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APPENDIX 4-H

AMBLER MINING DISTRICT INDUSTRIAL ACCESS ROAD ENVIRONMENTAL SOUND ANALYSIS

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AMBLER MINING DISTRICT INDUSTRIAL ACCESS ROAD ENVIRONMENTAL SOUND ANALYSIS

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November 12, 2015

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1.0 INTRODUCTION

The Alaska Industrial Development and Export Authority (AIDEA) is evaluating the potential of constructing a new 204-mile Ambler Mining District Industrial Access Road (AMDIAR), along the southern flanks of the Brooks Range in Alaska, extending west from the Dalton Highway to the south bank of the Ambler River. The road will initially be a single-lane, gravel, one-way controlled access road with turnouts for heavy tractor-trailer truck transport of mining ore, equipment and supplies to and from the mining district, and this scenario was evaluated for this analysis. Two roadway alignments are being considered through the Gates of the Arctic National Park and Preserve (GAAR). The Preferred (northern) Alignment travels approximately 26 miles east-west through the GAAR along the northern boundary of the Western (Kobuk River) Unit paralleling the GAAR wilderness boundary. The Alternative (southern) Alignment crosses approximately 17.5-miles of the GAAR through the middle, narrower section of the Unit. Both corridors would cross the Kobuk River (**Figure 1, attached**).

Big Sky Acoustics, LLC (BSA) was hired to complete the Environmental Sound Analysis to estimate the haul truck traffic noise to support the Application for Transportation and Utility Systems Right-of-Way. In the summer months of 2013 and 2014, the National Park Service (NPS) completed the *Gates of the Artic Soundscape Inventory* to document the ambient sound levels at various locations adjacent to the Preferred Alignment (NPS 2014), and the data were used for this analysis. This report summarizes the predicted haul truck noise levels at NPS-selected locations, provides noise contours for truck traffic on the single-lane gravel road, assesses the audibility of the trucks and their effect on the ambient environment, and discusses mitigation measures.

2.0 TERMINOLOGY

Sound levels heard by humans and animals are dependent on several variables, including distance and ground cover between the source and receiver and atmospheric conditions. Perception of sound is affected by intensity, frequency, pitch and duration. Noise can affect people or animals by interfering with normal activities or diminishing the quality of the environment.

Sound levels are quantified using units of decibels (dB). Decibels are logarithmic values and cannot be combined using normal algebraic addition. Humans typically have reduced hearing sensitivity at low frequencies compared with their response at high frequencies, and the “A-weighting” of sound levels, or A-weighted decibels (dBA), closely correlates to the frequency response of normal human hearing. Some common sound sources are shown for reference in **Table 2-1**, and although a “subjective evaluation” is provided for a range of sound levels, the perception of sound can vary widely from person to person.

Table 2-1: Common Sound Sources

Sound Level (dBA)	Source	Subjective Evaluation
120 110	• Hard rock concert • Motorcycle accelerating a few feet away	Deafening
100 90	• Automobile horn 10 feet away • Gas lawnmower 3 feet away • Diesel truck 50 feet away • Inside a computer equipment room	Very Loud
80 70	• Garbage disposal 3 feet away • Very loud speech 3 feet away • Vacuum cleaner 10 feet away • Outdoors in a commercial area	Loud
60 50	• Normal speech 3 feet away • Typical office activities • Background noise in a conference room	Moderate
40 30	• Library background noise • Quiet suburban environment at night • Typical background noise in a residence • Whisper 3 feet away • Quiet rural environment at night	Faint
20 10	• Concert hall background noise • Human breathing	Very Faint
0	• Threshold of hearing or audibility	

Sources: Egan 1988, Cavanaugh 1998, and Burge 2002.

Sound levels typically decrease by approximately 4 to 6 dBA every time the distance between the source and receptor is doubled, depending on the characteristics of the source and the conditions over the path that the sound travels. The sound levels are decreased if a solid barrier, such as a man-made wall, a building, or natural topography, blocks the line-of-sight between the source and receptor.

