Docket ID No. EPA-HQ-OAR-2008-0699

EPA Proposed Rule on Ozone Ambient Air Standards

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COMMENTS OF UTAH PHYSICIANS FOR A HEALTHY ENVIRONMENT ON THE EPA'S PROPOSED REVISION OF ITS PRIMARY AND SECONDARY AMBIENT AIR QUALITY STANDARDS FOR OZONE

(March 17, 2015)

Utah Physicians for a Healthy Environment (UPHE) is an association of nearly 300 physicians, other health care professionals, and industrial and environmental engineers who share a concern that the health of the residents of Utah, and the viability of its environment, are suffering ever greater adverse impacts from pollution and climate forcing largely from the burning of fossil fuels. Many of the illnesses that our health professionals treat are caused by, or exacerbated by, environmental pollution. We therefore offer our expertise to inform the debate about how society should deal with these threats to human health.

I.Summary

Without evidence, business interests reflexively claim that the health benefits of virtually any tightening of air quality standards are uncertain, while the costs, in terms of lost jobs and reduced economic output, are guaranteed. We prefer to base our conclusions on evidence. The evidence shows that, with respect to the tightening of the current ozone ambient air standards that are proposed in this rule, the opposite is true. The health benefits of the lower range of the ozone standards proposed in this rulemaking are known with reasonable certainty. We demonstrate that just a partial estimate of the economic benefits that would flow from their adoption are so large as to overwhelm any realistic estimate of compliance costs.

We endorse the comments of the president of the American Thoracic Society, Monica Kraft, MD, that, “what has [been] called a 'regulatory burden' is what we physicians call a protective health standard.” http://www.thoracic.org/about/ats-perspectives/epa.php. We implore the EPA to resist the political pressure of short-sighted business interests and stay tethered to the medical science on revising the ozone standard, as is required by the Clean Air Act. To that end, UPHE joins the American Medical Association, American Academy of Pediatrics, American Thoracic Society, American Lung Association, the Sierra Club, the Environmental Defense Fund, Earthjustice, and the Natural Resources Defense Council in asking the EPA to adopt a 60 parts per billion ozone standard. We also note that, in fact, even ozone levels below that standard cannot be considered “safe” or without adverse health consequences.

Utah’s legislature seems to have accepted the arguments of the business community that the state’s air can’t be cleaned up without destroying its economy. Our organization has attempted to summarize for the legislature the science that links air pollution to impaired health and productivity. It has also summarized the economic literature showing that investment in pollution abatement produces large net economic benefits. Nevertheless, the majority in the legislature currently rejects the policy implications of this research. These legislators disregard the hazard presented by what is before their very eyes—smog so thick that it is not safe for Utah’s children to go outdoors for weeks at a time during the school year.

Our children need the tighter ozone standards on which the EPA seeks public comment in this rulemaking. We urge the EPA to adopt a primary NAAQS ozone standard of 60 ppb. We also urge it to adopt a secondary standard of 7 ppm-hours (on the w126 index) and request that any exceptions for extraordinary events be narrowly drawn. Both of the standards that we recommend are at the low end of the range that the EPA’s own Clean Air Scientific Advisory Committee (CASAC) has long recommended.

II. BACKGROUND

The Wasatch Mountains form a 90-mile spine running down the center of northern Utah. Most of Utah’s 2.8 million people live along the western edge of those mountains. They occupy a string of high-altitude valleys that are hot, dry, and exposed to high levels of ultraviolet radiation much of the year. They are perfectly situated for automobile exhaust and oil refinery emissions to form and then trap ozone. The valleys of the Wasatch Front are developing in a manner that makes them increasingly resemble Los Angeles--vast, low-density development that is dependent on the automobile. Like Los Angeles, from downtown Salt Lake City, smog now obscures the 12,000-foot peaks that surround the valley for much of the year. In terms of ozone, the Wasatch Front has a liability that Los Angeles doesn't—the Great Salt Lake. Ultraviolet rays reflect off its vast surface and combine with Volatile Organic Compounds emitted by flue gas from half a dozen oil refineries on its eastern shore to amplify the automobile-induced smog that hangs over the Salt Lake Valley.

