

**Prepared for:**

Pacific Raceways LLC

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**PACIFIC RACEWAYS, KENT,  
WASHINGTON  
SOUND CONTROL PLAN**

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# 1. INTRODUCTION AND BACKGROUND

## 1.1 Introduction

The following Sound Control Plan has been prepared for Racetrack LLC (Pacific Raceways) regarding the construction and operation of new garage buildings at the Pacific Raceways property located at 31001 144th Ave SE, Kent, Washington (the Project). The Sound Control Plan is intended to be implemented at the beginning of excavation works and during construction of the new buildings, and would carry on through the buildings' operational life.

## 1.2 Project Background

Pacific Raceways proposes to excavate 1,000,000 cubic yards of gravel and construct 205,000 square feet of buildings on a parcel of Pacific Raceway's property currently utilized for event and Green River Community College parking. Pacific Raceways operates under approval of King County Conditional Use Permit (CUP) # A-71-0-81. The Project would be operated in compliance of this CUP. Note that once constructed, commercial facilities within the development will be available to tenants at all hours, and will be subject to King County noise limits at hours outside of those approved in the CUP.

The Project is located just north of the existing Pacific Raceways track, bordering 144th Street SE to the west and 148th Avenue SE to the east. Access to the site is planned at the existing access road bordering the south side of the site (currently an easterly extension to 144th Street SE). Project buildings will be used primarily as garages for storing and servicing race cars that would utilize the race track, as well as housing an automotive innovation center and related retail facilities.

Excavation and processing of materials will occur for a period of approximately three (3) years. Excavated material will be removed from the site along 144th St SE. Building construction is likely to commence following excavation of the building footprint area and may occur concurrently with excavation activities.

## 1.3 King County Permitting: Interim Use Permit and MDNS

On April 30, 2018, King County Department of Permitting and Environmental Review (DPER) issued a Mitigated Determination of Non-Significance (MDNS) in support of an Interim Use Permit (IUP) application by Pacific Raceways (file LUT417-0003). The IUP would grant Pacific Raceways permission to excavate 1,000,000 cubic yards of gravel, and then construct 205,000 square feet for garage buildings space. The MDNS included noise mitigation measures that were proposed by Pacific Raceways in a March 2018 report that was reviewed by the County. Mitigation measures included lowering the proposed new building elevations, maintaining a vegetative buffer, and construction of a noise barrier along the eastern property line of the new development area at the site.

On August 9, 2018, DPER issued a Report and Recommendation for an IUP for Pacific Raceways. The IUP recommendation included implementation of the existing Conditional Use Permit (CUP A-71-0-81) conditions that relate to noise, including timing restrictions and limits to racing schedules. In addition, the recommended IUP included the requirement for adherence to provisions provided within the MDNS, most notably the noise mitigation measures proposed by Pacific Raceways, as well as the preparation of a Sound Control Plan, as specified in the recommended IUP Section D *Review of Findings*, Item 12 *Noise*.

### **1.3.1 Summary of Timing Restrictions per existing CUP**

Commercial facilities within the new development will be available to tenants at all hours, and operation of these facilities outside of CUP operating hours will be subject to the applicable King County noise limits (see [Appendix B](#) for a review of the King County Regulatory Setting).

The following are the permitted hours of operation, as approved in the existing CUP:

#### May through August

- Sun 9 a.m. – 5:30 p.m.
- Monday and Tuesday: closed
- Wednesday: 9 a.m.-10 p.m.
- Thurs 9 a.m.-5:30 p.m.
- Friday and Saturday 9 a.m. – 11 p.m.
- One quiet weekend day per month (Saturday or Sunday)

#### September through April

- Monday and Tuesday: closed
- Wednesday – Sunday: 9 a.m. – 5:30 p.m.

### **1.3.2 Summary of Proposed Mitigation within the MDNS Application**

In the March 2018 report, prepared by Ramboll US Corporation (Ramboll) and submitted by Pacific Raceways, various mitigation measures were proposed to minimize the potential for noise impact at adjacent properties. These mitigation measures were intended to be implemented to shield from noise emissions during gravel excavation and during construction of the new garage buildings.

