



URBAN  
SOLUTION  
GROUP

## **ECMC Form 2A and WOGLA 1041 Noise Mitigation Plan**

Larkspur Fed Pad  
Weld County, Colorado

Prepared for:

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# TABLE OF CONTENTS

1	Executive Summary .....	1
2	Regulations and Noise Standards Summary.....	2
	ECMC Rule 423 Noise Regulation – Brief Overview .....	2
	WOGLA Noise Regulations and Standards – Section 21-5-435.....	4
	Compliance Summary (Unadjusted) .....	7
	Maximum Permissible Noise Levels (Adjusted) - Summary.....	8
3	Summary of BMPs and Mitigation to be Implemented .....	9
4	Site Information.....	10
5	Compliance Points .....	11
6	Estimated Operations & Duration Schedule .....	11
7	Ambient Sound Level Survey .....	12
8	Noise Impact Assessment.....	13
	Methodology.....	13
	Equipment Information and Site Layouts .....	14
	Drilling Noise Model Results .....	15
	Completions Noise Model Results .....	18
	Production Noise Model Results.....	21
	Flowback Operations Review.....	24
9	Continuous Monitoring / Complaint Resolution .....	25
10	Conclusion .....	25
11	Notations .....	25
	Appendix 1 – Equipment Layouts .....	26
	Appendix 2 – Sound Fundamentals .....	30
	Appendix 3 – Glossary.....	33

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## 1 EXECUTIVE SUMMARY

Urban Solution Group, LLC (Urban) was commissioned to prepare a Noise Mitigation Plan (NMP) for the proposed Larkspur Fed Pad to be operated by **Kerr-McGee Oil and Gas Onshore, LP** (KMOG). KMOG is proposing to develop oil and natural gas wells at the Larkspur Fed Pad located in Weld County, Colorado. The purpose of this plan is to assess predicted environmental noise impacts from the proposed operations on the surrounding area as compared to the maximum permissible noise level (MPNL) limits described in both the Colorado Energy and Carbon Management Commission (ECMC) Rule 423, and the Weld County Oil and Gas Location Assessment (WOGLA) Section 21-5-435, noise regulations.

To facilitate this work, the following analyses were completed:

- Completion of a full site-specific Noise Impact Assessment (NIA) with individual models for:
  - Drilling operations with the Precision Drilling Rig #461
  - Completions operations with a Halliburton Q10 XLE Low Noise Fleet
  - Production operations with the equipment and layout proposed by KMOG
- Specification of Best Management Practices (BMPs) that will be implemented at the proposed Larkspur Fed location such that all operations comply with both noise regulations and minimize the environmental noise impact on the surrounding area

The results of the analyses with full implementation of the BMPs for the Larkspur Fed location are summarized as follows:

Analysis Type	Result
Noise points of compliance	<ul style="list-style-type: none"><li>• All occupied residential building units (RBUs) and applicable building units (BUs) are beyond 2,000 feet from the edge of the location. Thus, there are no noise points of compliance per ECMC, and noise contours are provided for Weld County consideration.</li></ul>
Pre-Operational Ambient Sound Level Survey	<ul style="list-style-type: none"><li>• All occupied buildings units are beyond 2,000 feet from the edge of the location, so no ambient survey was required or performed.</li></ul>
Drilling Operations NIA	<ul style="list-style-type: none"><li>• No noise mitigation required.</li></ul>
Completions Operations NIA	<ul style="list-style-type: none"><li>• No noise mitigation required.</li></ul>
Flowback Operations	<ul style="list-style-type: none"><li>• Utilizes a fraction of similar, but smaller equipment compared to the three other operations studied. No noise mitigation required.</li></ul>
Production Operations NIA	<ul style="list-style-type: none"><li>• No noise mitigation required.</li></ul>

## 2 REGULATIONS AND NOISE STANDARDS SUMMARY

Noise for energy related facilities located in Weld County, Colorado, is regulated through two separate agencies. The first, at the state level, is through the Colorado Energy and Carbon Management Commission (ECMC) 423 series noise regulation. The second is through Weld County's Oil and Gas Location Assessment (WOGLA) Section 21-5-435, noise regulation. These regulations set the MPNLs, which limit noise emitted from energy facilities within the study area over a specified period, as measured at noise points of compliance. These allowable limits are dependent on the land use zoning within the study area. An overview of the ECMC regulation is presented first, followed by the Weld County WOGLA noise regulation. The most constraining components of each are then summarized at the end of this section to clarify compliance requirements.

### **ECMC Rule 423 Noise Regulation – Brief Overview**

Section 423.b (1) of ECMC Rule 423 states that all Oil and Gas Operations will comply with the MPNLs in Table 1 below unless otherwise required by Rule 423.

**Table 1. Maximum Permissible Noise Levels (ECMC Table 423-1)**

Zone	Daytime (7:00 a.m. – 7:00 p.m.)	Nighttime (7:00 p.m. – 7:00 a.m.)
Residential/Rural/State Parks & Wildlife Areas	55 dB(A)	50 dB(A)
Commercial/Agricultural	60 dB(A)	55 dB(A)
Light industrial	70 dB(A)	65 dB(A)
Industrial	80 dB(A)	75 dB(A)
All Zones	60 dB(C)	60 dB(C)

Exceptions to these MPNLs for Drilling, Completions and Flowback Operations are outlined in section 423.b (2) as follows:

- A. In Residential/Rural or Commercial/Agricultural, MPNLs will be 60 dBA in the hours between 7:00 p.m. to 7:00 a.m. and 65 dBA in the hours between 7:00 a.m. to 7:00 p.m.; and
- B. In all zones MPNLs will be 65 dBC in the hours between 7:00 p.m. to 7:00 a.m. and 65 dBC in the hours between 7:00 a.m. to 7:00 p.m.

These MPNLs are applied at “noise points of compliance”. These points are chosen as outlined in section 423.a (5) of the Regulation:

- (5) For proposed Oil and Gas Locations with a Working Pad Surface within 2,000 feet of one or more Residential Building Units (RBUs), at least one, and no more than six noise points of compliance where monitors will be located. Operators will identify noise points of compliance using the following criteria:

A. Provide one noise point of compliance in each direction in which an RBU is located within 2,000 feet of the proposed Working Pad Surface.

B. Noise points of compliance will be located at least 350 feet from the Working Pad Surface, and no less than 25 feet from the exterior wall of the RBU that is closest to the Working Pad Surface. If a Surface Owner or tenant refuses to provide the Operator with access to install a noise monitor, then the noise point of compliance will be located at either the next-closest RBU or an alternative location approximately the same distance and direction from the Working Pad Surface.

Demonstration of compliance with noise level limits during operation is outlined in section 423.c (2) as follows:

A. In response to a complaint or at the Director's request, Operators will measure sound levels at 25 feet from the complainant's occupied structure towards the noise source for low frequency (dBC) indicated issues. For high frequency (dBA) measurement will be at the nearest point of compliance. For equipment installed at Oil and Gas Locations subject to a Form 2A approved prior to January 15, 2021, after the Commencement of Production Operations, no single piece of equipment will exceed the MPNLs listed in Table 423-1 as measured at a point 350 feet from the equipment generating the noise in the direction from which the complaint was received.

Finally, adjustments to the MPNLs based on the measured pre-existing ambient noise levels are allowed. However, the new maximum allowable noise levels for permanent facilities such as Production Operations are capped and based on cumulative noise levels. Ambient adjustments and cumulative noise levels are outlined in section 423.d of the Regulation as follows:

d. Cumulative Noise. All noise measurements will be cumulative.

(1) Noise measurements taken at noise points of compliance designated pursuant to Rule 423.a.(5) will take into account ambient noise, rather than solely the incremental increase of noise from the facility targeted for measurement.

(2) At new or substantially modified Oil and Gas Locations where ambient noise levels at noise points of compliance designated pursuant to Rule 423.a.(5) already exceed the noise thresholds identified in Table 423-1, then Operators will be considered in compliance with Rule 423, unless at any time their individual noise contribution, measured pursuant to Rule 423.c, increases noise above ambient levels by greater than 5 dBC and 5 dBA between 7:00 p.m. and 7:00 a.m. or 7 dBC and 7 dBA between 7:00 a.m. and 7:00 p.m. This Rule 423.d.(2) does not allow Operators to increase noise above the maximum cumulative noise thresholds specified in Table 423-2 after the Commencement of Production Operations.

(3) After the Commencement of Production Operations, if ambient noise levels already exceed the MPNLs identified in Table 423-1, under no circumstances will new Oil and Gas Operations or a significant modification to an existing Oil and Gas Operations raise cumulative ambient noise above the following:

**Table 2. Maximum Cumulative Noise Levels (ECMC Table 423-2)**

Zone	Daytime (7:00 a.m. – 7:00 p.m.)	Nighttime (7:00 p.m. – 7:00 a.m.)
Residential/Rural/State Parks & Wildlife Areas	65 dB(A)	60 dB(A)
Commercial/Agricultural	70 dB(A)	65 dB(A)
Light industrial	80 dB(A)	75 dB(A)
Industrial	90 dB(A)	85 dB(A)
All Zones	75 dB(C)	70 dB(C)

### **WOGLA Noise Regulations and Standards – Section 21-5-435**

Section 21-5-435 of the WOGLA regulations require operators to describe plans for noise mitigation that demonstrate their capability to meet the MPNLs outlined in Table 435 A.1, which are reproduced in Table 3 below.

