REGIONAL HAZE SECOND PLANNING PERIOD FOUR-FACTOR ANALYSIS

Freeport-McMoRan – Sierrita Operations

Arizona Department of Environmental Quality

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1. EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) Regional Haze Rule (RHR) is designed to improve visibility at national Class I areas to natural levels by 2064. The program is designed to achieve this goal by assessing visibility during various "planning" periods, demonstrate that visibility improvements are progressing along the Uniform Rate of Progress (URP), and require controls to demonstrate reasonable progress. The current planning period requires that states submit updated implementation plans no later than July 31, 2021. The analysis requires the development of a "Source Screening" approach to remove sources from further consideration. Sources that are not screened out are subject to additional review such as a four-factor analysis (4FA).

The Arizona Department of Environmental Quality (ADEQ) informed the Freeport-McMoRan Sierrita Operations (FMSI) that they were selected for a 4FA. ADEQ has also provided FMSI with a list of the processes that are subject to the 4FA. This report details the methodology used to complete the 4FA for these processes and summarize the associated results. Table 1-1 summarizes the results of the 4FA for the Sierrita Operations.

Table 1-1. Sierrita Operations – Four Factor Analysis Conclusions

Unit Process Description	Pollutant	Conclusions
Unpaved Roads	PM_{10}	Compliance with fugitive dust control requirements contained in Pima County Code (PCC) 17.16.060 "Fugitive Dust Producing Activities"; PCC 17.16.090 "Roads and Streets"; 20% opacity limitations at PCC 17.16.050.B and no visible emissions beyond property line limitations at PCC.17.16.050.D
Sierrita Tailings	PM_{10}	Compliance with fugitive dust control requirements contained in PCC 17.16.060 "Fugitive Dust Producing Activities"; PCC 17.16.120 "Mineral Tailings"; 20% opacity limitations at PCC 17.16.050.B and no visible emissions beyond property line limitations at PCC.17.16.050.D
Blasting Operations	NO_x	None
Truck Load/Dump	PM_{10}	Compliance with fugitive dust control requirements contained in PCC 17.16.060 "Fugitive Dust Producing Activities"; PCC 17.16.100 "Particulate Materials"; 20% opacity limitations at PCC 17.16.050.B and no visible emissions beyond property line limitations at PCC.17.16.050.D

2. INTRODUCTION

In the 1977 amendments to the Clean Air Act (CAA), Congress set a nation-wide goal to restore national parks and wilderness areas to natural conditions by remedying existing anthropogenic visibility impairment and preventing future impairments. On July 1, 1999, the EPA published the final RHR located at Title 40 of the Code of Federal Regulations (40 CFR) §51.308. The objective of the RHR is to restore visibility to natural conditions in 156 specific areas across the United States, known as Federal Class I areas. Pursuant to 40 CFR §51.308(d)(1), the RHR requires states to set goals that provide for reasonable progress towards achieving natural visibility conditions for each Class I area in their jurisdiction. In establishing a reasonable progress goal (RPG) for a Class I area, each state must:

- Pursuant to 40 CFR §51.308(d)(1)(i)(B), "*Analyze and determine the rate of progress needed to attain natural visibility conditions by the year 2064. To calculate this rate of progress, the State must compare baseline visibility conditions to natural visibility conditions in the mandatory Federal Class I area and determine the uniform rate of visibility improvement (measured in deciviews) that would need to be maintained during each implementation period in order to attain natural visibility conditions by 2064. In establishing the reasonable progress goal, the State must consider the uniform rate of improvement in visibility and the emission reduction.*" The URP or improvement is also known as the "glidepath".

- Pursuant to 40 CFR §51.308(d)(1)(i)(A), "*Consider the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of any potentially affected sources, and include a demonstration showing how these factors were taken into consideration in selecting the goal.*" This is known as a four-factor analysis (4FA).

The program is designed to assess visibility at Class I areas during various "planning" periods. As part of the first planning period (for the period between 2004 to 2018) states were required to submit implementation plans (SIPs) no later than December 17, 2007. The second planning period (for the period between 2018 to 2028) requires that states submit updated SIPs no later than July 31, 2021 and is currently underway.

3. REGIONAL HAZE SECOND PLANNING PERIOD & FMSI

Pursuant to 40 CFR 51.308(d)(3)(iv), states are responsible for identifying the sources that contribute to the most impaired days (MID) in the Class I areas. To accomplish this, ADEQ reviewed 2014 emission inventory data for sources of PM_{10}, NO_x, and SO_2, and developed a “source screening” approach using a “Q/d” analysis (i.e. emissions in tons/year divided by the distance to an affected Class I area in miles or kilometers), to remove sources from further consideration. In this analysis “Q” is the aggregate tons per year of PM_{10}, NO_x, and SO_2, and “d” is the distance (km) of a facility to a Class I area. Arizona followed guidance from the Western Regional Air Partnership (WRAP) and screened out any source that had a Q/d ratio less than 10. For remaining sources, ADEQ evaluated 2018 facility operations and emissions to determine which processes have installed an “effective control” within the last five years. Those processes, which have an “effective control” were deferred from further evaluation during this planning period.[1] Based on ADEQ’s evaluation of the Q/d ratio and “effective control” analysis, ADEQ identified the Freeport-McMoRan Sierrita operations as required to conduct a 4FA. ADEQ determined that the facilities required to conduct a 4FA need only examine processes contributing to the top 80% of haze-causing pollutants. Table 3-1 summarizes the processes ADEQ determined are subject to a 4FA at Sierrita Operations.

3.1. PROCESSES SUBJECT TO FOUR FACTOR ANALYSIS

The Sierrita Operations is located in Pima County, Arizona. The nearest Class I area to the mine is the West Saguaro Wilderness, located about 42 kilometers away from the mine. ADEQ calculated the “Q/d” for the Sierrita Operations to be 21. Table 3-1 contains a list of the processes that ADEQ determined contribute to the top 80% of haze-causing pollutants and are subject to the 4FA based on ADEQ communication.[2]

For purposes of this analysis, unpaved road emissions were divided into those that emanate from sources primarily in the pit (haul and water trucks) and those mainly utilized outside of the pit (light duty vehicles) due to the nature of the varying controls that can be used in either scenario. After the top 80% of emissions were recalculated, emissions from unpaved roads that are primarily travelled by light duty vehicles did not qualify to be analyzed in this analysis.

[1] ADEQ 2021 Regional Haze State Implementation Plan Source Screening Methodology

[2] Per “Four Factor Processes” spreadsheet received September 2019.

Table 3-1. Sierrita Operations – Processes Subject to Four Factor Analysis

Unit Process Description	Pollutant	2018 Emissions Estimate (tpy)
Unpaved Roads – Haul/Water Trucks	PM_{10}	307.31
Unpaved Roads – Light Duty Vehicles	PM_{10}	30.27
Sierrita Tailings	PM_{10}	165.4
Blasting Operations	NO_x	127.5
Truck Load/Dump [3]	PM_{10}	101.4

3.2. PIT RETENTION

Emissions to the atmosphere from mining activities occurring inside the open pit are reduced due to the effect of the pit wall, such that only a fraction of the fugitive dust generated inside the pit escapes to the surface where it can potentially disperse. This phenomenon can be visually observed at any open pit mine. The tendency of dust particles to remain in the pit is referred to as "pit retention."[4] Studies have shown that pit retention can be as high as 80% for PM_{10}.[5,6] Based on this information, FMSI developed and proposed to ADEQ a methodology for estimating pit retention using AERMOD that showed pit retention could be as high as 80%; however, ADEQ suggested a second method of using AERMOD that demonstrated a pit retention value of 5-10%. Due to this discrepancy, FMSI has not included a pit retention control efficiency in its evaluation of potential control options. In addition, because a pit retention factor would decrease emissions from the pit, and thus also potential emission reductions, it would increase the $/ton cost of any potential control. FMSI reserves the right to continue to study the pit retention control efficiency and potentially include the findings of any study in future submittals to ADEQ.

[3] Per 2018 emissions inventory, emissions related to dumping at the primary crusher make up <1% of emissions. As such, this analysis will not include controls for dumping at the primary crusher.

[4] "Surface mine pit retention", C. F. Cole, A.J. Fabrick, 1984.

[5] Per Master's thesis "*Airflow Patterns and Pit-Retention of Fugitive Dust for the Bingham Canyon Mine*", only 20% of in-pit PM_{10} emissions escape the Kennecott Utah Copper Bingham Canyon Mine open pit. Kennecott Utah Copper has since been required to validate these retention factors.

