DAQ-008-15

COMMENTS OF UTAH PHYSICIANS FOR A HEALTHY ENVIRONMENT
ON THE UTAH DEPARTMENT OF AIR QUALITY'S PROPOSAL TO
AMEND THE UTAH STATE REGIONAL HAZE STATE IMPLEMENTATION PLAN

(May 1, 2015)

Utah Physicians for a Healthy Environment (UPHE) is an association of more than 300 physicians and other health care professionals, but it also includes industrial and environmental engineers. All of its members 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 disruption that are largely the result of relying on fossil fuels as our main source of energy. Many of the illnesses that our health professionals treat are caused by, or exacerbated by, environmental pollution. For this reason, we offer our expertise to inform the debate about how society should deal with the threat that air pollution presents to human health.

I. INTRODUCTION

The direct purpose of the EPA's regional haze air quality standards are aesthetic. They are designed to protect the ability of the public to see America's

national parks and the best of its wilderness areas under blue skies and clear air and thereby allow the public to draw the inspiration that comes from experiencing the most iconic examples of America's natural beauty. However, there are co-benefits to cleaning the air over these portions of our State. The pollution that currently impairs the view of Utah's national parks and wilderness areas more than 75% of the time greatly compromises their cultural and economic value to our State. Reducing that pollution has enormous economic and cultural value to our State, and that value should be fully accounted for in the Utah State Department of Air Quality's decision regarding compliance with the EPA's regional haze rule. Any balanced analysis of the economic impact of complying with the regional haze rule must also, however, reflect the economic cost of the health benefits that Utah's residents would gain as a co-benefit of reducing the pollutants that currently enshroud our national parks the vast majority of the time. The main purpose of UPHE's comments is to encourage the Department of Air Quality to take the latter costs into account.

The Utah State Department of Air Quality (DAQ) seeks comments on its proposed amendment of its State Implementation Plan. The plan originally would have determined, on case-by-case basis, the best available pollution control technology to apply to each of PacifiCorp's four surviving Emery County power plants. PacifiCorp has closed its oldest and smallest Utah power plant for reasons that are unrelated to reducing regional haze. Nevertheless, according to DAQ, the closing of that plant qualifies under EPA's regional haze rules as a comprehensive alternative to requiring PacifiCorp to install the Best Available Retrofit Technology (BART) on each of its surviving Emery County power plants to reduce the level of nitrogen oxides (NO_x) that are currently emitted by those plants.

Because of their age, the Carbon Plant 1 and Carbon Plant 2 are not subject to the EPA's regional haze rules. The Carbon Plant complex is one-seventh the size of PacifiCorp's surviving plants, is not part of any regional pollution trading program, and PacifiCorp has to close it anyway to comply with the EPA's new mercury restrictions. Despite all this, DAQ believes that PacifiCorp's plan to close the Carbon Plant complex constitutes an "alternative plan" that (somewhat mysteriously) "covers" PacifiCorp's

four surviving plants, which are subject to the regional haze rules, even though the closing of the complex was unrelated to any regional haze effects. DAQ explains that characterizing the closing of the Carbon complex as an "alternative" regional haze control plan has the virtue of excusing PacifiCorp from having to apply the best available retrofit technology (Selective Catalytic Reduction) to its four surviving plants.

The EPA's regional haze rules require DAQ to base any decision not to require the installation of BART to reduce a haze-causing pollutant (in this instance NO_x) on an analysis of the following five factors:

- Available technology
- Costs of compliance
- Energy and non-air quality impacts
- Existing control equipment and the remaining useful life of the facility
- The degree of improvement in visibility reasonably anticipated to result from the use of such technology

In 2012, the EPA rejected DAQ's determination not to require PacifiCorp to install BART to reduce the level of NO_x emitted by its Emery County plants, saying that DAQ needed to apply all five factors in making that determination.

In response, DAQ's amended five-factor analysis frankly admits that its primary concern is that requiring BART to reduce NO_x would cost Utah ratepayers too much, and, if PacifiCorp were required to install BART to reduce NO_x throughout its entire

electric power network, it would hurt PacifiCorp's bottom line too much.[1] DAQ accepts PacifiCorp's assertion that applying Selective Catalytic Reduction technology to its 4 surviving Emery County plants might require an investment of $170 million each ($680 million total). Id. at 23. It argues that much of this additional expense would be passed through to Utah ratepayers.

Although DAQ admits that applying Selective Catalytic Reduction technology to the four surviving plants can be expected to reduce their NO_x emissions by at least 86%, it brushes this aside as an "uncertain" benefit to visibility at the seven Class 1 air sheds affected by the Emery County plants (Arches, Canyonlands, Zion, Bryce Canyon, the Grand Canyon, Mesa Verde, and the Black Canyon of the Gunnison).

II. THE STATUS QUO IS NOT A GENUINE ALTERNATIVE TO IMPLEMENTING THE BEST AVAILABLE NO_X REDUCTION TECHNOLOGY

DAQ's amended five-factor review is written as though only two alternative ways of complying with the EPA's regional haze rules are on the table, 1) close the Carbon Plant or 2) apply best retrofit technology to the 4 surviving PacifiCorp plants in Emery County. But these are not properly characterized as alternative haze reduction plans. The Carbon plant is 60 years old and would have had to be retired soon regardless, simply because of its age and inefficiency.

The Carbon Plant is now closed and PacifiCorp's transmission system has been reconfigured to adapt to that fact. The fact that PacifiCorp couldn't meet the EPA's new

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[1] See Staff Review of 2008 Best Available Retrofit Technology (BART) Determination, September 12, 2014 (September 12 BART Review), at 24-29. This staff review commentary makes it clear that it accepts the argument made by PacifiCorp when it was fending off a proposal that it apply BART to reduce the NO_x emitted by its Jim Bridger Plant in Wyoming. PacifiCorp complained:

> more than 80% of PacifiCorp's 6,157 total owned megawatts of coal-fueled generating capacity are BART-eligible and approximately half (more than 3,000 megawatts) of PacifiCorp's coal-fueled generating capacity will be subject to the installation of controls within the next five years . . . If EPA ultimately attempts to require four additional SCR on PacifiCorp's coal-fueled Utah units as BART controls, which is beyond the NO_x controls already installed or planned for those units under the existing Utah SIP, then the impact on PacifiCorp, its customers, and system reliability will be even more severe.

This staff review was forwarded to the Air Quality Board by its Executive Secretary in a September 16, 2014 memo recommending approval of the staff recommendation.

mercury restrictions without closing the plant is just one of many additional reasons that it had to close the Carbon Plant and that there is no realistic prospect of reopening it. Even if implementation of the new mercury rule were to be held up by pending lawsuits, the EPA's new, tighter ozone standard to be issued in October of this year is highly likely to be violated in Utah's national parks, since they are occasionally in violation of the existing, more lenient standard. Because NO_x is the main precursor to ozone formation, complying with a new, tighter ozone standard is very likely to require Utah to draw up a State Implementation Plan that includes a major reduction in the amount of NO_x emitted by PacifiCorp's surviving Emery County plants. In 2016, DAQ will have to come up with a state plan to implement the EPA's Clean Power Plan—a plan that will require some degree of substitution of low-carbon energy for that which the Emery County coal-fired plants now provide. Finally, the EPA's regional haze rule requires "reasonable progress towards achieving natural visibility conditions" by 2064. Utah's strategy for meeting this requirement will require a new State Implementation Plan in three years (2018). DAQ recognizes that it will have to incorporate substantial further reductions in NO_x in that SIP. Id. at 28. The Carbon Plant had to close and it has to stay closed if PacifiCorp is to meet any of these pending regulatory requirements.

Under these circumstances, it is disingenuous for DAQ to treat its decision regarding regional haze reduction as a choice between requiring PacifiCorp to keep its Carbon Plant closed (which is a given) or requiring it to apply best available retrofit NO_x reduction technology to its surviving Utah plants. Because there are at least half a dozen reasons that there is no realistic prospect of reopening the Carbon Plant, the real choice that the DAQ is making is whether to require to require PacifiCorp to apply best available retrofit technology (Selective Catalytic Reduction) to its surviving Emery County power plants, or to settle for the status quo with regard to NO_x emissions and take its chances that the EPA will be persuaded to go along. It is clearly the intent of the EPA's regional haze rules that best available retrofit technology (BART) be applied unless other affirmative steps are being taken to produce an equally beneficial result—

steps other than simply standing back and allowing the inevitable demise of the Carbon plant to proceed.