Utah's most populous counties (Weber, Davis, and Salt Lake Counties) now outinely exceed current NAAQS primary standards for ozone, although there are a few monitors on the periphery of the core developed areas of those counties that do not show violations. (State of Utah Division of Air Quality: Area Designations at 13-14).

A. Effects of Exposure to Ozone on Healthy Populations

There is substantial body of research employing epidemiological studies and animal modeling that establishes with reasonable certainty the following harmful effects of human exposure to ground-level ozone.

Respiratory damage. Short-term ozone inhalation results in a loss of maximal inspiration, increase in airway resistance, and causes a broad array of respiratory symptoms consistent with airway inflammation and damage—coughing, throat irritation, chest pain, shortness of breath and wheezing. http://www.epa.gov/apti/ozonehealth/population.html. Ozone does this by oxidizing or "burning" the mucous membranes and the epithelial cells that line the lungs. Because ozone has limited solubility in water, the upper respiratory tract is less effective in scrubbing inhaled ozone before it penetrates deeper into the body than it is for more water soluble pollutants such as sulfur dioxide (SO_2) or chlorine gas (Cl_2). Consequently, most inhaled ozone reaches the lower respiratory tract and dissolves in the thin layer of epithelial lining fluid (ELF) throughout the conducting airways of the lungs. This aggravates respiratory diseases like asthma, and impairs lung function in both the vulnerable and the healthy segments of Utah's population.

Cardiovascular damage. When ozone (O_3) comes into contact with the human body, it reacts directly with organic double bonds, causing a wide variety of damage. As ozone degrades to O_2, it gives rise to oxygen free radicals, which are highly reactive and capable of damaging many organic molecules. Ozone and/or its reactive intermediates injure the epithelial cells that line the airway. This is followed by an inflammatory cascade. Among ozone's reactive intermediaries are cholesterol-derived metabolites that facilitate the build-up and pathogenesis of atherosclerotic plaques (a form of heart disease). (Smith, L.L., 2004)

Stroke. Ozone is associated with increased rates of strokes. Current-day concentrations of ozone increased rates of strokes 1.9% per interquartile increase in ozone concentrations in Allegheny County, PA. (Xu XI, Sun, Y., et al. 2013).

Neurological damage. There is emerging evidence that, like particulate matter, ozone triggers a stress response in the brain, and may alter neurologic repair mechanisms. (Gackiere, F., et al., 2011); (Gonzalez-Pina, R., et al., 2008).

Autism. Of several air pollution components that showed a correlation between exposure during infancy and rates of autism, ozone had the strongest. Specifically, for every 10 ppb, rates of autism rates increased 59%. (Jung, C.R., et al., 2013) A study of expectant mothers in Los Angeles from 1995 through 2006 found that for each 11.54 ppb increase in ozone concentration to which they were exposed, the odds that they would give birth to a child with autism disorder increased by from 12% to 15%. (Becerra, T., et al., 2013).

Diabetes. Numerous studies have been published showing a significant correlation between several air pollution components and diabetes, insulin resistance, and obesity. Ozone has been implicated independently of particulate matter. (Vella, R.E., et al. 2014).

Metabolic Syndrome. Metabolic syndrome is a set of conditions that combine to present a high risk of developing diabetes and heart disease. The conditions include atherogenic dyslipidemia [e.g., low HDL, high triglycerides], abdominal obesity, elevated blood sugar, insulin resistance, proinflammatory state [e.g., high C-reactive protein], and prothrombotic state [e.g., high fibrinogen and (PAI)-1]. Recent research indicates that exposure to ozone increases the incidence of glucose intolerance and metabolic syndrome. (Bass, V., et al., 2013).

