Appendix M – Noise and Vibration Analysis

Kalamazoo/Battle Creek International
Runway 17/35 Extension
Aircraft Noise Analysis

A. Aircraft Noise Analysis

This section addresses aircraft noise exposure and describes the methodology used to analyze the aircraft noise environment, the metrics used to quantify aircraft noise exposure levels, and the resultant noise contours used to visually depict the noise levels extending from the Kalamazoo/Battle Creek International Airport (AZO or Airport).

The following subsections provide a generalized description of the existing noise exposure at AZO based on 2019 operational levels of activity. Projected noise levels for the 5 and 10-year ranges (2024 and 2029) are based on the activity levels forecasted in the AZO EA Runway 17/35 Extension Projections of Aviation Demand report.

Aircraft Noise

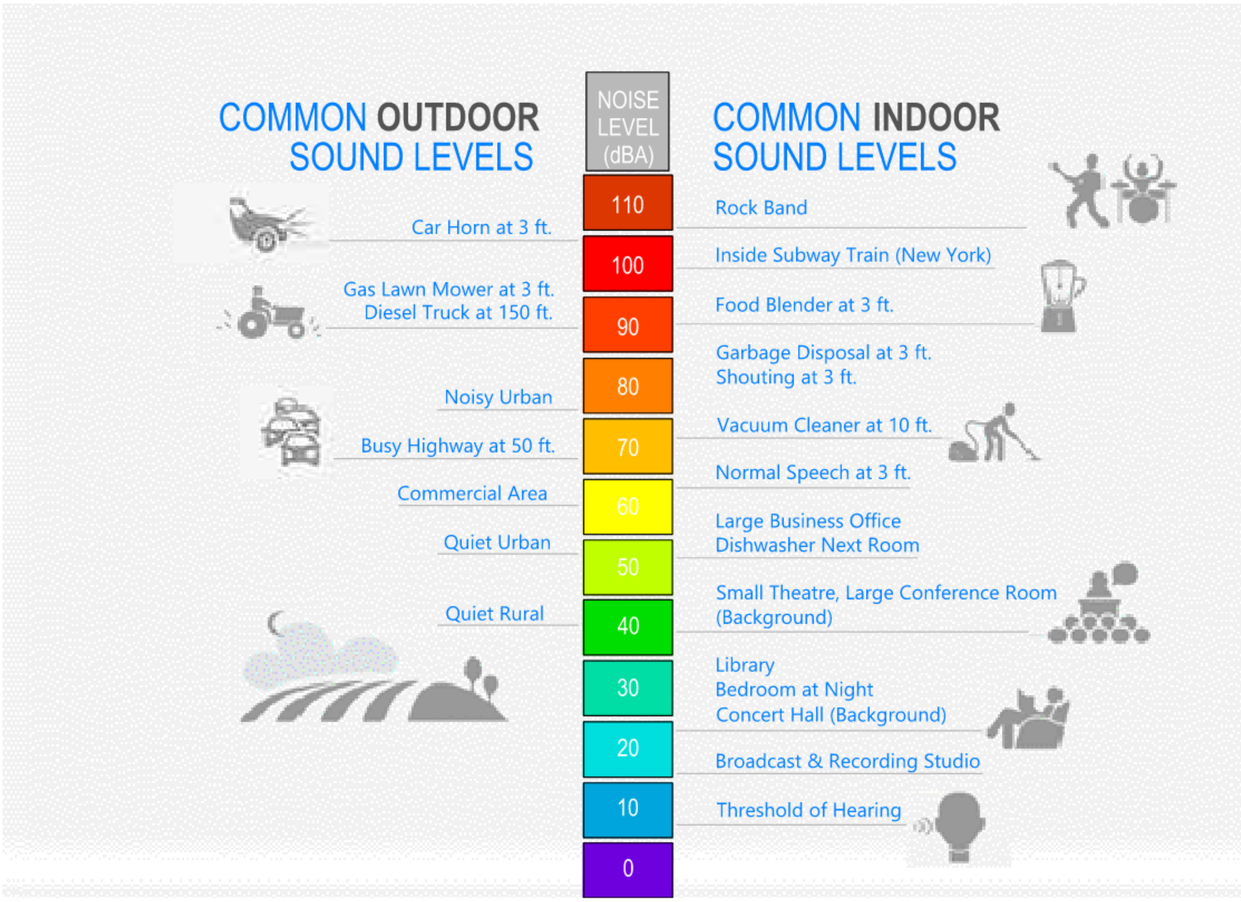
To understand airport noise and its effects on people, it is important to understand the characteristics of sound. Sound is a type of energy that travels in the form of a wave. Sound waves create minute pressure differences in the air that are recognized by the human ear or microphones. Sound waves can be measured using decibels (dB) to measure the amplitude or strength of the wave and Hertz (Hz)to measure the frequency or pitch of the wave.

The strength, or loudness, of a sound wave is measured using decibels on a logarithmic scale. The range of audibility of a human ear is 0 dB (threshold of hearing) to 120 dB (threshold of pain). The use of a logarithmic scale often confuses people because it does not directly correspond to the perception of relative loudness. A common misconception is that if two noise events occur at the same time, the result will be twice as loud. Realistically, the event doubles the sound energy, but only results in a 3 dB increase in magnitude. In person, a sound event needs to be 10dB higher to be observed as twice as loud as another.

Scientific studies have shown that people do not interpret sound the same way a microphone does. For example, humans are biased and sensitive to tones within a certain frequency range. The A-weighted decibel scale was developed to correlate sound tones with the sensitivity of the human ear. The A-weighted decibel (dBA) is a "frequency dependent" rating scale that emphasizes the sound components within the frequency range where most speech occurs. A comparative sound scale for the A-weighted decibel (dBA) is illustrated in **Figure 1.0**, which lists typical sound levels of common indoor and outdoor sound sources.

When sound becomes annoying to people, it is generally referred to as noise. A common definition of noise is any sound that is undesirable or interferes with people's ability to hear other sounds. One person may find higher levels of noise bearable while others do not. Studies have also shown that a person will react differently to the same noise depending on that person's activity at the time the noise is recognized, e.g., when that person is sleeping.

Figure 1.0: Comparative Noise Levels (dBA)



Source: FAA Fundamentals of Noise and Sound; https://www.faa.gov/regulations_policies/policy_guidance/noise/basics/#contours

Noise Metrics

Noise metrics can be categorized as cumulative metrics and single event metrics. Cumulative noise metrics have been developed to assess community response to noise. They are useful because these scales attempt to include the loudness and duration of the noise, the total number of noise events, and the time of day these events occur into one rating scale. Day-night average sound level (DNL), expressed in decibels (dB), is the standard federal metric[1] for determining cumulative exposure of individuals to noise. The DNL is the annual, 24-hour average sound level, obtained from the accumulation of all noise events, with the addition of 10 decibels to weighed sound levels from 10:00 p.m. to 7:00 a.m. The 10 dB weighting of nighttime events accounts for the fact that noise events at night are more intrusive when ambient levels are lower, and people are trying to sleep. The 24-hour DNL is annualized to reflect noise generated by aircraft operations for an entire year and is identified by noise contours showing levels of aircraft noise.

Single event metrics describe noise from individual events, such as an aircraft flyover. An example of this kind of metric is the maximum sound level (L_{max}), which identifies the highest noise level reached during

[1] In 1981, the FAA formally adopted the DNL as the primary measure for determining exposure of individuals to airport noise.

a particular noise "event" and ignores the duration of the event.

B. Noise Modeling Methodology

Existing aircraft noise environments for AZO were determined through computer modeling using the Federal Aviation Administration (FAA) designated Aviation Environmental Design Tool (AEDT). The following sub-sections explain the methodology and inputs used to generate the cumulative Day-Night Noise Level (DNL) contours.

Operational data used to generate the existing noise contours was derived from the FAA approved *Projections of Aviation Demand Report*, which provided the information on operations by aircraft category at AZO. Data for each aircraft type was then broken down by operation type, representative aircraft, runway utilization, and track utilization.

Computer Modeling

Computer modeling generates maps or tabular data of an airport's noise environment expressed in the applicable metric, such as DNL. Computer models are most useful in developing contours that depict areas of equal noise exposure, such as elevation contours on a topography map. Accurate noise contours are largely dependent on the use of reliable, validated, and updated noise models and collection of accurate aircraft operational data.

The AEDT software used to determine existing and future aircraft noise environments for AZO models civilian and military aviation operations and is required by FAA to be used for 14 CFR Part 150 Study aircraft noise analysis as well as NEPA noise analysis. The program includes standard aircraft noise and performance data for hundreds of aircraft types that can be tailored to the characteristics of specific individual airports. AEDT 3e is the most recent version of the software and was used for AZO noise models.

FAA Order 1050.1F requires a noise analysis that includes noise exposure maps for projects at airports with 90,000 annual piston-powered aircraft operations or 700 annual jet-powered aircraft operations that involve runway relocation, runway strengthening, or a major runway expansion. The number of operations at AZO is currently approximately 40,000 annual piston-powered aircraft operations and 400 jet-powered aircraft operations. However, since there is considerable interest in the aircraft noise analysis, the AEDT model was used to generate existing noise contours. AEDT Version 3c, the most up-to-date version of the software at the time the noise analysis was conducted, was used to model the noise exposure contours at AZO using the existing (2019) baseline operations. Results are indicated by a series of contour lines overlaid on a map of the airport and its environs.

Noise Model Inputs

The AEDT model requires a variety of operational data to model the noise environment around an airport. These inputs include the following bulleted data categories that are presented and discussed in more detail within the following sections and tables.

