

July 9, 2025

Project Cardinal - Design Team  
Pioneer Development

Re: Project Cardinal Preliminary Sound Study

Burns & McDonnell was retained by Pioneer Development (“Pioneer”) to conduct a preliminary sound study (the “Study”) for the proposed Project Cardinal Data Center Development (the “Project”). The objective of the Study was to estimate future noise impacts from operational equipment at the Project’s property boundaries.

The Project is proposed to be located in Yorkville, Illinois. The current site plan is presented in Figure 1 and includes fourteen (14) two-story data center buildings. The design includes eleven (11) large (~680,600 square foot) buildings and three (3) smaller (~390,000 square foot) buildings. The large buildings were modeled with 108 rooftop chillers and 80 auxiliary generators at ground level. The smaller buildings include 54 rooftop chillers and 40 auxiliary generators. The buildings, barriers, layout, and equipment counts were provided by Pioneer for the current design. However, this design is preliminary and would likely evolve throughout the detailed design stages of the Project. This analysis included predictive modeling to estimate Project-generated sound levels in the surrounding community for two operational scenarios. A comparison to the local sound level limits was performed at the Project boundaries. Sound level impacts at the nearest noise sensitive receptors would be expected to be lower as Project-generated sound would attenuate as it moves offsite.

## Acoustic Terminology

The term “sound level” is often used to describe two different sound characteristics: sound power and sound pressure. Every source that produces sound has a sound power level (PWL). The PWL is the acoustical energy emitted by a sound source and is an absolute number that is not affected by the surrounding environment. The acoustical energy produced by a source propagates through media as pressure fluctuations. These pressure fluctuations, also called sound pressure levels (SPL), are what human ears hear and microphones measure.

Sound is physically characterized by amplitude and frequency. The amplitude of sound is measured in decibels (dB) as the logarithmic ratio of a sound pressure to a reference sound pressure (20 micropascals). The reference sound pressure corresponds to the typical threshold of human hearing. To the average listener, a 3-dB change in a continuous broadband sound is generally considered “just barely perceptible”; a 5-dB change is generally considered “clearly noticeable”; and a 10-dB change is generally considered a doubling (or halving, if the sound is decreasing) of the apparent loudness.

Sound waves can occur at many different wavelengths, also known as the frequency. Frequency is measured in hertz (Hz) and is the number of wave cycles per second that occur. The typical human ear can hear frequencies ranging from approximately 20 to 20,000 Hz. Normally, the human ear is most sensitive to sounds in the middle frequencies (1,000 to 8,000 Hz) and is less sensitive to sounds in the lower and higher frequencies. As such, the A-weighting scale was developed to simulate the frequency response of the human ear to sounds at typical environmental levels. The A-weighting scale emphasizes sounds in the middle frequencies and de-emphasizes sounds in the low and high frequencies. Any sound level to which the A-weighting scale has been applied is expressed in A-weighted decibels, or dBA.

Sound in the environment is constantly fluctuating, as when a car drives by, a dog barks, or a plane passes overhead. Therefore, sound metrics have been developed to quantify fluctuating environmental sound levels. These metrics include the exceedance sound level. The exceedance sound level is the sound level exceeded during “x” percent of the sampling period and is also referred to as a statistical sound level. Common exceedance sound level values are the 10-, 50-, 90-percentile exceedance sound levels, denoted by  $L_{10}$ ,  $L_{50}$ , and  $L_{90}$ . The equivalent-continuous sound level ( $L_{eq}$ ) is the logarithmic average (i.e., energy

average) of the varying sound over a given time period and is the most common metric used to describe sound. The  $L_{90}$  is typically considered the “background” sound level since it excludes many short, intermittent sounds and captures the sound levels experienced most of the time (i.e., sound levels 90 percent of the time).

## City of Yorkville Noise Ordinance

The Code of Ordinances of Yorkville, Illinois Title IV, Chapter 4 limits noise levels from the Project. The ordinance states, “No person shall operate or cause to be operated any source of sound in such a manner as to create a sound level which exceeds the sound level limits in table 1 of this section, as adjusted according to table 2 of this section.” Table 1 is reproduced below.