For environmental studies, levels are typically described using A-weighted equivalent sound levels, L_{eq}, during a certain time period. The L_{eq} metric is useful because it uses a single number to describe the constantly fluctuating instantaneous ambient levels at a receptor location during a period of time, and accounts for all of the sounds and quiet periods that occur during that time period.

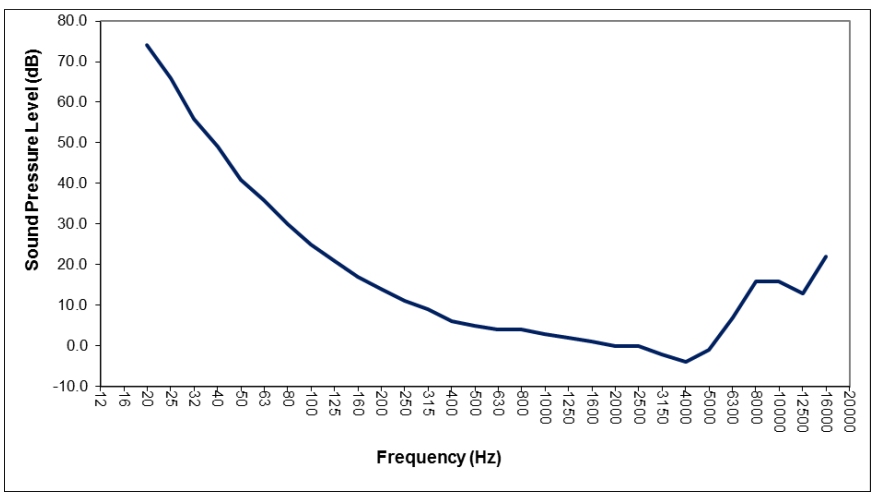
The 90th percentile-exceeded sound level, L_{90}, is a metric that indicates the single level that is exceeded during 90% of a measurement period, although the actual instantaneous sound levels fluctuate continuously. The L_{90} sound level is typically considered the ambient level, and is often

near the low end of the instantaneous sound levels during a measurement period. It typically does not include the influence of discrete sounds of short duration, such as truck doors closing, bird chirps, wind gusts, etc. For example, if a continuously operating piece of equipment is audible at a measurement location, typically it is the sound created by the equipment that determines the L_{90} of a measurement period even though other sources may be briefly audible and occasionally louder than the equipment during the same measurement period.

According to the NPS, an extrinsic sound is any sound not forming an essential part of GAAR's purpose, such as aircraft or vehicle traffic. The NPS uses the natural ambient metric (L_{nat}) to estimate what the acoustical environment would be without the contribution of extrinsic sounds (NPS 2013). In addition, the L_{max} metric denotes the maximum instantaneous sound level recorded during a measurement period.

The audibility of sound depends on the ambient environment at the listener location, and the frequency spectrum of the intruding sound compared to the ambient spectrum. If the sound in any individual frequency band is greater than the ambient sound at that same frequency, the intruding sound will be audible. The higher the intruding sound is above the ambient environment, the more noticeable it will be. In situations with very low background sound, such as in remote, natural environments like the GAAR, the ambient environment can be extremely low and even less than the threshold of hearing of a listener. In these cases, if the entire frequency spectrum of the intruding sound is below the threshold of audibility, then the intruding sound will not be audible. The threshold of audibility vs. frequency in humans is shown on **Figure 2-1**.

Figure 2-1: Threshold of Audibility in Humans



Source: Harris 1998.

Comparing the L_{eq} sound levels of a source to L_{90} (ambient) sound levels at a listener location helps approximate how significantly the ambient environment will change due to a new source, and how a listener might respond to the new sound. This comparison is summarized in **Table 2-2**, including the expected human response.

Table 2-2: Guidelines for Assessing the Change in Ambient Sound Levels

Sound Level Comparison (dBA)	Expected Human Response
$L_{eq} - L_{90} \leq 0$	Minimal
$0 < L_{eq} - L_{90} \leq 10$	Moderate
$L_{eq} - L_{90} > 10$	High

Sources: Menge 2005 and Cavanaugh 2002.

Since a person's response to sound is subjective, the perception of sound can vary from person to person. The significance of fluctuating sound levels and the effectiveness of noise control measures can be gauged using the approximate reaction of a person with typical hearing to a change in sound level. **Table 2-3** indicates the relationship between changes in sound levels and a person's typical perception of the change.

