Regional Haze
4-Factor Analysis

Montana Sulphur & Chemical Co.

Prepared for:

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EXECUTIVE SUMMARY

Bison Engineering, Inc. was retained by Montana Sulphur & Chemical Co (MSCC) to prepare a 4-Factor analysis for specific units located at their sulfur processing facility located in Lockwood, MT. The 4-Factor analysis was requested by the Montana Department of Environmental Quality (DEQ) in a phone call and follow-up email between Mark DeHart (MSCC) and Craig Henrikson of the Montana Department of Environmental Quality on March 14, 2019.

The analysis itself relates to “Round 2” of development of a State Implementation Plan (SIP) to address Regional Haze. Regional haze requirements and goals are found in Section 169A of the Federal Clean Air Act and codified in 40 CFR 51.308. The purpose of the 4-Factor analysis is to determine if there are emission control options at MSCC that, if implemented, could be used to attain “reasonable progress” toward the state’s visibility goals in an economically feasible manner.

A 4-Factor analysis was conducted for sulfur dioxide (SO_2) on the main stack at the MSCC facility as directed by the March 13, 2019 letter from DEQ. The results of the analyses presented in this document show that additional controls on this unit (sulfur recovery) are neither necessary nor justifiable due to excessive costs and the lack of a discernible impact on any nearby Class I area. We conclude that this facility is not suitable for additional emission controls or limitations based on the 4-Factor analysis.

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1.0 INTRODUCTION

With the 1977 amendments to the Federal Clean Air Act (42 USC 7401 *et. seq.*) Congress declared as a national goal "… *the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory class I Federal areas which impairment results from manmade air pollution."* [42 USC 7491(a)(1)]. With that goal, plans and requirements were eventually codified in the Code of Federal Regulations primarily in 40 CFR 51.308. (The entire visibility program is found in 40 CFR 51.300 → 309). Individual states are required to establish "reasonable progress goals" [40 CFR 51.308(d)(1)] in order to "attain natural visibility conditions" by the year 2064 [§308(d)(1)(i)(B)].

The Environmental Protection Agency (EPA), via a Federal Implementation Plan (FIP) promulgated the first round of those obligations with the establishment of Best Available Retrofit Technologies (BART) and a 4-Factor analysis for various sources in Montana.[1] MSCC was among those sources under consideration. The FIP, however, did not propose nor promulgate additional controls for this facility. EPA's stated reasons were:

> "*Based on costs of compliance for the only control option (SCOT), the relatively small size of the facility, and the relatively small baseline Q/D, we propose to eliminate this option. Therefore, we are proposing that no additional controls for SO_2 will be required for this planning period." (77 FR 24076).*

A second round of obligations is now under development. This second round, or planning period as it is sometimes referred, requires an additional step toward 'reasonable progress' in meeting the national goal.[2] The Regional Haze Rule (RHR)[3] identifies four factors which should be considered in evaluating potential emission control measures to make reasonable progress toward the visibility goal. These are as follows:

Factor 1. Cost of compliance
Factor 2. Time necessary for compliance
Factor 3. Energy and non-air quality environmental impacts of compliance
Factor 4. Remaining useful life of any existing source subject to such requirements

These four factors are collectively known as the 4-Factor analysis.[4]

To implement the requirement, Craig Henrikson of the Montana Department of Environmental Quality (DEQ) contacted MSCC on March 13, 2019 to introduce the

[1] The FIP was promulgated on Sept. 18, 2012 at 77 FR 57864.
[2] The national goal is to attain natural visibility conditions in mandatory Class I areas by the year 2064 [40 CFR 51.308(d)(1)(i)(B)].
[3] 40 CFR 51.308 *et. seq.*
[4] These four factors are referenced from: 40 CFR 51.308(f)(2)(i).

subject.[5] That contact was followed up via a phone conversation between MSCC (Larry Zink and Mark DeHart), Bison Engineering Inc. (Hal Robbins and Nathan Bartow), and DEQ (Craig Henrikson) on March 22, 2019. DEQ stated that they were seeking assistance with conducting the required 4-Factor analysis for MSCC (among other facilities). DEQ also noted that this same analysis is being required for multiple other sources in the Billings area as well as elsewhere in the state. DEQ followed up with an April 19, 2019 letter to further clarify various aspects of the requested analysis along with providing some EPA guidelines on the matter. (Appendix C)

The remainder of this document is dedicated to a further discussion on the general concepts and the MSCC-specific concepts of meeting the obligations of the 2nd planning period and the requested 4-Factor Analysis. It is concluded that there is currently adequate incremental progress being made toward that goal such that no additional or new reductions are required or justified at this time. The 4-Factor analysis, specific to MSCC, is also presented which further confirms our conclusion.

[5] The contact was via a phone call to Mark DeHart of MSCC and a follow-up email of March 13, 2019.

2.0 PROGRAM SUMMARY & STATUS

The Regional Haze program is an attempt to attain 'natural' (nonanthropogenic) visibility conditions in all mandatory Class I areas[6] by 2064.[7] The RHR itself was promulgated in substantially its current form in 1999 with adjustments made in 2017.[8] The rule is to be implemented by incremental steps. The first step, or sometimes referred to as the 1st planning period, was a combination of Best Available Retrofit Technology (BART) and a 4-Factor analysis. BART is a program that applied to certain older facilities.[9] The 4-Factor program, at that time, applied to 'larger' facilities which, via a Q/d analysis (See Section 2.1) had potential of impacting visibility in a mandatory Class I area.

2.1 Montana Summary

For Montana, the 1st planning period (Round 1) requirements were executed via the EPA. This planning period roughly included the period of 2006 to 2018. In July 2006, Montana decided it no longer had the resources to complete the requirements of the program and returned the program to EPA.[10] Following much discussion and analyses, EPA promulgated a FIP six years later, as it applied to sources in Montana.[11] MSCC was one of the subjects of analysis during that effort. As noted in Section 1.0 above, EPA concluded no additional or new controls were required of MSCC for the Round 1 planning period.

Given the timeframe for Round 1 has expired, the RHR now requires the implementation of the 2nd planning period (Round 2). Round 2 is meant to show an incremental and reasonable progress toward the national goal for the 10-year period 2018 to 2028. Additional 10-year implementation periods will follow until the national goal is achieved.[12]

Recently DEQ has decided to bring the program back to state control. With this decision, DEQ is taking the lead in the development of the 4-Factor analyses and plans associated with the 2nd planning period. As it stands, DEQ is seeking, by July 2021, to submit a State Implementation Plan (SIP) to EPA along with any enforceable reductions (emission limits or plans) that will go into effect before 2028.

To implement the program fully, it was first necessary to measure regional haze (visibility and its constituents) data in the various Class I areas; regardless of the source of the

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[6] A mandatory Class I area is usually a national park or wilderness area above a certain threshold size (4,000 or 5,000 acres) that was in existence on or before August 7, 1977. Montana has 12 (of 156) such areas.

[7] This date is established in 40 CFR 51.308(d) and elsewhere.

[8] 64 FR 35765; July 1, 1999; and 82 FR 3124; Jan. 10, 2017.

[9] The BART program is more fully explained in 40 CFR 51.308(e).

[10] Letter from DEQ to EPA dated July 19, 2006.

[11] The proposed FIP was published April 20, 2012 at 77 FR 23988 and became final on Sept. 18, 2012 at 77 FR 57864.

[12] 40 CFR 51.308(f)

haze. This monitoring is an ongoing effort via various ambient monitoring programs. Among them is the Interagency Monitoring of Protected Visual Environments (IMPROVE) program.[13] This visibility monitoring program began in 1988 and was (is) a cooperative effort between EPA and various federal land managers (primarily the National Park Service and the US Forest Service). The results of that monitoring and analysis, according to WRAP and DEQ, indicated for eastern Montana and Wyoming Class I areas, the primary materials accounting for the most anthropogenic regional haze degradation are (ammonium)sulfate and (ammonium)nitrate.[14] [15]

That being the case, DEQ has chosen to look at reductions in SO_2 and NOx emissions. (These are precursors to ammonium sulfate and ammonium nitrate formation.). The degree to which emissions may or may not be reduced is to be based primarily on the result of a 4-Factor analysis. The sources chosen for the analysis are those facilities whose emissions-to-distance (from the Class I area) ratio exceeds a value of 4.0 as noted below:

If $Q/d > 4$, then the facility is chosen for a 4-Factor analysis

Q = mean annual emissions mean (2014 → 2017) of SO_2 + NOx (tons)
d = distance to the nearest mandatory Class I area (kilometers)

DEQ determined a value greater than 4 for MSCC.[16] MSCC was chosen by DEQ for a 4-Factor analysis for this 2nd planning period.

We note here for the record that although DEQ used a numerical value as a means of selecting which facilities are to be subject to the 2nd planning period, the selected value (4.0) is itself arbitrary. A value greater than 4 does not by itself indicate a measurable or perceptible haze impact. In fact, previous modeling submitted during the 1st planning period indicated, for MSCC, that even a Q/d value in excess of 10 yielded no discernable impact on any mandatory Class I area. (See Section 5 and Appendix B).

2.2 Regulatory Summary

Because this request for information arises from the RHR we find it useful and prudent to review our understanding of the nature and purpose of the visibility protection program to ascertain important criteria that will lead to the selection of specific Reasonable Progress requirements.

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[13] http://vista.cira.colostate.edu/Improve/
[14] http://vista.cira.colostate.edu/improve/wp-content/uploads/2019/02/2016-IMPROVE-NR-Bext-SIA-Annual-IG90-w-Canada-vers-1.jpg
[15] http://deq.mt.gov/Portals/112/Air/AirQuality/Documents/CAAAC/PDF/Feb7_2019/2019-0207_CAAAC_Slides.pdf
[16] March 13, 2019 letter from DEQ to Mark DeHart. According to Table 1 of that letter: Q=1305.53 (tons); d = 137.5 km (North Absaroka Wilderness); Q/d = 9.53.

A visibility program aimed at attaining national visibility goals in mandatory Class I areas was authorized in Section 169A of the Clean Air Act.[17] The national goals are to be attained by the year 2064, approximately 45 years from now. The rules which are to implement this goal of protecting visibility are found at 40 CFR 51, Subpart P (subsections 300 through 309). A review of Subpart P indicates the purpose and goals of the program. The purposes of the program are outlined as follows:

> "*The primary purposes of this subpart are . . .to assure* ***reasonable progress*** *toward meeting the national goal of preventing any future, and remedying any existing,* ***impairment of visibility*** *in mandatory Class I Federal areas which impairment* ***results*** *from manmade air pollution;. . ."*
> [40 CFR 51.300(a)].

The visibility program may then be thought of as the implementation of two sub-programs. One regards new source review (NSR, PSD, etc.) and the other addresses "regional haze." Regional haze may further be broken down into the best available retrofit technology (BART) program[18] and the Reasonable Progress program. DEQ's March 13, 2019 letter is aimed at the implementation of "Reasonable Progress" by conducting a 4-Factor analysis.

In that regard, the RHR [§308(d)] outlines what it refers to as: "the core requirements" for the implementation of the regional haze goals. More specifically, §308(d)(1) states:

> "*For each mandatory Class I Federal area . . ., the State must establish goals . . . that provide for reasonable progress towards achieving natural visibility conditions.* ***The reasonable progress goals must provide for an improvement in visibility*** *for the most impaired days. ."* [40 CFR 51.308(d)(1)].

The rules go on to provide the states (Montana) with a list of what must be considered in developing reasonable progress. Among these details are the "four factors" analysis that is outlined above in Section 1.1 and in the March 13, 2019 letter.

Montana is tasked to establish (a plan for) Reasonable Progress in carrying out the visibility protection goals. Section 1.2 outlines the purpose of the program along with core elements. To that end, DEQ seeks a "*detailed review of additional process controls"* which will, we assume, be evaluated by Montana and EPA for applicability in establishing a set of specific, reasonable Montana control strategies that, in fact, produce "reasonable progress" toward the 2064 goals.

The March 13 request for a review of control options notwithstanding, it seems to us the visibility program itself and the reasonable progress portion of the program is clear as to intent. That is, the purpose of the program is to protect visibility (by, over time, remedying, and preventing man-made impairments through reasonable means) in mandatory Class

[17] 42 USC 7491.
[18] Applicable to certain sources built between 1962 and 1976.

I areas as to the effects of human activities. Reasonable Progress expresses the notion that states must have implementation plans to approach the national goal by 2064 along a 'glide-path' of improvements to visibility, with certain exceptions. Based on the language contained in the rule,[19] it is also clear that any activity, remedy or control (proposed or otherwise) that does not reasonably "improve visibility" in an impacted mandatory Class I area, "along the 2064 "glidepath," is <u>not</u> a candidate for those "reasonable progress" goals.[20]

As a result, we believe an analysis that only considers one or more emission control options is not enough for inclusion into reasonable progress mandates unless those emission controls are reasonably expected to improve actual visibility in a Class I area in a discernible manner. It is neither necessary nor appropriate to include an emission control as part of a reasonable progress goal or plan without a practical expectation of a resulting discernable improvement as a direct result of the application of the control. That is to say, the control must produce a discernible improvement in deciviews in a Class I area on the most impaired days. (The deciview metric is briefly explained below.)[21]

To that end, we have chosen to not only analyze various control "options" using the 4-factor test, we have also included an analysis of dispersion-modeled impacts this facility may have on several nearby mandatory Class I areas.[22] This was accomplished to determine if either 1) the current configuration or 2) future control options would fulfill the underlying need of the program to "***provide for an improvement in visibility***"[23] at an impacted mandatory Class I area.

As will be presented in following sections of this document, we also note that we have seen no measured evidence of any impact by MSCC's operations on the visibility in any mandatory Class I airshed.

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[19] The language in 40 CFR 51.300(d)(1), among other examples, make it clear that actions toward these "reasonable progress" goals must indeed result in an actual improvement in visibility; not just a reduction in emissions. The language states: "The reasonable progress goals must provide for an improvement in visibility. . ." [§300(d)(1)].

[20] Ibid.

[21] The definition of a deciview is as follows: Deciview haze index=10 $\ln_e(b_{ext}/10\ Mm^{-1})$. This is taken from the definitions found in 40 CFR 51.301. There are, of course, numerous articles and explanations for the deciview metric. One such article may be found in the publication "IMPROVE," Volume 2, No. 1, April 1993 which was written by Pitchford and Malm, 1993. From a practical point of view, the change in deciview of "1" is intended to represent a "just noticeable change" (or sometimes referred to as 'just discernible') in visibility regardless of the baseline visibility.

[22] As a side note, the nearest Class I area (North Absaroka) is about 135 kilometers southwest of Billings/Lockwood.

[23] 40 CFR 51.308(d)(1).

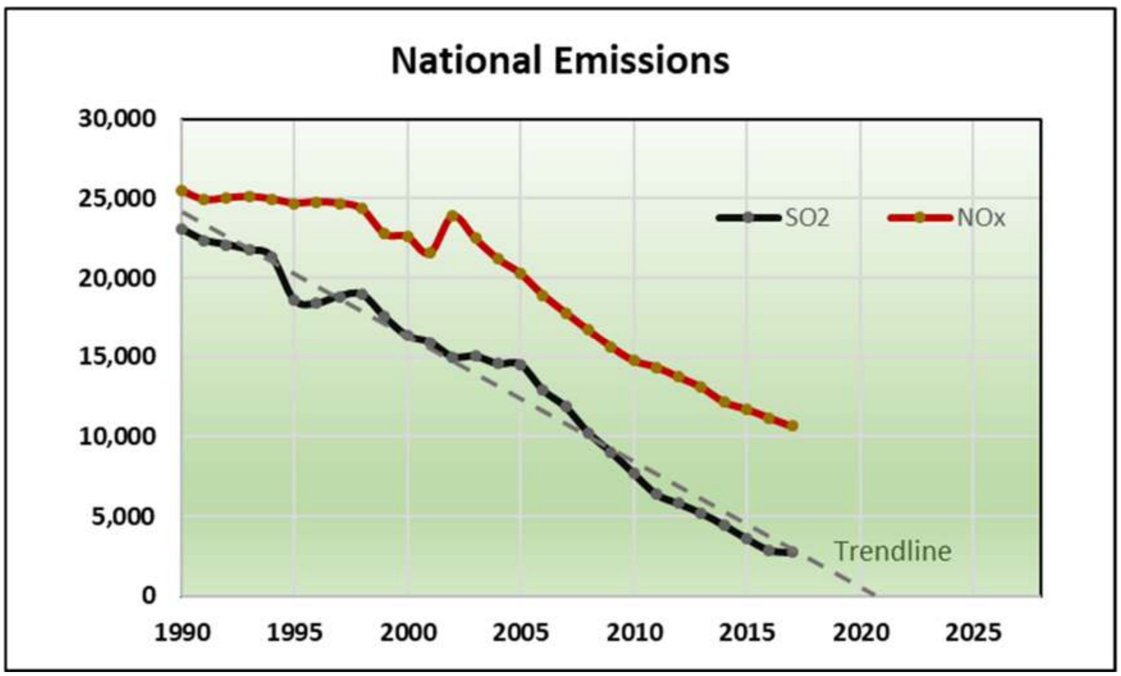
3.0 REASONABLE PROGRESS: PERSPECTIVE

The first few sections of this report have provided a summary of the overall regional haze program and the nature of this 2nd Round of implementation. The discussion has outlined the program's basic elements and background. This section of the report describes the efforts and actions already taken or being taken to reduce emissions not only from the state, but in the Billings-Laurel and Colstrip area. This review and discussion leads one to conclude that enough reductions have been or are about to be achieved which, by themselves constitute (more than) reasonable progress within the meaning of the Regional Haze Rule (RHR)[24].

3.1 National Emissions from Industrial Sources

Not surprisingly, there has been a national downward trend of industrial emissions of sulfur dioxide and oxides of nitrogen for many years.[25] The figure below shows the nation-wide emission rate of these two compounds from 1990 through 2017.

Figure 1: Historical National Emissions



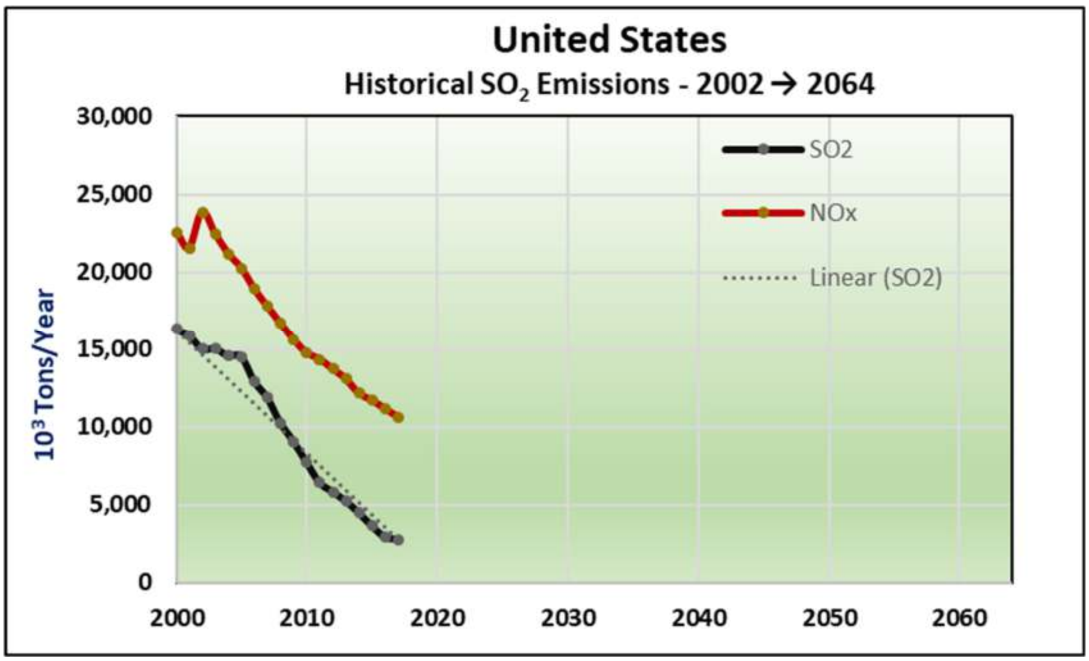
[24] 40 CFR 51.308 *et. seq.*

[25] Although oxides of nitrogen are not being address in this analysis of MSCC, the data is presented as a matter of interest and DEQ (and EPA) have indicated that this pollutant is a contributor to regional haze in Montana Class I areas.

The reductions observed over these years have occurred for many reasons mostly relating to requirements in the Federal Clean Air Act, the Montana Clean Air Act and from industrial facility shut-downs. Montana and area emissions are discussed below.

While the above graphic provides a historical perspective, it is also of interest to explore those emissions at roughly the start of the RHR program (2000). Those emissions are shown in the figure below. The graphic is presented through 2064 since that is the year in which the national goal is to be achieved.[26]

Figure 2: National SO2 Emissions: 2002 - 2064



From a national perspective, it appears that emissions of SO_2 and NOx are clearly on a fast-downward trend. While it seems unreasonable to infer that emissions will achieve "zero" by 2064, it is a fact that substantial reductions have occurred and will continue to occur. For example, two major factors propelling the continuing decline in recent years and into the future has been the shuttering (and planned shuttering) of coal-fired electrical generation plants, and a notable decline (approaching cessation) in the construction of new coal-fired power generation in the United States. These factors also apply in Montana.

This graphic and these facts imply that regardless of the decisions to be reached for Round 2, national (and state) emissions potentially contributing to regional haze will continue to decline, regardless of any discernible visibility improvement.

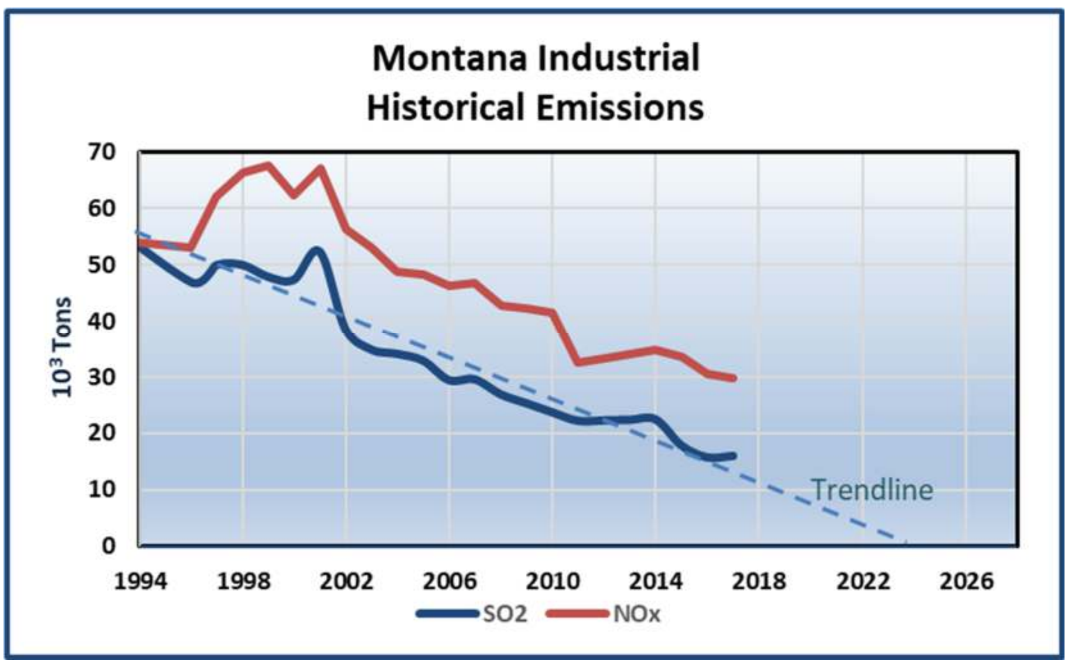
[26] This date is established in 40 CFR 51.308(d) and elsewhere.

Whatever the visibility impact of these emissions, national SO_2 emissions are presently about 1/4th of those emissions in 2000, and only about 1/5th of those same emissions the year the national goal was established (1990). For sound technical reasons, the vast preponderance of the possible progress toward zero emissions and toward zero possible visibility impact has already been achieved, 44 years ahead of the national goal year (2064) as to visibility. The nation is well ahead of schedule. As is discussed below, so is the state of Montana.

3.2 Montana Emissions

Also relevant to this document and analysis is the emissions and trend of the two primary compounds of concern (to DEQ) in Montana. Overall, in Montana, there has been a drastic reduction of both SO_2 and NOx. The Montana trend in lowering industrial emissions follows the same general pattern as the national data.