**Table 1: Sound Level Limits**

Time of Day	Receiving Property Land Use		
	Residential	Commercial	Public Parks and Other Public Open Spaces
Daytime (7:00 a.m. - 10:00 p.m.)	60 dBA	67 dBA	67 dBA
Nighttime (10:00 p.m. - 7:00 a.m.)	50 dBA	67 dBA	67 dBA

Table 2 of the ordinance provides adjustments for varying durations of noise within a given hour as well as penalties to apply for noise of an impulsive character or tonal. The specific equipment manufacturers and models for the Project have not been selected at this time. The type of equipment that generates noise as part of the Project (chillers and emergency generators) does not operate in an impulsive manner and the equipment can be specified and procured to not emit prominent discrete tones or tonal noise. Provided the developer of the Project selects non-tonal equipment for operations, the continuous noise generated by the Project would be limited to 60 dBA during the day and 50 dBA during the night at residential receptors. The City of Yorkville ordinance includes an exemption for “emergency short term operations.” The City of Yorkville has confirmed that the operation of the emergency generators during a full blackout would be exempt from the noise limits according to the exemption.

Design goals have been developed for the Project boundary based on the City of Yorkville ordinance. For normal operation, which could generate noise at any time of the day, the design goal is 50 dBA at the receiving residential property boundaries to meet the nighttime sound level limits. For generator testing, which occurs during daytime hours, the design goal is 60 dBA to meet daytime limits when maintenance generator testing would occur.

## Ambient Measurements

Variations in noise environments are typically due to existing land uses, population density, and proximity to transportation corridors. Elevated existing ambient sound levels in the region occur near major transportation corridors such as interstate highways and in areas with higher population densities. Principal contributors to the existing noise environment likely include motor vehicle traffic on local roadways, typical agricultural noise sources, and natural sounds such as birds, insects, and leaf or vegetation rustle during elevated wind conditions. Diurnal effects result in sound levels that are typically quieter during the night than during the daytime, except during periods when evening and nighttime insect noise dominates in warmer seasons.

Burns & McDonnell personnel conducted sound level measurements to establish the existing background sound levels in the area surrounding the Project site. Sound levels were measured using Larson Davis Model 821 sound level meters with associated preamplifiers and ½-inch free-field precision microphones meeting American National Standards Institute (ANSI) S1.4 Type 1 specifications. One-half inch random-incidence microphones were used on the meters. All measurement and field

calibration equipment were certified by a traceable laboratory within 12 months prior to the measurement. Field calibration confirmations were performed before and after the long-term measurements and before and after each set of short-term measurements. The meter and calibrator were checked within a year prior of the measurements to verify compliance with the U.S. National Institute of Standards and Technology specifications. The calibration drift was within tolerance over the duration of the measurement survey.

The sound survey protocol was developed based on procedures outlined in the ANSI 12.9 Quantities and Procedures for Description and Measurement of Environmental Sound standard. Continuous sound level measurements were collected near the boundaries of the proposed Project in the four cardinal directions. The meters were placed in the directions of the nearest residential receivers, set back from the roadways the appropriate distance per the standard. The survey was undertaken continuously from June 17 to 18, 2025, during daytime and nighttime hours. Weather data was reviewed from a nearby weather station (Weather Station ID: KILYORKV81). Average wind speeds were within ANSI guidance and the only recorded precipitation recorded during the measurement period was at the very end of the measurement at 1:00 p.m. on June 18<sup>th</sup>. The measurement locations are provided in Figure 2 of Attachment 1. A summary of the ambient measurements is provided in Table 2 below and hourly average sound levels are provided in Attachment 2.

**Table 2: Continuous Sound Level Monitoring Summary**

Measurement Location	Time of Day	L <sub>eq</sub> (dBA)	L <sub>90</sub> (dBA)
MP1	Daytime	69	52
	Nighttime	67	40
MP2	Daytime	61	44
	Nighttime	59	39
MP3	Daytime	69	48
	Nighttime	67	40
MP4	Daytime	59	37
	Nighttime	57	37

Sound levels in the Project area were variable; the major noise sources across the Project area included local traffic (passenger cars and large trucks) and typical sounds of nature (insects and bird calls). Transient noise levels were greater along local traffic thoroughfares (Highway 47 and Galena Road). Sound levels are provided in both L<sub>eq</sub> and L<sub>90</sub> to represent the background ambient sound levels for the Project. The L<sub>90</sub> sound levels exclude the majority of the instantaneous and intermittent noise from occasional traffic. L<sub>90</sub> is generally used to represent the typical background noise for a given area.

### Sound Modeling Methodology

Sound modeling was performed using the industry-accepted sound modeling software Computer Aided Noise Abatement (CadnaA), version 2025. The software is a scaled, three-dimensional program that takes into account air absorption, terrain, ground absorption, reflections and shielding for each piece of sound-emitting equipment and predicts sound pressure levels. The model calculates sound propagation based on International Organization of Standardization (ISO) 9613-2:2024, General Method of Calculation. ISO 9613-2 assesses the sound level propagation based on the octave band center-frequency range.

