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LSTN

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Subject: Sunset Amphitheater at Mustang Creek
Environmental Noise Assessment

Dear Bob,

In this document we summarize our current environmental noise assessment for the development of the Sunset Amphitheater at Mustang Creek in Oklahoma City.

Please let us know if you or the municipality have any questions.

Yours Sincerely,

MATT MAHON

Matt Mahon

Partner, LSTN Consultants

CC: Ken Andria, LSTN

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1 BACKGROUND

- Notes Live (Notes) is developing the Sunset Amphitheater on Mustang Creek in the wider Mustang Creek Crossing development within Oklahoma City.
- Notes is engaging with the community and seeking relevant planning approvals. As part of that effort, Notes has requested that LSTN provide an environmental noise assessment.
- This document summarizes our current environmental noise assessment.

2 VENUE PROGRAMMING AND SOUND SYSTEM CHARACTERIZATION

To clarify the expected environmental impact of the venue, we here characterize the expected use of the venue and its proposed sound system.

The noise levels expected to be generated at the amphitheater during events will relate to two primary factors:

- The types of events produced
- The types of sound systems used

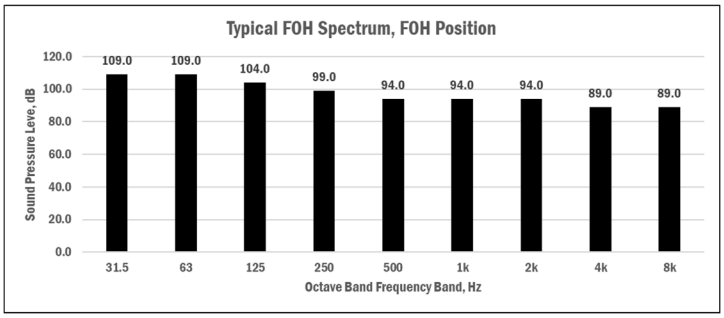
Notes propose to operate an amphitheater that will host live musical performances. The venue may host stand-alone productions and events but will primarily host tours that travel between similar venues to different regions.

For an idea of the programming for such a venue, consider the recent performers at the popular Red Rocks Amphitheatre outside of Denver, CO, reproduced here. The performances include a mix of Rock, Pop, Hip Hop, Electronic, and Folk genres.

Such performances rely on sound systems to amplify/reinforce sound produced on stage for the audience. The music performed is typically broad spectrum, i.e. it includes sounds across the audible frequency spectrum.

The level and spectrum of sound varies temporally throughout a performance and will differ broadly between different performance types (e.g. Electronic and Hip Hop performances typically have more low frequency sound than folk music).

Despite significant variation, we can make reasonable assumptions about the typical frequency spectrum and sound level produced for typical events to facilitate estimating environmental noise. The spectrum below corresponds to 100dB(A) of broadband sound, which would be a reasonable level for a performance to reinforce at the front of house (FOH) mix position, ~100ft from the stage. Note, these would be common peak levels to hit periodically during a single song (not average levels).



It is typical for acts touring venues of this type to travel with a main sound system which would be deployed to each side of the stage.

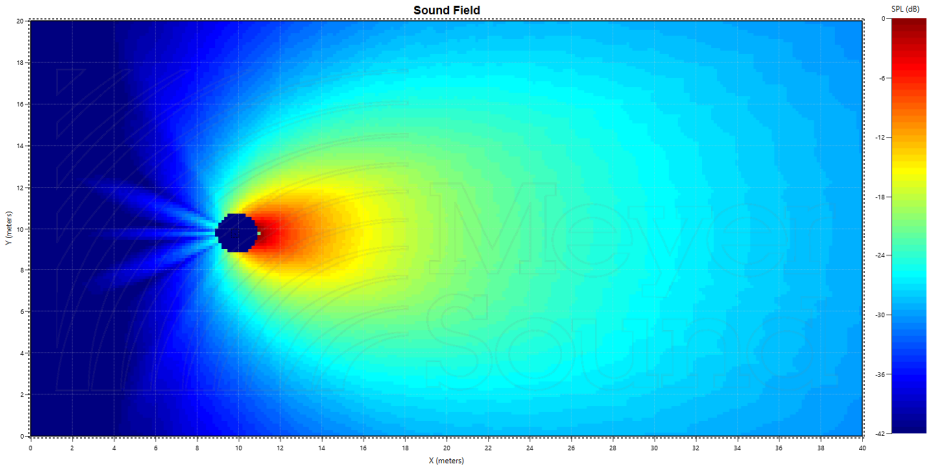
Tours typically deploy line array-type main loudspeakers. Line arrays consist of individual loudspeaker cabinets that are arrayed vertically together, as shown above.