- Aircraft Activity Levels
- Aircraft Fleet Mix
- Runway Utilization

- Time of Day
- Surrounding Terrain
- Flight Tracks

Airport Activity Levels and Fleet Mix

The operation counts entered into AEDT are divided by aircraft models (**Table 1.0**). The number of operations per aircraft is based on the IFR and VFR operation data from the FAA's TFMSC database. All IFR operations are considered itinerant and VFR operations local (touch-and-go operations) for modeling purposes. The forecasted operations per aircraft type are determined in the forecast developed for the **AZO EA Runway 17/35 Extension Projections of Aviation Demand** report. The Piper Cherokee and Cessna Skyhawk 172 were selected as the representative aircraft used for training touch-and-go operations.

Table 1.0: Operations by Representative Aircraft

Aircraft	Runway Utilization Category	Type	2019		2024		2029	
			Itinerant	Local	Itinerant	Local	Itinerant	Local
Boeing 767-300	AC/Mil/Jet	Jet	4		5		5	
Airbus A330-200	AC/Mil/Jet	Jet	1		1		1	
Bombardier CRJ-200	Commuter	Jet	5101		3,007		758	
Embraer ERJ-145	Commuter	Jet	1676		988		249	
Bombardier CRJ-700	AC/Mil/Jet	Jet	1256		5,762		7,764	
Fairchild Dornier 328 Jet	Commuter	Jet	130		0		0	
Bombardier CRJ-900	AC/Mil/Jet	Jet	46		213		286	
Embraer Brasilia EMB 120	Commuter	Jet	22		0		0	
Boeing 737-700	AC/Mil/Jet	Jet	14		17		16	
Embraer E195 E2	AC/Mil/Jet	Jet	0		0		487	
Embraer ERJ 135/140/Legacy	Commuter	Jet	14		0		0	
Dassault Falcon 2000	AC/Mil/Jet	Jet	442		535		512	
Cessna Excel/XLS	AC/Mil/Jet	Jet	285		345		330	
Cessna Citation Mustang	AC/Mil/Jet	Jet	277		335		321	
Cessna III/VI/VII	AC/Mil/Jet	Jet	230		278		266	
Hawker 800	AC/Mil/Jet	Jet	227		275		263	
Cessna Citation X	AC/Mil/Jet	Jet	201		243		233	
Bombardier BD-700 Global 5000	AC/Mil/Jet	Jet	183		221		211	
Beech Beechjet 400/T-1	AC/Mil/Jet	Jet	168		203		195	
Dassault Falcon 900	AC/Mil/Jet	Jet	159		192		184	
Bombardier Challenger 300	AC/Mil/Jet	Jet	152		184		176	
Beech Super King Air 350	GA Itn	Turbine	588		711		681	
Beech 200 Super King	GA Itn	Turbine	577		698		668	
Cirrus SR 22	GA Itn	Piston	6619		6,511		6,374	
Cessna Golden Eagle 421	GA Itn	Piston	6194		6,093		5,966	
Cessna Skyhawk 172/Cutlass	GA Itn	Piston	316	5,736	383	5,572	366	5,463
Beech King Air 90	GA Itn	Turbine	300		362		347	
Cessna 208 Caravan	GA Itn	Turbine	213		257		246	
Cessna 340	GA Itn	Piston	4070		4,004		3,920	
Piper Cheyenne 1	GA Itn	Turbine	209		253		242	
Piper Cherokee	GA Itn	Piston	191	3,455	230	3,356	221	3,290
Sikorsky SH-60 Seahawk	GA Itn	Helicopter	131		129		126	
Eurocopter EC-155	GA Itn	Helicopter	98		97		95	
Total Annual Operations			39,286		41,460		40,262	

Source: FAA TFMSC, AZO EA Runway 17/35 Extension Projections of Aviation Demand

Runway Utilization

Determining the frequency each runway is used is important to generating accurate noise contours. **Table 2.0** illustrates that the aircraft groups used for the noise contour model. These grouping categories were developed to determine the percentages for runway utilization, time of day for operations, and track utilization. Aircraft were categorized into these groups based on the aircraft type found in the TFMSC database. Jets were further categorized into air carrier and commuter based on the number of seats with air carrier aircraft having more than 60 seats while commuters have less than 60 seats. Helicopter operations are modeled as general aviation itinerant operations.

Table 2.0: Runway Utilization by Aircraft Type

Aircraft Group	17	35	5	23	9	27
Air Carrier	42.5%	57.5%	0%	0%	0%	0%
Commuter	45.5%	54.5%	0%	0%	0%	0%
Military	42.5%	57.5%	0%	0%	0%	0%
General Aviation Jet	42.5%	57.5%	0%	0%	0%	0%
General Aviation Local	37.7%	47.0%	2.7%	9.1%	0%	3.1%
General Aviation Itinerant	37.7%	47.0%	2.7%	9.1%	0%	3.1%

Based on data obtained from the airport and air traffic control personnel, all jet and military operations are limited to runway 17-35, the longest runway at the airport, with runway end 35 having the highest percentage of utilization. The air carrier, military, and general aviation (noted as AC/mil/Jet in **Table 1.0**) jet usage percentages are identical while commuter jets are noted to have relatively more operations occurring at runway end 17. The non-jet general aviation operations take place on all three runways with runway 17-35 being the most used. Runway 5-23 is the second most used while runway 9-27 is the least used.

Operations by Time of Day

The time of day or night that aircraft operate is an important component to the AEDT model. Every aircraft operation that occurs between 10 p.m. and 7 a.m. has 10 dB added to the aircraft noise level. This effectively doubles the noise level signifying that noise is more intrusive at night.

Conversations with Airport management and air traffic control personnel helped surmise the ratio between daytime and nighttime activity. **Table 3.0** shows the time-of-day information provided by the airport. The percentages are based on the operation types. For aircraft carrier operations, over 21 percent of operations occur in the nighttime while commuter jet operations have relatively more operations taking place after 10 p.m. with 38.5 percent of operations occurring during the night. For military and general aviation operations, all have less than 3.5 percent operations occurring after 10 p.m.

Table 3.0: Operations by Type of Day

Operations by Time of Day	Day (7AM – 10PM)	Night (10PM - 7AM)
Air Carrier (> 60 seats)	78.1%	21.9%
Commuter (< 60 Seats)	61.5%	38.5%
Military	96.6%	3.4%
GA Itinerant	97.5%	2.5%
GA Local	96.6%	3.4%

Flight Tracks

Flight paths represent where aircraft fly in relation to the ground. Aircraft do not fly exact or precise "tracks" associated with general aviation airports, but rather a wider "path" that represents some dispersion due to several factors, including weather (temperature, wind, barometric pressure), pilot proficiency, aircraft performance, other air traffic, and separation requirements.

In order to determine a representation of aircraft flight paths, the ATCT was asked to provide input on the location and usage of tracks. The tracks used for the noise analysis not only include straight in, straight out, and touch and go tracks but also accounts for the various turns aircraft are likely to take when departing and arriving. Input was received in the form of mark-ups on aerial maps, flight track screen shots and ADS-B screen shots, as well as written and verbal explanation. The percentage of tracks used per runway end is shown in **Table 4.0** and **Table 5.0** with the track routes are illustrated on **Figure 2.0**.

Table 4.0: AZO Arrival Track Utilization

Runway	Arrival Track	Track Utilization
	Straight-In	70%
35	Right	10%
	Left	20%
	Straight-In	65%
17	Right	15%
	Left	20%
	Straight-In	5%
9	Right	48%
	Left	48%
	Straight-In	5%
27	Right	48%
	Left	48%
	Straight-In	30%
5	Right	35%
	Left	35%
	Straight-In	55%
23	Right	22%
	Left	23%