Table 2-3: Changes in Sound Levels vs. Apparent Change in Loudness

Change in Sound Level (dBA)	Apparent Change in Loudness to a Person
±1	Imperceptible.
±3	Barely audible (i.e., barely noticeable increase or reduction).
±5	Clearly audible (i.e., clearly noticeable increase or reduction).
±10	Half as loud or twice as loud as the original sound (significant change).
±20	One quarter as loud or four times as loud as the original sound (very significant change).

Source: Egan 1988.

3.0 ANALYSIS

3.1 Analysis and Assumptions

In August – September 2013 and June – August 2014, the NPS completed ambient sound level measurements at seven locations within the GAAR boundaries. BSA used the NPS-measured data from the five measurement locations on Walker and Nutuvukti Lakes adjacent to the Preferred Alignment for this analysis (**Figure 1**). Ambient L_{90} sound levels ranged from 17 to 36 dBA, which included all sounds both manmade and natural. The NPS determined natural ambient levels, L_{nat}, without the contribution of extrinsic sounds (e.g., aircraft) from the measured data which ranged from 18 to 37 dBA (NPS 2014).

To complete the AMDIAR sound level predictions, BSA used the Cadna-A software program that uses algorithms from the International Organization for Standardization (ISO) Standard 9613-2, *Attenuation of Sound during Propagation Outdoors, Part 2: General Method of Calculation*. The model accounts for shielding due to changes in ground elevation and topography. The ISO calculations conservatively assume that atmospheric conditions are favorable for sound propagation. Favorable atmospheric conditions for sound propagation means that the wind is blowing from a source to a receiver at approximately 2 to 10 miles-per-hour (regardless of their location relative to each other), and a well-developed temperature inversion is in place, which typically occurs between approximately two hours after sundown to two hours after sunrise. However, atmospheric conditions can vary dramatically at large distances between a source and a receptor. Therefore, the predicted sound levels in this report should be assumed to be average sound levels, and significant positive and negative deviations from the averages can occur (Harris 1998).

BSA used the following assumptions for the sound level predictions:

1. Atmospheric conditions: Air temperature of 55°F and relative humidity of 70%. This weather data was selected from the mean recorded weather data in Ambler, Alaska from June through August 2014 (Weather Underground 2014), to correspond to the NPS 2014 measurement season.

2. The location of each alignment and ground elevations in 10-meter increments were used to define the natural terrain in the vicinity of the alignments (DOWL 2014a).

3. Ground factor: G = 1.0 for porous ground, which includes ground covered by grass, trees or other vegetation, and all other ground surfaces suitable for the growth of vegetation (ISO 9613-2). A G = 0.0 was used for the surface of large lakes.

4. Receiver height: 5.5 feet (1.7 meters), to represent a standing person.

5. Source height: 12 feet (3.6 meters), representing the height of a heavy truck exhaust stack.

6. Traffic conditions: For the single-lane, gravel roadway configuration modeled for this analysis, approximately 80 heavy trucks per day will use the AMDIAR, which equates to 40 round trips per day. The road will have a posted speed limit of 45 mph, with all trucks traveling in one direction simultaneously (east or west). Assuming that on average trucks will be spaced approximately 5 minutes apart, there will be approximately 12 trucks per hour along the road corridor. Therefore, it will take approximately three-hours from the first truck to the 40th truck to travel in each direction past a given point along the road in the GAAR (DOWL 2014b).

   Driving at 45 mph, trucks will need approximately 6 hours to traverse the entire AMDIAR between the mining district and the Dalton Highway, 3 hours to travel south from the AMDIAR/Dalton Road intersection to Fairbanks, and 3 hours to unload. Once

unloaded, the trucks would begin the westbound trip to the mining district for a possible total round trip time of 24-hours (DOWL 2014b).