Subwoofers are often hung in vertical arrays as shown in the left two images above. But sometimes they are stage-stacked as shown on the right.

The primary function of a sound system is to provide adequate sound level to the audience. Sound should also be consistent across the audience, i.e. not too loud at the front and too quiet at the back.

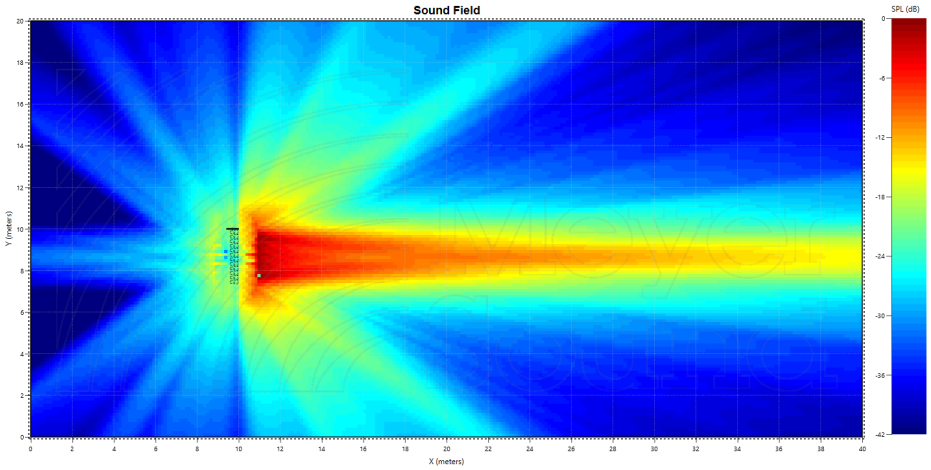
In addition to sound power output, a core characteristic of loudspeakers is directivity—How much sound energy the loudspeaker emits in different directions.

The physical design of line array loudspeakers inherently provides wide, even coverage over typical festival and amphitheater audience areas and limits noise spill in other directions.



Typical Horizontal Line Array Directivity

Note the line array's ability to limit sound emissions in the vertical plane to the axis of the loudspeaker—Little sound is "wasted" off axis. Though tours carry line array loudspeakers with different manufacturers, detailed specifications, and quantities, in practice the variation between typical line arrays is not significant.



Typical Vertical Line Array Directivity

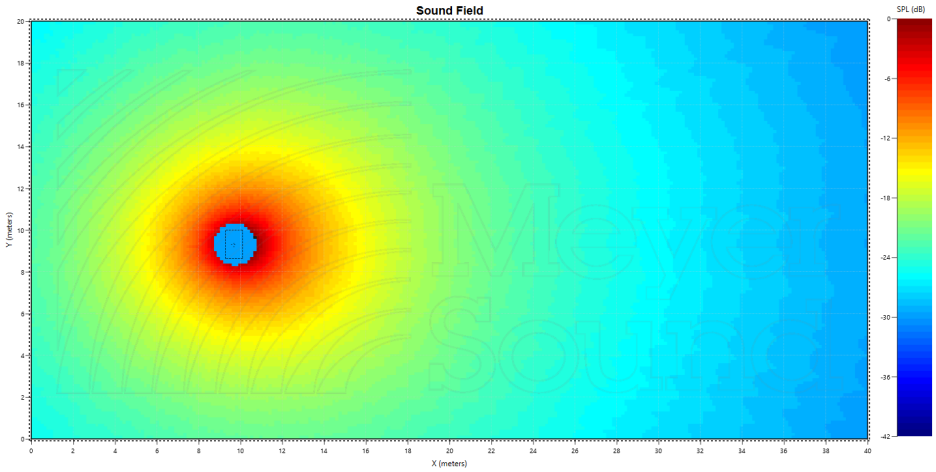
The analysis presented here was based on a Meyer LEO-M loudspeakers and is representative of all common touring line arrays (D&B, L'Acoustics, JBL, EAW, Nexo, Clair, etc)

Subwoofer systems have greater variation in their physical deployment (as shown in the photos above) and in their interior construction that can impact their directivity.