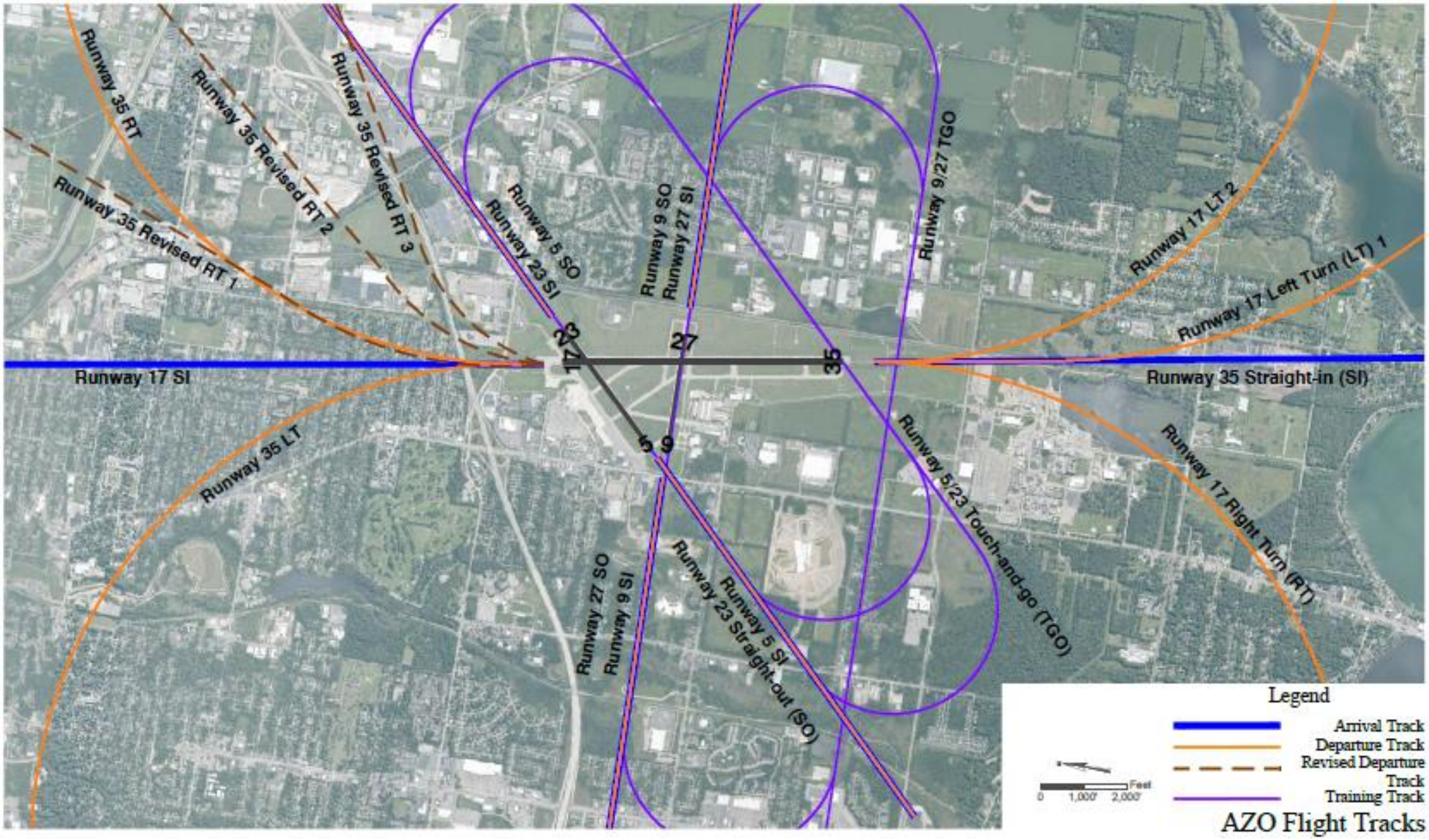
Source: AZO ATCT

Table 5.0: AZO Departure Track Utilization

Runway	Departure Track	Track Utilization
35	RT (heading 020)	55%
	Heading 060	10%
	Heading 320	20%
	Heading 330-010	5%
	Right Crosswind	5%
	Left Crosswind	5%
17	LT 140	35%
	RT 200	10%
	RT 230	55%
9	Straight-Out	5%
	Right	48%
	Left	48%
27	Straight-Out	5%
	Right	48%
	Left	48%
5	Straight-Out	30%
	Right	35%
	Left	35%
23	Straight-Out	30%
	Right	35%
	Left	35%

Source: AZO ATCT. The percentages are per runway end.

Figure 2.0: AZO Flight Tracks for Noise Modeling



Source: AZO ATCT

C. Resulting Noise Contours

i. Baseline (2019) Cumulative (DNL) Noise Contours

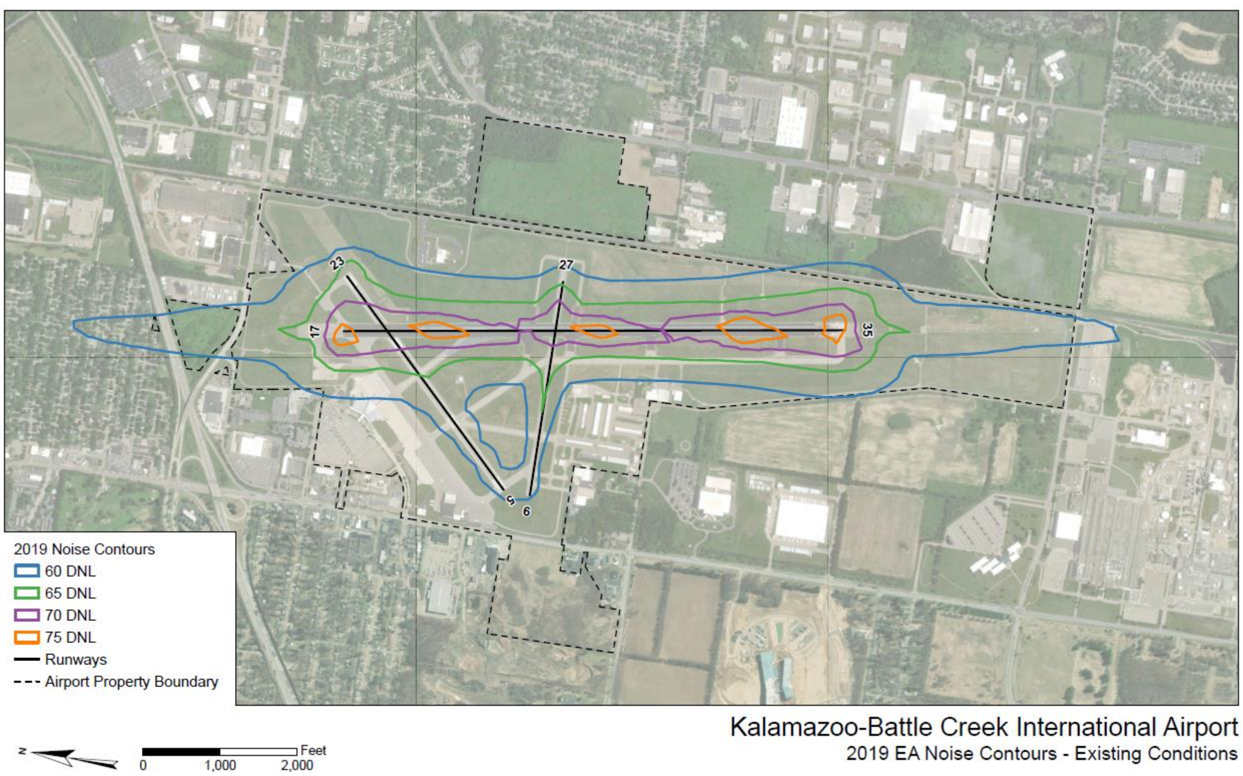
The DNL noise contours were modeled based on the most conservative assumptions; in other words, all piston aircraft operations were modeled as if they were all in the pattern performing touch-and-go operations. The majority of jet and turbo powered aircraft were modeled as straight in arrivals and departures, thus putting the loudest aircraft directly over the residents west and east of the Airport. These two assumptions tended to concentrate aircraft, which in turn tend to result in louder noise contours.

The weighted DNL metric is used to statistically predict the cumulative noise exposure levels in relationship to the land uses surrounding the Airport. A person does not "hear" a DNL due to the methodology of defining the DNL metric. As such, single event noise contours for some of the more demanding aircraft that use AZO were also developed and are presented in the following sections.

The lower the contour dB, the quieter the represented noise level; the 60 DNL is quieter than the 65 DNL. As discussed in earlier sections, the 65 DNL contour is the federally defined threshold for land use compatibility.

Figure 3.0 shows the baseline (2019) noise contours at AZO. The contours shown on the figure represent the 60, 65, 70 and 75 DNL contours. The the 65 DNL to 75 contours are entirely within the AZO property boundary. The 65 DNL is represented by the blue curve that generally runs along the runways. Enlarged contour maps comparing noise in 2024 and 2029, with and without the project, are included at the end of this report.

Figure 3.0: 2019 AZO Noise Contours (60 to 70 DNL)



ii. Forecasted Noise Contours

The forecasted noise analysis uses the projected operations and fleet mix changes for 2024 and 2029 and compares noise contours of the existing airport layout with a potential future scenario of an extended Runway 17-35. This creates two sets of contours for each forecast year, with four total forecasted contours. The AEDT input for the forecasted contours is the same as that of the 2019 contours with operation counts and some aircraft types being added or removed. The operation count and fleet mix projections are taken from the Runway 17/35 Extension EA forecast.

To summarize the four forecasted contours are:

- 2024 operations and fleet mix with the current runway layout
- 2024 operations and fleet mix with an extended Runway 17-35
- 2029 operations and fleet mix with the current runway layout
- 2029 operations and fleet mix with an extended Runway 17-35

In general, the contours for the forecasted operations on the current runway layout is similar to the 2019 noise contours with 2024 having the largest 60dB contour while the 2029 contours are comparable to that of 2019. The similar contours are because while the overall total operations are forecasted to be greater than that of 2019, the aircraft types and fleet mix are changing across the forecast years, particularly those of commuter and air carrier jets. The decrease in contour size from 2024 to 2029 can also be attributed to the lower number of total operations. **Figures 4.0 and 5.0** show the 2024 and 2029 noise contours.