The ISO standard considers sound propagation and directivity. The software calculates sound propagation using omnidirectional, downwind sound propagation and worst-case directivity factors. In other words, the model assumes that each piece of equipment propagates its worst-case sound levels in all directions at all times. Empirical studies accepted within the



industry have demonstrated that modeling may over-predict sound levels in certain directions, and as a result, modeling results generally are considered a conservative measure of a project's actual sound level. The modeled atmospheric conditions were assumed to be calm, and the temperature and relative humidity were left at the program's default values. Reflections and shielding were considered for sound waves encountering physical structures.

## Project Sound Sources

The sound level design goal is applicable at the Project property line and the most impacted locations were identified surrounding the Project. Project sound sources were modeled in the locations shown in Figure 1 of Attachment 1. A summary of the modeling assumptions for each piece of equipment is provided in Table 3.

**Table 3: Predictive Modeling Sound Level Inputs**

Source	Number of Sources	Modeled Equipment Sound Level Assumption <sup>a</sup>
Chillers (Low-Noise)	1,350	$L_w = 91$ dBA
Emergency Generators	1,000	$L_p = 65$ dBA at 50 feet
Substation Transformer (Low Noise)	17	$L_w = 89$ dBA

(a)  $L_w$  = sound power level;  $L_p$  = sound pressure level; dBA = A-weighted decibels, NEMA = National Electrical Manufacturers Association

### Chillers

Each chiller was estimated to have an overall sound power level of 91 dBA. This would likely be a low-noise option, or a model which may include mitigation in detailed design. The manufacture and model type for the chillers have not been selected at this time. To determine if a chiller for this data center could meet an overall sound power level of 91 dBA, Burns & McDonnell started with a common air-cooled chiller used in these applications, the York YVFA with 390-ton cooling capacity. The York unit is provided with an operating sound power level between 97 dBA (75% load) and 100 dBA (100% load). The units would likely operate at significantly quieter sound levels during nighttime hours, but due to the preliminary nature of this design, the load level during nighttime hours is unknown. The unit's octave band sound levels, show that the unit operates as a broadband source and does not operate in a tonal nature. To get down to a 91 dBA sound power level, additional mitigation would be required for these units. Chiller add-on mitigation would need to provide 6-9 dBA reductions to meet the design goal and can typically be supplied for these units through a supplier like BRD Hush Core. Some of their common add on mitigation options are listed below.

1. Standard (2-5 dBA reduction)
  - a. Treatment of the compressor circuits for chillers. HUSH COVERS are used for the compressor housing, suction and discharge piping and oil separator vessels.
2. Unitary (4-6 dBA reduction)
  - a. The Unitary System is a top mounted, unit supported plenum style acoustically insulated stack constructed using HUSH GUARD™ sound panels.
3. Louver (5-7 dBA reduction)
  - a. The Louver System uses high performance type HUSH DUCT silencers up to 36" deep for direct bolting to the chiller cabinet/frame.
4. Summit (9-15 dBA reduction)
  - a. The Summit System for air-cooled chillers is a high-performance source-applied treatment of the chiller's intakes and discharge fans using Hush Guard panels and Hush Duct Silencers.



During detailed design, nighttime cooling loads would be considered, and this level of noise mitigation may not be required. The standard offering of sound level reductions are shown above to confirm that mitigated chillers could reasonably get down to the levels specified in Table 3. Other chiller mitigation options include using a different chiller, sound walls, and relocation of the chiller equipment. Having the chillers on top of the building puts the chillers further away from the property boundaries and reduces the potential for offsite noise impacts.

### ***Emergency Generators***

Each emergency generator was estimated to have an overall sound power level of 105 dBA (sound pressure level of 65 dBA at 50 feet). The generators were modeled inclusive of both the generator enclosure and exhaust stack.

### ***Substation Transformers***

The Project is expected to include seventeen (17) 167-megavolt-ampere (MVA) substation transformers. According to National Electrical Manufacturers Association (NEMA) TR-1, the 167-MVA transformers would have a standard sound pressure level of 75 dBA, measured in accordance with the Institute of Electrical and Electronics Engineers (IEEE) Standard C57.12.90. The IEEE Standard requires sound level measurements to be averaged around the unit, measured at distances of 1 foot from the tank of the transformer and 6 feet from fan cooled surfaces. Based on typical transformer sizes the sound power level is expected to be around 95 dBA. In order to meet the City sound level limits at the property lines low-noise transformers would need to be specified to not exceed 89 dBA sound power level. The 89 dBA sound power level transformers were included in the predictive model.

