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Subject	Twin Pines Minerals, LLC Saunders Demonstration Mine Acoustical Analysis
Attention	Lewis Jones/Jones Fortuna LP
From	Mark Bastasch, P.E. (OR), INCE Bd. Cert.
Date	DRAFT: September 04, 2020 FINAL: October 2, 2023

1. Executive Summary

Jacobs was retained to assess potential sound levels at the Okefenokee National Wildlife Refuge and Okefenokee Wilderness Area from the proposed Saunders Demonstration Mine. Using assumptions and model inputs, as described throughout this memo, the predicted sound level at the boundary of the Wildlife Refuge and Wilderness Area is 40 A-weighted decibels (dBA), which is comparable to the sound level inside a quiet library or office. The sound level from the Saunders Demonstration Mine at more distant locations *within* the refuge and wilderness area will be less. The small motorboats that are permitted to operate within the Wildlife Refuge and Wilderness Areas can be reasonably expected to result in noise levels greater than 40 dBA in the areas they operate.

2. Introduction

Twin Pines Minerals, LLC proposes to mine heavy mineral sands from a 582-acre site located approximately 3 miles west of St. George in Charlton County, Georgia. The mining operation involves excavating mineral bearing sands from a pit that is approximately 100 feet wide that advances at an average rate of 115 feet a day. Mining of the site is estimated to take 4 years to complete. A conveyor system will transport the excavated materials from the mining pit to a wet concentration plant (WCP) located east of the mining area. After the heavy minerals have been removed from the sand, a conveyor will move the tailings back to the excavation site, where they will be used to refill the excavated area that will then be restored. The heavy minerals extracted at the WCP will be transported to a mineral separation plant (MSP) located southeast of the mined area, at the site of a former chip mill located on the south side of SR-94. After final separation, the minerals will be shipped by truck or by rail from a rail loadout facility to be developed on the Georgia Southern and Florida rail line running south of the MSP.

As indicated on Figure 1, the proposed Saunders Demonstration Mine site and its associated processing facilities are located approximately 2.9 miles southeast of the southeastern boundary of the Okefenokee National Wildlife Refuge. The mine site also lies within 2.9 miles from the closest boundary of the Okefenokee National Wilderness Area, a federally designated wilderness area located within the boundaries of the Wildlife Refuge, which encompasses a large portion, but not all the land in the Wildlife

Refuge. Recreational activities within the Wildlife Refuge include canoeing as well as small motorboat (less than 10 horsepower) and train tours. The closest overnight recreational area is the Monkey Lake Overnight Shelter which is 11 miles from the project area. In response to the mine proposal, members of the public and advocacy groups have raised concerns about the impact of sound levels from the proposed mine on the Okefenokee Wilderness Area.

The purpose of this memorandum is to provide some background information for understanding acoustics and document the sound levels that are anticipated from operation of the mine.

3. Project Area and Description

Figure 1 depicts the location of the proposed Saunders Demonstration Mine project site in relation to the boundaries of the Okefenokee National Wildlife Refuge, Okefenokee National Wilderness Area, and the Monkey Lake Overnight Shelter. Figure 2 is a site plan of the proposed mine project that highlights the locations where the primary noise generating equipment will be located.

3.1 Mining Area

The mining area encompasses approximately 582 acres. As shown by the colored bands on the mining area on Figure 2, mining of the site will proceed systematically over an estimated 4-year period. During this time, the area being actively excavated will consist of a trench that is approximately 100 feet wide and 500 feet long. Because the excavated area will be refilled as the mining process proceeds, the location of the active mining pit will shift over time, but its dimensions will remain approximately the same. The material from the mine will be excavated using a dragline, which is essentially a large electric crane used for digging and dumping. Because the location of the excavation area will be shifting over time, the distance of this area from the Wildlife Refuge, Wilderness Area, and overnight shelter shift over time as well. At its closest, when the excavation is taking place in the mining area's northwest corner during Year 4, the excavation area will be 2.9 miles from the boundary of the Wildlife Refuge and Wilderness Area, and 11 miles from Monkey Lake Overnight Shelter. At its farthest, when the excavation is taking place in the southeast corner of the mining area during Year 1, these distances will be 4.5 and over 12.5 miles, respectively.