[6] Per "*Significant Dust Dispersion Models for Mining Operations*", W. R. Reed, 2005, multiple models have been conducted concluding that approximately one-third of emissions from mining activities escape from the open pit.

4. FOUR FACTOR ANALYSIS METHODOLOGY & RESULTS

The 4FA completed as part of this report examines the following four factors in 40 C.F.R. 51.308(f)(2)(i):

1. Cost of compliance for the control;
2. Time necessary to comply with the control;
3. Energy and non-air quality impacts of the control; and
4. The remaining useful life of the source.

Factors 1 and 3 are considered by conducting a step-wise review of emission reduction options in a top-down fashion similar to the top-down approach that is included in the EPA RHR guidelines for conducting a review of Best Available Retrofit Technology (BART)[7]. These steps are set forth in 40 C.F.R. Appendix Y to part 51, Section IV.D as follows:

Step 1. Identify all available retrofit control technologies,
- FMSI has identified all possible control technologies through a review of the RACT/BACT/LAER Clearinghouse (RBLC) database, ADEQ guidance, and technical literature. In some cases, this process identified control technologies for which emissions reductions could not be quantified or that do not appear to result in emission reductions. These were carried forward to Step 2 for completeness.

Step 2. Eliminate technically infeasible options,
- FMSI eliminated options that have not been demonstrated in practice, could not physically be accomplished, or which created a safety hazard.

Step 3. Evaluate control effectiveness of remaining control technologies,
Step 4. Evaluate impacts and document the results, and
Step 5. Evaluate visibility impacts.

Factor 4 is also addressed in the step-wise review of the emission reduction options, primarily in the context of the cost of emission reduction options and whether any capitalization of expenses would be impacted by limited equipment life.[8] Once the step-wise review of control options is completed, a review of the timing of the emission reductions are provided to satisfy Factor 2 of the four factors.

4.1. UNPAVED ROADS – PM_{10} CONTROLS

This section presents the step-wise review of control options for PM_{10} for the unpaved roads in the pit located at the Sierrita Operations.

4.1.1. Haul Road Emission Calculations

The uncontrolled PM_{10} emissions from unpaved roads are calculated from AP-42, Section 13.2.2, Equation 1a for vehicles traveling on unpaved surfaces at industrial sites. The emissions factor, E, in lb/VMT, is calculated as follows:

[7] Pursuant to 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*", July 2016, page 94, "*many of the statements in the BART Guidelines continue to be relevant as recommendations for how a state should assess facts related to the four statutory factors.*"
[8] Pursuant to EPA " *Guidance on Regional Haze State Implementation Plans for the Second Implementation Period*", August 2019, pg 42.

$$E = 1.5 * \left(\frac{surface\ silt\ content\ [\%]}{12}\right)^{0.9} \left(\frac{mean\ vehicle\ weight\ [tons]}{3}\right)^{0.45} = [\mathrm{lb/VMT}]$$

The critical variables in determination of the emissions are, therefore: surface silt content, vehicle weight, and vehicle miles traveled. The PM_{10} emissions calculation does not take into account vehicle speed.

4.1.2. Identification of Potential Control Technologies

The following PM_{10} control technologies were identified:

- Traffic management (reduction in speed);
- Applying additional water;
- Applying chemical dust suppressant;
- Applying and maintaining surface gravel;
- Requiring haul trucks to be covered;
- Controlling freeboard and spillage; and
- Paving the road surface.

To identify all feasible control technologies, the RACT/BACT/LAER Clearinghouse (RBLC) database, ADEQ guidance, and technical literature was reviewed. Using these sources, potentially applicable PM_{10} control technologies for unpaved roads were identified based on the principles of control technology and engineering experience for unpaved roads. Although this emission source refers to all unpaved roads, the majority of those emissions[9] emanate from the haul truck and other large vehicles that are within the pit (e.g. water trucks) based on the weight and miles travelled of those vehicles. In many cases, the size of the haul trucks is the limiting factor in which controls can be applied. As such, this analysis will solely focus on potential controls that apply to large vehicular (e.g. haul trucks) travel on haul roads.

Each control technology is described in detail below, as well as its technical feasibility to satisfy Steps 1 and 2 of the top-down analysis approach. Where the control is deemed technically feasible, control effectiveness is also evaluated to satisfy Step 3.

4.1.2.1. Traffic Management / Speed Reduction

This control method was identified by ADEQ as a potential control option for unpaved roads.[10] For purposes of unpaved haul roads, the only available traffic management method is speed reduction. Emissions from this source, however, are not based on vehicle speed, as shown in the equation above (Section 4.1.1). As such, no control efficiency is calculated for this method. Additionally, reduced speed limits would significantly impact the production rate of the overall operations, considering that haul truck travel is critical to the ore throughput. If stricter speed limits were enforced, FMSI would have to buy additional haul trucks to make up for the loss in production. Increasing the amount of haul trucks on the roads would lead to an increase in PM_{10} emissions, as well as increased tailpipe emissions from additional fuel combustion

Reduction of speed of the haul trucks is technically feasible at the Sierrita Operations. Note that FMSI already self imposes speed limits of 34.5 mph for safety.

[9] Per 2018 Emissions Inventory, 91% of "unpaved road" emissions were attributed to haul trucks and water trucks.
[10] Draft List of Potential PM_{10} Controls for Nonpoint Source Sectors – Paved Road Dust and Unpaved Road Dust

4.1.2.2. Additional Water Application

Applying additional water to haul roads is another PM_{10} control method identified by ADEQ. Dust emissions are dependent on the moisture level of the mechanically disturbed material; therefore, when water is applied a cohesive crust is formed among the discrete grains of surface material.[11]

While additional water application is a feasible control option, water application is already utilized at the Sierrita Operations in accordance with Pima County Code (PCC) regulations and air quality permit conditions. Moreover, FMSI currently applies a 90% control efficiency for water application. While Figure 13.2.2-2 in AP-42 suggests that control efficiencies as high as 95% can be correlated to this control method,[12] it is FMSI's understanding that ADEQ will accept a maximum 90% control efficiency for this control method. Therefore, additional watering will not increase the control efficiency.

4.1.2.3. Applying Chemical Dust Suppressant

Chemical dust suppressants reduce PM_{10} emissions by changing the physical characteristics of the existing road surface material and forming a hardened surface that binds particles together.[13] Common chemical dust suppressants used at mines are magnesium chloride ($MgCl_2$) and lignosulfonate. These are used on sources such as light duty unpaved roads, tailings impoundments, and disturbed open areas. Chemical dust suppressants are not currently used on unpaved haul roads at Sierrita for several reasons. First, the crust formed by the chemicals would be short lived due to the extreme weight and crushing power of the haul trucks, weighing approximately 860,000 pounds loaded. Second, chemical dust suppressants would cause tire slippage during rainy conditions which is a safety hazard. Tire slippage is even more likely when haul trucks make turns or travel on a slope and the haul roads at Sierrita Operations have many turns and slopes. A third concern is the effect that the chemicals could have on the recovery of copper in the floatation process. Freeport-McMoRan (FMI) has performed many tests to determine the compatibility of $MgCl_2$ and lignosulfonate on the floatation processes. The majority of these tests returned results of poor compatibility and serious upsets. When used on light duty roads, chemicals are strategically placed so that runoff from these areas do not make its way to ponds where it could be pumped back into the process. In contrast, the existing in-pit haul roads will eventually be mined as the open pit is deepened and new haul roads constructed. FMI is continuing to research chemicals that could be used to control dust from unpaved haul roads, but at present none have been approved for use by FMSI.

Due to safety concerns, chemical dust suppressant on haul roads is determined to be technically infeasible.

4.1.2.4. Applying and Maintaining Surface Gravel

Although it is feasible to apply gravel to the haul road, it is infeasible to maintain it. Gravel would immediately degrade when driven on by a haul truck. Large ruts would form and haul trucks would likely slip when traveling up or down a slope. This control method will not be pursued further in this analysis due to infeasibility along with potential safety concerns.