Figure 3: Montana Emissions: 1994 - 2026

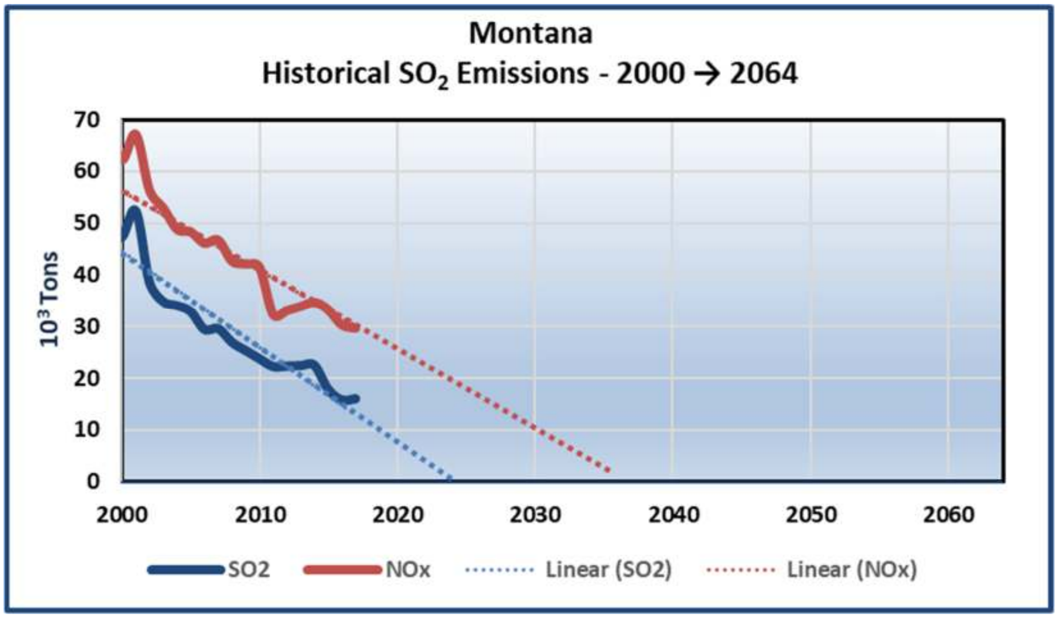


Except for a modest spike in NOx emissions around the year 2000, there has been a marked reduction in both NOx and SO_2. Clearly, to the extent that some of these emissions were discernibly impacting visibility in Class I areas, Montana has been doing its part to reach the national goals.[27]

[27] This statement presumes (without admission or proof) an *a priori* cause and effect between Montana emissions and observed visibility in any nearby Mandatory Class I area. For reasons that will be forthcoming in the following 4-Factor analysis, there is, in our opinion, no cause and effect relationship between MSCC SO_2 emissions and a measurable impact on visibility (expressed in deciviews).

The following figure shows the same general information but begins at about the same time as the RHR program began in earnest and projects itself through 2064.

Figure 4: Montana Emissions: 2000 - 2064



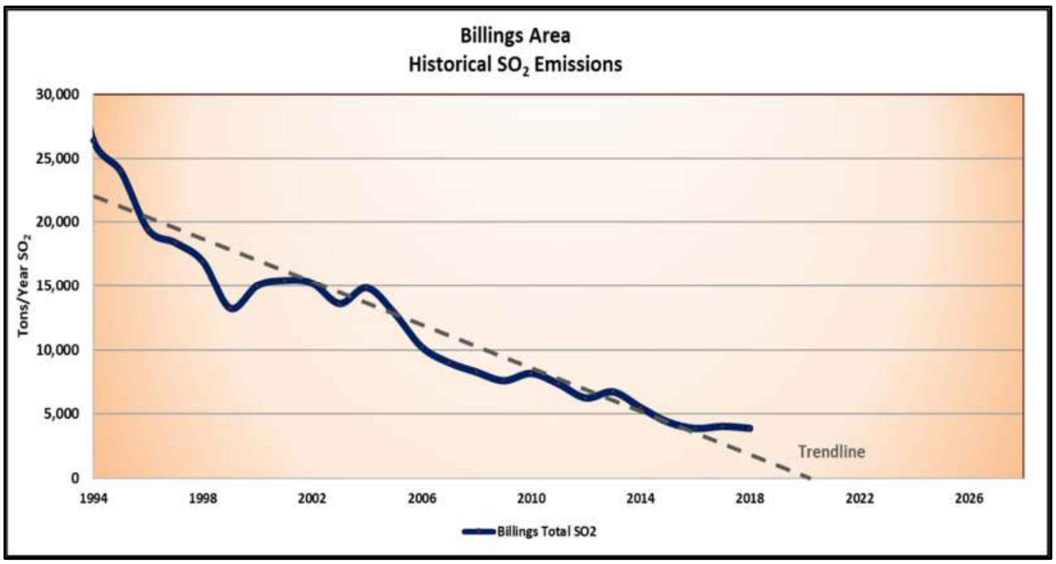
The trendline for SO_2 suggests that SO_2 emissions will reach zero during Round 2, and that NOx emissions will zero out a few years later. While this is not likely to reach zero, the reader should not discount this astounding trend. A national trend of coal-plant closures is also playing out in Montana (and nearby states). Plants in this source category, historically, have accounted for the bulk of sulfur dioxide and nitrogen oxide emissions from manmade sources. The effect of the Billings Corette Plant slowdown and final closure (2015) can be clearly seen in the recent historic SO_2 data. In the following sections we discuss other closures that are already “on the books” or “on the way” for coal plant sources with high Q/d values relative to the Class I areas of interest to Montana. These include Colstrip 1 & 2 and the Lewis & Clark station. These closures will support the downward trendlines seen above; well into the Round 2 planning period ending in 2028.

3.3 Billings and Laurel Area Emissions

The issue at hand is one that is intended to assess whether Montana, and the Billings and Laurel area (Billings area), can assist with making 'reasonable progress' toward the national goal of Class 1 visibility improvement via emission reduction[28], and, if so, how. Since there are a number of emission sources within the Billings area near MSCC, this area was chosen for analysis. Since DEQ's request for a 4-Factor analysis as to MSCC was limited to sulfur dioxide, only that compound is addressed here. MSCC is not a significant source of NOx.

To begin, the figure below shows Billings area local SO_2 industrial emissions from 1994 to the present. The demonstrated reduction is continuous and dramatic. (The graphic is even more dramatic when one extends the timeframe back to 1990 and earlier).

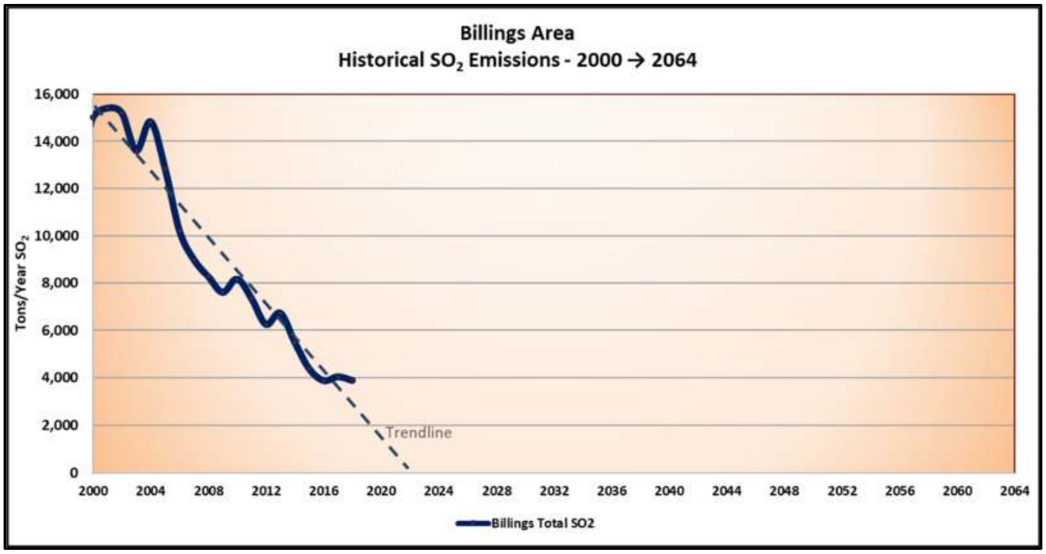
Figure 5: Billings Area SO_2 Emissions: 1994 - 2028



Like the national and Montana perspective, the same information is plotted below which includes, in general, the RHR program through its anticipated ending in 2064.

[28] It is assumed for this discussion alone that a reduction in emissions (SO_2 and/or NOx) may have a direct causal relationship with improved visibility at the Class I areas. Analyses to follow will show that this assumption is not the case. A further reduction in emissions in Billings, MSCC included, does not translate to an improvement in Class I visibility; linear or otherwise.

Figure 6: Billings Area SO_2 Emissions: 2000 - 2064



This graphic shows there has been a dramatic and continuous reduction in emissions since the inception of the RHR program and beginning well before the changes mandated in the 2012 FIP.[29] Emissions of SO_2 have declined almost 75% since 2000. On its face, this demonstrates that there has been more than reasonable progress toward the national goal assuming, for this discussion, that emissions reductions may have a direct effect on improvement in visibility. On that basis, the graphic indicates that the Billings-Laurel area has done more than its fair share toward the RHR program goal and that, assuming we are on the glidepath, nothing further needs to be done, at least for this 2nd round planning period.

3.4 MSCC Emissions and Perspectives

As this request for information arises from the RHR we find it useful and prudent to review our understanding of the nature and purpose of the visibility protection program to ascertain important criteria that will lead to the selection of specific Reasonable Progress requirements.

MSCC and Bison have been under the belief the RHR program historically has not considered MSCC's emissions as appropriate candidates for additional control under the reasonable progress (or any other) RHR criteria. First, MSCC's emissions (historical and current actuals) have been addressed and controlled by separate implementation plans, emission limitations, voluntary actions and projects undertaken by MSCC, and by subsequent federal implementation plan actions. Most of these emission controlling items occurred between 1998 and 2008.

[29] 40 CFR 52.1396.

Second, Montana and more particularly Billings-area emission inventory data (shown above) clearly shows substantial and adequate reductions in sulfur dioxide and nitrogen oxide emissions in the period since 1994 (and earlier although not shown in the figures as a matter of convenience). These reductions have resulted from voluntary source actions, implementation plans, plant closures, new plant constructions, and numerous consent decrees. Annual SO_2 emissions in Billings have fallen over 84% since 1994; 74% since 2002 (approx. start of RHR program). Particularly notable, a 53% reduction in SO_2 emissions has been realized during the first planning period (2008 → 2018). NOx emissions have also reduced by 52% (2,342 tons) during the planning period. These statistics are clear evidence, that to the extent local emissions were assumed to materially impact Class 1 visibility, emission reductions from the Billings area are well ahead of any reasonable or necessary "uniform rate"[30] of visibility improvement or progress contemplated for the present planning period at any nearby Class I area.[31]

To put MSCC in a historical perspective, the facility was established in 1955 to capture sulfur from fuel gases and acid gases. This sulfur was previously and traditionally burned as fuel or at flare without recovery, resulting in tens of thousands of tons of sulfur dioxide emissions annually in the area. As a pioneer facility, MSCC's plant operations immediately reduced area SO_2 emissions by tens of thousands of tons annually. MSCC's facility also produces sulfur products, including fertilizer and soil-amending materials, using molten sulfur created in its Sulfur Recovery Unit (SRU) and produces low sulfur fuel gases in its fuel gas scrubbing plant.

Fuel gases are scrubbed of hydrogen sulfide (H_2S) in an amine unit. Cleaned low-sulfur fuel gases are returned to their owner for combustion or other use. The concentrated sulfur gases recovered are designated "acid gases." Other acid gases are also received for processing and mingled with those recovered in the fuel gas scrubber operation. The acid gases feed into the sulfur recovery equipment where they are reacted with oxygen from the air in a thermal/catalytic system consisting of multiple reaction furnaces/boilers and multiple catalytic reaction stages. The result of these processes is to produce elemental sulfur and water vapor, along with some side-reaction products. Elemental sulfur is separated from the gas stream by condensation in multiple stages. The use of such multiple stages allows the reversible "Claus" reaction to be driven toward completion. About 92% to 95% of the incoming sulfur in these gases is practically recoverable in this manner. This is known as the modified "Claus/Chance" process.[32] Unrecovered sulfur and compounds from the plant were, in the 1950s and 1960s, vented through the smoke stack,[33] as a semi-opaque plume consisting of sulfur aerosol

[30] This term is found in RHR at 40 CFR 51.308(d)(1)(i)(B), §§308(f)(1)(vi) and elsewhere.

[31] These uniform rates or progress are taken in general terms from those "glidepaths" shown in "State of Montana Regional Haze, 5-Year Progress Report," Montana DEQ, August 2017, Appendix C, Figures 9, 31, 42, 64, 53, 75, 86, 97 and 108.

[32] AP-42 contains a description of this process. This information may be found at: http://www.epa.gov/ttn/chief/ap42/ch08/final/c08s13.pdf

[33] These emissions were routinely emitted through the 100-foot stack (EU4) during this period.

particulate, SO_2, H_2S, water vapor, carbon oxides and nitrogen, as was normal for the time period.

In anticipation of state regulation related to odor, opacity and visibility, these “tail gas” materials were next subjected to tail-gas oxidation or incineration. This tail-gas treatment process became established in its present form in about 1967 at MSCC. MSCC uses a selective oxidation catalyst in the presence of excess air and elevated temperature to convert aerosol sulfur and reduced sulfur compounds in the tail-gas to sulfur dioxide gas which is both transparent and (relatively) odorless.

In 1990, EPA contracted with E.H. Pechan and Associates to inventory both ‘actual’ and ‘potential-to-emit’ (PTE) SO_2 emissions in the Billings, Montana, area.[34] This government-initiated, -directed, and -funded study included emissions from MSCC as well as several other local industries. MSCC cooperated with Pechan in developing this inventory. Pechan concluded, based on spot-testing, that (as of 1989) for MSCC’s SRU, sulfur dioxide emissions were:

1989 Actuals:	3,450 tons/year
Potential to Emit:	12,200 tons/year[35]

By comparison, MSCC’s actual, continuously monitored, emissions from the SRU main stack were 917 tons in 2018. Thus, actual emissions have dropped from the 1989 study period by over 73%. Historical annual emissions are also shown as a graph later in this section.

In 1998, MSCC became subject to an agreed annual emission limitation of SO_2 at its main stack of 4,544 tons per year.[36] Thus, permitted emissions dropped almost 64% from the 1989 “potential to emit” permitted values. In 1998, MSCC also agreed to become subject to a routine flaring emission limit of 150 pounds per three hours. In December of 1998, MSCC voluntarily installed a SuperClaus® unit at the facility to assist in meeting the agreed shorter-term emission limitations, established by stipulation in 1998. This 1998-unit processes tail gas from the Claus plant and significantly reduces actual and annual emissions. The unit is, in effect, an additional emissions control device for the facility.

34 “*Development of a Sulfur Dioxide Emissions Inventory for Billings and Laurel, Montana – Volume 6 – Montana Sulphur & Chemical Company Sulfur Recovery Plant*,” EPA Contract 68-02-4400, EPA Region VIII.

35 These values represent the SRU -Main Stack unit only. Actual and PTE emissions from the separately vented boilers and flares were (and continue to be) much less than the SRU. As an example, PTE emissions from the boilers were, at the time of the Pechan report, 18 tons/year while flaring was determined at 271 tons/year.

36 This was the “Stipulation” limit adopted by the Montana Board of Environmental Review in 1998. EPA eventually adopted the same limit in their FIP which is found in 40 CFR 52.1392(g).

It is interesting to note that while MSCC's *allowable* emissions were reduced to 4,544 tons per year in 1998, its *actual* emissions the prior year (1997) were 4,058 tons.[37] In 1999, the first full year of SuperClaus™ operation, MSCC's actual emissions reduced to 1,137 tons/year, a 72% reduction. A graphical representation of annual emissions is found later in this section.

In May 2002, EPA found the 1998 SIP revision limitations "inadequate" to comply with various regulations and policy.[38] EPA then imposed additional restrictions on MSCC in a 2008 FIP using revised (more conservative) modeling assumptions. Those further restrictions became 'final' on April 21, 2008 (73 FR 21418) in 40 CFR 52.1392.

Like all processes, SuperClaus® processing must occasionally be interrupted, for example, for repairs and catalyst work. In such cases MSCC's emissions would again necessarily return to pre-1998 levels, if processing similar loads. About 2007 MSCC undertook to increase the on-line reliability of SuperClaus® processing by installing a second SuperClaus® unit in parallel with the 1998 unit.[39] This 2nd unit provides a great level of redundancy for enhanced SuperClaus® processing, so that sulfur and fuel gas processing can continue during periods of repair and maintenance affecting either (but not both) of the SuperClaus® process trains.

Shortly thereafter, MSCC similarly ramped up the reliability of incinerator processing for opacity control, with a second selective oxidation incinerator operating in parallel with the 1967 unit.[40] This provides a great level of redundancy for this processing, so that sulfur and fuel gas processing can continue, with incineration, even during periods of repair and maintenance affecting either (but not both) incineration trains.

Also, as part of the SO_2 2008 FIP,[41] MSCC's flare emissions during startup, shutdown, and malfunction (SSM) events also became regulated and limited to 150 pounds per 3-hour period (this is equivalent to 219 tons/year). This enforceable limitation on occasional SSM flaring represented a substantial reduction from the prior short-term flare PTE emissions presented in the EPA PECHAN study (8,000^{+} lb/hour).[42] In response, MSCC developed and installed a patented Flare Gas Treatment Unit (FGTU) to address occasional SSM flaring. With this unit, Flare SO_2 emissions for 2018, for example, amounted to much less than 1 ton.

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[37] The emissions for 1998 were 3,626 tons per year. However, 1998 includes partial operation of the new SuperClaus™ unit. The first full year of operation of the SuperClaus™ yielded in a 72% reduction in emissions from the 1998 year.

[38] May 2, 2002, at 67 FR 22168.

[39] Montana DEQ approved the installation of the second SuperClaus™ unit (and a redundant selective oxidizer incinerator) on March 1, 2007.

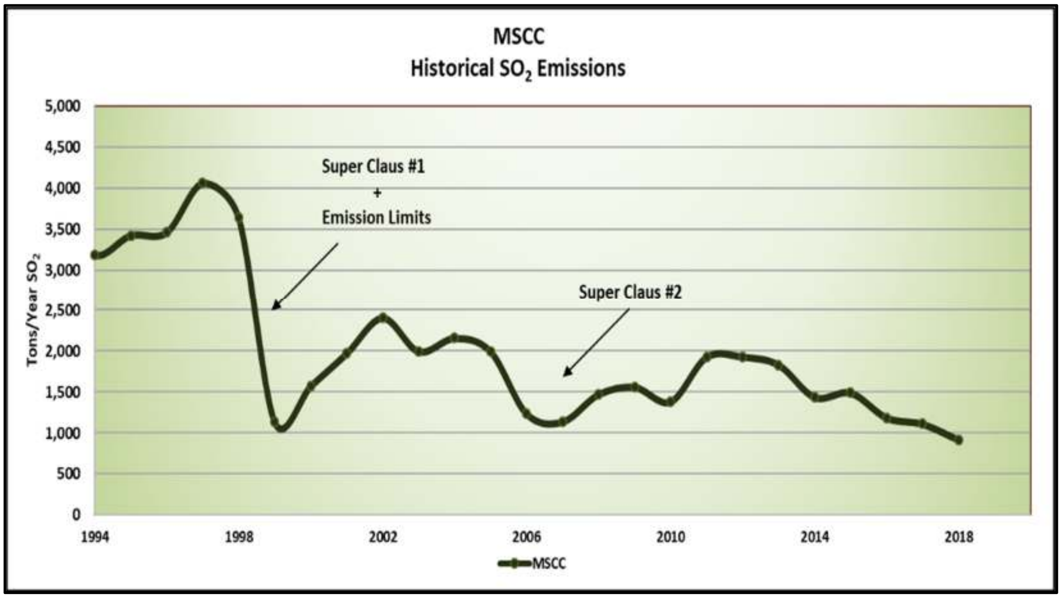
[40] Ibid.

[41] 40 CFR 52.1392(g).

[42] "*Development of a Sulfur Dioxide Emissions Inventory for Billings and Laurel, Montana – Volume 6 – Montana Sulphur & Chemical Company Sulfur Recovery Plant*," EPA Contract 68-02-4400, EPA Region VIII.

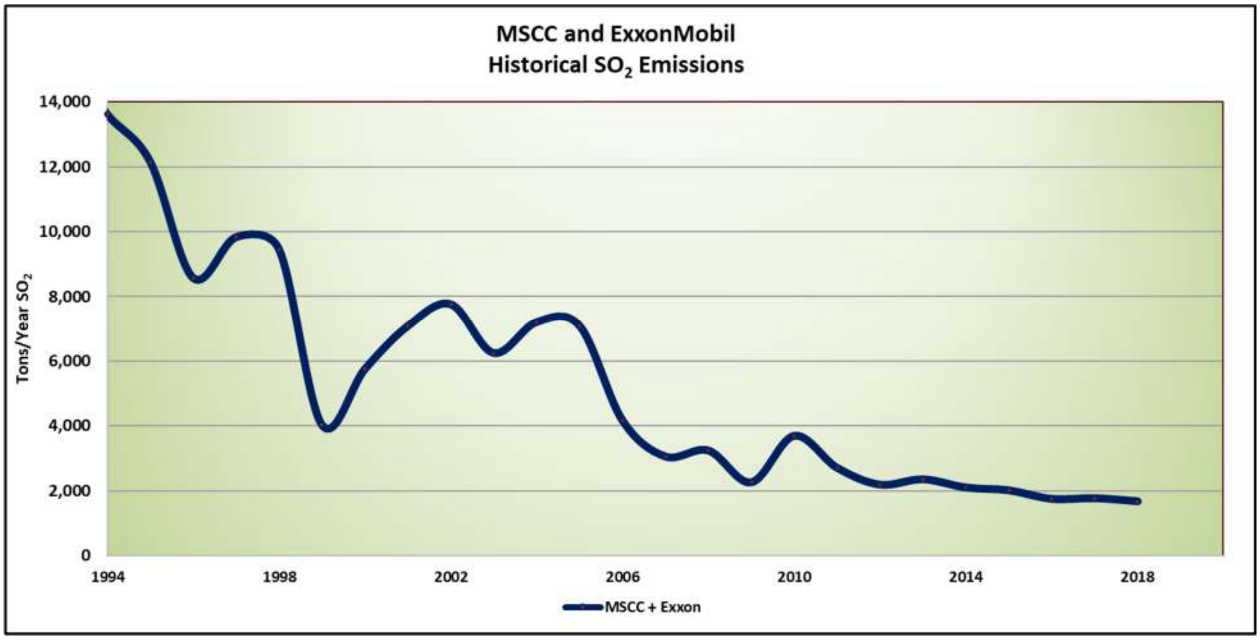
To aid the reader in understanding the depth of the changes in emissions at MSCC, the following figure shows historical emissions from the plant.

Figure 7: MSCC SO_2 Emissions: 1994 - 2018



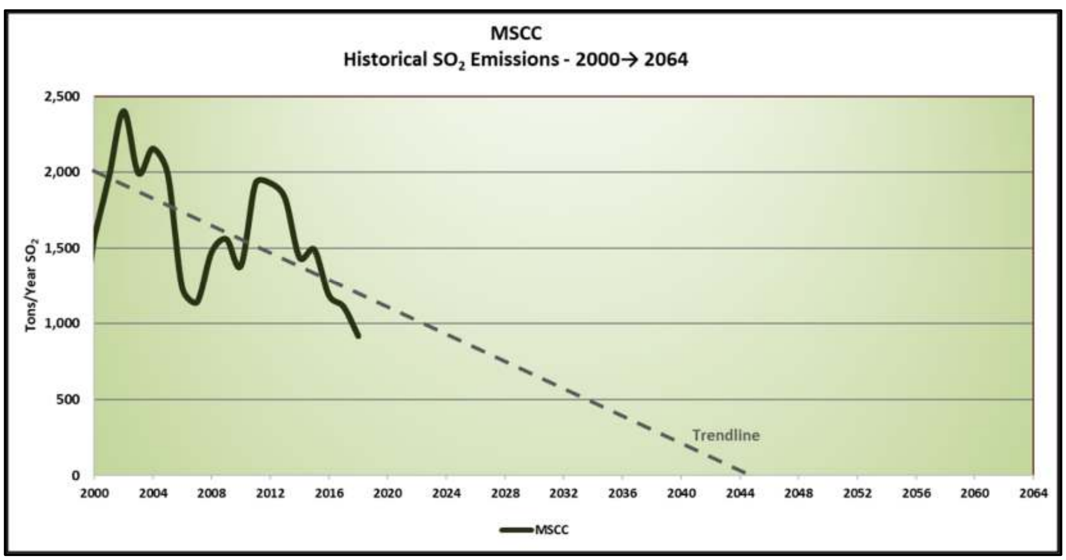
There are several relevant comments to be made regarding the graph. First, it is obvious that the addition of the SuperClaus® made a substantial reduction in emissions from the facility. The same is generally true for the second SuperClaus®, but to a lesser degree. Second, one must keep in mind that the sulfur recovery unit processes sulfur bearing gases that it receives from the ExxonMobil refinery in varying amounts. Thus, increases or decreases in throughput or quality of sulfur-bearing streams are not necessarily reflected in the graphic above. What is not shown is that as an integral result of reducing refinery emissions and fuel product sulfur (under other program requirements) ExxonMobil may direct additional sulfur-bearing gas to MSCC for processing. This assists in lowering SO_2 emissions in the Billings area in general, and for the combination of ExxonMobil and MSCC emissions, but not necessarily for MSCC alone. Regardless, this and earlier graphics show this combination of efforts by both facilities resulted in very substantial reductions over the past 20^+ years and beyond. A graphic of this data is shown below.