#### Construction

During construction, proposed mitigation measures included:

- Installation of high-performance exhaust silencers (i.e., high performance mufflers);
- Replacement of standard equipment (loaders and stationary equipment) with quieter models, if available;

- Installation of noise-dampening materials within gravel screen hoppers;
- Installation of temporary noise barriers around stationary equipment, if feasible, and;
- Other measures as identified through observation and assessment.

In addition to the above measures, and if warranted, Pacific Raceways would install a temporary noise barrier along the eastern property boundary, extending north from the proposed permanent barrier (see below, regarding the noise barrier for operational noise mitigation).

### Operation

During operation, proposed mitigation measures included:

- East-facing garage doors that are located on the eastern-most building, facing homes along 148th Ave SE, will remain closed between 10 p.m. and 7 a.m., and;
  - Note that from May through August, garage facilities may be active up to 11 p.m., per the existing CUP
  - Note that garage facilities would be available to tenants at all hours
- Construction of a noise barrier along the eastern property line, extending the southeast corner of the new development area, north along the property line, adjacent to 148th Ave SE. The barrier length ultimately will be determined through additional detailed assessment but is expected to be between 450 and 550 feet in length. The final height of the wall is anticipated to range from between 8 feet and 12 feet tall, and ultimately will depend on results of consultation with adjacent residential neighbors, and whether a tall noise barrier would be aesthetically pleasing.

### **1.3.3 Summary of Additional Mitigation Measures**

In addition to the CUP timing restrictions and mitigation measures proposed by Pacific Raceways, King County, in its recommendation for an IUP to further ensure that noise impacts do not occurred during construction and operation of the Project, has required that Pacific Raceways implement a Sound Control Plan:

*Pacific Raceway IUP Report & Recommendations, Section D, 12 (1):*

*The Applicant or its consultant shall prepare a Sound Control Plan to be implemented for raceway events and daily support operations at Pacific Raceways. The Sound Control Plan shall include:*

- *Identification of the appropriate performance standards in terms of A-weighted decibels (dBA) for non-exempt events and operations at Pacific Raceways. Prospective performance standards may include:*
  - *County Code standards of 57 dBA daytime and 47 dBA nighttime (10pm to 7am) based on commercial source impacting a residential source. Recognizing the Code exempts motor vehicle racing events and testing, it does so only when conducted within permit conditions.*
  - *56 dBA and 53 dBA nighttime. These potential standards were developed based on a 5-dBA increase over monitored sound levels at the existing receptors to the east of the facility of 51 dBA (average) daytime and 48 dBA (average) nighttime. The Federal Highway Administration identifies an 5-dBA increase as a readily perceptible change to a noise environment.*
  - *65 dBA, DNL or less. This is the upper limit of the standard used by the U.S. Department of Housing and Urban development as "Acceptable" for residential uses in an urban environment. The DNL descriptor is a 24-hour noise metric that applies a penalty to noise during nighttime hours. It is roughly equivalent to standards of 65 dBA daytime and 55 dBA nighttime. However, such a daytime standard would be more than 10 dBA over the existing daytime values and would result in more than a perceived doubling of loudness at nearby receptors.*
- *Identification of locations to be monitored for sound to determine whether operators are in compliance with the performance standards established. Such monitoring locations would be similar to those established in the applicant's consultant report.*
- *Identification of a monitoring schedule that takes into account racing operation hours and days as outlined in the Pacific Raceways Conditional Use Permit.*
- *Identifications of noise reduction measures to be taken if monitoring indicates noncompliance with performance standards. These measures could include temporary deployment of moveable sound barriers to locations of suspected non-compliant noise sources until permanent barriers can be installed or operational changes made to alleviate the non-compliance.*
- *Submit to the County a report of monitored noise levels and assessment of compliance with the performance standards established in the Sound Control Plan monthly for the first year of operation and annually, thereafter for the life of the permit.*

- *Designate a Noise Disturbance Coordinator who shall be responsible for responding to complaints about noise during operations. The contact information of the Noise Disturbance Coordinator shall be disseminated via website or to surrounding residents and shall be provided to the County. The coordinator shall respond within 48 hours to received noise complaints with a quantitative assessment of noise during the event at issue based on monitoring data and, if warranted, corrective action to be taken.*

## 2. SOUND CONTROL PLAN

The following sound control plan has been prepared for Pacific Raceways specifically as required within the recommended IUP, as per the King County requirements summarized above under Section 1.3.3.