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[11] WRAP Fugitive Dust Handbook, 2006
[12] Per EPA "*Control of Open Fugitive Dust Sources*", September 1988, pages 5-9 to 5-14.
[13] WRAP Fugitive Dust Handbook, 2006

4.1.2.5. *Covering Haul Trucks*

Covering haul trucks is another control technology suggested by ADEQ.[14] Unpaved road emissions at the Sierrita Operations exclusively correspond to the dust that becomes airborne due to the tires of the vehicles that travel on the unpaved roads. In the 1993 State Implementation Plan (SIP) for the Douglas PM_{10} Nonattainment Area, it was concluded that emissions that would be controlled by requiring haul trucks to be covered was negligible. Hence, no control efficiency was identified that can be correlated to this control method.

Covering haul trucks is a technically infeasible control option because covers are not readily available to accommodate the size of the haul trucks at the Sierrita Operations. Covers would either have to be made in-house, or a new type of cover would have to be sourced. In addition, the covers would have to accommodate the varying sizes of the material that is transferred in the haul trucks. Often times, large boulders can be placed in the haul truck which exceed the height of the bed, making it impossible to place a flat cover directly on top of the haul truck bed.

4.1.2.6. *Controlling Freeboard and Spillage*

Controlling freeboard and spillage is another control method identified by ADEQ.[15] The freeboard refers to the distance between the top of the load to the rim of the bed of the haul truck. Reducing freeboard could potentially reduce the amount of spillage onto haul roads. Unpaved road emissions at the Sierrita Operations exclusively correspond to the dust that becomes airborne due to the tires of the vehicles that travel on the unpaved roads. Material that spills from a haul truck could potentially increase the silt content on the road, although this is impossible to quantify and can reasonably be assumed to have a negligible effect.

Controlling freeboard and spillage are technically feasible control options. However, reducing freeboard would reduce the capacity hauled per truck and would require additional haul trucks to be purchased to make up for the loss in production. This would increase the total vehicle miles traveled per year and would lead to an increase in PM_{10} emissions, as well as an increase in tailpipe emissions from additional fuel combustion. Similar to the control method of covering haul trucks, emissions potentially controlled by implementing this method would be negligible; hence, no control efficiency was identified that can be correlated to this control method.

4.1.2.7. *Paving the Road Surface*

Paving the road surface is another control method identified by ADEQ.[16] Pavement has the potential to reduce PM_{10} emissions by changing the physical characteristics of the existing road surface material and forming a hardened surface that binds particles together.

Current federal laws allow vehicles up to the maximum of 80,000 pounds gross vehicle weight on the Interstate System.[17] This limit is in place to prevent serious damage to the infrastructure of the paved roads. Haul trucks at the Sierrita Operations would immediately damage any pavement due to their size since they can weigh up to 860,000 pounds (the water trucks and other trucks range in size from 62,000 pounds to 232,000 pound). Maintenance would be required on a regular basis, and ore throughput would be impacted due to the rerouting of haul

[14] Draft List of Potential PM_{10} Controls for Nonpoint Source Sectors – Non-Residential Construction Dust (Industrial, Commercial, Institutional)
[15] Ibid.
[16] Draft List of Potential PM_{10} Controls for Nonpoint Source Sectors – Paved Road Dust and Unpaved Road Dust
[17] ADOT "*Estimating the Cost of Overweight Vehicle Travel on Arizona Highways"* Final Report 528, January 2006.

trucks during maintenance of paved roads. Due to these considerations, paving haul roads is not technically feasible.

4.1.3. Rank of Remaining Control Technologies Based on Control Effectiveness

Table 4-1 lists the controls and their corresponding control efficiencies, satisfying Step 3 of the top-down analysis.

Table 4-1. Unpaved Roads - PM_{10} Control Technologies

Rank	Control Technology	Quantifiable PM_{10} Control Efficiency [1]
1	Speed Reduction	0%
2	Additional Water	0%
3	Control Freeboard/Spillage	0%

[1] PM_{10} control efficiencies calculated as detailed in Appendix A

4.1.4. Evaluation of Impacts for Remaining Control Technologies

The fourth step of the top-down control review is the impact analysis. The impact analysis considers the:

- Cost of compliance;
- Time necessary to comply with the control;
- Energy impacts and non-air quality impacts; and
- The remaining useful life of the source.

The cost of compliance in summarized in Table 4-2. The cost of compliance for all of the controls does not include a "$/ton" value as there is no quantifiable emissions reduction that could be associated with the controls. However, an annualized cost is still provided. The energy and non-air quality impacts are considered negligible for each of the controls. Per EPA guidance[18], the remaining useful life of the source is considered to be 20 years, although the concept of remaining useful source is typically used in the context of a discrete emission unit. As a haul road is a fugitive dust source and is frequently torn up and moved, they don't have a remaining useful life that can be accurately estimated. See Appendix A for the detailed analysis for the cost of compliance for each control.

[18] See EPA Control Cost Manual, Sixth Edition, page 2-26, available from http://www.epa.gov/ttncatc1/dir1/c_allchs.pdf.

Table 4-2. Unpaved Roads - Annualized Cost of Controls

	Control Method		
	Speed Reduction	Additional Water	Control Freeboard/Spillage
Tons Reduced	0	0	0
Annualized Cost ($/year)	10,419,073	1,444,266	26,047,682
$/Ton	N/A	N/A	N/A

4.2. TAILINGS – PM_{10} CONTROLS

The FMSI milling facility, commonly known as the concentrator, is designed to economically produce marketable copper and molybdenum concentrates. The valuable minerals are liberated from the ore by first crushing and grinding the ore. The free minerals are then collected into enriched concentrates by flotation. For each ton of ore FMSI processes, approximately five pounds of copper and a half pound of molybdenum are recovered in about twenty pounds of enriched material. The remaining 1,980 pounds of ground rock material is referred to as tailings.

Tailings slurry flows from the concentrator at about 25,000 gallons per minute and is about 50% solids by weight. This mixture is gravity fed through a 42-inch pipeline to a pump station located on the inactive Esperanza Tailings Impoundment. From there, the slurry is pumped to the surface of the Sierrita Tailings Impoundment. The tailings distribution pipeline system around the top of the impoundment is approximately 12.5 miles in length. The tailings impoundment itself covers an area of about 3,600 acres. It is approximately 5 miles southeast of the concentrator and is divided into two areas referred to as the North and South impoundment.

The North and South impoundments are each divided into three phases for a total of six phases. Typically, five phases are utilized for tailings deposition while the remaining phase goes through a construction period. During this period, the surface is allowed to dry to the point that it is safe for equipment to operate on it. The tailings deposition sequence can be altered due to operational necessities such as berm push, pipe lift, corrective maintenance, etc.

This section presents the step-wise review of control options for PM_{10} for tailings at the Sierrita Operations.

4.2.1. Tailings Emission Calculations

The PM_{10} emissions from windblown dust on tailings and material piles is calculated using methodology in *American Mining Report of Fugitive Dust Emission Factors for the Mining Industry* (July 1983), Pages 52-57. The emissions factor, E, in ton/acre/year, is calculated using a variety of site-specific data. This data includes the material surface moisture and silt content, annual precipitation, mean wind speed, surface roughness, and cross-sectional area exposed to wind. The exact calculation is beyond the scope of this report but results in a factor of:

$$E = 1.2307 = [\text{ton/acre/year}]$$

4.2.2. Identification of Potential Control Technologies

The following PM_{10} control technologies were identified:

- Applying additional water;
- Applying chemical dust suppressant;
- Applying crushed rock;
- Covering with tarps;
- Revegetating;
- Erecting an artificial windbreak; and
- Planting trees or shrubs as a windbreak.

To identify all feasible control technologies, the RBLC database, ADEQ guidance, as well as technical literature was reviewed. Using these sources, potentially applicable PM_{10} control technologies for tailings at the Sierrita Operations were identified based on the principles of control technology and engineering experience.

Per the permit-required Sierrita Tailings Dam Dust Control Management Plan[19], the following "precautions" are currently being utilized by FMSI:

- Use of "wet" dam construction method;
- Berm construction techniques to minimize dust emissions;
- Suitable products for stabilization of the side slopes;
- Encrustation of the surface of the impoundment;
- New tailings roads on the perimeter of the impoundment, constructed as part of pipeline lift, are capped with native dirt and treated with a dust suppressant;
- Heavily traveled light duty perimeter roads will be treated with dust suppressant (e.g. $MgCl_2$);
- Revegetation techniques used for side slope stabilization, where practical;
- Active berms and construction areas shall be sprayed with water or other dust suppressant, as necessary; and
- After heavy rainfall events (sufficient to cause surface runoff and flushing of natural dust suppressing surface salts) if the upper most layer becomes susceptible to wind erosion, a dust suppressant will be reapplied, as practicable and necessary, to the impoundment surface area requiring additional control.