Figure 8: MSCC + ExxonMobil Emissions: 1994 - 2018



To be consistent with previous historical (and projected) emission summaries, the same information regarding MSCC alone is provided graphically below for the RHR program history through 2064.

Figure 9: MSCC SO2 Emissions: 2000 - 2064



Clearly the rate of reduction of emissions represents a rate that is beyond “reasonable progress” in attaining the national goal.

3.5 Emission Reduction: 1st and 2nd Planning Period

In addition to the reductions achieved by Billings, including MSCC and ExxonMobil in particular, since 1998, it is important to note other significant changes in emission rates. This is necessary when studying any reasonable progress and emission reductions that have happened since the 1st RHR period began (2008) and since the resultant 1st period FIP. A discussion of emission reductions that have or are about to occur during this 2nd planning period is also necessary. Reductions that have occurred during the 1st planning period were, understandably, not anticipated by planners during that period, but should now be taken fully into account in determining our status within the "reasonable progress" toward the 2064 goal. Specifically, and without being all-inclusive these include:

(a) In 2015 the Corette Coal Generation Power Plant, at Billings, permanently closed. It has since been dismantled and removed and its air quality permit has been relinquished. In the 1st RHR planning period, Corette's SO_2 permissible emissions under the RHR Program FIP of (2012) were restricted to about 5,000 tons per year. NOx emissions had no specific annual mass limit but were limited to 0.4 lb/MMBtu (there was also a 30-day limit was 0.35). These limits were achieved by several factors including reduction in operating rates and selective use of alternative coal-fuels. Its baseline emissions in the 1st planning period were approximately 3,200 tons/year. As noted, however, the actual emissions, now enforceable, are **zero** as to both SO_2 and NOx.

    As a side note, the Q/d (explained in Section 3.5) value for this facility based on the last 5 complete years of operation would be about 24. This compares to MSCC's current Q/d at slightly more than 7. This information is relevant when concluding later in this document that neither MSCC nor Corette or any other Billings area sources have a discernible effect on visibility impairment at any of the nearby Class I areas.

(b) As a result of an enforceable consent decree, Colstrip Units 1 and 2 are required to be permanently closed in 2022. These 1970's coal-fired plants have PTE emissions of roughly 20,000 tons/year of SO_2 and 12,000 tons/year of NOx.[43] The Q/d based on PTE for these two units is about 190. As a result of the consent decree, these plant's emissions will become effectively zero after 2022. Furthermore, the Colstrip operator announced --in June 2019 -- that, in fact, the 2 Colstrip plants will close ahead of schedule in 2019 citing inability to obtain permitted fuel at a viable price from the nearby Rosebud mine. In either case, the effect of these emission reductions on reasonable progress for the 2nd Round RHR planning period and thereafter should be considered.

(c) Colstrip Units 3 and 4 face increasing pressure for closure as well. Fuel cost concerns and even coal availability relate here as well. The adjacent Rosebud Mine recently emerged from bankruptcy with prior creditors as new owners. Units

[43] Based on heat input and emission limit of 1.2 #/MMbtu (SO_2) and 0.7 #/MMbtu (NOx)

3 and 4—750 MW each—started operations in 1984 and 1986. Units 3 and 4 are owned to varying degrees by Talen Energy, PSE, Portland General Electric Co., Avista Corp., PacifiCorp, and NorthWestern Energy. No shut down date is set for the newer units; however, the state of Washington recently passed 100% clean electricity law mandates that coal be removed from utility power supplies by the end of 2025, so a change in ownership or closure are likely by then. Oregon, a major user of the power from these plants, also has similar legal mandates. New "coal combustion residuals regulations" also would impact these plants emissions and costs post-2025. These plants emissions (for all 4 units) in the 2nd planning period baseline are roughly 8,700 tons/year of SO_2 and 13,700 tons/year of NOx. Those emissions may reasonably be assumed to either shrink substantially or to disappear entirely by 2026.

(d) Montana Dakota Utilities (MDU) announced in 2019 that it will close its coal-fired Lewis and Clark plant at Sydney, Montana in 2020. In addition, it also will close two other coal-fired facilities in Mandan, ND. The Lewis & Clark facility is a 44-megawatt power plant that burns about 230,000 tons of coal annually from nearby Savage Mine, according to MDU. The emissions will clearly become **zero** after 2019.

(e) In adjacent Wyoming, recently announced studies by PacifiCorp indicate that several coal-fired plants will close or are likely to close during the 2nd RHR planning period. The study calls for closing the Dave Johnston Plant near Glenrock in eight years and shuttering two units at the Naughton Plant near Kemmerer in six years, along with other changes. In addition, the company recently requested Wyoming regulators to allow it to cut production at the Jim Bridger plant to meet Clean Air Act rules. Until this year, the utility had instead planned on investing in pollution controls to meet Federal requirements. The state Department of Environmental Quality has supported the request and expects to submit the issue to the federal EPA for approval. PacifiCorp told the DEQ it would reduce coal consumption by about 9.3% compared to current operations, according to WyoFile calculations. These reductions in consumption and emissions, therefore, are reasonable to consider for the current RHR planning period. In addition, PacifiCorp also closed its 213 MW Castle Gate coal fired plant, located in Carbon County Utah, in 2015.

(f) Rio Tinto Kennecott in 2019 announced the official retirement of the Magna Utah power plant following regulatory approval. Rio Tinto Kennecott says 6,000 tons (5,443 metric tons) of pollutants will be eliminated from the Salt Lake Valley airshed thanks to the closure. Approval is expected.

(g) Also, in Utah, owners of the Intermountain Power Project in Utah will stop operating coal-fired units in 2025. The two-unit, 1,800-MW power plant near Delta, Utah, owned by the Intermountain Power Agency began operating in 1986. The plant is facing the loss of existing customers, less demand for coal-fired electricity and environmental regulatory issues, the Intermountain Power Agency said in a May 23, 2019 announcement. Most of the power from the plant is for Los Angeles and nearby California cities which are phasing out coal-power. California cities will no longer use coal by 2025 causing the plant to shutdown coal operations. A state law also prevents future purchases in new contracts beyond 2027. Operating the coal units beyond 2025 would cause remaining power purchasers to incur significant additional expenses for compliance with new coal combustion residuals regulations (like Colstrip 3 & 4) and likely additional air emissions controls, according to the Power Agency. Therefore, these emissions will cease in, or before, 2025.

The above examples of major plant closures in Montana and surrounding states that either occurred since the 2012 FIP for the 1st planning period, or will occur during the 2nd planning period (before 2028) are compelling evidence that major emissions reductions are "in the bag" for large plants that have large Q/d values for Class I areas of concern to Montana. These closures (and planned reductions) should and must be fully considered in any determination of reasonable progress for the 2nd planning period.

Also, of note, is that the reductions from these recent past and future closures of coal-fired plants far exceed any potential reduction available from Billings in general or from MSCC.

3.6 Deciview / Anthropogenic Deciview

The term "deciview" is, on its face, a generic metric used to quantify visibility impairment (haze) regardless of its cause (relative humidity, fine particulate, forest fires, industrial emissions, home heating, etc.). The term is defined in RHR at 40 CFR 51.301 as:

Deciview haze index=10 $\ln_e(b_{ext}/10\ Mm^{-1})$

Where:

b_{ext} = the atmospheric light extinction coefficient, expressed in inverse megameters (Mm^{-1}).

There are, of course, numerous articles and explanations for the deciview metric. One such article may be found in the publication "IMPROVE," Volume 2, No. 1, April 1993 which was written by Pitchford and Malm, 1993. From a practical point of view, the change in deciview of "1" is intended to represent a "just noticeable change" (or sometimes referred to as 'just discernible') in visibility regardless of the baseline visibility. Changes of less than one (1.0) deciview are therefore imperceptible.

There has, unfortunately, been some confusion and complications as to the deciview term. On its face, the term means (via the definition) a change in visibility from any parameter; human caused or otherwise. However, Congress' instructions were:

" … the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory class I Federal areas which impairment ***results from manmade air pollution****."* [42 USC 7491(a)(1)].

That being the case, RHR is not, and should not be, an attempt to remedy or prevent all visibility impairment, but to remedy or prevent impairment resulting from manmade air pollution. To provide a distinction between impairment in general and impairment "from manmade air pollution" EPA (and DEQ) has attempted to provide specific meanings to the term "impairment" and "haze."

To avoid confusion when presenting information or data between impairment (manmade or not), EPA (and DEQ typically) use the following terms:

Impairment	=	Anthropogenic (manmade) regional haze or degradation
Haze	=	Regional haze or degradation caused by both Anthropogenic and Non-Anthropogenic sources.

However, for purposes of this report the following terms or phrases have the meaning shown:

Term		Meaning
Anthropogenic Deciview	=	Deciview as a result of all sources (natural and anthropogenic) **less** the deciview from natural sources. $\Delta dV_{anthopogenic\ impairment} = dV_{total} - dV_{natural}$ (Eqn 2)[44]
dV	=	" "
Anthro dV	=	" "
DV	=	" "
Anthro Deciview	=	" "
Deciview Haze	=	Deciview as a result of both Anthropogenic and Non-Anthropogenic sources including natural background. Equivalent to dV_{total} in Eqn 2 above.

Therefore, unless otherwise specifically noted in this report, the term deciview and its derivatives is in reference to anthropogenic (manmade) deciview (less natural background) only to be consistent with the definitions and purpose of RHR.

[44] Equation 2 from: "Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program", EPA-454/R-18-010, December 2018.

3.7 Emissions vs Visibility Impairment: Retrospective Analysis

The next step in discussing the reasonable progress perspective is to analyze the **current and historical visibility measurements against emissions** and glidepath. This type of analysis is essential to goals of the program. To reduce the anthropogenic impact on visibility, it must be necessary to determine which anthropogenic sources exist, and to what extent, if any, these sources discernibly impact the Class I area of interest.

It would, of course, be a significant error if one were to force a facility to reduce emissions under the umbrella of this program without a measurable or knowable resulting improvement in visibility as contemplated by the program. Such a requirement would force a facility to expend tens of millions of dollars or to cease operations while achieving no apparent improvement to visibility or impairment. Such a result would be inconsistent with the statute and the Regional Haze regulations.

Thus, in order to seriously consider the results of a 4-Factor analysis as described by the RHR, there must be a reasonable probability of an actual improvement in any visibility impairment arising from MSCC itself or in combination with other nearby regulated sources. If there is no discernible impairment presently arising from MSCC, then there can be no improvement. There are several methods one may employ to determine if any emission reduction would lead to discernible improvement in visibility at a 'nearby' Class I area. These methods fall into two classes:Prospective and Retrospective. The discussion in this section addresses retrospective analyses. A prospective analysis is found in Section 5.0 and uses dispersion modeling as the analysis tool.

For this planning period, we are fortunate to have about 18 years of both visibility data along with concurrent emissions data. The emissions data includes all 18 years for MSCC and all the Billings-Laurel industrial facilities. Emissions data has already been presented in Sections 3.1 through 3.4 above.

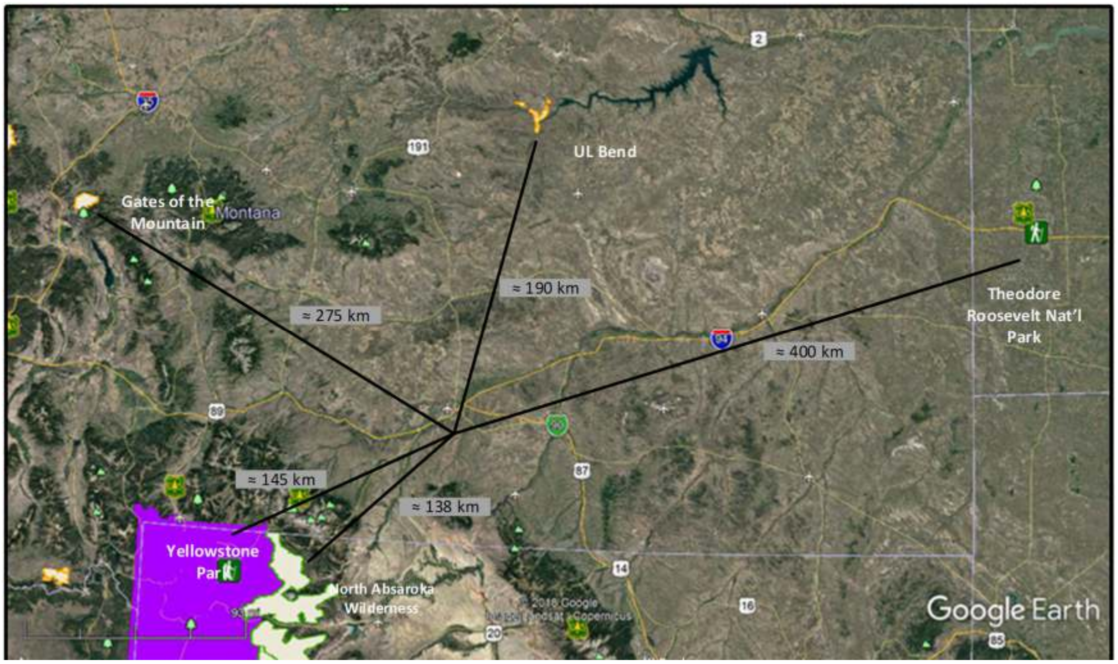
In addition to emissions data, there is concurrent visibility data at all the 'nearby' Class I areas. These areas and their closest proximity to MSCC are shown below.

Table 1: Nearby Class I Areas: Distance & Q/d

Nearby Class I Area	Approximate Distance from MSCC (*kilometers*)	MSCC Q/d
North Absaroka Wilderness Area	138	7.4
Yellowstone National Park	145	7.0
UL Bend Wilderness Area	190	5.4
Gates of the Mountain	275	3.2
Theodore Roosevelt National Park	400	2.5

To offer some perspective, the location of these areas relative to MSCC is shown in the figure below.

Figure 10: Nearest Class I Areas



The term "Q/d" refers to the sum of SO_2 and NOx (per year) divided by the distance to the Class I area.[45] The Q in the table uses the 2nd round baseline years of 2017-2018.

DEQ used Q/d as a threshold for determining which sources should be subject to the 2nd round 4-Factor analysis. The threshold selected by DEQ was 4. Thus, any Montana facility whose Q/d for any Class I area exceeded 4 became subject to the 4-Factor analysis.

The use of DEQ's Q/d concept is one practical way to determine which Class I areas should be the subjects of interest by MSCC for the purposes of this 2nd planning period analysis. A Q/d threshold of 4 indicates that only North Absaroka, Yellowstone Park and UL Bend need be addressed in this document.

Visibility data from these areas were taken from the Western Regional Air Partnership (WRAP)[46] and generated from the Interagency Monitoring for Protected Visual Environments (IMPROVE).[47]

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[45] The "Q/d" concept was explained by DEQ in the March 13, 2019 letter to Mark DeHart MSCC.
[46] Information regarding WRAP may be found here: http://www.wrapair2.org/reghaze.aspx
[47] Information regarding the IMRPOVE program may be found here: http://vista.cira.colostate.edu/Improve/improve-program/

What is of interest from this data is that it is now possible to compare declining/changing emissions data (MSCC and other) directly with *observed* visibility impairment data. Of further interest is that data spans both:

i) the baseline period for the visibility program (2000 → 2004); and
ii) roughly the 1st implementation and planning period (2005 → 2018).

The first planning period encompassed the analysis and implementation of BART for BART-qualified sources, along with 4-factor analyses that took place at the same time.

It is, therefore, now possible to glean some insight as to whether the visibility data is responding discernibly to actual changes in emissions during the same time period. If MSCC or other nearby facility has a measurable, discernable impact on visual impairment at a Class I area, then the observed visibility (using deciviews as the indicator) will necessarily follow the trend. Due to a myriad of statistical confounding variables, meteorology and other haze constituents[48] among them, it would not necessarily be expected that correlation between selected emissions and visibility (deciviews) to be linear or strong. Nonetheless, if MSCC or Billings as a whole, (or larger source areas, such as Colstrip) have a significant increase or decrease in emissions during the monitoring period (2000 to present), it is logical to assume the deciview parameter will have followed this trend (if the selected emissions were significant contributors). **Conversely**, if visibility does not improve significantly following the significant change in emissions, then it is not rational or reasonable to assume or conclude that future smaller reductions will have a different or significant effect.

The sections below provide such a comparison between emissions and visibility (deciviews) at the various "nearby" Class I areas.

3.7.1 Yellowstone Park Visibility vs Emissions

The first Class I area to consider is Yellowstone National Park which is a well-known area of concern in the RHR program. The distance is roughly 145 kilometers from the facility to the closest border of this large area. The area is generally southwest of Billings (and generally upwind). The Class I area is also in the Q/d "vicinity" of large sources outside of Billings, and outside of Montana. The visibility data used in this analysis and those following were taken from the WRAP Technical Support System web site.[49]

For interest, an annual wind rose (2013) is presented in the figure below to indicate the general wind directions observed in the Billings area. Longer prongs on the wind rose indicate higher prevalence of wind coming **<u>from</u>** that vector. The meteorological site is the Johnson Lane station which is located about 1 kilometer from the MSCC facility. The wind data is similar from both the Billings airport and Coburn Road site. That data is, of course, available to DEQ.

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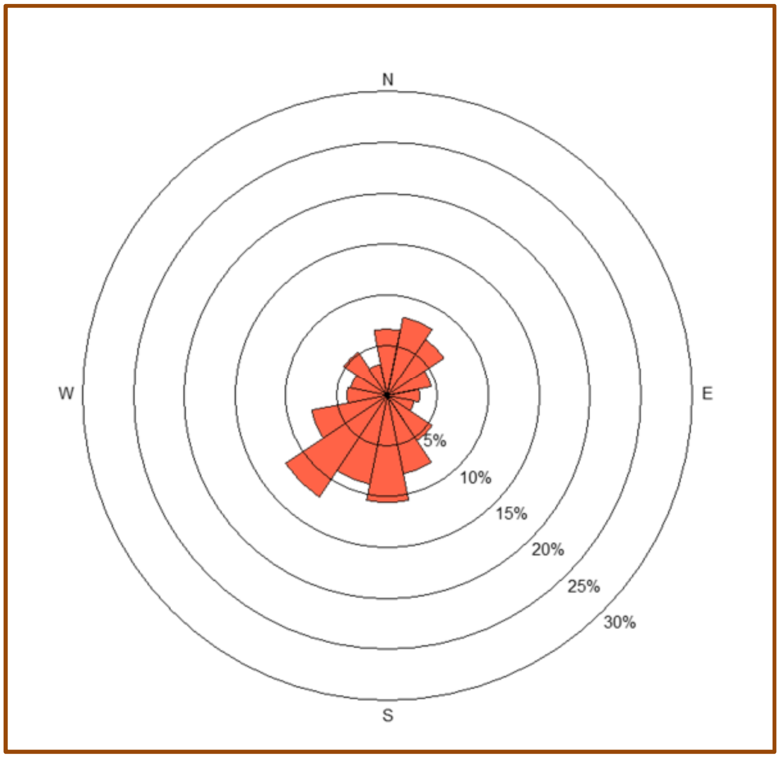
[48] Wildfire smoke, prescribed/planned burn smoke, dust, photo-active compounds from vegetation, to name a few.

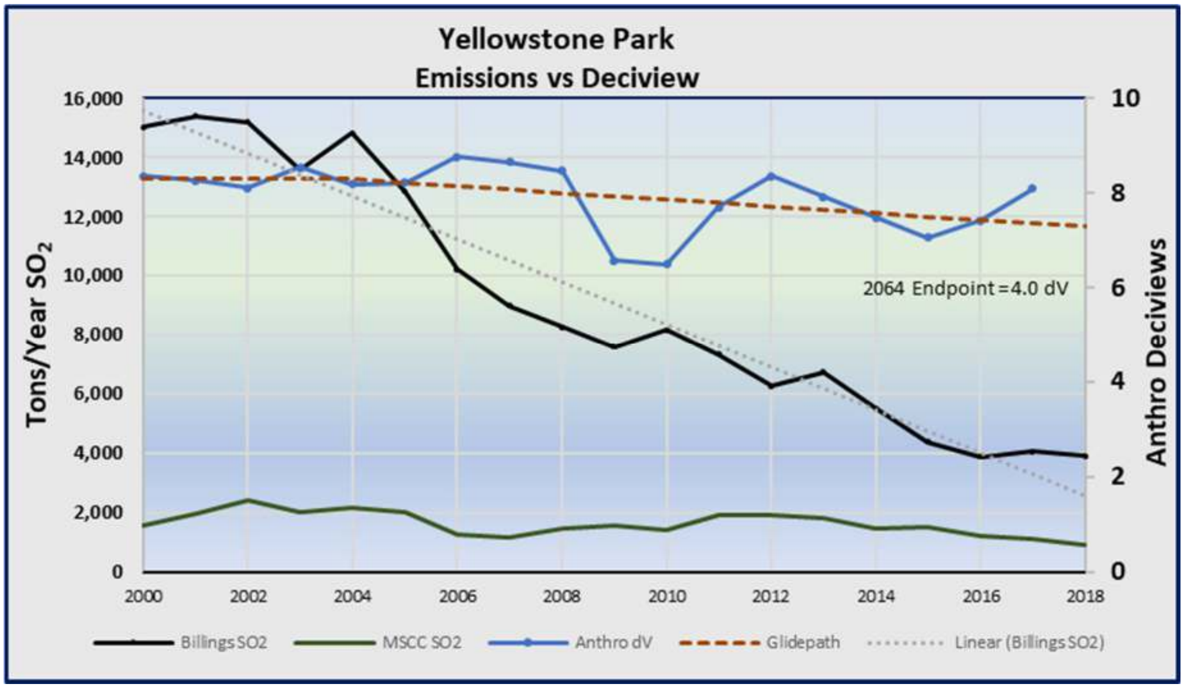
[49] WRAP Technical Support System: http://views.cira.colostate.edu/tssv2/

Figure 11: Wind Rose: Johnson Lane



The visibility/emissions analysis begins by creating a graphical representation of the emissions and visibility data over time. The figure compares visibility over time with Billings SO_2 data, including Laurel. Emissions data from MSCC are also shown as a separate variable.

Figure 12: Yellowstone Visibility Data: 2000 - 2018



Note: The term "2064 Endpoint" refers to the desired endpoint deciview upon reaching the national goal.