The Sound Control Plan has been organized into the following subcategories:

- Best Management Practices
- Sound Level Limits
- Noise Monitoring
- Noise Disturbance Coordinator
- Mitigation Measures
- Reporting

### 2.1 Best management Practices

#### 2.1.1 Construction

During construction of the Project, Pacific Raceways will implement a series of Best Management Practices (BMPs) to ensure the noise from construction of the facility is minimized. BMPs will apply to both stationary equipment and mobile equipment.

##### 2.1.1.1 Stationary Equipment

BMPs for stationary construction equipment shall include:

- Properly working and maintained exhaust mufflers;
- Equipment that is designed or redesigned to minimize noise emissions;
- Sound-control devices no less effective than those provided by the manufacturer shall be provided on all construction equipment;
- Air intake silencers, if necessary and feasible
- Ducting of exhaust directed away from sensitive receiving locations, and;
- Unnecessary idling of stationary internal combustion engines shall be prohibited.

##### 2.1.1.2 Heavy Mobile Equipment

Heavy mobile construction equipment includes loaders, excavators, and other large diesel-powered equipment that would operate continuously at the construction area. Control techniques for heavy mobile shall include:

- Properly working and maintained exhaust mufflers;

- Equipment that is designed or redesigned to minimize noise emissions;
- Sound-control devices no less effective than those provided by the manufacturer shall be provided on all construction equipment;
- Proper ducting of exhaust;
- Broadband back-up alarms in lieu of pure-tone alarms, and;
- Unnecessary idling of mobile internal combustion engines shall be prohibited.

### **2.1.2 Operation**

During operation of the new garage buildings, Pacific Raceways will implement BMPs to ensure that noise from these facilities is minimized. BMPs intended to minimize noise emissions during operation of the new garage facilities shall include:

- Construction of a noise barrier along the eastern property line, extending the southeast corner of the new development area, north along the property line, adjacent to 148th Ave SE. The barrier length ultimately will be determined through additional detailed assessment but is expected to be between 450 and 550 feet in length. The final height of the wall is anticipated to range from between 8 feet and 12 feet tall, and ultimately will depend on results of consultation with adjacent residential neighbors, and whether a tall noise barrier would be aesthetically pleasing;
- During daytime hours, unnecessary hammering, banging, high RPM revving or other excessive noises shall be discouraged;
- During daytime hours, unnecessary idling of mobile internal combustion engines shall be prohibited;
- Garage doors shall be closed at 10 p.m., in particular garage doors located along the east side of the eastern-most building. Exceptions will be made when opening or closing doors for short periods to move vehicles or personnel into or out of a garage, or when operating inside of CUP operating hours, and;
- During nighttime hours, loud talking, yelling, hooting, or otherwise, when in the vicinity of the garage building, shall be prohibited

## **2.2 Sound Level Limits**

Non-exempt operational activities within the Pacific Raceways facility are subject to County's daytime and nighttime sound level limits of 57 dBA and 47 dBA, respectively, for a commercial sound source affecting a residential receiver. Construction noise also is subject to the King County limits when occurring on weekdays between 7 p.m. and 7 a.m. and weekends between 7 p.m. and 9 a.m. A summary of the King County regulatory criteria is found in [Appendix B](#).

### **2.2.1 Project Operation**

CUP-exempted activities at Pacific Raceways include motor vehicle racing and testing; this exemption also applies to motor vehicle racing and testing activities at the Project garage buildings. Therefore, noise emissions from motor vehicle racing and testing within the Project, when occurring within CUP operating hours (see Section 1.3.1), is exempt from King County noise limits.