7. Source: Heavy trucks, as defined by FHWA's Traffic Noise Model (TNM). According to the Appendix A of the *TNM Technical Manual* (FHWA 1998), a single heavy truck traveling 45 mph at full throttle is L_{max} 84 dBA at 50 feet away, and has the following associated 1/1 octave-band spectrum:

Frequency (Hz):	**63**	**125**	**250**	**500**	**1,000**	**2,000**	**4,000**
L_{max} Sound Pressure Level (dB):	87	84	80	81	80	76	71

8. To estimate the audibility of individual truck pass-bys, a single heavy truck was modeled as a point source at the closest distance along an alignment to each individual NPS-selected location (**Section 3.2**) (**Figure 1**). The L_{max} heavy truck frequency spectrum listed above was used. The predicted L_{max} spectrum at each NPS-selected location was compared to the NPS-measured L_{90} ambient noise level and the threshold of audibility (**Figure 2-1**) to determine if the trucks would be audible at each location.

   The L_{max} spectrum was plotted with the measured L_{90} ambient sound level and the threshold of audibility to estimate the instantaneous audibility of a single truck (**Appendix A**). If the predicted L_{max} level exceeded the L_{90} and the threshold of hearing spectra at any frequency, then the truck noise was determined to be "audible" at that location. If the truck noise was less than the threshold of audibility at every frequency, then the trucks were determined to be inaudible (**Figure 2-1**).

9. To estimate the change in the ambient environment, the 1-hour L_{eq} [L_{eq}(h)] of the truck traffic was calculated as a line source for the entire length of each alignment. The predicted L_{eq}(h) frequency spectrum was compared to the NPS-measured L_{90} and L_{nat} levels. The comparison of the predicted L_{eq}(h), to the L_{90} and L_{nat} levels, determines the expected reaction of people to the change in the ambient environment due to the truck traffic (**Table 2-2**). The predicted L_{eq}(h) values are only applicable during the times that trucks are using the road. Since the L_{eq}(h) is similar to the average sound level over the course of a 1-hour period, the comparison of L_{eq}(h), to L_{90} and L_{nat} levels, helps quantify the change in longer-term ambient sound levels (**Appendix A**).

3.2 NPS-Selected Locations

The GAAR ambient soundscape is characterized by natural sounds in most areas, including wildlife, birds, insects, flowing water, wind, etc. Existing manmade noise includes aircraft overflights (planes and helicopters) and localized use of snowmachines, boats, rafts and four wheelers. The Kobuk River corridor supports numerous recreational activities from motorized and non-motorized river travel, subsistence and sport hunting, wildlife observation and backpacking. Most human uses adjacent to the Preferred and/or Alignment Alternatives are along the Kobuk River and at Walker Lake (**Figure 1**). BSA analyzed sound at 25 locations,

including the five NPS Soundscape Inventory measurement locations along Walker and Nutuvukti Lakes (NPS 2014), and 20 NPS observation point locations used for the GAAR Visual Impact Analysis (**Figure 1**) (DOWL 2014c).

4.0 RESULTS

The predicted L_{max} pass-by sound levels for individual trucks and L_{eq}(h) levels for hourly truck traffic at each NPS-selected location are summarized in **Tables 4-1 and 4-2**. The predicted L_{eq}(h) noise contours are shown on **Figures 2 and 3** (attached). The predicted L_{max} and L_{eq}(h) frequency spectra at each location are plotted in **Appendix A**.

For the Preferred Alignment, the heavy trucks are predicted to be audible at 10 out of the 25 NPS-selected locations (**Table 4-1**). In general, the 10 locations include the south end of Walker Lake, the Nutuvukti Lake area, and the GAAR boundaries. Although audibility will depend on the ambient sound level at a given location, if the trucks are audible, their audible noise is estimated to be a "moderate" level at two locations, "faint" at four locations, and "very faint" at four locations (**Table 2-1**). The L_{eq}(h) for hourly truck traffic is predicted to be less or equal to the ambient L_{90} level at 20 locations which would invoke a minimal human response (**Table 2-2**), to be between 1 and 10 dBA greater than the L_{90} at three locations, which would typically invoke a moderate human response, and more than 10 dBA greater than the ambient at two locations, which may invoke a high response and be twice as loud or more compared to the ambient sound (**Table 2-3**).

