on that it would be best to partner under one umbrella brand, Oakridge Air, to engage with the community about smoke and health.

Oakridge Air has two primary streams of communication to the public:

- 1) general seasonal educational information about smoke and health
- 2) specific messages about smoke events

Seasonal educational information will repeat in seasonal cycles:

- **Wintertime smoke** season - how to burn wood safely and ways to avoid yellow and red home wood heating advisory days
- **Prescribed fire smoke** season - when to expect land managers and the public to engage in fuels reduction and ecological burning
- **Wildfire smoke season** - how to reduce the risk of wildfire smoke and Firewise activities at both the community and individual levels

Specific smoke event messages are shared in preparation for planned events that may bring smoke to the community or in response to unplanned events:

- Wintertime inversions that cause degraded air quality and lead to yellow or red home wood heating advisories
- Prescribed fires scheduled by Forest Service or private land managers and smoke impacts
- Wildfires and wildfire smoke impacts

Internal Communication Methods

The Oakridge Air partners follow the communications processes and methods outlined in the internal *Oakridge Air Outreach and Engagement Plan*. Oakridge Air Communications Committee meetings are held monthly and are open to all partners to plan seasonal smoke messaging and community events. For internal coordination regarding specific smoke events, key partners are notified through an email distribution list.

One shared email address, smoke@oakridgeair.org, auto-forwards emails to the following key partners: City of Oakridge, Forest Service, LRAPA, the Southern Willamette Forest Collaborative (SWFC), Oakridge Air, and ODF. Partners have access to a shared database of smoke and health safety public outreach materials that are distributed to the community via flyers, news media, Oakridge Air and City of Oakridge websites, and social media. Public messages are typically branded under the Oakridge Air brand and are then amplified by all partners' regular outreach methods.

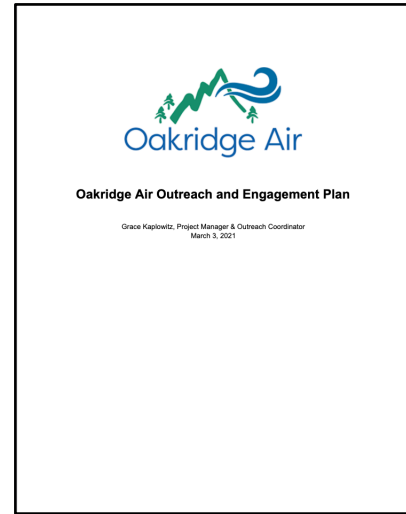


Figure 6: Cover Page of Oakridge Air Outreach and Engagement Plan

PRESCRIBED FIRE COMMUNICATIONS TEMPLATES


PROJECT TITLE	Oakridge Air Communications Committee	ORGANIZATION							
DATE		May 2021							
CAMPAIGN TYPE	1. PRE-EVENT COMMUNICATIONS			2. EVENT COMMUNICATIONS			3. POST EVENT COM		
	Start to prescribed burn season	Pile burning planned	Understory burning planned	Planned prescribed burns 3-10 days	Planned burns 1-3 days out	Planned burns today	Burns went as planned	Burns did not planned/ sm	
Press Releases	Details here	1A_PR	1B_PR	1C_PR	2A_PR	2B_PR	2C_PR	3A_PR	3B_PR
Email									
Blog/Newsletter	Details here	1A_Blog	1B_Blog	see 1B	2A_Blog	2B_Blog	2C_Blog	3A_Blog	3B_Blog
Online									
Social Media/Website	Oakridgeair.org	1A.i_SM	1B_SM	1C_SM	2A_SM	2B_SM	2C_SM	3A_SM	3B_SM
	Oakridge Air Facebook								
		1A.ii_SM							

Figure 7: Screen capture of Oakridge Air smoke messaging template

Internal coordination process for smoke events:

Wintertime smoke alerts and home wood heating bans: LRAPA emails the smoke@oakridgeair.org distribution list and can directly implement Oakridge Air communications processes. Oakridge Air partners help to distribute through communications channels.

Wildfire smoke: LRAPA participates in the statewide Oregon Severe Smoke Response calls and shares relevant information to the distribution list. The Forest Service has included smoke@oakridgeair.org as an important contact in the forest briefing package to be shared with any incoming wildfire incident management teams.⁷ Oakridge Air partners help to distribute through communications channels.

Prescribed fire smoke: Prescribed fire is the most difficult to coordinate due to multiple jurisdictions and possible impacts from backyard burning and private burning on non-ODF administered lands. The Forest Service and ODF fire management include the smoke distribution list, smoke@oakridgeair.org, in any relevant communications for prescribed fire as outlined in the flow chart in Appendix A. Oakridge Air partners help to distribute through multiple communications channels.

Public Communication Methods

Oakridge Air provides information through a range of media including online, print, and word of mouth. Regional media outlets such as the Register Guard newspaper, television news stations, and KLCC radio station rarely pick up Oakridge-specific news. The local Oakridge newspaper closed in 2020, and was quickly replaced by the online newspaper, the Highway 58 Herald. Facebook is the preferred method of informal information sharing, with dozens of community-specific groups. While social media information sharing is increasingly popular, print methods of outreach and word of mouth are still very important. Only 65% of Oakridge households have an internet subscription at home and many households do not have a computer. Past experience has taught that posting flyers in key public locations and distributing flyers with water bills are two of the most effective ways to spread information. Oakridge Air partners make a concerted effort to post information across numerous online and traditional information outlets to reach the public.

⁷ This process was tested during the 2020 Labor Day fires and worked surprisingly well through multiple team transitions on multiple large incidents.

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Print

- Informational flyers and postcards are available at the Oakridge Air office, City Hall, and Orchid Health.
- The post office, Banner Bank, Ray's Market, and Oakridge Pharmacy are regular locations for flyers.
- Seasonal smoke message flyers are also shared periodically with the City of Oakridge via water bills reaching 1400 customers.
- The Forest Service sets up temporary prescribed fire and wildfire information kiosks at Ray's Market and the Westfir Portal.



Figure 8: Forest Service kiosk

Online

- Press releases are distributed to the Highway 58 Herald, the local online newspaper.
- The Oakridge Air Facebook page is updated regularly, and these messages feed automatically to the Oakridge Air website.
- Social media posts from the Oakridge Air page are shared on the City of Oakridge and SWFC pages as well as in community forum groups.
- Educational YouTube videos are shared online such as this one about [wildfire smoke](#) from the Orchid Health clinic.

In addition to the Facebook message feed, the Oakridge Air website provides:

- Real-time readings of the Oakridge air quality monitor
- Information about the home heating upgrades program to reduce ambient/indoor woodsmoke
- Firewise and real-time prescribed fire information
- Tips to protect health during smoke events or poor air quality
- Links to interactive agency maps with prescribed fire locations and status

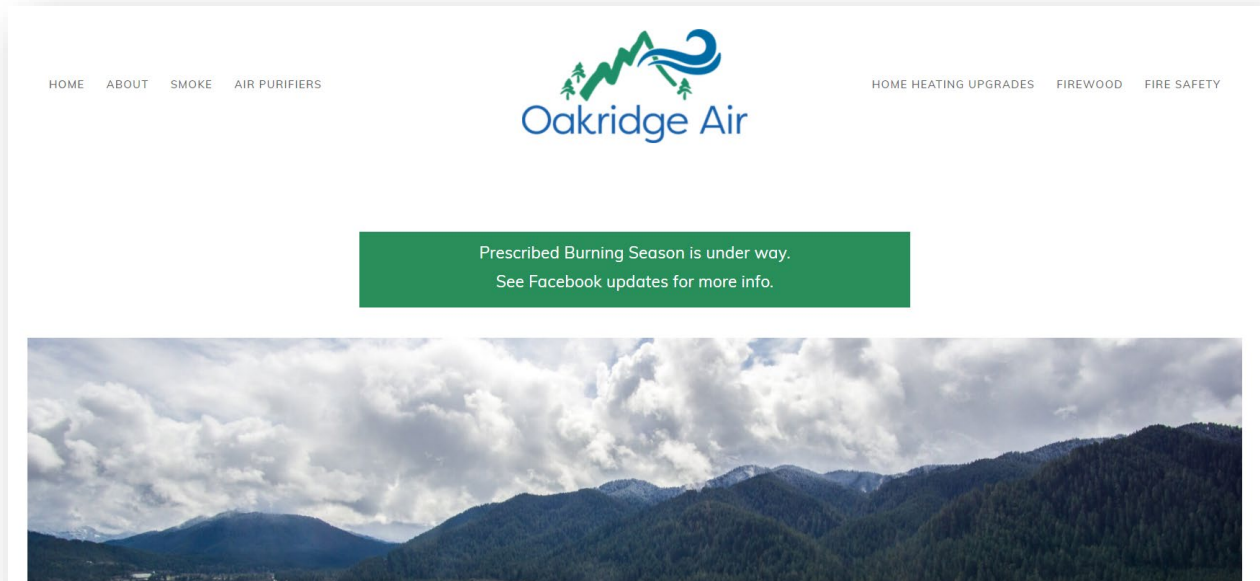


Figure 9: Oakridge Air website home page

The website is designed to transition easily between wintertime woodsmoke, summer wildfire, and spring and fall prescribed fire seasons. This ensures that information, overarching communication, and engagement strategies are relevant and applicable regardless of the smoke source.

Direct Communication

- Oakridge Air distributes a quarterly newsletter via email, and community members can sign up to receive it on the Oakridge Air website.
- LRAPA maintains a text alert system for home wood heating advisories and prescribed fire and wildfire smoke alerts that community members can opt into by texting “Oakridge Air” to 313131.
- The Oakridge Air team can help answer questions by phone at 541-782-3422
- LRAPA can help answer calls at 541-736-1056 ext. 217

External Resources

These external resources are regularly linked to the Oakridge Air website and in informational posts

- [LRAPA](https://www.lrapa.org/) (https://www.lrapa.org/)
- [Oregon Smoke Blog](http://oregonsmoke.blogspot.com/) (http://oregonsmoke.blogspot.com/)
- [Oakridge Purple Air map](https://www.purpleair.com/map?opt=1/mAQI/a10/cC4#12.92/43.74304/-122.46444) (https://www.purpleair.com/map?opt=1/mAQI/a10/cC4#12.92/43.74304/-122.46444)

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- Willamette National Forest [prescribed fire map](https://usfs.maps.arcgis.com/apps/webappviewer/index.html?id=8e594a41f6e44aa5a92e2e435f4d167b) (https://usfs.maps.arcgis.com/apps/webappviewer/index.html?id=8e594a41f6e44aa5a92e2e435f4d167b)
- Oregon Department of Forestry [prescribed fire map](https://geo.maps.arcgis.com/apps/webappviewer/index.html?id=a7e321dc8fc444b7a33fbc67bc673a3b) (https://geo.maps.arcgis.com/apps/webappviewer/index.html?id=a7e321dc8fc444b7a33fbc67bc673a3b)
- Relevant [InciWeb](https://inciweb.nwcg.gov/) (https://inciweb.nwcg.gov/) wildfire incidents

All messages are paired with information about how to protect health. Regardless of the type of smoke message, Oakridge Air uses best practices for communicating with the public.