**Table 3. WOGLA Table 435 A.1 Maximum Permissible Noise Levels**

Noise Levels	Daytime (7:00 a.m. – 7:00 p.m.)	Nighttime (7:00 p.m. – 7:00 a.m.)
<b>A-scale</b>		
NL-1	55 dB(A)	50 dB(A)
NL-2	60 dB(A)	55 dB(A)
NL-3	65 dB(A)	60 dB(A)
NL-4	70 dB(A)	65 dB(A)
<b>C-scale</b>		
All Zones	65 dB(C)	65 dB(C)

Section 21-5-435.A also states:

1. During the Construction Phase or during operations involving Pipeline or Gas Facility installation or maintenance, use of a Workover rig, or stimulation, operators must comply with the following noise levels:
  - a. For Oil and Gas Locations within the Ag-Rural Planning Area, as depicted on the map in Appendix 21-B, Operators shall comply with the MPNL for the NL-4 standard.
  - b. For Oil and Gas Locations within the Near-Urban Planning Area, as depicted on the map in Appendix 21-B, Operators shall comply with the MPNL for the NL-3 standard.
  - c. The OGED Director may require Operators to comply with a lower MPNL in consultation with the Colorado Department of Public Health and Environment, or Colorado Parks and Wildlife.

2. During the Production Phase, Operators with Oil and Gas Locations in both the Ag-Rural and Near-Urban Planning Areas shall comply with the MPNL for the NL-1 standard.
3. As part of the 1041 WOGLA Application, a noise mitigation plan as outlined in Section 21-5-320.B.10., shall be required for all Oil and Gas Locations within the Near-Urban Planning Area. For Oil and Gas Locations within the Ag-Rural Planning Area, a noise mitigation plan shall be required only if there are Building Units (BUs), DOAAs, and/or High Priority Habitats within the 1041 WOGLA Zone.

Section 21-5-435.B: To demonstrate compliance with the standards set forth in Section 21-5-435.A, sound levels shall be measured according to the following standards:

1. Pursuant to an A-scale complaint:
  - a. Sound levels shall be measured at a distance of three hundred fifty (350) feet from the Oil and Gas Location, in the direction of the complainant.
  - b. At the request of the complainant or OGED Director, sound levels may be measured at a point beyond three hundred fifty (350) feet that the complainant or OGED Director believes is more representative of the noise impact.
  - c. If an Oil and Gas Location is located closer than three hundred fifty (350) feet from an existing occupied structure, sound levels shall be measured at a point twenty-five (25) feet from the structure towards the Oil and Gas Location.
  - d. On property owned by the Operator, noise levels shall be measured at three hundred fifty (350) feet from the Oil and Gas Location, or at the property line, whichever is greater.
  - e. In situations where measurement of noise levels at three hundred fifty (350) feet is unrepresentative or non-attainable due to topography, measurements may be taken at a more attainable/accessible distance and be extrapolated to a three hundred fifty (350) foot equivalent using the following formula:
    - d.  $\text{Unknown db(A)} = \text{Known db(A)} - (20 \times \log_{10}(d_2/d_1))$ 

This same formula should also be used when calculating db(C).
  - e. ( $d_2$  = standard distance 350 ft. &  $d_1$  = measured distance)
  - f. If a baseline noise survey has been conducted, the overall Leq within the closest direction of the complainant will be utilized to determine compliance.
2. Pursuant to a C-scale complaint:
  - a. In situations where the complaint or on-site inspection indicates that low frequency noise is a component of the problem, sound level measurements shall be taken twenty-

- five (25) feet from the exterior wall of the complainant's residence or occupied structure in the direction of the Oil and Gas Location, using a noise meter calibrated to the db(C) scale.
- b. If the noise source is on the same property as the complainant, db(C) readings will be taken twenty-five (25) feet from the exterior wall of the residence.
  - c. If the sound levels exceed the MPNLs as defined in Table 435 A.1, the OGED Director shall require the Operator to obtain a low frequency noise impact analysis by a qualified sound expert, including identification of any reasonable control measures available to mitigate such low frequency noise impact. Such study shall be provided to the OGED Director for review and possible action.
  - d. If a baseline noise survey has been conducted, the overall Leq within the closest direction of the complainant will be utilized to determine compliance.

Cumulative Noise:

- 1. When required, or in instances when baseline noise surveys have previously been conducted, noise measurements will take into account ambient noise, rather than solely the incremental increase of noise from the facility targeted for measurement.
- 2. If ambient noise levels already exceed the noise thresholds identified in Table 435 A.1 (Table 3), then during drilling or completion operations, including Flowback or operations involving Pipeline or Gas Facility installation or maintenance, use of a Workover rig, or stimulation, Operators will be considered in compliance, unless at any time their individual noise contribution, measured pursuant to Section 21-5-435.B, increases noise above ambient levels by greater than five (5) db(C) and five (5) db(A).
- 3. If ambient noise levels already exceed the maximum permissible noise thresholds identified in Table 435 A.1, under no circumstances shall the Production Phase exceed the ambient noise levels shown on the baseline noise survey.



### **Compliance Summary (Unadjusted)**

Under ECMC Rule 423, noise points of compliance can only be identified with respect to existing RBUs within 2,000 feet of the proposed oil and gas location. There are no occupied RBUs within 2,000 feet of the working pad surface, therefore there are no noise points of compliance regarding ECMC Rule 423.

With respect to WOGLA Regulation Section 21-5-435, there are no RBUs or applicable BUs within 2,000 feet of the proposed oil and gas location and thus, no compliance points are provided in this study (though it is recognized that the entire 350 foot buffer line is a potential compliance point for any complaints that come from BUs farther away).

The location is zoned with an agricultural land use designation and is situated in the Ag-Rural planning area based on information from the Weld County Zoning Department. The most stringent applicable MPNLs are summarized in Table 4 below.

***Table 4. Compliance Summary, Maximum Permissible Noise Levels (Unadjusted)***

Zone	Operation	Daytime (7:00 a.m. – 7:00 p.m.)	Nighttime (7:00 p.m. – 7:00 a.m.)
Commercial/Agricultural (ECMC)	Drilling, Completions & Flowback	65 dB(A)	60 dB(A)
		65 dB(C)	65 dB(C)
	Production	60 dB(A)	55 dB(A)
		60 dB(C)	60 dB(C)
Ag-Rural (WOGLA)	Drilling, Completions & Flowback	70 dB(A)	65 dB(A)
		65 dB(C)	65 dB(C)
	Production	55 dB(A)	50 dB(A)
		65 dB(C)	65 dB(C)

### **Maximum Permissible Noise Levels (Adjusted) - Summary**

Section 423.d(2) of the ECMC Regulation and Section 21-5-435.C of the WOGLA regulation allow for adjustments to the MPNLs if the measured ambient sound levels exceed the MPNLs. ECMC code allows for an adjustment of 7 dBA/dBC during daytime, and 5 dBA/dBC during nighttime for all operations (though production operations are also constrained by the cumulative maximums in Table 423-2 of ECMC Rule 423). Whereas the WOGLA regulation Section 21-5-435.C allows for an adjustment of 5 dBA/dBC for both daytime and nighttime periods during drilling, completions, and flowback operations; and production operations are not allowed to exceed the measured ambient noise level.

No ambient study was performed at the Larkspur Fed location, so no ambient adjustments are available or necessary at this time.

### 3 SUMMARY OF BMPS AND MITIGATION TO BE IMPLEMENTED

Best Management Practices (BMPs) are practices that are designed to prevent or reduce impacts caused by oil and gas operations on the environment and wildlife, and to minimize adverse impacts to public health, safety, and welfare.

The BMPs that KMOG plans to implement for the proposed Larkspur Fed site are as follows:

- KMOG conducted a Noise Impact Assessment (NIA) for each phase of operations (drilling, completions, and production) to assess operational noise levels against the maximum permissible dBA and dBC noise levels stated in both the ECMC Rule 423 and the WOGLA Section 21-5-435 noise regulations. Each phase of operation will comply with the MPNLs of both codes as summarized in Table 4 in Section 2 of this document.
- KMOG is utilizing a modified drilling rig designed to reduce overall noise levels. This will include low noise level shale shakers and modifications to the generator house to reduce noise levels from the exhaust vents and radiator fans. Additional noise reduction modifications may also be implemented depending on the rig contractor utilized following a noise survey study.
- KMOG will utilize a low noise completions fleet for all completions operations.
- Flowback operations and equipment were reviewed as part of this Noise Mitigation Plan (NMP). Flowback utilizes a fraction of similar, but smaller equipment compared to the three other operations studied. No mitigation is required for flowback operations.
- If the drilling rig or completions fleet is changed prior to commencement of operations, the mitigation measures employed will be equally or more protective. A sundry form will be submitted to outline any changes, per both codes, as required.
- KMOG will post contact information to receive and address noise complaints arising from preproduction operations around the clock, 24 hours, 7 days per week. Upon receipt of a complaint, either directly to KMOG, from the ECMC, or from Weld County, a KMOG representative will contact the associated stakeholder within 48 hours of receipt.

## 4 SITE INFORMATION

The proposed Larkspur Fed Pad will be located southeast of the intersection of the US Highway 85 and Weld County Road 26, in Weld County, near Platteville, CO. The location is zoned with an Agricultural land use designation, and is situated in the Ag-Rural planning area based on information from the Weld County online zoning portal. The closest major road is US Highway 85, located approximately 2,170 feet west of the proposed pad.

The Larkspur Fed location is slated for drilling, completions, and production operations. Drilling is planned utilizing the Precision Drilling Rig #461, and completions will be carried out with a Halliburton Q10 XLE Low Noise Fleet. Planned production equipment is provided in Figure 10 of Appendix 1.

Detailed location information is presented below, and an aerial view of the proposed location is shown in Figure 1 below.

**Location:** NW 1/4 SEC. 5, T2N, R66W, 6TH P.M.

**Drilling Rig:** Precision Drilling Rig #461

**Completions Rig:** Halliburton Q10 XLE Low Noise Fleet

**Production Equipment:** Details provided in Figure 10 of Appendix 1

**Pad Location Coordinates:** 40.168603°N, 104.804647°W

**Regulation Noise Target:** ECMC Rule 423 and WOGLA Section 21-5-435

**Figure 1. Aerial View of the Proposed Larkspur Fed location**



## 5 COMPLIANCE POINTS

The MPNLs for all operations are applied at noise compliance points. These points are chosen as outlined in both the ECMC Rule 423, and the Weld County WOGLA Section 21-5-435, noise regulations. The A-weighted compliance locations are chosen at points 350 feet from the proposed location in the direction of occupied structures within 2,000 feet of the proposed location; and the C-weighted compliance points are chosen as the occupied structures located within 2,000 feet (25 feet away from the occupied structure in the direction of the proposed Larkspur Fed location).