Modeling assumed all mining area equipment was operating in the northwest corner of the mining area closest to the Wildlife Refuge and Wilderness Area. The equipment modeled consisted of three dozers, three track hoes, two trucks, one drill rig, four skid-steer loaders, and one crane. The reference sound levels for this equipment vary between approximately 80 to 85 dBA at 50 feet. For the purposes of this analysis, it was conservatively assumed all equipment was operating simultaneously with a reference sound level of 85 dBA at 50 feet. It was further conservatively assumed that the sound was concentrated in the 250 Hertz octave band, a frequency band that is not subject to substantial atmospheric absorption.

Two electrically driven conveyor systems will extend from the area being excavated to the WCP. One of the conveyors will transport the mined material to the WCP. The other conveyor will transport the tailings back to the excavation, where they will be returned. As the precise configuration will be determined during detailed design and will shift as the mining/reclamation process progresses, the overall sound level from conveyance equipment was treated as a uniform line source having an overall sound level equivalent to 10 drop points each, yielding 73 dBA at 50 feet.

3.2 Wet Concentration Plant

The WCP is located approximately 4.0 miles from the closest boundary of the Wildlife Refuge and Wilderness Area, and approximately 11.9 miles from Monkey Lake Overnight Shelter. The WCP will be a several-story, open structure that comprises electrically-driven pumps and motors. Hearing projection is not required within the WCP as it complies with the typical Occupational Safety and Health (OSHA) action level for hearing protection, 85 dBA, assuming an 8-hour workday. Nonetheless, a sound level of 85 dBA in this area was assumed to be a conservative estimation of the average sound level with no shielding from intervening structures or equipment, an additional conservative approach.

3.3 Mineral Separation Plant

The MSP will be located southeast of the mining area and south of SR-94 at a site formerly used as a wood chip mill. The MSP site is located approximately 5.1 miles from the closest boundary of the Wildlife Refuge and Wilderness Area, and approximately 12.9 miles from Monkey Lake Overnight Shelter. This area will consist of the MSP and an office building and associated transportation facilities (weigh scales and truck loading area, a train loadout facility, and a parking area). Similar to the WCP, hearing protection is not required within the MSP as it complies with the typical OSHA action level for hearing protection. Nonetheless, a sound level of 85 dBA in this area was presumed to be a conservative estimation of the average sound level with no shielding from intervening structures or equipment assumed, an additional conservative approach.

3.4 Fuel Storage Area

A fuel storage area will be located on the WCP access road, halfway between SR-94 and the WCP. This facility is located approximately 4.4 miles from the closest boundary of the Wildlife Refuge and Wilderness Area, and approximately 12.3 miles from Monkey Lake Overnight Shelter. As this is primarily a storage area, noise generating activities will be very limited and associated with sporadic traffic for fuel loading and unloading/dispensing. The sound from this area was presumed to be minimal compared to the other areas and was not included in the modeling.

4. Fundamentals of Acoustics

Acoustics is the study of sound, and noise is defined as unwanted sound. Airborne sound is a rapid fluctuation or oscillation of air pressure above and below atmospheric pressure creating a sound wave. Acoustical terms used in this evaluation are defined in Table 1.

Table 1. Definitions of Acoustical Terms

Term	Definition
Ambient noise level	The composite of noise from all sources near and far. The normal or existing level of environmental noise or sound at a given location. The ambient noise level is typically defined by the L_{eq} level.
Sound pressure (noise) level decibel (dB)	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).

Table 1. Definitions of Acoustical Terms

Term	Definition
A-weighted sound pressure (noise) level (dBA)	The sound level in decibels as measured on a sound level meter using the A-weighted filter network. The A-weighted filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound (noise) levels in this report are A-weighted.
Equivalent Noise Level (L_{eq})	The average A-weighted noise level, on an equal energy basis, during the measurement period.
Day-night noise level (L_{dn} or DNL)	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 dBs from 10:00 p.m. to 7:00 a.m.