III. DAQ'S DECISION TO FOREGO THE BENEFITS OF LARGE REDUCTIONS IN NO_X EMISSIONS, IN EFFECT, CONSIDERS ONLY THE POLLUTER'S COSTS

Since DAQ has chosen to accept the status quo regarding PacifiCorp's NO_x emissions, and to label that the status quo an "alternative regional haze reduction plan," one would think that the DAQ would want to have a pretty compelling reason for passing up the chance to reduce NOx pollution by 86% by requiring the application of Selective Catalytic Reduction (SCR) technology, which has been demonstrated to be reliable, efficient, and cost effective.

It may be true that retrofitting the four surviving Emery County power plants with SCR would require an investment of $680 million, but DAQ's memorandum supporting its amended SIP shows little recognition that there is another side to the economic analysis. As the National Park Service notes in April 2 comments on the amended SIP, the "Big 5" national parks whose air is polluted by the Emery County coal plants bring in $750 million in tourist dollars to Utah's economy each year. The National Park Service's comments recognize that the only thing that allows these national parks to be appreciated by the traveler as breathtaking natural wonders rather than desolate wastelands is the chance to view them under clear air and blue skies.

Utah's own clean air rules recognize this as well in their articulation of the State's basic policy. Utah's Visibility SIP, Section XVII.J says:

> The State recognizes that visibility and the ability to see the great scenic views in Southern Utah is a rare and unique treasure and should be preserved, both for the benefit and pleasure of Utah residents, and to support our large tourist industry. In addition to the distance one can see, the clarity, color, and detail of the visible features are also important.

Policy statements are one thing, but implementation is another. Currently, the Park Service notes, the Colorado Plateau's Big 5 national parks are so heavily polluted that the odds that a traveler will be able to view these parks haze free is no better than

one day in four. This means that the odds that a traveler will receive full value for the time and money that he or she has invested in visiting any of the Big 5 is 25% or less. According to the Park Service, the Big 5, on average, is obscured by haze 75% of time, and its crown jewel (Zion) is obscured by haze 80% of the time.

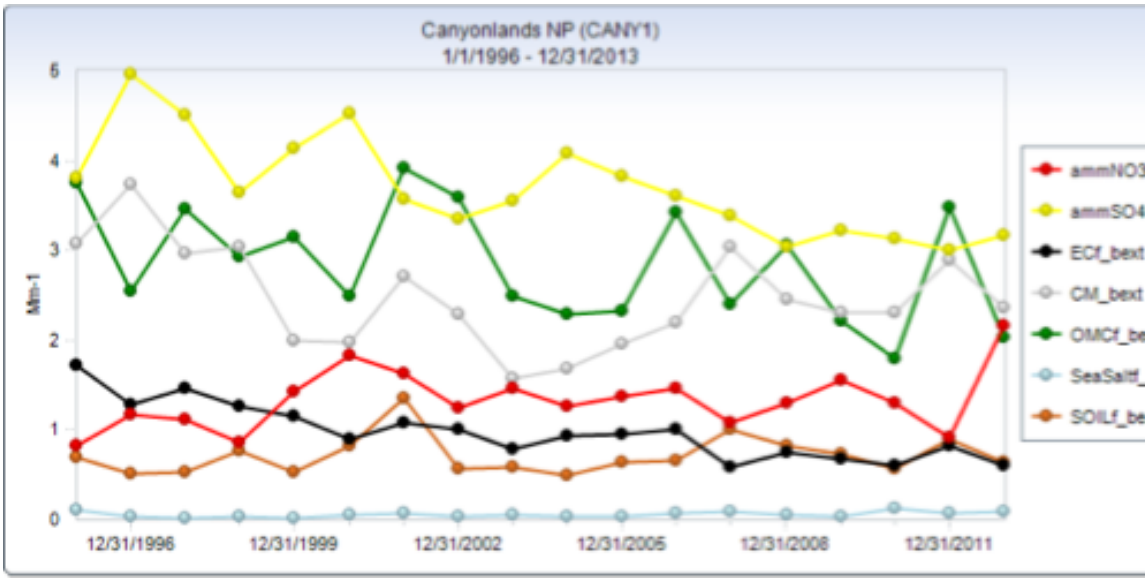
The Big 5 is a unique concentration of natural wonders that is unmatched anywhere else in the world. Their enormous cultural and economic value, however, is far less than what it could be if it were not for the polluted air in which they are chronically engulfed. Laboring under that handicap, it is remarkable to think that they bring in $750 million a year. Think of what they would be worth to the State if the percentage of the time that those 5 renowned national parks could be experienced haze free could be doubled from the current one-fourth of the time to one-half of the time. It is not unreasonable to think that that might double their economic worth to our State—adding another $750 million each year to Utah's economy--as satisfied visitors report back to their home state or home country that they have at least an even chance of seeing the natural spectacle that they came to see.

IV. DAQ UNDERESTIMATES THE LIKELY EFFECTIVENESS OF REDUCING NOX EMISSIONS BY 86% IN CLEARING THE AIR OVER UTAH'S NATIONAL PARKS

Reducing NO_x emitted by the Emery County power plants by 86% might not double the number of days that the Colorado Plateau's parks and wilderness could be experienced haze free. Its air-clearing effect, however, should be substantial.

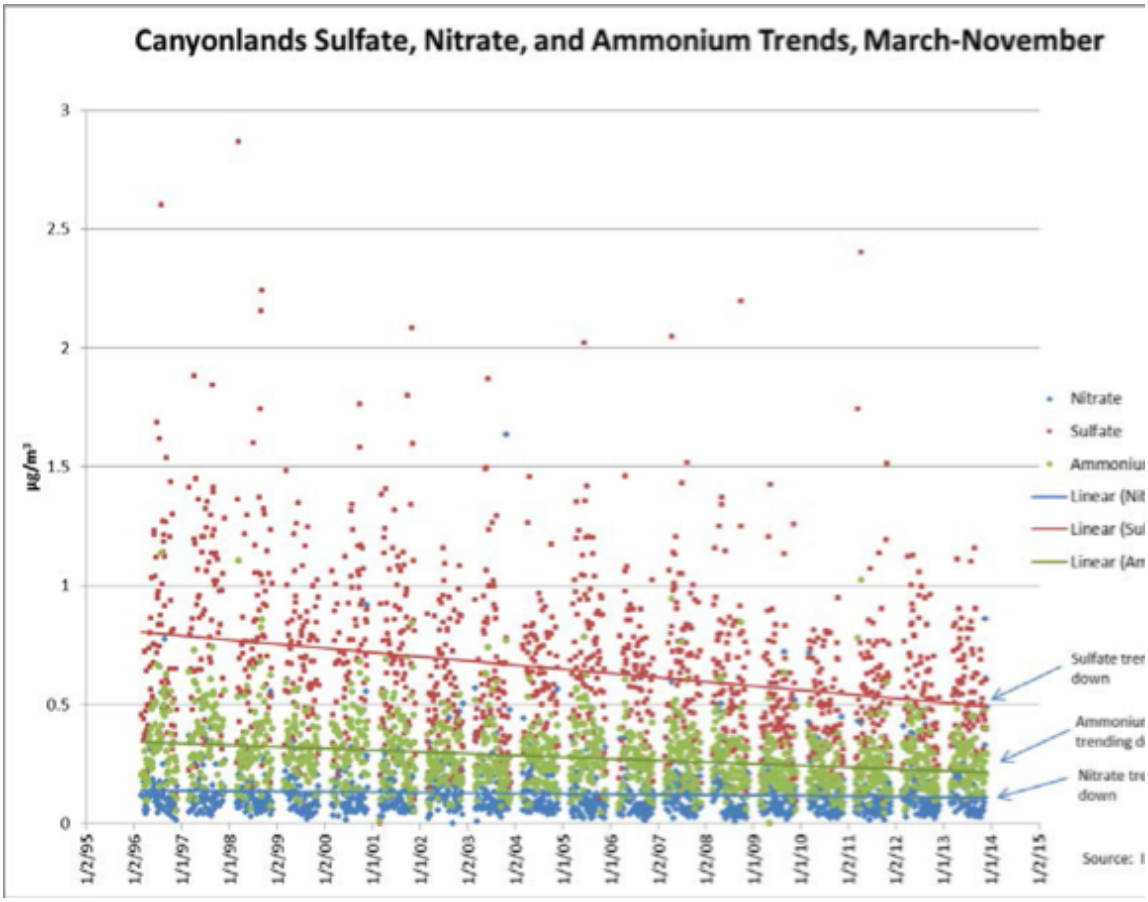
Figure 1 at page 1 of the DAQ staff's September 12, 2014 BART Review Memo is reproduced below. It shows the contributions of the major sources of visibility impairment at Canyonlands National Park, the park most affected by the Emery County power plants. The figure shows that sulfate (in the form of $ammSO_4$) is the most significant contributor to the haze at Canyonlands, but, thanks to recently implemented control measures, it is losing its dominant role. Fire (OMC), dust (CM), and nitrates ($ammNO_3$) are the next most important contributors to haze. In the most recent year reported (2012), nitrates had about two-thirds of the impact on haze that sulfates had. Smoke and dust are not within the DAQ's direct control, but nitrates are. If there is to

be significant progress in freeing the Big 5 scenic attractions from the smog that normally enshrouds them, Figure 1 indicates that it will have to come from measures that reduce NO_x, not just SO_2.