Although there are two RBUs within 2,000 feet of the Larkspur Fed location, they are permanently unoccupied (abandoned). Therefore, there are no compliance points regarding the ECMC regulation, since there are no occupied RBUs within 2,000 feet of the well pad. For Weld County, there are no occupied BUs within 2,000 feet of the well pad, so no compliance points have been provided in this study since it is very low risk (though it is recognized that the entire 350 foot buffer line is a potential compliance point for any complaints that come from BUs farther away).

## 6 ESTIMATED OPERATIONS & DURATION SCHEDULE

The following table reflects KMOG's planned construction and operations schedule for the Larkspur Fed Pad at the time of this Noise Mitigation Plan. The schedule in Table 5 below includes an estimated duration of each stage of operation, including construction, drilling, completion, flowback, and production.

***Table 5. KMOG's Planned Operations Schedule***

Phase	Duration (Days)	Estimated Start Date
Construction	60	Q2 2025
Drilling	77	Q2 2025
Completion	36	Q3 2025
Flowback	26	Q4 2025
Production	9,125 (25 years)	Q4 2025

## 7 AMBIENT SOUND LEVEL SURVEY

WOGLA Regulation Section 21-5-435.A.7 states that a baseline ambient sound level survey may be required if there are existing industrial/commercial activities within the 1041 WOGLA Zone, or it is requested by the Director.

Section 423.b of the ECMC regulation requires that the operator conduct a background ambient noise survey to establish baseline conditions for both A-scale and C-scale noise levels near the site if there are any RBUs within 2,000 feet of the oil and gas location.

Since there are no existing industrial/commercial activities within the 1041 WOGLA Zone; and there are no RBUs within 2000 feet of the working pad surface; and there are no affected high priority habitats in the area; and the Director has not made an explicit request to conduct a baseline ambient sound level survey (at the time of this NMP); there is no regulatory requirement for either noise regulation to conduct a baseline ambient sound level survey for this proposed location. Correspondingly, since there are no RBUs/BUs within 2000 feet of the location, operations at the proposed Larkspur site are very low risk with respect to environmental noise as a nuisance impact on the surrounding area. Therefore, a baseline ambient sound level survey was not conducted.



## 8 NOISE IMPACT ASSESSMENT

A Noise Impact Assessment (NIA) was conducted for the proposed Larkspur Fed Pad using a three-dimensional computer noise modeling software. This is a predictive model to aid in ascertaining the environmental impact of the proposed facility during all planned operations on the surrounding environment. The results of this assessment will compare the predicted levels of the Larkspur Fed Pad operations to the permissible noise level limits described in both the ECMC Rule 423, and WOGLA Section 21-5-435 noise regulations.

A brief explanation of the methodology is presented first, followed by noise model results for drilling, completions, and production.

### **Methodology**

All computer models and predicted noise levels generated for the assessment are developed with the commercial noise modeling software SoundPLAN 9.0. The ISO 9613-1 and 2 international standards are utilized in this software as they are widely accepted both internationally as well as in North America. The algorithms used in the commercial software package are based on methods and theory accepted in the environmental acoustics community. Both detailed equipment technical information and location specific topography, are used to generate comprehensive noise predictions that take into account environmental conditions, buildings, ground cover and barriers (natural, topographical, and otherwise). Note that actual field measurements may differ from modeled noise levels on any given day due to ever changing environmental factors and other noise sources in the study area not explicitly in the computer model. Table 6 below lists the conditions used in the model.

***Table 6. Conditions Used in SoundPLAN 9.0 Software***

Parameter	Modeled Input and Description
Temperature	55°F – Represents typical summer nighttime temperature
Topography	Modeled as is, with proposed location modified per grading plan
Wind Velocity	2.2 - 11.2 mph – ISO 9613 uses a slight downwind condition from each noise source to each receiver.
Wind Direction	From the noise source to the receptor points
Relative Humidity	40% - Typical summer nighttime relative humidity
Ground Absorption	Ranges from 0.0 for water bodies & major roadways up to 1.0 for thick grasslands

It is assumed that facility operating conditions do not change significantly between the daytime and nighttime periods. The resulting predicted noise levels are compared to the MPNLs outlined in both regulations to determine if the subject facility is compliant.

The noise levels generated in this predictive model are strictly from oil and gas operations at the proposed facility. Pre-existing sound sources such as those from animals, weather, road traffic, and all other ambient sounds are not included in the noise models.

### **Equipment Information and Site Layouts**

Drilling Operations at the Larkspur Fed location will be carried out using Precision Drilling Rig #461. The sound power levels used in this NIA are taken from the E21068 Precision Drilling Rig #461 Sound Signature Report prepared by Urban in 2021. The drilling equipment layout for the Larkspur Fed Pad is shown in Figure 8 of Appendix 1.

Completions Operations at the Larkspur Fed location are carried out using the Halliburton Oilfield Services (HAL) Low Noise Fleet. The sound power levels used for the HAL Low Noise Fleet in this NIA are taken from the E21067 HAL Low Noise Fleet Sound Signature Report prepared by Urban in 2021. The completions equipment layout for the Larkspur Fed Pad is shown in Figure 9 of Appendix 1.

Production Operations at the Larkspur Fed Pad are implemented per the equipment layouts supplied by KMOG. The sound power levels used for the production equipment in this NIA are taken from the E22003 Production Equipment Sound Signature Report (for the 60" separators), with the balance of production equipment taken from the E21069 Production Equipment Sound Signature Report; both of which were prepared by Urban Solution Group. The production equipment layout for the Larkspur Fed Pad is shown in Figure 10 of Appendix 1.





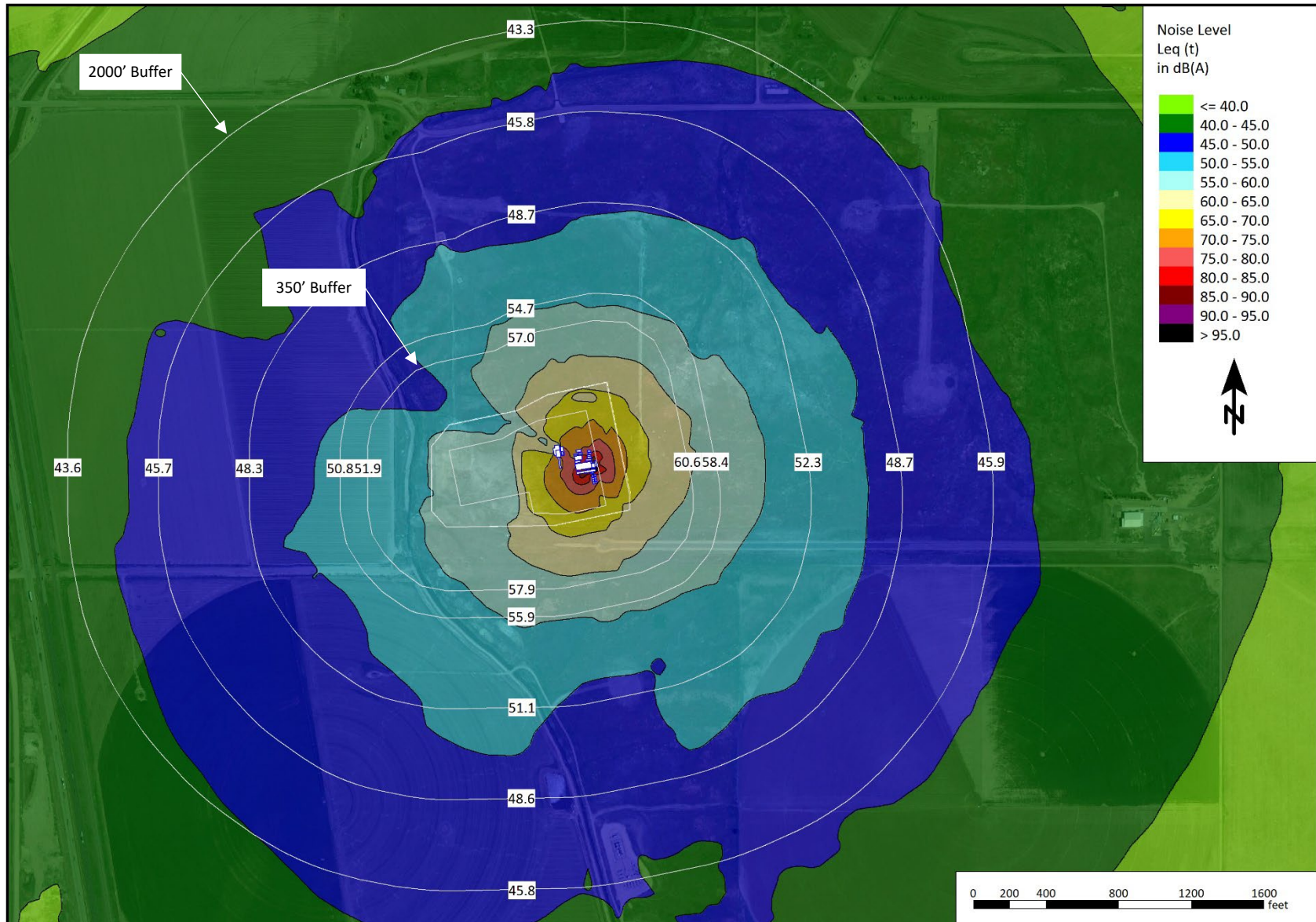
### **Drilling Noise Model Results**

Results for unmitigated drilling operations are presented on the following pages. The predicted levels only include sound levels from drilling operations and do not include ambient noise or noise contribution from other sources outside of the planned operations.

