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PACIFIC RACEWAYS EXPANSION PROJECT, KENT, WASHINGTON

ENVIRONMENTAL NOISE, AIR QUALITY, GHG, AND LIGHT & GLARE REPORT

RAMBOLL

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1. INTRODUCTION

1.1 Project Description

Pacific Raceways LLC (Pacific Raceways) proposes to excavate up to 1,000,000 cubic yards of gravel and construct up to 200,000 square feet of buildings on a currently undeveloped parcel in unincorporated King County (the Project). The 40-acre parcel commonly is referred to as Parking Lot C, used infrequently as overflow parking for Pacific Raceways events. Currently, 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 commercial facilities within the development will 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 tracks at the existing Pacific Raceway property, as well as housing an automotive innovation center and related retail facilities.

Excavation and processing of materials will occur for a period of between approximately 3 and five 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.

Operation of the proposed Project buildings would occur within the currently approved operations schedule, as summarized in Pacific Raceway's CUP. However as stated commercial facilities within the new development will available to tenants at all hours, and operation outside of CUP-approved hours will be subject to King County noise limits:

<u>May through August</u>

- 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.

<u>September through April</u>

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

This report identifies the potential for Project impacts on environmental noise, air quality, greenhouse gas, and lighting and glare.

2. REGULATORY SETTING

2.1 Environmental Noise

The Project 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 "L_{eq}" [1]. Noise from sources at Pacific Raceways may be intermittent (i.e., not continuous or steady), and therefore the limits in **Table 1** are assumed be the L_{eq} 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_{max}. [2]

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

[1] 80 Fed. Reg. 65,292 (Oct. 26, 2015 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.

[2] The Lmax is the maximum sound level over a given measurement interval

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

The Project site 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 L_{eq} for an Industrial source affecting a Rural receiver, and a maximum (L_{max}) sound level limit of 72 dBA L_{max}.

2.1.1 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

2.1.2 Operation

The Pacific Raceways facilities is permitted for operation in King County under Conditional Use Permit #A-71-0-81, which permits the facility to operate within the hours identified above under Section 1.1.

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.

2.2 Air Quality

Air quality is generally assessed in terms of whether concentrations of air pollutants are higher than or lower than ambient air quality standards established to protect human health and welfare. Three agencies have jurisdiction over ambient air quality in the Project area: the U.S. Environmental Protection Agency (EPA), the Washington Department of Ecology (Ecology), and the Puget Sound Clean Air Agency (PSCAA). These agencies establish regulations that govern both the concentrations of pollutants in the outdoor air and contaminant emissions from air pollution sources. Although their regulations are similar in stringency, each agency has established its own standards. Unless the state or local jurisdiction has adopted more stringent standards, the EPA standards pertain.

To track air quality conditions over time, Ecology and PSCAA maintain a network of monitoring stations throughout the Puget Sound region. These stations are typically located where air quality problems may be expected to occur and are usually in or near urban areas or close to specific large air pollution sources. Other stations are used to indicate regional air pollution levels. Based on monitoring information collected over a period of years, the EPA and Ecology designate regions as being "attainment" or "nonattainment" for particular air pollutants. Attainment status therefore is a bench-mark of whether air quality in an area complies with the National Ambient Air Quality Standard (NAAQS) for one or more "criteria" air pollutants. Regions that were once designated nonattainment that have since attained the standard are considered air quality "maintenance" areas through two 10-year cycles of review, after which the area achieves "attainment" if the ambient standards have been maintained.

Although the Project area was once designated maintenance for CO and ozone, as of 2017, the second term of both maintenance plans have concluded, and there have been no measured air quality concentrations exceeding the standards in recent years. Therefore, the area is considered to be in attainment for all air quality pollutants of concern. [3]

A complete list of local, state, and federal ambient air quality standards are displayed in **Table 2**.

[3] Communication between Ramboll and Joanna Ekrem of the State Implementation Planning Committee, WA Department of Ecology (January 2017).

Table 2: Applicable Ambient Air Quality Standards for Criteria Pollutants

Pollutant	Terms of Compliance [(a)]	Concentration
Inhalable Particulate Matter (PM_{10}) 24-Hour Average ($\mu g/m^3$)	Not to be exceeded more than once per year, averaged over 3 years	150 $\mu g/m^3$
Fine Particulate Matter ($PM_{2.5}$) Annual Average ($\mu g/m^3$) 24-Hour Average ($\mu g/m^3$)	The 3-year average of the annual mean must not exceed The 3-year average of the 98th percentile of daily concentrations must not exceed	12 $\mu g/m^3$ 35 $\mu g/m^3$
Carbon Monoxide (CO) 8-Hour Average (ppm) 1-Hour Average (ppm)	The 8-hour average must not exceed more than once per year The 1-hour average must not exceed more than once per year	9 ppm 35 ppm
Ozone (O_3) 8-Hour Average (ppm)	The 3-year average of the 4th highest daily maximum 8-hour average must not exceed	0.07 ppm

Note: $\mu g/m^3$ = micrograms per cubic meter; ppm = parts per million

[(a)] All limits are federal *and* state air quality standards and represent "primary" air quality standards intended to protect human health.

2.3 Lighting/Glare

Currently, and as is consistent with most local and county jurisdictions, King County does not have established quantitative restrictions on light and glare. KCC 12A.14.280 Rural Industry Development Standards, provides the following on lighting located in an industrial zone with a rural area:

> 12A.14.280(B)(6): *Outdoor lighting shall be focused downward and configured to minimize intrusion of light into surrounding rural residential areas*:

Further, as described within the Project's *PREA17-0128: Pacific Raceways Interim Use Permit under Demonstration Project KCC 21A.55.105* document:

> Site Design (6, Lighting): *A lighting plan is required to demonstrate that exterior lighting is not projected onto adjacent properties, into adjacent homes or onto the street ROW. Not to exceed one foot-candle at the property line is typical.*

3. EXISTING ENVIRONMENT

3.1 Environmental Noise

A sound level measurement was made in February 2016 to document and characterize the existing noise environment in the Project vicinity. The sound level measurement was conducted over a period of three days at a location representative of residential properties in the vicinity of the Project. Specifically the meter was located within the wooded areas just east of 148th Ave SE and north of 311th Ave SE. The measurement location is representative of homes along 148th Ave SE with potential exposure to noise emitted by the Project. The measurement location is illustrated in **Appendix A**, **Figure 1**.

The existing acoustic environment is typical of a relatively quiet suburban area with few continuous sources of dominant noise. Distant traffic from Highway SR-18 is at times audible, as is infrequent traffic noise on local roadways. Other sources of noise include Pacific Raceways event noises (i.e., races and other motor vehicle events), birds, and miscellaneous neighborhood noises.