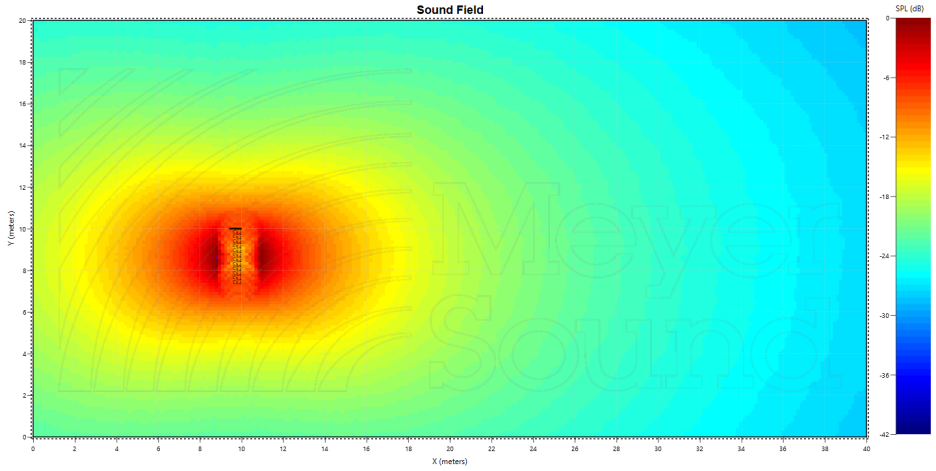
A basic individual subwoofer is effectively omnidirectional (in the vertical and horizontal planes).

When you array basic subwoofers vertically (like the line array loudspeakers), the subwoofer array exhibits pattern control in the vertical direction. In plan, the directivity is effectively unchanged.

Cardioid directivity for subwoofers can be accomplished with either inherently cardioid subwoofer cabinets or by reorienting subwoofer cabinets in array. There is significant variation on the methods to achieve cardioid subwoofer directivity.



Typical Omnidirectional Subwoofer Directivity



Vertical Array Subwoofer Directivity

3 ENVIRONMENTAL NOISE MITIGATION

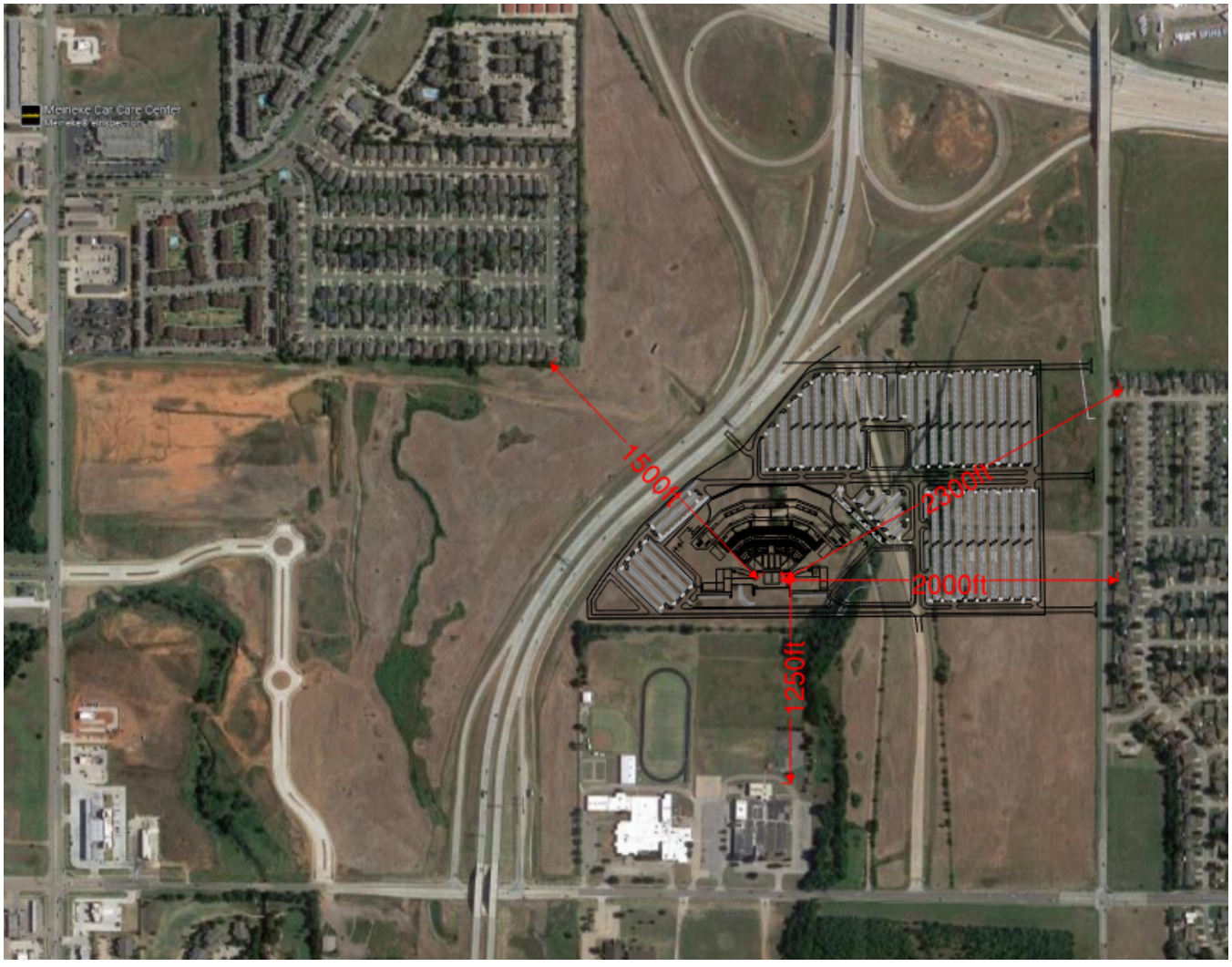
Incorporating mitigation measures can help reduce environmental noise. Noise emissions to the surrounding environment can be mitigated the following factors:

- Physical Mitigation
- Electroacoustic Mitigation
- Operational Mitigation

Physical Mitigation

The proposed amphitheater is located in Oklahoma City, Ok in the Mustang Creek Crossing Development, adjacent to the John Kilpatrick Turnpike. Much of the immediately surrounding area is undeveloped but is expected to be developed as part of the Mustang Creek Crossing Development. Existing nearby properties that are expected to be sensitive to noise include the following:

- Single family homes in the Centerpointe development, approx. 1,500ft to the northwest
- Single family homes across S Sara Dr, approx. 2,000ft to the east
- Mustang Middle and High Schools, approx. 1,250ft to the south



The site's location adjacent to the turnpike employs good planning practice—The site and nearby environs are already impacted by noise from the turnpike. The natural terrain is generally flat, but the raised rake of the seating bowl will reduce noise emissions north, north-east, and northwest.

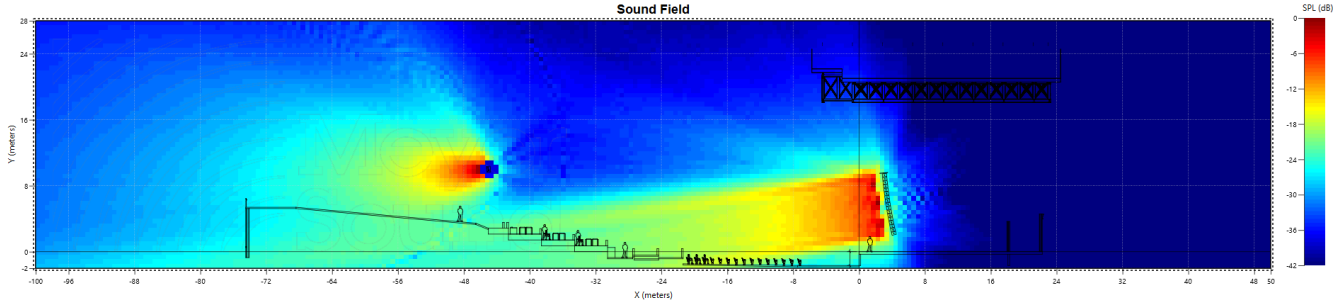
The stage has been oriented such that loudspeakers will fire north, towards the junction of the turnpike with the interstate, an area that is not noise sensitive.

Electroacoustic Mitigation

The types of loudspeakers typically used for performances demonstrate inherent benefits for the control of environmental noise:

- Sound from line arrays is vertically controlled to allow directing sound to the audience, without sending sound higher vertically or beyond the venue footprint horizontally. This will reduce noise emissions from the amphitheater to the north, east and west.
- Some subwoofer systems may be deployed in configurations to affect a cardioid directivity. This will reduce low frequency noise spill to the rear of the stage.

To further reduce sound system noise spill, the design proposes to incorporate house delay loudspeaker clusters that would be located at the front of the lawn seating (as illustrated in the conceptual mapping below). By using delay clusters, all loudspeakers (main loudspeakers at stage and delay clusters) may be operated at a lower overall sound power thus reducing overall noise emissions.