Figure 4.0: 2024 AZO Noise Contours – Existing Runway Layout

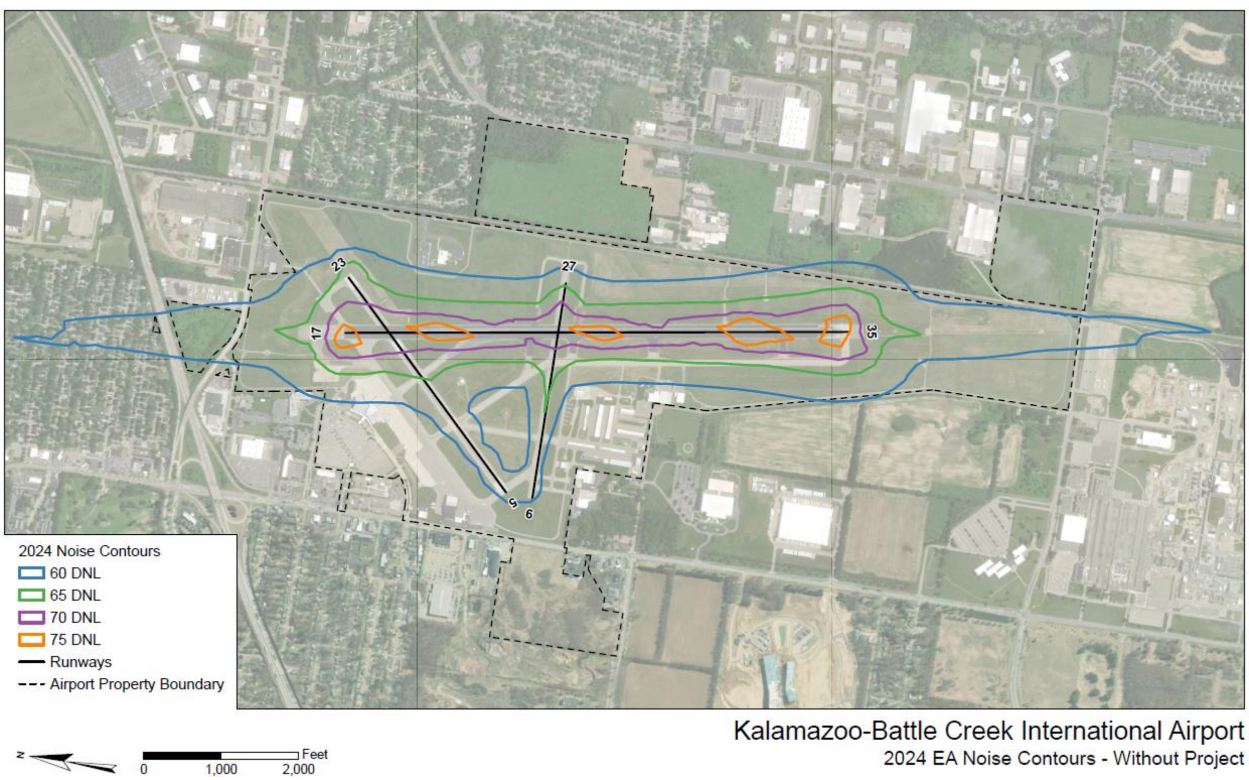
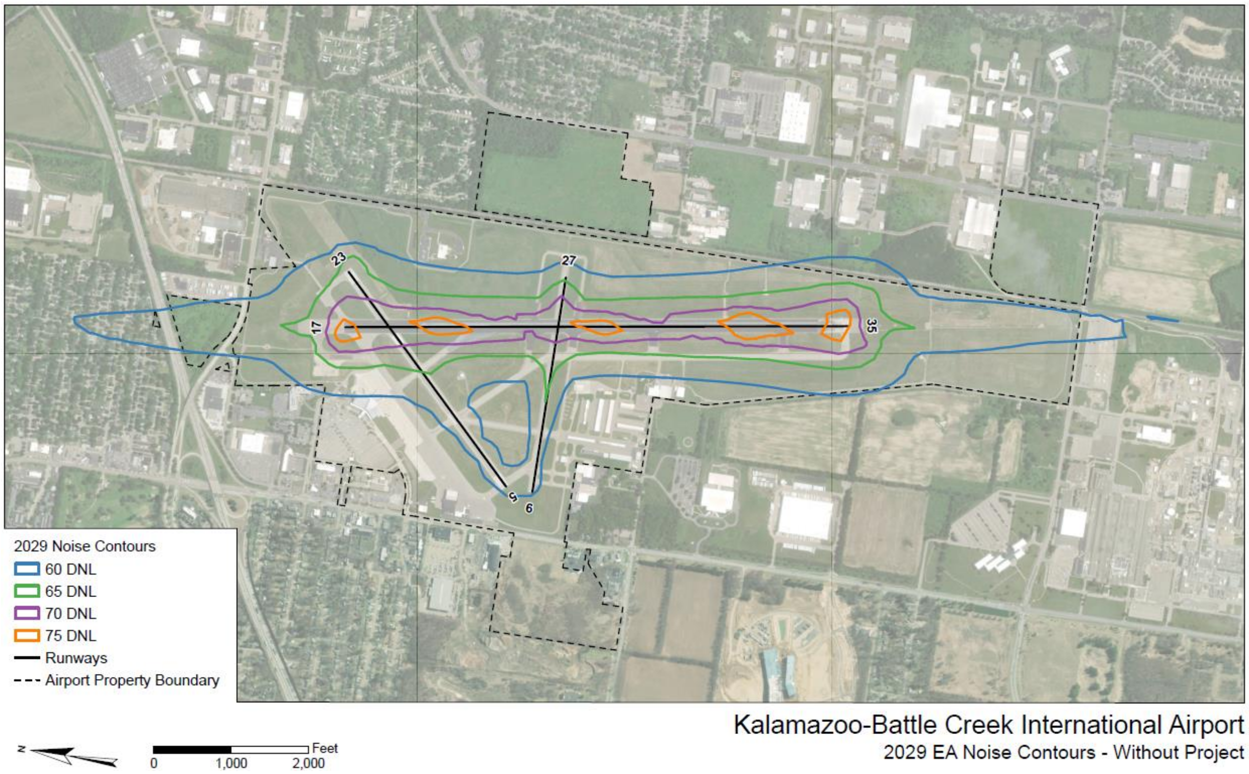


Figure 5.0: 2029 AZO Noise Contours – Existing Runway Layout



The proposed runway 17-35 extension results in the overall lengthening of the contours compared to the current layout. This is to be expected as the runway extensions will push the turning points for departures, arrivals, and touch-and-goes out. For 2024 operations on the 35 end of the runway, the 60dB contour is extended longer while on the 17 end the 60dB contour appears to be more well defined after the extension. For 2029 operations the difference between the current and extended layouts is more noticeable on the 35 end. **Figures 6.0 and 7.0** show the 2024 and 2029 contours with the runway extension in place.

Figure 6.0: 2024 AZO Noise Contours – Extended Runway 17-35

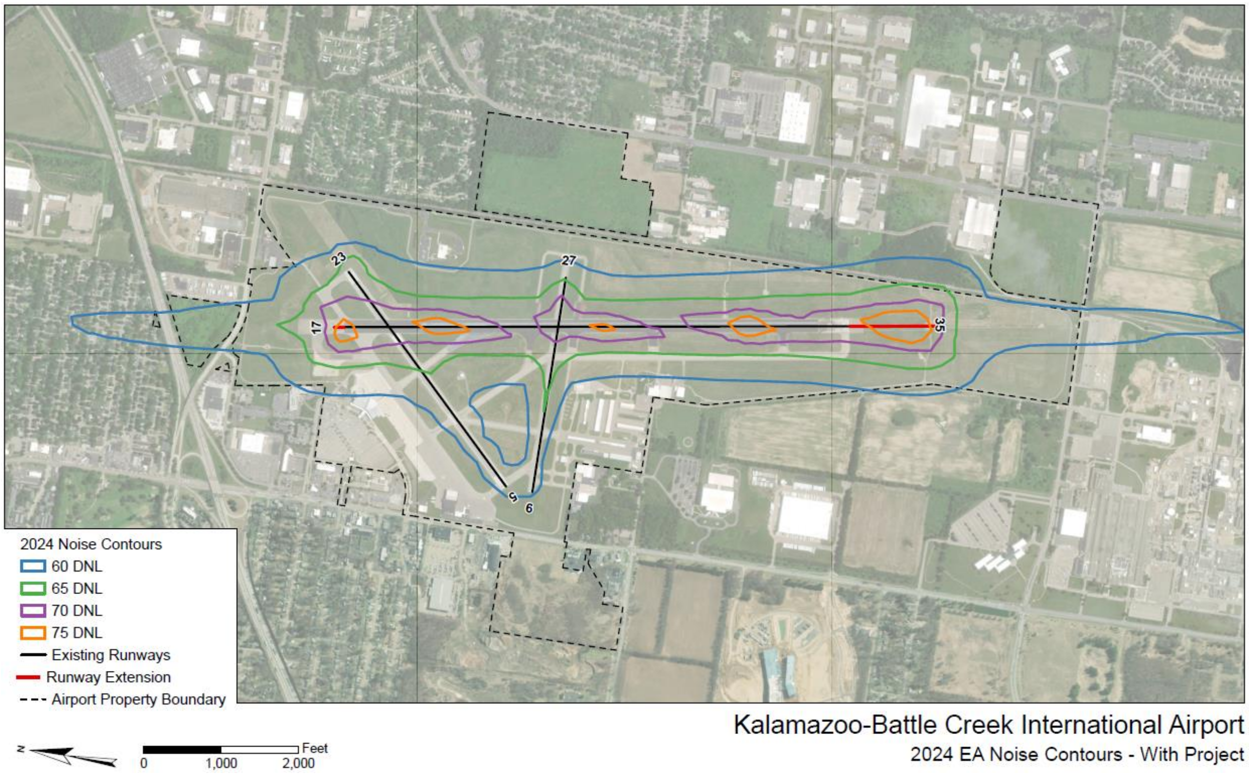
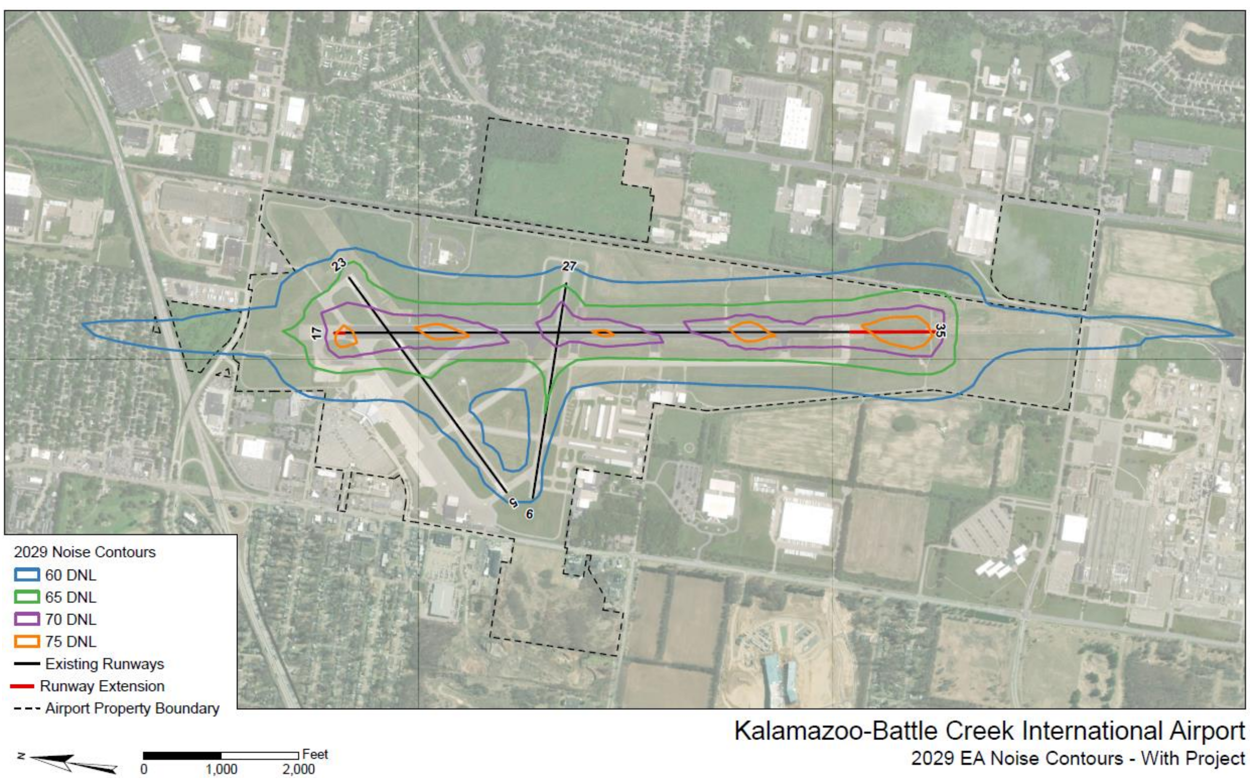