A cursory review of the chart indicates a few observations:

1) The observed visibility at the Yellowstone Park site seems, on the whole, to be following the designed glidepath toward the year 2064 endpoint.[50]
2) The rate of emission reduction from all Billings-area sources vastly outpaces the modest rate of visibility improvement.
    i. The local reduction is about 11,000 tons
    ii. The total dV reduction corresponding in time to this massive emission decrease is about 1 deciview (barely discernible)
    iii. The relationship, if any, supported by the data is very weak – **≈ 0.06 dV per 1,000 tons of local emission reduction**.
    iv. There are several cases (≈ 4) where deciviews increased as emissions decreased.
3) There appears to be a slight trend in emission reductions at MSCC; as noted above, most MSCC emissions had been controlled by earlier projects. The rate of emission reduction and any relationship to the visibility data is not clear

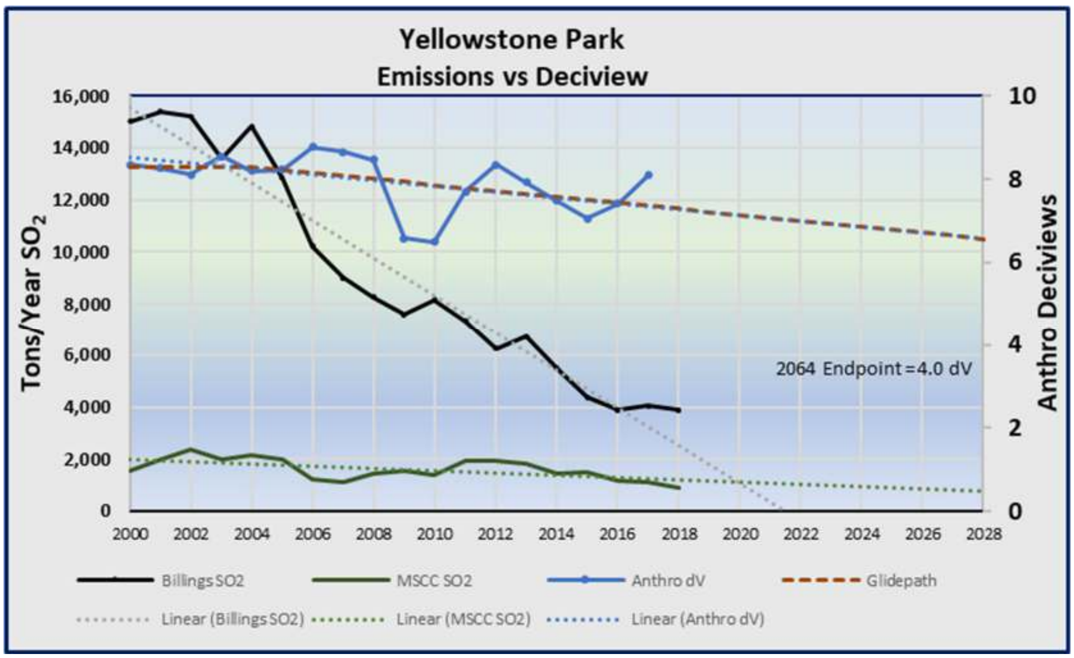
[50] The "glidepath" is a straight line of deciviews starting at the baseline (≈ 2000-2004) through the 2064 endpoint of the RHR program. **The "endpoint" is the final desired deciviews which is intended to represent "remedying of … existing impairment of visibility … which … results from manmade pollution."** (1990 Clean Air Act). If visibility is following this glidepath it is evidence of reasonable progress towards the national goal.

without further statistical analysis. The remaining tons of emissions at MSCC is about 1,000 tons. See 2.(iii) above.

4) The remaining emissions in Billings (total) is about 4,000 tons. Even if the weak relationship of emissions to visibility is assumed to be true, then the closure of all the sources in Billings would have no discernible benefit in reducing impairment.

Since it is a purpose of this exercise to provide support for or comply with a "uniform rate of progress"[51] for the 2nd planning period, we deemed it instructive to plot the same data but expanding the abscissa to include the baseline period, 1st planning period, and the 2nd planning period.

Figure 13: Yellowstone Visibility Data: 2000 - 2028



This graphic even more clearly indicates that the rate of reduction in emissions far outpaces any observed, or required, uniform rate of progress. Based on the relative rates of change observed (in emissions and deciviews), any relationship between the two is weak, at best, even when observing past actual changes in emissions that are **far** larger than all remaining emissions. The graphic further suggests that, statistically speaking, emissions from the Billings sources would reach zero less than 3 years from today. Obviously, this is not likely the case. Nonetheless, the historical information is instructive in that it makes clear that further reductions by either Billings or MSCC cannot and **will not yield discernible visibility improvements**, as required by the program to justify such reductions.

[51] "Uniform rate or progress" is discussed in detail at 40 CFR 51.308(f)(1)(vi).

The graphics may be followed up by calculating a few basic statistics of the data. More specifically the Pearson Correlation Coefficient (r) was determined. The correlation coefficient measures the linear correlation between two variables in the table below. The value of “r” may vary from -1 to +1. A value of -1 indicates a perfect negative correlation (when one variable increases, the other variable decreases). A value of zero indicates no correlation whatsoever and a value of +1 indicates a perfect positive correlation.

The other variable of interest is r^2 (the square of the correlation coefficient r). This variable is useful because it gives an indication of the “strength” of a correlation. In general, the r^2 value is an indication of what percentage of the data “fits” the linear model of a correlation between two variables. For example, an r^2 value of 0.50 would indicate that roughly 50% of the data fits the linear model well. Or put another way, 50% of the data suggests a good linear correlation and 50% of the data suggests no correlation. Correlation, of course, even if very strong, does not confirm causation.

The table below is a summary of various statistics of the emissions and visibility data for Yellowstone National Park.

Table 2: Yellowstone: Visibility vs Emissions Statistics

Anthro dV vs.	r	r^2
Time (year)	-.47	.22
Glidepath	.48	.23
Billings SO_2	.46	.21
MSCC SO_2	.18	.03

There are a few interesting observations from the data:

(1) Visibility via deciviews has decreased (improved) over time although the correlation coefficient is not particularly strong. On the other hand, the correlation data (not shown in the table) between Billings SO_2 emissions and time is very strong (-0.97).

(2) The deciview vs Billings SO_2 emissions, however, is only a weak to moderate correlation. The r^2 value indicates only about 20% of the local emission data correlates with anthropogenic deciview.

(3) The rate of visibility change for this Class I area is about 0.06 dV per 1,000 tons local reduction of SO_2. This does not support the notion that a perceptible change in deciviews would reasonably result from elimination of the remaining ≈4,000 tons.

(4) The deciview vs MSCC SO_2 emissions alone show virtually no relationship at all. In fact, the r^2 value is, for all practical purposes: Zero.

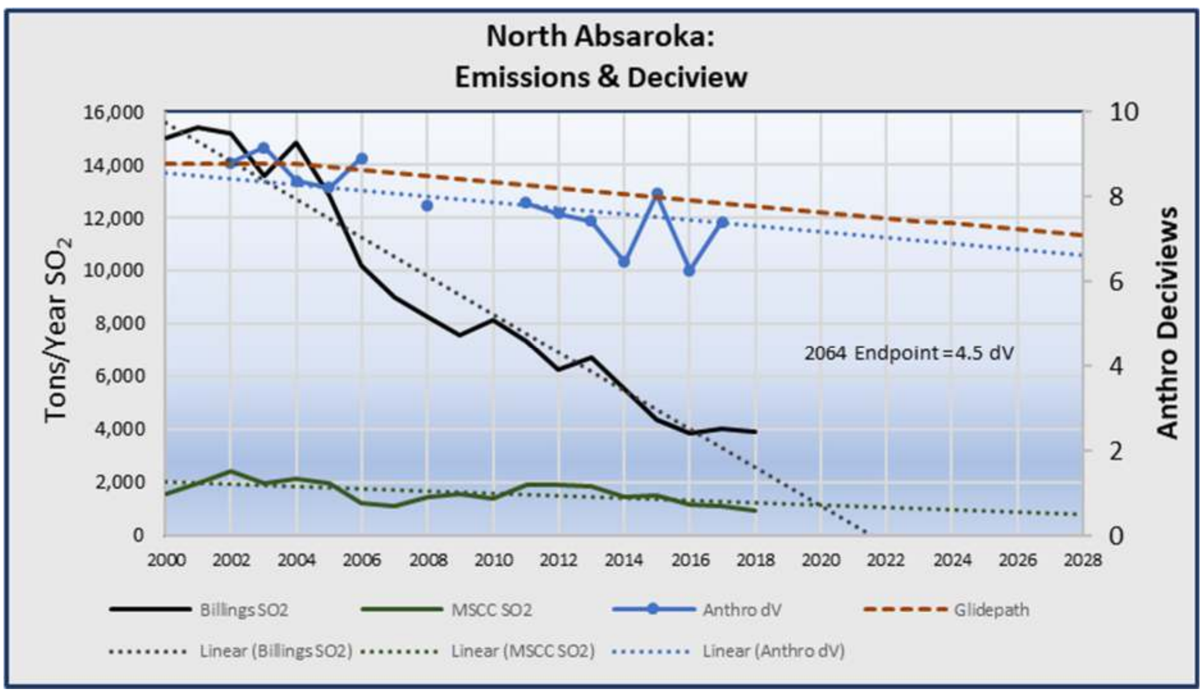
The data demonstrates that there is no apparent relationship between observed changing emission rates at MSCC with observed anthropogenic deciview.[52] Without such a relationship, a cause and effect conclusion cannot be reasonably supported.

3.7.2 North Absaroka Visibility vs Emissions

The next Class I area to consider is the North Absaroka Wilderness area which happens to be the closest to MSCC. It is roughly 135 kilometers from the facility to the border of this area, which is also generally southwest of Billings and again is generally upwind. Again, it is also in the dV "vicinity" of numerous other sources in Montana and neighboring states. As is the case for all these analyses, the visibility data used in this analysis and those that follow were taken from the WRAP Technical Support System web site.

The analysis starts by a graphical review of the emissions and visibility data over time. The figure compares observed visibility with Billings area and MSCC (separately) SO_2 data.

Figure 14: Absaroka Visibility Data: 2000 - 2028



Note: The term "2064 Endpoint" refers to the desired endpoint deciview upon reaching the national goal.

The most important observation to be gleaned from this chart is that the observed deciview data clearly indicates that this closest Class I area is already out performing the uniform rate or progress requirement (the glidepath). If there is no change in emissions from all SO_2 sources (Billings and otherwise) and all other parameters remain the same,

[52] The term anthropogenic deciview here is in reference to the definition of "Most impaired days" per 40 CFR 51.301.

the North Absaroka area already achieves and will have achieved the glidepath target at the end of 2028 without any reductions required during this 2nd planning period.

To complete the analysis, the correlation data, like the similar data regarding Yellowstone above, is also presented.

Table 3: N. Absaroka: Visibility vs Emissions Statistics

Anthro dV vs.	r	r^2
Time (year)	-.81	.64
Glidepath	.80	.64
Billings SO_2	.77	.59
MSCC SO_2	.52	.27

There are a few interesting observations from the data:

(1) Anthro dV has decreased (improved) over time. The correlation is relatively good.

(2) There is a modest correlation (59%) between North Absaroka deciview and the Billings area SO_2. This modest correlation, however, is not present for MSCC SO_2 (r^2 = 27%).

(3) Similar to what has been observed at Yellowstone National Park, the rate of visibility change for this Class I area is about 0.15 dV per 1,000 tons local reduction of SO_2. This again does not support the notion that a perceptible change in deciviews would reasonably result from elimination of the remaining ≈4,000 tons.

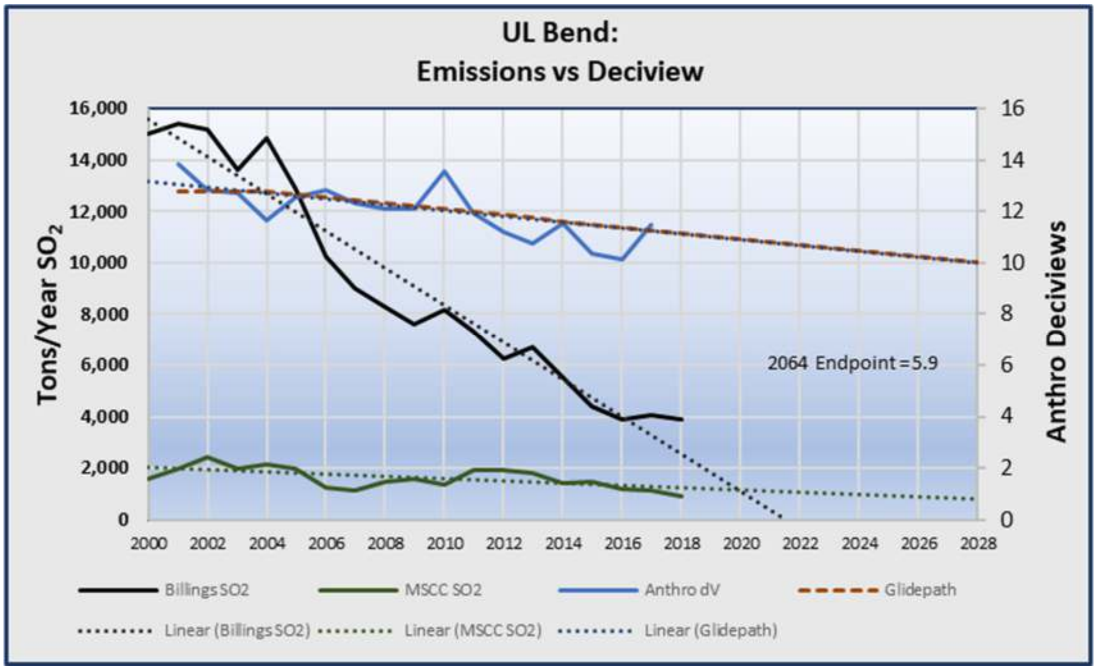
The raw data (see graphic) also clearly indicates the North Absaroka area has already attained its targeted uniform rate of progress (glidepath) without the need for reductions at MSCC or anywhere else in the Billings area.

3.7.3 UL Bend Wilderness Visibility vs Emissions

Another Class I area to consider is the UL Bend Wilderness. This area is located about 190 kilometers NNE of the MSCC facility. As is the case for all these analyses, the visibility data used in this analysis and those that follow were taken from the WRAP Technical Support System web site.

A graphical review of the emissions and visibility data over time is provided below.

Figure 15: UL Bend Visibility Data: 2000 - 2028



Note: The term "2064 Endpoint" refers to the desired endpoint deciview upon reaching the national goal.

The graphic indicates that the desired glidepath and observed deciview data match relatively closely (see correlation data below). Thus, data to date shows that the area is meeting the uniform rate of progress (glidepath) prescribed by RHR.

In addition to the graphic, the correlation data is also analyzed and compared per the table below.

Table 4: UL Bend: Visibility vs Emissions Statistics

Anthro dV vs.	r	r^2
Time (year)	-.76	.58
Glidepath	.74	.55
Billings SO_2	.70	.49
MSCC SO_2	.24	.06

The table reveals a few interesting observations:

(1) Visibility via deciviews has decreased (improved) over time. The correlation is relatively good. Although not shown in the table, the correlation is not nearly as strong as Billings SO_2 emissions over the same time period (≈ -0.97).

(2) There is virtually no correlation (r^2 = 6%) between the observed anthropogenic deciviews at UL Bend and MSCC emissions.

(3) The modest correlation for Billings area is also weaker than that calculated for North Absaroka.

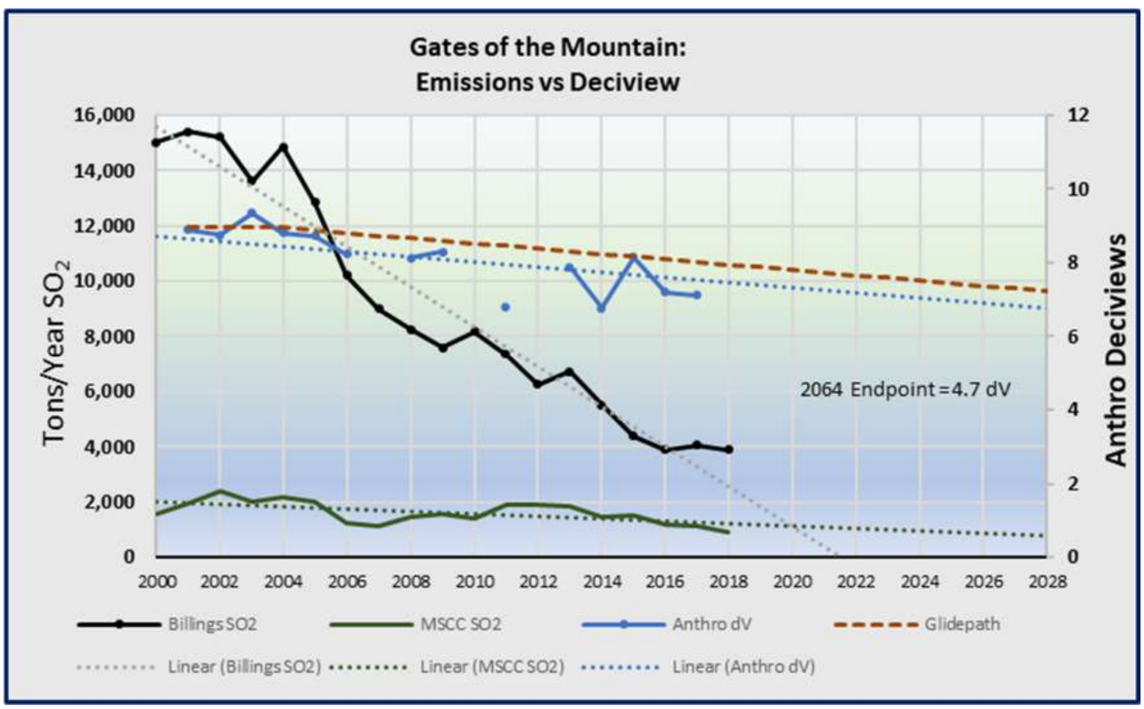
(4) The rate of visibility change for this Class I area is about 0.17 dV per 1,000 tons local reduction of SO_2. This again does not support the notion that a perceptible change in deciviews would reasonably result from elimination of the remaining ≈4,000 tons.

The data show that as emissions increase and/or decrease at MSCC, there is no corresponding change in deciviews. Thus, emission reductions as MSCC will not materially contribute to the uniform rate of progress observed at UL Bend.

3.7.4 Gates of the Mountain Visibility vs Emissions

The Q/d data for the Gates of the Mountain Class I area was less than the DEQ threshold of 4. As a result, the area is not necessarily a candidate for analysis. Nonetheless, it is included in this report as a matter of completeness. The area is about 275 kilometers NW of the MSCC facility making it an area even more unlikely to be impacted by MSCC or Billings as a whole. Nonetheless a review of that data was undertaken for completeness. A graphical review of the emissions and visibility data over time is provided below.

Figure 16: Gates of Mtn Visibility Data: 2000 - 2028



Note: The term "2064 Endpoint" refers to the desired endpoint deciview upon reaching the national goal.

The graphic reveals a few interesting features. First, the rate of emission improvement for Billings is (again) much faster than the rate of observed change for deciviews. The deciview trendline improved by about 1½ deciviews (barely discernible) during the entire period. (About 1 dV per 5,500 tons). During the same period, Billings SO_2 declined by roughly 70% or about 11,000 tons/year. This indicates that Billings SO_2 emissions, even as a whole were not and certainly are not likely contributing materially to visibility impairment at this site. Given the much smaller remaining emissions (≈4,000 tons), it also confirms that further (smaller) reductions in Billings (including MSCC) cannot reasonably be presumed to contribute to further reasonable progress.

Second the visibility improvement is, again, ahead of the desired uniform rate of progress wanted for the program. Finally, the current visibility (mean visibility for past 5 years) is already near the desired level for this 2nd planning period.

The data is presented in a statistical form (correlation) in the table below.

Table 5: Gates of the Mtn: Visibility vs Emissions Statistics

Anthro dV vs.	r	r^2
Time (year)	-.83	.69
Glidepath	.82	.68
Billings SO_2	.81	.66
MSCC SO_2	.59	.35

The following is noted:

(1) The correlation between Billings SO_2 and Gates of the Mountain visibility impairment is better than one might expect given the surface winds for all eastern Montana are in the wrong direction (west) to impact this area. West winds are not conducive to impacts from Billings or MSCC since they are nearly 200 miles from the Class I area (and in the opposite direction). It is, therefore, reasonable to presume that this correlation is most likely an artifact of the data in the period. In other words, visibility improved at a roughly consistent rate during the same time period as emissions were being reduced at a (different) roughly consistent rate. However, the data still frequently move in opposite directions similar to other the other Class I areas.

(2) The same general comment is noted for MSCC. The linear correlation's ability to "explain" the variance is weaker than for Billings as a whole, and not particularly strong ($r^2 \approx 37\%$). Thus, the same "artifact" conclusion is drawn per (1) above.

(3) The rate of visibility change for this Class I area is about 0.14 dV per 1,000 tons local reduction of SO_2. This again does not support the notion that a perceptible change in deciviews would reasonably result from elimination of the remaining ≈4,000 tons of local emissions.

Regardless of the minor to modest correlations and considering the observations noted for the graphical data, the Gates of the Mountains area has again already attained its uniform rate or progress (glidepath) without the need for considering reductions at MSCC or anywhere else in Billings/Laurel.

3.8 Analysis Summary

This study has provided some insight as to the nature of the regional haze program. More importantly, numerous analyses have been conducted to review historical and current emissions data and compare them against observed visibility data. These analyses and observations may be summarized as follows:

Emissions Trends.

i) National emissions of sulfur dioxide and nitrogen oxides have decreased substantially since the 1970s.[53] That same trend continues from 2000 through 2018 which spans the effective start of the regional haze program to date.

ii) Montana emissions of sulfur dioxide have also decreased substantially, largely mirroring the national trend. This is also true during the existence of the RHR program (2000 – 2018).

iii) Emissions from the Billings area (including Laurel) have also shown extensive reductions since the early 1990s. In fact, there has been a 75% reduction in sulfur dioxide emissions since 2000 (the beginning of RHR).

iv) Montana Sulphur & Chemical Company has also yielded large reductions in sulfur dioxide emissions. The installation of two SuperClaus® units, among other improvements, has reduced emissions by about 75% since the late-1990s.

All these observations show that the nation, Montana, Billings-Laurel and MSCC have all made significant reductions in emissions. These reductions have, by themselves, provided evidence for the case that more than “reasonable progress” toward the national goal has been achieved (assuming a correlation between emissions and visibility impairment that is not mere coincidence)[54].

A reduction in emissions (MSCC, or Billings as a whole) does not, however, necessarily translate into an improvement in visibility, let alone to a discernible improvement, even when much larger past reductions are considered against changes in visibility. A discussion of that observation immediately follows.

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[53] According to EPA and DEQ sulfur dioxide and nitrogen oxides are the primary causes of anthropogenic visibility impairment for nearby mandatory Class I areas. Sulfur dioxide is the pollutant of interest for this document’s 4-Factor analysis per the Montana DEQ email letter of April 19, 2019. (Appendix C).

[54] The data presented in this study does not support a correlation between emissions and visibility impairment in the ‘nearby’ Class I areas.

Emissions vs. Visibility Observations.

Numerous graphics and data analyses were conducted to compare actual emissions (MSCC and Billing-Laurel as a whole) against visibility observations within the various nearby Class I areas. If MSCC or Billings emissions impact visibility impairment in any meaningful way, then there should be good relationship (mathematical or visual) between the two.

That was not the case.

Emissions and visibility (expressed in anthropogenic deciviews) were compared side-by-side for calendar years 2000 through 2018. The comparison was made among the 4 nearest Class I areas.

In all cases, there was a modest but somewhat erratic improvement in visibility (2000 to present) within each of the analyzed Class I areas based on a graphical analysis of the data. However; there was a substantial and roughly continuous reduction in emissions for the same period. The rate of actual emission reductions far outpaced the rate of change in visibility, and the preponderance of emissions have already been eliminated. Using a trend line, an emission rate of zero (MSCC or all of Billings) would not achieve (or prevent the achievement of) the national goal. In fact, it appears that any moderate reduction in emissions will not have a measurable, let alone discernible, impact, on visibility or visibility impairment at all.

Finally, the same information was compared using the basic "r" and "r^2" statistic.[55]
The statistic provides a non-biased estimate as to the strength of any linear relationship between two variables (emissions and anthropogenic deciviews), without regard to causation. The results (for all class I areas and MSCC) indicate either low or nearly non-existent relationship. The values ranged from 3% to 35%.

The sum of these observations indicates:

a) Emission reductions have been substantial during and before the RHR program.

b) Emission reductions that have already occurred have, by themselves, eliminated the vast majority of the emissions potentially available for reduction at the beginning of the program, and have provided progress toward the goal (if one incorrectly assumes that visibility impairment is mathematically dependent on the selected emissions).

c) The graphical representation of the data shows that the rate of improvement in emissions far out paces any improvement in visibility.

[55] "r" is in reference to the Pearson Correlation Coefficient. "r^2" is in reference to the square of "r". There are numerous references to this parameter and its explanation. One such source is: http://www.dmstat1.com/res/TheCorrelationCoefficientDefined.html

d) Based on the decline in visibility observed during the period of large emissions reductions, the graphical data shows that even an emission rate near zero for Billings could not have a discernible effect on class I areas. On average, the improvement was about 0.13 deciviews per 1,000 tons of SO_2 removed. Using that as a metric, and assuming (incorrectly) an established causal relationship, visibility could only improve by about 0.5 deciviews for the Class I areas if **all** the local emissions were zero. This amounts to no discernible change in visibility.

e) The statistical data shows little to no correlation between visibility observations (expressed as anthropogenic deciviews) and emissions and does not support or demonstrate causation.