## **Operational Scenario Assumptions**

The model was evaluated for two operational scenarios: Normal Operation and Generator Testing. Normal Operation represents the condition where all campus chillers are at 100% load without the use of generators. Generator Testing represents the condition where all campus chillers are at 100% load and two generators per data center building are being tested at 100% load. Emergency operations would represent a condition during an emergency situation where all equipment is operation and running at 100% load. The emergency operation scenario was not modeled because it is not considered “normal conditions” and the City of Yorkville confirmed the emergency scenario is exempt from the limits. A summary of each modeled scenario is provided in Table 4.

**Table 4: Summary of Operating Scenarios**

<b>Operating Scenario</b>	<b>Normal Operation</b>	<b>Generator Testing</b>	<b>Emergency Operation</b>
Design Goal	50 dBA at property lines	60 dBA at property lines	--
<b>Equipment in Operation for Each Scenario</b>			
Chiller	All On at 100% Load	All On at 100% Load	All On at 100% Load
Generators	All Off	2 per Building at 100% Load	All On at 100% Load
Transformers	All On	All On	All Off

## **Sound Modeling Results**

The Project equipment was modeled using the provided sound level assumptions for Normal Operation and Generator Testing scenarios. A tabulated summary of the most impacted property line location is provided in Table 5.

**Table 5: Modeled Project Sound Levels at Property Lines**

Receiver	Modeled Sound Level (dBA)	
	Normal Operation	Generator Testing
Boundary NW	48	49
Boundary N	50	50
Boundary NE	50	50
Boundary E	49	49
Boundary SE	50	50
Boundary SW	49	49
Boundary NW	48	49

The most impacted property line receivers were modeled to be below the design goals during Normal Operation and Generator Testing. Sound level contours were generated for the two operating scenarios, in 5-dBA increments, at a height 5 feet above grade as shown in Figure 3 and Figure 4 of Attachment 1.

## Conclusion

Burns & McDonnell provided an acoustic analysis for the proposed Project Cardinal data center based on representative equipment sound levels and the site plan provided. The modeling results show that the Project design can feasibly meet the City of Yorkville sound level limits using low-noise chillers. Placing the chillers on top of the buildings puts the units farther from the Project property boundaries, which is used to help reduce noise offsite. Specifying non-tonal chillers when purchased will allow the Project to not emit prominent discrete tones offsite and would not require a 10-dBA penalty be applied to the limits.

Sincerely,

Burns & McDonnell



Gabriel Weger  
Section Manager – Acoustics

## Attachments

- Attachment 1 – Figures
- Attachment 2 – Measurement Data

## Attachment 1 – Figures

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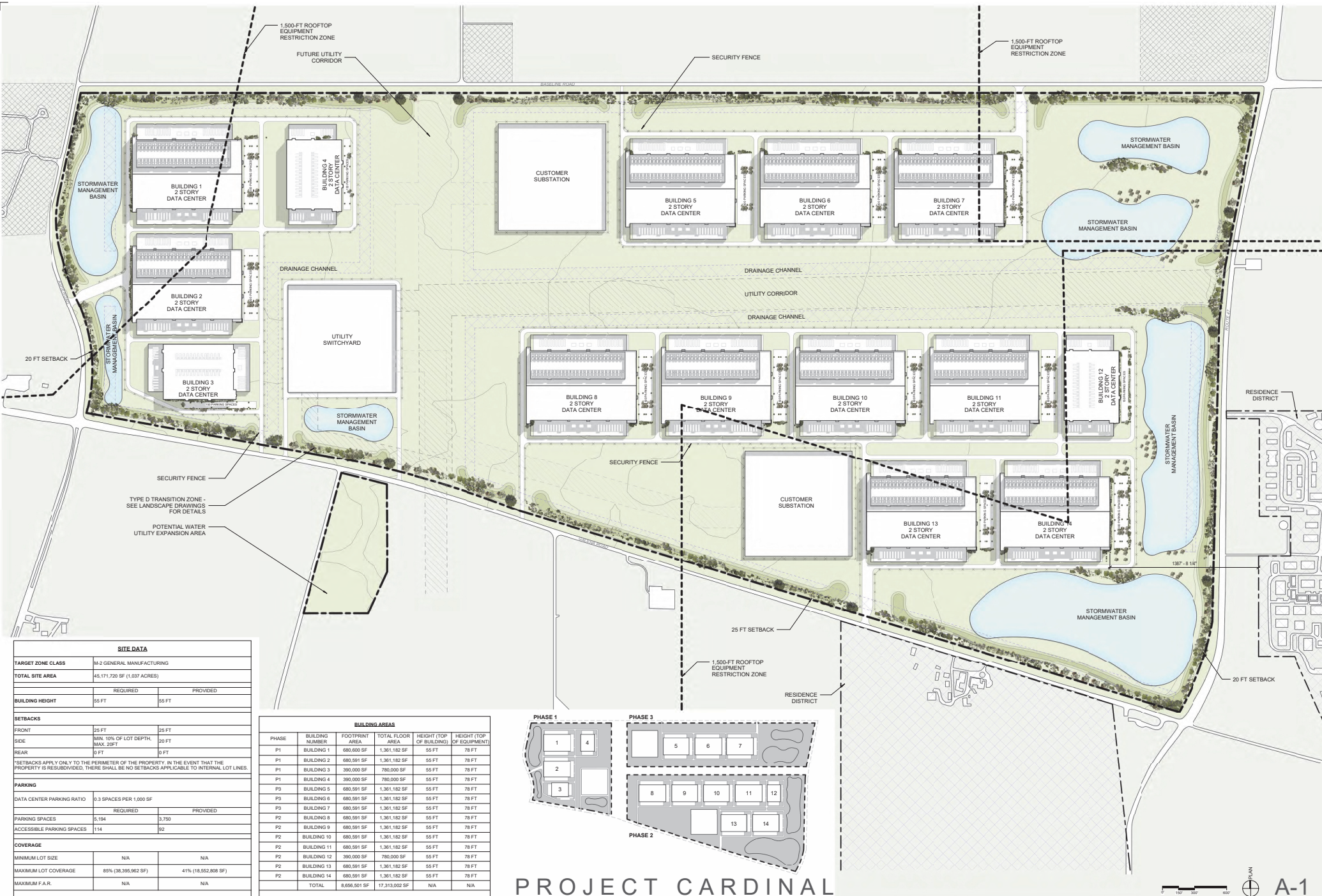