Susceptibility to infection. Ozone makes the lungs more susceptible to infection. This is likely due, in part, to a decrease in macrophage function that has the potential to interfere with host defenses. (Hollingsworth, J.W., et al., 2007)

Systemic effects. The inflammatory cascade that is commonly induced by inhaling ground-level ozone can make the lung more permeable to particulate matter and allergens. Ozone reaction products, as well as mediators produced in the lung, enter the blood. Through this mechanism, ozone exposure leads to systemic effects on the body. This is one plausible explanation for the observed synergistic impacts between ozone, NO_X and particulate matter, on human health. (Kurhanewicz, N., et al., 2014); (Yu, I.T., et al., 2013).

B. Effect of Ozone Exposure on Sensitive Subpopulations.

Ground-level ozone impairs the lung, heart, and other functions of healthy adults in the ways described above. The American Lung Association estimates that at least one-third of Utah's residents are especially vulnerable to the impacts of ozone. Of a population of 2.8 million, more than 1 million are under 18 or over 64. Applying national averages to Utah's population indicates that about 230,000 have asthma, 494,000 have cardiovascular disease, and roughly 900,000 have metabolic syndrome.

The elderly and women. There is strong evidence that the elderly, women, and diabetics are especially vulnerable to the effects of short-term exposure to ozone. (Stafoggia, M., et al., 2010) For example, a study concludes that for every 10 ppb increase in ozone concentration, mortality rates in the elderly to increase 1.27%. (Bell, M., Zanobetti, A., Dominici, F., 2014). For women over 70 years of age, each increase of 5 ppb of ozone has been associated with an increase in emergency room visits for cardiopulmonary symptoms or stroke of 7.8%. For men of the same age group, the rate of increase was 3.9%. (Carlsen, H., et al., 2013)

Diabetics. Numerous studies have been published showing a significant correlation between several air pollution components and diabetes, insulin resistance, and obesity. Ozone is implicated independently of particulate matter. (Vella, R.E., et al. 2014).

Metabolic syndrome. Recent research concludes that those exhibiting metabolic syndrome (about one-third of Utah's population) are slower than the healthy segment of the population to recover from the effects of short-term exposure to ozone, and much slower to recover from such exposure to a combination of ozone and fine particulate (PM2.5) pollution. (Wagner, J., et al., 2014). Both pollutants routinely exceed current NAAQA primary standards in Utah's most populous counties (Weber, Davis, and Salt Lake Counties).

Fetuses. Pregnant women exposed to ozone give birth to infants with lower birth weight. (Salam M, et al., 2005). This effect is independent of exposure to fine particulates and carbon dioxide. Animal studies imply that prenatal exposure to ozone disrupts the function of neurotransmitters in newborns (Gonzalez-Pina, R. et al., 2008) and increases the incidence of glucose intolerance and metabolic syndrome in newborns. (Bass, V., et al., 2013); (Toxicol Appl Pharmacol., 2013). A study of expectant mothers in Los Angeles from 1995 through 2006 found that for each 11.54 ppb increase in ozone concentration to which they were exposed, the odds that they would give birth to a child with autism disorder increased by between 12-15%. (Becerra, T., et al., 2013).

Those with pulmonary disease. Physiologic and symptomatic disabilities due to pre-existing lung diseases like asthma, emphysema, and chronic bronchitis are exacerbated by ozone. (Peng, R.D., et al., 2013)

III. The Need for Tightened Ozone Standards

A. The Primary (Sort Term) Standard Should Be 60 ppb or Below

The Clean Air Act is based on an assumption that there is a threshold concentration of air pollutants below which there are no significant health effects, even for the most susceptible groups. While this assumption seemed to be reasonable at the time, more sophisticated and targeted studies are documenting harmful effects at lower and lower ambient concentrations. We provide a sample of those studies below.

The primary ozone standard is based on a three-year average of the fourth-highest ozone reading over an eight-hour period. The EPA's proposal to tighten the primary ozone standard from 75 ppb to between 65 and 70, ppb, is not strict enough to be consistent with the available science. In 2008, when the 75 ppb standard was adopted, CASAC, the EPA's own scientific advisory panel, had already concluded that a tighter standard was necessary to protect public health. At that time, studies demonstrated that asthmatics show adverse effects, and mortality rates significantly increase, in response to short-tern exposure of 40 ppb. See, e.g., (Dahl, R., 2006).