Aggregate Effect

The Physical and Electroacoustic mitigation measures described above are expected to reduce environmental noise emissions from the amphitheater, particularly toward the south, east and west. In the table below, we summarize initial analysis of the benefits of the physical and electroacoustic mitigation measures.

Corner lot at S W 8th and Garrison Ln ~1,500ft NW	Decibels (dB) at Octave Band Center Frequency (Hz)									
	32	63	125	250	500	1k	2k	4k	8k	Overall
FOH Mix Position	109	109	104	99	94	94	94	89	89	100dB(A)
Without Mitigation	85	85	80	75	69	68	67	56	33	74dB(A)
With Physical and Electroacoustic Mitigation	85	85	79	71	63	65	62	49	28	70dB(A)

Across S Sara Rd ~2,300ft NE	Decibels (dB) at Octave Band Center Frequency (Hz)									
	32	63	125	250	500	1k	2k	4k	8k	Overall
FOH Mix Position	109	109	104	99	94	94	94	89	89	100dB(A)
Without Mitigation	82	82	77	71	65	63	61	46	10	69dB(A)
With Physical and Electroacoustic Mitigation	82	80	74	63	53	55	50	34	0	62dB(A)

Mustang Schools ~1,250ft S	Decibels (dB) at Octave Band Center Frequency (Hz)									
	32	63	125	250	500	1k	2k	4k	8k	Overall
FOH Mix Position	109	109	104	99	94	94	94	89	89	100dB(A)
Without Mitigation	87	87	82	77	71	70	69	59	40	76dB(A)
With Physical and Electroacoustic Mitigation	87	86	79	70	58	42	34	13	0	66dB(A)

On Axis with Venue 2,500ft N	Decibels (dB) at Octave Band Center Frequency (Hz)									
	32	63	125	250	500	1k	2k	4k	8k	Overall
FOH Mix Position	109	109	104	99	94	94	94	89	89	100dB(A)
Without Mitigation	81	81	76	70	64	62	59	44	5	68dB(A)

These results are typical for outdoor amphitheaters—High frequency sounds are well attenuated by loudspeaker orientation and directivity, barriers, and air absorption at reasonable distances from the amphitheater. Low frequency sounds are the hardest to reduce at distance.

Operational Mitigation

In addition to the physical and electroacoustic mitigation described in the preceding sections, we propose that the amphitheater should adopt additional operational mitigations strategies. These are appropriate both as a good faith effort as a member of the community and to address the limitations of the physical and electroacoustic mitigation strategies:

- Some productions may be inclined to operate sound systems at noise levels in excess of our assumed spectrum.
- Weather events (wind, temperature inversions) may cause noise emissions in excess of those estimated here.

As such, the following specific operational mitigation strategies have been developed with Notes:

Operating Hours	• Sunday through Thursday
	  • Events would typically occur during the evening.
	  • Performances would typically begin between 7-8pm.
	  • Sound check would begin after 3pm.
	  • Performances would end not later than 10:30pm.
	• Friday and Saturday
	  • Events would typically occur during the afternoon and evening.
	  • Performances would typically begin between 3-8pm.
	  • Sound check would begin after 12pm.
	  • Performances would end not later than 11:00pm.

Controls on Touring Sound Systems	• The main loudspeakers of touring sound systems are expected to be line-array type. • The main loudspeakers and subwoofers would be rigged no higher than 40ft above stage. • Where practical, subwoofers can be arrayed to provide low frequency directivity. • Performances are expected to make use of permanently installed delay cluster loudspeakers. Main loudspeakers would be rigged and aimed only to serve the lower, seated sections.

Noise Monitoring and Performance Controls	**The amphitheater is expected to establish operational maximum sound levels for performances and if performances exceed these levels, active steps would be taken to reduce noise levels.**
	• Noise monitoring would be conducted during performances at the FOH Mix position. The limits at FOH are expected as follows:
	  • The broadband noise levels measured at the FOH mix position:
	  • An L1 exceeding 105dB(A) in any 10 minute period.
	  • An L10 exceeding 95dB(A) in any 10 minute period.
	• Should noise levels exceed those documented above, the venue operator would promptly inform the event production team and instruct the event production team to reduce noise levels to a level appropriate to maintain the requirements.
	• Event production teams are expected to be obligated by their contracts to comply with the venue operator's directions and may be subject to prematurely terminating events if the performance remains out of compliance.

4 NEXT STEPS

We propose the assessment here be reviewed with the city. Following relevant approvals, we expect to further develop the details of these mitigation strategies into the architectural design for the project.