FIGURE 1 - SITE PLAN



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Project Area

Project Structures

Measurement Points

Barriers

00.150.3

MILES

00.150.3

KILOMETERS

N

**Figure 2**  
**Monitoring Locations**

LOCATION: Yorkville, Illinois

PROJECT: Pioneer Development - Project Cardinal

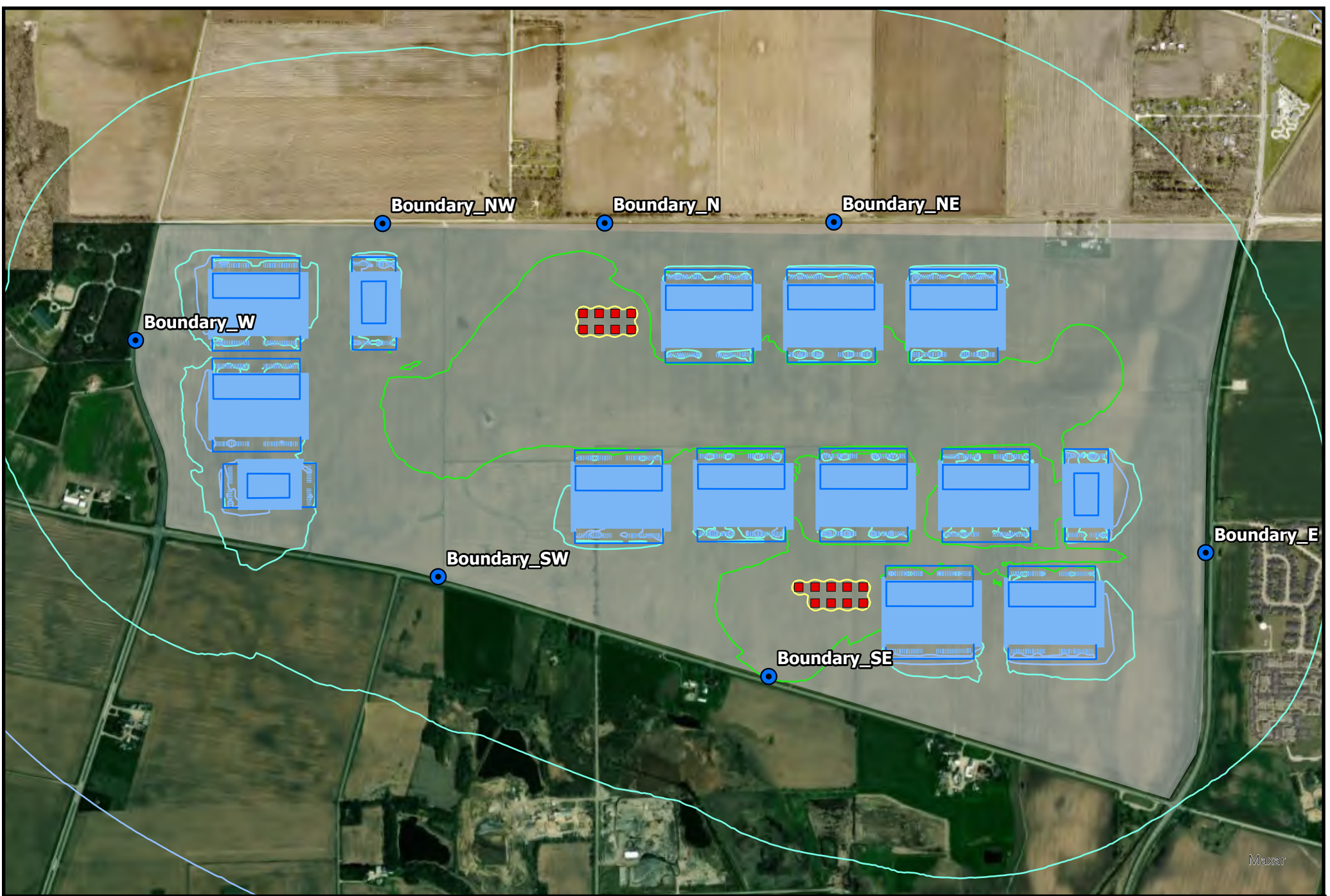
PROJ. NO.: 182671