4.0 4-FACTOR ANALYSIS

A 4-Factor analysis was completed, at the request of Montana DEQ for MSCC primarily by Bison Engineering Inc. (Bison). This facility was selected by Montana DEQ because of a simple “Q/d” screening.[56] This analysis is limited to emissions emanating from the Claus/SuperClaus unit(s) and main stack at the facility since these units are responsible for 99^{+}% of the total sulfur dioxide emissions from the plant.

The following outlines the analysis for this source using primarily the direction of the EPA Draft Guidance[57] and the WRAP 2009 4-Factor analysis[58].

The initial step in the 4-Factor analyses was to identify “possible” additional control options for this source. The options chosen include control techniques addressed in guidelines published by the EPA, emission control cost models such as AirControlNET, Best Available Retrofit Technology (BART) analyses, White Papers prepared by the Midwest Regional Planning Organization (MRPO), and National Association of Clean Air Agencies (NACAA).

The options for this source/source category are summarized in the Table 1.

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[56] See email letter from DEQ dated March 13, 2019

[57] “*Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals and Other Requirements for Regional Haze State Implementation Plans for the Second Implementation Period,*” EPA, EPA-457/P-16-001, July 2016. https://www.epa.gov/sites/production/files/2016-07/documents/draft_regional_haze_guidance_july_2016.pdf

[58] “*Supplementary Information for Four-Factor Analyses for Selected Individual Facilities in North Dakota”,* Brad Nelson, William Battye, Janet Hou, EC/R Incorporated, Western Regional Air Partnership (WRAP) and Western Governors’ Association (WGA), M
May 18, 2009

Table 6: Source and Control Options

Source	Title V Unit ID	Pollutant	Existing Controls	Overall Control Efficiency *	Potential Additional Control Measures
Sulfur Recovery Unit (SRU)	EU3	SO_2	3-Stage Claus + SuperClaus + tail gas incinerator	~98.4%	Oxidation or Reduction Options (SCOT, LO-CAT, CBA etc.)
					Traditional Flue Gas Desulfurization (FGD)

* Approximate value determined for this 2nd planning period baseline data (2017-2018). The overall control efficiency is based on the input sulfur to the sulfur recovery unit at the plant as is customary for sulfur recovery facilities. It is not based on the portion of removal occurring exclusively in the post-Claus sections (SuperClaus) of the plant.

4.1 Existing SO_2 Control System

The existing SRU unit at MSCC controls sulfur dioxide (SO_2) emissions via two steps. The first is a 3-stage Claus process. (On occasion, the unit is operated in a 2-stage fashion, allowing for necessary maintenance). This process converts hydrogen sulfide (H_2S) and SO_2 into elemental sulfur (S) via the 'Claus' reaction. The general reaction is:

$$H_2S + SO_2 \leftrightarrow S + H_2O \text{ (unbalanced)}.$$

To achieve additional reduction, the Claus process is followed up by the addition of the "SuperClaus®" technology.[59] This technology uses selective oxidation catalysts to oxidize residual H_2S to elemental sulfur using air. The first SuperClaus unit was installed in 1998. A second (parallel) SuperClaus unit was installed in 2007/2008 as a redundant system in order to improve system reliability and continue reducing emissions during periods of maintenance on one of the units.

Generally, the units collectively control SO_2 emissions by about 97-98% of input sulfur gases. The efficiency was recorded at 98.4% for the baseline period (2017↔ 2018).

4.2 SO_2 Treatment Options and Technical Feasibility

The most common control measures that may be applied to a typical Claus facility are generally categorized as Tail-Gas Scrubbing Treatment units (TGST). These units use either an oxidation or a reduction measure to continue to convert some of the underlying sulfur gases exiting the Claus systems to additional elemental sulfur. Another common measure of removing sulfur dioxide from some gas streams is a traditional Flue Gas Desulfurization (FGD) unit which is more typically used at coal or oil-fired electrical generating units. However, this is not generally applied to Claus systems in the US.

4.2.1 Oxidation – Reduction Techniques

The TGST control typically adds an additional scrubbing process to the Claus exhaust stream prior to the tail-gas incinerator. The processes classically convert the Claus exhaust to either H_2S (reducing process) or SO_2 (oxidizing process). In most cases, the 'newly created' H_2S or SO_2 is then captured, concentrated and returned to the Claus portion of the facility to extend the elemental sulfur recovery. Alternatively, an oxidizing process selectively converts low-concentration hydrogen sulfide residue from the Claus system directly to elemental sulfur (e.g. SuperClaus®).

There are several processes that achieve this aim:

<u>Oxidation</u>

[59] Information regarding the Superclaus® may be found here: http://www.digitalrefining.com/literature/1000817,Sulphur_Recovery_SUPERCLAUS___Process.html#.W-TGFPZFzDI

Regarding the oxidation method, the exhaust stream from the Claus or SuperClaus® would be treated to oxidize the various residual reduced sulfur compounds (S, H_2S, COS …) to sulfur dioxide (similar to the plant's incinerators). The sulfur dioxide is then captured, concentrated and recycled back to the Claus process itself. There are several varieties of processes within the oxidation method. They include the Stauffer, Wellman-Lord, and Aquaclaus. Only the Wellman-Lord process has been applied successfully in any US refinery.[60]

Reduction

The reduction process is the more typical refinery-based method of additional sulfur dioxide control.[61] This process catalytically converts the sulfur-containing gases from the Claus back to H_2S. The H_2S-containing gas is then sent to a scrubber for capture prior to routing the remaining gases to a tail-gas incinerator. The H_2S scrubber typically uses a specialized amine process (similar to the MSCC amine unit itself) to selectively capture the H_2S while rejecting carbon dioxide. Then this captured H_2S is regenerated from the specialized amine to produce a suitably concentrated stream and is then sent back to the Claus plant for reprocessing.

Five common systems utilizing the reduction-oxidation control method are the LO-CAT®, Beavon (MDEA), Shell Claus Off Treatment (SCOT), and ARCO. (Additional oxidation-reduction processes for converting H_2S into sulfur include Cold Bed Adsorption (sub dewpoint), Sulferox, Stretford, and Paques biological process.) For the oxidation-reduction processes, LO-CAT®, SCOT and CBA have been among the predominant industry choices.[62] LO-CAT® is a proprietary liquid redox process that converts H_2S in the acid gas to solid elemental sulfur using an aqueous solution of iron as catalyst. LO-CAT® units are in service treating refinery fuel gas, off gas, sour-water-stripper gas, amine acid gas, and Claus tail gas. The SCOT process, however, is the most common in the U.S, and is discussed below.

SCOT

In the Shell Claus Off Treatment (SCOT) process, and numerous variants, tail gas from the SRU is re-heated and mixed with a hydrogen-rich reducing gas stream. Heated oxygen-free tail gas is treated in a catalytic reactor where free sulfur, sulfur dioxide, and reduced sulfur compounds are substantially reconverted to H_2S. The H_2S-rich gas stream is then routed to a cooling/quench system where the gases are cooled, and substantial process water is condensed as sour water. Excess condensed sour water from the quench system is routed to a separate sour water system for further treatment and disposal. The cooled quench system gas effluent is then fed to an absorber section where the acidic gases (H_2S, CO_2), which must be substantially free of SO_2 to prevent damage, comes in contact with a selective

[60] AP-42, Section 8.13, 1995, p 8.13-4.
[61] It is important to note that MSCC does not meet the definition of a "refinery" for any regulatory purposes.
[62] Merichem reports 200+ installations. http://www.merichem.com/gas/upstream/natural-gas/lo-cat

amine solution and is absorbed into solution; the amine must selectively reject carbon dioxide gas to avoid problems in the following steps, and must not be exposed to unreduced materials (e.g., unconverted SO_2 or sulfur) or to oxygen that may arise during malfunctions. The rich solution is separately regenerated using steam, cooled. The regenerated amine is cooled and returned to the scrubber/absorber. The cooled H_2S-rich gas released at the regenerator is reprocessed by the SRU.

In certain applications, particularly newly designed plants designed for use with Tail Gas Treatment, SCOT can reportedly achieve overall sulfur recovery as high as 99.8%-99.9%.[63] Bison and MSCC believe this recovery percentage to be theoretically possible, but unlikely achievable at the MSCC Claus facility which dates to the 1950s. For clarity, this sulfur recovery percentage value represents the amount of sulfur removed from the untreated acid gas streams entering the upstream Claus SRU and not the amount of further SO_2 reduction from the tail gas stream. The effective reduction to the existing already-controlled SO_2 emissions (e.g. ~98% control) would be substantially lower than these overall sulfur recovery rates.

Cold Bed Adsorption (CBA)

The Cold Bed Adsorption (CBA) process is effectively an extension of the Claus process. The Claus reaction [$H_2S + SO_2 \leftrightarrow S + H_2O$ (unbalanced)] is driven closer to completion by a reduction in temperature over certain catalyst beds/reactors. CBA, of which Sulfreen® is one variant, operates at lower temperatures (260 to 300ºF) to recover tail-gas SO_2 and H_2S as sulfur. Operating at a lower temperature tends drives the Claus reaction in the desired direction but will clog or otherwise obstruct the catalyst itself over a short period of time. CBA (Sulfreen®) attempts to solve this problem with parallel reactors in which one reactor is active while the other is being cleaned and regenerated. Tail gas passes through one of usually three reactors on line at a given time. Two reactors are on either heating or cooling cycles while the third is on the gas stream. Gas flow is switched from one reactor to the next, on a schedule determined by the sulfur-holding capacity of each catalyst bed in the reactors. During regeneration, sulfur is vaporized by using hot inert gas using a blower, resulting in the regeneration of the catalyst bed. The hot inert gas is then cooled in a condenser, where most of the liquid sulfur is removed. The hot regenerated catalyst bed must be cooled with inert gas before going back on the gas stream. Sulfreen® systems reportedly can achieve 98%[64] to 99.5%[65] overall

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[63] From: http://www.gec.jp/JSIM_DATA/AIR/AIR_6/html/Doc_142.html

[64] Sulfreen® description adapted from "Encyclopedia of chemical processing and design, Volume 1." http://books.google.com/books?id=JoZbcFQvHJ8C&pg=PA210&lpg=PA210&dq=Sulfreen+Process+Description&source=bl&ots=yWr1jJ6Aq3&sig=3yS-ffTUZ7lcwISqSy3BbopfH7g&hl=en&sa=X&ei=_awoT-eQGImyiQKXs721Cg&ved=0CDsQ6AEwAw#v=onepage&q=Sulfreen%20Process%20Description&f=false

[65] Sulfreen® Recovery of up to 99.5% per "Concawe Cost and Cost-Effectiveness, Assessment of Abatement Technology/Techniques for Refineries". Link: http://www.citepa.org/forums/egtei/5-White-refineries.pdf

sulfur recovery efficiency, again based on the input sulfur content of the acid gases to the upstream Claus plant and very high-quality feeds. AP-42 Chapter 8.13 Sulfur Recovery suggests the upper range is about 99% overall recovery when associated with a modern Claus design and very high-quality stable feeds.

This high end of this recovery percentage may be theoretically possible, but unlikely achievable at the MSCC facility. These are substantially similar efficiencies as those reported for current SuperClaus™ systems in conjunction with modern Claus plants. The MSCC facility operates SuperClaus™ systems at this time, as retrofits to an older Claus design, as already noted. Review of the available information does not suggest that application of these costly "low-temperature Claus" alternative technologies would result in significant additional reduction as compared to SuperClaus™ systems. We also cannot expect a vendor to guarantee the higher end of this sulfur recovery percentage range due to atypical conditions necessarily existing in the upstream Claus system and feeds at MSCC.

The recovery percentage ranges represent the amount of sulfur removed from the untreated gas stream(s) entering a sulfur recovery facility and not the amount of SO_2 reduction from the existing tail gas stream. The effective reduction to the existing already controlled SO_2 emissions at MSCC would be substantially lower than the theoretically possible overall sulfur recovery rates.

LO-CAT®

The LO-CAT® technology uses a redox process to oxidize H_2S to elemental sulfur. It does so by using an iron based aqueous solution in which the iron acts as a catalyst. An acid gas stream is compressed and fed to an absorber unit where it contacts the dilute, iron chelate catalyst solution and the H_2S is absorbed and then directly oxidized to solid sulfur. Gas leaves the absorber for disposal via a tail gas disposal system. The reduced catalyst solution returns to the oxidizer, where sparged air reoxidizes the catalyst solution. Product water resulting from the reaction must also be removed and treated. The catalyst solution is then returned to the absorber. The presence of SO_2 or other non-H_2S species in the treated gases may make this process impractical. Sulfur is concentrated in the bottom of the oxidizer and sent to a sulfur filter, which produces the solid sulfur filter cake.

A critical concern with this technology for MSCC is the quality of the produced sulfur. Contaminants commonly present in the raw acid gas are not converted to sulfur, may remain with the product sulfur, and may be highly odorous. The catalyst itself also is a source of product contamination. MSCC not only removes sulfur from various streams at the facility, MSCC creates many saleable products.[66] Many of the products require up to 99.9% purity to meet client demands. The LO-CAT® system does not consistently meet this expectation.[67] The primary provider of this

66 Some products are listed here: https://montanasulphur.com/products/
67 "Flexibility of Liquid Redox Processing in Refinery Sulfur Management," G. Nagl, Merichem, http://www.merichem.com/company/overview/technical-lit/tech-papers/liquid-redox-flexibility

technology (Merichem) has, according to their web site, made strides in improving this situation. However, MSCC is in no position to jeopardize a primary source of sales and income without a long-term demonstration of reliable product (sulfur) quality. Therefore, this technology is rejected because it could undermine the fundamental purpose of the facility itself.

Other

A few other oxidation-reduction processes are mentioned from time to time in literature searches. However, a detailed analysis of these units was not included for further consideration for the following reasons:

- Shell's Sulferox is effectively a more concentrated form of the LO-CAT® solution, but with resulting operational issues that makes it less widely used.
- Stretford has significantly declined in popularity due to environmental concerns due to the heavy metal vanadium used in the process.
- The Paques Biological Process has capital intensity like SCOT and others, but with much less operational history, using sodium hydroxide and a bioreactor in the process to generate sulfur cake instead of the LO-CAT® approach using aqueous iron catalyst and air.
- Euroclaus[68] is promoted as a (modest) improvement over the Superclaus® process. Euroclaus uses a catalytic hydrogenation reactor (similar to SCOT) and a specialized hydrogenation catalyst installed ahead of a separate selective catalytic oxidation reactor (similar to SuperClaus®), followed by cooling to capture sulfur and then reheating for incineration. Since the Superclaus® technology is already installed at MSCC, a replacement to Euroclaus® would be largely redundant with a theoretical improved removal overall efficiency from approximately 98.4% to perhaps 99.0% to 99.5% overall. A 99.5% recovery rate would be applicable only to new plants with high quality stable feeds. In retrofit situations, such as MSCC's it is not expected to achieve levels in this upper range, and a vendor guarantee at such levels would not be available. In addition, specific cost information of this technology, as a retrofit, is not widely available.

With this information in mind and for purposes of this analysis, it was decided not to attempt a specific cost analysis for each process mentioned above. It is more reasonable to pick a few of the methods described above and conduct an analysis on those processes.[69] It seems more than reasonable to presume that the cost of one of these processes is within the range of what might be expected for any single process. Additionally, cost estimates for these other processes is not readily

[68] Information regarding the Euroclaus may be found here.
http://www.digitalrefining.com/literature/1000580,Sulfur_recovery___EUROCLAUS___process.html#.W-TFnfZFzDI

[69] This approach is discussed in the EPA Guidance. "*Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals and Other Requirements for Regional Haze State Implementation Plans for the Second Implementation Period,*" EPA, EPA-457/P-16-001, July 2016.
https://www.epa.gov/sites/production/files/2016-07/documents/draft_regional_haze_guidance_july_2016.pdf

available. For example, Bison found there is little recent published data for the Euroclaus and Stretford. Additionally, we found that cost data is very vague or not available for many of the other units as well.

After consideration, it was decided to use the SCOT and CBA (Sulfreen®) processes as a reasonable approximation for any and all the oxidation or reduction options discussed above, for economic analysis. MSCC or Bison has, in the past, received some cost estimates information from some designers as well as other information helpful to the process. In addition, the removal efficiency potentials for these two processes are relatively similar. Should either the SCOT or CBA technologies (as a representative of oxidation or reduction option) indicate a low $/ton cost effectiveness, then a more detailed review may be appropriate. That review could or would extend to other processes previously mentioned.

4.2.2 Flue Gas Desulfurization Techniques

The second class of sulfur dioxide scrubbing for consideration is the Flue Gas Desulfurization (FGD) unit. As noted earlier, this is the typical sulfur dioxide control system found in most coal and oil-fired electrical generation systems across the U.S. The FGD unit may be configured as a wet, semi-dry, or dry scrubber system. In all cases an alkaline compound (typically $CaCO_3$ or CaO) is used to react with SO_2 (an acidic gas) to form a compound such as $CaSO_3$. The $CaSO_3$ (and its related compounds) are then removed via a particulate control device such as a baghouse. EPA estimates FGD units' reduction in emissions in the range of 50% to 98% of input sulfur dioxide (to the scrubbing unit), where typically wet scrubbers and the highest sulfur dioxide concentration feeds achieve the highest control potential.[70] Wet scrubbing or semi-dry scrubbing would entail the additional burden of handling, treating and disposing the copious water vapor necessarily present from the Claus reaction creating an additional waste stream.

While this may seem attractive, the FGD scrubbers have significant *a priori* disadvantages for this application. Among them include:

(a) To operate an FGD system, it is necessary to place a significant amount of (solid) material handling equipment on site. This would also include a large surface area to store, move and otherwise handle the reagent and spent-reagent materials. This equipment and space might typically be available and designed in an FGD installation such as a new coal-fired electrical generation station which also handles bulk solid materials (coal, e.g.) on routine basis. For this facility, however, none of the required space for solids handling and storage equipment is readily available. There is simply not enough space in MSCC's very narrow footprint to accommodate a significant redesign of the facility in both layout and surface disturbance.

[70] EPA Air Pollution Control Technology Fact Sheet – Flue Gas Desulfurization: https://www3.epa.gov/ttncatc1/dir1/ffdg.pdf *

(b) FGD systems require a particulate control device to remove the alkaline scrubbing agent ($CaCO_3$, $Ca(OH)_2$, CaO, …). In a typical power plant facility, a control device to remove particulate would be required regardless of the SO_2 scrubber. For this application, however, no such device is installed nor necessary because particulate emissions from amine sweetening units (with Claus sulfur recovery and catalytic incineration) is nearly non-existent.

Thus, to install and operate an FGD for this facility, not only is an FGD itself necessary, but a complete particulate removal system will be required as well (typically a fabric filter). Thus, the FGD will add new particulate emission sources at this facility; offsetting some of the reduction achieved by the sulfur-removing FGD system.

(c) FGD systems are not typically designed to process high concentrations streams of SO_2 or containing H_2S. EPA suggests that inlet loading of SO_2 is limited to streams with less than 2,000 ppm.[71] Emissions monitoring data reported to DEQ typically show an average SO_2 concentration between 2,000 and 3,000 ppm, with excursions to higher levels. Thus, we concluded this technology is not feasible for use at MSCC

(d) Any FGD system, regardless of the type, will require disposal of the spent reagent. Since space is limited at this site, the disposal needs to take place at a "new" offsite landfill, able and willing to accept the effluent. Thus, in addition to the cost necessary for the FGD, a suitable landfill site would need to be identified and a permit would need to be obtained. There is, in addition, no available land at MSCC's small site. This would be a significant undertaking and not especially productive given other non-FGD processes are available producing lower levels of solid waste.

(e) As discussed above, for wet scrubber FGD, or any so-called 'dry' or semi-dry system involving quench of the hot-incoming Claus off gases, a complete water system, including disposal off-site, would be required. The water content of Claus off gas is necessarily very high compared to coal firing. This corrosive water system and off-site disposal is deemed unnecessary given other alternatives and the potential environmental consequences.

(f) To our knowledge, no FGD system has been installed at any acid gas processing facility in the US similar to the MSCC plant. This fact makes it clear that an FGD system is not a viable option for consideration.

For all the reasons above, it was decided to not pursue the FGD option further in this study and it was dropped from analyses that follow.

[71] EPA's Air Pollution Control Technology Fact Sheet, FGD, EPA-452/F-03-034

4.3 Factor 1: Cost of Compliance

The cost of compliance estimates the capital cost of purchasing and installing new control equipment along with the annual operation and maintenance (O&M) cost as generally outlined in EPA Draft Guidance. These categories of costs include categories such as direct capital cost, indirect capital cost, labor cost, contingency cost, and annual cost. Methodologies given in the EPA Air Pollution Control Cost Manual (Control Cost Manual) are the indicated reference for determining the cost of compliance as directed by the EPA Draft Guidance.[72]

Costs were expressed in terms of cost-effectiveness in a standardized unit of dollars per ton of actual emissions reduced by the control option. Baseline emissions for the SRU were taken from the baseline emission rate suggested by DEQ and used for the baseline dispersion modeling as it relates to this 2nd planning period.

Capital Recovery Analysis

The capital recovery factor was applied to the control options based on a 20-year equipment life expectancy and applying the prime interest rate (5.5% as of December 19, 2018)[73]. The resulting cost of compliance is presented in Table 2 and the following sections. Details of the calculations may be found in Appendix A.

It needs to be noted here that for MSCC to be able to use the prime interest rate (5.5%) appears to be more than farfetched. A typical corporation that owns and operates sulfur recovery plants, primarily in petroleum refineries, would almost certainly have the financial resources to attain a prime rate loan (or its equivalent as an opportunity cost or other such financial instrument). MSCC, on the other hand, is a small family-owned business that has no such support.

Prime rate is the best/lowest rate a borrower will typically achieve. For example, adequately secured commercial real estate will be very close to prime. However, real estate is the best collateral, and single purpose equipment is not. The equipment being contemplated in this analysis will, insofar as the lending institution is concerned, depreciate rapidly in value over time while real estate is generally less volatile and is likely to appreciate. So MSCC's ability to use the prime rate is highly speculative.

Nevertheless, in the interest of conducting this analysis using preferred DEQ methods and data, the prime interest rate was used in the initial calculations. However, a higher interest rate value (prime + 3%) was also analyzed to more correctly indicate the capital recovery costs for MSCC.

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[72] EPA Cost Control Manual (sixth edition): https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution#cost%20manual

[73] http://www.fedprimerate.com/

Emission Control Efficiency Adjustment

Also, of relevance here is a short discussion regarding claimed (vendor) emission control percentages for the various equipment and processes. The installation of an additional control technology at MSCC is limited for two major reasons (among others):

- Extremely limited space;
- Retrofit to an older, operating process.

As DEQ is aware, the MSCC facility is tucked in between a major refinery (ExxonMobil) and an active railroad line (MRL/BNSF) on a very narrow strip of land. A power generation plant occupies the land immediately to the south. Both the refinery and power plant are less than 100 meters from MSCC's main office. In the area of interest in the plant, the existing SRU is surrounded by existing equipment and structures, including incinerators, SuperClaus trains, and Claus-related equipment such as reactors, heaters, condensers, stacks, product run-down equipment, and railroad tracks – essential to the operation. Immediately adjacent is equipment used in the production and handling of MSCC product fertilizer materials.

In addition, this would be a retrofit process to a 60^+ year old facility that must operate continuously to service the refinery. There would, necessarily, be many design compromises that would need to be made for retrofit to this facility. It would be unreasonable to believe that normal or published vendor-claimed control efficiencies would be able to be achieved at MSCC. To the extent they were approached, there would be significant additional costs not yet considered. Thus, there needs to be some method to attempt to consider these limitations of space and retro-fit compromises.

One such way is to use actual data from MSCC itself regarding approach to vendor claimed efficiencies in a retrofit. Recall that MSCC installed a SuperClaus® unit in 1998. A second redundant SuperClaus unit was installed 9 years later. These retrofit units have led to a substantial reduction in SO_2 emissions at the plant, and they were successful in meeting the target emission limitations for the facility arising from the 1998 SIP and the 2008 FIP. From this data, one can calculate the actual effectiveness of these units. That value may then be compared against published information about the efficiency of a new grass-roots SuperClaus® unit.

The overall efficiency of sulfur removal from MSCC during 2017-2018, the baseline years used for this 2nd planning period analysis, calculates as 98.4%. A review of published materials on the SuperClaus® states that up to a 99.2% removal efficiency may be obtained. The information is taken from Jacobs Comprimo® Sulfur Solutions, a recognized licensor of SuperClaus® and numerous other sulfur control systems (including SCOT).[74] Thus, the vendor-claimed efficiency is 99.2% vs an actual achieved level of 98.4% for this facility.