Each potential control technology is described in detail below as well as its technical feasibility to satisfy Steps 1 and 2 of the top-down analysis approach.

4.2.2.1. Additional Water Application

Additional water application is not a feasible control option. The stability of the tailings impoundment is based on carefully controlling the water balance contained within the impoundment and applying additional water could affect that stability and reduce the safety of the tailings impoundment.[20] In addition, FMSI currently has an extensive $MgCl_2$ application program. FMSI typically applies 50,000 gallons of $MgCl_2$ per week to the tailings impoundment,

[19] Per FMSI response letter to Notice of Violation PC 1810-033 dated March 25, 2019.
[20] For example the Vale and Mt Poly Tailings dam failures (https://www.cdp.net/en/articles/water/risk-and-the-mining-industry-after-the-brumadinho-tailings-dam-failure)

depending on the weather. This chemical is typically applied using all-track vehicles that can travel on the drier, relatively more stable surfaces of the tailings impoundment without getting stuck, or by manual application using hand held firehoses connected to pumps. Therefore, while water application is an available[21] control option, it is not technically feasible based on the above stated considerations.

4.2.2.2. Applying Chemical Dust Suppressant

Applying chemical dust suppressant assists in the reduction of PM_{10} emissions associated with windblown dust. Chemical dust suppressants reduce PM_{10} emissions by changing the physical characteristics of the existing surface material and forming a hardened surface that binds particles together.[22]

As stated above in Section 4.2.2.1, the use of $MgCl_2$ chemical dust suppressant is already being utilized at the Sierrita tailings impoundment to the maximum extent possible, in accordance with PCC regulations and air quality permit conditions. FMSI is currently completing a dust suppressant study on the Sierrita Tailings Impoundment to investigate if different types of chemical dust suppressants could further reduce tailings impoundment emissions without jeopardizing the stability of the tailings impoundment. While additional chemical suppressant application is an available[23] control it is not applicable prior to the results of the dust suppressant study. As a result, different types of chemical suppressant application is not a technically feasible control for the Tailings Impoundment.

4.2.2.3. Applying Crushed Rock

Application of larger crushed rock onto an active tailings impoundment is an infeasible control option as it would affect the stability of the impoundment. Additionally, the gravel would be quickly covered by deposition of fresh tailings. As a result, the introduction of crushed rock is not considered an applicable control.[24]

4.2.2.4. Covering Tailings with Tarps

Covering the tailings impoundment with tarps is an infeasible control option. The sheer quantity of tarps that would be required to cover several thousand acres would be impossible to acquire, store, apply or move. Attaching the tarps to the surface of the tailings impoundment would also not be achievable due to the characteristics of the impoundment surface. This would leave the tarps susceptible to windblown removal. Finally, whenever new deposition of tailings is necessary, that portion of the impoundment would need to be uncovered or the tarps would be buried. As a result, tarp covering is an available[25] control but is not technically feasible due to the above listed physical limitations.

4.2.2.5. Revegetating

Revegetating provides partial protection from the wind thereby reducing the PM_{10} emissions associated with windblown dust.

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[21] Per EPA's 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 (Guidance) P.182
[22] WRAP Fugitive Dust Handbook, 2006 Pg 6-12
[23] Per EPA's 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 (Guidance) P.182
[24] Ibid
[25] Ibid

Revegetation would require a large amount of fertile topsoil and regular watering in order for the vegetation to survive. Organic plant material on impoundments may also create slime pockets once covered which can create stability issues. The tailings at the Sierrita Operations consist of over 3,600 acres of land. Considering the conditions of the tailings, there is not enough soil to support this control method. Additionally, the revegetation of active tailings is not possible due to consistent surface covering. As a result, revegetation is an available[26] control but is not technically feasible due to the above listed soil and surface disturbance limitations.

4.2.2.6. Erecting Artificial Windbreak

Artificial windbreaks are used to prevent the wind from reaching the disturbed dust, thus preventing particles from becoming airborne. The tailings at the Sierrita Operations utilize more than 3,600 acres of land. Constructing any sort of perimeter wind barrier to surround such an expansive area is not feasible as a windbreak could not be built high enough to reduce wind speeds sufficiently on the vast interior area of the impoundment to potentially stop dust from becoming suspended. As a result, wind breaks are an available[27] control but are not technically feasible due to the limitations for use on large areas such as the tailings impoundment.

4.2.2.7. Planting Trees or Shrubs as Windbreak

Planting trees and shrubs would provide partial protection from the wind thereby potentially reducing the PM_{10} emissions associated with windblown dust. The concerns of constructing an artificial windbreak apply to planting trees or shrubs as a windbreak as well. In addition, the soil surrounding the tailings impoundment is not conducive to plant growth as a result of mix of constituents in the tailings materials. Fresh soil would have to be brought onsite to facilitate plant growth. Also, a large quantity of water would have to be regularly transported to the tailings to support growth. As a result, vegetation windbreaks are an available[28] control but are not technically feasible due to the above listed soil and watering limitations.

4.2.3. Rank of Remaining Control Technologies Based on Control Effectiveness

Upon review of the technical feasibility of available controls, no additional controls (outside of FMSI's current enforceable controls outlined in permit-required Tailings Dam Dust Control Management Plan required in FMSI's air quality permit) are considered technically feasible for PM_{10} emissions from the FMSI tailings impoundment.

4.2.4. Evaluation of Impacts for Remaining Control Technology

The fourth step of the top-down control review is the impact analysis. The impact analysis considers the:

- Cost of compliance;
- Time necessary to comply with the control;
- Energy impacts and non-air quality impacts; and
- The remaining useful life of the source.

[26] Per EPA's 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 (Guidance) P.182
[27] Ibid
[28] Ibid

As no additional control was determined to be technically feasible for the tailings impoundment, no additional review of the 4FA components have been included for the tailings impoundment.

4.3. TRUCK LOADING/DUMPING – PM_{10} CONTROLS

Truck operations at FMSI include the routine loading, unloading and dumping of various materials. These operations have the potential to generate windblown fugitive particulate emissions. This section presents the step-wise review of control options for PM_{10} for truck loading and dumping located at FMSI.

4.3.1. Ore Handling Emission Calculations

The PM_{10} emissions from ore and waste loading and unloading are calculated from AP-42, Section 13.2.4 – Aggregate Handling and Storage Piles. The emissions factor, *E*, in lb/ton of material loaded, is calculated as follows:

$$E = 0.00112 * \frac{\left(\frac{mean\ wind\ speed\ [mph]}{5}\right)^{1.3}}{\left(\frac{material\ moisture\ content\ [\%]}{2}\right)^{1.4}} = [\text{lb/ton}]$$

The critical variables in determination of the emissions are, therefore:

- Mean wind speed (FMSI uses wind speed recorded at an onsite met station, 12.5 mph in 2018); and
- Material moisture content (FMSI uses average ore moisture, 2% in 2018)

4.3.2. Identification of Potential Control Technologies

The following PM_{10} control technologies were identified:

- Regularly applying water;
- Altering loading and unloading procedures; and
- Ceasing operations during high winds.

To identify all feasible control technologies, the RBLC database, ADEQ guidance, as well as technical literature was reviewed. Using these sources, potentially applicable PM_{10} control technologies for loading/unloading ore at FMSI were identified based on the principles of control technology and engineering experience.

Each control technology is described in detail below as well as its technical feasibility to satisfy Steps 1 and 2 of the top-down analysis approach. Where the control is deemed technically feasible, control effectiveness is also evaluated to satisfy Step 3.

4.3.2.1. Regularly Applying Water

Applying additional water is a potential control method that is feasible. Many of the locations where loading and unloading operations occur are already watered as necessary to stay in compliance with PCC and permit conditions limiting opacity. Control from the water addition, however, is not taken into account when calculating emissions from these sources. The Sierrita

Operations can operate up to 5 loading sites at a time. To apply the amount of water needed to increase the moisture content to a level that would reduce emissions on a continuous basis, Sierrita would need to employ a water truck at each loading/unloading site to ensure that the moisture content in the ore during loading and unloading procedures is sufficient.

4.3.2.2. Altering Loading and Unloading Procedures

In the context of ADEQ's non-point four-factor analysis, ADEQ has suggested altering loading and unloading procedures, such as loading trucks on the downwind side of loading equipment. This is a control option presumably because the loading equipment itself forms a windbreak. While this may be feasible with the types of equipment seen in the aggregate industry, the massive electric shovels and haul trucks used in the copper mining industry cannot be moved whenever the wind shifts directions. This would not be a feasible control at Sierrita.