CREATED: 06/27/2025

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LEGEND			
Project Area	40 dBA	60 dBA	Receptors
Project Structures	45 dBA	65 dBA	Transformers
Barriers	50 dBA		
	55 dBA		

REFERENCE	
	0 0.15 0.3 MILES
	0 0.15 0.3 KILOMETERS

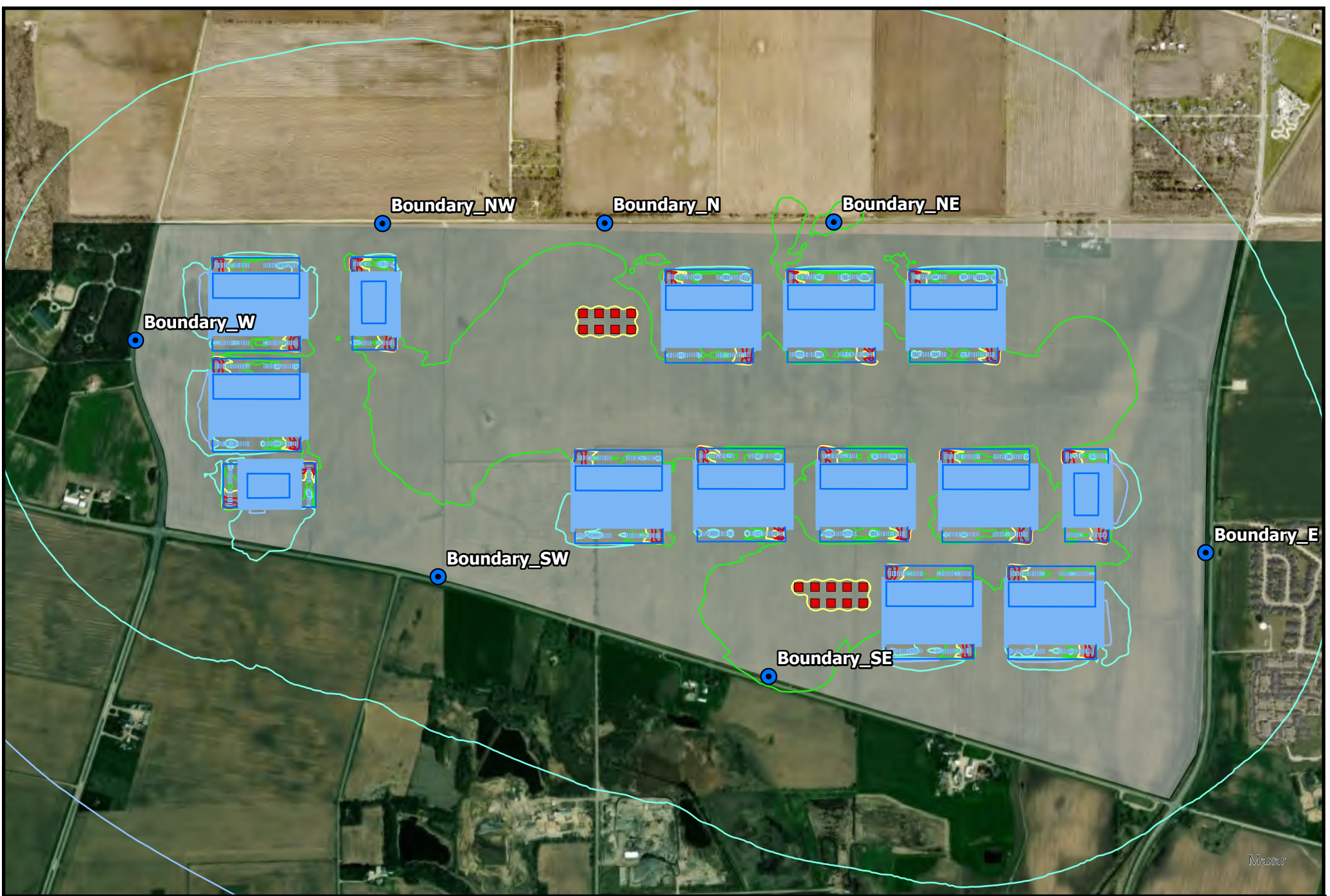
**Figure 3**  
**Operational Sound Level Contours (dBA)**