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[74] The informational brochure that contains Information regarding the Superclaus® may be found here: http://www.digitalrefining.com/literature/1000817,Sulphur_Recovery_SUPERCLAUS___Process.html#.W-TGFPZFzDI. Jacobs-Comprimo's business is now called Advisian and is part of the Worely-Parsons organization, as of 2019.

It would appear from the data that the difference between the best claimed control and actual control (for this application) is nearly 1 full percentage point of overall control. This differential is not meant to tarnish Jacobs Comprino® or MSCC; it merely reflects the reality that will be present if an additional retrofit control technology is attempted at MSCC. A further retrofit at this facility does not allow ideal conditions per discussion above and given the space limitations arising from the existing retrofits, would be no more likely to approach the idealized values.

In order to estimate the control efficiency of the technologies discussed herein, it was decided to "derate" the claimed efficiencies by 0.4%. This appears to be a reasonable figure based on the data above. It takes into account (partly) the observed realities of retrofit installation at MSCC but continues to provide some optimism as to the claimed achievable efficiencies. The remainder of this document, therefore, discounts any claimed control efficiencies up to 0.4 percent absolute.

Retrofit Adjustment

Although reasonable efforts may be made to estimate the cost of control equipment, its installation and operation; it is quite another matter to meld these costs into an existing 60^{+} year old facility. Nonetheless, it would be unreasonable to estimate the cost of additional processes without some consideration of the additional costs associated with this facility.

It is understood and acknowledged by EPA that this is the " … most subjective part of a cost estimate …"[75] The cost of adding new equipment to an existing facility depends on the availability of existing land and floor space at the facility among many other factors. As noted earlier, the MSCC facility is tucked in between a major refinery (ExxonMobil) and an active railroad line (MRL/BNSF) on a very narrow strip of land. A power generation plant occupies the land immediately to the south. Both the refinery and power plant are less than 100 meters from MSCC's main office. The addition of either SCOT or Sulfreen® would need to be shoe-horned into this narrow strip of land.

Regarding the ability to quantify the retrofit cost, EPA provides the following insight:[76]

> "*To quantify the additional costs of installation not directly related to the capital cost of the controls themselves, engineers and cost analysts typically multiply the cost of the system by a retrofit factor. The proper application of a retrofit factor is as much an art as it is a science, in that it requires a good deal of insight, experience, and intuition on the part of the analyst. The key behind a good cost estimate using a retrofit factor is to make the factor no larger than is necessary to cover the occurrence of expected (but reasonable) extra costs for demolition and installation. Such expected but extra costs include - but are certainly not limited to - the unexpected magnitude of anticipated cost elements; the costs of unexpected delays; the cost of re-*

[75] Section 2.6.4.2 of the EPA Cost Estimation chapter of the 7th Edition (2017) of the Cost Control Manual.
[76] Ibid.

engineering and refabrication; and the cost of correcting design errors. The magnitude of the retrofit factor varies across the kinds of estimates made as well as across the spectrum of control devices. The retrofit factor is calculated as a multiplier applied to the TCI. For instance, if a retrofit factor of as much as 50 percent can be justified, then the retrofit factor in the cost estimate is 1.5."

While no specific recommendation is provided, since each location has its own unique requirements, EPA seems to indicate that a retrofit factor of 50% is a possibility. Earlier EPA cost control manuals have suggested a figure of 30% as another likely possibility. This facility, given its age and very little land (nor a reasonable ability to acquire more nearby property), justifies a higher figure. However, given the uncertainty of any chosen figure, it was decided that a mid-value might be reasonable. Thus a 25% factor, unless otherwise noted, was applied to the TCI calculations. The value is ½ of the larger quoted 50% figure above and is less than previously indicated 30% value.

Table 7: Estimated Costs of Control Options for MSCC

Source	Potential Control Option	Pollutant	Estimated Control Efficiency (%)	Potential Emission Reduction (tons/year)	Estimated Capital Cost ($1000)	Estimated Annual Cost including Capital Recovery ($1000/year)	Cost Effectiveness ($/ton)
100 Meter Stack (Sulfur Recovery Unit)	SCOT	SO_2	99.3	570	103,655	15,895	$27,882
	CBA (Sulfreen®)	SO_2	99.1	443	48,963	8,424	$18,999

See Appendix A for Cost Details – Prime interest rate used in this calculation

4.3.1 SCOT – Cost of Compliance

The Shell Claus Off Treatment (SCOT) unit is one of two technologies chosen for deeper analysis. The cost estimates include both capital costs and annual costs. The costs themselves were derived from various sources including primarily consultation with a vendor (Jacobs Comprimo Sulfur Solutions), data from studies on abatement technologies reported by Concawe[77] and methods outlined in the EPA Cost Control Manual. The estimated control efficiency of this technology (coupled with an existing 3-stage Claus plant and two parallel SuperClaus units and two parallel incinerators) ranges from roughly 99.5% to 99.9^{+}%.[78] Given MSCC is a 60^{+} year old facility that would need significant retrofitting and design compromise and, given the discussion found in Section 4.3, a 0.4% downward adjustment was applied to a the middle value (99.7%). This yields an anticipated overall recovery of 99.3%, an aggressive starting point estimate.

The results of the first pass analysis indicate the cost effectiveness of this SCOT technology would be about \$27,882/ton SO_2 removed. Using a more reasonable interest rate of 8.5% (previously discussed) yields a cost of \$31,880/ton. The derivation of these numbers and sources of data is provided in Appendix A.

In the case of a retrofit, it is also reasonable to a premium to account for retrofit costs which can include demolition, relocation of other facilities, special costs for piping tie-ins, operational disruption during construction, and the like. In addition, the retrofit would need to be accomplished without disruption in the processing of gases for the client refinery, as MSCC effectively acts as part of the pollution control for that operation. A reasonable premium for retrofit is 25% which was used. (See Section 4.3 brief discussion).

4.3.2 Cold Bed Adsorption (Sulfreen®) – Cost of Compliance

The Sulfreen® technology was used as a surrogate to the various forms of Cold Bed Adsorption (sub-dewpoint method). The cost estimates were derived from studies on abatement technologies reported by Concawe and the methods outlined in the EPA Cost Control Manual. The typical estimated control efficiency of this technology (coupled with an existing 3-stage Claus plant and two parallel SuperClaus units and two parallel incinerators) is roughly 99.5%. However, this value is too aggressive given MSCC as a 60^{+} year old facility that would need significant retrofitting. It is highly doubtful that a vendor would guarantee this figure. Thus, as a first cut and following the discussion in Section 4.3, a slightly lower value, but aggressive nonetheless of 99.1% was chosen as a first cut.

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[77] Concawe is an organization that conducts research on environmental issues relevant to the oil industry. It began in 1963 and more information may be found here:
https://www.concawe.eu/about-us/

[78] Linde Engineering publication "Sulfur Process Technology":
https://www.linde-engineering.com/en/images/Sulfur%20Process%20Technology_tcm19-111155.pdf

The results of the analysis indicate the cost effectiveness of this technology would be about $18,999/ton SO_2 removed, and then only at an upper 99.1% recovery level. Using a more reasonable interest rate (for capital recovery factor) of 8.5% (previously discussed) yields a cost of $21,428/ton. The derivation of this number and sources of data is provided in Appendix A.

4.4 Factor 2: Time Necessary for Compliance

The EPA Draft Guidance[79] suggests that the provisions found in the BART program[80] are useful in determining the time necessary for compliance per Factor #2. Additionally, the best guide to determine time necessary for compliance is prior experience with the planning and installation of new emission controls. Source-specific factors should be considered as well.

EPA has estimated that it takes approximately 30 months to design, permit, build, and install a typical, single SO_2 scrubbing control unit for a single source. No specific data was located as it regards the SCOT or CBA unit (or their equivalent). Using the EPA estimate as a guide, their analysis also determined that 12-months is additionally required for a project including the installation of control equipment on multiple sources. Another 12 months may be required for staging the installation process across the multiple sources. Added to this timeline is the period necessary for permitting and other regulatory requirements (non-air included). Permit preparation (if one is required), agency review and the public comment period could add from 6 months to a year to the timeline. Finally, it is generally recognized that facilities may require 1 year (or more) for the procurement of project funding.

As a result, the time necessary for compliance for either the SCOT or CBA (Sulfreen®) unit is estimated at five to six years. This time period accounts for about one to two years of capital acquisition;[81] two to three years for designing, permitting, constructing, and installing the control equipment; and one year for shakedown and commissioning.

This timeframe is, of course, a rough estimate at this point. Installation, tuning and integration would need to be executed in a sequential fashion in order to keep the facility in operation during this time. This will stretch the time necessary for full completion. Also, it is likely that outside influences could come to bear to alter this estimate. For the purpose of this exercise, however, we conclude that a six-year estimate is the best that may be offered.

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[79] "*Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals and Other Requirements for Regional Haze State Implementation Plans for the Second Implementation Period*," EPA, EPA-457/P-16-001, July 2016, p. 92.

[80] 40 CFR 51, Appendix Y

[81] Capital acquisition is assumed to take longer than typical industrial averages because MSCC is a small company without the financial resources of a representative refinery or gas-plant to which a SCOT or CBA unit might be typically applied.

4.5 Factor 3: Energy and Non-Air Quality Environmental Impacts

Similar to Factor 2, the provisions of the BART Guidelines are recommended for assessing both energy and non-environmental impacts. The EPA Draft Guidance states that an energy impacts assessment should be considered in terms of kilowatt-hours or mass of fuels used accounting for direct energy consumption cause by control implementation. They also state that indirect energy inputs to produce the raw materials for construction of equipment should be excluded from the analysis. The Control Cost Manual is the preferred reference and provides advice on estimating energy requirements. Non-air environmental may include the cost associated with solid waste disposal, wastewater treatment and discharge, acid or nitrogen deposition, and climate impacts.

Per Merichem (proprietary), a SCOT system itself does not consume any new toxic chemicals as reagents and does not produce any hazardous waste byproducts new to a typical refinery. It requires a reasonable amount of catalyst, although the catalyst is continuously regenerated many times in the process. Spent catalyst eventually requires disposal. In the case of MSCC, the catalysts used would be “new” to the site and, more importantly, would add new waste streams. Similarly, the SCOT process generates a new volume of sour water requiring processing and disposal. Unlike a typical refinery, MSCC does not have sour water treatment facilities since it is not a petroleum refinery. The implications of disposal of these waste streams, while believed to be significant, has not been analyzed at this time since the cost effectiveness does not make SCOT’s use a practical alternative.

There is also an energy cost associated with this added level of emission controls. It has been estimated that this level of technology would require about 610 kW per hour of use,[82] before considering the additional energy demand of sour water processing which are believed to be significant.

4.5.1 Energy Impacts

The example SCOT and Sulfreen® systems require substantial additional energy to operate. Both systems require natural gas or fuel gas[83] to heat the Claus tail gas prior to entering a reducing reactor (SCOT) and/or for heating recycle gas for regeneration requirements (Sulfreen). Sulfreen® systems require electric power for operation of large regeneration blowers. Low-temperature based systems (either SCOT or Sulfreen®) also typically require additional fuel for reheat of the final tail gas for incineration prior to discharge.[84] SCOT systems also require substantial electricity to operate numerous

[82] Proprietary information provided by Merichem.
[83] Natural gas must be burned either directly in a re-heater or fuel gas/natural gas fired in new boiler equipment to produce high pressure steam in a new boiler. MSCC does not presently own or operate any boilers of the 600-pound pressure class necessary for use of steam re-heat.
[84] MSCC currently reheats gases for incineration, but this is reheated from a higher temperature than SCOT effluent, and thus has lower fuel requirements.

pumps, coolers, and a condenser. The SCOT unit also has a large load of steam needed to regenerate the amine catalyst. Additional power is required to provide relatively large amounts (compared to current) of cooling water. Additional fuel and power energy (and equipment) is required for processing of the new sour water waste continuously produced in the quench processes necessary for scrubbing.

The limited time to evaluate these options has not allowed a detailed energy evaluation for SCOT, and none for Sulfreen®. However, we are advised that energy requirements for SCOT are (at least) as follows for a plant the size of MSCC:

Table 8: SCOT Utility Estimates

Equipment	Normal Consumption	Maximum Consumption	Units	Required Heat Input (MMBtu/hr)
Low Pressure Steam Service (50 psig)	19,654	22,046	lb/hr	27.5 to 30.9
Superheated Mid-Pressure Steam Service (150 psig)	331	661	lb/hr	0.5 to 1
High Pressure Steam Service (600 psig)*	3,382	4,526	lb/hr	4.7 to 6.4
Total Steam:	*19,654*	*22,046*	lb/hr	*32.7 to 38.1*
Power Service	220	222	kW/hr	~0.8
Nitrogen Service	5	1,404	Nm^3/hr	n/a

Note: MSCC does not have 600 psig steam produced on site. A new boiler system and additional licensing certifications would be required.

These also necessarily represent increases in greenhouse gas emissions and other pollutants either at MSCC or at provider facilities.

4.5.2 Non-Air Quality Impacts

The quench system in the SCOT system produces a sour water waste effluent that requires treatment prior to disposal. This effluent would contain hydrogen sulfide, and may contain sulfur and other troublesome species as well, particularly during upsets. MSCC currently does not have sour water treatment facilities nor access to a public sewer system to accommodate such a waste stream. A permissible solution to this problem would have to be engineered if this system were installed at the facility.
SCOT would also require a few non-fuel consumables of significant cost:

1. Catalyst for the reduction stage,
2. MDEA or proprietary blends of amines,
3. Corrosion inhibitors,
4. Water treatment chemicals.

Other processes (e.g. FGD) evaluated would produce substantially greater solid or liquid waste streams requiring treatment and disposal off site. All processes evaluated represent an increase in solid/liquid waste and energy consumption as compared with the current control option (SuperClaus).

4.6 Factor 4: Remaining Useful Life

A brief history of MSCC is critical to a discussion regarding its remaining useful life. As a summary, the facility began construction in 1955, and has operated continuously since 1956. It is a privately-held, family business, now operated by second-generation management. Estimates vary on the typical useful life of SRU equipment, but in our view, it would be typical to expect plants to last about 40 years or more with careful maintenance and operation. Thanks to careful operation, quality maintenance and continual improvements in reliability, this facility has exceeded that typical expectation. No specific additional life of the sulfur recovery plant can be offered. The facility has operated under a succession of essential contracts relating to raw material supply and gas processing. There is no way to assuredly predict if such contracts will continue or will cease. However, for purposes of planning, it would be reasonable to assume that the facility, which remains serviceable, effective and reliable today, would continue to operate at least 15 years into the future.

5.0 DISPERSION MODELING ANALYSIS

Section 3.5 of this document provided a retrospective analysis of emissions compared against current and historical observed (anthropogenic) visibility data. An analysis of emissions and visibility impact becomes more complete, however, if the investigation extends to a prospective analysis as well. This section of the report contains an analysis of current and anticipated impacts MSCC may (or may not) have on any nearby Class I areas.

As suggested earlier, no analysis which purports to address or implement a plan for "reasonable progress" in visibility improvement would be complete without ascertaining "visibility improvement." An analysis of cost-effectiveness of alternatives, useful life and other factors could certainly play into a decision of what alternatives could be important, but **only if** such alternatives yield human-perceptible changes in visibility at a nearby mandatory Class I area. Visibility improvement in such areas is the sole purpose of the RHR program; and visibility is an aesthetic resource at its core, as perceived by the human eye and mind. Any proposal to reduce emissions for the purpose of RHR must first, and foremost, yield visibility improvement that could indeed be observed as a result of such proposed emission reductions.

In an April 19, 2019 letter to MSCC: "DEQ will consider information provided by a facility, including supplemental visibility modeling." This section of the report provides that information. The April letter goes on to request that such modeling be conducted in accordance with 40 CFR 51, Appendix W and include a modeling protocol.

It is noted, however, that visibility dispersion modeling has already been completed in support of the 1st planning period and development of the FIP.[85] In support of the FIP, MSCC conducted a 4-Factor analysis along with a dispersion modeling study to estimate its impact on visibility (change in deciviews) on the 4 closest Class I areas. That modeling study used the CALPUFF modeling system[86] and generally followed the modeling recommendations for BART.[87] No discernible impact was found at any Class I area, even when considering a higher baseline emission level. EPA, in developing the 1st planning period FIP, concluded no additional emission controls were appropriate for MSCC. Nothing has happened that, in our mind, would change the conclusion.

Therefore, rather than attempt a new dispersion modeling effort at considerable time and cost, it is wiser and reasonable to simply use the results of prior modeling as the basis for impacts regarding this 2nd planning period and 4-Factor analysis. It is also possible to

[85] The Montana 1st planning period (BART and 4-Factor) FIP was proposed on 4/20/12 (77 FR 23988) and became final on 9/18/12 (77 FR 57864).

[86] Information about CALPUFF modeling may be found here: http://www.src.com/calpuff/download/CALPUFF_UsersGuide.pdf

[87] CALPUFF was the model of choice when conducting visibility assessments at that time: BART or otherwise.

review the prior approved modeling results and project impacts on the Class I areas as a result of the lower emission rates currently in effect.

Appendix B to this report contains a more complete discussion and rationale associated with the dispersion modeling effort. The reader is referred to that appendix for more information regarding the model, input parameters and modeled output. For convenience, only the results of the Appendix B modeling are presented below.

As a side note, we understand EPA has altered Appendix W (Guideline on Air Quality Models) to remove any dispersion model as 'preferred' regarding long-range visibility analyses. Neither the CALPUFF model nor any other model is listed as a 'preferred' model of choice. Models other than CALPUFF, however, may now be considered for visibility modeling. The modeling conducted here is not for a health-based or a hard-ambient impact analysis. Rather this modeling investigation is meant to be a supporting effort to the 4-Factor analysis itself. It is concluded that the use of the FIP modeling, adjusted for current emission rates etc., is of sufficient precision that the results serve to confirm conclusions already reached in Section 4.0, and elsewhere. Thus, those model results, adjusted accordingly, serve the purpose of providing DEQ with additional information to affect the 4-Factor conclusion per the April 19 letter.

5.1 Visibility Model

As noted above, the CALPUFF modeling system was chosen for this modeling effort. The emissions data used in the modeling were the baseline emissions for the 2nd planning period. These baseline values were provided and agreed upon by DEQ in a June 10 email from MSCC to DEQ and prior. Table 6.1-1 summarizes the emission rates used in the baseline visibility modeling analysis.

Table 9: Modeled Emission Rates

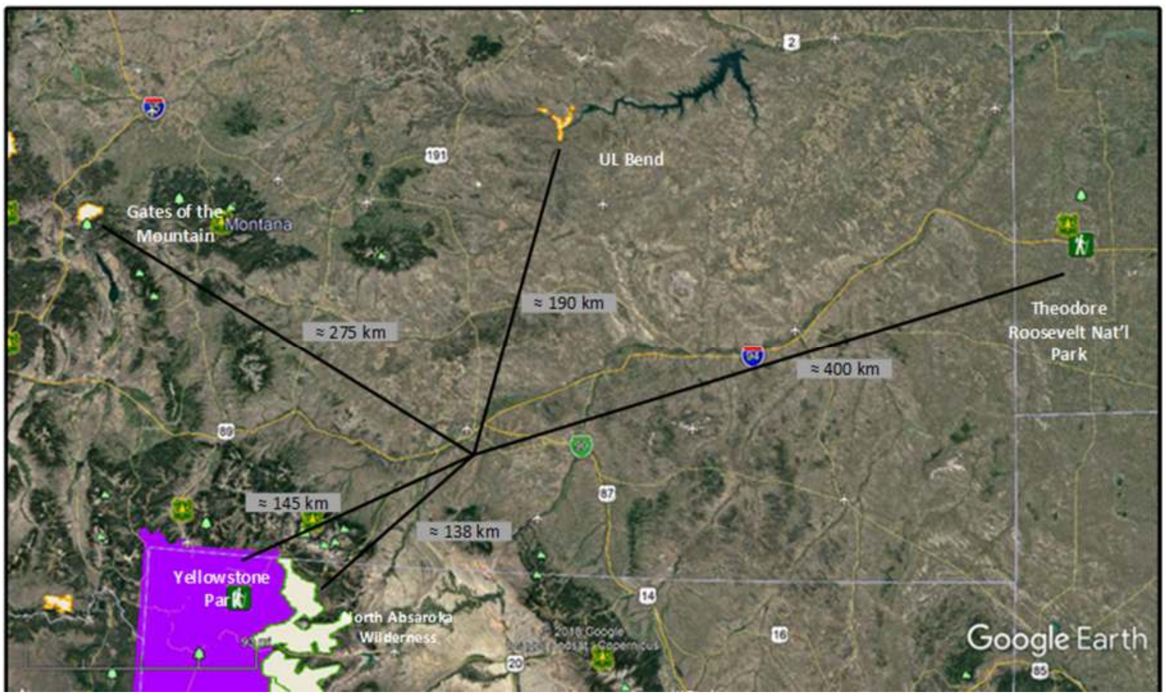
Pollutant	tons/year
SO_2	1,014
NOx	4.2
PM_{10}	0.5

A number of mandatory Class I areas were chosen for analysis. These included the following:

- Yellowstone National Park,
- UL Bend Wilderness Area,
- North Absaroka Wilderness Area,
- Gates of the Mountains Wilderness Area.

These areas include all the nearby areas covering the major quadrant directions.

Figure 17: Class I Modeling Areas



5.2 Modeling Results

As specified in the RHR and BART analysis guidelines, the visibility impacts were calculated and presented using the 98th percentile modeled visibility impacts using MSCC's 2nd planning period baseline emission rate on these mandatory Class I Areas. Table 6.1-2 below provides the results of the modeling using the emission those rates. This represents the impacts "base case" emissions from the facility assuming no additional controls are added to the current operation.

Table 10: Base Case Visibility Impacts

Mandatory Class I Area	Visibility Impact (ΔdV) 98th Percentile 24-Hour
Yellowstone National Park	0.06
UL Bend	0.10
North Absaroka Wilderness Area	0.07
Gates of the Mountains Wilderness Area	0.05

From the data in the table, one observes that the highest modeled impact was only 0.10 deciview at the UL Bend Wilderness located approximately 190 km NNE of the facility. As a quick reminder, the deciview metric was developed (and adopted by EPA) to more easily understand a measure of visibility change and at the same time provide a more uniform (linear) representation of observed or modeled visibility impairment. More specifically, a "1.0" deciview impact is usually described as a **"just noticeable change"** (JNC) in a visibility scene.[88]

Therefore, it should be clearly understood that a 0.10 deciview modeled impact is **not** remotely discernible. As a result, it can only be concluded that MSCC does not contribute to regional haze at any mandatory Class I areas. That is the case at both current emissions and at Potential to Emit (permitted) emission rates which are substantially higher. That alone reasonably exempts MSCC from consideration of any additional control options that might otherwise be considered as candidates for visibility improvement or reasonable progress toward the 2064 goals.

The above discussion notwithstanding, it is worth noting EPA's position on what would be an acceptable impact from a new facility. EPA generally considers an impact, by the facility alone, of less than 0.5 deciviews to be acceptable. Therefore, if MSCC were a new source of sulfur dioxide in the Billings area, its current emission impact on the mandatory

[88] There are numerous articles and explanations for the deciview metric. This discussion is taken from the publication "IMPROVE," Volume 2, No. 1, April 1993. The information itself is taken from a publication by Pitchford and Malm, 1993. The article contains the following quote:

> *"Ideally, a just noticeable change (JNC) in scene visibility should be approximately a **one or two** dv change in the deciview scale (i.e., a 10% to 20% fractional change in extinction coefficient) regardless of the baseline visibility."*

The idea that a "1" deciview change represents 'just discernible' to the human eye is also found in many other publications and web sites such as the Arizona Department of Environmental Quality and the "Group Against Smog and Pollution" (GASP) which may be found at:
http://gasp-pgh.org/publications/hotline/spr02-2/
http://www.phoenixvis.net/education.html

Class I areas would be considered acceptable, and negligible at 0.10 deciviews, and be acceptable at levels essentially three times as high.[89]

The data in the table shows that MSCC, by itself as currently configured and controlled, has no perceptible effect on visibility at any mandatory Class I area. It is reasonable to conclude that the addition of any additional emission controls, therefore, cannot change that conclusion. Since the statutory purpose and authorization of the program is to improve regional haze in Class I areas, toward a national goal in the year 2064, and given MSCC does not now impact regional haze discernibly, no additional controls are warranted. Thus, the addition of controls or further limitations at MSCC would not serve the program's purpose of creating "reasonable progress" toward the national goal, since no measurable progress would be created.