Noise emissions from all other Project-related activities (e.g., innovation center and retail facilities), and any Project activities that occur outside of CUP operating hours, would be subject to King County sound level limits for a commercial source affecting a residential receiver: 57 dBA during daytime hours, 47 dBA during nighttime hours.

### **2.2.2 Construction**

Pacific Raceways has committed to ensuring that construction noise levels are minimized, as received at the Project's eastern property boundary (see Construction BMPs, Section 2.1.1). Although exempt from daytime noise limits, Pacific Raceways will make every reasonable effort to ensure that construction noise does not exceed an hourly sound level of 57 dBA at the eastern Project boundary.

Note that construction will not occur during nighttime hours.

## **2.3 Noise Monitoring**

### **2.3.1 Noise Monitoring Location**

To facilitate the recording and review of noise received at the eastern Project boundary, Pacific Raceways will install two (2) Noise Monitoring Terminals (NMTs), including along the eastern property boundary and within the Project area. The NMTs will be identified as NMT1 and NMT2, respectively. The approximate location of the NMTs is represented graphically in [Appendix A, Figure 1](#).

NMT1 will be conservatively representative of noise levels received at residential dwellings located along 148th Ave SE.<sup>1</sup> The microphone of NMT1 will be located approximately six (6) feet above ground, approximately in line with the single-story residential dwellings along 148th Ave SE.

NMT2 will be positioned to monitor noise within the Project, used for comparison with noise data collected at NMT1. The microphone of NMT2 will be located at least six (6) feet above ground, and potentially higher if fixed to a Project building.

Pacific Raceways will coordinate with a qualified acoustical consultant to select the exact location for installation of the NMTs, accounting for the availability of a power source, security of the equipment, and an unobstructed line of sight toward construction and operational activities. Note that NMT2 will be positioned so that it best captures noise from anywhere within the new garage building area.

### **2.3.2 Noise Monitoring Installation and Operation Schedule**

NMT1 will be installed prior to Project construction and will be maintained throughout the duration of construction and the operational life of the Project.

NMT2 will be installed once Project buildings are constructed, and immediately prior to their use. NMT2 will be maintained throughout the operational life of the Project.

### **2.3.3 Noise Monitoring Equipment**

The NMTs will be stand-alone, self-powered (e.g., solar-powered) or A/C-powered units (if feasible) that are capable of providing continuous noise monitoring. The NMTs will be equipped with an ANSI Type I integrating sound level meters and all-weather microphones, telemetry (i.e., a modem), and battery back-ups.

Sound level data recorded at the NMTs will be collected and maintained by Pacific Raceways (or a designee) through an online interface that will provide real-time access to the measured sound level data, as well as historical data records and sound level threshold-triggered audio recordings. All sound level data and audio recordings will be available for manual and automatic downloading, and will be stored for up to one (1) year.

### **2.3.4 Noise Monitoring Schedule**

The NMTs will be continuous noise monitoring systems, recording sound level data 24-hours per day, seven (7) days per week.

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<sup>1</sup> This location is up to approximately 100 feet west of the homes that are located along the east side of 148th Ave SE, and so sounds received from activity within Pacific Raceways may be higher at the NMT than are actually received at the represented homes.

Sound level data will be automatically downloaded on a weekly basis and tabulated for the purposes of noise reporting (see Section 2.6).

## **2.4 Noise Disturbance Coordinator**

Pacific Raceways will designate a Noise Disturbance Coordinator (NDC) who will be responsible for responding to complaints received during construction and operation at Pacific Raceways. Contact information for the NDC, including phone number and email address, will be posted to Pacific Raceway's website and also on signage along the eastern property boundary, adjacent to 148th Ave SE. The NDC's contact information also will be provided to King County.

### **2.4.1 Noise Complaint Process**

The nearby public will be able to register complaints by contacting the NDC either by phone or email. Complainants will be requested to provide details of the complaint including the complainant's name, address, phone number, and time and nature of the complaint event.