4.3.2.3. Ceasing Operations During High Winds

Ceasing operations during high winds (sustained wind speeds over 25 mph[29]) is a potential control method used to reduce PM_{10} emissions that is feasible. This would reduce calculated emissions by assuming there are no emissions from loading and unloading during high winds. Loading and unloading operations are critical to the operation of the mine and ceasing operations during high wind speeds would shut down production.

4.3.3. Rank of Remaining Control Technologies Based on Control Effectiveness

Table 4-3 lists the remaining controls and their corresponding control efficiencies.

Table 4-3. Truck Loading/Unloading - Remaining PM_{10} Control Technologies

Rank	Control Technology	Potential PM_{10} Control Efficiency [1]
1	Regular Water Application	71%
2	Limit Operations During High Winds	1%

[1] PM_{10} control efficiencies calculated as detailed in Appendix A

4.3.4. Evaluation of Impacts for Remaining Control Technology

The fourth step of the top-down control review is the impact analysis. The impact analysis considers the:

- Cost of compliance;
- Time necessary to comply with the control;
- Energy impacts and non-air quality impacts; and
- The remaining useful life of the source.

The cost of compliance in summarized in Table 4-4. The energy and non-air quality impacts are considered negligible for each of the controls. Per EPA guidance, the remaining useful life of the source is considered to be 20 years, although the concept of remaining useful source is typically used in the context of a discrete emission unit. See Appendix A for the detailed analysis for the cost of compliance for each control.

[29] WRAP Fugitive Dust Handbook, 2006 Pg 11-13

Table 4-4. Truck Loading/Unloading - Annualized Cost of Controls

	Control Method	
	Regular Water Application	Limiting Operations During High Winds
Tons Reduced	57.73	0.66
Annualized Cost ($/year)	1,730,080	5,349,315
$/Ton	29,968	8,076,145

4.4. BLASTING OPERATIONS – NO_X CONTROLS

This section presents the step-wise review of control options for NO_x for blasting operations at the Sierrita Operations.

4.4.1. Blasting Operations Emission Calculations

The NO_x emissions from blasting is calculated using AP-42 Table 13.3-1. The emissions factor, *E*, is a constant value of 17 lb/ton of ammonium nitrate/fuel oil (ANFO) used. No other variables are used in the determination of NO_x emissions from blasting.

4.4.2. Identification of Potential Control Technologies

Emissions from blasting are released rapidly and in high concentrations that dissipate out of the mine area in gas plumes.[30] A review of the RBLC and relevant literature[31,32,33] and FMSI's internal blasting engineering knowledge, was unable to identify any technically feasible NO_x control options for blasting. Hence, the remaining steps of the top-down analysis will not be discussed. Note that FMSI will continue to perform blasting operations per best blasting practices.

[30] *NO_x Emission of Equipment and Blasting Agents in Surface Mining,* January 2013

[31] Lashgari, A. et al. (2013) *NOx Emission of Equipment and Blasting Agents in Surface Coal Mining, Mining Engineering*, Vol. 65, No. 10, pp. 34-41.

[32] Rowland, J.H. and Mainiero, R.J. *Factors Affecting ANFO Fumes Production,* Proceedings of the 26th Annual Conference on Explosives and Blasting Technique (Anaheim, CA, Feb. 13-16, 2000). Vol. 1. Cleveland, OH: International Society of Explosives Engineers, 2000 Feb; 163-174.

[33] Sapko, M.J. et al. *Chemical and Physical Factors that Influence NOx Production During Blasting: Exploratory Study*, Proceedings of the 28th Annual Conference on Explosives and Blasting Technique (Las Vegas, NV, Feb. 10-13, 2002). Vol. 2. Cleveland, OH: International Society of Explosives Engineers, 2002 Feb; :317-330.

Pursuant to EPA guidance,[34] a back-trajectory analysis was completed to determine if the emissions from the Sierrita Operations might affect visibility at the nearest Class I area. For the Sierrita Operations, the assessment was completed for possible impacts at the Saguaro National Park. The trajectory analysis was completed using the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model based on ADEQ feedback and guidance regarding details of model execution.[35]

5.1. HYSPLIT MODEL - OVERVIEW

HYSPLIT is a hybrid model using both the Lagrangian approach, which uses a moving frame of reference for the advection and diffusion calculations as the trajectories or air parcels move from their initial location, and the Eulerian methodology, which uses a fixed three-dimensional grid as a frame of reference to compute pollutant air concentrations. The dispersion of a pollutant is calculated by assuming either puff or particle dispersion. The back-trajectory analysis utilized applies a particle model, where a fixed number of particles are advected about the model domain by the mean wind field and spread by a turbulent component. The model's default configuration assumes a 3-dimensional particle distribution (horizontal and vertical).

5.2. HYSPLIT MODEL - EXECUTION DETAILS

HYSPLIT was applied in back-trajectory mode with the starting location as the Class I Interagency Monitoring of Protected Visual Environments (IMPROVE) monitor location or the approximate center of the Class I area if IMPROVE data was not available. The starting locations listed below were used for this analysis.

Table 5-1. HYSPLIT Assessment Locations

Class I Area	Assessment Location		
	Monitor Name	Latitude	Longitude
Saguaro National Park	Saguaro West	32.2487	-111.2185
	Saguaro East	32.1745	-110.7371

While EPA[36] and ADEQ guidance[37] recommend a 72-hour look back period, a 48-hour look back period was more than adequate to capture the back trajectories given the short distances between the Class I area and the source, as the figures show the 48-hour period was sufficient for the plume to travel out of the general area of the source and often out of the state. The sigma height option was used with an initial target height of 0.5 sigma per ADEQ recommendation.[38] ADEQ provided a list of MIDs and a 5 year look back period from 2014 – 2018 was analyzed. Per ADEQ recommendation,[39] each hour of the MID was run (24 runs per day).

[34] EPA Memorandum, "*Guidance on Regional Haze State Implementation Plans for the Second Implementation Period*," Section II.B.3, August 20, 2019
[35] Based on multiple email communications between Stephen Ochs, Trinity Consultants, and Hao Zhou, ADEQ, in November 2019.
[36] EPA Memorandum, "*Guidance on Regional Haze State Implementation Plans for the Second Implementation Period*," Section II.B.3, August 20, 2019
[37] Ibid.
[38] Based on multiple email communications between Stephen Ochs, Trinity Consultants, and Hao Zhou, ADEQ, in November 2019.
[39] Ibid.

5.3. HYSPLIT MODEL - RESULTS

ArcGIS shape files of the trajectory hourly location (points) and path (lines) were created for each hourly run. A plot showing the percentage of the back-trajectory paths that pass within a 1 km x 1 km grid centered around Sierrita Operations was produced using all hourly MID back trajectories over the 5-year period, and is contained in Appendix B. For example, approximately 2,700 back-trajectory paths were created for MIDs in the 5-year assessment period for Saguaro National Park. However, less than 2% of these paths entered the 1 km x 1 km grid centered around the Saguaro National Park. Therefore, the plot indicates the probability of emissions from the Sierrita Operations impacting the Saguaro National Park is between 0.5% and 2.0%.

APPENDIX A: FOUR FACTOR ANALYSIS WORKSHEETS

Table A-1a. FMI - Sierrita - RH 2PP - 4FA - Summary - PM_{10} Sources with Feasible Controls

Source Characteristics		Baseline Operations		Baseline Emissions
Type	**Sierrita ID**	**2016 - 2018 Avg. Throughput**	**Unit**	**(tpy) [1]**
Unpaved Roads	77	1,749,351	VMT	449.3
Truck Load/Dump	97	57,882,719	tons/year	81.7

[1] Baseline emissions per 2028 projections.