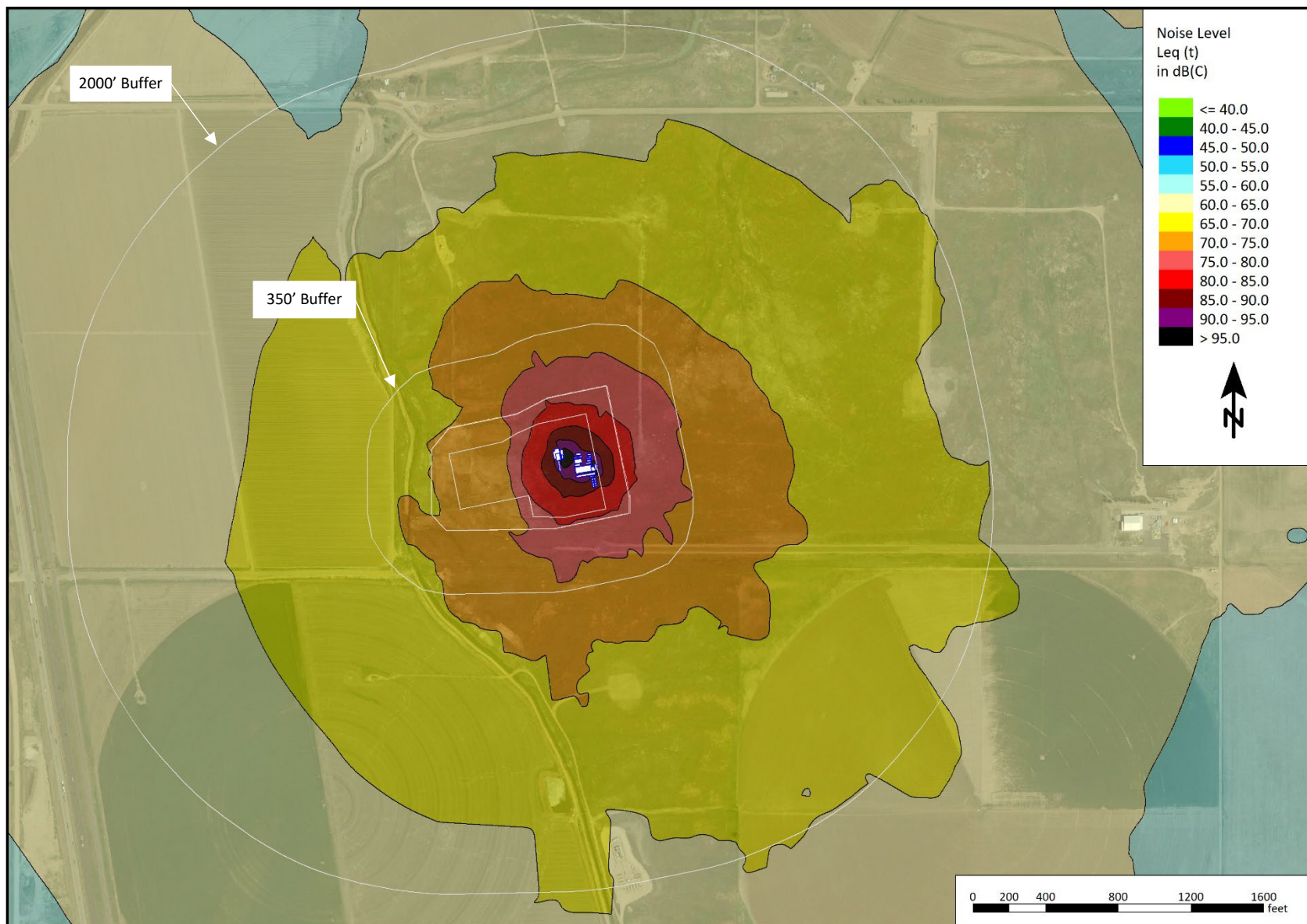
There are no occupied RBUs or BUs within 2,000 feet of the proposed Larkspur Fed location and thus, there is no tabular data presented in this section. Instead, noise contour maps are provided for the area surrounding the Larkspur Fed Pad. The contours are provided in 5 dB increments with the color scale indicating the sound level of each contour. Unmitigated drilling operations noise contour maps are presented in Figure 2 and Figure 3.



**Figure 2. Unmitigated Drilling Noise Contour Map (dBA)**



**Figure 3. Unmitigated Drilling Noise Contour Map (dBC)**



### **Completions Noise Model Results**

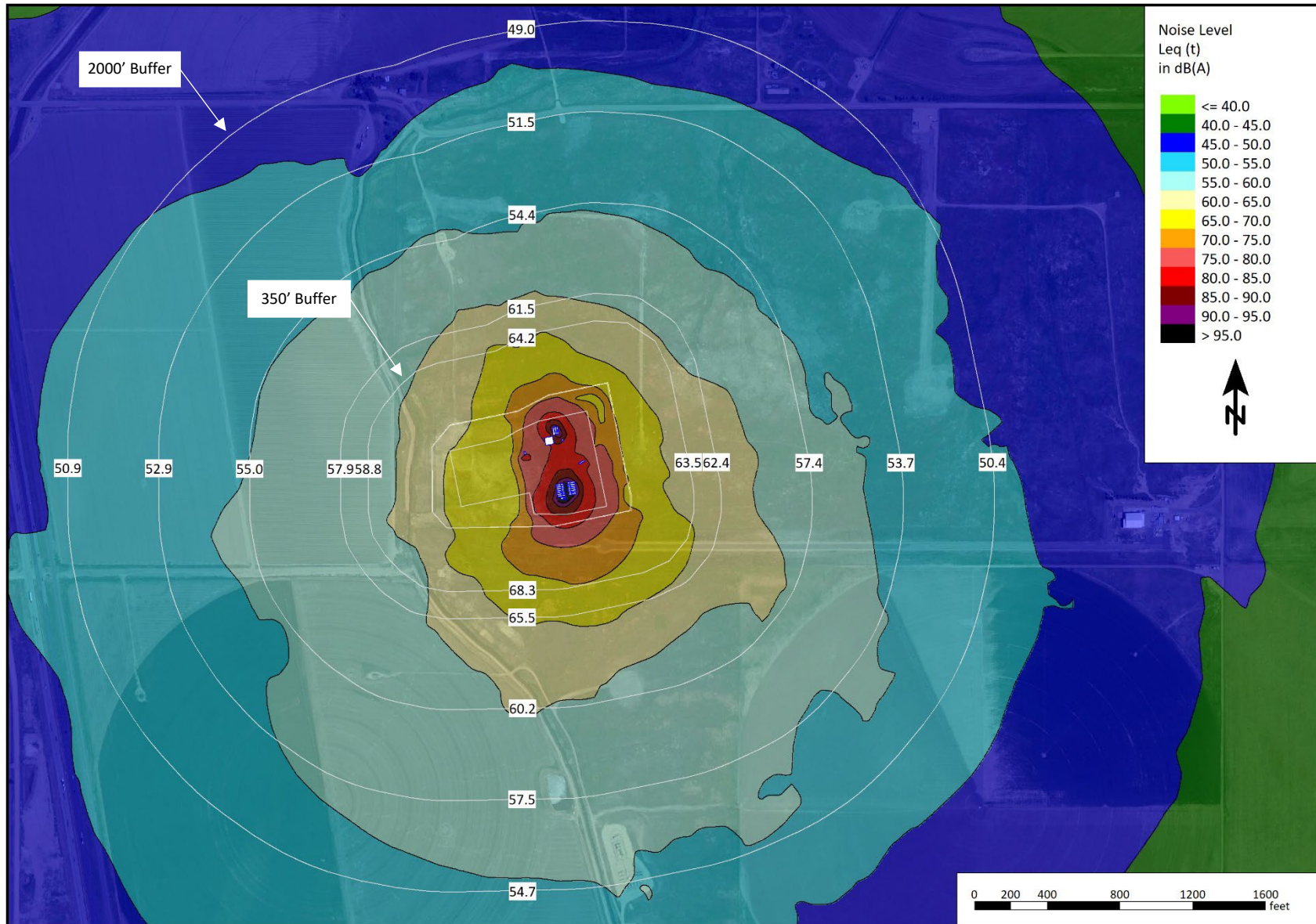
Results for unmitigated completions operations are presented on the following pages. The predicted levels only include sound levels from completions operations and do not include ambient noise or noise contribution from other sources outside of the planned operations.

There are no occupied RBUs or BUs within 2,000 feet of the proposed Larkspur Fed location and thus, there is no tabular data presented in this section. Instead, noise contour maps are provided for the area surrounding the Larkspur Fed Pad. The contours are provided in 5 dB increments with the color scale indicating the sound level of each contour. Unmitigated completions operations noise contour maps are presented in Figure 4 and Figure 5.