VI. [Annual Reporting](#)

Per OAR 629-048-0180 Section 3(f) of the 2020 Oregon prescribed fire SMP, the City of Oakridge and Lane County jointly commit to reporting annually to ODF and DEQ on our implementation of the Oakridge-Westfir SSRA SSP. In the annual report, we will document continued compliance with the four required components of the Oakridge-Westfir SSRA SSP (outlined above, see page 5-6), as well as a summary of the methods used to communicate to the public and smoke-vulnerable populations, a log of dates and times the Oakridge-Westfir SSRA SSP is initiated, and a record of local meetings to discuss or update the Oakridge-Westfir SSRA SSP.

Unless otherwise specified, we will plan to submit annual reports in March of each year, prior to the commencement of each spring prescribed burn season.

VII. [Conclusion](#)

The communities of Oakridge-Westfir and partner agencies and organizations have a proven track record of successful collaboration and coordination around the most pressing environmental and natural resource challenges. Thanks to a long history of locally-driven initiatives, such as the SWFC and now the Oakridge Air program, we have a foundation of robust community dialogue, outreach, and engagement to build upon in the creation and implementation of the Oakridge-Westfir SSP. Creating Oakridge Air and developing an easily replicated process for internal information sharing and external communications and outreach will provide timely, accurate, reliable, locally relevant, and proactive outreach to residents, visitors, and smoke-vulnerable populations of Oakridge and Westfir.

VIII. Declaration of Agreement

The Oakridge City Council, in coordination with the Lane Regional Air Protection Agency (LRAPA), has reviewed and approved the Oakridge Smoke Sensitive Receptor Area Smoke Safety Plan (Oakridge-Westfir SSRA SSP). Per OAR 629-048-0180 of the 2020 Oregon prescribed fire Smoke Management Plan. The City of Oakridge and LRAPA jointly agree to submit the Oakridge-Westfir SSRA SSP to the Oregon Department of Forestry and Oregon Department of Environmental Quality as a formal request for exemption from the 1-hour smoke intrusion threshold for the Oakridge-Westfir SSRA.

City of Oakridge

Date

Lane Regional Air Protection Agency

Date

Appendix A: Partner Roles and Responsibilities

Oakridge Air and Smoke Communications Roles and Responsibilities			
Partner	Type	Roles	Communication roles for smoke events
City of Oakridge	Local municipality, Oakridge Air implementing partner	<ul style="list-style-type: none"> • Oakridge Air implementing partner • Code enforcement • Collaborate on Firewise Assessments • Community Firewood Program Partner 	<ul style="list-style-type: none"> - included in smoke@oakridgeair.org distro list - provide backup for smoke@oakridgeair.org - amplify messages on City website and facebook page
Oakridge Fire Department/ Hazeldell Rural Fire Department	Local Fire Protection Agency	<ul style="list-style-type: none"> • Assist with Firewise assessments 	<ul style="list-style-type: none"> - amplify Oakridge Air messages on social media
South Willamette Solutions/ Southern Willamette Forest Collaborative	Local NGO, Oakridge Air implementing partner	<ul style="list-style-type: none"> • Oakridge Air implementing partner • Coordinate the Community Firewood Program • Manage residential upgrade coordination • Facilitator for Oakridge Air Community Response Plan • Collaborate on Firewise Assessments 	<ul style="list-style-type: none"> - host Oakridge Air google drive and emails @oakridgeair.org - included in smoke@oakridgeair.org distro list - provide backup for smoke@oakridgeair.org
Good Company	Lead implementing partner for Oakridge Air	<ul style="list-style-type: none"> • Oakridge Air implementing partner • Oversee all Oakridge Air project components • Coordinate Oakridge Air messaging YR 1 • Manage oakridgeair.org 	<ul style="list-style-type: none"> - manage smoke@oakridgeair.org - main POC for local smoke event notifications - update Oakridge Air facebook page

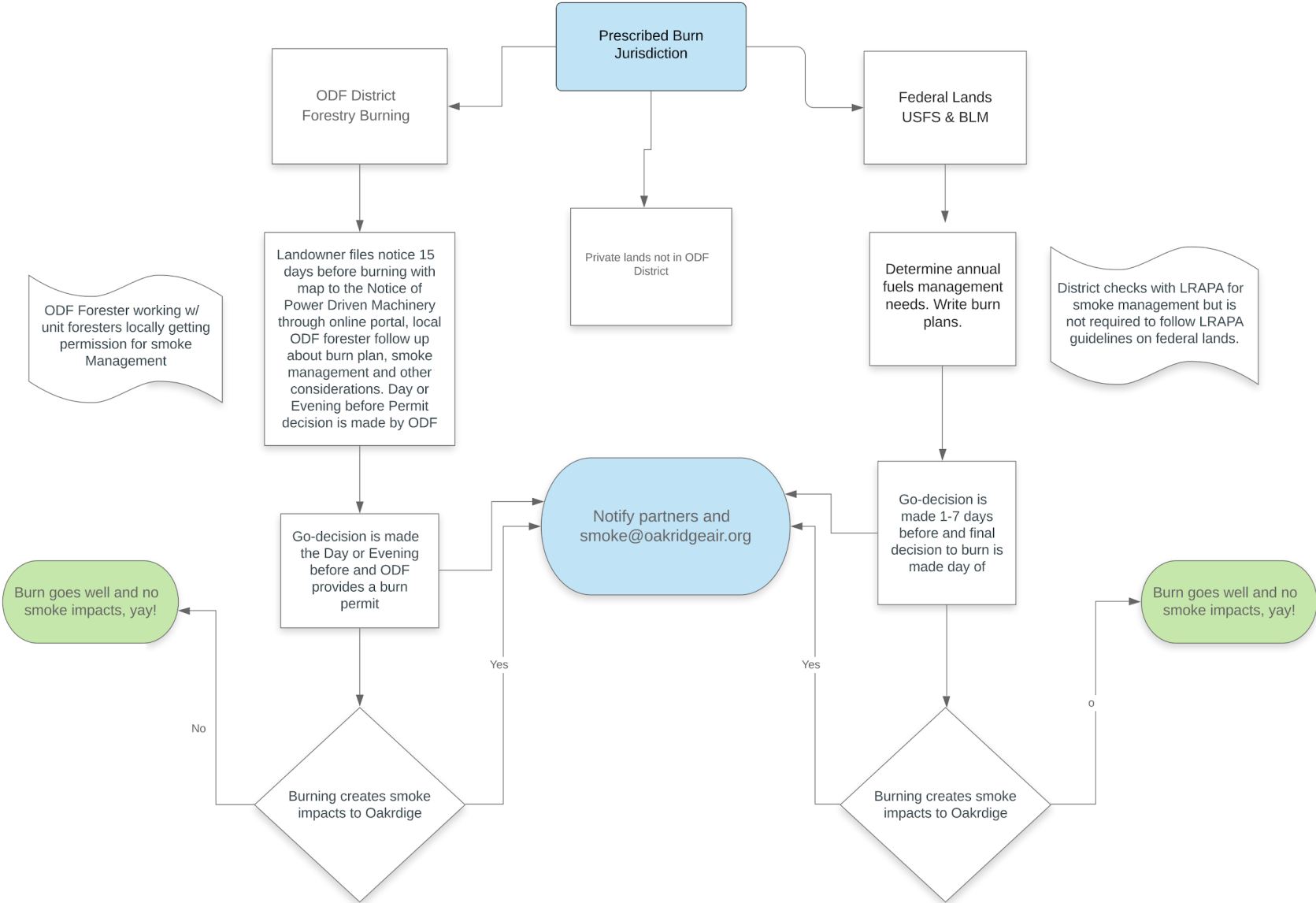
Lane Regional Air Protection Agency	Regional Agency	<ul style="list-style-type: none"> • Monitor air quality in Oakridge and the south Willamette Valley Region • Provide public notifications and press releases for smoke events and Home Heating notices for red and yellow burn days • Manage text notices 	<ul style="list-style-type: none"> - main POC for smoke notifications - included in smoke@oakridgeair.org distro list - update Oakridge Air facebook page
Lane County	Local Government	<ul style="list-style-type: none"> • Public Health Air purification resources 	
Lane County	Local Government	Emergency Management	<ul style="list-style-type: none"> - main POC for emergency incidents in Lane County
Oregon Department of Forestry, South Cascades District	State Agency	<ul style="list-style-type: none"> • Provide permits, work with burn boss to mitigate any items identified, lead burn planning and implementation through their Vegetation Management Program • Manage prescribed fire on BLM lands east of Oakridge • Collaborate on Firewise Assessments 	<ul style="list-style-type: none"> - included in smoke@oakridgeair.org distro list - communicate to Oakridge Air partners if planned prescribed fires are in area - provide information for ODF statewide prescribed fire map
Oregon Department of Environmental Quality	State Agency	<ul style="list-style-type: none"> • Communicate about smoke events through wildfire smoke protocol calls 	
Oregon Health Authority	State Agency	<ul style="list-style-type: none"> • Communicate about health impacts from smoke events through wildfire smoke protocol calls 	

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Willamette National Forest (WNF)	Federal Agency	<ul style="list-style-type: none"> • Manage prescribed fire panning on the forest • Collaborate on Firewise Assessments 	<ul style="list-style-type: none"> - notify ODF and partners of prescribed fire and wildfire events - added to smoke@oakridgeair.org distro list - assist with season smoke messaging and public outreach - host WNF prescribed fire map
Middle Fork Ranger District (WNF)	Federal Agency	<ul style="list-style-type: none"> • Manage FS prescribed fire and wildfire surrounding Oakridge • Collaborate on Firewise Assessments 	<ul style="list-style-type: none"> - notify ODF and partners of prescribed fire and wildfire events - added to smoke@oakridgeair.org distro list - assist with seasonal messaging and public outreach - update WNF prescribed fire map
McKenzie Ranger District (WNF)	Federal Agency	<ul style="list-style-type: none"> • Manage FS prescribed fire and wildfire north of Oakridge 	<ul style="list-style-type: none"> - notify ODF and partners of prescribed fire and wildfire events
Cottage Grove Ranger District, Umpqua National Forest	Federal Agency	<ul style="list-style-type: none"> • Manage FS prescribed fire and wildfire south east of Oakridge 	<ul style="list-style-type: none"> - notify ODF and partners of prescribed fire and wildfire events
Bureau of Land Management	Federal Agency	<ul style="list-style-type: none"> • Manage BLM prescribed fire east of Oakridge 	<ul style="list-style-type: none"> - notify ODF and partners of prescribed fire and wildfire events