Figure 7.0: 2029 AZO Noise Contours – Extended Runway 17-35



There are various contributing factors to the differences between the current layout contours and the extended runway contours. Most operations occur on runway end 35. There are more overall arrivals and departures that occur on the runway 35 end. Thus, extending runway 35 means that departing aircraft are taking off sooner which leads to a reduction in the contour on runway end 17. Arriving aircraft are also flying at lower elevations earlier since the landing threshold for runway end 35 is extended out to the south due to the runway extension. The bulk of the contours are also shifted out due to the two runway ends being extended. **Figure 8.0 and 9.0** compares the current layout and extended runway contours for 2024 operations and 2029 operations respectively.

Figure 8.0: 2024 AZO Noise Contour Comparisons – Existing and Extended Runways

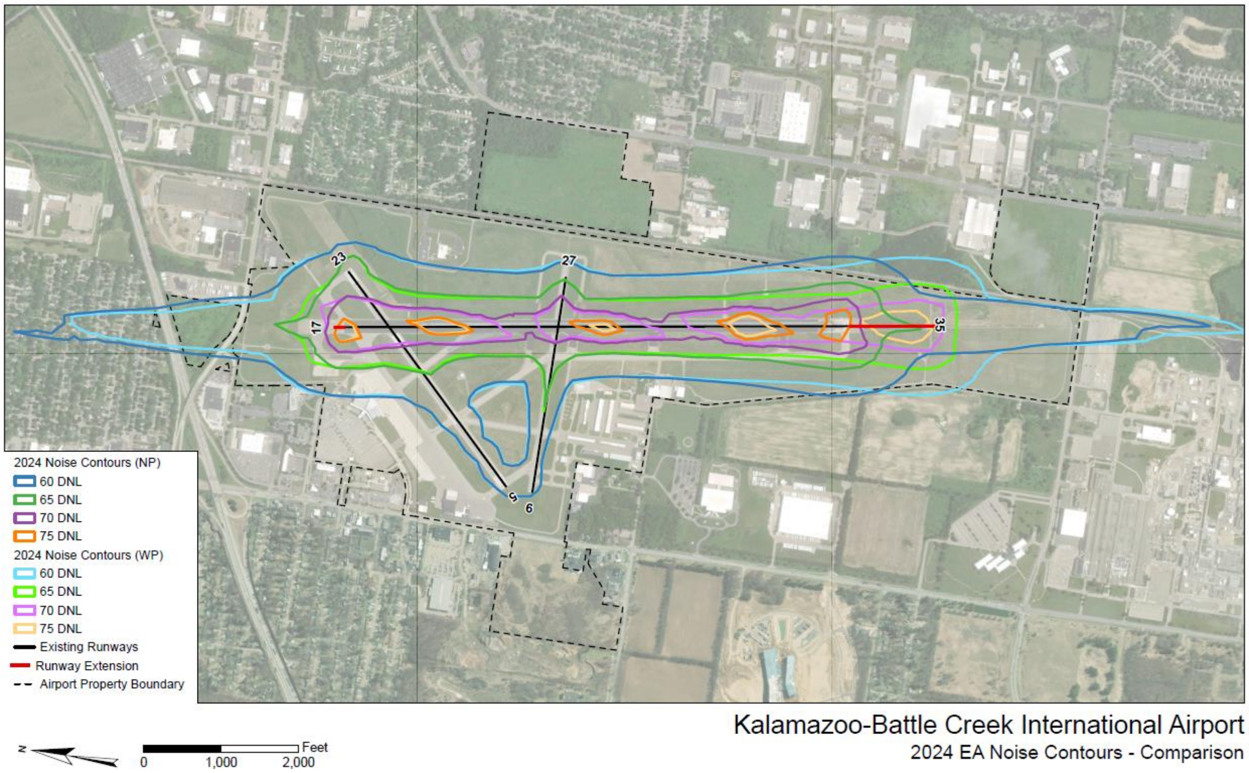
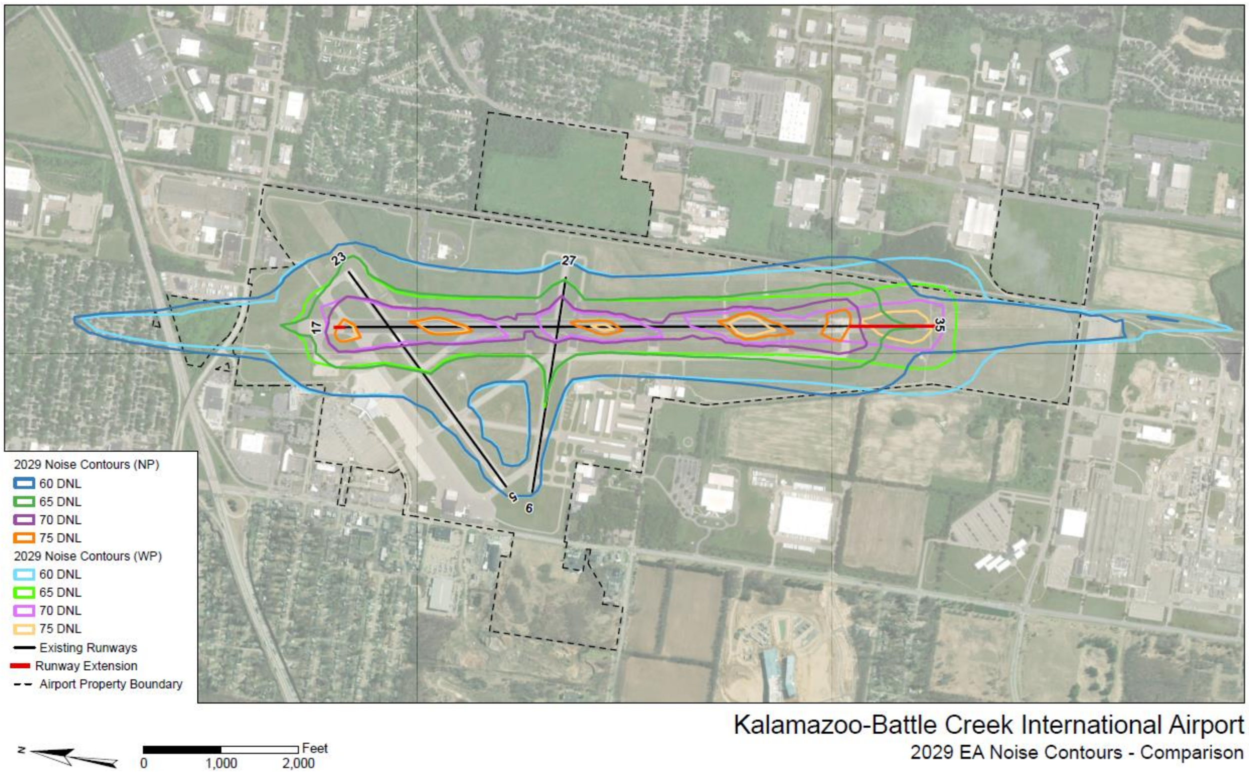
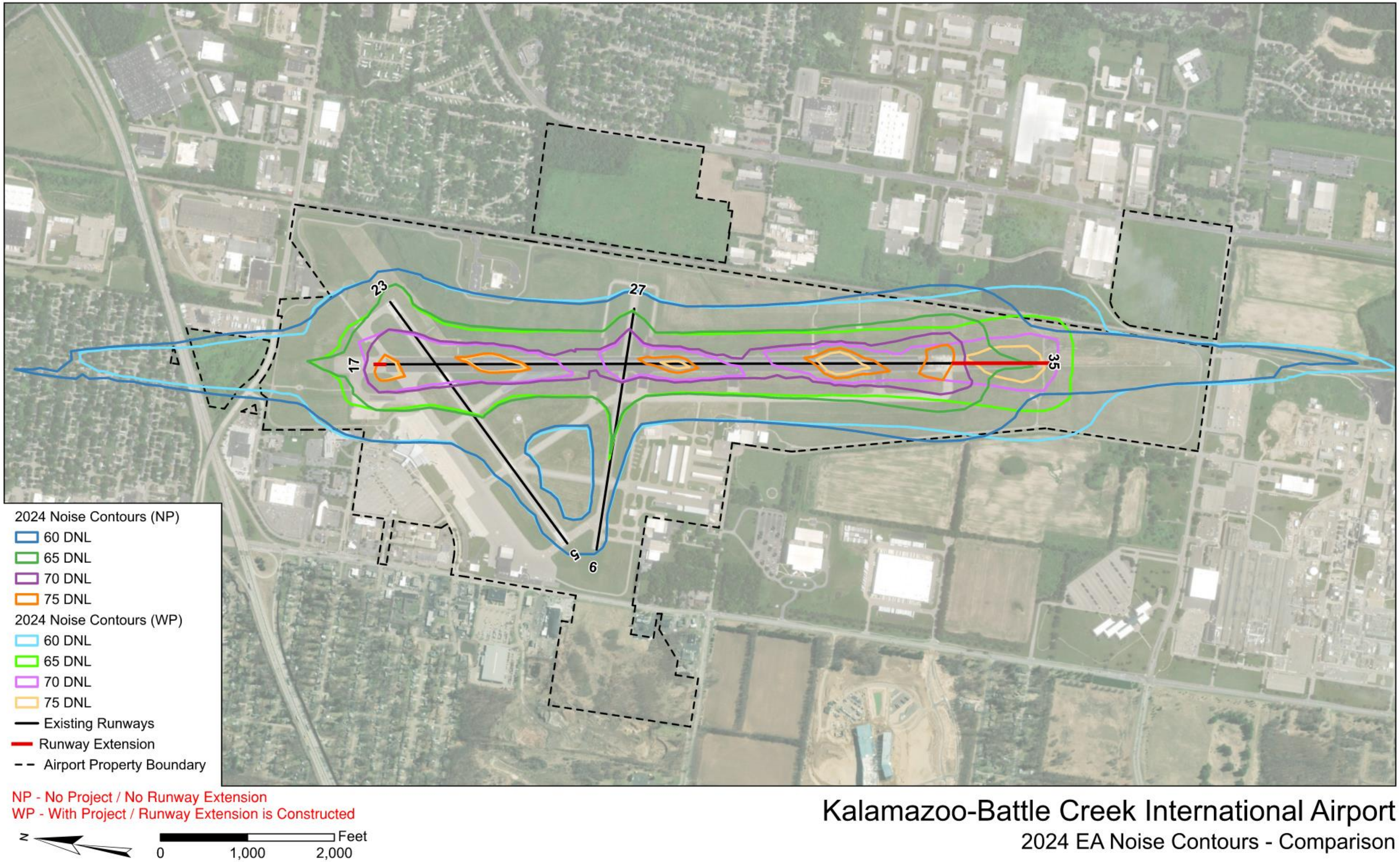