The sound level measurement was taken using a Larson Davis model LxT Class I sound level meter set to capture hourly data over the three-day period. The meter's microphone was placed in an acoustically-neutral wind screen positioned approximately five (5) feet above ground. The meter was factory calibrated within the previous 12 months and was field calibrated immediately prior to use.

Sound level measurement data are summarized in **Table 3**, including the range of hourly average L_{eq} sound level data for daytime (7 a.m. to 10 p.m.) and nighttime (10 p.m. to 7 a.m.) periods.

Table 3. Ambient Noise Monitoring Summary (dBA)

Time of Day [a]	Range of Hourly Sound Levels [b]	
	Leq Range	Leq Average
Day	45 - 57	51
Night	39 - 54	48

[a] "Day" refers to the hours between 7 a.m. and 10 p.m., "Night" to the hours between 10 p.m. and 7 a.m.

[b] Measured over a three-day period, from February 9 – 11, 2016. Contributing sound sources included distant traffic from SR-18, as well as nearby residential activity and birds.

Source: Ramboll

3.2 Air Quality

Weather is one of several variables that influence air quality, with wind (speed and direction) and atmospheric stability being two major factors that affect dispersion of both air emissions and noise. Periods with stable high-pressure systems and periods that include nighttime thermal inversions due to the low solar heating of the land in winter create stable atmospheric conditions. It is during these very stable atmospheric conditions when little vertical air emission dispersion occurs, and high concentrations of air pollutants emitted at ground level typically occur. Ground-level emitted pollutants include CO from motor vehicles and particulate matter from vehicles and wood stoves.

In the Puget Sound region, summers are cool and comparatively dry and winters are mild, wet, and cloudy. The winter months are dominated by a stronger south wind and frequent precipitation. Annual average precipitation in the region is around 38 inches. Annual mean temperature in the urban areas of Seattle/Tacoma is about 53°F. The annual mean wind speed is about seven (7) mph, with a predominately southerly wind direction (i.e., from the south).

3.2.1 Carbon Monoxide

Carbon monoxide is a by-product of incomplete combustion. CO is generated by vehicular traffic and other fuel-burning activities, such as residential space heating, especially space heating using solid fuels such as coal or wood. There are two short-term air quality standards for CO: a 1-hour average standard of 35 ppm and an 8 hour average standard of 9 ppm.

The impacts of CO are usually localized near the source(s), with the highest ambient concentrations typically occurring near congested roadways and intersections during periods of cold temperatures (autumn and winter months), light winds, and stable atmospheric conditions. Such weather conditions reduce the atmospheric mechanisms that disperse and dilute pollutants.

As summarized earlier, the Project area is now considered attainment for CO.

3.2.2 Ozone

Ozone is a reactive form of oxygen created by sunlight-activated chemical transformations of nitrogen oxides and volatile organic compounds (hydrocarbons) in the atmosphere. Ozone problems tend to be regional in nature because the atmospheric chemical reactions that produce ozone occur over a period of time, during which ozone precursors can be transported far from their sources. Transportation sources like automobiles and trucks are among the sources that produce ozone precursors.

In the past, due to violations of the federal 1-hour ozone standard, the Puget Sound region was designated as nonattainment for ozone. In 1997, EPA determined that the Puget Sound ozone nonattainment area had attained the health-based ozone standard in effect at that time. EPA then reclassified the Puget Sound region as attainment for ozone and approved the associated air quality maintenance plan. In 2005, EPA revoked the 1-hour ozone standard in most areas of the US including the Puget Sound region, which ended the ozone maintenance status of this region. In March of 2008, the EPA adopted a new more stringent 8-hour average ozone standard of 75 parts per billion (ppb). The 8-hour standard was later strengthened to 70 ppb for most areas, effective December 2015.[4]

Based on ozone measurements over the last few years, the Puget Sound region may again be on the brink of becoming nonattainment for ozone. Under present plans and policies, the ozone attainment/nonattainment status of the area would have no direct effects on the proposed Project.

3.2.3 Inhalable Particulate Matter – PM_{10} and $PM_{2.5}$

Particulate matter air pollution is comprised of particles either emitted directly into the air (e.g., dust) or formed when hot gases cool and condense. Such air pollution is generated primarily by industrial activities and operations involving fuel combustion and material handling, and by other fuel combustion sources like motor vehicle engines, vessel engines, and residential wood burning. Federal, state, and local regulations set limits for particle concentrations in the air (i.e., weight per unit volume) based on the size of the particles and the related potential threat to health. When first regulated, particle pollution limits were based on "total suspended particulate, which included all size fractions. As sampling technology improved and the importance of particle size and chemical composition became more apparent, ambient standards were revised to focus on the size fractions thought to be most dangerous to human health. Based on the most recent studies, EPA has redefined the size fractions and set new, more stringent standards for particulate matter based on fine and coarse inhalable particulate matter to focus control efforts on the smaller size fractions.

There are currently health-based ambient air quality standards for PM_{10}, or particles less than or equal to about 10 micrometers (microns) in diameter, as well as for $PM_{2.5}$, or particulate matter less than or equal to 2.5 microns in diameter. The latter size fraction and even smaller (ultra-fine) particles are now considered the most dangerous size fractions of airborne particulate matter because such small particles (e.g. a typical human hair is about 100 microns in diameter) can be breathed deeply into lungs. In addition, such particles are

[4] 80 Fed. Reg. 65,292 (Oct. 26, 2015).

often associated with toxic substances that are deleterious in their own right that can adsorb to the particles and be carried into respiratory system.

In 1987, EPA determined a portion of Kent and the industrial areas of Seattle and Tacoma had greater than 95% probability that they would exceed the PM_{10} 24-hour average standard. In 1990, all three locations were designated moderate PM_{10} nonattainment areas. State Implementation Plans (SIP) were developed by Ecology and PSCAA to address the nonattainment status and in 2001, EPA redesignated the areas from nonattainment to maintenance. The Project is located southeast of the Kent PM_{10} 24-hour maintenance area and is not subject to the controls defined in the latest maintenance plans.[5]

With the revocation of the federal annual standard for PM_{10} in October 2006, the focus of ambient air monitoring and control efforts related to particle air pollution in the Puget Sound region has been almost entirely on fine particulate matter ($PM_{2.5}$). The nearest $PM_{2.5}$ nonattainment area to the Project site encompasses Tacoma and surrounding lowland areas in Pierce County.[6] However, the Project site is not in this area and is considered to be in attainment of the $PM_{2.5}$ standards.