Appendix B: Prescribed Fire Event Communications Flow Chart

Smoke Event Communications
Oakridge Air: Smoke, Health and Safety Committee
July 2020



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Appendix C: Smoke Messaging Templates


PRESCRIBED FIRE COMMUNICATIONS TEMPLATES

PROJECT TITLE	Oakridge Air Communications Committee	ORGANIZATION							
		DATE	May 2021						
CAMPAIGN TYPE		1. PRE-EVENT COMMUNICATIONS			2. EVENT COMMUNICATIONS			3. POST EVENT COMMUNICATIONS	
		Start to prescribed burn season	Fire burning planned	Understory burning planned	Planned prescribed burns 3-10 days	Planned burns 1-3 days out	Planned burns today	Burns went as planned	Burns did not planned/ smoke
Press Releases									
Press Releases	Details here	1A_PR	1B_PR	1C_PR	2A_PR	2B_PR	2C_PR	3A_PR	3B_PR
Email									
Blog/Newsletter	Details here	1A_Blog	1B_Blog	see 1B	2A_Blog	2B_Blog	2C_Blog	3A_Blog	3B_Blog
Online									
Social Media/Website	Oakridgeair.org	1A.i.SM	1B_SM	1C_SM	2A_SM	2B_SM	2C_SM	3A_SM	3B_SM
	Oakridge Air Facebook								
		1A.ii.SM							
Text messages		1A_TM	1B_TM	1C_TM	2A_TM	2B_TM	2C_TM	3A_TM	3B_TM

WOODSMOKE COMMUNICATIONS TEMPLATES

PROJECT TITLE	Oakridge Air Smoke, Health & Safety Committee	COMPANY NAME							
		DATE	May 2021						
CAMPAIGN TYPE		1. START OF SEASON (Aug/Sep)							
		YARD DEBRIS	HHE	LIHEAP	SWEPPER PROGRAM	WOODSTOVE EFFICIENCY	CODE ENFORCEMENT	SMOKE DIVERSION PROGRAM	HOME HEATING PRACTICE
Press Releases									
Press Releases	Details here	1A_PR	1B_PR	1C_PR	1D_PR	1E_PR	1F_PR	1G_PR	2A_PR
Email									
Blog/Newsletter	Details here	1A_Blog	1B_Blog	1C_Blog	1D_Blog	1E_Blog	1F_Blog	1G_Blog	2A_Blog
Online									
Social Media/Website	Oakridgeair.org	1A_SM	1B.i.SM	1C_SM	1D_SM	1E_SM	1F_SM	1G_SM	2A_SM
	Oakridge Air Facebook								
			1B.ii.SM						
Text messages		1A_TM	1B_TM	1C_TM	1D_TM	1E_TM	1F_TM	1G_TM	2A_TM

WILDFIRE SMOKE/FIREWISE COMMUNICATIONS TEMPLATES

PROJECT TITLE	Oakridge Air Smoke, Health & Safety Committee	COMPANY NAME							
		DATE	May 2021						
CAMPAIGN TYPE		1. PRE-EVENT COMMUNICATIONS	2. EVENT COMMUNICATIONS				3. POST EVENT COMMUNICATIONS		
		START OF WILDFIRE SEASON	SMOKE	SMOKE SENSITIVITY	DIY AIR FILTERS	MASKS	VULNERABLE POPULATIONS	RED DAY	FIREWISE
Press Releases									
Press Releases	Details here	1A_PR	2A_PR	2B_PR	2C_PR	2D_PR	2E_PR	3A_PR	3B_PR
Email									
Blog/Newsletter	Details here	1A_Blog	2A_Blog	2B_Blog	2C_Blog	2D_Blog	2E_Blog	3A_Blog	3B_Blog
Online									
Social Media/Website	Oakridgeair.org	1A_SM	2A_SM	2B_SM	2C_SM	2D_SM	2E.i.SM	3A_SM	3B_SM
	Oakridge Air Facebook						2E.ii.SM		
							2E.iii.SM		

Prescribed Fire Communications Templates

Social Media	2
1A.i. Social Media - Prescribed Fire Season - Pre-event	2
1B. Social Media - Prescribed Burn piles (SM - RX piles)	2
1C. Social Media - Understory Burning	3
2A. Social Media - Prescribed Burn Planned (3-10 days)	3
2B. Social Media - Prescribed Burn planned (SM - RX)	3
2C. Social Media - Prescribed Burn today (SM - RX)	4
3A. Social Media - Prescribed Burn success (SM - RX)	5
3B. Social Media - Smoke (SM)	6
3C. Social Media - Prescribed Burn escaped (SM - RX)	7
4A. Social Media - Prescribed Burn Education (SM -RX)	8
Text Alerts	9
1A. Text - Prescribed Fire Season - Pre-event	9
1B. Text - Prescribed Burn piles	10
1C. Text - Understory Burning	10
2A. Text - Prescribed Burn Planned (3-10 days)	10
2B. Text - Prescribed Burn planned	10
2C. Text - Prescribed Burn today	10
3A. Text - Prescribed Burn success	10
3B. Text - Smoke	10
4A. Text - Prescribed Burn Education	10
Press Releases	10
1A. Press Release - Prescribed Fire Season	10
1B. Press Release - Beginning of Pile Burning Season	12
1C. Press Release - Understory Burning	13
2A. Press Release - Prescribed Burn planned (PR)	13

Appendix D: Health Analyses

DSPG Data Analysis: Air Quality Impacts to Health

Data Analysis: Air Quality Impacts to Health

As part of the Smoke Safety Plan development, Oakridge received a grant from the Data Science for Public Good (DSPG) program at Oregon State University (OSU). Oakridge Air partners worked with the DSPG team for four months: a master's student lead, and two senior-level undergraduates. The team analyzed general trends in seasonal air quality and sought to answer this overarching research question:

From January 2015 to 2019, have past peak smoke events caused a statistically significant increase in prescriptions known to treat select respiratory and cardiac diseases in Oakridge and Westfir?

The DSPG team hypothesized that the rate of prescription fills for the select medications increases within 30 days of a smoke event in Oakridge and Westfir due to the increased concentration of PM_{2.5}. To test this, DSPG obtained air quality data from LRAPA and local prescription fill count data from the local pharmacy.

Air Quality Data

The air quality data was obtained from LRAPA for the time period between 2015 and 2019. This dataset was derived from a single nephelometer located at the lowest point in Oakridge along the Willamette River. The dataset contained information about temperature, humidity, vectored wind speed, solar radiation, and PM_{2.5} concentration.

Health Data

DSPG obtained prescription count data from the local pharmacy, which provided the number and type of prescriptions filled each day between 2015 to 2019. Prescription counts were separated by their use as a smoke-related treatment for respiratory or cardiac diseases from the total number obtained. Throughout the time period, cardiac medications made up 16% of fills, while respiratory medications made up around 8%. Together, these medications made up almost a quarter of all medications filled in this time period.

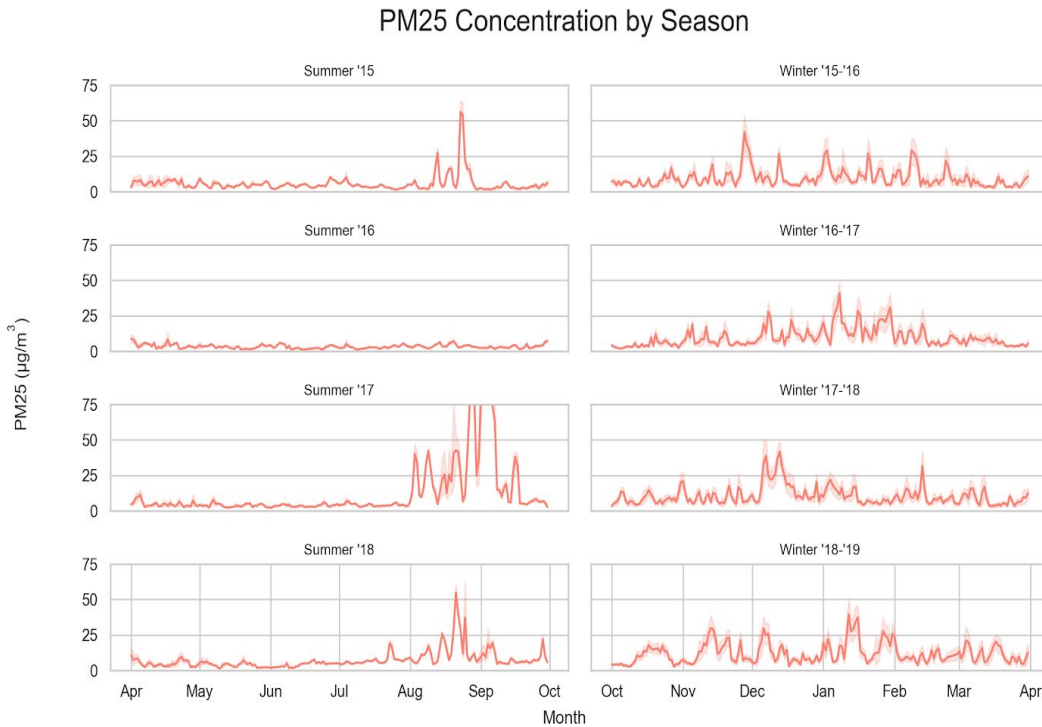
Results

The team found that there was a 3% increase in prescription counts within 30 days of a smoke event in Oakridge and Westfir for every 10 µg/m³ increase in PM_{2.5} concentration.

This means, if PM_{2.5} concentration is at 50 µg/m³ then 30 days later, there would be a 15% increase in prescription fills. This statistically significant result is useful to Oakridge Air partners to understand and communicate the health impacts of smoke. The team suspects there is unexplained seasonality in the model, which may be addressed in future work.

Additionally, DSPG found that around a quarter of the prescriptions filled (24%) between 2015 to 2019 were prescriptions specifically used to treat smoke-related cardiac and respiratory conditions.