A-weighted sound levels are typically measured or presented as equivalent noise level (L_{eq}), defined as the average sound level on an equal-energy basis for a stated period of time. Some metrics used in determining the impact of environmental noise consider the different response of people to daytime and nighttime noise levels. During the nighttime, exterior background noises are generally lower than the daytime levels. However, most household noise also decreases at night, and exterior noise becomes more noticeable. Furthermore, most people sleep at night and are sensitive to intrusive noises. To account for human sensitivity to nighttime noise levels, the day-night sound level (L_{dn} or DNL) was developed. L_{dn} is a noise index that accounts for the greater annoyance of noise during the nighttime hours.

L_{dn} values are calculated by averaging hourly L_{eq} sound levels for a 24-hour period and applying a weighting factor of 10 decibels (dBs) to nighttime L_{eq} values. The weighting factor, which reflects the increased sensitivity to noise during nighttime hours, is added to each hourly L_{eq} sound level before the 24-hour L_{dn} is calculated. For the purposes of assessing noise, the 24-hour day is divided into two time periods, with the following weightings:

- Daytime: 7 a.m. to 10 p.m. (15 hours) weighting factor of 0 dB
- Nighttime: 10 p.m. to 7 a.m. (9 hours) weighting factor of 10 dB

The two time periods are averaged to compute the overall L_{dn} value. For a continuous noise source, the L_{dn} value is computed by adding 6.4 dBA to the overall 24-hour noise level (L_{eq}). For example, if the expected continuous noise level from a noise source is 60.0 dBA, the resulting L_{dn} from the facility would be 66.4 dBA.

The effects of noise on people can be listed in three general categories:

1. Subjective effects of annoyance, nuisance, and dissatisfaction
2. Interference with activities such as speech, sleep, and learning
3. Physiological effects such as startling and hearing loss

In most cases, environmental noise produces effects in the first two categories only. However, workers in industrial plants may experience noise effects in the third category. No completely satisfactory way exists to measure the subjective effects of noise or to measure the corresponding reactions of annoyance and dissatisfaction. This lack of a common standard is primarily due to the wide variation in individual thresholds of annoyance and habituation to noise.

Table 2 depicts the relative A-weighted noise levels of common sounds measured in the environment and in industry for various sound levels.

Table 2. Summary of Typical Sound Levels

Sound	Loudness compared to 70 dB		Decibels
Stock car race, jackhammer, air raid siren		PAINFUL	130
Jet plane at ramp, ambulance siren	32X		120
Rock concert, power saw, crying baby	16X	EXTREMELY LOUD	110
Factory machinery, sporting event			100
Tractor, leaf blower, food processor	4X		90
Alarm clock, lawn mower, doorbell		VERY LOUD	80
Vacuum cleaner, washing machine		LOUD	70
Normal conversation, sewing machine			60
Rainfall, large office	1/4 X		50
Quiet library, quiet office		FAINT	40
Soft whisper	1/16 X		30
Ticking watch			20

Source: American Academy of Otolaryngology (https://www.entnet.org/content/block-out-noise); Centers for Disease Control and Prevention (https://www.cdc.gov/vitalsigns/hearingloss/infographic.html#infographic); Center for Hearing and Communication (http://chchearing.org/noise/common-environmental-noise-levels/), Hearing Sense (http://hearingsense.com.au/hearing-tests-services/ear-protection/).

Areas with active railroads will also typically experience periodic noise from locomotives, railcars as well as train horns at crossings. The Federal Railroad Administration (FRA) summarizes the Train Horn Rule (49 CFR Part 222) as requiring the use of horns at least 15 seconds, and no more than 20 seconds, in advance of all public grade crossings or within ¼ mile of the crossing, when a train is traveling faster than 60 mph. The maximum volume level for the train horn is 110 decibels at 100 feet while the minimum sound level is 96 decibels.

Noise levels from construction equipment are provided in the Federal Transit Administration (FTA) *Transit Noise and Vibration Impact Assessment Manual* (FTA, 2018). This manual represents the most recent and comprehensive tabulation of noise from common pieces of construction equipment. The noise levels from the FTA manual are presented in Table 3.