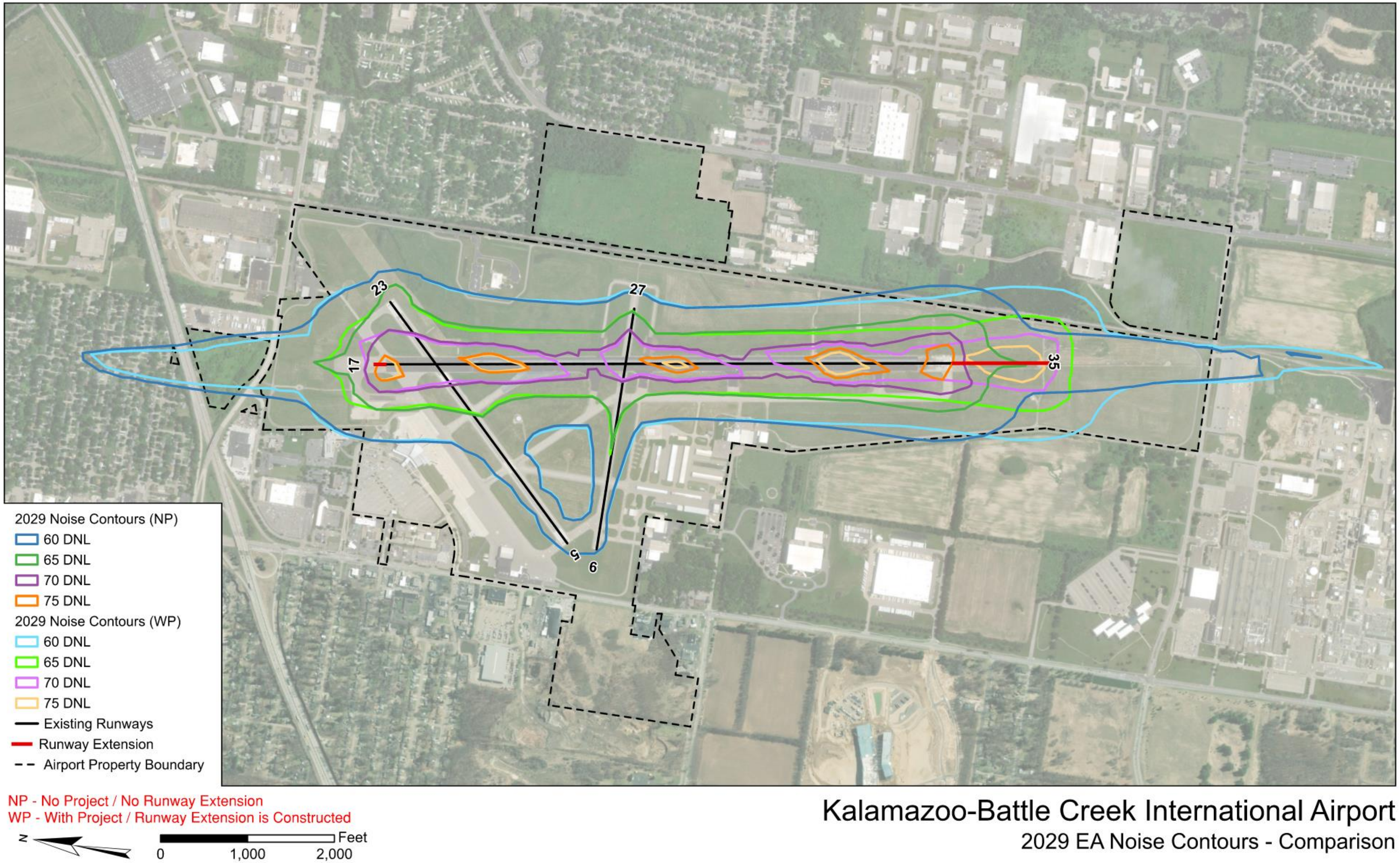
Figure 9.0: 2029 AZO Noise Contour Comparisons – Existing and Extended Runways





Kalamazoo-Battle Creek International Airport

2024 EA Noise Contours - Comparison



Kalamazoo-Battle Creek International Airport

2029 EA Noise Contours - Comparison

General Noise Assessment and Vibration Screening
Kalamazoo Airport Runway Expansion Project

INTRODUCTION AND METHODOLOGY

A noise impact assessment was prepared in accordance with Title 49 CFR 1105 and with the Federal Transit Administration (FTA) guidance manual Transit Noise and Vibration Impact Assessment Manual FTA Report No. 0123 September, 2018 (FTA Manual). The assessment examined the potential for noise impacts from the relocation of the existing railroad line currently located to the east and south of existing runway 35 at Kalamazoo Airport, 5235 Portage Road, Portage MI 49002. The project location is shown on Figure 1 Appendix A. This noise assessment will describe the existing noise environment and will evaluate the impact, if any, the proposed project might have on noise sensitive land use within the project area.

EXISTING CONDITIONS

The existing runway ends approximately 570 feet north of the railroad tracks that trend in a north/south direction. The majority of the land in the project area is undeveloped with a few commercial buildings and residential houses, mostly located on the east side of South Sprinkle Road, approximately 900 feet away.

PROPOSED PROJECT

The project proposes to extend runway 35 approximately 1,000 feet south. As shown on Figure 2 in Appendix A, the existing railroad will be relocated outside of the runway 35 clear zone. The railroad tracks will be moved to the east crossing over Romence Road about 700 feet east of the existing crossing. The railroad track will continue toward the south and east before circling west and reconnecting to the existing railroad tracks about 1,800 feet south of Romence Road.

NOISE IMPACT ANALYSIS

The FTA noise impact analysis process is a multi-step process used to evaluate the project for potential noise impacts for FTA and FRA NEPA approvals. If an impact is determined, measures necessary to mitigate adverse impacts must be considered for incorporation into the project. There are three levels of analysis to evaluate noise on a railroad project based on the type and scale of the project and the environmental setting. The Noise Screening Procedure, conducted first, defines the study area and determines the need for subsequent noise impact assessment. Where there is potential for noise impact, The General Noise Assessment is used to determine the extent and severity of the impact.

NOISE SCREENING PROCEDURE

Step 1: The screening distance (feet) for the proposed Kalamazoo Airport railroad relocation has been determined using Table 4-7 from the FTA manual. The proposed project best fits a Low and Intermediate Capacity Transit, Steel Wheel system project type. With these criteria, it was determined the unobstructed screening distance is 125 feet from the center of the railroad tracks. See table 4-7 below.