LOCATION:	Yorkville, Illinois
PROJECT:	Pioneer Development - Project Cardinal
PROJ. NO.:	182671
CREATED:	07/09/2025

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LEGEND			
	Project Area		40 dBA
	Project Structures		45 dBA
	Barriers		60 dBA
			65 dBA
			50 dBA
			55 dBA
	Receptors		Transformers

REFERENCE	
	0 0.15 0.3 MILES
	0 0.15 0.3 KILOMETERS

**Figure 4**  
**Maintenance Sound Level Contours (dBA)**

LOCATION:	Yorkville, Illinois
PROJECT:	Pioneer Development - Project Cardinal
PROJ. NO.:	182671
CREATED:	07/09/2025

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## Attachment 2 – Measurement Data

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Table 1 - Hourly Average Sound Levels - MP01

Time	MP01 [dBA]			
	Leq	L10	L50	L90
6/17/25 11:00 AM	70	73	65	54
6/17/25 12:00 PM	69	73	65	55
6/17/25 1:00 PM	69	73	65	53
6/17/25 2:00 PM	68	72	65	50
6/17/25 3:00 PM	69	72	65	54
6/17/25 4:00 PM	69	71	65	55
6/17/25 5:00 PM	68	71	65	54
6/17/25 6:00 PM	67	71	65	52
6/17/25 7:00 PM	66	69	61	48
6/17/25 8:00 PM	65	68	59	47
6/17/25 9:00 PM	67	68	58	46
6/17/25 10:00 PM	66	71	58	45
6/17/25 11:00 PM	64	66	48	38
6/18/25 12:00 AM	63	63	45	35
6/18/25 1:00 AM	60	60	40	32
6/18/25 2:00 AM	63	62	43	33
6/18/25 3:00 AM	66	66	49	40
6/18/25 4:00 AM	66	69	53	42
6/18/25 5:00 AM	70	73	63	48
6/18/25 6:00 AM	70	74	66	51
6/18/25 7:00 AM	70	73	66	52
6/18/25 8:00 AM	69	73	65	52
6/18/25 9:00 AM	70	74	65	53
6/18/25 10:00 AM	70	74	65	50
6/18/25 11:00 AM	71	75	67	54
6/18/25 12:00 PM	70	73	65	51
6/18/25 1:00 PM	65	76	69	56
<b>Average Daytime:</b>	69	72	64	52
<b>Average Nighttime:</b>	67	67	52	40

*\*Note: The average Leq daytime and nighttime sound levels shown are the logarithmic energy average of the 1-hour sound levels measured. The L10, L50, and L90 are the arithmetic averages of the 1-hour values*