Numerous epidemiological studies demonstrate that ozone still has significant mortality effects down to 60 ppb and below. For example, studies estimate that between 5,210 and 7,990 premature deaths would be avoided by lowering the current primary ozone standard from 75 ppb to 60 ppb. (Berman, J.D., et al., 2012). Concentrations as low as 60 ppb have been shown to cause decreases in lung function as measured by the FEV1 ratio.[1] (Schelegle, E., et al., 2009). A study of the effect on healthy adults of breathing ozone at 60 ppb for a period of 6.6 hours during which they exercised intermittently, found that it significantly reduced lung function and increased neutrophils in sputum by 15.7% within a day after exposure. (Kim, C., Alexis, N., et al.,

[1] FEV1 is the maximal amount of air you can forcefully exhale in one second. It is then converted to a percentage of normal.

2011). As already noted, a study of pregnant women exposed to ozone found that such exposure caused infants to be born with lower birth weights. This study suggests even a 60 ppb threshold would not be sufficiently protective of this adverse public health outcome. (Salam M, et al., 2005).

One of the largest epidemiological studies of the effects of short-term ozone exposure done in the United States found that there was a 0.5% overall excess risk in daily non-accidental mortality for each 20 ppb average on the same day. The effect was greatest on the day of exposure. There were smaller residual effects for several subsequent days. (Bell ML, McDermott A, Zeger SL, Samet JM, Dominici F., 2004).

Subsequent studies reveal significant correlations between mortality and the previous day's exposure at half of the 20 ppb increment. (Bell ML, Peng RD, Dominici F., 2006). A series of studies has shown that increases in short-term ozone concentrations of as little as 10 ppb increase daily mortality by from 0.25%-0.87%. (Bell, M., Kim, J., Dominici, F., 2007); (Bell ML, Dominici F, Samet J, 2005); (Bell, M., McDermott, A., Zeger, S., et al., 2004).

A more recent and more sophisticated approach to modelling the effect of short-term exposure to ozone recently provided evidence that there is an even more powerful association between small increases in ambient ozone concentrations and mortality than the results of the series of studies summarized above. Both nitrogen dioxide (NO_2) and ozone (O_3) are powerful oxidants in ambient air that are intimately linked through atmospheric chemistry and which continuously interchange over very short timescales. This provides a strong, a priori, reason for modeling O_3 and NO_2 together in epidemiological studies, rather than modeling either of the two pollutants separately.

A time-series study of the effects of O_3 and NO_2 used both single-oxidant models and a composite-oxidant model (in which $O_3 + NO_2 = O_X$) and compared the two modeling approaches. The dosage investigated was a 10 ppb increase in mean 24-h concentrations of Ox. Analyzing the effects of a 10-ppb-increase in the dosage of O_X, using the composite oxidant model, the study concludes that the O_3 component was responsible for a 1.54% increase in mortality, while the NO_2 component was responsible for an increase in mortality of 1.07%. (These results were consistent with the estimated 1.30% increase for which the O_X composite was found responsible.) Importantly, single-oxidant models estimated substantially weaker effects on mortality. Those models estimated that O_3 was responsible for a 0.87% increase in mortality, while NO_2 was responsible for a 0% increase. (Williams ML, Atkinson RW, Anderson HR, Kelly FJ, 2014)

These composite oxidant model results were robust for both summer increases and winter decreases in the composite oxidant. This modelling approach captures the simultaneous impact of both oxidants while avoiding many of the potential statistical biases associated with more traditional two-pollutant models. It therefore provides a better guide for pollution-control policy than the results of the earlier set of two-pollutant models of mortality effects that were summarized above.