For the Alternative Alignment, the heavy trucks are predicted to be audible at 10 out of the 25 NPS-selected locations (**Table 4-2**). In general, the 10 locations include the Reed and Kobuk river areas. Although audibility will depend on the ambient sound level at a given location, if the trucks are audible, their audible noise is estimated to be a "moderate" level at three locations, "faint" at six locations, and "very faint" at one location (**Table 2-1**). The L_{eq}(h) for hourly truck traffic is predicted to be less or equal to the ambient L_{90} level at 21 locations, which would invoke a minimal human response (**Table 2-2**), to be between 1 and 10 dBA greater than the L_{90} at one location, which would typically invoke a moderate response, and more than 10 dBA greater than the ambient at three locations, which may invoke a high response and be twice as loud or more compared to the ambient sound (**Table 2-3**).

Table 4-1: Results Summary - Preferred Alignment

Location (Figure 1)	Audibility			Comparison to Ambient Sound Level		
	Predicted L_{max} (dBA)	Audible?	Subjective Evaluation if Audible (Table 2-1)	Predicted $L_{eq}(h)$ (dBA)	$L_{eq}(h) - L_{90}$ Difference (dBA)	Expected Human Reaction (Table 2-2)
NPS MEAS LOC: Walker Lake, North	-4	No		2	-31	Minimal
NPS MEAS LOC: Walker Lake, Swan Island	6	No		8	-19	Minimal
NPS MEAS LOC: Walker Lake, South	20	Yes	Very faint	19	2	Moderate
NPS MEAS LOC: Nutuvukti Lake, North	35	Yes	Faint	28	9	Moderate
NPS MEAS LOC: Nutuvukti Lake, South	17	Yes	Very faint	14	-22	Minimal
Reed R1	0	No		4	-24	Minimal
Reed R2	-1	No		3	-25	Minimal
Reed R3	3	No		7	-21	Minimal
ROW S ReedW	4	No		6	-22	Minimal
Kobuk R S, Ridge 1	6	No		6	-22	Minimal
Kobuk R S, Ridge 2	0	No		4	-24	Minimal
Kobuk R S1	3	No		5	-23	Minimal
Kobuk R S2	4	No		6	-22	Minimal
Kobuk R S3	14	Yes	Very faint	12	-16	Minimal
KobukR, N. ROW	54	Yes	Moderate	42	14	High
ROW W, High	12	Yes	Very faint	19	-9	Minimal
ROW West, Low	56	Yes	Moderate	43	15	High
Nutuvukti Lake 1	34	Yes	Faint	28	0	Minimal
Nut Summit	22	Yes	Faint	18	-10	Minimal
WalkerW, High	7	No		9	-19	Minimal
Walker Lk SE	12	No		12	-16	Minimal
Upper Kobuk	2	No		5	-23	Minimal
Hogaza Summit	3	No		8	-20	Minimal
ROW E Boundary	36	Yes	Faint	29	1	Moderate
Kobuk R S, Ridge 3	-2	No		2	-26	Minimal

Note: Refer to **Appendix A** for the detailed data results and graphs.

Table 4-2: Results Summary - Alternative Alignment

Location (Figure 1)	Audibility			Comparison to Ambient Sound Level		
	Predicted L_{max} (dBA)	Audible?	Subjective Evaluation if Audible (Table 2-1)	Predicted $L_{eq}(h)$ (dBA)	$L_{eq}(h) - L_{90}$ Difference (dBA)	Expected Human Reaction (Table 2-2)
NPS MEAS LOC: Walker Lake, North	Too low	No		-12	-45	Minimal
NPS MEAS LOC: Walker Lake, Swan Island	-5	No		-5	-32	Minimal
NPS MEAS LOC: Walker Lake, South	-2	No		3	-14	Minimal
NPS MEAS LOC: Nutuvukti Lake, North	3	No		9	-10	Minimal
NPS MEAS LOC: Nutuvukti Lake, South	8	No		12	-24	Minimal
Reed R1	59	Yes	Moderate	45	17	High
Reed R2	27	Yes	Faint	21	-7	Minimal
Reed R3	26	Yes	Faint	23	-5	Minimal
ROW S ReedW	24	Yes	Faint	22	-6	Minimal
Kobuk R S, Ridge 1	37	Yes	Faint	30	2	Moderate
Kobuk R S, Ridge 2	31	Yes	Faint	25	-3	Minimal
Kobuk R S1	58	Yes	Moderate	44	16	High
Kobuk R S2	52	Yes	Moderate	41	13	High
Kobuk R S3	14	Yes	Very faint	12	-16	Minimal
KobukR, N. ROW	1	No		5	-23	Minimal
ROW W, High	1	No		5	-23	Minimal
ROW West, Low	0	No		7	-21	Minimal
Nutuvukti Lake 1	2	No		9	-19	Minimal
Nut Summit	7	No		9	-19	Minimal
WalkerW, High	-4	No		0	-28	Minimal
Walker Lk SE	-4	No		0	-28	Minimal
Upper Kobuk	-4	No		-2	-30	Minimal
Hogaza Summit	8	No		11	-18	Minimal
ROW E Boundary	5	No		7	-22	Minimal
Kobuk R S, Ridge 3	22	Yes	Faint	18	-10	Minimal