3.2.4 Greenhouse Gases and Global Climate Change

The phenomenon of natural and human-caused effects on the atmosphere that cause changes in long-term meteorological patterns is known as climate change. Due to the importance of the greenhouse effect and related atmospheric warming to climate change, the gases that affect such warming are called greenhouse gasses (GHGs). The GHGs of primary importance are CO_2, methane, and nitrous oxide. Because CO_2 is the most abundant of these gases, GHGs are usually quantified in terms of CO_2e (carbon dioxide equivalent), based on their relative longevity in the atmosphere and the related "global warming potential" of these constituents. CO_2 is not considered an air "pollutant" that causes direct health-related effects, so it is not subject to ambient air quality standards used to gauge pollutant concentrations in the air.

Fuel combustion used for transportation is a significant source of GHG emissions, primarily through the burning of gasoline and diesel fuels. National estimates indicate the transportation sector (including on-road, construction, airplanes, and vessels) accounts for

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[5] Puget Sound Clean Air Agency and Washington Department of Ecology, "The Kent, Seattle, and Tacoma, WA Second 10-year Limited Maintenance Plan for PM10," September 17, 2013. http://www.ecy.wa.gov/programs/air/sips/pdfs/PM10-LMP_Draft-Kent_Seattle_Tacoma.pdf

[6] The nonattainment area is called the Wapato Hills-Puyallup River Valley area. See information and maps at: http://www.ecy.wa.gov/programs/air/Nonattainment/Nonattainment.htm.

about 31 percent of total domestic CO_2e emissions from fossil fuels in 2014.[7] In an interim tabulation of 2012 emissions within Washington, Ecology estimated transportation accounted for about 46 percent of statewide GHG emissions;[8] the higher percentage is due to lower GHG emissions from electrical generation because the state relies heavily on hydropower for electricity.

No specific federal, state, or local emission reduction requirements or targets are applicable to the proposed Project, and there are no generally accepted emission level thresholds against which to assess potential localized or global consequences of GHG emissions. In December 2010, Ecology adopted WAC 173-441, which requires mandatory GHG reporting for all facilities that emit 10,000 metric tons or more per year in total GHG emissions from all applicable sources. Applicable sources, listed in WAC 173-441-120, include general stationary sources of combustion, production and manufacturing sources, transportation fuel suppliers, and emissions from industrial waste landfills. Emissions from mobile fleets associated with facilities are not applicable because these emissions are accounted by transportation fuel suppliers. The GHG emissions associated with project operation were analyzed in this report using the King County Department of Development and Environmental Services SEPA GHG Emissions Worksheet.[9]

3.3 Light/Glare

In the vicinity of the nearest residential area along 148th Ave SE there are relatively few sources of nighttime light or glare. Streetlights and residential lighting along 148th Ave SE, as well as headlights from traffic, are the only existing continuous sources. Nighttime activity at the existing Pacific Raceways facility generally does not result in lighting impact at these homes.

The Project property is currently a vacant field, used occasionally for parking during large events at Pacific Raceways. During nighttime hours or dark times of day (i.e., during winter evenings), headlights from traffic utilizing this additional parking area may be occasionally noticeable at residences along 148th Ave SE.

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7 Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2014, April 2016, https://www.epa.gov/sites/production/files/2016-04/documents/us-ghg-inventory-2016-chapter-3-energy.pdf

8 2012 Washington State Greenhouse Gas Inventory Report Table, http://www.ecy.wa.gov/climatechange/docs/2012GHGtable.pdf

9 The King County Department of Development and Environmental Services SEPA GHG Emissions Worksheet, accessed December 2017, is available at: http://www.kingcounty.gov/depts/permitting-environmental-review/info/SiteSpecific/ClimateChange.aspx

4. CONSTRUCTION IMPACT ASSESSMENT

Construction of the proposed Project would include excavation of an estimated 1,000,000 cubic yards of gravel and the construction of approximately 200,000 square feet of buildings to be used mostly for garages, as well as an automotive innovation center and related retail facilities.

Gravel excavation would lower the grade of the Project site to an elevation that would be beneficial to operational noise emissions and also to reduce the potential for lighting and glare impacts at nearby existing homes. Building construction is likely to occur concurrently with excavation, following excavation of the building footprint area within the approximate southern half of the site.

Construction activities are anticipated to continue for between approximately 3 and 5 years, including excavation and building construction. Construction hours are anticipated as follows:

- Excavation: between 7 a.m. and 7 p.m., Monday through Friday, and between 9 a.m. and 7 p.m. on Saturdays.
- Screening: between 8 a.m. and 5 p.m., Monday through Friday, and between 9 a.m. and 5 p.m. on Saturdays.
- Building Construction: between 7 a.m. and 7 p.m., Monday through Friday, and between 9 a.m. and 7 p.m. on Saturdays.
- No construction, including excavation, screening or building construction, would occur on Sundays.

As indicated, noise from construction activities is exempt under KCC 12.86.520(1) between 7:00 a.m. and 7:00 p.m. on weekdays, and between 9:00 a.m. and 7:00 p.m. on weekends. However, given the duration of the construction program, noise from construction activities, specifically excavation equipment including a continuously-run screen plant and loader operations, was evaluated against the sound level limits identified in the County code as a means to identify and reduce to the potential for perceived impact at nearby residential neighbors to the east, along 148th Ave SE.

Noise emissions during excavation and building construction would vary by equipment type, duration of use, and location. **Table 4** displays typical noise levels produced by equipment that could be used during excavation and construction of the Project buildings. Sound levels near many types of construction equipment listed in **Table 4** decrease at a rate of about 6 dBA for each doubling of distance from the source(s). Typical construction sound levels are given for distances of 100, 200, and 400 feet to give some idea of equipment sound levels at varying distances.

Table 4. Typical Noise Levels From Construction Activities & Equipment (dBA)

Activity	Range of Hourly Leqs		
	At 100 Feet	At 200 Feet	At 400 Feet
Grading	69-82	63-76	57-70
Paving	66-82	60-76	54-70
Erection	66-78	60-72	54-66
Types of Equipment	**Range of Hourly Sound Levels**		
	At 100 Feet	**At 200 Feet**	**At 400 Feet**
Loader	75	69	63
Grave Screen	74	68	62
Bulldozer	71-90	65-84	59-78
Dump Truck	76-88	70-82	64-76
Scraper	74-87	68-81	62-75
Paver	80-82	74-76	68-70
Generators	65-76	59-70	53-64
Compressors	68-75	62-69	56-63
Source: EPA and others, compiled by Ramboll			

4.1 Construction Noise

4.1.1 Excavation and Screening

Excavation and screening activity would include use of front-end loaders, an on-site gravel screening plant, and off- site transport of excavated material using haul trucks.