Ozone levels far below the current NAAQS have been found to have adverse impacts on human health in ways other than premature mortality. For example, low-level exposures have been found to obstruct the airway in healthy adults. (Thaller, e., et al., 2008) At minimal concentrations, ozone is associated with impaired cardiovascular performance. Each increase of 17 ppb of ozone has been shown to decrease aerobic fitness scores by 1.5%. (Cakmak S., Dales R., Leech J., Liu L., 2011). As noted in the previous section, a study of expectant mothers in Los Angeles from 1995 through 2006 found that for each 11.54 ppb increase in ozone concentration to which they were exposed, the odds that they would give birth to a child with autism disorder increased by between 12-15%. (Becerra, T, et al., 2013).

Each increase of 5 ppb of ozone has been shown to increase the need for angina medication (glyceryl trinitrate) by 9.4% over the three days following exposure. (Finnbjornsdottir, R., et al., 2013). These results were corroborated by the companion study, referenced above, which found that for women over 70 years of age, each increase of 5 ppb of ozone was associated with an increase in emergency room visits for cardiopulmonary symptoms or stroke of 7.8%. (Carlsen, H., et al., 2013). Other studies corroborate these effects. (Xu X, Sun Y, Ha S, Talbott EO, Lissaker CT, 2013).

To quote from the EPA, “Limited exposure-response modeling suggests that if a population threshold for these ozone effects [mortality] exists, it is likely near the lower limit of ambient ozone concentrations in the United States.” http://www.epa.gov/apti/ozonehealth/population.html. This is consistent with the previously established and more thoroughly documented effect of particulate pollution on mortality, which has been demonstrated to be linear, without a threshold below which harm is no longer found.

The European Union’s short-term ozone standard is 60 ppb. The World Health Organization’s recommended standard is 51 ppb. Short-term standards at 60 ppb or below are much more consistent with the epidemiological science than the 65-70 ppb standard that the EPA is officially proposing. According to EPA’s own impact analysis published in 2008, a primary standard of 70 ppb would, by the year 2020, prevent twice as many premature deaths, prevent nearly as many heart attacks, avoid 2.5 times as many hospital and emergency rooms visits and missed school and work days as the current 75 ppb standard. At the same time, the EPA estimates that a primary standard of 60 ppb would prevent about 5 times as many premature deaths, about 4 times as many heart attacks, about 8 times as many hospital and emergency room visits, and 9 times as many missed work and school days. Summarized in Weinhold, B., 2010.

As the research described above demonstrates, the many groups that are especially sensitive to exposure to ground-level ozone comprise a minority of the population, but a very large minority. In addition, there is wide personal variation in the degree to which individuals within the same age group and general state of health respond to acute ozone exposure. The public policy implication to draw from this is that the national standards adopted should be sufficiently protective for those most sensitive. Clearly, if the EPA were to follow the science, it would adopt a standard of 60 ppb or below. This is especially true since the Clean Air Act requires the EPA to provide a margin of safety when setting National Ambient Air Quality Standards.

B. The Secondary Standard Should Be 7 PPM-Hours (On The W126 Index) With Narrowly Drawn Exceptions For Extraordinary Events.

The primary ozone standard is based on a three-year average of the fourth-highest ozone reading over an eight-hour period. This emphasizes the desirability of avoiding exposure to short-term peaks over the need to avoid long-term exposure. This short-term emphasis may be appropriate for the eastern half of the United States where ozone concentrations are typically only a problem in the summer and its flanking months. But a standard formulated this way doesn't address the problem of long-term exposure.

Most of the inland western United States has ozone concentrations year round that are above the World Health Organization's short-term standard of 51 ppb. The Wasatch Front, in particular, exceeds the current primary standard of 75 ppb at most monitoring stations. The EPA assumes that those who live in the West are adequately protected because short-term peaks above its own standard are relatively infrequent.

This assumption is not warranted by the science. Epidemiological studies show that increases in long-term ozone exposure of 10-15 ppb result in increased mortality. Because residents of the West run a greater risk of harm from long-term, low-level exposure, the EPA should adopt a primary ozone standard that is strict enough to protect us from those risks.

Long term exposure to ozone is associated with mortality from all causes, with some studies indicating there is no threshold below which that relationship is no longer found. (Atkinson RW, 2012). Chronic exposure to ozone increases the risk of death from respiratory causes by 4% for each 10 ppb increase is ozone concentration. (Jerrett M, Burnett R, Pope CA, et al., 2009).