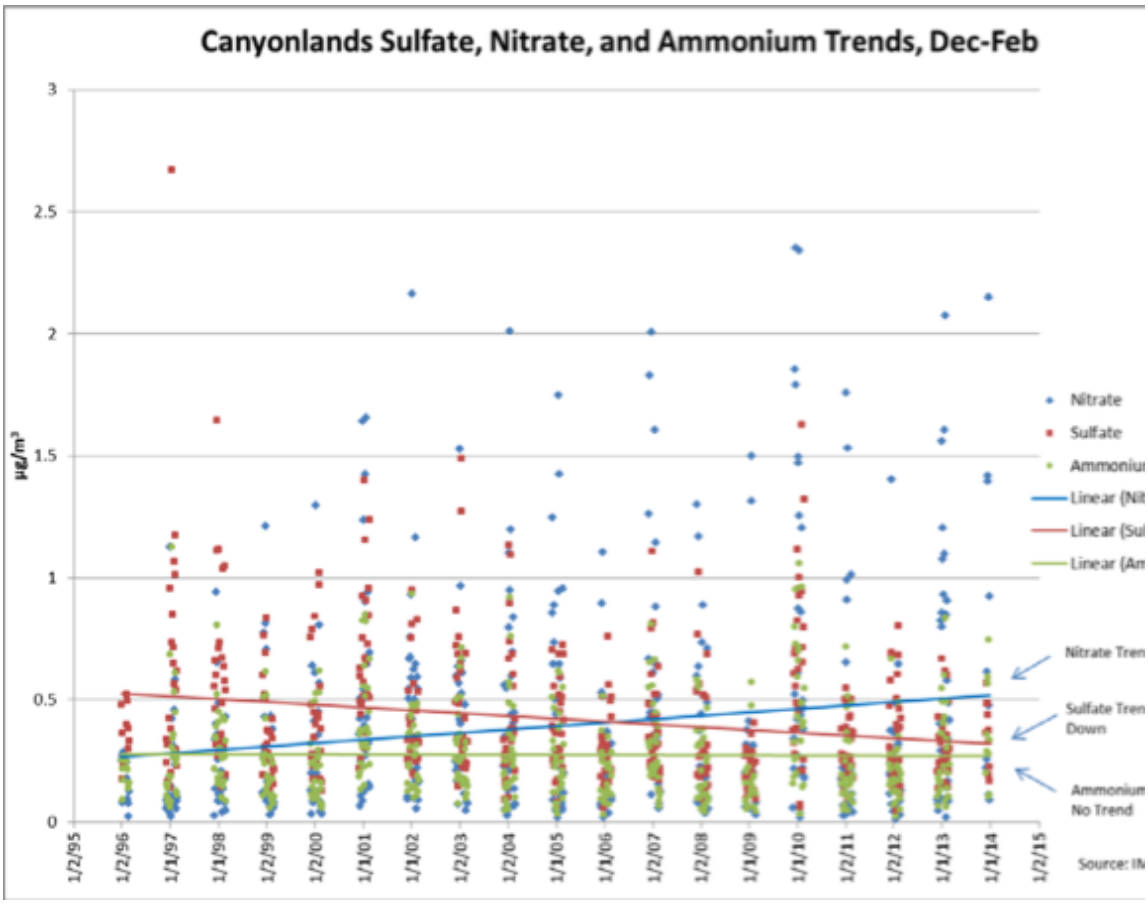


DAQ's September BART review tries to build a case for doing nothing with respect to NO_x by noting that there were significant reductions in NO_x emissions by the Emery County plants as a result of partial emissions controls that were installed after 2008.[2] It notes that on a yearly basis, the level of a nitrates at Canyonlands has been declining, as one would expect if emissions of NO_x are declining. See graph from Figure 11 at page 14 of DAQ's September 12 BART Review Memo, which is reproduced below.

[2] The controls that DAQ required under its regional haze SIP in 2008 were "low NOx burners and overfire air (LNB + OFA). They remove less than half of the NO_x emissions that BART technology would remove.



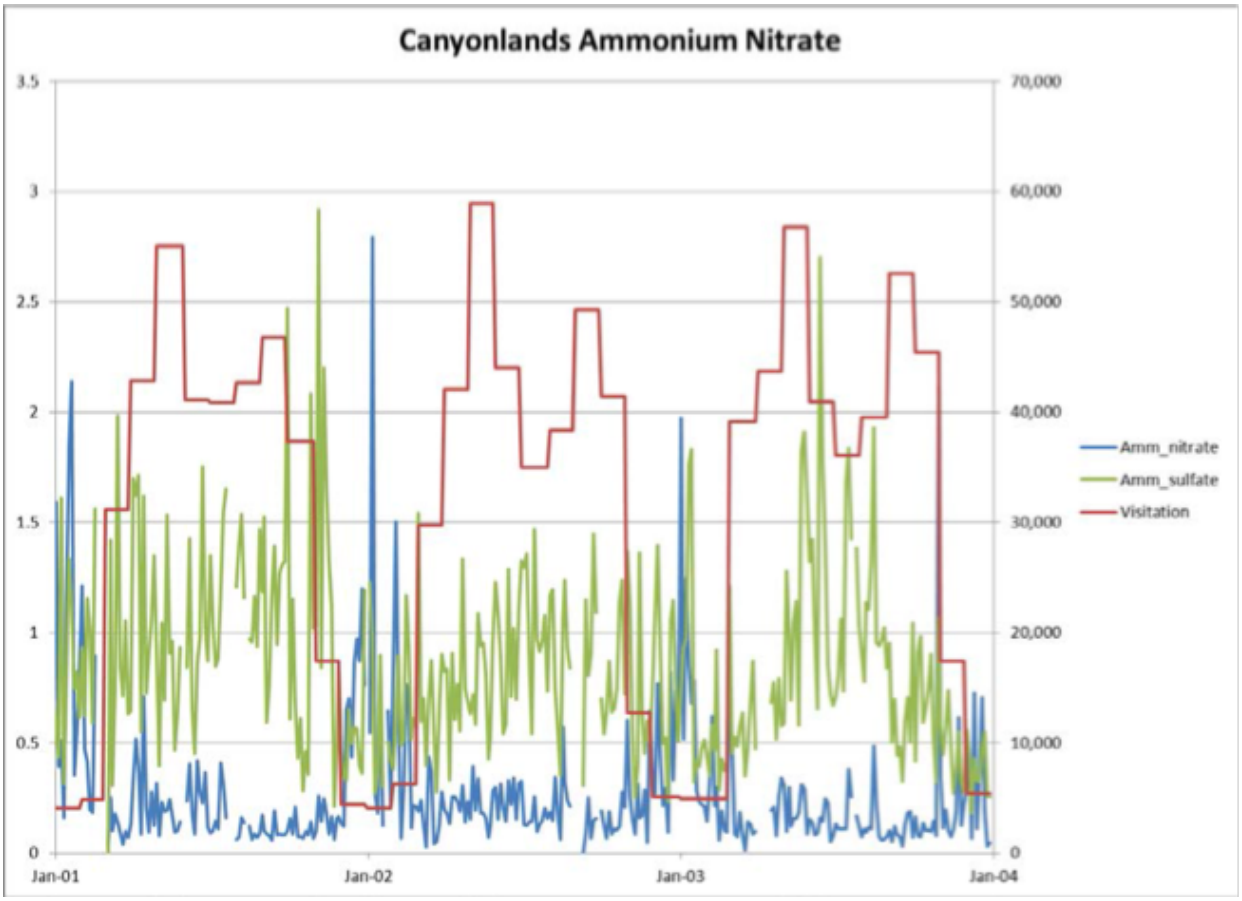
But for purposes of evaluating improvements in visibility that reducing NO_x would achieve, DAQ regards the annual trend in nitrate concentrations as unimportant. It focuses, instead, on winter, where ambient nitrate concentrations appear to be trending up, as the companion following graph from Figure 11 shows:



DAQ treats this winter trend in nitrate concentrations as conclusive evidence of the futility of trying to clear the air over Canyonlands, or any other national park in the Colorado Plateau, by further reducing NO_x emissions from the surviving Emery County power plants.