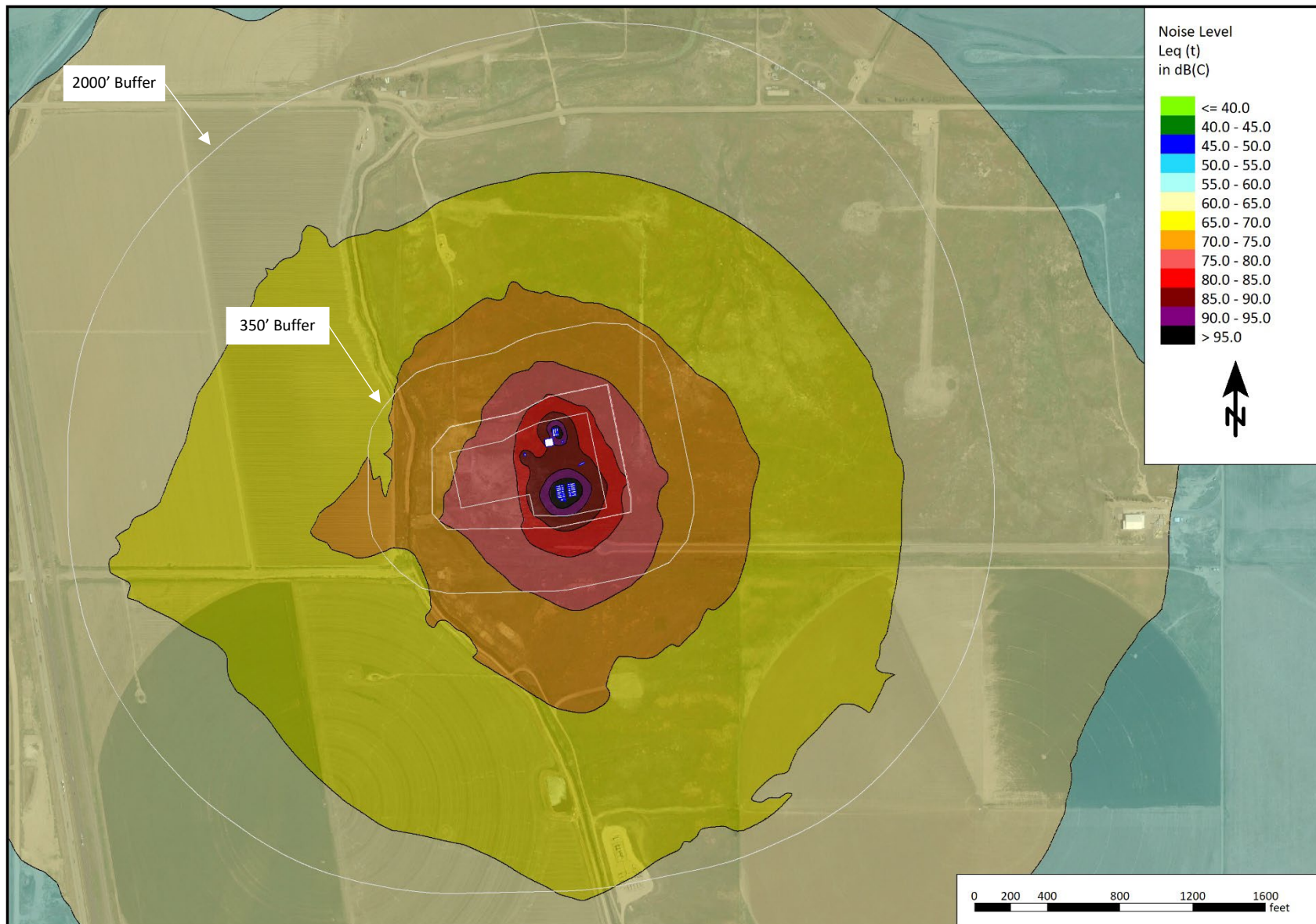




**Figure 4. Unmitigated Completions Noise Contour Map (dBA)**



**Figure 5. Unmitigated Completions Noise Contour Map (dBC)**



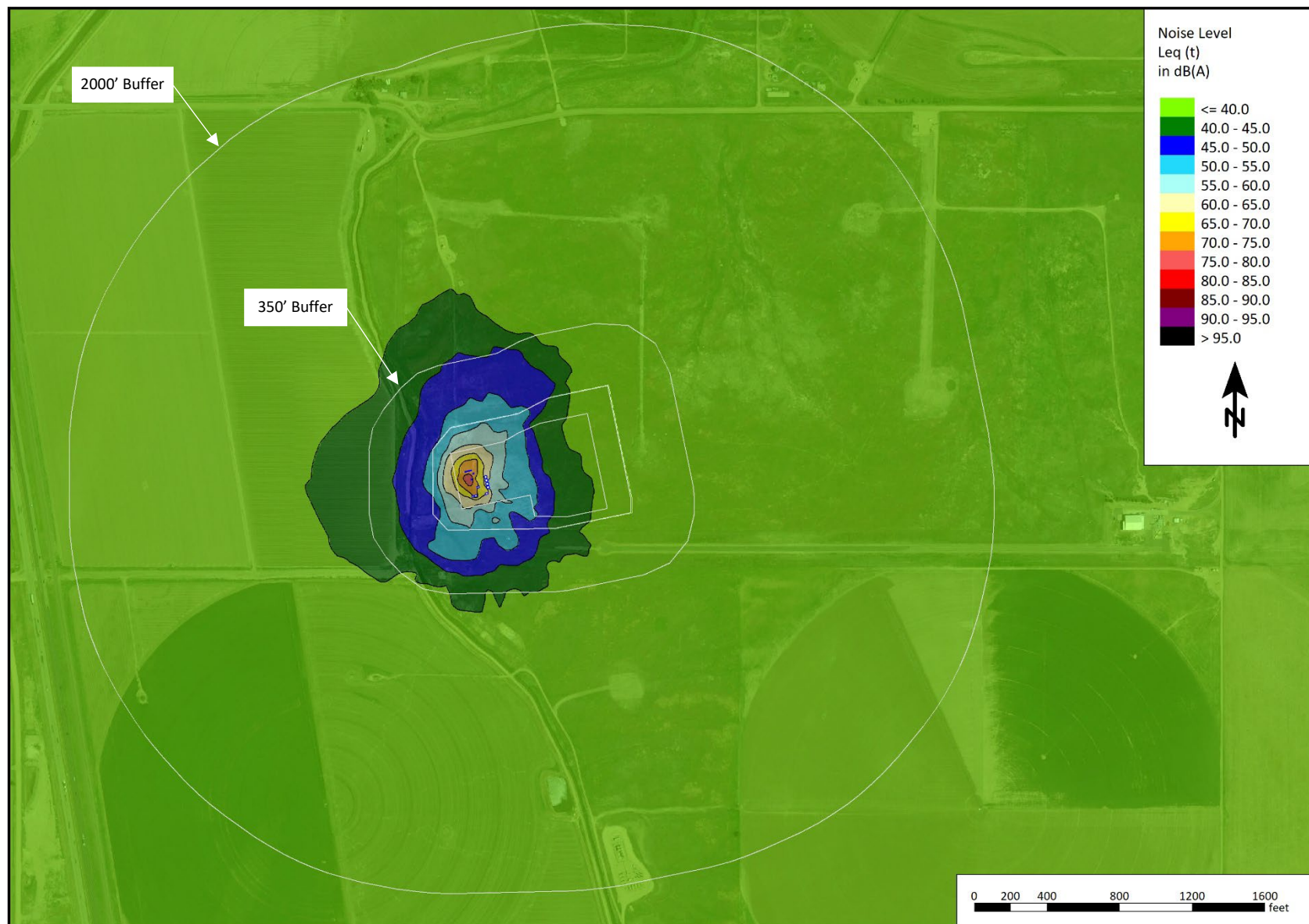
### **Production Noise Model Results**

Model results for unmitigated production operations are presented on the following pages. The predicted levels only include sound levels from production operations and do not include ambient noise or noise contribution from other sources outside of the planned operations.

There are no occupied RBUs or BUs within 2,000 feet of the proposed Larkspur Fed location and thus, there is no tabular data presented in this section. Instead, noise contour maps are provided for the area surrounding the Larkspur Fed Pad. The contours are provided in 5 dB increments with the color scale indicating the sound level of each contour. Unmitigated production operations noise contour maps are presented in Figure 6 and Figure 7.