Table A-1b. FMI - Sierrita - Inputs

Parameter	Value	Units	Notes
Estimated yearly revenue from Sierrita Operations	660,000,000	USD/year	Based on 2018 revenue
Number of haul trucks in fleet	22		Per Mine Engineering
Number of water trucks in fleet	4		Per Mine Engineering
Average cost of haul trucks	4,500,000	$/truck	Estimate per haul truck maintenance team
Average cost to rebuild haul truck	2,000,000	$/rebuild	Estimate per haul truck maintenance team
Average cost of water trucks	2,500,000	$/truck	Estimate per haul truck maintenance team
Average capacity of water trucks	23,750	gallons	Two 30,000 gallon trucks, one 20,000 gallon truck, and one 15,000 gallon trucks.
Annual water usage on roads	7,315,000	gallons/year	Based on average of September and October 2019 water truck logs
Annual spending on water for dust control	50,168	USD/year	Calculated using water rate per ton
Height of haul truck bed	8	ft	Estimated
Average height of the pile of rock over the rim of the bed	6	ft	Per Dispatch
Speed reduction if using traffic management as a control	15%		Assumed 15% speed reduction.
Increase in volume of water added to unpaved roads	100%		Per EPA "Dust Suppression on Wyoming's Coal Mine Haul Roads". 2.5x the amount of water is needed to increase control efficiency from 75% to 95%. FMSI already utilizes an 90% control efficiency. So, for illustrative purposes, it was assumed that twice the amount of water would be necessary.
Amount of freeboard to achieve control	0.25	ft	
Annual hours above the high wind threshold (25 mph)	71	hours	Per 2018 met data
Cost of water in Tucson	0.007	$/gal	https://www.tucsonaz.gov/water/residential-rates-and-monthly-charges

Table A-2a. FMI - Sierrita - RH 2PP - 4FA - Unpaved Roads In Pit

Parameter		Speed Reduction		Additional Water Application		Control Freeboard and Spillage	
Value	**Units**	**Value**	**Reference**	**Value**	**Reference**	**Value**	**Reference**
Potential PM_{10} Reduction							
PM_{10} Reduction	%	0%	[9]	0%	Calculated	0%	[9]
PM_{10} - baseline	tpy	449	[1]	449	[1]	449	[1]
PM_{10} - post control	tpy	449	Calculated	449	[7]	449	Calculated
PM_{10} Reduced	tpy	0.0	Calculated	0.0	Calculated	0.0	Calculated
Capital Implementation Costs							
Total Capital Cost	$	$18,000,000	[5]	$10,000,000	[6] , [10]	$45,000,000	[5] , [8]
Capital Recovery Factor	%	9.44%	[2]	9.44%	[2]	9.44%	[2]
Annualized Cost	$/yr	$1,699,073	Calculated	$943,929	Calculated	$4,247,682	Calculated
Admin, Taxes, Insurance	$/yr	$720,000	[3]	$400,000	[3]	$1,800,000	[3]
Operating Cost	$/yr	$8,000,000	[4]	$100,337	[10]	$20,000,000	[4]
Total Annual Cost	$/yr	$10,419,073	Calculated	$1,444,266	Calculated	$26,047,682	Calculated
Cost of Compliance (Statutory Factor 1)							
Cost of Control	$/ton removed	ND	[11]	ND	[11]	ND	[11]

[1] 2028 Projected Emissions per ADEQ Emissions Projection Methodology

[2] Capital Recovery factor (CRF) calculated as follows

Interest Rate	7%
Remaining useful life of source	20
Capital Recovery Factor	9.44%

Note that the number of years corresponds to the remaining life of the unit after 2028, the earliest time that controls are expected to be installed. Per EPA "Guidance on Regional Haze State Implementation

Plans for the Second Implementation Period" dated August 20, 2019:

"Typically, the remaining useful life of the source itself will be longer than the useful life of the emission control system under consideration unless there is an enforceable requirement for the source to cease operation sooner ... annualized compliance costs are typically based on the useful life of the control equipment rather than the life of the source, unless the source is under an enforceable requirement to cease operation"

[3] Admin, Taxes, Insurance assumed to be: 4.00% Per EPA Air Pollution Control Cost Manual, Seventh Ed., 2017, Sect. 2.6.5.8, pg 2-35

[4] Per haul truck maintenance staff, each haul truck must undergo a scheduled rebuild every 12 - 16 months costing $2 million. For purposes of this calculation, it was assumed that the maintenance cost would be $2 million per year.

Table A-2a. FMI - Sierrita - RH 2PP - 4FA - Unpaved Roads In Pit

Parameter		Speed Reduction		Additional Water Application		Control Freeboard and Spillage	
Value	Units	Value	Reference	Value	Reference	Value	Reference

[5] Calculated based on the amount that the control would slow down the production process, since haul truck travel is a bottleneck process. The cost reflects the number of additional new haul trucks needed to make up for the slowdown in production rate. Cost of new haul trucks = cost per new truck * # of current trucks * %speed reduction (or %load reduction). The calculated number of new haul trucks required is rounded up to the nearest integer. It is assumed that the decrease in production rate is proportional to the decrease in speed. Additionally, it is assumed that the majority of the "unpaved road" emissions emanate from the haul trucks.

[6] Calculated based on the number of additional water trucks to be purchased to fulfill greater water application requirements. Water trucks are currently used at full capacity during the summer months.

[7] FMSI currently implements a 90% control efficiency. The post control emission rate as well as the emission reductions take this into account. It is FMSI's understanding that 90% is the highest control efficiency that will be accepted by ADEQ.

[8] When adding freeboard: % load reduction= new height of material in haul truck/current height of material in haul truck = 44.6%

[9] Emissions for unpaved road travel based on AP-42 Section 13.2.2, Equation 1a, which incorporates silt content and weight of the vehicle. This control method would have no impact on the emission factor and would not reduce emissions based on Equation 1a.

[10] Per EPA "Dust Suppression on Wyoming's Coal Mine Haul Roads", 2.5x the amount of water is needed to increase control efficiency from 75% to 95%. Sierrita already utilizes a 90% control efficiency. So, for illustrative purposes, it was assumed that twice the amount of water would be necessary.

[11] A "$/ton" amount could not be calculated as there is no control efficiency related to this control; hence, PM_{10} emissions are not reduced.

Table A-2b. FMI - Sierrita - RH 2PP - 4FA - Haul Truck Loading and Dumping

Parameter		Regular Water Application		Ceasing Operations During High Winds	
Value	**Units**	**Value**	**Reference**	**Value**	**Reference**
Potential PM_{10} Reduction					
PM_{10} Reduction	%	71%	[4]	0.81%	[8]
PM_{10} - baseline	tpy	81.72	[1]	81.72	[1]
PM_{10} - post control	tpy	23.99	Calculated	81.06	Calculated
PM_{10} Reduced	tpy	57.73	Calculated	0.66	Calculated
Capital Implementation Costs					
Total Cost	$	$12,500,000	[5]	-	-
Capital Recovery Factor	%	9.44%	[2]	-	-
Annualized Cost	$/yr	$1,179,912	Calculated	-	-
Admin, Taxes, Insurance	$/yr	$500,000	[3]	-	-
Operating Cost	$/yr	$50,168	[7]	$5,349,315	[6]
Total Annual Cost	$/yr	$1,730,080	Calculated	$5,349,315	Calculated

Table A-2b. FMI - Sierrita - RH 2PP - 4FA - Haul Truck Loading and Dumping

Parameter		Regular Water Application		Ceasing Operations During High Winds	
Value	**Units**	**Value**	**Reference**	**Value**	**Reference**
Cost of Compliance (Statutory Factor 1)					
Cost of Control	$/ton removed	$29,968	Calculated	$8,076,145	Calculated

[1] 2028 Projected Emissions per ADEQ Emissions Projection Methodology

[2] Capital Recovery factor (CRF) calculated as follows

Interest Rate	7%
Remaining useful life of source	20
Capital Recovery Factor	9.44%

Note that the number of years corresponds to the remaining life of the unit after 2028, the earliest time that controls are expected to be installed. Per EPA "Guidance on Regional Haze State Implementation Plans for the Second Implementation Period" dated August 20, 2019:

"Typically, the remaining useful life of the source itself will be longer than the useful life of the emission control system under consideration unless there is an enforceable requirement for the source to cease operation sooner ... annualized compliance costs are typically based on the useful life of the control equipment rather than the life of the source, unless the source is under an enforceable requirement to cease operation"

[3] Admin, Taxes, Insurance assumed to be:	4.00%	Per EPA Air Pollution Control Cost Manual, Seventh Ed., 2017, Sect. 2.6.5.8, pg 2-35

[4] Control efficiency based on highest achievable moisture content as seen in AP-42 Section 13.2.4 applied to the emission factor and compared to the old emission factor:

Original moisture content:	2	%
New moisture content:	4.8	%

[5] Assumes that a new water truck must be purchased for each loading site (maximum of five) in order to keep material saturated.