Research suggests that long-term ozone exposure might play a role in the development or progression of chronic lung disease and/or asthma, or the impairment of overall respiratory performance in otherwise healthy subjects. For example, a study found that for every increase in ozone of 10 ppb cumulative average over the previous six days, rates of an initial diagnosis of asthma increased 5%. (Wendt JK, 2014). Increases in emergency room visits for pediatric episodes of asthma are associated with modest increases in ozone during the few days prior to the visit. (Gleason J, et al., 2014).

The EPA itself, recognizes the need to take the risk to human health from long-term exposure to ozone by noting that "In spite of the inconclusive nature of the epidemiologic literature, the repeated cycles of damage, inflammation, and repair in humans and the morphological findings from the animal toxicological studies suggest that it would be prudent to avoid repeated short-term exposures, particularly in young children, until more is known about the effects of long-term ozone exposure." http://www.epa.gov/apti/ozonehealth/population.html.

C. The Mountain West Has a Special Need Tightened Ozone Standards

The secondary ozone standard measures cumulative, rather than average, exposure over several years, and is designed to regulate long-term, lower levels of ozone pollution. Currently, the primary and the secondary standard are identical. The EPA seeks comment on a separate secondary standard of between 7-13 ppm-hours (on the w126 index).

The Mountain West has a particular vulnerability to long-term, low-level concentrations of ozone because of its geography. The region is characterized by high-altitude, low humidity, and temperatures that are rising faster in response to climate change than is observed in the East. All of these characteristics facilitate ozone formation, leading to the highest background levels of ozone of any major geographical region in the country.

During heat waves, ozone concentrations rise because plants absorb less ozone. Ground level ozone interferes with photosynthesis and stunts the overall growth of some plant species, significantly reducing agricultural yields. Elevated ozone retards the growth of softwood trees and leaves them vulnerable to pests and disease. It facilitates the depredations of bark beetles, in particular, which are decimating forests in the Mountain West essentially unchecked until the supply of host tree species is consumed.

Ground-level ozone has a significant climate-forcing effect. Though not as potent as CO_2, the IPCC's Fourth Assessment report identified ozone as having about 20% of the warming effect of carbon dioxide. While it persists, ground-level ozone is 1,000 more potent than CO_2 as a greenhouse gas, but it degrades much more quickly than CO_2. For this reason, radiative forcing by ozone is less strong than CO_2 on a global scale, but can be 50% stronger than CO_2 on a regional scale. (NASA Goddard Homepage For Tropospheric Ozone). For reasons explained below, ozone is likely to have such an effect in the Mountain West.

The rise in ozone concentrations in the growing population centers of the Mountain West has created a climate-change feedback loop. Rising heat, drought, and elevated ozone turn our forests to kindling, and the resulting fires elevate ozone. Climate warming has doubled the length of the fire season in the Mountain West since 1970. During that time, the annual burned area in its mid-altitude pine forests has increased by 650%. Throughout the summer, smoke-filled air from regional forest fires has become so common as to be the rule, rather than the exception. If the EPA treats all brush and forest fires in our region as "extraordinary events" for purposes of meeting ozone standards, that exception could apply to such a large portion of the ozone season as to nullify the benefits of the primary standard. The EPA should adopt a secondary ozone standard that acknowledges this risk and is designed to mitigate it. A secondary standard of 7 ppm-hours (on the w126 index) *with* narrowly drawn exceptions for extraordinary events would do the most to dampen this feedback loop.

In the past, high concentrations of ground-level ozone in the Mountain West were confined to population centers, as auto and industrial emissions reacted in the presence of sunlight and heat. High concentrations of ground-level ozone are now appearing outside of our cities, and in winter as well as summer. Thousands of oil and gas wells have recently been drilled in southwest Wyoming, northwest Colorado, and northeastern Utah, with thousands more planned. Fugitive emissions of nitrogen oxides, methane and other VOCs, and carbon monoxide from this activity have led to eight-hour ozone concentrations above 100 ppb across this remote region, even in the dead of winter. These levels exceed those now experienced in Los Angeles—formerly the nation's worst ozone violator.