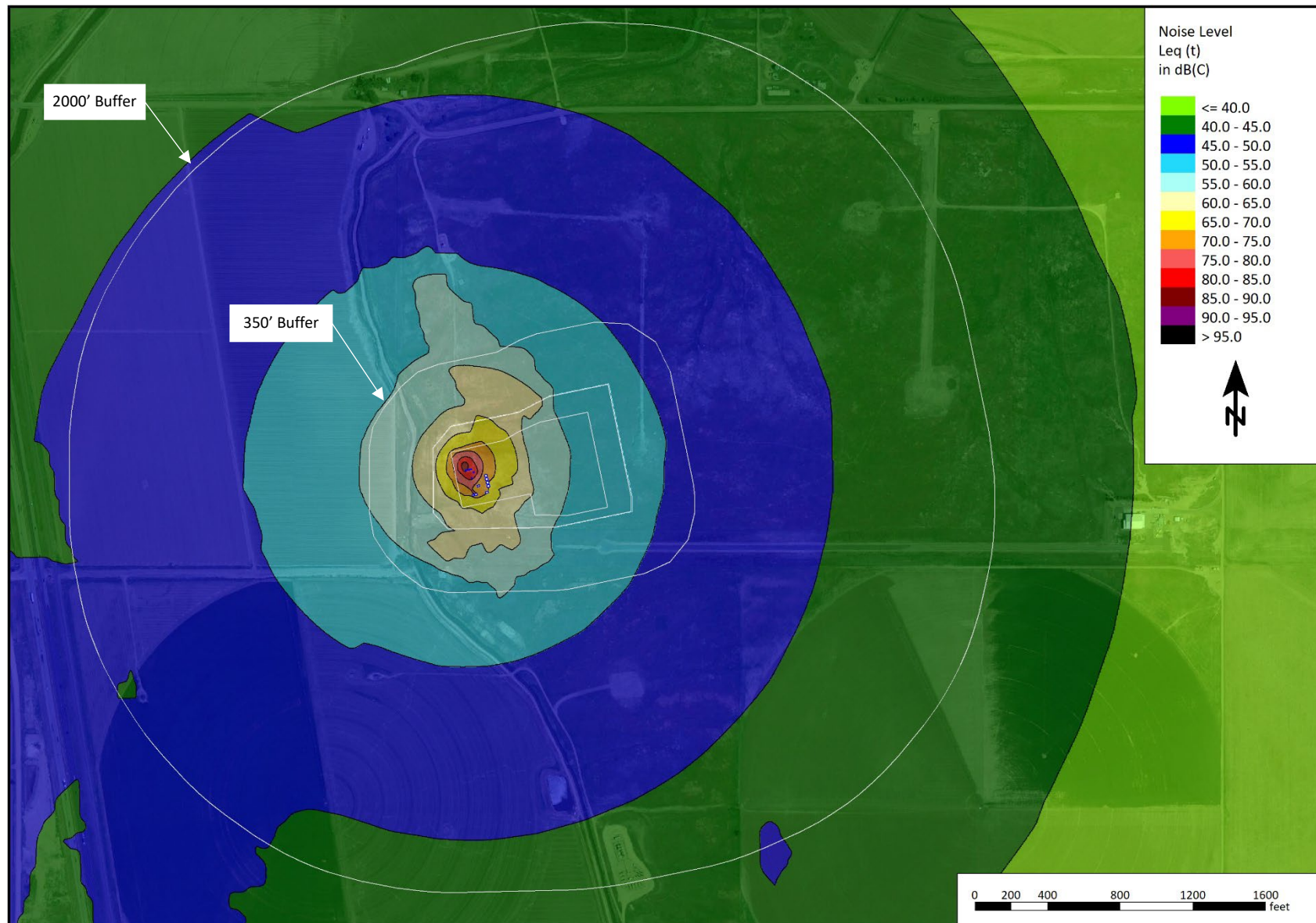


**Figure 6. Unmitigated Production Noise Contour Map (dBA)**





**Figure 7. Unmitigated Production Noise Contour Map (dBC)**



### **Flowback Operations Review**

A review of flowback operations was carried out by Urban based on information supplied by KMOG. It was determined that flowback can be reduced to two simple, successive, operations from a noise perspective; these are “drill out” and “surface flow”. Both flowback operational components were assessed, and it was found that neither warrant noise modeling as outlined below.

The drill out operation utilizes equipment similar to a large production drilling rig, but much smaller in size, with reduced equipment quantities and produce much lower noise signatures as compared to the large production rig. This results in a noise signature of the drill out portion of flowback operation having much lower noise levels than either the production drilling rig or completions operations (on both a dBA and dBC basis).

The second part of the flowback operation is conducted once the drill out operation is complete, when well flows are initiated and directed to a series of temporary valves, screens, sand traps, separators, and mobile tanks instead of the production facility equipment. The temporary flowback equipment is similar to the production equipment already studied for production operations but utilizes smaller units with reduced quantities of individual equipment pieces, again with lower noise levels. This results in noise levels lower than the production operation studied in this assessment (on both a dBA and dBC basis). Since flowback operations are held to the higher MPNLs of preproduction operations instead of the lower MPNLs associated with production operations, there is very low risk from a nuisance environmental noise perspective for the surface flow portion of flowback operations.

Given the characteristics of the two components of the flowback operation outlined above and the fact that both the drill out and surface flow portions have noise levels significantly lower than other phases of operations assessed in this study, there is no need for special consideration (noise modeling, etc.) of the flowback operation.



## **9 CONTINUOUS MONITORING / COMPLAINT RESOLUTION**

There are no occupied RBUs within 2,000 feet of the proposed Larkspur Fed Pad. Thus, there is no requirement to conduct continuous monitoring.

KMOG will post contact information to receive and address noise complaints arising from preproduction operations around the clock, 24 hours, 7 days per week. Upon receipt of a complaint, either directly to KMOG or from the ECMC, or Weld County, KMOG will contact the associated stakeholder within 48 hours of receipt.

## **10 CONCLUSION**

The results of the proactive planning, noise modeling, and implementation of BMPs as discussed in this NMP indicate that noise levels generated by KMOG's proposed oil and gas operations at the Larkspur Fed Pad are expected to comply with permissible noise levels required by both the ECMC Rule 423 and WOGLA Section 21-5-435, noise regulations; as well as minimize the noise impact on the surrounding environment for all operations proposed (drilling, completions, flowback, and production).

## **11 NOTATIONS**

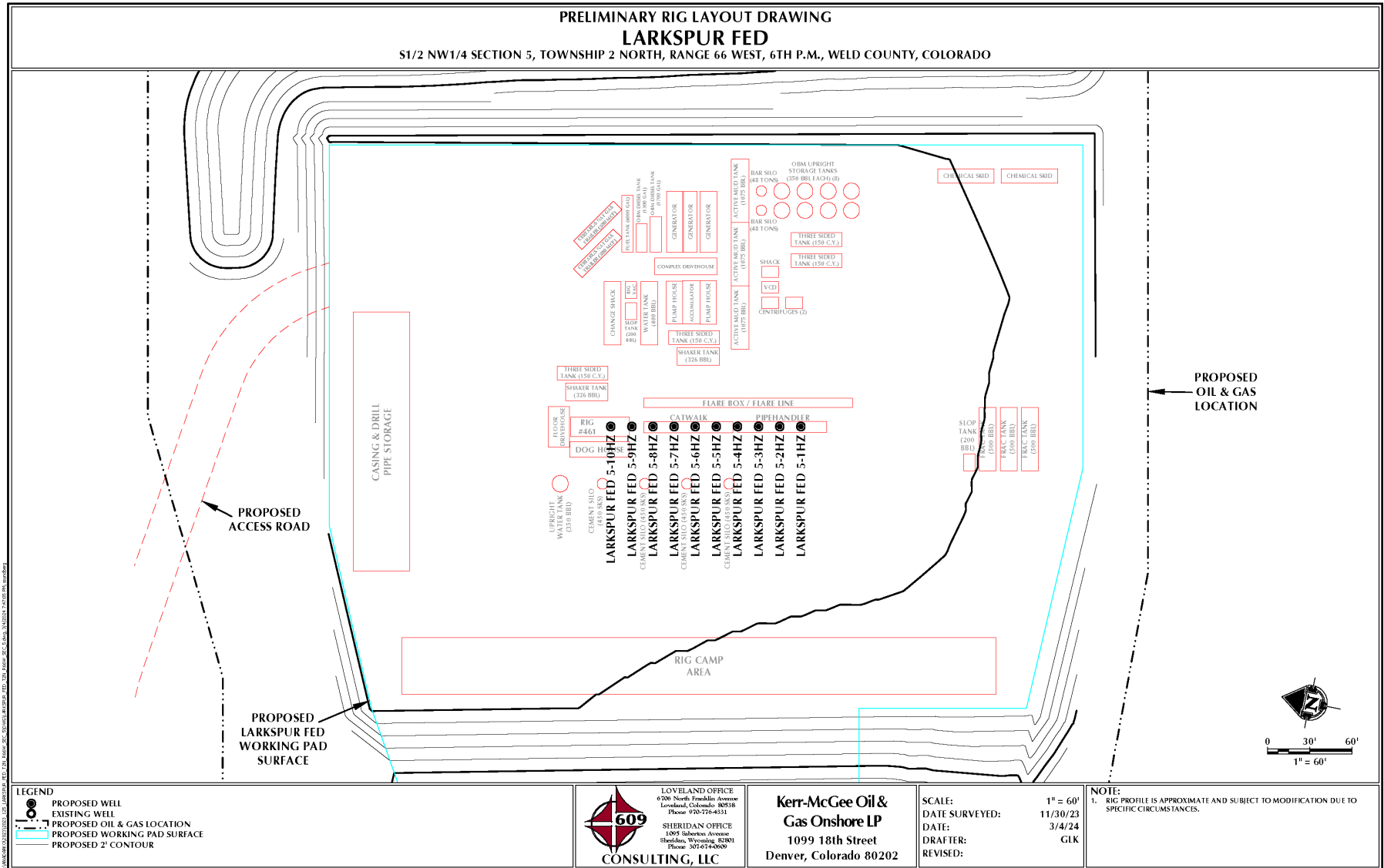
The services provided for this project were performed in accordance with generally accepted professional consulting services. No warranty, expressed or implied, is made or intended by rendition of these consulting services or by furnishing oral or written reports of the findings made. Urban Solution Group generated this report for the exclusive use of KMOG.