Table 3. Construction Equipment Noise Emission Levels

Equipment	Typical Noise Level 50 feet from Source, dBA	Equipment	Typical Noise Level 50 feet from Source, dBA
Air compressor	80	Pile-driver (Impact)	101
Backhoe	80	Pile-driver (Sonic)	95
Ballast equalizer	82	Pneumatic tool	85
Ballast tamper	83	Pump	77
Compactor	82	Rail saw	90
Concrete mixer	85	Rock drill	95
Concrete pump	82	Roller	85
Concrete vibrator	76	Saw	76
Crane, derrick	88	Scarifier	83
Crane, mobile	83	Scraper	85
Dozer	85	Shovel	82
Generator	82	Spike driver	77
Grader	85	Tie cutter	84
Impact wrench	85	Tie handler	80
Jack hammer	88	Tie inserter	85
Loader	80	Truck	84
Paver	85		

Source: Table 7-1, FTA, 2018

Note that pile driving (impact or sonic), rail saw, and rock drilling are not anticipated for this project. Rather, the 85 dBA sound level used for the equipment identified for this project is reasonable, if not somewhat conservative, for the type of equipment likely to be used.

5. Modeling Methods

The commercial software used to prepare the acoustical model is Cadna/A by DataKustik GmbH. The sound propagation factors used in the acoustical model have been adopted from International Organization for Standardization (ISO) 9613-2, Acoustics—Sound Attenuation During Propagation Outdoors Part 2: General Method of Calculation (1996). Cadna/A as well as ISO 9613-2 have been used by researchers and regulatory bodies worldwide to model complex outdoor facilities. The ISO 9613-2 method is based on an omnidirectional downwind condition. That is, the sound prediction algorithms assume every point at which sound level is calculated is downwind of all noise-emitting equipment simultaneously. In essence, the prediction assumes each receiver or prediction point is a “black hole” and the wind is blowing from each source and into this black hole. While this is physically impossible, the ISO 9613-2 model has been widely and successfully used to develop acoustical models for industrial facilities. Numerous agencies and regulatory bodies rely on properly conducted ISO 9613-2 modeling. The ISO 9613-2 parameters used in this assessment are a receptor height of 1.5 meters and mixed ground (G = 0.5, where G may vary between 0 for hard pavement or water and 1 for acoustically absorptive ground such as plowed earth).

6. Results and Discussion

Figure 3 presents the predicted sound level contours based on the analysis described herein. With the mining activity concentrated in the northwest corner of the mine, the predicted sound level at the closest corner of the wildlife refuge is 40 dBA. Lower sound levels are anticipated when the mining activity is occurring in more distant areas of the mine, and the farther that you move into the Wilderness Area. Also, note that the sound levels at the Monkey Lake Overnight Shelter, which is the closest access point where significant human activity exists in the Wilderness Area, is an additional eight miles beyond the boundary of the refuge, resulting in substantially lower sound levels. Modeled sound levels of the WCP and MSP are anticipated to be conservative as sound in these areas are not predicted to be at levels requiring hearing protection. Nonetheless, even with these presumed WCP and MSP levels, the model predicted sound level at the boundary of the Wildlife Refuge is only 40 dBA, which is indicated in Table 2 to be comparable to the sound level inside a quiet library or office. Such a result is not surprising given a distance of almost 3 miles between the mining area and the wildlife refuge.

As is typical at this stage of a project, the results are subject to both negative and positive variance, the level of which depends on a number of factors, including timescale, metric, and methods of evaluation. As design progresses, more detailed acoustical modeling can be completed to assess specific equipment sound emissions. In addition, once the project is constructed a survey of operational sound levels can be conducted that may identify areas where localized measures (small sound walls, noise curtains, enclosures, etc.) could provide meaningful reduction in offsite sound levels. As the overall sound level is the sum of both project and non-project sounds, a field study of project-only sounds during periods of substantial non-project sounds may require statistical or engineering methods to minimize the undue influence of non-project sounds.

7. References

Federal Railroad Administration. 2021. The Train Horn Rule and Quiet Zones. https://railroads.dot.gov/highway-rail-crossing-and-trespasser-programs/train-horn-rulequiet-zones/train-horn-rule-and-quiet

Federal Transit Administration. 2018. *Transit Noise and Vibration Impact Assessment Manual*. FTA Report No. 0123. September.

International Organization for Standardization (ISO). 1996. ISO 9613-2, Acoustics—Sound Attenuation During Propagation Outdoors. Part 2: General Method of Calculation. Geneva, Switzerland.