Seasonal woodsmoke patterns



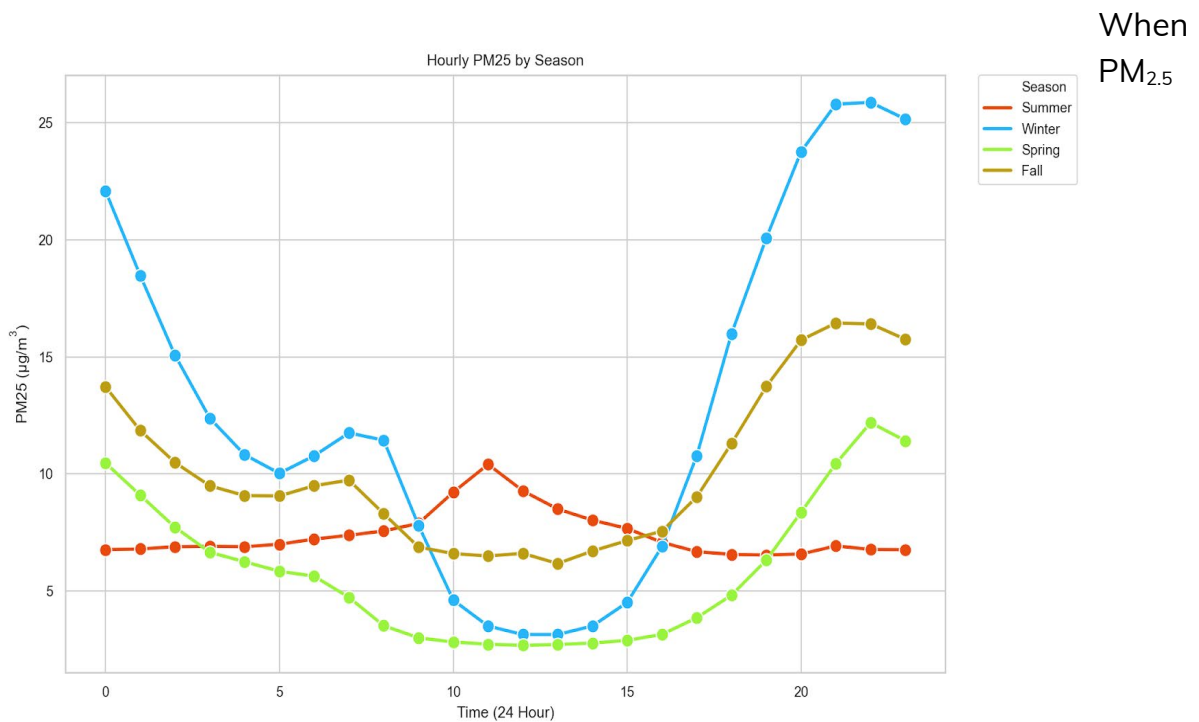
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On average, there are 6 days a year where PM_{2.5} concentration is above 35 µg/m³

Each season has varying PM_{2.5} concentrations in the Oakridge-Westfir SSRA. Notably, winter and summer seasons experience spikes in poor air quality. This is due to wintertime wood stove smoke and summertime wildfires. In the graph above, we see seasonal PM_{2.5} concentration variation between 2015 to 2019. March through July PM_{2.5} concentrations are quite low, whereas we see the largest spikes occurring from mid-August through September for most years. From November to mid-February, we see PM_{2.5} concentrations vary with steady peaks and valleys until warmer weather begins.

Wintertime Woodsmoke and Air Quality

Poor air quality spikes at 22:00 (10:00 pm) and drops down at 10:00 (10:00 am) during every season except summer.

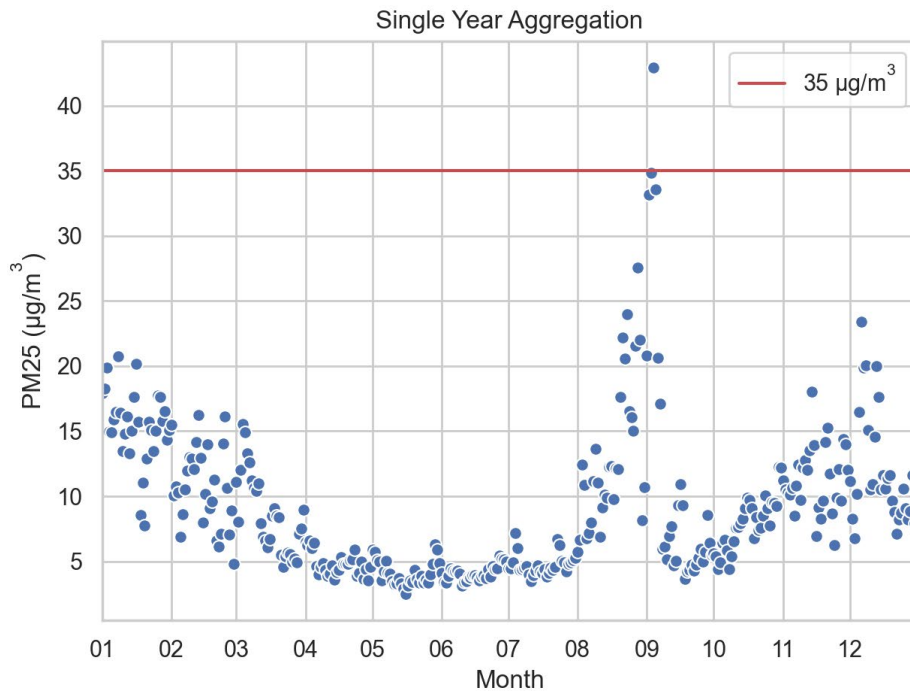


concentration was compared throughout the day and depending on the season, it appeared that winter time concentrations had the largest hourly variations. The graph displays averaged, hourly PM_{2.5} concentrations from 2015 to 2019 separated by season. The largest spike in the winter time occurs around 22:00 (10:00 pm), with the

concentration dropping down again by 10:00 (10:00 am). It's important to notice that, when averaged, the PM_{2.5} concentrations are not outside the “healthy” range. If these concentration patterns were recreated on a particular red day, we may see the same pattern, a high at 10:00 pm and a drop by 10:00 am, but at a concentration that is considered unhealthy. When these red days happen, it's important people protect their health and safety and stay inside between 10:00 pm to 10:00 am to avoid spikes in poor air quality.

Summertime Wildfire Smoke and Air Quality

In recent years wildfire has been a primary contributor to the poorest air quality experienced in the Oakridge-Westfir SSRA throughout the entire year. Oakridge air quality in 2014-2016 met the national ambient air quality health standards (NAAQS) for PM_{2.5}, both the annual and the 24-hour standards. However, large wildfires in Oregon and nearby states in 2017, and again in 2020, resulted in many major wildfire



Oakridge Smoke Sensitive Receptor Area

smoke impacts above the 24-hour PM_{2.5} standard in communities that requires documentation and submittal to EPA for review and approval as Exceptional Events⁸.

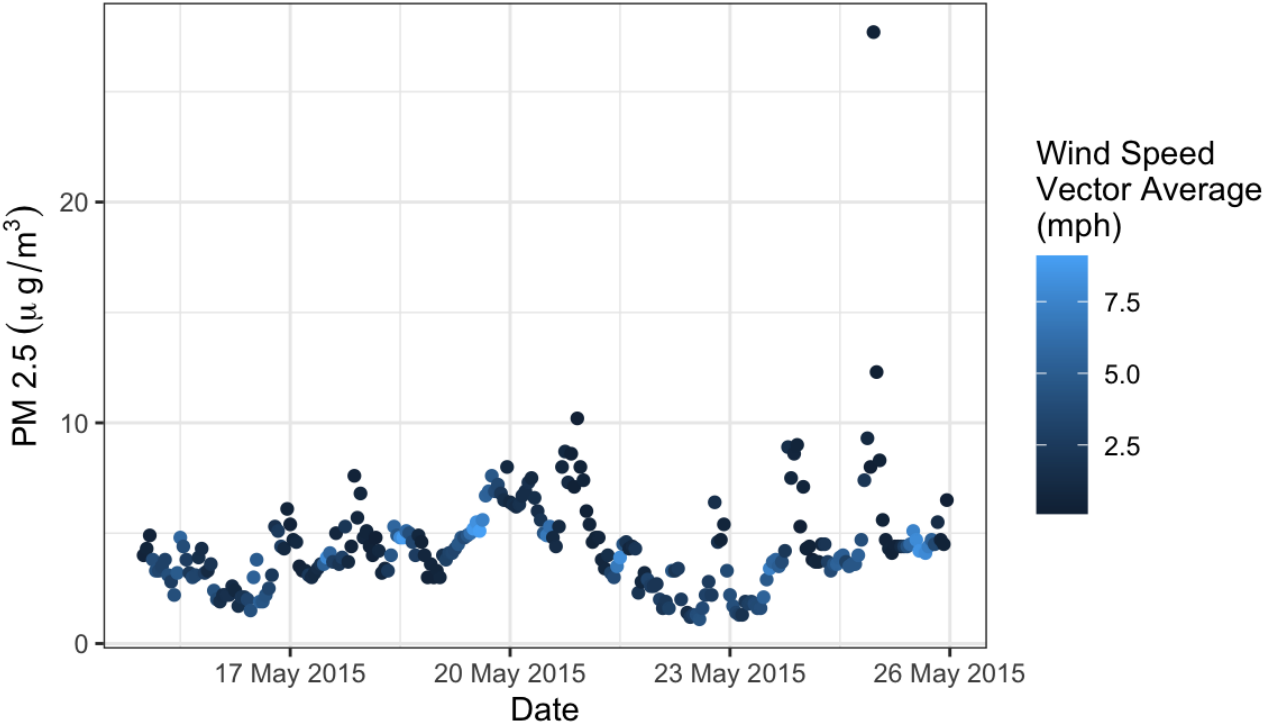
The graph above demonstrates the average 24-hour PM_{2.5} from 2015-2019 all averaged into a single year. We see between August and September wildfire contributes to the largest spike in PM_{2.5} concentration, which pushes Oakridge-Westfir SSRA daily concentrations above the 35 µg/m³ threshold.

Prescribed Fire Smoke and Air Quality

Prescribed fire smoke events in the Oakridge-Westfir SSRA do not often cause smoke impacts to residents. Detailed analysis of air quality data from the Oakridge nephelometer by the DSPG team did not find significantly significant smoke impacts from prescribed fire. The graph below demonstrates a 10-day window when a prescribed underburn occurred. Each dot represents a nephelometer reading, while a lighter color represents an increase in wind. Even when wind increases, we see PM_{2.5} concentrations well below the 24-hour PM_{2.5} standard. It should be noted that the absence of prescribed fire smoke coincides with a decline in prescribed fire underburning by the Middle Fork District and an increase in backlog of untreated prescribed burning acres. It is expected that there will be an increase in prescribed burn acres treated in the future as the Forest Service completes OWTFR work and fuels reduction projects in the WUI increase.

⁸ The Exceptional Events (EE) guidance developed by EPA, in consultation with other agencies and the public, is intended to prevent penalizing communities for events outside their control. The EE guidance only allows EPA to approve wildfire smoke impacts (or other exceptional events) that have “regulatory significance.”