It is common for Ozone to form in places that are far from where its precursors are emitted.[2] The concentration of ozone precursors is building where Utah, Wyoming,

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[2] For example, the nation's highest concentrations of ozone are recorded in California's Central Valley, even though the Central Valley emits relatively small amounts of ozone precursors. High volumes of ozone precursors are emitted by automobile traffic in the San Francisco Bay and Los Angeles areas and funneled into the Central Valley where they are trapped by the topography.

and Colorado intersect to the point that it threatens to spill over into the heavily populated valleys of Utah and Colorado, and to turn the skies over Grand Teton and Yellowstone Parks grey. Endless blue vistas, stretching 100 miles in some directions, were once the hallmark of Canyonlands, Arches, Bryce Canyon and Zion National Parks. Now, ozone levels above 70 ppb are routinely recorded throughout the state, even in its most remote areas, such as Canyonlands and Great Basin National Park. See State of Utah, Department of Environmental Quality, Division of Air Quality, Memorandum No. DAQ-085-14, September 18, 2014, available at http://airquality.utah.gov/Public-Interest/Public-CommenHearings/Docs/2014/10Oct/ITEM_VI_R307-501_to_504.pdf, at 3. Skies in these areas fill with haze much of the summer, as the massive, chronic, yellow-brown palls that have formed over Salt Lake City, Phoenix, and Las Vegas encroach.

This is a major loss to the quality of life in the Southwest. In setting a secondary ozone standard, its mitigating effects on the visual blight descending on this part of the Mountain West is an important to benefit to consider.

In addition to its potential benefits for human health, and on the iconic viewsheds of the Mountain West, a tightened secondary ozone standard would have important mitigating effects on regional and global warming. The IPCC's Fourth Climate Assessment states that

> Because of the intimate relationship between global warming and adverse public health impacts, reducing ozone then will have public benefit beyond what is identified in all of the medical research cited in our report, and well known to the scientific advisers to the EPA (CASAC).

A secondary ozone standard of 7 ppm-hour is needed not only to mitigate the physiological harm to people and vegetation from long-term, low-level exposure to ozone, but to mitigate regional climate change, and to recover the blue vistas that once distinguished America's most iconic national parks.

IV.The EPA's Estimate of Benefits is Substantially Understated

Whenever tightened pollution controls are proposed, defenders of the status quo are quick to argue that we can't afford them. They say that while we could require industry and transportation to employ cleaner technologies, the expense of doing so would slow economic growth and reduce employment. They assume that the public policy choice is a Hobson's choice, in which we must either choose to protect air quality and human health, or protect the economy.

Recent studies strengthen the evidence that this is a false choice. These studies imply that reducing pollution is much more likely to be a net benefit, rather than a net cost, to the economy. Reducing pollution doesn't just improve workers' health and wellbeing, it improves their productivity--and the economic value of this improved productivity can be measured.

It has been customary in the past to think of environmental protection as purely a tax on producers and consumers to be weighed against the consumption benefits associated with improved environmental quality. Environmental protection, however, is more legitimately viewed as an investment in human capital in the same sense that investments in education and information technology improve the productivity of the nation's workforce. The contribution of pollution mitigation to firm productivity and economic growth should be incorporated in the calculus of policy makers. With respect to ozone, specifically, new studies show that reducing ambient concentrations even by small amounts can substantially increase worker productivity, even where base levels of ozone are below current air quality standards.

Excluding California, the EPA estimates that the social benefits of tightening its primary ozone standard from the current 75 ppb to 65 ppb would be as much as $38 billion by 2025, compared to compliance costs of $15 billion. This estimated benefit is far too low because it considers only externally-manifested health impacts--impacts that are highly visible and easily modeled such as deaths, emergency room admissions, and missed workdays. This leaves out of the analysis any benefits that are manifested internally, such as improvements in wellbeing and productivity, even though these effects apply to populations across the board, and are therefore potentially much larger. Modelling internally-manifested benefits such as the productivity impacts of reducing pollution is a relatively new field, but is of crucial importance.