All complaints received by the NDC will be reviewed to confirm whether the event or activity that triggered the complaint:

- 1) Resulted in sound levels that exceeded the applicable sound level limits,
- 2) Originated from activity within Pacific Raceways property, and
- 3) Originated from a source within Pacific Raceways that was not exempt from the noise limits (i.e., racing and testing of vehicles during CUP operating hours).

To aid in the review of noise complaints, the NDC will review sound level data collected at the NMTs. NMT data, including sound levels and audio, will be reviewed for the day and time during which the event is alleged to have occurred. For complaints that are received during Project construction, the NDC will review data from NMT1. During operation, the NDC will review data from both NMT1 and NMT2. Data collected at NMT2 will assist the NDC in determining whether noises originated from the Project area, or whether they originated from outside sources (e.g., from within the community, along public roadways, etc.)

In addition to review of NMT data, the NDC may review construction activity logs, materials receiving logs, and may conduct interviews with construction personnel.

The NDC will complete their review within 48 hours of receiving the complaint.

### **2.4.2 Corrective Action**

If a noise complaint is found to be substantiated by measurement data, corrective action will be taken to ensure that a repeat event does not occur. If necessary, administrative controls will be employed to restrict selected operations (i.e., modified times of day, duration per hour, or location).

If additional mitigation is warranted beyond administrative controls, the NDC will review and determine the most appropriate mitigation measure(s). See Section 2.5 for a list of mitigation measures that may be employed, depending on whether complaints arise during construction or operation.

### **2.4.3 Complaint Response**

The NDC will provide a response to all noise complainants, whether found to be substantiated by measurement data or not, within 48 hours of receiving the complaint. The NDC will inform the complainant whether the complaint is substantiated by monitoring data or not, and if so, what corrective action was/is being taken to avoid a repeat of the offending noise event.

### **2.4.4 Automated Noise Alerts**

In addition to responding to noise complaints, the NDC also will receive automatic notifications from NMT1 when measured sound levels exceed established sound level limits by 5 dBA. A 5-dBA increase in a given noise environment is readily perceptible by most people.

Note that a short-duration exceedance of the sound level limit does not necessarily indicate whether the hourly sound level limit will be exceeded. Often short-duration and high-level noises that are single, isolated events, will not greatly influence an hourly average sound level. However, repeated occurrences of a high-level, short-duration event may result in exceedance of an hourly limit. If continued exceedances are documented, and if the NDC has confirmed that these events are due to non-exempt Pacific Raceways activity, the NDC will pro-actively work to identify to the offending sound source and, if necessary, employ noise mitigation measures to reduce the potential for an exceedance of the applicable hourly sound level limit.

## **2.5 Mitigation Measures**

Sound level exceedances that are documented through review of hourly NMT data, and when verified to result from non-exempt sound sources within Pacific Raceways, and that are determined to have a real potential to repeat, may warrant review of additional mitigation measures for the given sound source.

### **2.5.1 Construction Noise Mitigation**

Noise from construction activities often can be mitigated through administrative controls (i.e., adjustment to timing and location of specific equipment or activities, as summarized in Section 2.4.2). Should administrative controls not be feasible or effective at controlling the sound source, additional measures may be warranted.

Pacific Raceways is committed to the construction of a permanent noise barrier that would shield operational noise from the garage, as received at residences along 148th Ave SE. Depending on the construction schedule, the barrier may be installed prior to the start of major construction activity in the vicinity of the barrier. The approximate location of the noise barrier is illustrated in [Appendix A, Figure 1](#).

#### **2.5.1.1 Stationary Equipment**

Noise mitigation for stationary equipment, in addition the BMPs identified in Section 2.1.1.1, may include:

- Installation of temporary enclosures around stationary equipment, and;
- Installation of temporary noise barriers around stationary equipment. Temporary noise barriers may be constructed in the location of the permanent barrier prior to permanent barrier construction, or they may be constructed further north along the eastern property boundary, as needed.