An estimate of up to 40 truckloads per day is anticipated to remove material from the site during construction activities. Haul trucks would travel from SE 304th Place south to the site via 144th Ave SE. Assuming typical construction periods would be between 7 a.m. and 5 p.m. (see page 11 for a schedule of construction hours by activity), an average of 8 trucks per hour are anticipated to enter and exit the Project site.

To estimate noise from excavation, screening, and hauling of gravel, Ramboll used sound level data from its sound source library of similar equipment. Specifically, the noise level from a typical loader is estimated to be 81 dBA at 50 feet (i.e., 75 dBA at 100 feet), and the noise level from a screen of the size and type and expected at the Project construction site is estimated to be 80 dBA at 50 feet (see **Table 4**).

To estimate noise from loaders, a screen, and haul traffic, Ramboll used the CadnaA noise model. CadnaA is a sophisticated three-dimensional noise model that considers topography, distance, intervening structures, and ground absorption to estimate equipment sound levels at specific receptor locations. The model setup included the screen, two front-end loaders operating on the Project site, and 8 haul trucks per hour.

For the purposes of this assessment, the equipment was assumed to operate at existing elevation. The screen was assumed to operate near the western property boundary of the Project area in tandem with a loader used for loading trucks. A second loader was assumed to excavate material in the western region of the site (i.e., dispersed along an estimated travel route). Trucks were assumed to enter the site from the western property boundary, loop near the screen, and depart. See **Appendix A, Figure 1** for an illustration of the model source locations.

Noise model results indicate that, based on the above operating scenario, noise levels during most excavation activities would be within 57 dBA L_{eq}.[10] However, during periods of time when the excavating loader is operating nearest the eastern property boundary, noise from excavation could at times exceed 57 dBA at the nearest residential receivers east of the Project along 148th Ave SE by up to 3 or 4 dBA, depending on the specific location of the excavating loader.

4.1.1.1 Excavation Noise – Mitigation Methods

To ensure that noise from construction activities at Pacific Raceways does not result in perceived noise impacts (i.e., a perceived and sustained increase over ambient levels), Pacific Raceways will closely monitor excavation operations along the eastern property line with a permanent noise monitoring terminal (NMT) equipped with a noise level-triggered video feed. Data from the NMT will be analyzed to determine whether repeated construction events result in average hourly sound levels (i.e., hourly L_{eq}) that exceed ambient conditions by 15 dBA or more. Video recordings will be reviewed to confirm the source(s) of the offending noise. If construction activities are found to exceed ambient conditions by 15 dBA or greater on a continuous and ongoing basis, and if it is anticipated that such increases over ambient conditions is likely to continue for an extended time period, then noise control measures will be evaluated. Noise mitigation measures may include:

[10] As defined in Section 2.1, and in **Table 1**, 57 dBA L_{eq} is the sound level limit in KCC 12.86 for an Industrial noise source affecting a Rural noise receiver; the maximum (L_{max}) sound level limit is 72 dBA L_{max}. As noted, this evaluation is for comparison only because noise from construction is exempt during daytime hours, as defined in KCC 12.86.520

- 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
- Installation of a temporary noise barrier along the eastern property boundary, extending north from the proposed permanent barrier (see **Figure 2**)
- Other measures as identified through observation and assessment

If noise mitigation is warranted, Pacific Raceways will consult with a qualified noise expert to determine the most appropriate mitigation method. Once mitigation measures have been applied, Pacific Raceways will monitor their effectiveness through assessment of NMT data.

4.1.2 Building Construction

Construction of the proposed Project buildings would occur over a relatively shorter period of time than excavation. As with excavation activities at the Project site, building construction is exempt from the King County noise limits (see Section 2.1).

Site development and construction of the proposed Project buildings could result in elevated noise levels on and near the Project property lines, particularly at adjacent residential areas to the east. Primary sound sources could include grading equipment, and large haul trucks used for materials such as concrete. Other smaller pieces of equipment may include generators, compressors, and pumps all with the potential to contribute to cumulative noise emissions during construction.

Given the temporary nature of construction activities, and the restriction of construction to daytime hours, it is anticipate that the potential for perceived impacts from construction would be minimal. In addition, the developer would employ best management practices to reduce construction noise, as summarized in the proceeding section.

4.1.2.1 Construction Noise – General Mitigation Methods

The following may help to reduce to the potential for high levels of noise from construction equipment or activities, as may be received at existing noise-sensitive land uses to the west of the Project, and therefore would help to reduce the potential for perceived impact:

- Require that all equipment be fitted with properly sized mufflers.
- Require that all equipment be in good working order.
- Use quieter construction equipment models if available, and whenever possible use pneumatic tools rather than diesel or gas-powered tools.

- Place portable stationary equipment as far as possible from existing residential and noise-sensitive commercial areas, and if necessary, place temporary barriers around stationary equipment.
- For mobile equipment that routinely operate near residential areas (i.e., within approximately 200 feet to the north of the Project site), consider placement of typical fixed pure-tone backup alarms with ambient-sensing and/or broadband backup alarms.

4.2 Construction Air Quality

Construction of the proposed project could temporarily change localized air quality. For example, dust from construction activities would contribute to ambient concentrations of suspended particulate matter. Construction contractor(s) would have to comply with the PSCAA regulations requiring all reasonable precautions be taken to minimize fugitive dust emissions. Note that Pacific Raceways will ensure that a water truck will be present when needed to control fugitive dust emissions.

Construction would require the use of heavy trucks and smaller equipment such as generators and compressors. These engines would emit air pollutants that would slightly degrade local air quality. There is little or no danger of these emissions resulting in pollutant concentrations that would exceed a health-based ambient air quality standard. Nonetheless, emissions from construction equipment, and especially from diesel-fueled engines, are coming under increasing scrutiny because of their suspected risk to human health, and pollution control agencies are now urging that emissions from diesel-powered equipment be minimized to the extent practicable in order to reduce potential health risks.

Some phases of construction would cause odors detectable to some people in the area. This would be particularly true during paving operations using asphalt. The construction contractor(s) would have to comply with the PSCAA regulations during activities that emit odor bearing air contaminants. Such odors from paving operations would be short term.

With implementation of required measures to provide reasonable controls of dust and odors, construction of the proposed project would not be expected to result in significant air quality impacts.

4.3 Construction Light and Glare

Construction activities are anticipated to occur during daytime hours only. During summer months, additional lighting requirements will be minimal or not required. During winter months, lighting may be required during early morning hours (i.e., between approximately 7 a.m. and 8 a.m.) and during afternoons (i.e., between approximately 3 p.m. and 5 p.m.). However during times of year when addition lighting may be required, lighting will be limited to equipment operation only (i.e., at the gravel screen, or to light building

construction activities). These lighting requirements would be temporary and would be directed so that the lighting faces only the targeted equipment or process.