Note: Refer to **Appendix A** for the detailed data results and graphs.

BSA developed noise contours indicating the L_{eq}(h) A-weighted sound levels along the Preferred and Alternative Alignments through the GAAR. Cadna-A calculates the contours by determining the sound level at points on a user-defined grid. Because of the large study area, a 300-meter by 300-meter (984-feet by 984-feet) grid was used to balance reasonable results and calculation time. The contours were overlaid on USGS topographic maps, and the general effect of terrain on sound propagation can be seen for both alignments on **Figures 2 and 3** (attached).

The median ambient sound level from the NPS measurement data is L_{90} 28 dBA and L_{nat} 30 dBA (NPS 2014). Based on the hourly truck traffic noise, the L_{eq}(h) 40 dBA contour, which is approximately 10 dBA above and twice as loud as the ambient levels, is predicted to generally be approximately 1,500 feet from an alignment. The L_{eq}(h) 30 dBA contour, which is approximately equal to the ambient levels, is predicted to generally be approximately 4,500 feet from an alignment. As shown on **Figures 2 and 3**, the distances of these noise contours from an alignment at a specific point vary based on the nearby terrain, and as shown in **Tables 4-1 and 4-2**, the trucks may be audible much further off the alignments.

5.0 CONSTRUCTION

Road construction may cause localized, intermittent, short-duration noise that will increase the overall sound levels in the area. Construction noise will vary by construction phase, types of equipment used, and distance between activities and a listener location. During construction, the contractor should consider using the following techniques to reduce construction noise levels in the GAAR:

1. Place stationary noise sources away from sensitive locations.
2. Turn idling equipment off.
3. Drive equipment forward instead of backward; lift instead of drag materials; and avoid scraping or banging activities.
4. Use quieter equipment with properly sized and maintained mufflers, engine intake silencers, less obtrusive backup alarms (such as manually adjustable, self-adjusting, or broadband sound alarms instead of traditional “beep-beep-beep” alarms), engine enclosures, or noise blankets.
5. Purchase and use new equipment rather than using older equipment. New equipment tends to be quieter than older equipment due to new technology, improvements in mechanical efficiency, improved casing and enclosures, etc. When purchasing new equipment, require vendors to provide sound level data as part of their submittals for comparison, so the quietest equipment can be selected. For existing equipment, determine if the manufacturer has a retrofit noise control package available specifically for reducing the exterior noise of the truck, not the noise levels inside the operator cab. Also implement a regular maintenance and lubrication schedule to ensure that equipment is operating properly.

6.0 MITIGATION

There are limited options for reducing the truck traffic noise along the AMDIAR. Reducing the speed of the traffic, barriers and quieter trucks were evaluated for mitigation.

Reducing traffic speed can reduce L_{max} levels of a truck pass-by and the L_{eq}(h) levels for multiple trucks during 1-hour of time. Traffic noise levels are reduced by approximately 1 to 2 dBA for every 5 mph reduction in speed, and therefore, a 10 to 20 mph reduction in speed would be needed to make a clearly noticeable reduction in noise (**Tables 4-1 and 4-2**). However, lower speed also means it will take longer for trucks to complete the route, and the truck noise at the NPS-selected locations will be present for longer periods of time through the GAAR.