#### **2.5.1.2 Heavy Mobile Equipment**

Noise mitigation for heavy mobile equipment, in addition the BMPs identified in Section 2.1.1.2, may include:

- Engine enclosures, if feasible and/or necessary, and;
- Installation of temporary noise barriers along the eastern property boundary, constructed further north than the permanent noise barrier, as needed.

#### **2.5.2 Operational Noise Mitigation**

Operational noise mitigation measures would be primarily administrative controls, as the new garage buildings will be equipped with doors that can close completely to shield interior activity from being audible at exterior locations.

In addition to the BMPs identified in Section 2.1.2, the following mitigation measures may apply to operation of the proposed new garage buildings:

- At the discretion of the NDC, noise complaints that are received during daytime hours, and that are due to activity within the garages, may result in required closing of select garage doors before 10 p.m.

#### **2.6 Reporting**

Monthly noise monitoring reports will be provided by Pacific Raceways to the County for the first year of construction, and then annual thereafter for the life of permitted use of the new garage facilities.

The monitoring reports will include:

- Tabulation of hourly sound level data
- Graphical summaries of sound level data
- A full list of complaints received, including:
  - Name and address of complainant;
  - Date, time, and duration of offending noise event;
  - Method and results for substantiating noise complaint, including review process, sound levels and source(s) of offending noise(s), and;
  - Mitigation measure employed to reduce level of offending noise source

## **APPENDIX A**

### **Figures**



**Figure 1. Noise Monitoring Terminal**

**APPENDIX B**  
**Regulatory Setting**

Pacific Raceways is located within unincorporated King County. Noise rules within the King County Code (KCC) are defined in KCC Title 12, Chapter 12.86 (KCC 12.86) and are reproduced in the table below.

**Table 1. King County Maximum Permissible Sound Levels**

District of Sound Source	District of Receiving Property Within King County			
	Rural	Residential	Commercial	Industrial
Rural	49	52	55	57
Residential	52	55	57	60
Commercial	55	57	60	65
Industrial	57	60	65	70

**Notes:**  
 Note that for rural and residential receiving properties, the noise limits between 10:00 p.m. and 7:00 a.m. are reduced by 10 dBA  
**Source:** KCC 12.86

The sound level limits identified in [Table 1](#) are based on the energy-average sound level over a given time period, or "Leq"<sup>2</sup>. Noise from sources at Pacific Raceways may be intermittent (i.e., not continuous or steady), and therefore the limits in [Table 1](#) are assumed to be the Leq sound level averaged over a minimum 30 minutes time period.

The above limits may be exceeded by a maximum of 15 dBA, as documented by the L<sub>max</sub>.<sup>3</sup>

The districts of the sound source and receiving properties are based on zoning and are summarized as follows, as defined in KCC 12.86.030:

- Rural - includes zones designated in the King County zoning code as A and RA
- Residential - includes zones designated in the King County zoning code as UR and R-1 through R-48
- Commercial - includes zones designated in the King County zoning code as O, NB, CB and RB

<sup>2</sup> The Leq is the level that if held constant over the same period of time would have the same sound energy as the actual, fluctuating sound. As such, the Leq can be considered an energy-average sound level. This metric should not be confused with an arithmetic average which tends to de-emphasize high and low values. The Leq noise metric has been found to be highly correlated to community response to noise, and is often the metric calculated by noise models used to assess potential impacts and the need for mitigation.

<sup>3</sup> The L<sub>max</sub> is the maximum sound level over a given measurement interval

- Industrial - includes zones designated in the King County zoning code as I and M and special uses

The Project is located on property zoned I-P, an industrial zoning designation. The nearest receivers to the Project are located in land zoned RA-5, a rural zoning designation. Therefore, during non-exempt operation and times of day (see below), the limits applicable to the Project are 57 dBA Leq for an Industrial source affecting a Rural receiver, and a maximum (L<sub>max</sub>) sound level limit of 72 dBA L<sub>max</sub>.