DAQ argues that the contribution of NO_x to regional haze only matters in the winter months because that is when sulfate concentrations fall sharply, and NO_x becomes the dominant pollutant. It notes that since visits to Canyonlands fall off sharply in the winter, and concludes that it would be a waste of money to clear the air over Canyonlands and other Class 1 view sheds in winter. DAQ illustrates the winter peak in NO_x concentrations and winter trough in Canyonlands visits by presenting

Figure 16. This Figure appears at page 27 of the September 12 BART Review, and is is reproduced below.



This apparent winter in NO_x trend in a single Colorado Plateau location is far too weak a reed to support DAQ's determination not to require BART technology to achieve an 86% reduction in nitrate emissions. The argument that sulfates significantly impair visibility year round but nitrates do so only in winter is rebutted by DAQ's Figure 1 reproduced at page 8 of these comments. Figure 1 shows that the year-round impact of NO_x emissions on visibility at Canyonlands has recently amounted to about two-thirds that of sulfate emissions.

Figure 1 provides a more reliable indication than Figure 16 of the relative significance of the impact of NO_x emissions on visibility. Figure 1 shows year-round impacts of emissions on visibility, reflecting the effect of all seasons. Figure 16 shows those impacts only for the season that matters least. Visibility impacts when the parks are relatively deserted should not drive determinations of the value of clearing the air during the other three-quarters of the year when the parks are more heavily visited. It is also important to note that Figure 1 shows the relative impacts that gas phase sulfates and nitrates ultimately have on visibility. The link between ambient aerosols and their gas-phase precursors (such as the NO_x emitted by the Emery County power plants) is complicated and difficult to model. (C.L. Heald, et al., 2012) Figure 16 shows concentrations of ambient aerosols, but the exact nature of their relationship to their gas-phase precursors is not entirely clear.

DAQ makes a technical argument for disregarding the potential impact on visibility of the large reduction in NO_x emissions that it declines to require. It says that the year-to-year rise in nitrate concentrations since 2008 is unexpected given the substantial decline in NO_x emissions from the Emery County power plants over that time. It purports to illustrate the absence of the expected relationship between NO_x emissions and NO_x concentrations with Figure 9 at page 12 of the DAQ September 12 BART Review. Figure 9 is reproduced below.

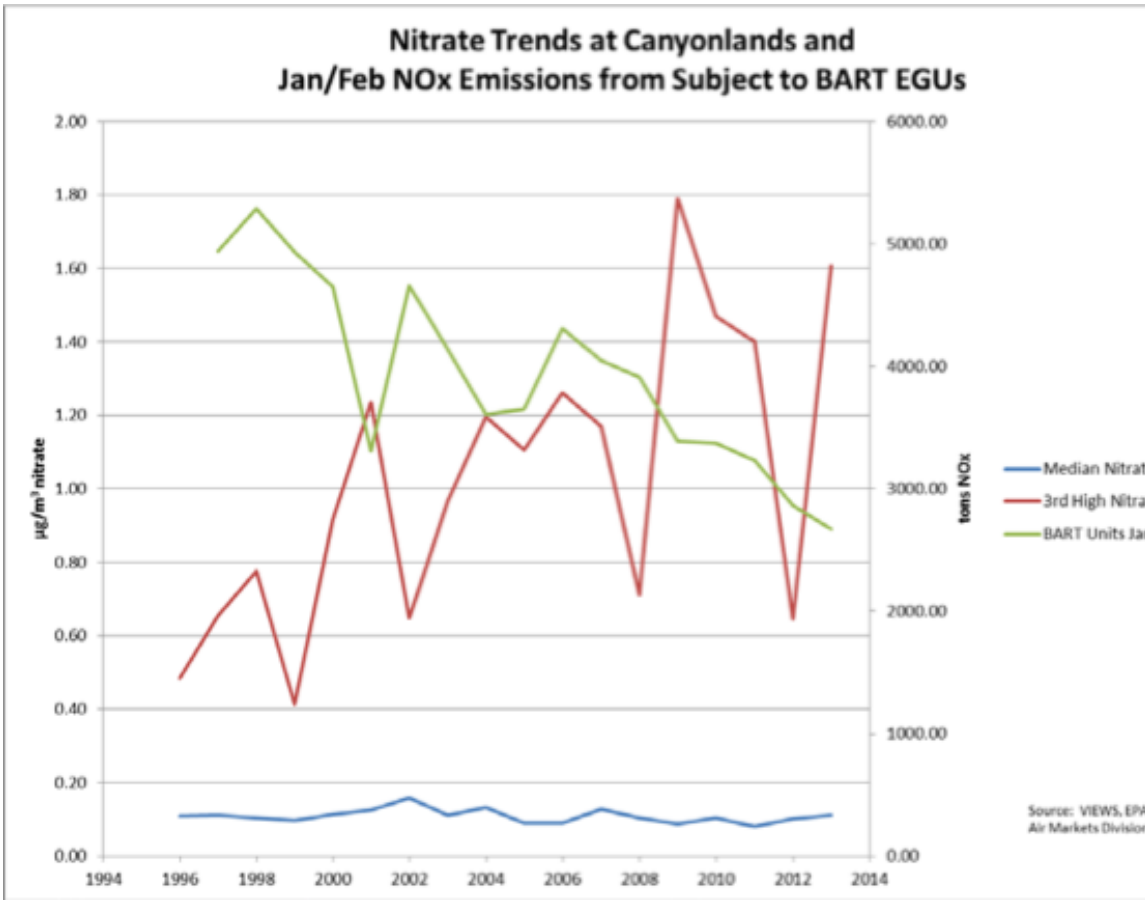


Figure 9 plots wintertime trends in the emissions of NO_x from the surviving Emery Counter power plants against the ambient concentration of nitrates at Canyonlands. It plots both mean concentrations and third-highest-day concentrations for each year. DAQ interprets the third-highest-day results as demonstrating that the NO_x emissions and concentrations of NO_x are uncorrelated. Its ensuing discussion suggests that this data demonstrate not just that reducing NO_x from the Emery County power plants would not improve visibility in winter, at Canyonlands, but that it wouldn't improve visibility year round, anywhere in the 360-mile-wide area that is affected by the emissions of the Emery County power plants.

Figure 9 shows that NO_x concentrations are stable and trend-free when measured at the annual mean, but that they fluctuate wildly when measured on the third highest day of each year. DAQ interprets these wild fluctuations as evidence that reducing NO_x emissions does not reduce NO_x. These extreme values for NO_x concentrations, however, appear to be too unstable to allow statistically valid inferences to be drawn about the relationship between wintertime NO_x emissions from the surviving Emery County power plants and wintertime concentrations of nitrates at Canyonlands.[3]

According to the academic literature, the persistence of NO_x in the atmosphere increases, and its ability to spread from its source increases, when temperatures drop, humidity goes up, and the atmospheric boundary layer lies close to the surface. (Fei Song, et al., 2011).

These conditions describe winter inversions on the Colorado Plateau. Their incidence varies markedly from one winter to the next. The wide fluctuations in the occurrence of extreme concentrations of NO_x in winter in Canyonlands that are reflected in Figure 9 are consistent with similarly wide fluctuations in the occurrence of winter temperature inversions there. Because atmospheric conditions have such a large effect on concentrations of NO_x in the winter, and because the incidence of extreme atmospheric conditions varies so widely, the behavior of the tail of the distribution of winter NO_x concentrations at Canyonlands provides little basis for discerning the relationship between NO_x emissions and NO_x concentrations in winter in Canyonlands, let alone what that relationship might be during the rest of the year--in Canyonlands, or anywhere else in the 360-mile-wide area that it is impacted by emissions from the Emery County power plants.

Although Figure 9 isn't sufficient to prove it, emissions of NO_x from the Emery County Plants and NO_x concentrations at Canyonlands may not be well correlated in winter. The more important question, however, is whether the two are well correlated at Canyonlands throughout the rest of the year (the high visitation part of the year), and

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[3] Such large fluctuations are not surprising, since measurements taken on the third-highest day each year are designed to represent the 98th percentile (the far right tail) of the distribution.

whether the two are well correlated at the other Class 1 view sheds on the Colorado Plateau. DAQ makes little effort to answer either of these questions. The answers to these questions, however, are essential to support its conclusion that there is uncertainty that reducing NO_x emissions from the Emery County power plants by 86% would significantly reduce haze *during most of the year over most of the Class 1 view sheds of the Colorado Plateau.* The literature in the field of atmospheric chemistry indicates that reducing NO_x emissions reduces atmospheric concentrations of NO_x for most of the year, in most parts of the United States, as expected. (Tsimpidi, A.P., et al., 2008 at 1472).