[89] See Appendix A for linear equation that predicts deciview impact based on SO_2 emission rate.

6.0 CONCLUSIONS

A 4-Factor analysis has been conducted for the MSCC facility. The analysis was conducted to meet the requirements of "Round 2" to develop of a State Implementation Plan (SIP) to address Regional Haze. Regional haze requirements and goals are found in Section 169A of the Federal Clean Air Act and codified in 40 CFR 51.308(d)(1). To implement the requirement, the Montana Department of Environmental Quality (DEQ) submitted a letter to MSCC dated April 19, 2019 seeking such an analysis.

The 4 factors to be analyzed based on the DEQ letter and the regional haze rule were:

- Factor 1. Cost of compliance
- Factor 2. Time necessary for compliance
- Factor 3. Energy and non-air quality environmental impacts of compliance
- Factor 4. Remaining useful life

The April 19 letter asked MSCC to conduct a 4-Factor analysis on the Sulfur Recovery Unit (SRU). The analysis was to be applied only for SO_2. For the purpose of this study, the SRU includes the Claus and the downstream SuperClaus® units and the incinerators. The SRU was analyzed for these factors in general accordance with the April 19 letter and EPA's Draft Guidance documents.[90] The details of those results were presented in prior sections of this report.

The RHR has one and only one purpose; to protect visibility in mandatory Class I Areas.[91] To that end, a (historical) visibility modeling analysis has also been conducted. The modeling was conducted to assess the predicted impacts from MSCC's current facility emissions and from emissions that could result from the addition of alternative SO_2 controls. The modeling analysis has shown that current (and allowable) emission rates result in impacts far below the 1.0 deciview threshold. In fact, the results show an impact less than $1/10^{th}$ of that value. EPA employs 1.0 deciview as a level to indicate a barely discernible visible impact. Also, EPA routinely considers an impact below 0.5 deciviews (for new or modified facilities) as a permissible contribution to modeled visibility impact. Effectively, an impact less than 0.5 deciviews is considered *de minimis*.

Two control technology groups were considered for this unit-pollutant combination: Oxidation-Reduction Control (SCOT, CBA, …) and Flue-gas de-sulfurization (FGD). The FGD group was concluded as not practical nor appropriate for this application. Those reasons include (but not limited to):

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[90] *Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals and Other Requirements for Regional Haze State Implementation Plans for the Second Implementation Period,*" EPA, EPA-457/P-16-001, July 2016
EPA Air Pollution Control Cost Manual, and
EPA Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze.
https://www.epa.gov/sites/production/files/2016-07/documents/draft_regional_haze_guidance_july_2016.pdf

[91] The nearest Class I area is North Absaroka Wilderness and is located about 138 kilometers from MSCC.

- A new emitting source (particulate) would be added to the plant offsetting some of the benefits of a reduction in SO_2;
- A new disposal system would be required to treat the spent reagent,
- FGD has never, to our knowledge, been used in treating SO_2 emissions from any gas processing facility; and
- Earlier (2009) 4-Factor analyses for this and similar facilities did not identify nor consider FGD as a viable technology.

The Oxidation-Reduction group yielded 3 potential technologies. SCOT, CBA and Lo-Cat. There are other technologies, but all are, effectively, a variant to one of the three listed. Had the results of the 3 yielded favorable results, the variants could have been considered further in more detail.

The Lo-Cat technology was rejected at the outset because of low sulfur quality. MSCC relies and prides itself on high-quality sulfur for its various products. The use of Lo-Cat endangers the very nature of its saleable material and thus a foundation of the facility itself.

The remaining two technologies [SCOT and CBA (Sulfreen®)] were considered since they may, on first pass, be technically applied to a facility such as MSCC. However, both were rejected because:

(a) The cost of additional controls is excessive (+ $18,000/ton);

(b) The existing controls and operation MSCC facility does not demonstrate any discernible impact on any nearby mandatory Class I area; and

(c) The addition of emission controls at MSCC would not improve discernible visibility attributes in any nearby mandatory Class I area.

Following a careful review of the information it is concluded that additional emission controls and limitations for MSCC are not necessary nor would provide any discernable improvement in visibility in order to make reasonable progress based on the 4-Factor analysis.

APPENDIX A: COST CALCULATIONS

100 Meter Stack
Sulfur Recovery Unit

Sulfur Dioxide

SCOT Control Technology

Montana Sulphur & Chemical Co
4-Factor Cost Analysis
SRU
SO_2

Total Capital Costs - SCOT

Total Capital Costs for SCOT		
Cost Item	**Factor**	**Cost**
DIRECT COSTS		
Purchased equipment costs		
SCOT Capital ≈ 252 t/day (See note below)	A	$57,500,000
Instrumentation	0.10 A	$5,750,000
Sales taxes	0.00 A	$0
Freight	0.05 A	$2,875,000
Purchased equipment cost, PEC	B = 1.15 A	**$66,125,000**
Direct installation costs		
Foundations & supports	0.08 B	*(included)*
Handling & erection	0.40 B	*(included)*
Electrical	0.04 B	*(included)*
Piping	0.30 B	*(included)*
Insulation for ductwork	0.01 B	*(included)*
Painting	0.01 B	*(included)*
Direct installation cost		**$0**
Site preparation	(estimated) SP	$250,000
Buildings	(estimated) Bldg	$250,000
Total Direct Cost, DC	B + SP + Bldg.	**$66,625,000**
INDIRECT COSTS (Installation)		
Engineering	0.10 B	$6,612,500
Construction and field expenses	0.05 B	$3,306,250
Contractor fees	0.10 B	$6,612,500
Start-up	0.02 B	$1,322,500
Performance test	0.01 B	$661,250
Retrofit factor	0.25 B	$16,531,250
Contingencies	0.03 B	$1,983,750
Total Indirect Cost, IC	0.56 B	**$37,030,000**
TOTAL CAPITAL INVESTMENT (TCI) = DC + IC		**$103,655,000**

Annual Costs - SCOT

Total Annual Costs for SCOT				
Cost Item				**Cost**
DIRECT ANNUAL COSTS				
Fixed Operating Cost		4%	Capital Cost [1]	$2,645,000
Variable Operating Cost [2]		$6.37	Per ton of sulfur processed [3]	$430,193
Utilities				
Natural Gas	0 (kft^3/yr)	$ 5.18	$/kft3	*(included)*
Electricity	0 (kWh/yr)	$0.059	$/kWh	*(included)*
INDIRECT ANNUAL COSTS, IC				
Overhead	60% of sum of operating labor and maintenance labor (materials overhead not included).			*(not included)*
Administrative Charges		2%	of TCI	$2,073,100
Property Taxes		1%	of TCI	$1,036,550
Insurance		1%	of TCI	$1,036,550
Capital Recovery Rate Factor	(20 years at Prime (5.5%))			0.0837
Annualized Capital Recovery				$8,673,781
TOTAL ANNUAL COST				**$15,895,174**

Baseline Emissions (tons/yr):[4]	1,014
Current S Efficiency Removal (2017 ↔ 2018)	98.4%
Control Efficiency (with new controls)[5]	99.3%
Control Efficiency above current levels	56%
Tons Removed (tons/yr):	570
New Emission Rate (tons/yr)	443
Cost-Effectiveness ($/ton):	**$27,882**

Note:
Capital costs derivation provided on separate page and are based on data from vendor (Jacobs Comprimo Sulfur Solutions) - January, 2012.

Capital Recovery Factor

$$CR = \frac{i(1+i)^n}{-1 + (1+i)^n}$$

n = 20 years
i = 5.5% interest rate
CR = 0.0837

Footnotes:
[1] Estimated based on 4% of the Capital Cost per:
"Concawe Cost and Cost-Effectiveness Assessment of Abatement Technology/Techniques For Refineries Contributing to the Update of the EGTEI Synopsis Sheets For the Petroleum Sector L. White, Special Advisor, May 6th, 2011
Link: http://www.citepa.org/forums/egtei/5-White-refineries.pdf

[2] From document above and calculated on cost/ton of sulfur processed

[3] Basis = 5.11€/ton sulfur processed (Year: 2011)
1.12 Conversion from € to $ — As of July, 2019
252.16 Consumer Price Index (June-2018)
226.67 Consumer Price Index (January 2012)
1.11 = Ratio
= $6.37 per ton of sulfur processed

[4] Average annual emissions for 2017 - 2018 per DEQ directive

[5] Adjusted from vendor claim 0.4% points per discussion in Section 4.3

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SCOT Capital and Operating Cost References

Based on:
Email and data exchange with Dennis Koscieinuk and Frank Scheel
Jacobs Comprimo
January - February, 2012
Frank.Scheel@jacobs.com
https://www.jacobs.com/comprimo-sulfur-solutions

Basis of Estimate:

252 long tons/day Claus plant capacity
Separate sour water stripping capabilities not considered (but may be needed)
Acid gas feed rate is about 88% H_2S
SCOT unit will need its own MDEA / solvent regenerator
It was assumed no "new" steam unit is required, and thus no new source/cost was considered
This may not be a correct conclusion since steam is limited. This may need to be re-evaluated in the future.

Two options considered

1 = single stand alone with capacity for 252 t/day unit
2 = dual stand alone 126 t/day units operating in parallel

Cost estimate:

Min	Max		
$40	$45	Million USD	Option 1
$55	$60	Million USD	Option 2

Comments:

The cost estimates are for a direct installed unit(s). They generally include the raw equipment cost, installation electrical, ductwork, etc. Jacobs Comprimo reports that the vaues are in the -25%/+50% range.

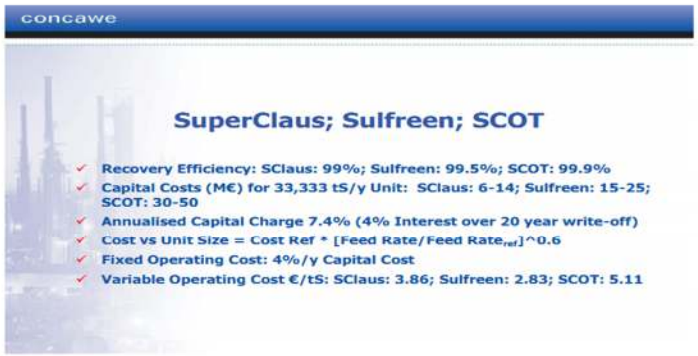
Indirect costs were not assumed to be included since they are somewhat plant specific.

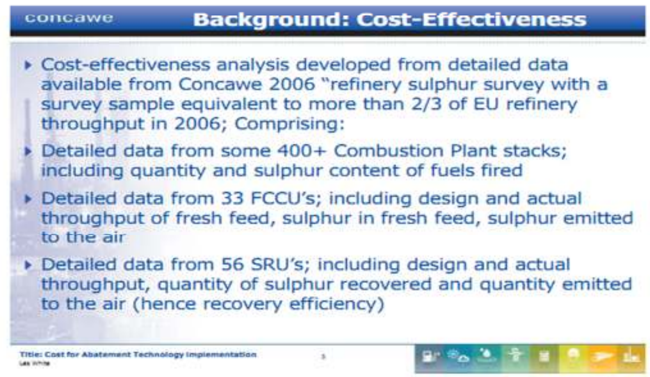
Because of the necessity for continued operation which is required by the client refinery, Option 2 was chosen. the only practical solution would be Option 2. Option 1 endangers the possibility of continued operation in compliance with any emission limits associated with a requirement to install this technology.

SCOT Capital and Operating Cost References

Based on: Concawe Cost and Cost-Effectiveness Assessment of Abatement Technology/Techniques For Refineries Contributing to the Update of the EGTEI Synopsis Sheets For the Petroleum Sector
L. White, Special Advisor, May 6th, 2011

Link: http://www.citepa.org/forums/egtei/5-White-refineries.pdf





Reference Size of Plant Used for Estimate:	33,333	tS/year
Reference Size of Plant Used for Estimate:	91	tS/day
Nominal Size of Plant at MSCC (tS/day)	252	tS/day
Nominal Size of Plant at MSCC (tS/year)	91,980	tS/year
Conversion from Euros to USD (July 2019):	1.12	http://www.google.com/search?q=%E2%82%AC+to+dollars&ie=utf-8&oe=utf-8&aq=t&rls=org.mozilla:en-US:official&client=firefox-a
Year of Cost Data	2006	
Consumper Price Index (mid-2018)	252.15	
Consumper Price Index (2006)	201.60	

	SCOT	Sulfreen (Single 126t/d Unit)	Sulfreen (2nd,126 t/d unit)
Capital Cost Low (Euro)	30,000,000 €	15,000,000 €	---
Capital Cost High (Euro)	50,000,000 €	25,000,000 €	---
Capital Cost Median (Euro)	40,000,000 €	20,000,000 €	---
Cost vs. Unit Size: [Cost Ref *(Feed Rate/Feed Rate Reference]$^{0.6}$	73,544,702 €	24,260,704 €	48,521,408 €
Convert Capital Cost to 2018 USD:	$ 103,022,236	**$ 21,725,004**	**$ 43,450,008.24**
Fixed Operating Cost (4%/y Capital Cost):	$ 4,120,889	$ 869,000.16	$ 1,738,000.33

SCOT Variable Operating Cost Factor (Euro/tS):	5.11 €
Variable Operating Cost Factor (2006 USD/tS)	$ 5.72
Variable Operating Cost Factor (2018 USD/tS)	$ 7.16
Annual Variable Operating Cost (USD):	$ 658,406.16

100 Meter Stack
Sulfur Recovery Unit

Sulfur Dioxide

CBA (Sulfreen®) Control Technology

Montana Sulphur & Chemical Co
4-Factor Cost Analysis
SRU
SO_2

Based on methodology described in
EPA Pollution Cost Control Manual, 6th Edition
January 2002
Section 5.2, Chapter 1 Wet Scrubbers for Acid Gas Removal

Total Capital Costs - CBA (Sulfreen®)

Cost Item	Factor	Cost
DIRECT COSTS		
Purchased equipment costs		
Number of systems required:		2
Capacity of Each Unit (tpd)		126
Cost of system(s) + auxiliary equipment[1]:		$26,338,500
Total system+ auxiliary equipment	A	$26,338,500
Instrumentation	0.10 A	$2,633,850
Sales taxes	0.00 A	$0.00
Freight	0.05 A	$1,316,925
Purchased equipment cost, PEC	B = 1.15 A	**$30,289,275**
Direct installation costs		
Foundations & supports	0.12 B	$3,634,713
Handling & erection	0.40 B	$12,115,710
Electrical	0.01 B	$302,893
Piping	0.30 B	$9,086,782
Insulation for ductwork	0.01 B	$302,893
Painting	0.01 B	$302,893
Direct installation cost	0.85 B	**$25,745,884**
Site preparation	As required, estimate	$250,000
Buildings	As required, Estimate.	$250,000
Total Direct Cost, DC	1.30 B + SP + Bldg.	**$30,789,275**
INDIRECT COSTS (Installation)		
Engineering	0.10 B	$3,028,927
Construction and field expenses	0.10 B	$3,028,927
Contractor fees	0.10 B	$3,028,927
Start-up	0.01 B	$302,893
Performance test	0.01 B	$302,893
Retrofit factor	0.25 B	$7,572,319
Contingencies	0.03 B	$908,678
Total Indirect Cost, IC	0.56 B	**$18,173,565**
TOTAL CAPITAL INVESTMENT (TCI) = DC + IC[a]		**$48,962,840**

Annual Costs - CBA (Sulfreen®)

Cost Item			Cost
Fixed Operating Cost			
Fixed Operating Cost (4%/y Capital Cost):	Reference: http://www.citepa.org/forums/egtei/5-White-refineries.pdf		$1,958,514
Variable Operating Cost			
$4.46/ton S Processed	Reference: http://www.citepa.org/forums/egtei/5-White-refineries.pdf		$410,231
INDIRECT ANNUAL COSTS, IC			
Administrative Charges		2% of TCI	$979,257
Property Taxes		1% of TCI	$489,628
Insurance		1% of TCI	$489,628
Capital Recovery Factor (Annualized Capital Cost, 20 yrs at Prime Rate 5.5%)			$4,097,178
TOTAL ANNUAL COST (Sulfreen®):			**$8,424,436**

Baseline Emissions (tons/yr):[2]	1,014
Current S Efficiency Removal (2017 ↔ 2018)	98.4%
Control Efficiency (with new controls)[3]	99.1%
Control Efficiency above current levels	43.8%
Tons Removed (tons/yr):	443
New Emission Rate (tons/yr)	570
Cost-Effectiveness ($/ton):	**$18,999**

Capital Recovery Factor $CR = \frac{i(1+i)^n}{-1+(1+i)^n}$

n = 20 years
i = 5.5% interest rate
CR = 0.0837

Notes:

1 Estimate based on "Concawe Cost and Cost-Effectiveness Assessment of Abatement Technology/Techniques For Refineries Contributing to the Update of the EGTEI Synopsis Sheets For the Petroleum Sector" L. White, Special Advisor, May 6th , 2011, http://www.citepa.org/forums/egtei/5-White-refineries.pdf

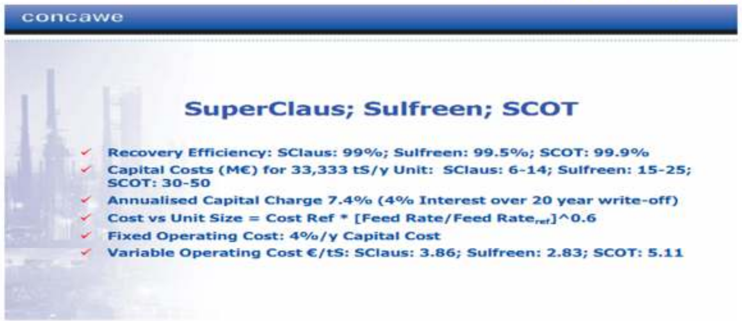
2 Average annual emissions for 2017 - 2018 per DEQ directive

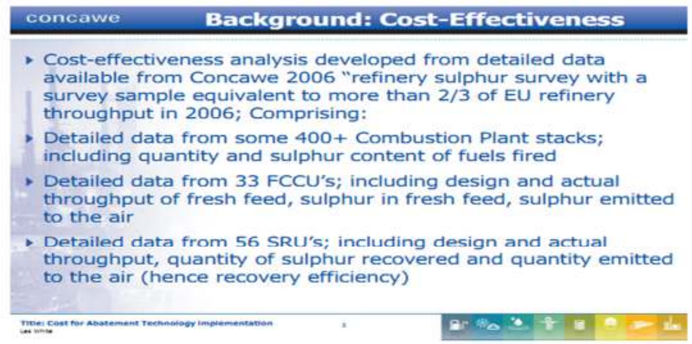
3 Adjusted from vendor claim 0.4% points per discussion in Section 4.3

Sulfreen Capital and Operating Cost References

Based on: Concawe Cost and Cost-Effectiveness
Assessment of Abatement
Technology/Techniques For Refineries
Contributing to the Update of the EGTEI
Synopsis Sheets For the Petroleum Sector
L. White, Special Advisor, May 6th , 2011

Link: http://www.citepa.org/forums/egtei/5-White-refineries.pdf





Reference Size of Plant Used for Estimate:	33,333	tS/year
Reference Size of Plant Used for Estimate:	91	tS/day
Nominal Size of Plant at MSCC (tS/day)	252	tS/day
Nominal Size of Plant at MSCC (tS/year)	91,980	tS/year
Conversion from Euros to USD (January 2012):	1.13	https://www.google.com/search?q=exchange+rate&rlz=1C1PQCZ_enUS731US731&oq=exchange+rate&aqs=chrome.0.0l6.5192j1j8&sourceid=chrome&ie=UTF-8
Year of Cost Data	2006	
Chemical Engineering Plant Cost Index 2006	499.6	
Chemical Engineering Plant Cost Index 2011	596	

	Sulfreen (252 t/d)	Sulfreen (Single 126t/d Unit)	Sulfreen (2nd,126 t/d unit)
Capital Cost Low (Euro)	15,000,000 €	15,000,000 €	---
Capital Cost High (Euro)	25,000,000 €	25,000,000 €	---
Capital Cost Median (Euro)	20,000,000 €	20,000,000 €	---
Cost vs. Unit Size (Cost Ref *(Feed Rate/Feed Rate Reference)^.6	36,772,351 €	24,260,704 €	48,521,408 €
Convert Capital Cost to 2011 USD:	**$ 49,570,542**	**$ 32,704,361**	**$ 65,408,722.83**
Fixed Operating Cost (4%/y Capital Cost):	$ 1,982,821.70	$ 1,308,174.46	$ 2,616,348.91
Sulfreen Variable Operating Cost Factor (Euro/tS)	2.83 €	2.83 €	2.83 €
Variable Operating Cost Factor (2006 USD/tS)	$ 3.20	$ 3.20	$ 3.20
Variable Operating Cost Factor (2011 USD/tS)	$ 3.81	$ 3.81	$ 3.81
Variable Operating Cost (USD):	$ 350,898.99	$ 175,449.49	$ 350,898.99

SCOT Variable Operating Cost Factor (Euro/tS):	5.11 €
Variable Operating Cost Factor (2006 USD/tS)	$ 5.77
Variable Operating Cost Factor (2011 USD/tS)	$ 6.89
Annual Variable Operating Cost (USD):	$ 633,602.06

APPENDIX B: DISPERSION MODELING

Dispersion Modeling Report

Assessment of Visibility Impacts: Mandatory Class I Areas

Montana Sulphur & Chemical Co.

1.0 INTRODUCTION

This appendix provides a summary of the dispersion modeling conducted in support of MSCC's 4-Factor analysis as it regards the 2nd Planning Period in the Regional Haze Rule (RHR).[92] The analysis was requested by DEQ in an email letter dated April 19, 2019. Dispersion modeling was not specifically required in response to the request; therefore, this appendix is only a brief summary of the model and various options used. More details of model options along with all modeling input and output files are available upon request.

The modeling described here was originally conducted for the 1st planning period and submitted to EPA on 2/6/12. That modeling effort was eventually relied upon by EPA in creating the requirements of the 1st planning period of the RHR.[93] EPA concluded, appropriately, that no additional controls or reductions in emissions at MSCC were necessary for that planning period.

Although the April 19 letter did not specifically seek or address MSCC's visibility impacts on any nearby mandatory Class I areas, we believe that such an analysis is required and appropriate in order to address the underlying requirements of the RHR program.

We note that the entire program of protecting visibility is found at 40 CFR 51, Subpart P (subsections 300 through 309). A review of Subpart P indicates the purpose and goals of the program. To begin, the overall purpose of the program is outlined as follows:

> "*The primary purposes of this subpart are . . .to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment of visibility in mandatory Class I Federal areas . . . .*" [40 CFR 51.300(a)].

Insofar as regional haze is concerned, the following is noted when describing the "core requirements"[94] for an implementation plan for regional haze.

> "*For each mandatory Class I Federal area . . ., the State must establish goals . . . that provide for reasonable progress towards achieving natural visibility conditions.* ***The reasonable progress goals must provide for an improvement in visibility*** *for the most impaired days . . .*" [40 CFR 51.308(d)(1)].

The rules go on to provide states with what must be considered in developing reasonable progress. These details are outlined in 40 CFR 308(f).

The review of control options notwithstanding, it seems the visibility program is clear as to its intent. That is, the purpose of the program is to protect visibility (remedy, prevent

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[92] The RHR and information regarding planning periods are found in 40 CFR 51.301 *et.seq.*
[93] The 1st planning period requirements were promulgated on 9/18/12 (77 FR 57864) and are found at 40 CFR 52.1396. EPA
[94] 40 CFR 51.308(d).

impairment compared to natural conditions) as perceived in mandatory Class I areas. Based on the 51.308(d)(1) language above, it is also quite clear that any activity or goal (proposed or otherwise) that does not “improve visibility” is not, therefore, a candidate for those “reasonable progress” plans or goals.

As a result, we believe an analysis that only addresses emission control options is not sufficient for inclusion into reasonable progress elements unless those emission controls actually improve visibility. It would be at odds with the program to include an emission control scenario that did not improve visibility (i.e., did not predictably produce a discernible improvement in deciviews).

To that end, we have chosen to conduct an analysis of modeled impacts this facility has on the nearest mandatory Class I areas, and to relate these numeric values to discernible visibility improvements (or lack thereof). In order to conduct the analysis, we have chosen, as a matter of convenience and consistency, to follow the general elements of the BART dispersion modeling effort relating to visibility impacts. The modeling effort used by BART, including this submittal, is found in 40 CFR 51, Appendix Y.