A 2012 study published in the American Economic Review modelled the effect of variable ozone concentrations on the productivity of field workers in California's central valley. (Graff-Zivin, J., Neidell, M., 2012). It demonstrated a statistically robust dose response between ozone concentrations and productivity. The more physical exertion the various tasks required, the greater the measured effect was. This result is consistent with ozone's depressive effect on respiratory capacity that has been amply documented by laboratory tests.[3]

The study found that a decrease in ozone concentration of 10 ppb increases the productivity of field laborers in California's central valley by 5.5%, on average. The authors apply the estimated productivity increase associated with a 10 ppd reduction in ozone concentrations (in the range that this rulemaking in now considering) to the compensation paid to agricultural laborers nationwide in 2007. It concludes that such a reduction in ambient ozone concentrations would have saved approximately $700 million in agricultural labor costs in 2007.

This approach can be applied nationally for professions in addition to agricultural labor that are also performed predominantly outdoors and require enough physical exertion over the workday to raise respiration and heart rates above resting rates on a sustained basis. The U.S. Bureau of Labor Statistics compiles mean annual wage and employment data broken down by 400 industries and 800 job classifications. This highly disaggregated dataset is sufficient to identify, with reasonable precision, job classifications that are performed predominantly outdoors and can be expected to require sustained periods of physical exertion during the majority of the workday. See BLS May 2013 Occupational Employment Statistics.

To obtain an estimate of the total value of labor performed in qualifying professions in 2013, we multiplied employment totals in professions that meet this criterion by their corresponding mean annual salary. Table ^ displays the list of qualifying professions including descriptions taken from the BLS's May 2013 Occupational Employment Statistics report, total employment in each profession, its mean annual salary. Total annual salaries of qualifying labor came to approximately $400 billion in 2013.

Because this $400 billion in wages excludes benefits (health care, retirement, etc.) it should be multiplied by an appropriate factor to include the value of benefits. An appropriate factor is 1.33, since the most relevant industry category for which the BLS estimates benefits is the "Natural Resources, Construction, and Maintenance" category. Benefits paid in that industry average 33.3% of salaries. (BLS 2014 Table of Benefits).

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[3] Econometric regression models have also been used successfully to estimate the effects of pollutants other than ozone on the productivity of workers. For example, reducing ambient air concentrations of PM2.5, which penetrate buildings at high rates, has been estimated to have significant effects on the productivity of factory workers at concentrations well below the current NAAQS for PM2.5. This study concludes that increased factory worker productivity produced labor savings that were equal to one third of all of the economic benefits associated with the nationwide decline in PM2.5 ambient air concentrations from 1999 to 2008. (Chang, T., Graff Zivin, J., Gross, T., Neidell, M., 2014).

Total salaries and estimated benefits of qualifying workers in 2013 come to $533.2 billion. This figure should then be reduced to $133.3 billion to reflect the fact that, averaging across the country, only three months of the year exhibit substantially elevated ambient ozone concentrations. This adjusted total of $133.2 billion is then multiplied by 5.5% to obtain the value of the increased productivity (or labor saved) that the models predict would result from reducing ambient ozone concentrations by 10 ppb. The nationwide savings that would have resulted from increased labor productivity in 2013, therefore, rounds to $7.3 billion.

Between 2015 and 2025, the savings would come to $73.3 billion without adjusting for net present value. A discount rate of 3% is a reasonable assumption for purposes of obtaining the net present value of the $73.3 billion that would be saved over ten years. Applying this net present value, the nationwide labor savings obtained by reducing ambient ozone concentrations by 10 ppb would round to $61.9 billion. This estimate of internally-manifested savings exceeds the EPA's entire estimate of externally-manifested savings of $38 billion associated with a reduction of ambient ozone concentrations by 10 ppb. This result forcefully argues for reducing the primary NAAQS for ozone from 75 ppb to 60 ppb or below for its large net economic benefits, as well as for its benefits to public health.

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