PM 2.5 Concentration 10 Days Face #9 Underburn



APAC Health Data Analysis

Study Purpose

Air quality in the Oakridge and Westfir airshed is primarily affected by winter woodsmoke with winter inversions and smoke intrusions from wildfire in the summer months. Wildfire has and will continue to play a role in coming years as winter woodsmoke can be mitigated more easily. The Oakridge Air program, funded by an EPA Targeted Airshed grant, is assisting with multi-strategy interventions over a five-year timeframe are intended to improve air quality and reduce particulate matter (PM_{2.5}) emissions to improve the health of the community. Given the long-term exposure, decades of being out of attainment for PM_{2.5} standards, we are attempting to better understand the connection between health visits (claims and pharmaceuticals) associated with respiratory and cardiac issues to better serve the community. This health analysis will help us to communicate important public health information to the community.

Main Research Questions

Overall: Since 2015, how have public health impacts (overall claims and pharmaceuticals for select respiratory/cardiac issues) been impacted by PM_{2.5} exposure from winter woodsmoke in the Oakridge/Westfir airshed using LRAPA data? How have these claims and pharmaceutical counts shifted following significant wildfire events?

Data and Methods

Lane Regional Air Protection Agency (LRAPA) provided particulate matter (PM_{2.5}) data measured using regulatory monitors that are designated as federal reference method (FRM) or federal equivalent method (FEM). The FRM daily data is used to determine the observation and control date periods based on a threshold of 20 µg/m³ indicating a yellow warning for poor outdoor air pollution. An observation date period is defined as a week (7 days) following a day with a FRM PM_{2.5} value higher than the yellow threshold. The control periods are dates outside of the observation date periods, except a less-than-three-day control period between two observation date periods are combined with the observation periods to avoid small medical data for confidentiality. The FEM hourly data is used to calculate the daily number of hours above the yellow or red threshold, and the daily mean and maximum PM_{2.5}, which are considered more relevant to understand the health impacts caused by PM_{2.5}. The predictors including the mean and max PM_{2.5}, the average and sum of hours when the hourly PM_{2.5} equals to or is above the yellow (20 µg/m³) and red (35 µg/m³) thresholds, are calculated in each control and observation date period.

The Oregon All Payer All Claims Reporting Program (APAC) data provided by the Oregon Health Authority (OHA) are summarized both in seasons and date periods. Each year period is split into two seasons – winter or home wood heat season from October 16th to April 15th and summer or wildfire season from April 16th to October 15th. The two seasons are further split into control and observation date periods. The APAC data include information in claims, total paid, people, claims with zero paid, claims paid, and paid per claim. Claims per person per day and claims paid (> \$0) per person per day are calculated based on the number of claims and number of days in each observation or control date period. The responsive variables number of claims and dollars paid for the total and with or without pay, claims per person, per day, and per person per day are calculated for exploratory data analysis. These variables are further compared between control and observation date periods, and between home wood heat and wildfire seasons using a Wilcoxon signed rank test in the median and a bootstrapping method in the mean.

In the bootstrapping process, the two comparing groups are sampled randomly in the combined data 10,000 times to compare the mean, and the quantiles at 0.025 and 0.975 are shown in the histogram of the bootstrapping results to indicate the significance of the difference in the mean. If the observation is outside of the quantile range, it indicates the difference in the means of the two groups is significant. The relationship between PM and APAC is also explored using correlation and simple linear regression, with only the strongest relationship is shown in the results. The comparisons, correlations and simple linear regressions are conducted in diagnosis and pharmacy claims that include both cardiovascular and respiratory claims in two geographies – Oakridge and rural Oregon areas. The data in both geographies are combined in the comparisons of claims per person per day to increase data quantity while separated in the comparisons of total claims or dollar amount due to the different population sizes.

Results

According to the boxplots and Wilcoxon tests, the difference in claims per person per day between the medians of observation and control date periods are not significant in both seasons (Figure 1) except in the summer (Figure 2). Similarly, wildfire seasons have significantly higher claims per person per day (total and paid) and claims per person than home wood heat seasons (Figures 3 - 5). Furthermore, the difference in the means of claims per person per day between the observation and control date periods is also not significant in both seasons (Figure 6) but only in summer (Figure 7).

There is a significantly strong positive correlation between PM and APAC claims. Figure 8 presents the strongest example of this relationship using the total number of hours above the yellow threshold in PM_{2.5} and total number of claims paid. The total paid, claims, and claims per

Oakridge Smoke Sensitive Receptor Area

person are all significantly increased with the mean and maximum of the daily mean and maximum PM 2.5, and the mean and total number of hours when PM2.5 equals to or is above the yellow and red thresholds, during the observation periods. However, insignificant positive or significantly negative relationships in the same pairs are shown in the control periods. The same results repeat in both Oakridge and rural areas, and diagnosis and pharmacy data.

In conclusion, there is strong evidence in the LRAPA and APAC data to support that PM2.5 (particularly during wildfire seasons) negatively impacts public health. The public is very likely more susceptible to both cardiovascular and respiratory diseases with a longer period of yellow-warning outdoor air quality. This negative health impact of poor air quality is more significant in summers, while we cannot exclude other factors such as influenza that could have also increased the APAC claims in the winter control date periods.

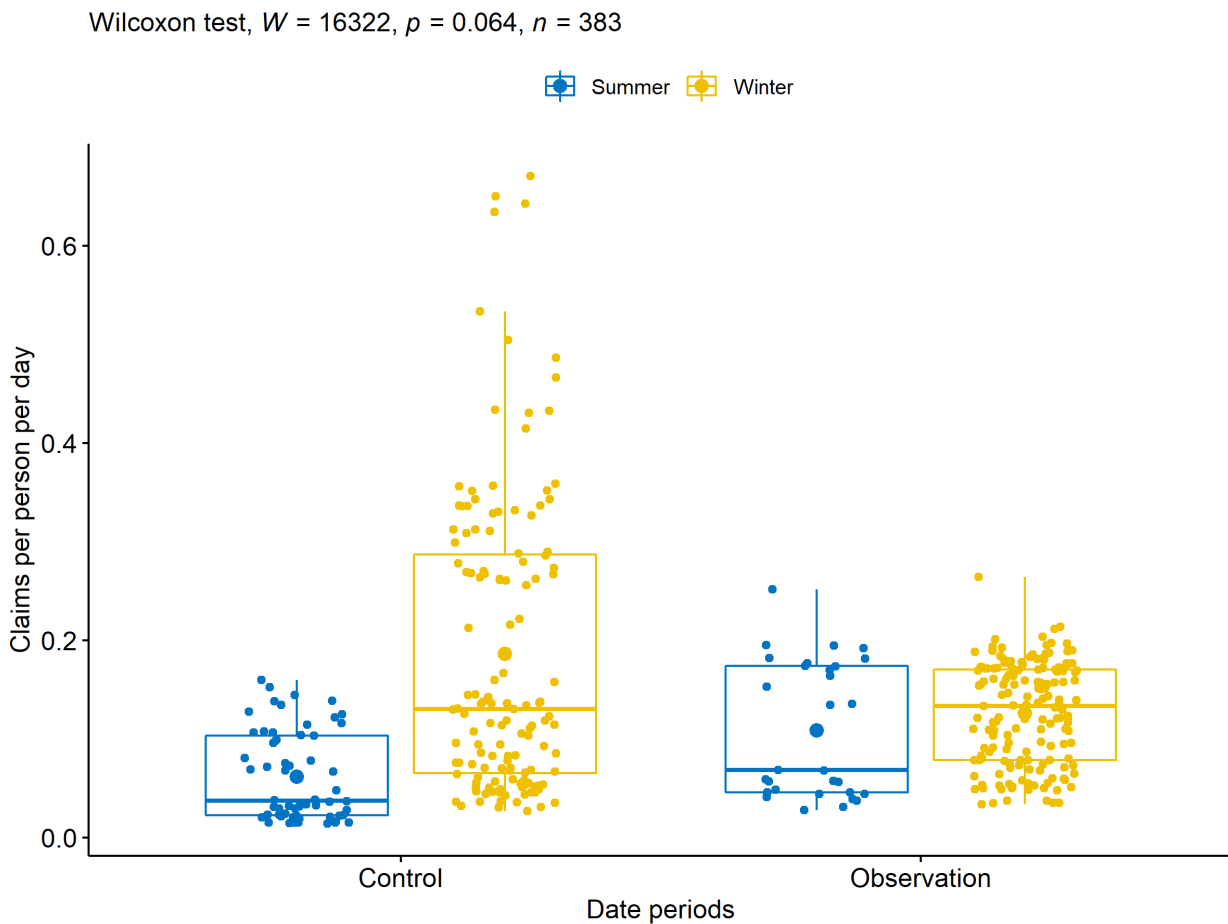


Figure 1. Boxplot with a Wilcoxon test and the mean value shown as a larger point, between date periods for control and observation and claims per person per day, in both cardiovascular and respiratory groups in diagnosis and pharmacy