The EPA's models of visibility impacts predict that applying BART technology to the surviving Emery County power plants would significantly reduce the number of haze-impaired days in Canyonlands.[4] DAQ concedes this, but it speculates that, at least in winter, further reducing NO_x might actually increase the concentration of ammonium nitrate (NH_3NO_3) at Canyonlands (an aerosol that contributes to haze) in a way that the EPA models don't capture. DAQ implies that this possibility is enough to make applying SCR technology to the Emery County power plants a bad investment risk, regardless of whether reducing NO_x by 86% would significantly reduce haze at other times of the year, and at places other than Canyonlands.

In its September 12 BART Review, at page 11, DAQ presents Figure 10, which is reproduced below. Once again, DAQ focuses only on the extreme right-hand tail of the distribution (the third-highest day for both NO_x emissions and NO concentrations) which undermines the statistical validity of the trends that it purports to demonstrate. Nevertheless, based on this graph, DAQ speculates that (at least during high-nitrate days in winter) there is enough background ammonia to turn available atmospheric sulfate into ammonium sulfate, and when atmospheric sulfate is depleted, background ammonia turns nitrate into ammonium nitrate, which would increase winter haze.

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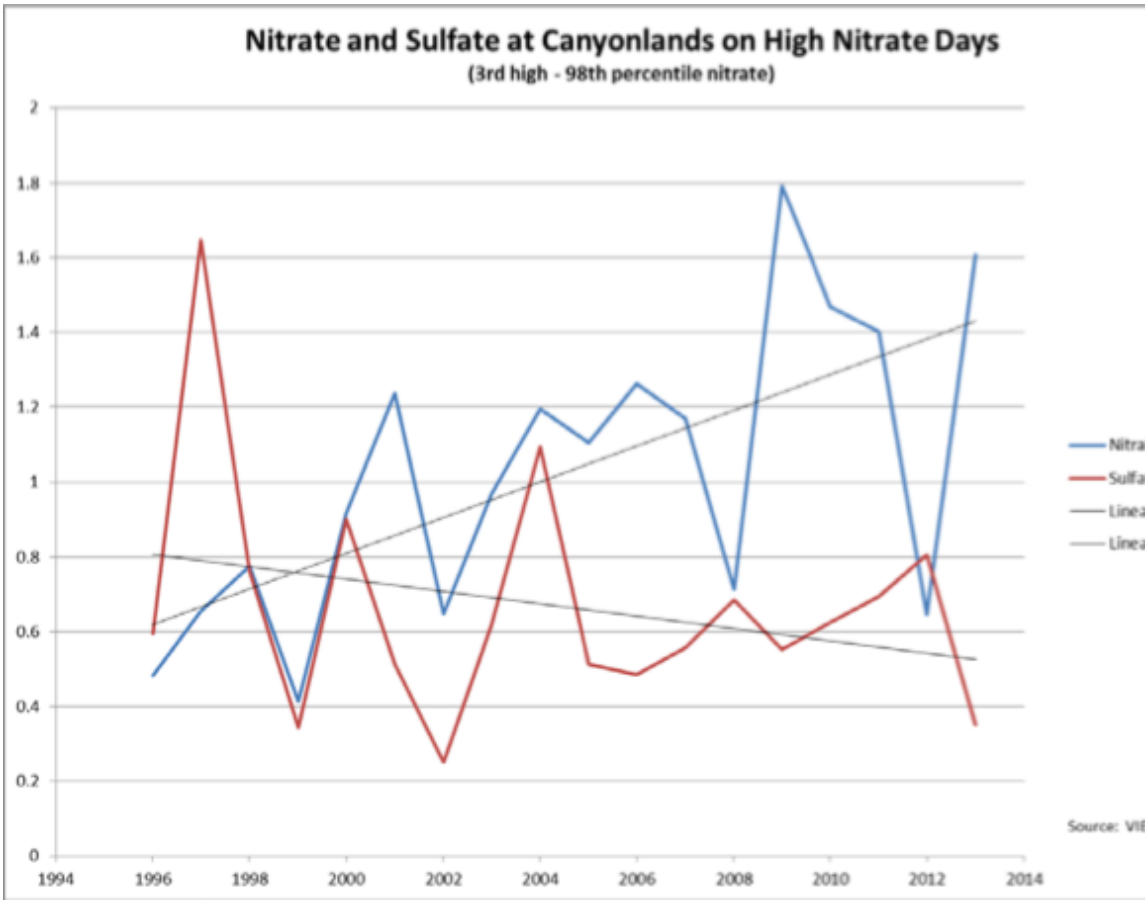
[4] See September 12 BART Review, at 25-26.



Concentrations of sulfate and nitrate have seasonal patterns that are driven largely by changes in ambient temperatures. This is well recognized in the atmospheric chemistry literature. The concentration of gas-phase sulfates is expected to decrease in winter as atmospheric ammonia converts them to ammonium sulfate. Ammonium nitrate formation generally takes place only when sulfate has been fully neutralized. (Heald, C. L., et al. 2012 at 2; McMurry, Shepherd, Vickery, 2004, at Ch. 10.7.6).

The literature recognizes that reducing emissions of sulfur oxides and nitrogen oxides can produce a mix of beneficial and adverse effects in terms of their propensity to produce aerosol particulates that reduce visibility. The literature also recognizes the mix of effects can vary with the season. The literature provides recommended

strategies for optimizing these seasonally divergent results. For example, in one prominent study, a three-dimensional chemical transport model[5] was used to investigate changes in fine particle (PM2.5) concentrations in response to 50% reductions in emissions of NO_x, SO_x, and anthropogenic volatile organic compounds (VOCs) during July and January in three regions of the eastern United States.

The simulated reduction of NO_x emissions by 50% during the summer was found to have predominantly beneficial results. It reduced average PM2.5 levels by 8%, mainly because of reductions of aerosol sulfates (9 –11%), nitrates (45–58%), and ammonium (7–11%). Organic particulate matter (PM) was found to decrease slightly in rural areas, but to increase slightly in cities.

Reduction of NO_x emissions by 50% in winter, however, was found to have mixed results. Levels of some oxidants increased while others decreased. The response of the PM components was rather complicated, leading to small net overall changes in PM. Specifically, sulfate increased by 8 –17%, while nitrate decreased by 18 – 42%. Organic PM increased slightly as well, and ammonium either increased or decreased a little depending on the local circumstance.[6]

Although reducing sulfur dioxide (SO_2) was found to be the single most effective approach for reducing sulfates, simultaneously reducing both SO_2 and NO_x was found to be significantly more effective in reducing total PM2.5 mass than was reducing SO_2 alone. In the Northeast, in winter, simultaneous reduction of emissions of both SO_2 and NO_x emissions was found to avoid an increase in PM2.5. It was also found to be beneficial in summer because controlling SO_2 emissions lead to a significant reduction

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[5] The study referred to is Alexandra P. Tsimpidi, Vlassis A. Karydis & Spyros N. Pandis, Response of Fine Particulate Matter to Emission Changes of Oxides of Nitrogen and Anthropogenic Volatile Organic Compounds in the Eastern United States, Journal of the Air & Waste Management Association, 58:11, 2008, 1463-1473. The study employed the Particulate Matter Comprehensive Air Quality Model with Extensions (PMCAMx).

[6] The reduction of VOC emissions by 50% during the summer was found to yield a mix of beneficial and adverse effects on particulate formation. On average, it produced a small increase in oxidant levels leading to a marginal increase in PM2.5. This small net change is due to simultaneous increases in the inorganic components and decreases of the organic ones.

of sulfate--the predominant aerosol component in the eastern United States during summer.

During the summer, reducing NO_x alone by 50% was found to lower PM2.5 by an average of 8%. Reducing SO_2 alone was found to lower PM2.5 by an average of 26%. Reducing them both by 50% reduced PM2.5 by 27%. Although the reduction in total PM2.5 mass caused by the latter two control strategies appears to be similar, the coupled strategy was found to reduce nitrates by 56% compared to just 4% after the reduction of SO_2 alone.

During winter, reducing SO_2 alone by 50% had very modest benefits in reducing aerosol particulates that reduce visibility. It was found to cause an 8% reduction of ammonium and a minor increase in nitrates, which led to a reduction in PM2.5 of 6%. Similarly, reducing NO_x alone by 50% had only modest benefits in terms of overall oxidant levels. This led to a marginal increase in PM2.5. Reducing both simultaneously, however, was found to reduce PM2.5 concentrations by 7%. A key finding is that reducing SO_2 and NOx simultaneously also significantly reduced the three major inorganic particulates that reduce visibility. Sulfate was reduced by 11%, nitrate by 25%, and ammonium by 11%. The only adverse effect of following a simultaneous emissions reduction strategy in winter was an increase of 6% in organic particulate mass (OM).