The actual Calpuff runs were conducted with the emission rates that were applicable at that time. For this 2nd planning period, those rates have been adjusted accordingly. Given only the sulfur dioxide emission rates have varied materially (40% lower than the 2012 runs) and the NOx and particulate emissions data is minimal, one does not need to rerun the model itself to determine the visibility impact. There is, for our purposes and in our judgment, a (near) linear relationship between visibility output using the ‘old’ emission rate versus the ‘new’ rate. On that basis, the results of the previous model runs are adjusted (linear transformation) to account for the new emission rate for sulfur dioxide.[95]

The remainder of this Appendix outlines some of the details of the modeling. Values in the tables consider the 2nd planning period baseline emissions.

[95] This linear relationship between visibility and emissions was confirmed by reviewing results of previous modeling. The 2012 model analyzed emissions from 3 different scenarios (no additional controls, 50% control and 99.9% control expressed as a % of total plant input). Those model results demonstrated a linear relationship between sulfur dioxide emissions and changes in deciviews. Even at the higher emissions modeled, there was no discernible impact on visibility.

2.0 MODEL SELECTION

For this analysis, and as generally required by EPA for assessing visibility impacts, we used the CALPUFF dispersion model system. This is the same system that was applied for the BART analyses carried out under 40 CFR 51.308(e). BART is, itself, an element of the regional haze program and an element in the overall protection of visibility found in 40 CFR 51, Subpart P.

CALPUFF is a non-steady-state Lagrangian dispersion model that simulates pollutant releases as a continuous series of "puffs." It is supported by two primary sub-programs, CALMET and CALPOST. CALMET is used in refined analyses to simulate three-dimensional wind fields based on multiple sources of geophysical and meteorological data. The output of the CALPUFF model consists of binary data files with information on pollutant concentrations, wet and dry flux rates, and visibility parameters. CALPOST processes these data based on specified input parameters or assumptions, and reports calculated impact values.

The CALPUFF analyses utilized for this project are noted below and were obtained from the CALPUFF developer, Atmospheric Studies Group (ASG) at:

http://www.src.com/calpuff/calpuff1.htm.

Geophysical Data Processors

- TERREL (Version 3.311, Level 030709)
- CTGCOMP
- CTGPROC (Version 2.42, Level 030709)
- MAKEGEO (Version 2.22, Level 030709)

Meteorological Preprocessors

- SMERGE (Version 5.31a, Level 040706)
- PXTRACT
- PMERGE (Version 5.31, Level 030528)
- READ62 (Version 5.52, Level 040716)

Main Models

- CALMET (Version 6.211, Level 060414)
- CALPUFF (Version 6.112, Level 060412)

Postprocessors

- CALPOST (Version 6.131, Level 060410)
- PRTMET

The version and level identifiers for the major modules used for this project are identified above. Electronic executable files for the primary modules and the primary electronic input and output files associated with this analysis are available upon request from Bison Engineering, Inc.

3.0 CALMET

CALMET, the meteorological preprocessor for CALPUFF, was used to compile and process land use data, terrain data, and meteorological data for use in the CALPUFF model. The CALMET output files define gridded fields of wind speed, wind direction, mixing heights, stabilities, micrometeorological parameters, and precipitation – all parameters required for input to the CALPUFF dispersion model. The following sections provide a brief description of each of these data sets.

3.1 Land Use Data

CALMET uses specific land use data developed by the U.S. Geological Survey (USGS) [available for download from the USGS Earth Resources Observation and Science (EROS) web site]. The data files used by this project are 1:250,000-scale files. Each land use cell, typically 200 meters square, is assigned a land use code by USGS.

3.2 Terrain Data

CALMET uses USGS 1:250k Digital Elevation Models (DEMs) to determine the terrain elevation in the model domain. The terrain data are preprocessed into a data set recognizable by CALMET and used to help create the CALMET output file.

3.3 Meteorological Data

CALMET output files representing meteorological data for the 2001, 2002, and 2003 calendar years were prepared for this analysis. The input surface and upper air meteorological data and the Mesoscale Model version 5 (MM5) data (processed with the CALMM5 processor) are those data sets used for the Montana Best Available Retrofit Technology (BART) modeling conducted by EPA.

3.3.1 Mesoscale Model Data

The MM5 meteorological data for the 2001, 2002, and 2003 calendar years were obtained from the Western Regional Air Partnership - (WRAP) web site at http://pah.cert.-ucr.edu/aqm/308/bart.shtml. These data are generated by the CALMM5 processor from MM5 mesoscale meteorological model output files. The CALMM5 data have a spatial resolution of 36 kilometers. The mesoscale models are limited-area, nonhydrostatic or hydrostatic, terrain-following sigma-coordinate models designed to simulate or predict mesoscale and regional-scale atmospheric circulation. The data are used as a basis for generating an "initial guess field" of multilayer meteorological parameters in CALMET.

3.3.2 Surface Data

Hourly surface meteorological data for 2001, 2002, and 2003 also were obtained from the WRAP internet site. This data set includes data from 39 locations for 2001 and 36 locations for 2002 and 2003. The WRAP data are in the SMERGE format and are ready for input into CALMET Version 6. The data have been manually converted for use with CALMET Version 5.8 (involving only minor changes to the header records in the data files).

Surface data from the following locations were used in the CALMET analysis:

- Badger Peak, MT (2001 only)
- Billings, MT
- Bismarck, ND
- Boise, ID
- Bozeman, MT
- Butte, MT
- Casper, WY
- Coeur d’Alene, ID
- Cut Bank, MT
- Dickinson, ND
- Dillon, MT
- Estevan, SK
- Havre, MT
- Kalispell, MT
- Garfield Peak, MT (2001 only)
- Glacier National Park, MT
- Glasgow, MT
- Great Falls, MT
- Helena, MT
- Havre, MT
- Lander, WY
- Lewistown, MT
- Livingston, MT
- Medicine Hat, AB
- Miles City, MT
- Minot, ND
- Missoula, MT
- Morningstar, MT (2001 only)
- Peabody Coal, MT
- Pocatello, ID
- Rapid City, SD
- Rexburg, ID
- Riverton, WY
- Salmon, ID
- Sheridan, WY
- Spokane, WA
- Spring Creek Coal, MT
- Theodore Roosevelt National Park, ND
- Williston, ND
- Yellowstone National Park, WY

3.3.3 Upper Air Data

Upper air rawinsonde data collected at seven National Weather Service (NWS) stations were obtained from the rawinsonde data repository maintained by the National Oceanic and Atmospheric Administration (NOAA) at http://esrl.noaa.gov/raobs/. The data were provided in the standard FSL data format for use in the CALMET system. The seven NWS upper air rawinsonde locations used for this project are:

- Bismarck, ND
- Boise, ID
- Glasgow, MT
- Great Falls, MT
- Rapid City, SD
- Riverton, WY
- Spokane, WA

3.3.4 Precipitation Data

Hourly precipitation data in the National Climatic Data Center (NCDC) TD-3240 format were obtained from the data set developed by the Montana Department of Environmental Quality (DEQ) for their BART modeling analysis effort. All precipitation stations located within the CALMET modeling domain were extracted from the data set and used in the CALMET analysis. A total of 286 stations were selected for each of the three modeled years. A complete list of precipitation stations is included in the CALMET input files.

3.4 CALMET Technical Options

The CALMET meteorological processor was executed using the technical options recommended in the EPA/IWAQM guidance, the EPA Model Clearinghouse memorandum of May 15, 2009, and the EPA-Federal Land Managers (FLM) Model Clearinghouse clarification memorandum of August 31, 2009.

4.0 CALPUFF

4.1 CALPUFF Technical Options

CALPUFF applies mathematical algorithms to calculate pollutant concentrations at specified receptor locations. CALPUFF's output files contain concentration values for every receptor and every hour modeled. These output files must be processed through CALPOST to evaluate model results against regulatory limits or guideline thresholds. CALPUFF requires inputs of CALMET data files, source characteristics and emission rates, and receptor grids to model impacts.

For brevity, a complete list of the technical options chosen for this modeling exercise is not presented. As noted earlier, the same options used for the Montana BART analyses were used here as well.

4.2 Receptors

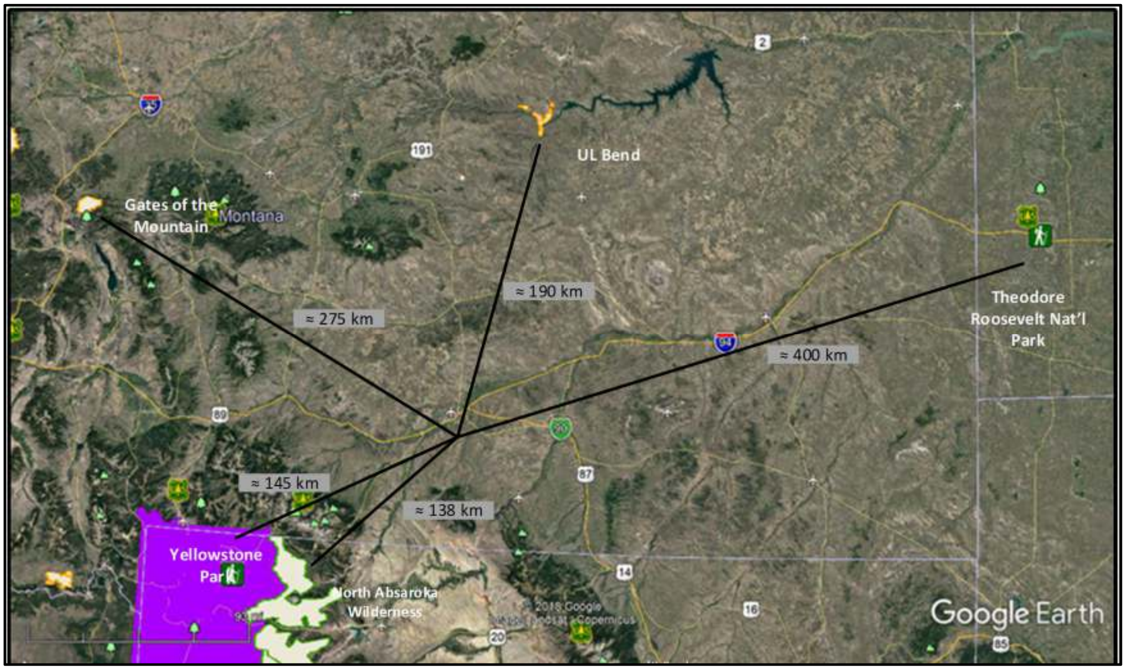
The receptors chosen for this modeling were those of the nearby mandatory Class I areas. The mandatory Class I areas chosen were:

- Gates of the Mountain Wilderness
- UL Bend Wildlife Wilderness Area
- North Absaroka Wilderness
- Yellowstone National Park

These four areas represent the closest areas to the facility and display a relatively wide range in direction from the plant. The nearest of these areas is approximately 130 kilometers from MSCC's location at Lockwood, Montana. Figure B-1 below shows the relative distance from the MSCC facility.

The specific receptors used for the runs are the same as those generated by the federal land managers and used in prior BART analyses. The exact receptor locations are not presented here to keep this report brief.

Figure B-1: Class I Locations and Distances



4.3 Modeled Sources and Emission Rates

The modeled source for this analysis was the MSCC facility in Billings, Montana. Emissions from the Sulphur Recovery Unit (SRU) vent to a 100-meter stack. In very rare cases, emissions from the SRU may be routed to a 30-meter stack, but this has not occurred since approximately 1994. Certain low sulfur emissions are permitted from the 30-meter stack, although such emissions are rare and have not occurred since before 1998.

The emission rate for this analysis was based on the average emission rate of 2017 and 2018. This value (1,014) is the emission rate provided to DEQ regarding the baseline for the 2nd planning period. Additional modeling, in 2010, was conducted using arbitrarily lower emission rates to insure results were directly proportional to the emission rate. Those additional runs were conducted to provide a range of predicted visibility impacts using a range of emission values.

The baseline emission rates used in the model are shown in the table below.

Table B-1: Modeled Emission Rates (2nd Planning Period)

SO_2 (tpy)	NOx (tpy)	PM_{10} (tpy)
1,014	4.1	0.47

5.0 CALPOST CLASS I VISIBILITY ASSESSMENT

Visibility impacts (expressed in terms of percentage change in 24-hour average background extinction relative to natural background visibility) were calculated using the CALPUFF modeling system and data. The analysis was conducted using concentration files produced by CALPUFF and CALSUM. The visibility assessment is based solely on the MSCC facility.

The methods recommended in the BART program were followed in the visibility analyses. CALPOST Version 6.131, Level 060410 was used in these analyses. The technical options employed in the CALPOST analyses are not presented here for the sake of brevity. It is noted, however, that some visibility options are specific to the mandatory Class I area being evaluated. Those area-specific data were applied as appropriate.

6.0 RESULTS

6.1 Visibility Analysis

The methodology for the visibility analysis portion of this project is the same as the methods used for the BART program [40 CFR 51.308(e)] discussed during the 1st planning period. The analysis is conducted by calculating concentrations of particulate, sulfate, nitrate and other compounds in the atmosphere from the modeled facility in question. The concentration of those compounds in the atmosphere is used to estimate changes to modeled visibility.

Impacts to natural background visibility, expressed in terms of percentage change in 24-hour average background extinction (ΔBex) were calculated by CALPOST processor (an integral part of the CALPUFF modeling system) and was then linearly adjusted to account for the 2nd planning period emission rates. In accordance with 40 CFR 51, Appendix Y, the 24-hour average 98th percentile impact results are summarized in the following table. Please note, however, that this measurement parameter (98th percentile) is not directly consistent with the IMPROVE reporting data in Section 3.0 of the main document. That latter data is a measure the 20% of the most impaired days of the reported year. The data in this Appendix and tables below over-estimate that 20% parameter (the basis of the RHR) by using a 98th percentile value. Although this is a weakness for direct data comparison, the modeled data is, nonetheless, reported because even though it is biased high, with that bias it continues to serve the purpose of demonstrating no discernible visibility impacts from the MSCC facility.

To serve as a baseline, the table below shows the results of the CALPUFF modeling results. The data uses the 2nd planning period emission rate (1,014 tons/year SO_2) and assumes no additional controls as discussed in the main document.

Table B-2: Visibility Impacts: Base Case

Class I Area	Visibility (ΔdV)	% of a Discernible Change in Visibility	% of a 'de minimis' Change in Visibility
Yellowstone National Park	0.06	6%	12%
UL Bend	0.10	10%	20%
North Absaroka	0.07	7%	14%
Gates of the Mountains	0.05	5%	10%

The results of this analysis are revealing. The deciview values themselves represent the change in modeled visibility (ΔdV) that could occur as a result of the facility as currently operating. The values in the table are all below 0.5 deciview (see comparison in the last column where it is used as the "de minimis" value). EPA has used this 'threshold' value for some time as a measure and demonstration of a non-measurable or nil impact, for example in new source permitting. According to general guidance, if a facility's impact, by itself, is less than 0.5 dV, then the facility's impact is *de minimis*.

Since the impact predicted from this facility, without the consideration of additional reduction or controls, is *de minimis*, then clearly the addition of additional controls contributes nothing toward the national goal or toward reasonable progress. Since the addition of controls does not create any "progress" toward the national goal, no additional controls at MSCC constitute [already attained] "reasonable progress."

As a matter of interest, the table below was also created to compare the modeled visibility impact of the MSCC facility in a range of emission scenarios: actual and with additional controls of some arbitrary levels. For reasons discussed above, these levels of additional reductions are not necessarily achievable with controls. The table shows that the MSCC facility in any configuration, including the current configuration, does not yield a discernible impact on the mandatory Class I areas. In addition, all the scenarios show an impact below 'de minimis.'

Table B-3: Visibility Impacts: Multiple Scenarios

Class I Area	Emission Scenarios		
	Actual (2017 – 2018)	50% Reduction in Actuals	90% Reduction in Actuals
Yellowstone National Park	0.06	.03	.01
UL Bend	0.10	.05	.01
North Absaroka	0.07	.03	.01
Gates of the Mountains	0.05	.03	.01

Units: Deciviews (ΔdV) – reported to 2 decimals

Note: All values are less than discernible visibility impacts, and all values are less than 0.5, the de facto 'de minimis' value for an impact on a mandatory Class I area.

Therefore, the only logical and reasonable conclusion for this report is that existing controls and emission limitations are enough, and no additional emission controls or restrictions at this facility are justified based on reasonable progress or the national goal of improved visibility at Class I areas.

APPENDIX C: DEQ CORRESPONDENCE

April 19, 2019

Sent electronically to: mark@montanasulphur.com

Mark DeHart
Environmental Manager
Montana Sulphur

RE: Regional Haze Reasonable Progress Analysis

Dear Mr. DeHart:

As you are aware, the Montana Department of Environmental Quality, Air Quality Bureau (AQB), is in the process of developing a State Implementation Plan (SIP) for the second implementation period of the federal Regional Haze program, which is codified at 42 U.S. Code §7491 – Visibility protection for Federal class I areas. This implementation period focuses on making reasonable progress toward national visibility goals by analyzing progress to-date from the 2000-2004 baseline and considering whether additional emission reductions are necessary to continue a reasonable rate of progress.

The reasonable progress analysis involves assessing potential emission control technology against four statutory factors, including cost of controls, time necessary to install controls, energy and non-air quality impacts, and remaining useful life. Through this process, DEQ is also working with the Western Regional Air Partnership (WRAP) to prepare regional air quality modeling of visibility conditions associated with current emissions, projected future emissions, and potential future control scenarios. DEQ will work with you to ensure the accuracy and representativeness of emissions data for modeling.

Now that we have completed initial calls and discussed the screening process for Montana Sulphur, DEQ is formally requesting assistance from Montana Sulphur in developing information for the reasonable progress analysis. In order for this information to be included in the regional modeling analyses, we request that it be submitted to DEQ no later than September 30, 2019.

The purpose of this letter is to provide additional clarification to help you prepare information associated with the reasonable progress analysis. We understand that confirming as many details as possible early in the analysis will reduce the chance of repeating or re-doing calculations later in the process. We hope these clarifications will help define the analysis, but please contact DEQ if you have any further questions.

In reviewing reasonable progress analyses, DEQ will rely on the following three resources to ensure accuracy and consistency. All information prepared as part of the reasonable progress analysis should be prepared using the guidance provided in these documents.

1. **EPA Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals, and Other Requirements for Regional Haze State Implementation Plans for the Second Implementation Period ("Draft Guidance")**[i]

2. EPA Air Pollution Control Cost Manual ("Control Cost Manual")[ii]

3. EPA Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze ("Modeling Guidance")[iii]

Guidance for Developing Cost of Control Estimates for Reasonable Progress Analysis

For the purpose of the requested reasonable progress analysis, a 20-year planning horizon should be assumed. The only exception to this horizon is if there is a unit shutdown date identified that will cease operations before 20 years has expired. Additionally, the generally accepted accuracy in the Control Cost Manual is within plus or minus 30%. Facilities using technical experts and consultants may have more accurate projections due to their previous hands-on experience. DEQ requests that you please explain any deviations from the 20-year planning horizon or the presumed 30% accuracy in your estimates.

The latest guidance from EPA points to the interest rate that is most appropriate for your facility based on previous project engineering experience at your facility. This most likely will result in the selection of an interest rate between 3% and 7%. In the absence of a more specific interest rate, EPA recommends that you use the current bank prime rate, which is 5.5% as of the date of this letter, as a default.[iv]

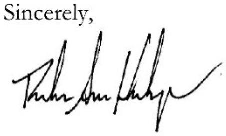
DEQ also requests that capital and annual costs be estimated as if the project will be constructed at the time the cost estimate is prepared. The annualized cost of the project should be presented by annualizing the capital cost and adding that to the annual operating costs. Please also calculate the cost in dollars per ton of emission reduction for each evaluated control alternative by dividing the uniform annual cost by the tons of annual emission reduction anticipated.

Additional Guidance for Preparing Reasonable Progress Analyses

As part of the reasonable progress analysis, DEQ will consider additional information provided by a facility, including supplemental visibility modeling. This modeling is not required. In lieu of supplemental visibility modeling, DEQ will use the information provided by WRAP to assess visibility impacts from a facility. Please note, a visibility modeling demonstration can support but not replace the four-factor analysis described in this letter. If you choose to prepare your own modeling demonstration, DEQ requests that it be prepared in accordance with EPA's modeling guidance cited above and Appendix W to Title 40, Part 51 of the Code of Federal Regulations.[v] DEQ also requests the opportunity to review your modeling protocol to ensure consistency with EPA guidance.

Thank you in advance for your support in this analysis effort. Again, please submit any reasonable progress analysis information by September 30, 2019. We are working closely to meet regional timelines for visibility modeling and this due date will allow adequate time for review and discussion of the analysis in advance of regional deadlines. If you have any questions, please contact Craig Henrikson at 406-444-6711or by email at chenrikson@mt.gov.

Sincerely,



Rebecca Harbage
Regional Haze Project Manager
Air Quality Bureau

Cc: Craig Henrikson, AQB
John Raty, AQB
David L. Klemp, Chief, AQB

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[i] Environmental Protection Agency, "Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals, and Other Requirements for Regional Haze State Implementation Plans for the Second Implementation Period," July 2016, EPA-457/P-16-001. https://www.epa.gov/sites/production/files/2016-07/documents/draft_regional_haze_guidance_july_2016.pdf. EPA anticipates releasing a final version of the guidance in Spring 2019 and DEQ will contact you as soon as possible following its release if there are any major changes.

[ii] EPA, "EPA Air Pollution Control Cost Manual." https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution#cost%20manual. EPA is in the process of updating what will be the Seventh Edition of this document and some updates have already been finalized. Please refer to the most current finalized versions.

[iii] EPA, "Modeling Guidance for Demonstrating Air Quality Goals for Ozone, PM2.5, and Regional Haze," November 2018, EPA-454/R-18-009. https://www.epa.gov/scram/state-implementation-plan-sip-attainment-demonstration-guidance.

[iv] The current bank prime rate can be found on the Federal Reserve website: https://www.federalreserve.gov/releases/h15/.

[v] EPA, "Appendix W to Part 51 – Guideline on Air Quality Models," 40 CFR Part 51, Appendix W, July 1, 2018. https://www.govinfo.gov/content/pkg/CFR-2018-title40-vol2/xml/CFR-2018-title40-vol2-part51-appW.xml.

DEQ
Montana Department
of Environmental Quality

Air, Energy & Mining Division

March 13, 2019

Sent electronically via email to: mark@montanasulphur.com

Mark DeHart
Environmental Manager
Montana Sulphur

RE: Regional Haze Source Screening Analysis

Dear Mr. DeHart

The Montana Department of Environmental Quality, Air Quality Bureau (AQB), is working on a State Implementation Plan (SIP) for the second planning period of the Regional Haze program, which is codified at 42 U.S. Code §7491 – *Visibility protection for Federal class I areas.* This planning period focuses on making reasonable progress toward national visibility goals.

As discussed during our phone conversation on March 13, 2019, the AQB has completed an initial Regional Haze screening analysis of Montana Sulphur (MT Sulphur) and determined that the facility needs further review of process controls specifically related to sulfur dioxide (SO_2).

Monitoring data indicate that sulfates and nitrates are the main contributors to anthropogenic haze in Montana. The primary precursors of nitrates and sulfates are emissions of NO_x and SO_2. The AQB based its initial analysis on the annual emission inventories submitted by MT Sulphur to the AQB for the years 2014-2017, which are compiled in Table 1 below. The initial screening analysis also considers the distance from the facility to the boundary of the nearest Federal class I area (North Absaroka Wilderness). Taken together, emissions and distance provide a screening tool to identify facilities that may be contributing to haze and that therefore may require further analysis.

Table 1 – Facility-Level NO_x and SO_2 Emissions and Screening Analysis

NO_x 2014-2017 Average	SO2 2014-2017 Average	Nearest Class I Area	Distance to Class I Area	2014-2017 Q/d ($Q=NO_x+SO_2$)
4.74	**1,305.53**	North Absaroka Wilderness	137.5	9.53

Table 2 – Existing Process Controls

Unit	SO_2 Control	% Removal Est.
Claus Plants	None	

At this time, the AQB requests your review of the emissions and control equipment information the AQB has on file for the facility. Following this initial review, the AQB will be asking that you prepare a detailed review of additional process controls, specifically considering (1) the cost of control, (2) the time required to achieve control, (3) the energy and non-air quality environmental impacts of control,

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and (4) the remaining useful life of the source of emissions. The AQB will be contacting you shortly to schedule a call to discuss the initial screening analysis in more detail.

If you have any questions or concerns, please contact me by phone at (406) 444-6711 or by e-mail at chenrikson@mt.gov

Sincerely,

Craig Henrikson

Craig Henrikson
Air Quality Bureau

Cc: John Raty, AQB