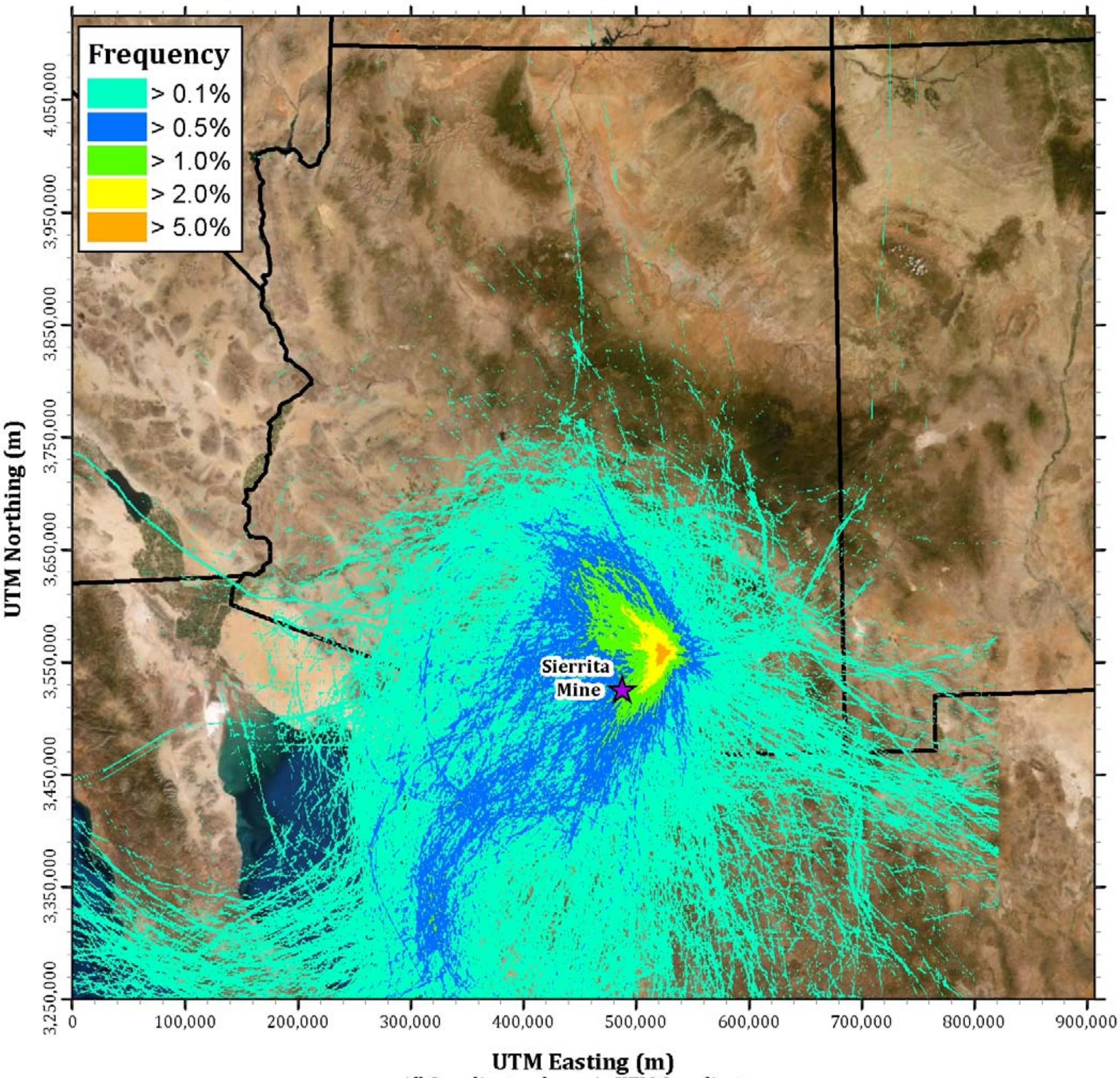
[6] Operating cost per cost of lost revenue to not operate during hours where wind speed exceeds 25 mph. Number of hours that exceed 25 mph is estimated based on 2018 on-site Met Data.

[7] Per EPA "Dust Suppression on Wyoming's Coal Mine Haul Roads", 2.5x the amount of water is needed to increase control efficiency from 75% to 95%. FMSI already utilizes a 90% control efficiency. So, for illustrative purposes, it was assumed that twice the amount of water would be necessary.

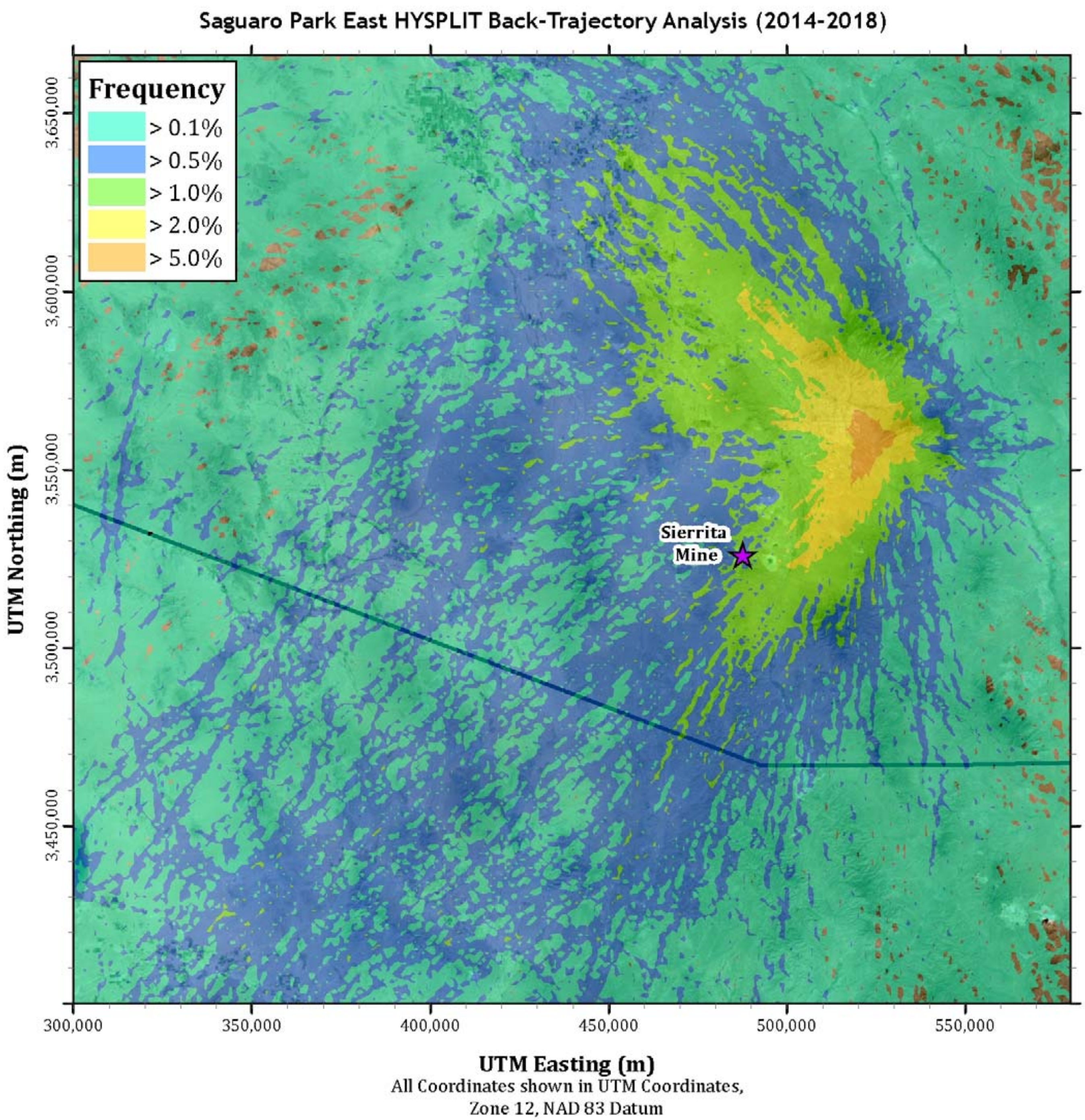
[8] Control efficiency based on proportion of hours that loading operations would not be ceased.