Figures

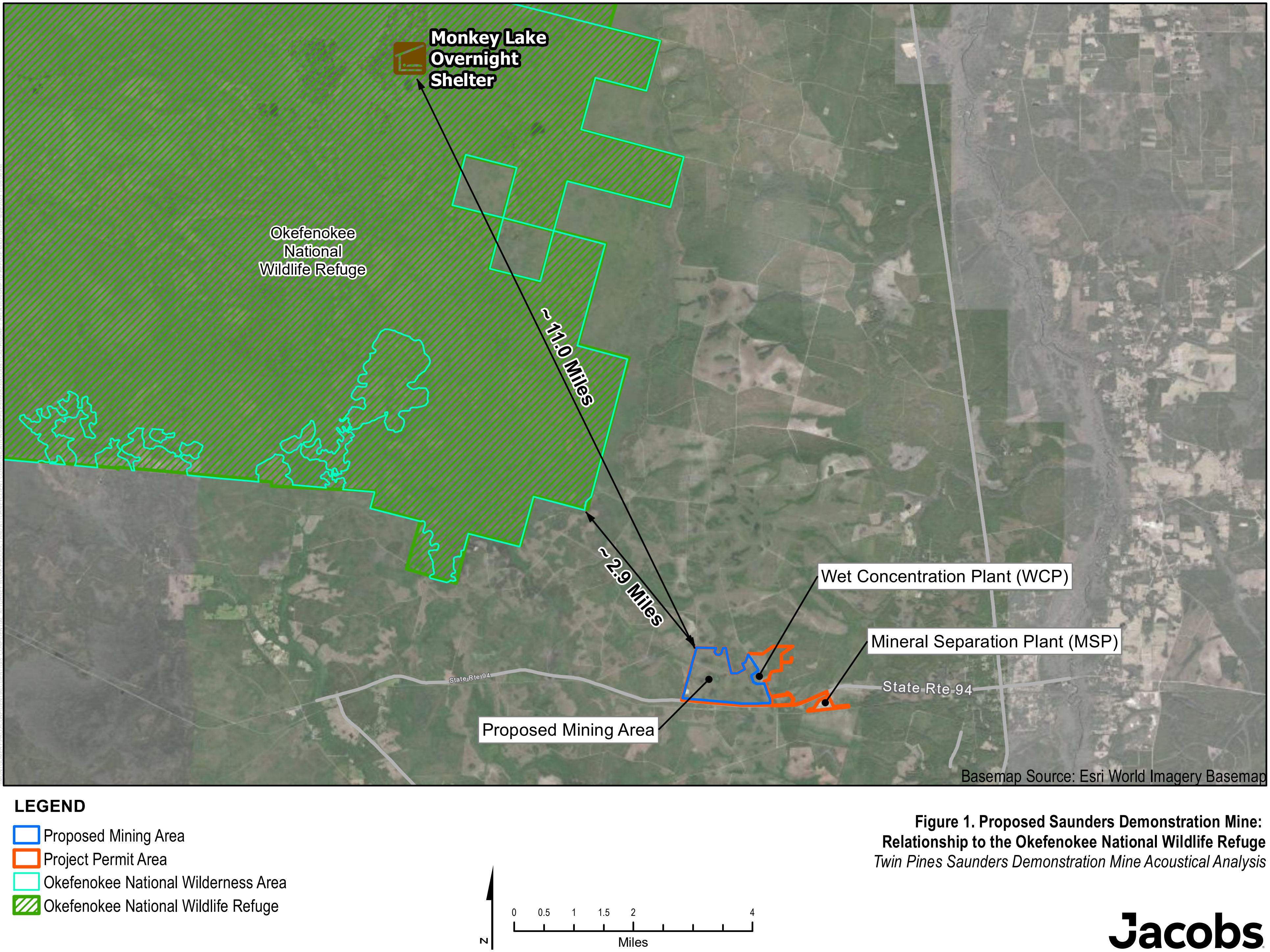

Figure 1. Proposed Saunders Demonstration Mine: Relationship to the Okefenokee National Wildlife Refuge