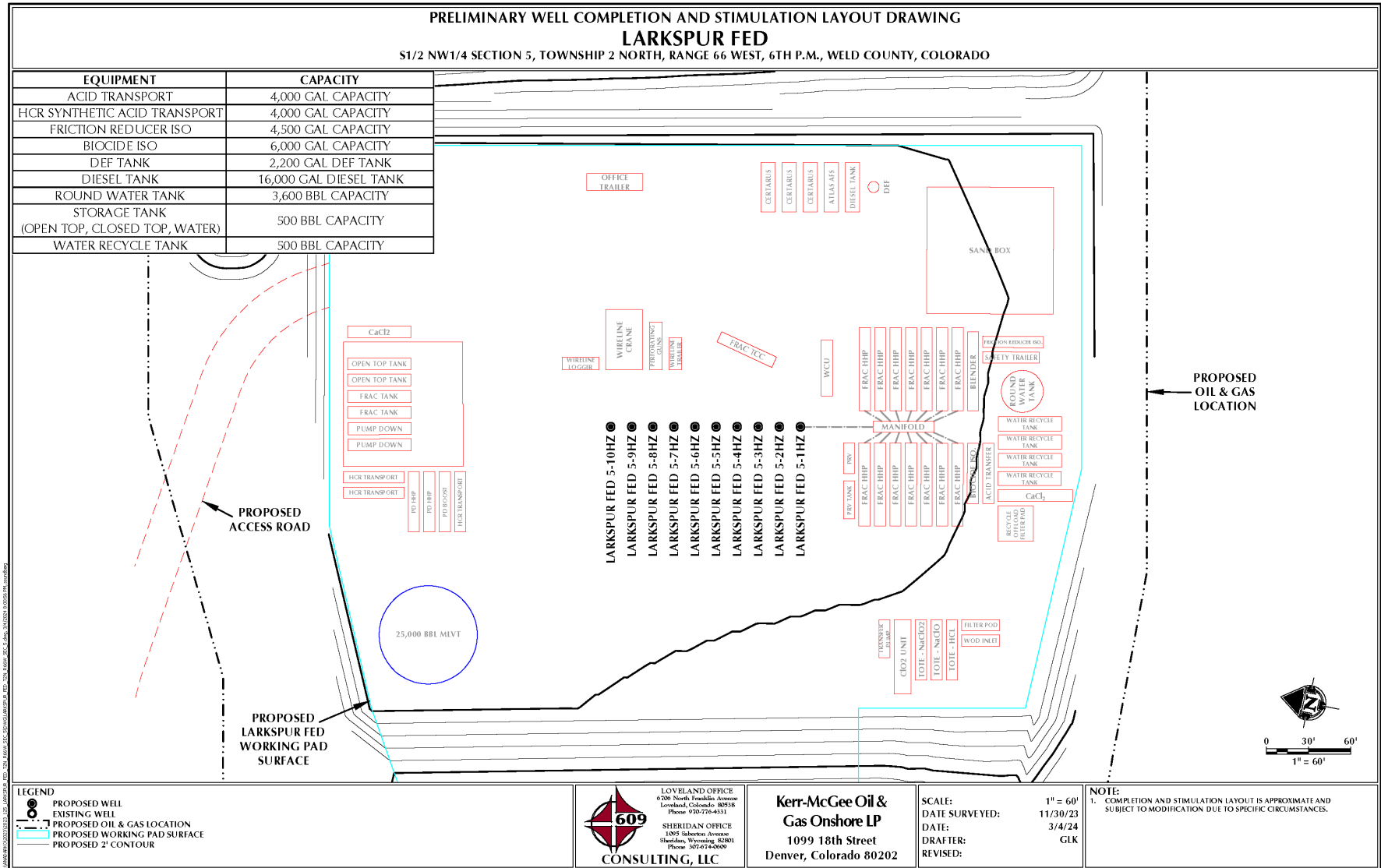
## **Appendix 1 – Equipment Layouts**



**Figure 8. Drilling Equipment Layout for the Precision Drilling Rig #461**

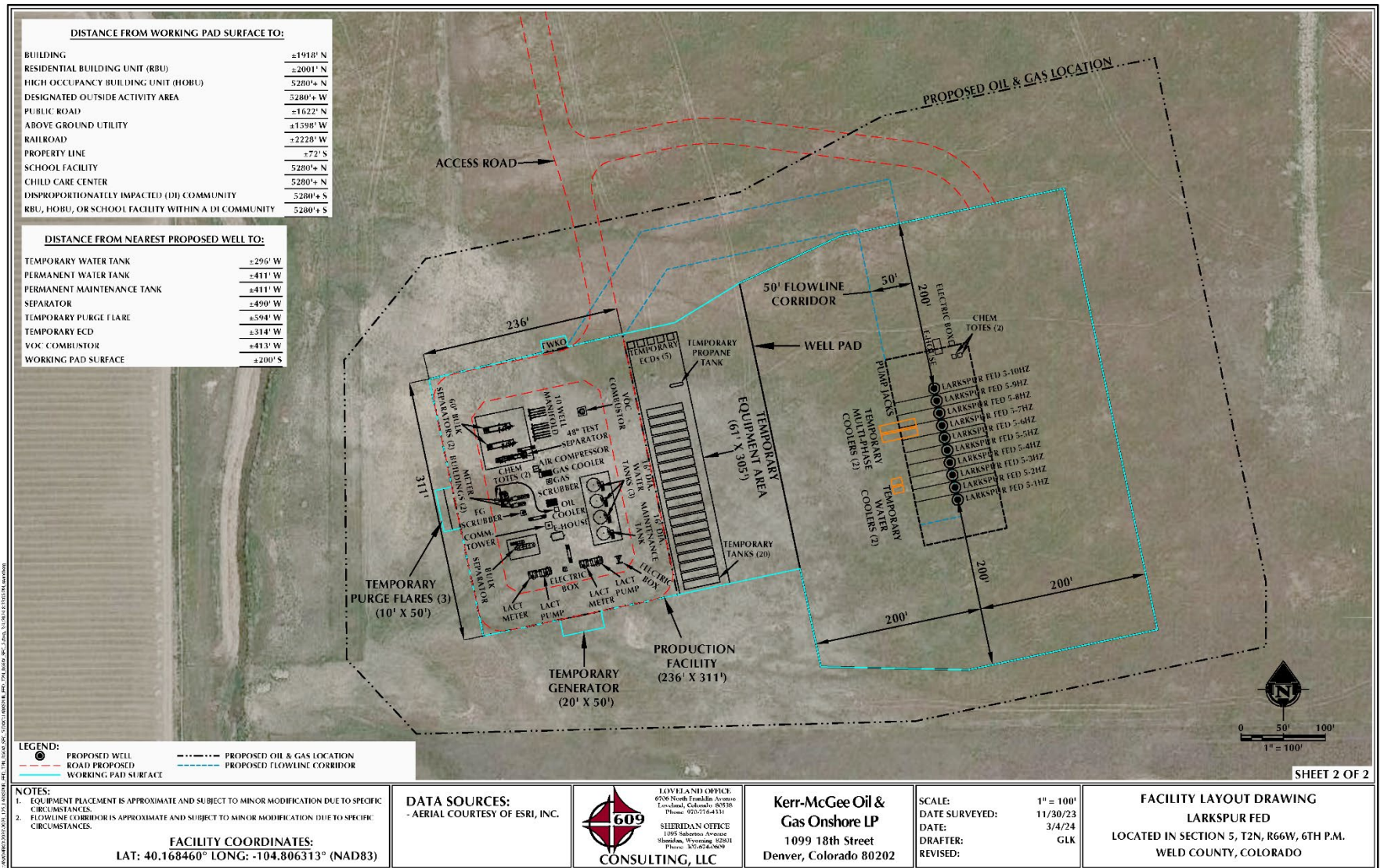


**Figure 9. Completions Equipment Layout for the Halliburton Low Noise Fleet**





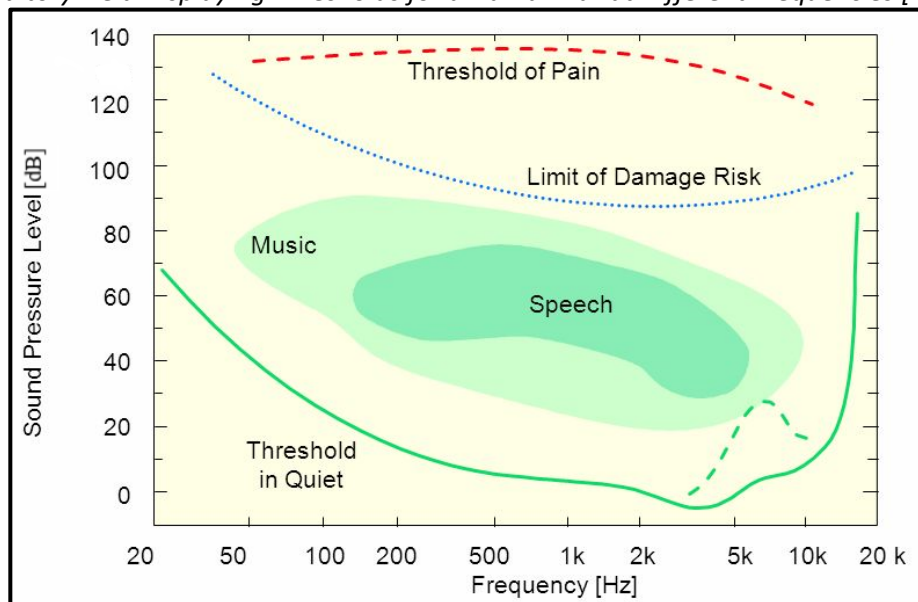
**Figure 10. Production Equipment Layout**



## Appendix 2 – Sound Fundamentals

Sound is a series of vibrations transmitted through the air, or other medium, and can be heard when they are processed by the human ear. There are two important properties that describe sound; frequency and amplitude. Frequency is determined by the rate of movement and is measured in cycles per second, which is known as Hertz (Hz). A healthy human ear can hear 20 Hz – 20,000 Hz (Figure A). The sensation associated with frequency is commonly referred to as the pitch of a sound. High frequencies produce a higher pitch and vice versa. The amplitude of a sound is determined by the maximum displacement of air molecules produced by the vibrations. These displacements lead to pressure fluctuations in air, which are expressed in decibels (dB). Decibels are a logarithmic ratio of sound pressure over the standard threshold of hearing. The more energy a sound has, the larger the pressure fluctuations, resulting in a louder sound.