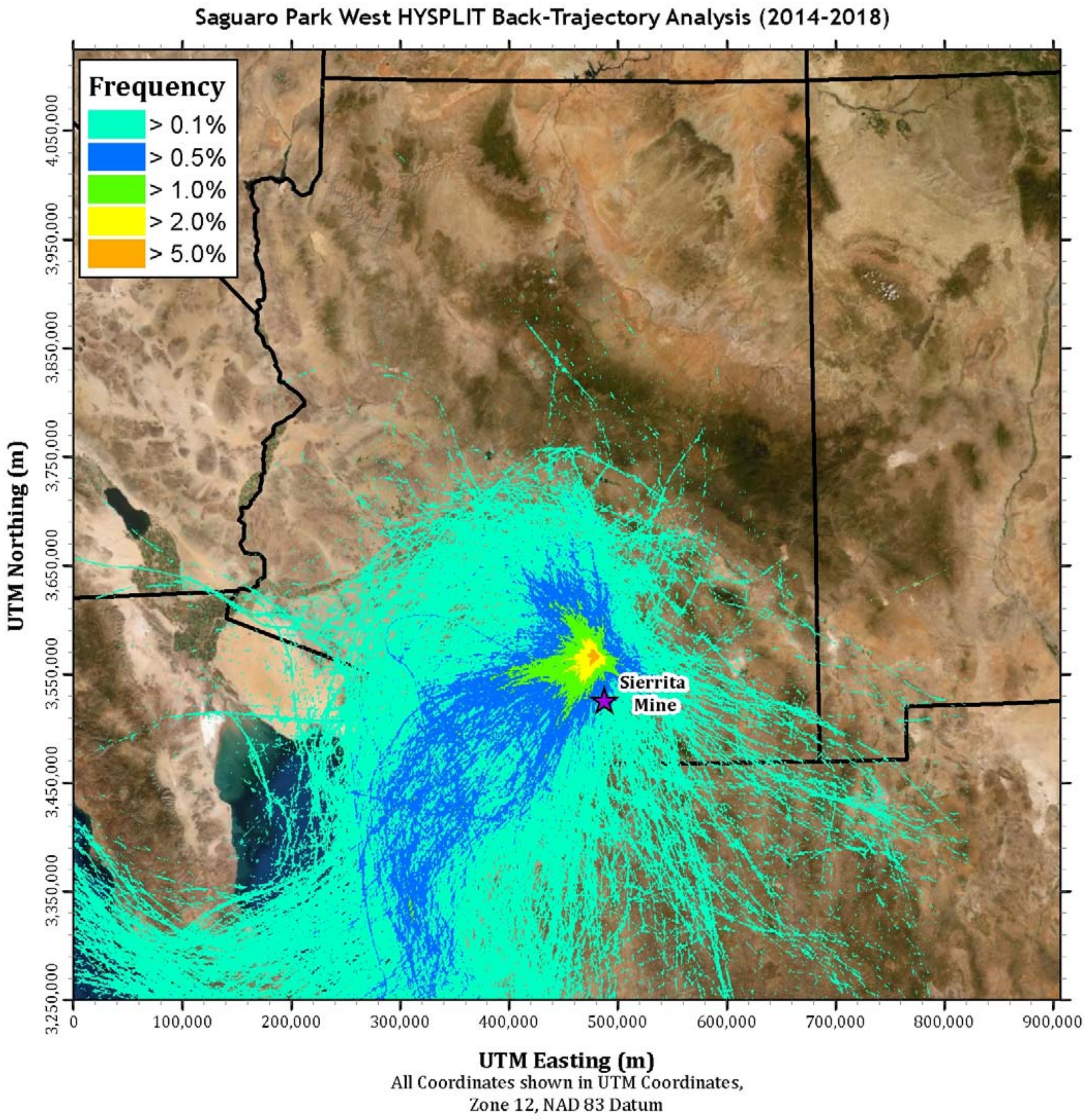
APPENDIX B: HYSPLIT ANALYSIS

Saguaro Park East HYSPLIT Back-Trajectory Analysis (2014-2018)

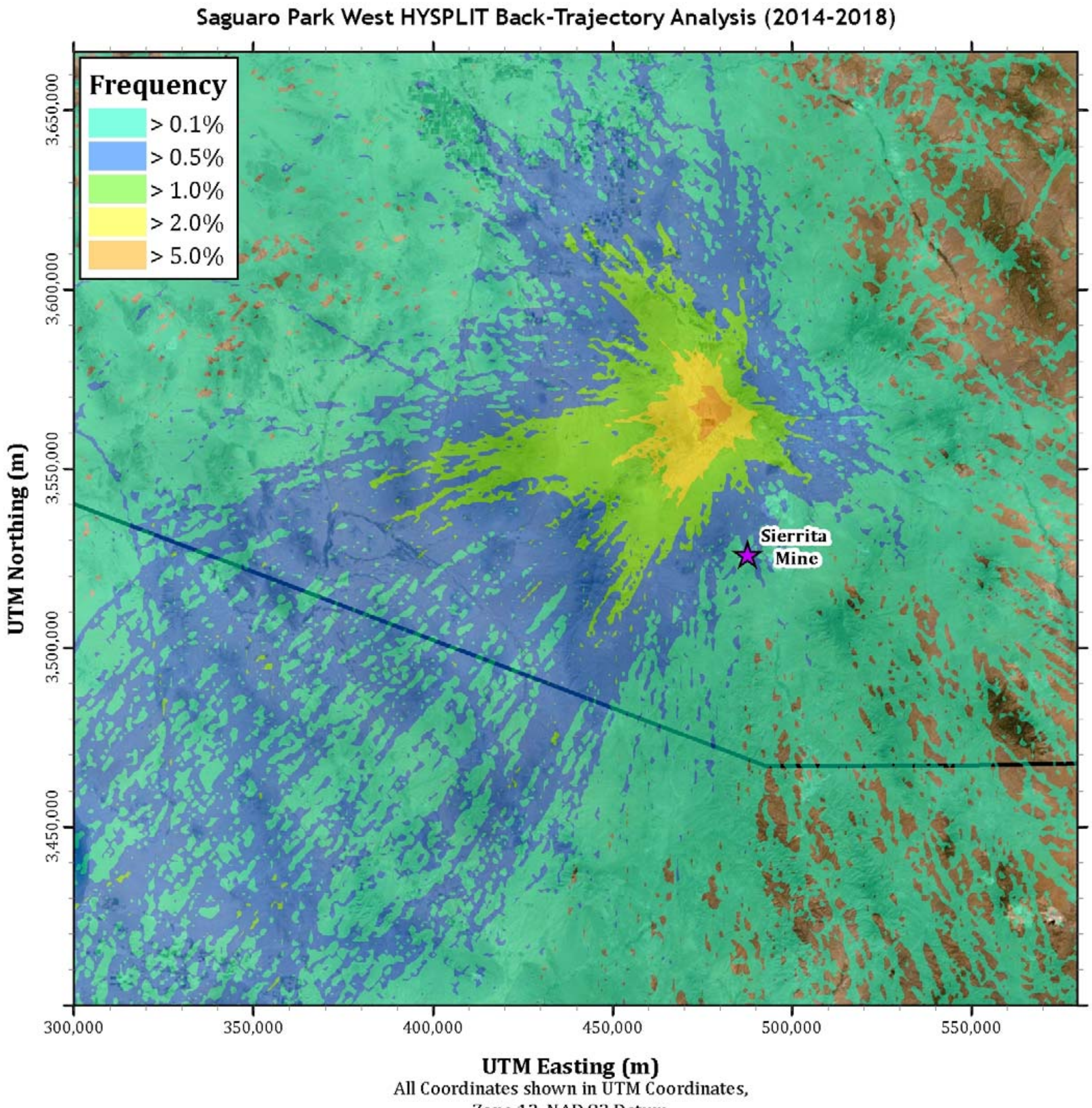


All Coordinates shown in UTM Coordinates,
Zone 12, NAD 83 Datum


Saguaro Park East HYSPLIT Back-Trajectory Analysis (2014-2018)
Frequency
> 0.1%
> 0.5%
> 1.0%
> 2.0%
> 5.0%
Sierrita Mine
UTM Northing (m)
3,650,000
3,600,000
3,550,000
3,500,000
3,450,000
300,000
350,000
400,000
450,000
500,000
550,000
UTM Easting (m)
All Coordinates shown in UTM Coordinates,
Zone 12, NAD 83 Datum



All Coordinates shown in UTM Coordinates,
Zone 12, NAD 83 Datum



All Coordinates shown in UTM Coordinates,
Zone 12, NAD 83 Datum