Twin Pines Saunders Demonstration Mine Acoustical Analysis

Jacobs

Date created: September 29, 2023

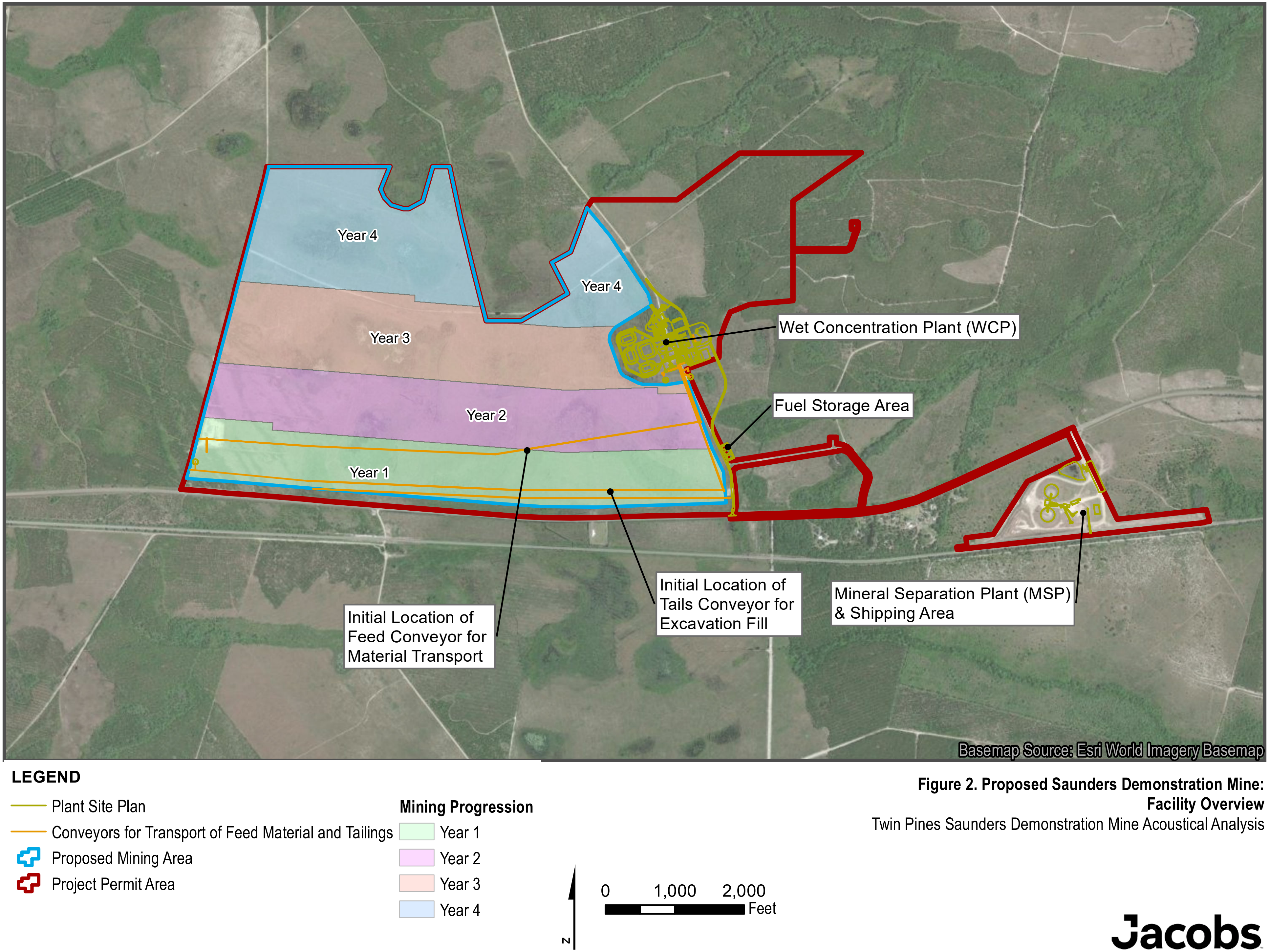

Figure 2. Proposed Saunders Demonstration Mine: Facility Overview

Twin Pines Saunders Demonstration Mine Acoustical Analysis

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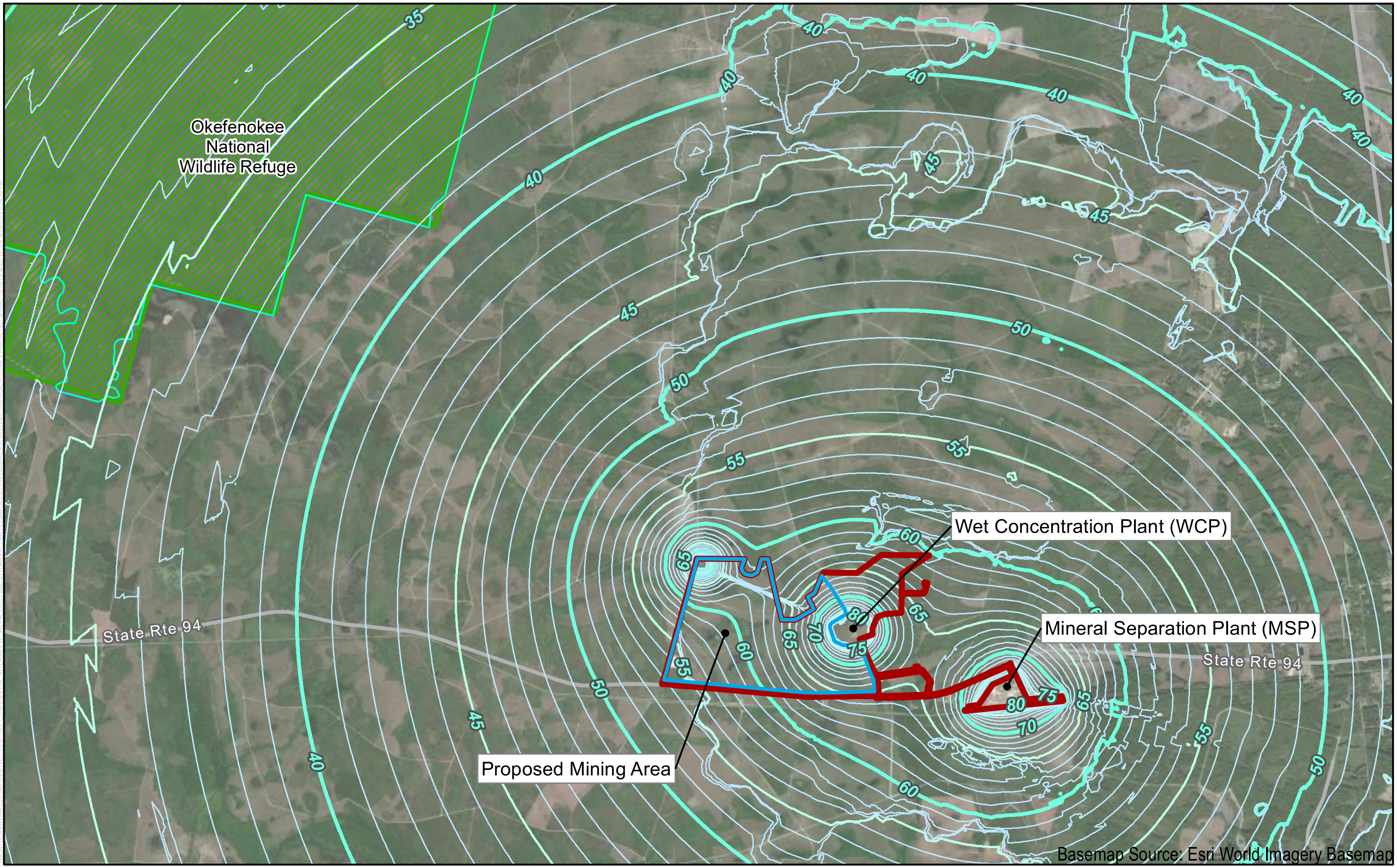

LEGEND

Predicted Sound Level (dBA)

- 40 Typical
- 41 Typical
- 45 Typical

- Proposed Mining Area
- Project Permit Area
- Okefenokee National Wilderness Area
- Okefenokee National Wildlife Refuge

N

0 0.25 0.5 0.75 1 2

Miles

Figure 3. Proposed Saunders Demonstration Mine: Predicted Sound Level Contours

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