Table 4-7 Screening Distance for Noise Assessments

Project Systems		Screening Distance, ft* Unobstructed	Screening Distance, ft* Intervening Buildings
Fixed-Guideway Systems			
Commuter Rail Mainline		750	375
Commuter Rail Station	With Horn Blowing	1,600	1,200
	Without Horn Blowing	250	200
Commuter Rail Road Crossing with Horns and Bells		1,600	1,200
RRT		700	350
RRT Station		200	100
LRT		350	175
Streetcar		200	100
Access Roads to Stations		100	50
Low and Intermediate Capacity Transit	Steel Wheel	125	50
	Rubber Tire	90	40
	Monorail	175	70
Yards and Shops		1000	650
Parking Facilities		125	75
Access Roads to Parking		100	50
Ancillary Facilities: Ventilation Shafts		200	100
Ancillary Facilities: Power Substations		250	125
Bus Systems			
Busway		500	250
Bus Rapid Transit (BRT) on exclusive roadway		200	100
Bus Facilities	Access Roads	100	50
	Transit Mall	225	150
	Transit Center	225	150
	Storage & Maintenance	350	225
	Park & Ride Lots w/Buses	225	150
Ferry Boat Terminals		300	150

*Measured from centerline of guideway for fixed-guideway sources, from the ROW on both sides of the roadway for highway/transit sources, from the center of noise-generating activity for stationary sources, or from the outer boundary of the proposed project site for fixed facilities spread out over a large area.

Step 2: Sensitive receptors near the project best fit the Land Use Category 2, Residential. Residential houses can be found approximately 900 feet east of the railroad relocation. Table 4-3 in the FTA Manual provides the descriptions to determine the Land Use Category.

Table 4-3 Land Use Categories and Metrics for Transit Noise Impact Criteria

Land Use Category	Land Use Type	Noise Metric, dBA	Description of Land Use Category
1	High Sensitivity	Outdoor $L_{eq(1hr)}$*	Land where quiet is an essential element of its intended purpose. Example land uses include preserved land for serenity and quiet, outdoor amphitheaters and concert pavilions, and national historic landmarks with considerable outdoor use. Recording studios and concert halls are also included in this category.
2	Residential	Outdoor L_{dn}	This category is applicable all residential land use and buildings where people normally sleep, such as hotels and hospitals.
3	Institutional	Outdoor $L_{eq(1hr)}$*	This category is applicable to institutional land uses with primarily daytime and evening use. Example land uses include schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds, and recreational facilities are also included in this category.

* $L_{eq(1hr)}$ for the loudest hour of project-related activity during hours of noise sensitivity.

Step 3: The Kalamazoo Airport runway expansion project was determined to also be considered Undeveloped Land with some commercial/industrial land use. Even though majority of the land is undeveloped, a noise impact assessment must be completed.

Step 4: To determine the noise sensitive areas, the unobstructed distance of 125 feet was measured from the proposed relocation of the railroad. It was determined that there are no noise sensitive areas within 125 feet of the relocated railroad tracks. This is shown on Figure 3 in Appendix A.

There are no noise sensitive land uses within the unobstructed distance of the railroad tracks, thus no additional analysis beyond the Noise Screening Procedure is necessary.

VIRBRATION SCREENING

Figure 6-3 from the FTA manual is shown below and was used to determine if a Vibration Analysis is required.

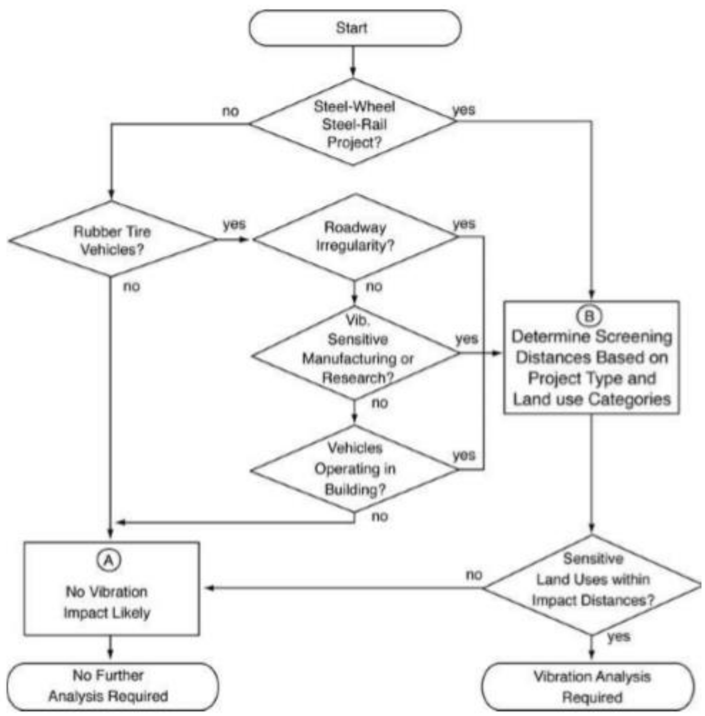


Figure 6-3 Flow Chart of Vibration Screening Process

Step 1: Based on the description provide on page 134 in the FTA manual, the vehicle type for this project was determined to be a steel-wheeled/steel-rail vehicle. Since the project best fits a steel wheel/steel-rail type, the vibration screening distance needs to be determined.

Step 2: The project type was determined to be a Project Type Number 4, Intermediate Capacity Transit, based on the description shown in Table 6-7 from the FTA manual.

Table 6-7 Project Types for Vibration Screening Procedure

Project Type Number	Project Type	Description
1	Conventional Commuter Railroad	Both locomotives and passenger vehicles create vibration. For commuter trains, the highest vibration levels are typically created by the locomotives. Electric commuter rail vehicles create levels of ground-borne vibration that are comparable to electric rapid transit vehicles.
2	RRT	Ground-borne vibration impact from rapid transit trains is one of the major environmental issues for new systems. Ground-borne vibration is usually a major concern for subway operations. It is less common for at-grade and elevated rapid transit lines to create intrusive ground-borne vibration and noise since air-borne noise typically dominates.
3	LRT and Streetcars	The ground-borne vibration characteristics of light rail systems are very similar to those of rapid transit systems. Because the speeds of light rail systems are usually lower, typical vibration levels are usually lower. Steel-wheel/steel-rail AGT is included in either this category or the ICT category depending on the level of service and train speeds.
4	Intermediate Capacity Transit	Because of the low operating speeds of most ICT systems, vibration problems are not common. However, steel-wheel ICT systems that operate close to* vibration-sensitive buildings have the potential of causing intrusive vibration. With a stiff suspension system, an ICT system could create intrusive vibration.
5	Bus and Rubber-Tire Transit Projects	This category encompasses most projects that do not include steel-wheel trains of some type. Examples include diesel buses, electric trolley buses, and rubber-tired people movers. Most projects that do not include steel-wheel trains do not cause vibration impacts.**

*See the screening distances for category 1 land uses in Table 6-8.

** Most complaints about vibration caused by buses and trucks are related to rattling of windows or items hung on the walls. These vibrations are usually the result of airborne noise and not ground-borne vibration. In the case where ground-borne vibration is the source of the complaint, the vibration can usually be attributed to irregularities in the road.

Step 3: The screening distanced was determined to be 100 feet based on Table 6-8 from the FTA manual. The project type is Intermediate Capacity Transit (ICT) and is Land Use Category 2.

Table 6-8 Screening Distances for Vibration Assessments

Type of Project	Critical Distance for Land Use Categories* Distance from ROW or Property Line, ft		
	Land Use Cat. 1	Land Use Cat. 2	Land Use Cat. 3
Conventional Commuter Railroad	600	200	120
RRT	600	200	120
LRT and Streetcars	450	150	100
ICT	200	100	50
Bus Projects (if not previously screened out)	100	50	--

*For the Vibration Screening Procedure, evaluate special buildings as follows: Category 1 - concert halls and TV studios, Category 2 - theaters and auditoriums

Step 4: The screening distance of 100 feet was measured out from the center of the proposed relocated railroad tracks. It was determined that there are no vibration sensitive areas located within 100 feet of the proposed railroad relocation. This is shown on Figure 4 in Appendix A.

There are no vibration sensitive land uses within the screening distance, thus no additional analysis beyond the Vibration Screening Procedure is necessary.