5. OPERATIONAL IMPACT ASSESSMENT

5.1 Noise

As identified in Section 2.1.2, operation of the proposed Project garages is exempt from the limits identified in KCC 12.86 during approved hours of operation. Regardless, noise emissions from Project operation would be received at the adjacent residential community to the east of the Project site, along 148th Ave SE. Therefore, noise from operation was evaluated to determine what mitigation measures, if any, may be warranted to reduce the potential for perceived noise impacts.

Operational noise sources expected from the Project would include mostly activity within individual garages, including noises from use of pneumatic tools, engine revving, clangs, voices, etc. The proposed innovation center, to be located within the proposed buildings, is not anticipate to generate high levels of noise, and so the focus of the following assessment is on garage operation.

Garage doors would be located on both east and west sides of the Project buildings, and so when open during daytime hours, noises from these activities could be audible at nearby homes. Note that during nighttime hours, should tenants be present and active within a garage, garage doors will remain closed after 10 p.m. In addition, Pacific Raceways will implement rules for tenants that restrict noisy activities to daytime hours only. Therefore, noise emissions from nighttime activity would be negligible. Note that during Fridays and Saturdays, between May through August, garages may be active to support racing events up until 11 p.m., as permitted in the CUP.

Pacific Raceways has proposed the construction of an 8 to 12-foot tall noise barrier along the east property line to shield operational noise from homes located directly east of the site, along the east side of 148th Ave SE. Due to site excavation, the floor of the Project buildings would be approximately 10 feet or more below the existing grade in vicinity of 148th Ave SE. Therefore, the combination of the excavated site floor, and a barrier placed at the top of the excavated slope, would provide an overall effective noise barrier to operation of Project.

To determine the potential for perceived impact from Project operation, noise emissions from garage activity was calculated using CadnaA, the same noise model that was employed for the construction assessment. Noise levels were calculated for fully-open garage doors along the east-facing wall of the eastern-most proposed garage building (approximately 15 foot-tall openings, modeled as vertical area sources of noise), and received at the property

lines of homes on the east side of 148th Ave SE (see **Appendix A, Figure 2**). For this assessment, it was assumed that half, or six (6) of the twelve (12), east-facing garage doors at the eastern-most Project building would be open and operating at the same time, continuously over an hour, considered a conservative operating scenario.

Noise emissions for operation were based on measurements conducted of a garage with activity similar to what can be expected at the Pacific Raceways garage (mainly pneumatic tools, some clanging, and engine revving).

In addition to noise from garage operation, traffic accessing the site during peak hour periods (i.e. hour of highest use and traffic volume) was included in operational noise assessment. As summarized in the project's traffic study, the total peak-hour traffic volumes include 171 vehicles exiting the facility and 52 vehicles entering the facility for a total of 223 peak-hour vehicles.[11] Traffic noise modeling was completed using the same CadnaA noise model equipped with the FHWA Traffic Noise Model Version 2.5 calculation module. Traffic were assumed to travel north/south along 144th Ave SE, south of SE 304th Street, and along the southern boundary of the project site. The assumed travel speed included in the model is 25 mph.

Table 5 summarizes results of the operational noise modeling assessment, including from both stationary source (garage noise) and peak-hour traffic. Receivers are represented by R1 through R4, as illustrated in **Appendix A, Figure 2**.

[11] Heath and Associates, Inc. "Pacific Raceways Traffic Impact Analysis," December, 2017.

Table 5. Worst-Case Operating Conditions, Daytime Hours

Receiver	Existing Sound Levels [a]	Sound Levels, Average Hourly Leq (dBA)			
		Project Garages Only [b]	Project Traffic Only [c]	Existing + Project (Garages and Traffic)	Highest Potential Increase Over Existing
R1	51	50	28	53	2
R2		50	23	54	3
R3		51	27	54	3
R4		49	37	53	2

Notes:

[a] Based on average of three (3) days of measurement, daytime hours, conducted February 10, 2016

[b] Represents a worst-case operating scenario during which all east-facing garage doors would be open and operational for a full hour. Assumes excavated terrain and a 12-foot tall noise barrier.

[c] Based on a total of 223 total vehicles accessing the site during a peak-hour period. Assumes excavated terrain and construction of a 12-foot tall noise barrier.

Source: Ramboll

Assuming the unlikely operating condition that 6 east-facing garage doors would be open and emitting noise from pneumatic tools and engines revving for a full hour, also assuming that peak-hour traffic would occur during the same time period, and assuming the installation of a 12-foot tall noise barrier along the eastern property line, operational noise could result in an overall increase in daytime noise levels (hourly L_{eq}) of between 2 dBA and 3 dBA. Note that increases of 3 dBA or less typically are not noticeable by most people in urban outdoor environments.

Note that without excavation of the site or construction of the 12-foot tall noise barrier, noise emissions from project operation, mainly from garages, would be substantially higher than is identified in **Table 5**. **Table 6** summarizes noise emissions from project operation (garages and traffic) with and without excavated terrain and a noise wall. As noted, the combined benefit of excavation and a noise barrier result in between a 5 and 9 dBA reduction at nearby noise sensitive receivers.

Table 6. Summary of Noise Benefit: Excavation and Barrier

Receiver	Sound Levels, Average Hourly Leq (dBA) Existing + Project (Garages and Traffic)		
	Existing Terrain, No Noise Barrier [(b)]	Excavated Terrain, With Noise Barrier [(c)]	Noise Reduction (Benefit) Due to Excavated Terrain and Noise Barrier [(d)]
R1	58	53	5
R2	62	54	9
R3	62	54	8
R4	59	53	6

Notes:

(a) Based on average of three (3) days of measurement, daytime hours, conducted February 10, 2016

(b) Represents a worst-case operating scenario during which all east-facing garage doors would be open and operational for a full hour. Assumes excavated terrain and a 12-foot tall noise barrier

(c) Based on a total of 223 total vehicles accessing the site during a peak-hour period. Assumes excavated terrain and construction of a 12-foot tall noise barrier

(d) Apparent errors due to rounding of decimal values

Source: Ramboll

It is noted that Pacific Raceways is committed to working with the residential community along 148th Ave SE to consult on whether the proposed 12-foot tall noise barrier would be aesthetically pleasing, or whether a shorter wall would be more appropriate, balancing noise mitigation with community aesthetics.

Other operational equipment and noise sources at the Project, including air handing equipment, local on-site traffic, and miscellaneous activities, are expected to emit low levels of operational noise, as received off-site, and would be well within the applicable King County limits during non-exempt hours of operation.

Should the Project require installation of an emergency power generator, the generator will be placed far from homes east of the Project, shielded by Project buildings.