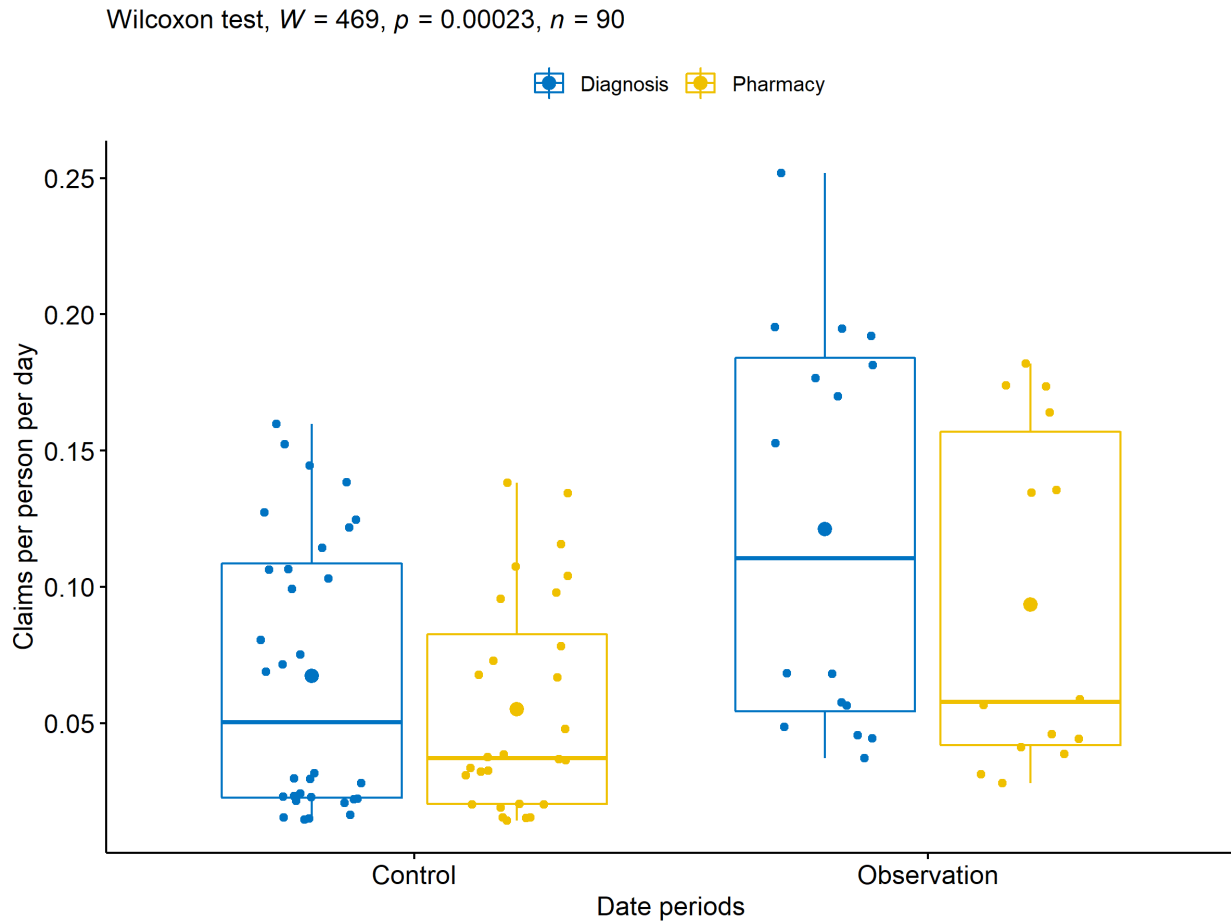


Figure 2. Boxplot with a Wilcoxon test and the mean value shown as a larger point, between summer date periods for control and observation and claims per person per day, in both cardiovascular and respiratory groups

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Wilcoxon test, $W = 350.5$, $p = 0.0092$, $n = 68$

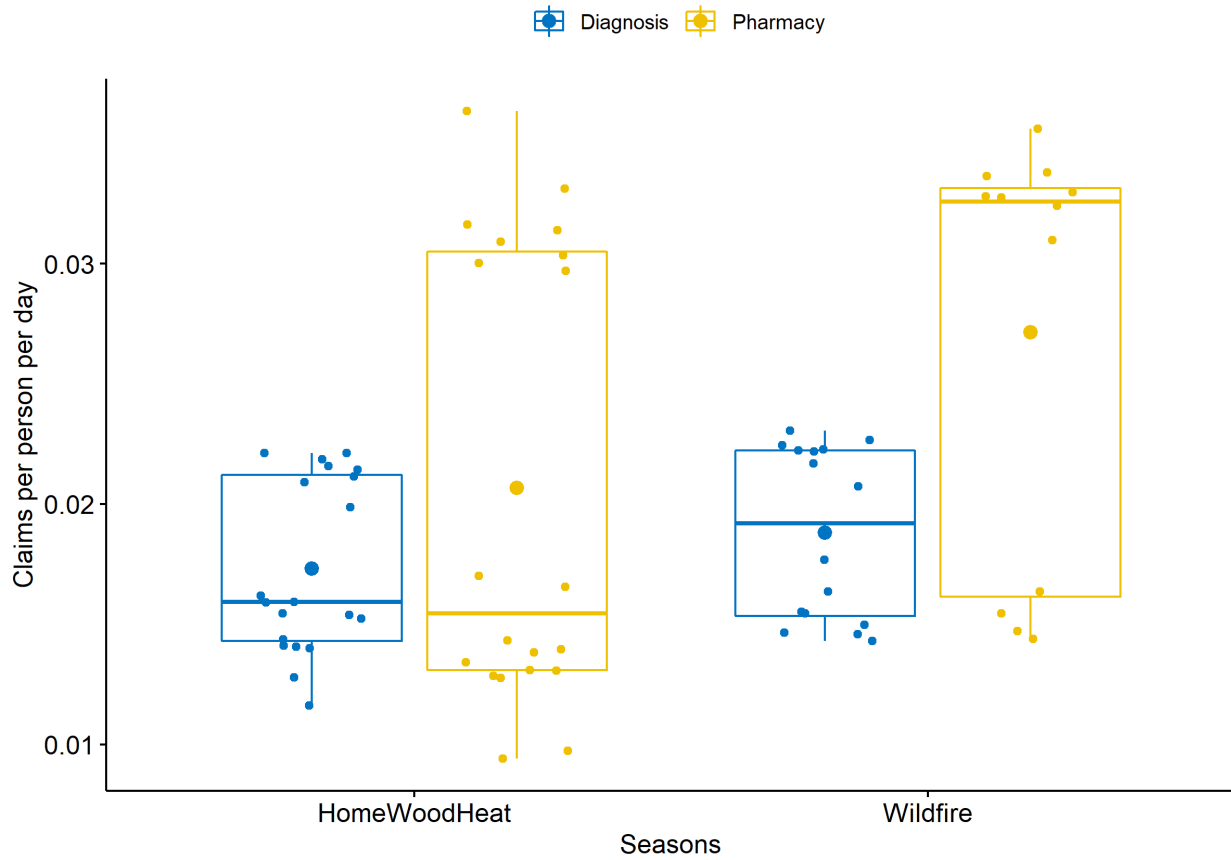


Figure 3. Boxplot with a Wilcoxon test and the mean value shown as a larger point, between seasons and claims per person per day, in both cardiovascular and respiratory groups

Wilcoxon test, $W = 355$, $p = 0.01$, $n = 68$

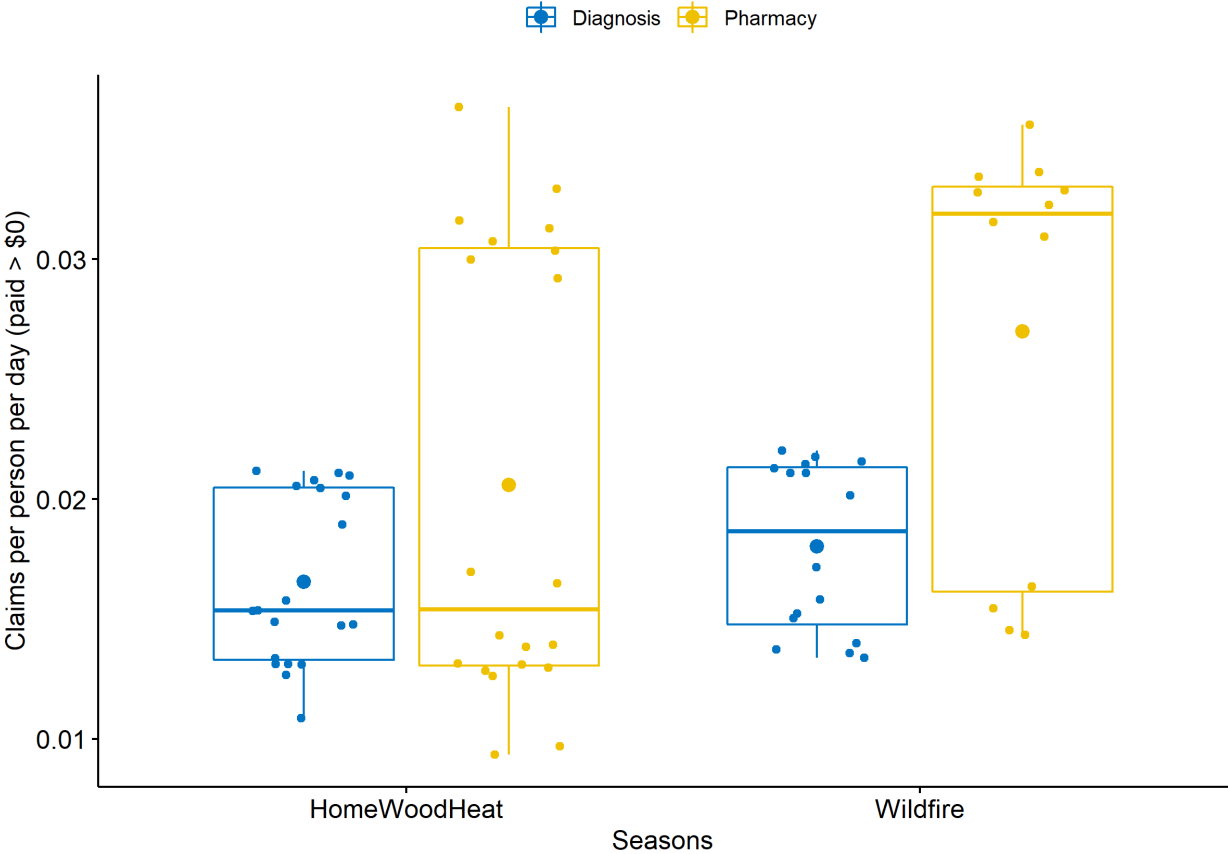


Figure 4. Boxplot with a Wilcoxon test and the mean value shown as a larger point, between seasons and claims per person per day (paid > \$0), in both cardiovascular and respiratory groups