The Tsimpidi study described above predicts that following a strategy of simultaneously reducing SO_2 and NO_x emissions will produce superior results in the Northeastern United States because it overcomes the divergent seasonal effects that are observed when these two pollutants are reduced unilaterally. The superior results of reducing SO_2 and NO_x simultaneously in the Northeastern United States is due, in part, to the fact that SO_2 is the dominant pollutant there. According to DAQ, SO_2 is also the dominant pollutant in Utah in terms of impairing visibility. It would seem, therefore, that simultaneously reducing SO2 and NOx emissions in Utah would also be the preferred strategy for overcoming the divergent seasonal effects of emissions reduction in Utah.

Figure 10 supports a weak inference that unilaterally reducing SO_2 (or, more accurately, reducing SO_2 to a much greater degree than reducing NO_x) is having mixed results on visibility at Canyonlands in winter. DAQ cites this evidence as its main reason for failing to require the installation of BART technology to reduce NO_x emissions from the surviving Emery County power plants by 86%. The academic literature strongly implies that the most effective way to overcome mixed seasonal effects of this kind would be to for the Emery County power plants to reduce NO_x emissions in proportion to the reductions in SO2 emissions that have already been achieved. This strategy should produce superior results for Utah, just as it is predicted to produce superior results in a number of other regions of the United States.

V. AN INVESTMENT THAT DRASTICALLY REDUCES NO_X EMISSIONS WOULD HAVE HIGH CULTURAL AND COMMERCIAL RETURNS RELATIVE TO ITS COSTS

As already noted, NO_x from the surviving Emery County power plants can be reduced by 86% for a one-time investment of $680 million. This comes to $34 million per year if the retrofit is amortized over the expected remaining life of these plants (which average 20 years). DAQ admits that its primary motive in not requiring the surviving PacifiCorp power plants to reduce their NO_x emissions by 86% is that it would 1) cost Utah ratepayers too much and 2) help set a precedent that would harm PacifiCorp financially if it were required to install the best available NO_x control technology throughout its electric power network.

Although it cites the potential impact on Utah ratepayers as its main motive in declining to require an 86% reduction in NO_x emissions, DAQ does not attempt to estimate that impact. PacifiCorp's financial data shows that the rate impact would be exceedingly modest. The ability of PacifiCorp to install the best available NOx control technology without substantially affecting its return on equity or raising rates in its Utah market is evident from the 2014 Annual Report of its parent company (Berkshire Hathaway Energy). Page 44 of that report shows that in 2014, PacifiCorp earned total retail electricity revenue of $2.068 billion. If PacifiCorp were to install the best available NO_x control technology at its surviving Emery County power plants at an annual

amortized cost of $34 million,[7] it would require PacifiCorp to raise additional revenues by 1.6% annually. This implies that the expense of installing SCR technology could be covered by a rate increase of only 1.6% for Utah retail electricity customers going forward.

Interestingly, regulators in the other states that PacifiCorp's electric power network serves have been less receptive than DAQ appears to have been to PacifiCorp's plea that installing best available NO_x reduction technology will cause it unwarranted financial hardship or that such technology will be ineffective in reducing haze. Unlike DAQ, regulators in other states are requiring PacifiCorp to spend $770 million to install SCR technology on 863 megawatts of capacity (its Jim Bridger Units 3 and 4, Hayden Units 1 and 2, and its Craig Unit 2). See 2014 Annual Report of Berkshire Hathaway Energy at 55-56.

As noted above, the Colorado Plateau's Big 5 national parks are world renowned, yet are so heavily polluted that the odds that a traveler will be able to view them on a haze-free day is only one in four. In other words, the chance that the traveler will receive full value for the time and money that he or she has invested in visiting any of the Big 5 is no better than 25%.

The enormous cultural and economic value of the Big 5 to the State of Utah is far less than what it could be if it were not for the polluted air in which they are chronically engulfed. Laboring under that handicap, it is remarkable to think that they still bring in $750 million a year. If the percentage of the time that those national parks could be experienced haze free could be doubled from the current one-fourth of the time to one-half of the time, it could, conceivably, double their economic worth—adding another $750 million each year to Utah's economy as a higher percentage of satisfied visitors report back to their home state or home country their success in actually seeing the natural spectacles that they came to see.

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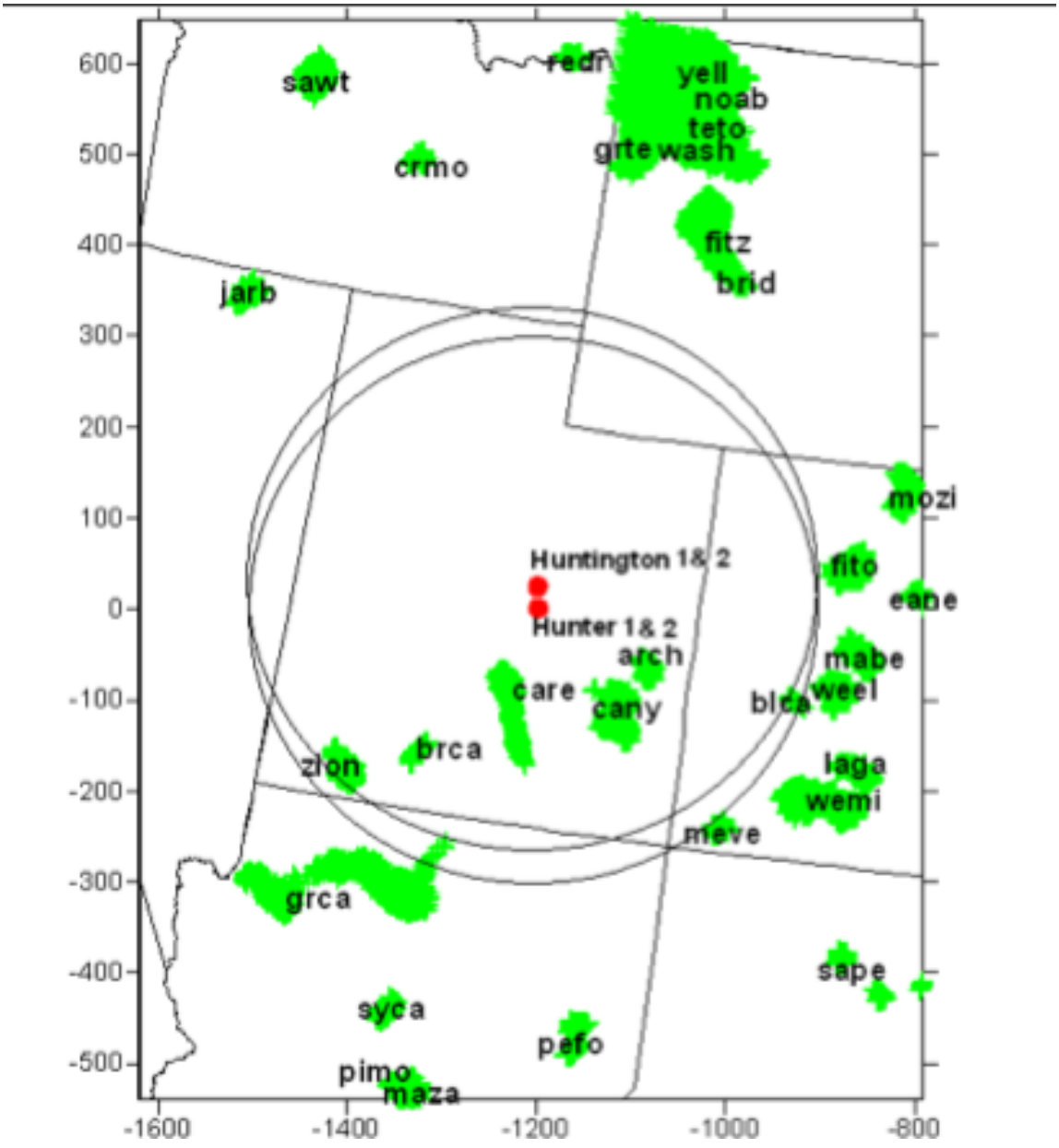
[7] Annual operating costs would increase as well, but these are usually a small fraction of the capital costs of installing advanced pollution control systems such as Selective Catalytic Reduction.

An annual cost of $34 million (and the rate increase of 1.6% that it implies) would seem to be a bargain, considering how much closer it might bring the Big 5 national parks (not to mention other famous Colorado Plateau tourist attractions such as Kolob Canyon, Cedar Breaks, Capital Reef, Lake Powell, and Monument Valley) to realizing their cultural and economic potential.

Thirty-four million dollars per year would seem to be all the greater bargain when it is recognized that an 86% reduction in NO_x emissions at the Emery County power plants would substantially improve visibility across the entire state of Utah, including the heavily-populated Wasatch Front. Both the EPA and DAQ agree that haze-generating pollution from the Emery County power plants travels at least 300 kilometers in all directions from those plants. The area affected is illustrated by the figure below.