5.1.1 Noise Monitoring

Although noise impacts are not anticipated during operation of the project, Pacific Raceways will maintain the NMT described above in Section 4.1.1.1, equipped with a noise level-triggered video feed, for review of offending noise events that may have originated from the project site. Data collected at the NMT will be stored for responding to and resolving noise complaints, should they be received from the nearby residential community.

5.2 Air Quality

Air emissions from operation of the Project are expected to comply with applicable regulatory limits, and are not expected to result in adverse ambient air quality impacts under the National and State Ambient Air Quality Standards, as describe in Section 2.2. As indicated, the Project area is now considered attainment for all air quality pollutants of concern.

Operation and maintenance of the Project is expected to generate relatively low levels of increased local traffic compared to existing traffic at Pacific Raceways and along area roadways. The proposed garages may also generate low levels of dust and other air emissions. However emissions associated with increased traffic and vehicle maintenance are expected to be very low, and are not expected to result in significant air emissions.

5.3 Greenhouse Gas Emissions

The greenhouse gas (GHG) emissions that would be associated with the Project were calculated using King County's SEPA GHG Emissions Worksheet. King County's GHG worksheet estimates all GHG emissions that are created over the life span of a project from construction materials, fuel used during construction, energy consumed during a building operation, and transportation by building occupants.

Note that is analysis does not quantify or consider any potential efforts to reduce either GHG emissions or resource consumption by incorporating sustainable features into the development. However, it is assumed that sustainable features would be incorporated into the Project to reduce such impacts. These sustainable features would be considered in the approach to the design of buildings, and in ongoing site programming and management.

Table 6. Estimated Greenhouse Gas Emissions ($MTCO_2e$)

Components	Area (sq.ft.)	Lifespan Emissions[(b)]	Annual Emissions[(c)]
Other [(a)]	200,000	**314,835**	**5,037**

Notes:

(a) Defined as other miscellaneous buildings that do not fit into any other category listed in the King County GHG Worksheet

(b) Estimated of lifecycle emissions are based on an assumed average useful life of about 62 years for all types of structures that are not considered residential. These emissions are reported in $MTCO_2e$ representing to metric tons (tonnes) of carbon dioxide equivalent, or 2,204.62 pounds of CO_2. This metric is a standard measure of CO_2 equivalent emissions that include CO_2 and other GHGs. Note that carbon is not the same as carbon dioxide, and sequestering 3.67 tons of CO_2 is equivalent to sequestering one ton of carbon.

(c) Annual emissions estimates are based on dividing total emissions by assumed facility useful lifespan as indicated in note (b) above.

Source: Ramboll

The Project is expected to produce about 315,000 metric tons (tonnes) of CO_2 equivalent ($MTCO_2e$) over a 62.5 year lifespan. Annually, this corresponds to about 5,000 tonnes. To put these values into some context, in the Washington State GHG emissions inventory for 2010-2013, Ecology estimated state-wide annual GHG emissions in 2013 at about 94 *million* $MTCO_2e$. [12] Estimated annual worldwide GHG emissions for 2010 were about 46 *billion* $MTCO_2e$. [13] Thus, the Project annual GHG emissions represents between 0.005 and 0.006 *percent* of estimated annual 2013 GHG emissions within Washington, and much smaller percentages of worldwide emissions.

It is important to note that the scale of global climate change is so large that the impacts any one project, no matter the size, would almost certainly have no discernible effect on increasing or decreasing global climate change. In reality, any such effects can only be considered on a "cumulative" basis. It is, therefore, appropriate to conclude that the Project's GHG emissions would combine with emissions across the City, Country, State, nation, and planet to cumulatively contribute to increases or decreases in the rate and effects of global climate change.

And to reiterate, the estimates of Project GHG emissions do not consider any potential efforts to reduce GHG emissions and/or resource consumption by incorporating sustainable features into the development, although such sustainable features would be incorporated into the Project by virtue of the City and State Building and Energy Code requirements and the likely use of green building technologies.

The GHG emissions associated with the Project would contribute to the cumulative carbon footprint of unincorporated King County. No significant climate change impacts would be expected due to project-related GHG emissions.

5.4 Light and Glare

Depending on the location within the Project site, the excavation proposed by Pacific Raceways and described earlier, would lower the elevation of the site by between 5 and 30 feet, depending on the location within the site. As described within the noise section above, Pacific Raceways also proposes to construct a noise barrier along the eastern property boundary, in the vicinity of the eastern-most garage building, at the top of the excavated slope.

It is anticipated that the effect of the change in topography, enhanced by the addition of the noise barrier, would block direct line of sight between light sources at the garage buildings and homes along 148th Ave SE, and would result in significantly reduced potential for light

[12] http://www.ecy.wa.gov/climatechange/ghg_inventory.htm
[13] https://19january2017snapshot.epa.gov/climate-indicators/downloads-indicators-report.html

and glare impacts. For example, direct light from headlights facing east toward nearby residences would be eliminated by excavated terrain and the noise barrier. Note that in addition to the benefit of the barrier and excavated terrain, a proposed 25-foot green-belt buffer, comprised of underbrush and medium density mature coniferous woods, would provide additional partial visual shielding and may further reduce the potential for light or glare received offsite along 148th Ave SE.

Sources of light emissions associated with the garage building would include outdoor security lighting, indoor overhead lighting that is visible through windows, and headlights from vehicles accessing the garages. Outdoor security lighting will be active under low light conditions and will be directional and downward, intended to illuminate paths and building entrances.

Indoor overhead lighting and vehicle headlights may be visible offsite while the garages are in use, however are not expected to be considered major light sources as they are expected only to be noticeable as incidental light emitted through windows. These light sources are not expected to be visible at homes in the immediate vicinity of the nearest garage, along 148th Ave SE, due to the proposed noise barrier. As noted, garages would be available for use at any hour, however garage doors would only be allowed to remain open during approved operating hours.

Sources of glare include reflective building surfaces, such as the vertical and slanted metal siding and ribbed seam metal roof panels. The potential for glare impacts from building surfaces depends on several factors, including the type of treatment selected for the building facade and roof materials, the location of the building relative to nearby receivers, the design shape, visibility, and age, as well as the density of intervening vegetation, the time of day, time of year, and the amount of cloud cover. At excavated depth, building roofs may be visible, at least partially, at some homes along 148th Ave SE. However preliminary design features, including the lowered excavated area and noise barrier, as well as intervening vegetated buffer, is expected to result in a partially obstructed view only of the top of slanted garage roofs, resulting in a low likelihood of glare impacts.

5.4.1 Photometric Analysis

To quantify the potential for light impact from the Project, a photometric analysis was completed with consideration of proposed lighting methods (type, location, and strength). The results were used to evaluate whether the Project would remain within the designed limit of 1 foot candle at the property line (see Section 2.3).