Oakridge Smoke Sensitive Receptor Area

Wilcoxon test, $W = 356.5$, $p = 0.011$, $n = 68$

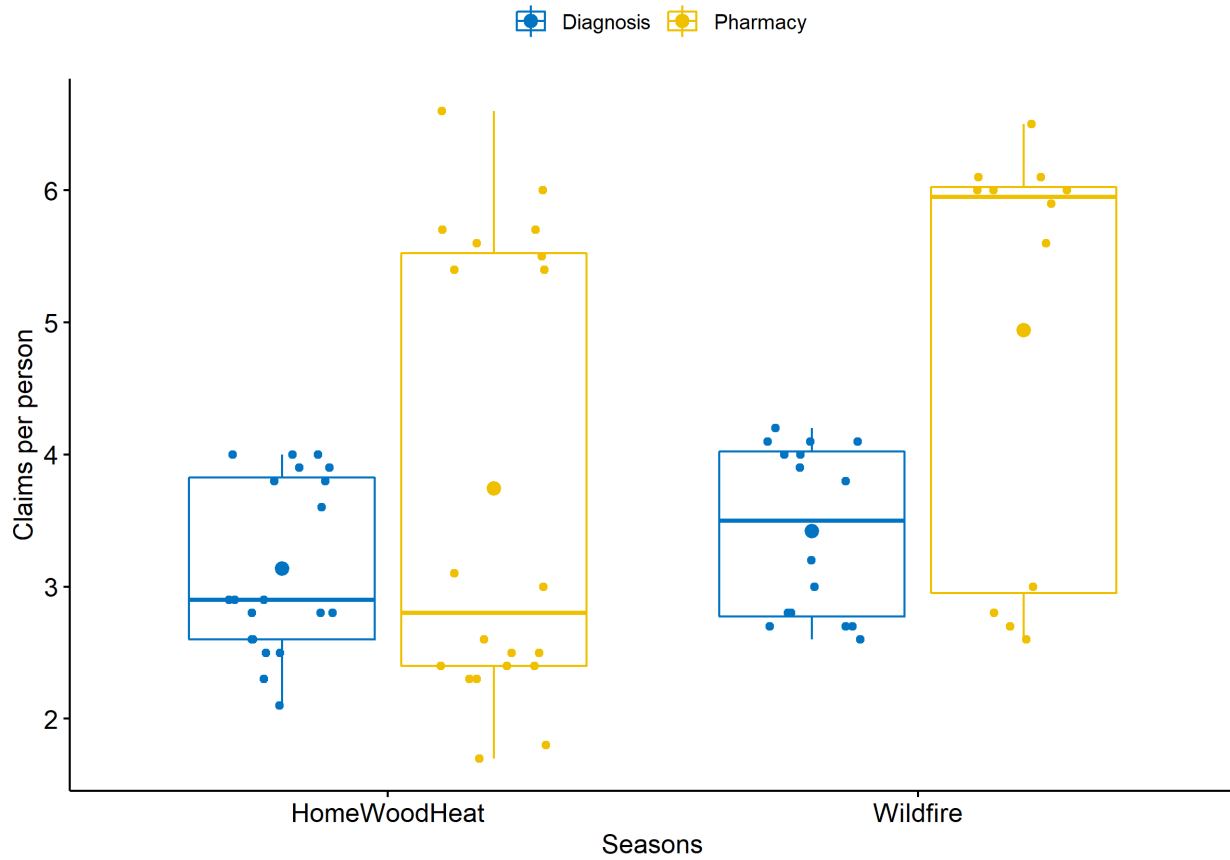


Figure 5. Boxplot with a Wilcoxon test and the mean value shown as a larger point, between seasons and claims per person, in both cardiovascular and respiratory groups

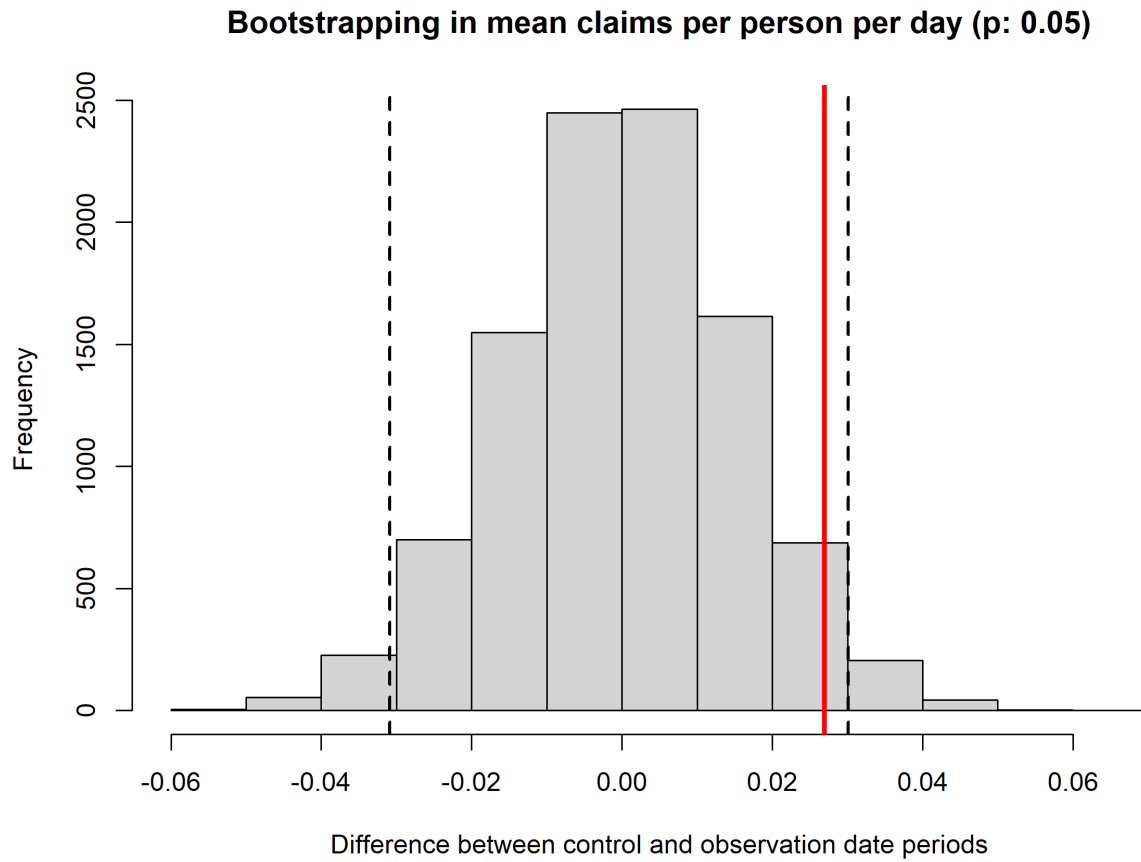


Figure 6. Bootstrapping in the mean difference between control and observation date periods in the diagnosis (cardiovascular and respiratory diagnoses and all seasons combined), with the quantiles of the difference at 0.025 and 0.975 indicated as dashed lines and the observation value indicated as a solid red line

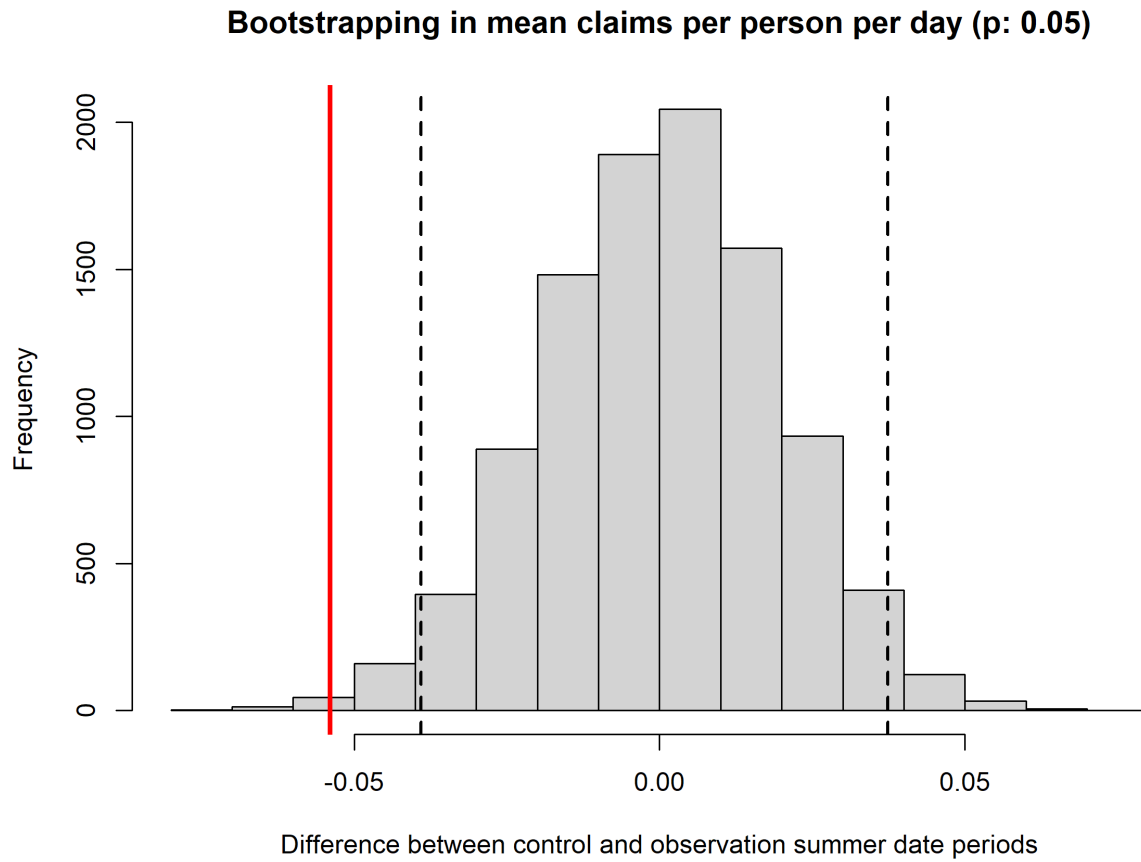


Figure 7. Bootstrapping in the mean difference between control and observation summer date periods in the diagnosis, with the quantiles of the difference at 0.025 and 0.975 indicated as dashed lines and the observation value indicated as a solid red line

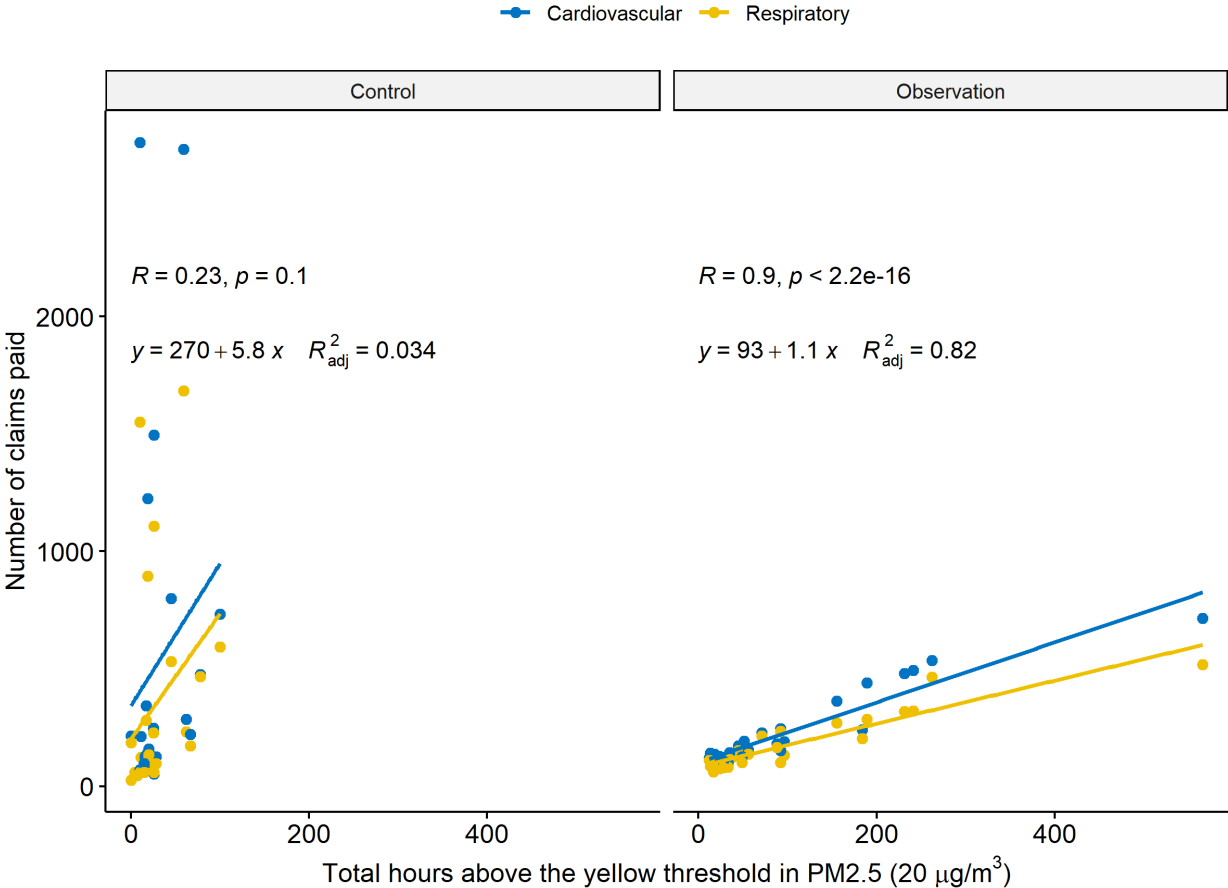


Figure 8. Correlation between the total hours above the yellow threshold in PM2.5 ($20 \mu\text{g}/\text{m}^3$) and the number of claims paid in the control and observation date periods in Oakridge

Appendix

Partnership efforts for health data analysis

There is a multi-year effort in the Oakridge airshed to improve health and air quality.