With the rapid growth of the population along the Wasatch Front there has been a correspondingly rapid growth of automobile exhaust. One of the primary components of automobile exhaust is NO_x. NO_x is a precursor from which haze-generating particulates and ozone form along the Wasatch Front, particularly in the summer. The resulting yellow-brown haze that chronically overhangs Cache, Weber, Salt Lake, and Utah valleys lowers the quality of life of the over 2 million residents of those valleys. In

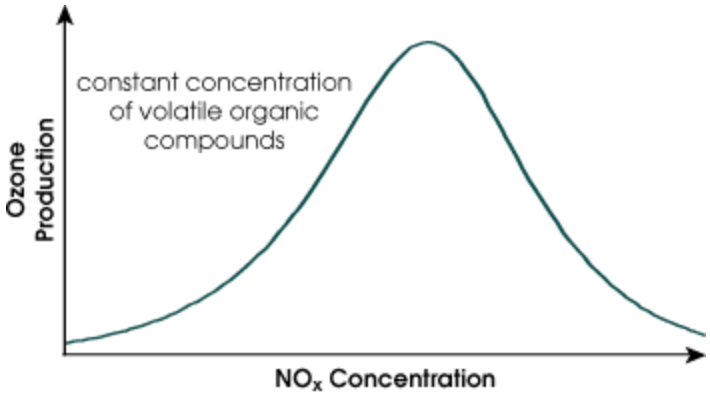
addition, when inhaled, the fine particulate and ozone components of this smog cause chronic, low-level inflammation throughout the body. This impairs the respiratory and circulatory systems of all of the inhabitants of the Wasatch Front, and shortens their lives, including children, the elderly, asthmatics, and the general population. The Emery County power plants are responsible for a substantial share of the NO_x, particulates, and ozone along the Wasatch Front. Reducing that share should noticeably improve visibility there at the same time that it improves the health of its residents.

VI. HEALTH IMPACTS OF USING BEST AVAILABLE RETROFIT TECHNOLOGY TO REDUCE NO_X EMISSIONS

The $34 million annualized expense required to reduce NO_x emissions from the Emery County power plants by 86% should be recognized as even more of a bargain when the substantial health benefits of removing the ozone and fine particulates which those NO_x emissions generate are taken into account.

A. The Benefits of Reduced Ozone

Coal fired power plants are the primary source of NO_2 in the atmosphere. Under the right conditions, ultraviolet energy can split an oxygen atom from NO_2, freeing it to combine with O_2 to form ozone (O_3). This process makes NO_2 the primary source of ground-level ozone in the environment. For a given level of volatile organic compounds (VOCs) in the atmosphere, ozone production will rise as the concentration of NO_2 rises, and then fall as concentrations of NO_2 continue to rise. This is illustrated in the figure below.



Ozone can be transported hundreds of miles from its source. In the case of the surviving Emery County power plants, ozone formed from their NO_x emissions can spread across the entire state, including the Wasatch Front and the Uinta Basin. This adds to the considerable burden of ozone formed from the NO_x emitted by automobile traffic along the Wasatch Front and from the NO_x generated by the extensive drilling activity in the Uinta Basin.

Ozone, at current levels experienced in both the Wasatch Front and the Uinta Basin, causes substantial to harm to the health of both the vulnerable and the healthy segments of the population in those regions. The discussion that follows lists the various kinds of harm that ozone is causing the inhabitants of those regions, and which would be significantly reduced if DAQ were to require an 86% reduction in the NO_x emitted by the Emery County power plants.

1. 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 liabilities that Los Angeles doesn't. Ultraviolet rays reflect off the vast surface of the Great Salt Lake 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. The Wasatch Front is also next door to PacifiCorp's four coal-fired power plants, and shares in the emissions that they produce. Consequently, Utah's most populous counties (Weber, Davis, and Salt Lake Counties) occasionally 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, an 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)

2. The Value of Meeting the Tightened Ambient Ozone Standards Due in October.

a. The Value of Meeting a Primary (Short Term) Ozone Standard Below 60 ppb.

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.[8] (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., 2011). As already noted, a study of pregnant women exposed to ozone found that

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

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 modeling 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 older 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 interact 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 $O_3 + NO_2$ is defined as the composite variable O_X) and compared the two modeling approaches. The dosage investigated was a 10 ppb increase in mean 24-hour concentrations of O_x. Analyzing the effects of a 10-ppb-increase in the dosage of O_X, 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)

The composite oxidant model results showing significant mortality effects for small changes in concentrations of O_x were robust for both summer increases and winter decreases of the composite oxidant. Because this modeling approach captures the simultaneous impact of both oxidants, it avoids 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 Utah, the young, the elderly, asthmatics, and those with metabolic syndrome comprise half of its population.

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 our society were to respect 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 Value of Meeting a Secondary Ozone Standard Below 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 as well as DAQ assume 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 are more likely than other Americans to experience 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 recognizes the need to take the risk to human health from long-term exposure to ozone seriously 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.[9] The concentration of ozone precursors is building where Utah, Wyoming, 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 form over Salt Lake City, Phoenix, and Las Vegas combine with the smog generated by the Emery County coal-fired power plants. 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 for the iconic view sheds of the Colorado Plateau, 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

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[9] 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.

> 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 that is characteristic of the Mountain West, but to mitigate regional climate change, and to recover the blue vistas that once distinguished America's most iconic national parks.

d. The EPA's Estimate of the Benefits of Meeting Tighter Ozone Standards 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. Modeling 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.[10]

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 ppb reduction in ozone concentrations (in the range that this rulemaking is now considering) to the compensation paid to agricultural laborers nationwide in 2007. It concludes that such a

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[10] 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).

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 have multiplied employment totals in professions that meet this criterion by their corresponding mean annual salary. Qualifying professions were identified based on descriptions taken from the BLS's May 2013 Occupational Employment Statistics report. Total employment in each profession and its mean annual salary were also taken from that report. Total annual salaries of qualifying labor came to approximately $400 billion in 2013.

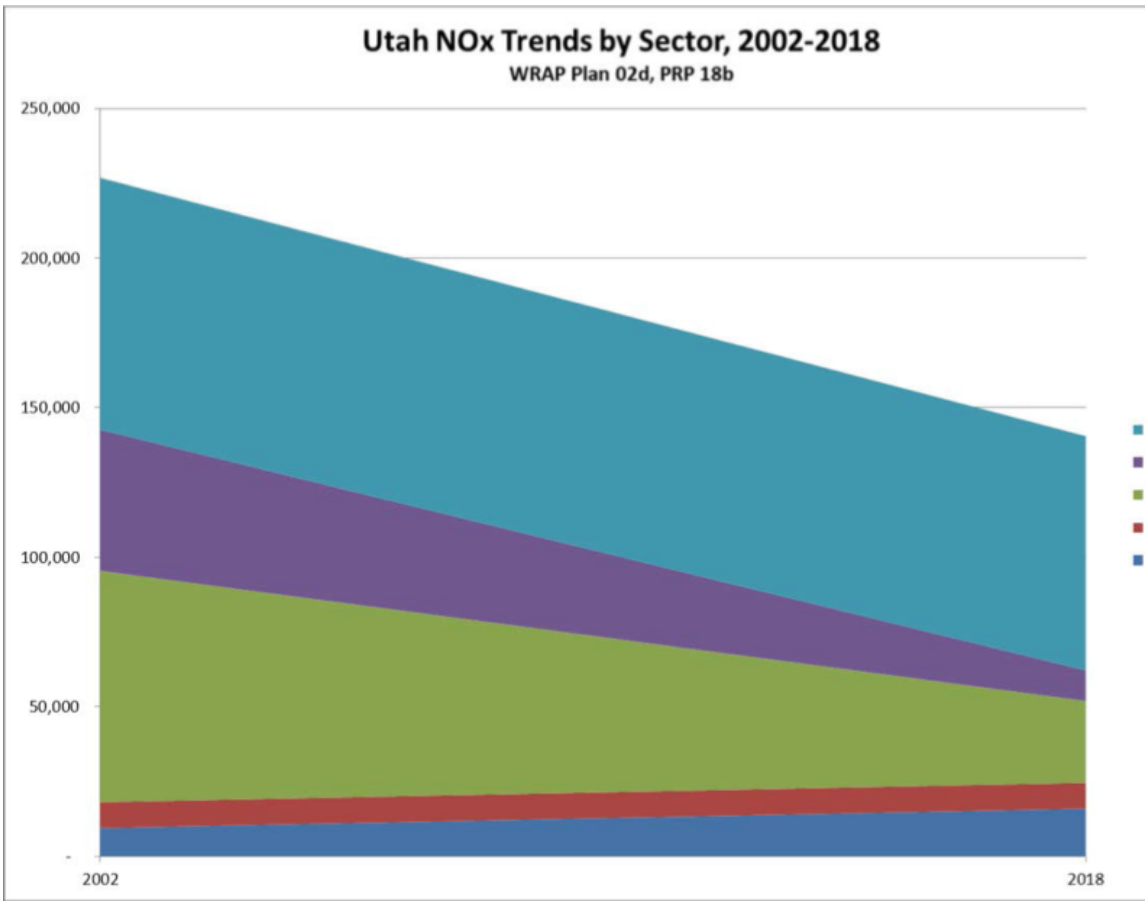
This $400 billion in wages excludes benefits (health care, retirement, etc.) it should be multiplied by an appropriate factor to include the value of benefits. An appropriate factor is 1.33, since the most relevant industry category for which the BLS estimates benefits is the "Natural Resources, Construction,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

Total salaries and estimated benefits of qualifying workers in 2013 come to $533.2 billion. This figure should be reduced to by three-fourths to $133.3 billion to reflect the fact that, averaging across the country, only three to four 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.