APPENDIX A

Project Location

Proposed Project

Noise Screening Distance

Vibration Screening Distance

Figure 1
Project Location
Kalamazoo Airport

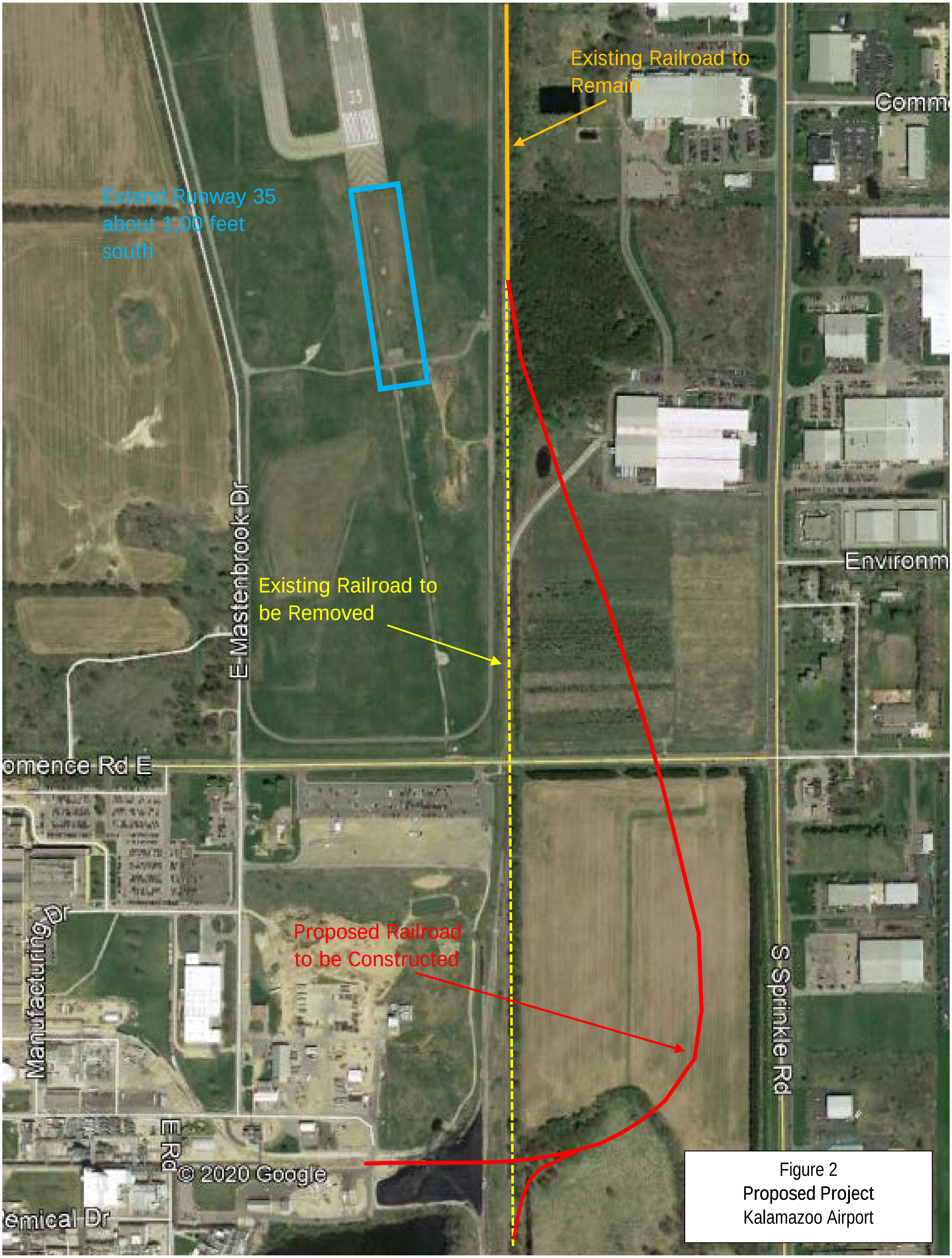


Figure 2
Proposed Project
Kalamazoo Airport

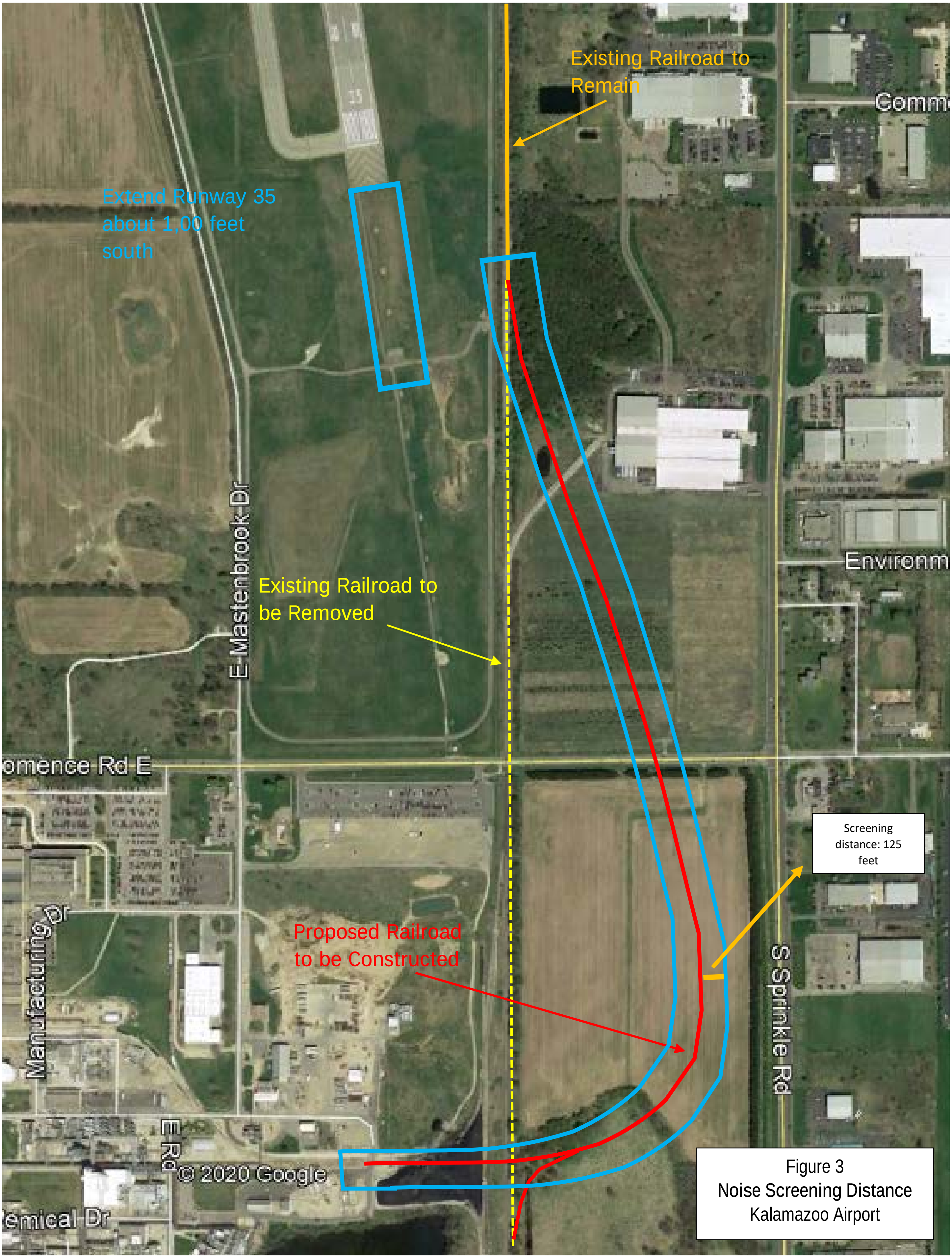


Figure 3
Noise Screening Distance
Kalamazoo Airport

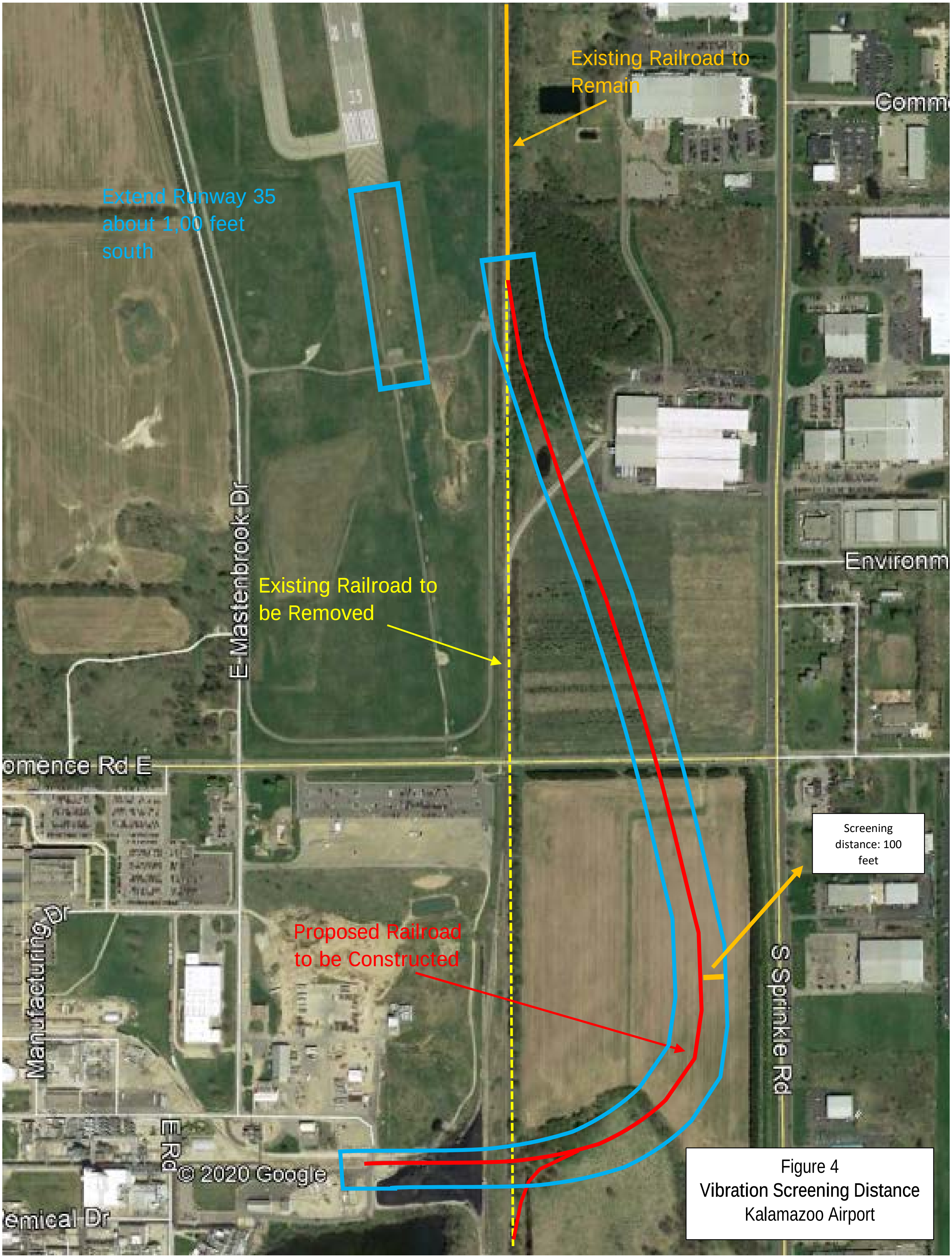


Figure 4
Vibration Screening Distance
Kalamazoo Airport