5.4.1.1 Model and Model Input Parameters

The photometric analysis was completed using computer modeling software that considers light intensity based on location and direction, light reflection off surfaces (glare), and shielding/shading effect provided by intervening objects (walls, vegetation).

Building data, including building design, preliminary colors, and material types, was provided by the Project's structural architect, Fisher Architects. Lighting information was provided by Fisher Architects and Pacific Raceways. In total, the photometric analysis evaluated 684 interior, overhead pendulant lights, 164 exterior, wall mounted lights above doorways, and 152 exterior, wall mounted lights above the garage bay doors. Note that at the time of this analysis, Project design was not final, and so assumptions were made regarding the precise location of light fixtures, the intensity, type, and directionality of lighting sources. However, results from this study are assumed a reasonable estimate regarding expected lighting at the Project.

5.4.1.2 Results

Modeling results suggest that lighting from the Project, as received at residences along the east side of 148th Ave SE, would be minimal, and would not exceed 1 foot candle at any adjacent properties. An illustration of results of the photometric analysis is found in **Appendix A, Figure 3**.

6. CONCLUSIONS

The proposed Project would include the excavation of approximately 1,000,000 cubic yard of gravel, followed by the construction and development of approximately 200,000 square feet of garage space and an innovation center, distributed over five buildings. An environmental noise, air quality, greenhouse gas, and light and glare assessment was prepared to evaluate the potential impact related to construction and operation of the Project.

Noise from both construction and operation the proposed Project (during approved hours of operation) is exempt from the noise limits in the King County code, as defined under KCC 12.86.520 and 12.86.500(P), respectively. Regardless, an assessment of construction and operations noise was completed to determine what measures, if any, could be employed to ensure that noise received off-site along 148th Ave SE does not result in a perceived impact. To support this assessment, sound level measurements were made in the vicinity of the nearest potentially affected residential receivers along 148th Ave SE, east of the Project. An assessment of construction activity included the proposed gravel screening operation, as well as loaders and haul traffic. Construction noise modeling results indicate that noise from construction activities may at times reach or exceed 57 dBA L_{eq}, the limit that typically is applied for an industrial source affecting a rural receiver. Therefore, Pacific Raceways will employ best management practices to reduce construction noise levels, and will install a continuous noise monitoring terminal during construction activity nearest the eastern property boundary. Noise monitoring results that demonstrate an exceedance of existing ambient levels of 15 dBA or more, on a continuous basis, will warrant evaluation and implementation of additional mitigation measures.

Operation of the Project would generate noise mostly through open garage doors along the east side of the eastern-most Project building. However due to the expected excavated depth of the Project, and a proposed noise barrier at the top of the excavated slope along the east property line, the potential for noise impacts would be mitigated. Existing residences may experience increases in ambient noise conditions between 2 and 3 dBA, however this would only occur under worst-case operating conditions. Noise impacts are not anticipated. Regardless, Pacific Raceways will maintain the noise monitoring terminal on the eastern property line to review noise events for response to and resolution of complaints, should they be received by Pacific Raceways.

For air quality, air emissions from construction and operation of the Project are expected to comply with applicable regulatory limits, and are not expected to result in adverse ambient air quality impacts under applicable National and State Ambient Air Quality Standards. The Project is located within an area considered to be attainment for all air quality pollutants of

concern. In addition, no significant unavoidable adverse greenhouse gas emission-related impacts have been identified and none are anticipated.

For light and glare, due to the excavated depth and proposed noise barrier, no direct lighting impacts are anticipated, and incidental light from visible windows is expected to be minimal, potentially shielded by the intervening vegetated buffer along the east property line. Light levels are not expected to exceed 1 foot candle at the property line and installation of an 8 or 12 foot noise barrier would further reduce visual impacts at offsite receivers.