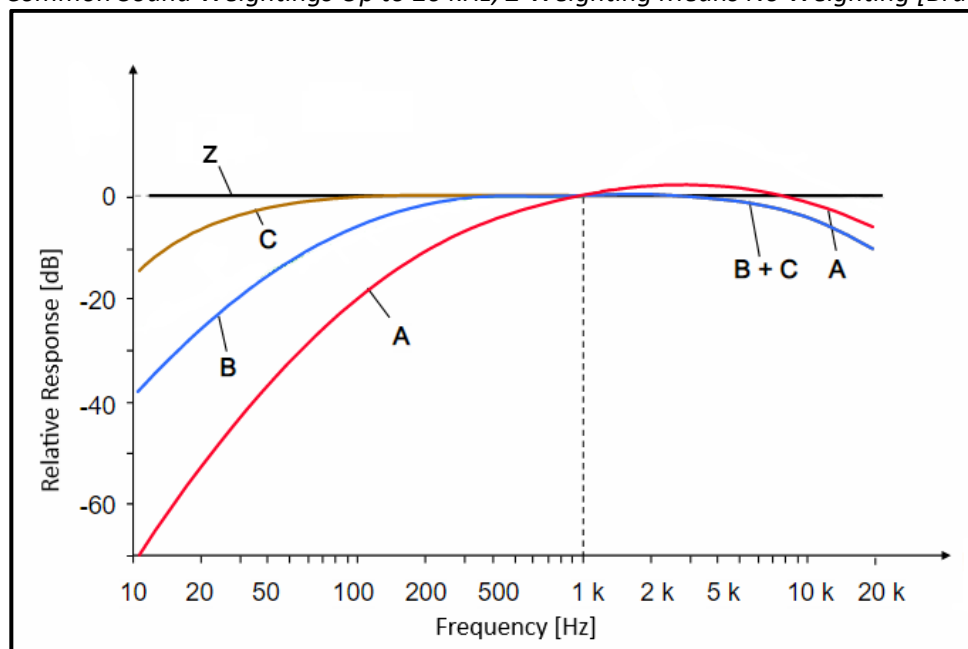
**Figure A:** Auditory Field Displaying Thresholds for a Human Ear at Different Frequencies [Brueel and Kjaer]



Frequency weightings are applied to measurements to provide a better match between measured results and human perception. Each weighting, in relation to their frequency components, allows for a consistent measurement of the different types of noise sources. A-weighted decibel sound pressure levels (dBA) are measurements recorded from a sound level meter measuring sounds similar to the response of the ear (Figure B). While C-weighted (dBC) measurements are for low-frequency components.

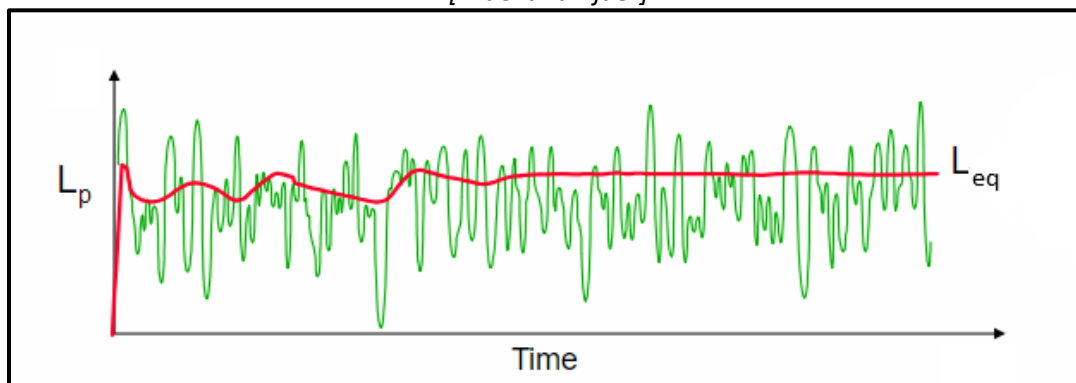


**Figure B: Common Sound Weightings Up to 20 kHz, Z-Weighting Means No Weighting [Bruel and Kjaer]**



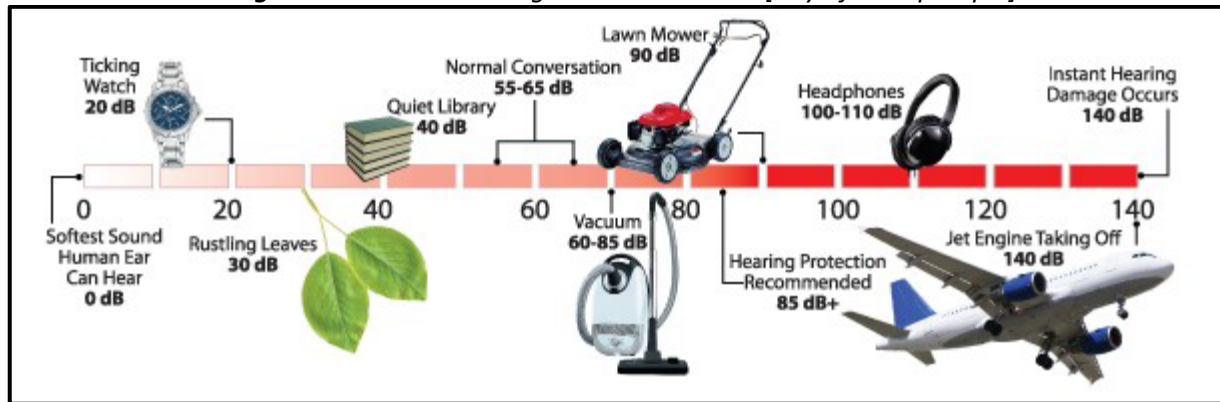
Each measurement has an exponential time factor. Slow time weighting is the most common for environmental noise measurements and will be used for these measurements. For recording over long periods of time, the sound level meter records each weighted decibel reading with an equivalent, or average, continuous sound level reading ( $L_{eq}$ ).  $L_{eq}$  represents the same energy as the actual time varying sound signal (Figure C).  $L_{Aeq}$  refers to the equivalent continuous sound level for an A-weighted measurement.

**Figure C: Sound Level Recording Displaying  $L_{eq}$ , a Steady-State Sound Level, Over a Noise Measurement [Bruel and Kjaer]**



Environmental noise is a combination of various noise sources. These sources may include; vehicle traffic, aircraft flyovers, wind, weather disturbances, commercial or industrial activities, and other short-term events. These sources create “background noise”. Background noise varies throughout the day, generally following the cycle of human activity. Figure D below presents typical A-weighted (dBA) sound levels for common sources of sound.

**Figure D: Common A-weighted Sound Levels [City of Albuquerque]**



## **Appendix 3 – Glossary**

### **Ambient Noise**

All noises that exist in an area and are not related to facility. Ambient noise includes sound from other industrial noise not subject to this directive, transportation sources, animals and nature.

### **Average Sound Level**

See Energy Equivalent Sound Level.

### **A-weighted sound level**

The sound level measured on a sound level meter using a setting that emphasizes the middle frequency components similar to the frequency response of the human ear.

### **Calibration**

A procedure used for the adjustment of a sound level meter using a reference source of a known sound pressure level and frequency. Calibration must take place before and after the sound level measurements.

### **C-weighted Sound Level**

The C-weighting approximates the sensitivity of human hearing at the industrial noise levels (above 85 dBA). The C-weighted sound level is more sensitive to the sounds used to assess the low- frequencies than the A-weighted sound level. It is sometimes used to assess the low-frequency content of complex sound environments.

### **Day Night Sound Level (Ldn)**

Is the average noise level over a 24-hour period. The noise between the hours of 22:00 and 07:00 is artificially increased by 10 dB. The nighttime noise is weighted to consider the decrease in community background noise.

### **Daytime Average Sound Level**

The time-averaged A-weighted sound level measured between the daytime hours, usually defined as 7:00 am to 7:00 pm.

### **Decibel (dB)**

A unit of measure of sound pressure that compresses a large range of numbers into a more meaningful scale. The basic unit of measurement for sound levels.

### **dBA**

The decibel (dB) sound pressure level filtered through the A filtering network to approximate human hearing response. See dB and A-weighted Sound Level.

### **dBC**

The decibel (dB) sound pressure level filtered through the C filtering network. See dB and C-weighted Sound Level.

**Energy Equivalent Sound Level ( $L_{eq}$ )**

The  $L_{eq}$  is a single-number, average, sound level, that represents cumulative acoustical energy as measured over a specified time interval.

**Facility**

Any operation used in exploration, processing, development and transportation of energy resources.

**Frequency**

The number of oscillations per second for a sound wave.

**Impulse Noise**

Unwanted, instantaneous sharp sounds that create sudden impulses of pressure similar to gunfire and explosions.

**Noise Reduction**

The difference in sound pressure level between two points.

**Nighttime Average Sound Level ( $L_{night}$ )**

The time-averaged A-weighted sound level measured between the nighttime hours, usually defined as 7:00 pm to 7:00 am.

 **$L_{dn}$** 

See Day night sound level.

 **$L_{eq}$** 

See Energy Equivalent Sound Level.

**Noise**

Generally understood as unwanted sound.

**Noise Impact Assessment (NIA)**

Identifies the expected sound level emanating from operations and receptor points are placed in locations related to compliance. It also identifies what the permissible sound level is and how it was calculated.

**Noise Reduction Coefficient (NRC)**

A single number rating of the sound absorption properties for a material. An NRC value of zero indicates the material is purely reflective. An NRC value of one indicates perfect absorption.



**Octave Band**

An octave band is a frequency band that spans one octave. A band is said to be an octave in width when the upper band frequency is twice the lower band frequency. Octave bands are commonly used in engineering acoustics. The nine common octave bands used for the study of industrial noise are identified by their center frequencies as 31.5Hz, 63Hz, 125Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz.

**Point Source**

A source that radiates sound from a single point. Generally used to model equipment when looking at the sound impact over a large area.

**Receiver**

A person or piece of equipment that is affected by noise.

**Sound**

A series of vibrations transmitted through the air, or other medium, that can be heard when they are processed by the human ear.

**Sound Level Meter (SLM)**

An instrument that contains a microphone and filter used to measure sound levels, using standard frequency-weightings and exponentially weighted time averaging.

**Sound Power Level**

A physical measurement of the amount of power a sound source radiates into the surrounding air. It is the rate at which sound energy is emitted, or received, per unit time.

**Sound Pressure Level (SPL)**

The sound level received at a given location. The decibel equivalent of the rate of sound pressure waves at a measured location, usually with a microphone.

**Sound Transmission Class (STC)**

An integer rating that measures how well a barrier or building partition attenuates sound. Indicates how well a barrier is at stopping sound from transmitting through it.

**1/3 Octave Band**

The 1/3 octave band analysis provides a finer breakdown of sound energy distribution (compared to full octave band) as a function of frequency.