### **Construction**

KCC 12.86.520 exempts noise from various types of construction activity during specific times of day, as follows:

12.86.520(1): *For heavy equipment, including crawlers, tractors, bulldozers, rotary drills and augers, loaders, power shovels, cranes, derricks, graders, off-highway trucks, ditchers, trenchers, compactors, compressors and other similar equipment:*

- Exempt between the hours of 7:00 a.m. and 7:00 p.m. on weekdays, and between 9:00 a.m. and 7:00 p.m. on weekends

12.86.520(3): *For all other construction activities:*

- Exempt between the hours of 9:00 a.m. and 10:00 p.m. on weekdays, and between 9:00 a.m. and 8:00 p.m. on weekends

### **Operation**

The Pacific Raceways facilities is permitted for operation in King County under CUP #A-71-0-81, which permits the facility to operate within the hours identified above under Section 1.3.1 (p. 4).

As identified in KCC 12.86.500, Sounds Exempt At All Times, the following applies to all operational activities at Pacific Raceways:

- 12.86.500(P): *Sounds created by motor vehicle racing events and motor vehicle testing and training, governed by and conducted in accordance with applicable King County permit conditions.*

Therefore, because the Pacific Raceways facility is a King County-permitted facility, noise emissions generated during operation of Pacific Raceways, including all vehicle testing and training, and including operation of the buildings proposed for this Project, is exempt from the KCC limits identified in [Table 1](#) during approved hours of operation.

## **APPENDIX C**

### **Common Noise Descriptors**

Noise is sometimes defined as unwanted sound, and the terms noise and sound are used more or less synonymously.

The human ear responds to a very wide range of sound intensities. The decibel scale (dB) used to describe sound is a logarithmic rating system which accounts for the large differences in audible sound intensities. This scale accounts for the human perception of a doubling of loudness as an increase of 10 dB. Therefore, a 60-dB sound level will sound about twice as loud as a 50-dB sound level. People generally cannot detect differences of 1 or 2 dB. In ideal laboratory situations, differences of 2 or 3 dB can be detected by people, but such a change probably would not be noticed in a typical outdoor environment. A 5-dB change would probably be clearly perceived by most people under normal listening conditions.

On the logarithmic decibel scale used to describe noise, a doubling of sound-generating activity (i.e., a doubling of the sound energy) causes a 3-dB increase in average sound produced by that source, not a doubling of the loudness of the sound (which requires a 10-dB increase). For example, if a generator is causing a 60 dB sound level at some nearby location, a second identical generator operating at the exact same location would cause the sound level at this same location to increase to 63 dB. Such an increase might not be discernible in a complex acoustical environment.

When addressing the effects of noise on people, it is useful to consider the frequency response of the human ear. Sound-measuring instruments are therefore often programmed to "weight" measured sounds based on the way people hear. The frequency-weighting most often used is A-weighting because it approximates the frequency response of human hearing and is highly correlated to the effects of noise on people. Measurements from instruments using this system are reported in "A weighted decibels" or dBA.

Relatively long, multi-source "line" sources, such as roads with continuous traffic, emit cylindrical sound waves. Due to the cylindrical spreading of these sound waves, sound levels from such sources decrease with each doubling of distance from the source at a rate of about 3 dBA. Sound waves from discrete events or stationary "point" sources, such as a stationary generator, spread as a sphere, and sound levels from such sources decrease 6 dBA per doubling of the distance from the source. Conversely, moving half the distance closer to a source increases sound levels by 3 dBA and 6 dBA for line and point sources, respectively.

For a given source, a number of factors affect the sound transmission from the source, which in turn affect the potential for noise impacts. Important factors include distance from the source, frequency of the sound, atmospheric conditions, absorbency and roughness of the intervening ground surface, the presence or absence of intervening obstructions (e.g.,

buildings, barriers), and the duration of the noise-producing event. The degree of impact on humans also depends on who is listening (individual physiological and psychological factors) and on existing sound levels (background noise). Typical sound levels of some familiar noise sources and activities are presented in [Table 2](#).