Table 2 - Hourly Average Sound Levels - MP02

Time	MP02 [dBA]			
	Leq	L10	L50	L90
6/17/25 12:00 PM	61	73	55	47
6/17/25 1:00 PM	61	73	54	46
6/17/25 2:00 PM	62	73	53	44
6/17/25 3:00 PM	60	72	53	45
6/17/25 4:00 PM	59	72	55	45
6/17/25 5:00 PM	59	71	54	43
6/17/25 6:00 PM	58	71	52	39
6/17/25 7:00 PM	65	71	49	37
6/17/25 8:00 PM	57	69	50	39
6/17/25 9:00 PM	60	68	52	42
6/17/25 10:00 PM	60	68	51	41
6/17/25 11:00 PM	56	71	48	38
6/18/25 12:00 AM	54	66	41	36
6/18/25 1:00 AM	53	63	39	35
6/18/25 2:00 AM	54	60	41	35
6/18/25 3:00 AM	57	62	44	39
6/18/25 4:00 AM	60	66	48	42
6/18/25 5:00 AM	62	69	54	45
6/18/25 6:00 AM	61	73	54	44
6/18/25 7:00 AM	61	74	53	44
6/18/25 8:00 AM	61	73	54	44
6/18/25 9:00 AM	60	73	53	44
6/18/25 10:00 AM	61	74	53	43
6/18/25 11:00 AM	62	74	56	47
6/18/25 12:00 PM	60	75	53	41
6/18/25 1:00 PM	61	73	59	54
<b>Average Daytime:</b>	61	72	53	44
<b>Average Nighttime:</b>	59	66	46	39

\*Note: The average Leq daytime and nighttime sound levels shown are the logarithmic energy average of the 1-hour sound levels measured. The L10, L50, and L90 are the arithmetic averages of the 1-hour values

Table 3 - Hourly Average Sound Levels - MP03

Time	MP03 [dBA]			
	Leq	L10	L50	L90
6/17/25 12:00 PM	68	72	56	43
6/17/25 1:00 PM	68	72	56	44
6/17/25 2:00 PM	69	73	60	46
6/17/25 3:00 PM	70	74	66	51
6/17/25 4:00 PM	70	74	67	54
6/17/25 5:00 PM	71	74	66	53
6/17/25 6:00 PM	68	73	61	49
6/17/25 7:00 PM	67	72	57	46
6/17/25 8:00 PM	66	71	56	45
6/17/25 9:00 PM	66	70	56	42
6/17/25 10:00 PM	67	71	58	45
6/17/25 11:00 PM	64	66	50	42
6/18/25 12:00 AM	61	61	44	35
6/18/25 1:00 AM	61	59	41	35
6/18/25 2:00 AM	64	58	41	33
6/18/25 3:00 AM	61	60	44	37
6/18/25 4:00 AM	68	72	55	43
6/18/25 5:00 AM	71	75	61	49
6/18/25 6:00 AM	71	76	63	50
6/18/25 7:00 AM	71	75	63	50
6/18/25 8:00 AM	70	75	62	47
6/18/25 9:00 AM	69	74	58	46
6/18/25 10:00 AM	69	73	56	44
6/18/25 11:00 AM	71	75	61	48
6/18/25 12:00 PM	70	74	61	46
6/18/25 1:00 PM	72	78	65	56
<b>Average Daytime:</b>	69	73	60	48
<b>Average Nighttime:</b>	67	65	49	40

\*Note: The average Leq daytime and nighttime sound levels shown are the logarithmic energy average of the 1-hour sound levels measured. The L10, L50, and L90 are the arithmetic averages of the 1-hour values

Table 4 - Hourly Average Sound Levels - MP04

Time	MP04 [dBA]			
	Leq	L10	L50	L90
6/17/25 12:16 PM	57	59	47	39
6/17/25 1:00 PM	56	59	45	38
6/17/25 2:00 PM	55	60	44	37
6/17/25 3:00 PM	57	61	44	36
6/17/25 4:00 PM	56	61	43	36
6/17/25 5:00 PM	57	62	42	35
6/17/25 6:00 PM	56	61	41	33
6/17/25 7:00 PM	55	59	42	34
6/17/25 8:00 PM	55	60	45	33
6/17/25 9:00 PM	59	64	45	37
6/17/25 10:00 PM	63	69	46	38
6/17/25 11:00 PM	52	53	44	38
6/18/25 12:00 AM	50	50	38	33
6/18/25 1:00 AM	51	49	37	33
6/18/25 2:00 AM	55	46	40	35
6/18/25 3:00 AM	50	48	40	35
6/18/25 4:00 AM	55	56	43	39
6/18/25 5:00 AM	59	63	48	42
6/18/25 6:00 AM	60	64	48	41
6/18/25 7:00 AM	58	62	45	40
6/18/25 8:00 AM	58	62	45	39
6/18/25 9:00 AM	55	59	44	37
6/18/25 10:00 AM	56	60	42	36
6/18/25 11:00 AM	58	62	48	39
6/18/25 12:00 PM	57	62	46	33
6/18/25 1:00 PM	60	64	53	49
<b>Average Daytime:</b>	59	61	45	37
<b>Average Nighttime:</b>	57	54	42	37

*\*Note: The average Leq daytime and nighttime sound levels shown are the logarithmic energy average of the 1-hour sound levels measured. The L10, L50, and L90 are the arithmetic averages of the 1-hour values*