This back-of-the-envelope calculation of the productivity benefits of reducing ozone concentrations is relevant to DAQ's decision not to apply BART to reduce NO_x emissions because NO_x is the main precursor to ozone formation. The tightened ozone standards that the EPA must issue by October of this year will very likely put large areas of the State out of compliance with the new, tighter standard. DAQ will have to draw up a plan to achieve the tighter ozone standard. Figure 3 appearing on page 2 of DAQ's September 12 BART Review is reproduced below.



It shows that the three major sources of NO_x in the State are mobile, non-road, and point source. Of those sources, mobile and non-road are already obligated to make significant sacrifices toward the goal of reduced NO_x pollution. Point sources, including the Emery County power plants, however, are not currently being asked to share in this sacrifice. DAQ will not be able to meet the new tighter ambient ozone standard without requiring major reductions in the point sources of NO_x. It would be appropriate to recognize that now, in the context of the regional haze rules, so that PacifiCorp will be able to plan accordingly

B. Particulate Exposure

In the Rocky Mountains, and the higher elevations of the Colorado Plateau and the Great Basin, forests have been unable to adapt to the heat and drought of a rapidly warming climate. As a result they are succumbing to fire and pests. Wildfires emit between 1.5 and 2.5 million tons of particulate matter each year—more than fuel combustion, industrial processes, or transportation. See Center for Disease Control: A Review of Factors Affecting the Human Health Impacts of Air Pollutants from Forest Fires. Division of Environmental Hazards and Health Effects National Center for Environmental Health. www.forestencyclopedia.net/p/p819. The annual mean burned area in the forests of the Rocky Mountains is expected to increase by 175% by the year 2050. Increased burned area is expected to cause a near doubling of the region's inhabitants' exposure to wildfire smoke by mid-century. (Spraklen et al., DOI:10.1029.)

Approximately 80 to 90 percent of wood smoke particles are PM2.5 or smaller. These are dagger-shaped particles, so tiny that they penetrate deep into the lungs and even pass into the blood. They damage the lungs, the heart, and human genes. The young, the old, and the sick are most heavily impacted. Center for Disease Control: Forest Fire Impacts) www.forestencyclopedia.net/p/p819.

NO_x as a source of fine particulate matter in the United States is estimated to range from 15 to 35%. That fine particulate load is added to the load from forest fires and dust storms to which Utah is already vulnerable. Reducing NO_x from the Emery County power plants would substantially ease the fine particulate burden to which the residents all over the State of Utah are exposed.

The World Health Organization published a hundred-page study titled, "The Health Risks of Particulate Matter from Long-Range Transboundary Air Pollution." It observes that PM in the size between 0.1 μm and 1 μm can stay in the atmosphere for days or weeks and thus can be transported over long distances in the atmosphere (up to thousands of kilometers). The coarse

particles are more easily deposited and typically travel less than 10 km from their place of generation. However, dust storms may transport coarse mineral dust for over 1000 km.

By 2006, medical research had identified ultrafine particle pollution as the most dangerous because it travels deeper into body membranes when inhaled, can invade virtually any cell in the body, penetrate cell membranes, and create a chemical toxicity within organelles and the nucleus of the cell. (Geiser, et al., 2005, pp.:1555-1560). The WHO report states:

> Health effects are observed at all levels of exposure, indicating that within any large population there is a wide range of susceptibility and that some people are at risk even at the lowest end of the observed concentration range.

Medical research has since significantly strengthened this conclusion. In the United States, the current annual standard of allowable fine particulate pollution is 35 micrograms per square meter (35 μm²).[11] The corresponding European standard is a more stringent 25 μm². A large European study of the health effects of fine particulate pollution (PM 2.5) was published in the December 9, 2013, issue of *the Lancet*. That study concludes that both of the U.S. and the European standard for fine particulate are too lax to adequately protect public health.[12]

The study found that there is no safe level of fine particulate pollution. It estimates that the risk of death goes up by 7% with each 5 μm² increase in concentrations of PM2.5. (Beelon, R., et al., 2013). This study brings new urgency to lower the study for fine particle pollution to the standard of 10 μm² that the World Health Organization recommends. Currently, the air along the Wasatch Front greatly exceeds this standard, and unchecked global warming

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[11] The concentration is defined as the 98th percentile concentration averaged over 3 years.

[12] The study analyzed 22 European cohort studies conducted in 13 countries to investigate the link between natural-cause mortality and long-term exposure to fine particulate pollution. Approximately 370,000 participants were monitored for an average of 14 years. The study controlled for all other major factors known to influence mortality.

will cause the air to exceed this standard still further through the mechanisms of increased heat, drought, dust, and fire.

These alarming conclusions were recently reinforced by a pair of studies in the United States. They found that if concentrations of fine particulates are increased by 10 micrograms per cubic meter, and the increase persists for two years, mortality rates go up by 32% for people with diabetes, by 28% for people with COPD, asthma and pneumonia, by 27% for people with congestive heart failure, and by 22% for people with inflammatory diseases. (Am. J. Respir. Crit. Care Med. March 15, 2006, Vol. 173 (6): Reduction in Fine Particulate Air Pollution and Mortality, Extended Follow-Up of the Harvard Six Cities Study; Lepeule, J., et al., 2012.)

Exposure to fine particulates in the western United States is expected to double by mid-Century due to increased forest fires alone. The desertification of the Great Basin's valleys will add still more fine particulates to the region's air. There are now one million Utahns who fall into categories that have been identified as especially vulnerable to particulate pollution. With population growth by mid-Century, this number is projected to double. The burden of fine particulates to which they will be exposed will be greatly increased going forward due to increased incidence of forest fires and dust storms associated with climate change. Under these circumstances, strategies that can reduce that burden at reasonable cost are of great value to the residents of Utah. Applying the best available retrofit technology to the NO_x emissions from the Emery County power plants is such a strategy.

VI. CONCLUSION

DAQ has decided to amend its regional haze SIP to label the status quo as "an alternative plan" to applying the Best Available Retrofit Technology to NO_x emissions from the four remaining PacifiCorp power generating plants in Emery County. This is an abdication of its responsibility under the EPA's regional haze rules to require the installation of BART technology unless there is an alternative

that is superior to BART. The status quo is clearly not that. Compared to the status quo, applying BART would reduce NO_x emissions by 86%, removing over 14,000 tons of NO_x from Utah's skies.

DAQ declines to take this opportunity to achieve much-needed reductions in the smog that enshrouds Utah's world-renowned Big 5 national parks three-quarters of the time, and which severely degrades their cultural and economic value to the State of Utah. DAQ's explains that it is doing this to avoid the cost that BART technology would impose on PacifiCorp and, by implication, Utah rate payers. That annual cost, however, is a relatively trivial 1.6% of PacifiCorp's annual Utah-generated revenues. This annual amount ($34 million) is almost certainly dwarfed by the increase in commercial value of Utah's world-famous national parks and wilderness areas (worth $750 million annually) as vastly-reduced NO_x pollution clears the air over these scenic vistas.

To this commercial benefit, DAQ should have added the cultural benefit of affording Utah's residents all across the State the increased enjoyment of their immediate surroundings beneath a bluer sky. DAQ's cost/benefit analysis should also have taken into account the value of the improved health and longer lives for all of Utah's residents that would be made possible by substantial reductions NO_x as it reduces the ozone and the fine particulate matter that they would otherwise breathe.

Had DAQ done a comprehensive cost/benefit analysis of this kind, it likely would do what regulators in surrounding states have done—order PacifiCorp to apply the best available retrofit technology to remove unnecessary NO_x emissions from the air in those states. UPHE urges DAQ to join those states in requiring PacifiCorp to apply the Best Available Retrofit Technology to the NO_x emissions of Utah's power plants.

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