APPENDIX A

Figures

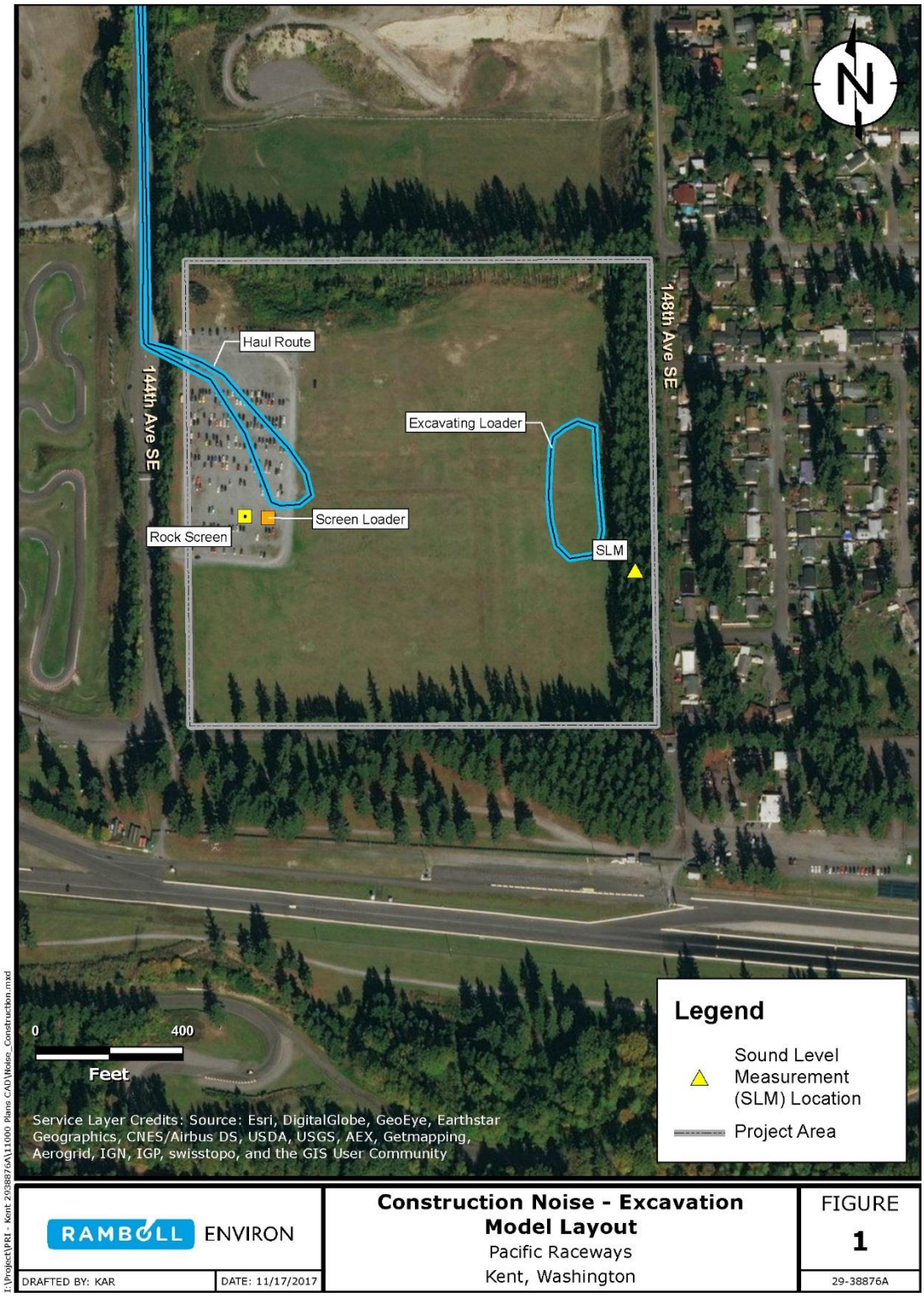

Figure 1. Construction Noise Assessment

Figure 2. Operational Noise Assessment, Barrier

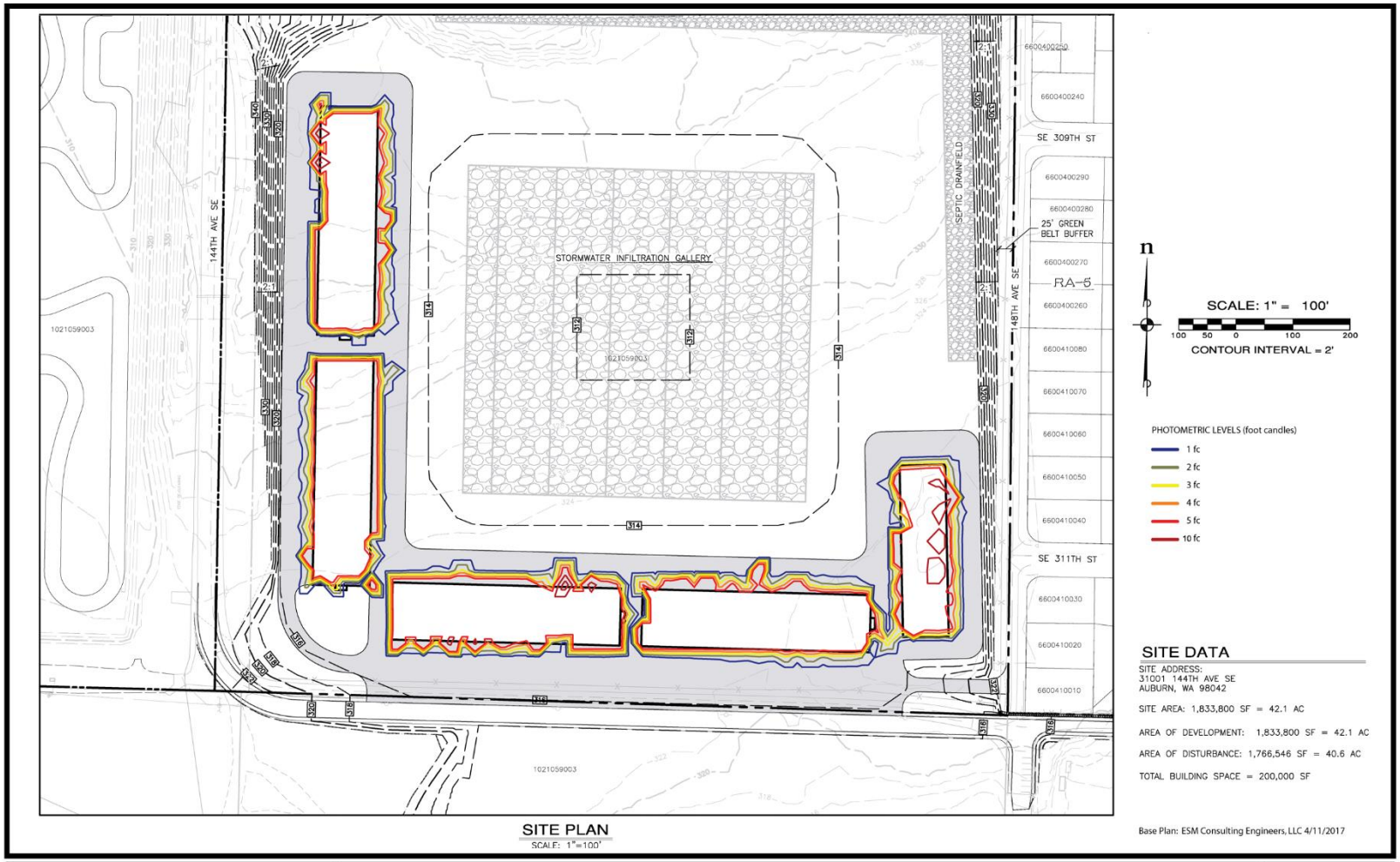

Figure 3. Photometric Analysis

APPENDIX B

Common Noise Descriptors

Noise is sometimes defined as unwanted sound. This report makes no such distinction, 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 70-dB sound level will sound about twice as loud as a 60-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 traffic along a road is causing a 60 dB sound level at some nearby location, twice as much traffic on this same road 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. All sound levels in this evaluation are reported in A weighted decibels.

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 car horn, 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), 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 7**.

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. Those applicable to this analysis are the Equivalent Noise Level (L_{eq}), and the Day-Night Noise Level (L_{dn}). 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, 24 hours, etc.).

The L_{dn} is a 24-hour L_{eq} with a 10-decibel penalty added to sound levels that occur between 10:00 p.m. and 7:00 a.m. in consideration of potential for sleep disturbance.

Table 7: 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		
Lawn mower (3 ft) Noisy motorcycle (50 ft)	100	Very Loud	
Heavy truck (50 ft)	90		
Pneumatic Drill (50 ft) Busy urban street, daytime	80	Loud	Speech Interference
Normal automobile at 50 mph Vacuum cleaner (3 ft)	70		
Large air conditioning unit (20 ft) Conversation (3 ft)	60	Moderate	
Quiet residential area Light auto traffic (100 ft)	50		Sleep Interference
Library Quiet home	40	Faint	
Soft whisper (15 ft)	30		
Slight Rustling of Leaves	20		
Broadcasting Studio	10	Very Faint	
Threshold of Human Hearing	0		

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.

Source: United States Environmental Protection Agency (EPA) and others.

APPENDIX C

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 L_{eq}, 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 (L_{eq})	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)
fc	Foot candle, a non-SI unit of illuminance or light intensity.
L_{eq}	Equivalent sound level (see above)
L_n	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., L_{eq}, or L_{max})
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. *Not* 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 µPa (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