When assessing potential community response to noise, it is helpful to have a metric that averages varying noise exposure over time and quantifies the result in terms of a single number descriptor. Several such metrics have been developed that address community noise levels. Applicable to this analysis is the Equivalent Noise Level ( $L_{eq}$ ). The  $L_{eq}$  is the level of a constant sound that has the same sound energy as the actual fluctuating sound. As such, it can be considered an energy-average sound level for a given period of time (e.g., 15 minutes, 1 hour, etc.).

**Table 2: Sound Levels Produced by Common Noise Sources**

Thresholds / Noise Sources	Sound Level (dB)	Subjective Evaluations	Possible Effects on Humans	
Human Threshold of Pain	140	Deafening	Continuous Exposure Can Cause Hearing Loss	
Carrier jet takeoff (50 ft)	130			
Siren (100 ft)	120			
Chain saw Noisy snowmobile	110	Very Loud		
Lawn mower (3 ft) Noisy motorcycle (50 ft)	100			
Heavy truck (50 ft)	90			
Pneumatic Drill (50 ft) Busy urban street, daytime	80	Loud		
Normal automobile at 50 mph Vacuum cleaner (3 ft)	70			
Large air conditioning unit (20 ft) Conversation (3 ft)	60	Moderate		Speech Interference
Quiet residential area Light auto traffic (100 ft)	50			
Library Quiet home	40	Faint	Sleep Interference	
Soft whisper (15 ft)	30			
Slight Rustling of Leaves	20			
Broadcasting Studio	10	Very Faint		
Threshold of Human Hearing	0			
<p>Note that both the subjective evaluations and the physiological responses are continuums without true threshold boundaries. Consequently, there are overlaps among categories of response that depend on the sensitivity of the noise receivers.</p> <p><b>Source:</b> United States Environmental Protection Agency (EPA) and others.</p>				

## **APPENDIX D**

### **Acronyms and Abbreviations**

Acoustically neutral .....	A description of equipment or material such as a wind screen used over a sound level meter microphone that, due to its composition, has little or no effect on the sound pressure levels reaching the microphone
Day-night sound level (Ldn) ...	A 24-hour sound level metric similar to a 24-hour Leq, except the Ldn includes an additional 10 dBA added to sound levels in each hour between 10 PM and 7 AM to account for increased sensitivity to noise during times when people are typically trying to sleep
dB.....	decibel, referring to a unit measured on the decibel scale used to quantify sound levels
dBA .....	A-weighted decibel, a system for weighting measured sound levels to reflect the frequencies that people hear best
Distance attenuation.....	the rate at which sound levels decrease with increasing distance from a noise source based on the dissipation of sound energy as the sound wave increases in size (think of a balloon getting thinner as it becomes more inflated)
Equivalent sound level (Leq) ...	A sound level metric that is the level that if held constant over the same period of time would have the same sound energy as the actual, fluctuating sound (i.e., an energy-average sound level)
Leq .....	Equivalent sound level (see above)
Ln.....	Statistical noise level, the level exceeded during n percent of the measurement period, where n is a number between 0 and 100 (for example, L50 is the level exceeded 50 percent of the time)
Noise criteria .....	A set of definitions establishing the conditions under which a noise impact is determined to have occurred.
Noise impact.....	A measured or model-calculated condition in which the absolute (i.e., total) sound level and/or a project-related sound level increase exceed a defined noise impact criterion.
Noise metric .....	One of a number of measures used to quantify noise (e.g., Leq, or Lmax)
SLM.....	Sound level measurement
Sound level .....	Sound pressure level (see below)
Sound power level.....	A measure of the sound energy emitted by noise source expressed as energy per unit of time. <i>Not</i> to be confused with sound pressure level.
Sound pressure level .....	Ten times the base-10 logarithm of the square of the ratio of the mean square sound pressure, in a stated frequency band (often weighted), and the reference mean-square sound pressure of 20 $\mu$ Pa (micro pascals, a standard reference unit

of pressure), which is approximately equal to the threshold of human hearing at 1 kilohertz. Sound pressure level is expressed in decibels.

Type I meter A type of sound level meter defined by American National Standards Institute as being to measure sound pressure levels to an accuracy within 0.5 dBA