- **Lane Regional Air Protection Agency – LRAPA** (*APAC applicant, smoke data*): Travis Knudsen
- **Good Company** (*Oakridge Air program manager, report developer*): Justin Overdevest
- **Lane Council of Governments – LCOG** (*data security, data analysis*): Dongmei Chen
- **Oregon Health Authority – OHA** (*advisory capacity*): Carol Trenga, Mary Dinsdale
- **Oregon State University Data Science for Public Good** (*data analysis*): Guen Patty – depending on APAC analysis timeline potential for involvement in 2021 analysis
- **Lane County Public Health** (*advisory capacity*): Dr. Patrick Luedtke
- **Orchid Health** (*advisory capacity*): Sarah Scott
- **South Willamette Solutions**: (*advisory capacity, Oakridge Air residential upgrades program manager*): Sarah Altemus-Pope

Timeline

- 2017 Oregon Solutions project for Oakridge led by Sen Prozanski and former Mayor Coey. Good Company facilitated multi-partner stakeholder collaboration to develop a woodsmoke mitigation plan. During the effort, Oakridge and Oregon experienced significant wildfire smoke inundation. Good Company connected with Orchid Health, Five Rivers (now Nova), Oakridge ER/Fire dept, Postal Pharmacy to collect data on visits before and after peak events.
- 2018 Oregon DEQ grant funded Woodsmoke Mitigation position. During this time, Good Company coordinated with Oregon Health Authority's Kirsten Aird on school absenteeism data for Oakridge (limited data – inconclusive).
- 2019 Coordination with Trillium CCO on initial data for Oakridge/Westfir area as a preliminary effort to gather data. Intention of expanding data analysis in 2020 to cover ~80% of community.
- 2019 Initial connection to Carol Trenga at OHA and coordination with Oregon DEQ on health data analysis.
- 2019 Acquisition of EPA Targeted Airshed Grant.
- 2020 Oregon DEQ funded Community Response Plan for prescribed fire and small allocation to health data analysis. OSU Data Analysis for the Public Good and LCOG support for health data analysis in summer 2020 – needed to pivot to pharmacy data when Trillium wasn't able to provide data.
- 2021 Intention to use OHA APAC data for health data analysis exploring health visits

Example of Observation and Control Periods for Winter and Summer Timeframes

2016-2017					
Observation Period - Winter 2016-2017			Observation Period - Summer 2017		
Observation period (beginning)	Observation period (end)	# of days	Observation period (beginning)	Observation period (end)	# of days
11/5/16	11/12/16	8	8/3/17	9/24/17	53
12/6/16	12/25/16	20			
1/1/17	2/6/17	37			
2/13/17	2/20/17	8			
Total		73	Total		53

Control Period - Winter 2016-2017					
Control period (beginning)	Control period (end)	# of days	Observation period (beginning)	Observation period (end)	# of days
10/16/16	11/4/17	19	4/16/17	8/2/17	109
11/13/16	12/5/17	23	9/25/17	10/15/17	23
12/26/16	12/31/17	6			
2/7/17	2/12/17	6			
2/21/17	4/15/17	54			
Total		108	Total		132

Summary Tab in Spreadsheet for Claims and Expenditures

Claims				
	Home Wood Heating		Wildfire Season	
	October 16th to April 15th		April 16th to October 15th	
	Observation	Control	Observation	Control
2015-2016				
Respiratory Claims				
Cardiac Claims				
Respiratory Pharmaceuticals				
Cardiac Pharmaceuticals				
2016-2017				
Respiratory Claims				
Cardiac Claims				
Respiratory Pharmaceuticals				
Cardiac Pharmaceuticals				
2017-2018				
Respiratory Claims				
Cardiac Claims				
Respiratory Pharmaceuticals				
Cardiac Pharmaceuticals				
2018-2019				
Respiratory Claims				
Cardiac Claims				
Respiratory Pharmaceuticals				
Cardiac Pharmaceuticals				
2019-2020				
Respiratory Claims				
Cardiac Claims				
Respiratory Pharmaceuticals				
Cardiac Pharmaceuticals				

Oakridge Smoke Sensitive Receptor Area

Expenditures				
	Home Wood Heating		Wildfire Season	
2015-2016	Observation	Control	Observation	Control
Respiratory Expenditures				
Cardiac Expenditures				
Respiratory Pharma Expenditures				
Cardiac Pharma Expenditures				
2016-2017	Observation	Control	Observation	Control
Respiratory Expenditures				
Cardiac Expenditures				
Respiratory Pharma Expenditures				
Cardiac Pharma Expenditures				
2017-2018	Observation	Control	Observation	Control
Respiratory Expenditures				
Cardiac Expenditures				
Respiratory Pharma Expenditures				
Cardiac Pharma Expenditures				
2018-2019	Observation	Control	Observation	Control
Respiratory Expenditures				
Cardiac Expenditures				
Respiratory Pharma Expenditures				
Cardiac Pharma Expenditures				
2019-2020	Observation	Control	Observation	Control
Respiratory Expenditures				
Cardiac Expenditures				
Respiratory Pharma Expenditures				
Cardiac Pharma Expenditures				

Appendix E: Cleaner Air Space Memorandum of Understanding

Emergency Shelter and Operations Center Memorandum of Understanding between the City of Oakridge (City) and Oakridge School District (OSD)

Background

In 2020, OSD secured a \$600,000 USDA Rural Development grant that was exclusively available to communities that were impacted by the 2019 winter storm. During the winter storm, the City and OSD partnered to provide hot meals and shelter the Oakridge Jr/Sr High School which is a designated Red Cross shelter.

Lessons learned from the storm identified the need for a designated public emergency response space that is independent of education facilities with reliable backup power. The OSD and City worked together to secure multiple grants to supplement a school improvement bond and seismic retrofit funding. In all, the \$1.5 million dollar project redesigned existing locker rooms and ancillary spaces to accommodate a 7,500 sq. ft. multipurpose room, two individual bathrooms with showers, two locker rooms and a flex space. The remodeled area is adjacent to the gymnasium and can be locked off from the rest of the school. The multipurpose room is reinforced by a backup propane generator and the entire wing is seismically retrofitted and has MERV 13 filtered air.

Purpose

The purpose of this memorandum of understanding (MOU) is to provide the City of Oakridge access to the Oakridge High School multipurpose room and auxiliary rooms for an emergency shelter or emergency operations center in the event of an emergency or disaster.

This memorandum of understanding provides a framework for when the multipurpose room and adjacent facilities can be used for the public. A Red Cross Emergency Shelter will be activated when the City or County must formally declare an emergency. Outside of a declared emergency event, the City may request that the OSD Superintendent approve emergency shelter activation or emergency operations center (EOC) for lesser events including: severe smoke events, power outages, significant cold or heat events or any other natural or human caused disaster that is significantly impacting District residents or the City's capability to respond to emergency situations.

The OSD Superintendent and Oakridge City Administrator serve as the primary points of contact for matters relevant to this MOU.

The City and OSD Agree to Following Terms of Use

1. A facilities use request must be completed by the City and signed by the Superintendent that includes a plan that includes: how the space will be used, who may use the site, how security will be managed, who will be provided keys, any specific equipment and technology requests.
2. Site monitoring, supervision and oversight of public spaces will be provided by the City or its designee.
 - a. Background checks are necessary for all volunteers unless coordinated through Oakridge Police Department or otherwise approved by the Superintendent.
3. A check in/ check out and badging system will be used to identify all staff, volunteers and the public.
4. Prior to opening to the public, the City and OSD will agree upon emergency shelter rules that will be clearly posted and adhered to by all users.
5. Parking will be provided on site if the emergency use does not conflict with school hours. If school is in session, on site handicap access will be provided and any other parking availability will be at the discretion of the superintendent.
6. The City and OSD will work together to track expenses associated with an emergency response in order to seek any available reimbursement under the Stafford Act or other authorities.
7. To the extent that immunity does not apply, each party shall bear the risk of its own actions, as it does with day to day operations and determine for itself what kinds of insurance and in what amounts it should carry.
8. This MOU becomes effective on the date of execution and shall remain in effect unless terminated by written notification by either jurisdiction to the other.
9. This MOU may be amended by written mutual agreement.

City of Oakridge

Date

Oakridge School District

Date

Reference Documents for Activating a Shelter

1. FEMA/ Red Cross [Shelter Field Guide](#)
 - a. Emergency Shelter Rules (page 11)
 - b. Sample organization chart (page 16)
 - c. Registration (page 27)
2. Oregon Health Authority guidance for Cleaner Air spaces for protection from wildfire smoke
<https://www.oregon.gov/oha/PH/PREPAREDNESS/PREPARE/Documents/IdentificationOfCleanAirShelters.pdf>
3. Centers for Disease Control and Prevention guidance for Cleaner Air Shelters during Covid <https://www.cdc.gov/coronavirus/2019-ncov/php/cleaner-air-shelters.html>

Resources referenced for this MOU:

1. FEMA Disaster-Specific Memorandum of Understanding
https://www.fema.gov/sites/default/files/2020-06/Disaster-Specific_MOU.pdf
2. Lessons learned from School Crises and Emergencies
https://rems.ed.gov/docs/LL_Vol3Issue2.pdf