Barriers, such as man-made walls or earthen berms along the side of a road, are only effective for mitigation when they are tall enough and long enough to completely block the direct line-of-sight between the entire truck and a listener location. Therefore, barriers are not practical for locations at considerably higher elevations than the road (**Figure 1**). Also, barriers are most effective when the listener is located within approximately a few hundred feet of the road. Listeners located more than 0.1 miles away from the road will receive little, if any, benefit from a barrier.

Noise from heavy trucks is predominantly from the engine and exhaust system. Therefore, high-grade mufflers should be installed on all trucks that will use the AMDIAR to reduce the truck noise.

7.0 CONCLUSION

Based on the predicted truck noise levels, one alignment is not significantly better than the other acoustically (**Figures 2 and 3**). The haul trucks traveling on each alignment are predicted to be audible at 10 out of the 25 NPS-selected locations, and the noise, if audible, is predicted to be considered moderate to very faint (**Table 2-1**). The L_{eq}(h) truck noise is predicted to exceed the ambient L_{90} sound levels at five locations for the Preferred Alignment (**Table 4-1**) and four locations for the Alternative Alignment (**Table 4-2**).

The acoustical effect of an alignment is geographic. The Preferred Alignment will affect the south end of Walker Lake, the Nutuvukti Lake area, and the GAAR boundaries. The Alternative Alignment will affect the Reed and Kobuk river areas (**Figures 2 and 3**). Therefore, determining the more beneficial acoustical alignment will depend on which areas are determined to be the most sensitive to human and wildlife receptors.

8.0 REFERENCES

Big Sky Acoustics, LLC (BSA). 2014. Memorandum to Kristen Hansen at DOWL, Inc. regarding the AMDIAR Noise Evaluation Assumptions and Approach.

Burge, P. 2002. "The Power of Public Participation." *Proceedings of the 2002 International Congress and Exposition on Noise Control Engineering,* Inter-Noise 2002 Conference, Dearborn, Michigan, August 19-21, 2002.

Cavanaugh W. and G. Tocci. 1998. Environmental Noise - The Invisible Pollutant. Published in ESC, Volume 1, Number 1, Fall 1998. USC Institute of Public Affairs.

Cavanaugh, William and G.C. Tocci. 2002. "Criteria for Community Acceptance of outdoor Concert Sound…A Progress report on Continuing Research." The 2002 International congress and Exposition on Noise Control Engineering, Dearborn, MI, August 19-21, 2002.

DOWL, Inc. 2014a. AutoCAD drawing AMDIAR Data for Noise Study.dwg showing Preferred and Alternative Alignments, and 10-meter ground contours from Alaska Digital Elevation Model. November 8, 2014.

DOWL, Inc. 2014b. GAAR Visual Impact Analysis, NPS Observation Point Locations, Figures 1 and 2. November 7, 2014.

DOWL, Inc. 2014c. Memorandum from Kristen Hansen. AMDIAR Noise Evaluation Traffic Assumptions. November 11, 2014.

Egan, M. 1988. *Architectural Acoustics*. McGraw-Hill, Inc., New York, New York.

Federal Highway Administration. 1998. FHWA Traffic Noise Model Technical Manual.

Harris, C., ed. 1998. *Handbook of Acoustical Measurements and Noise Control*. Acoustical Society of America, Woodbury, New York.

International Organization for Standardization (ISO). 1996. Attenuation of Sound during Propagation Outdoors, Part 2: General Method of Calculation. Designation: 9613-2.

Menge, Christopher. 2005. "Assessment of Community Reaction to Proposed Club Racetrack." *Proceedings of the Institute of Noise Control Engineering (INCE) NOISE-CON 2005 Conference,* Minneapolis, Minnesota, October 17-19, 2005.

National Park Service (NPS). 2014. Gates of the Artic National Park and Preserve, *2013-2014 Soundscape Inventory Selected Analysis Methods + Metadata*, and supporting spreadsheet data.

National Park Service (NPS). 2013. Acoustic Monitoring Report, Denali National Park and Preserve – 2012. November.

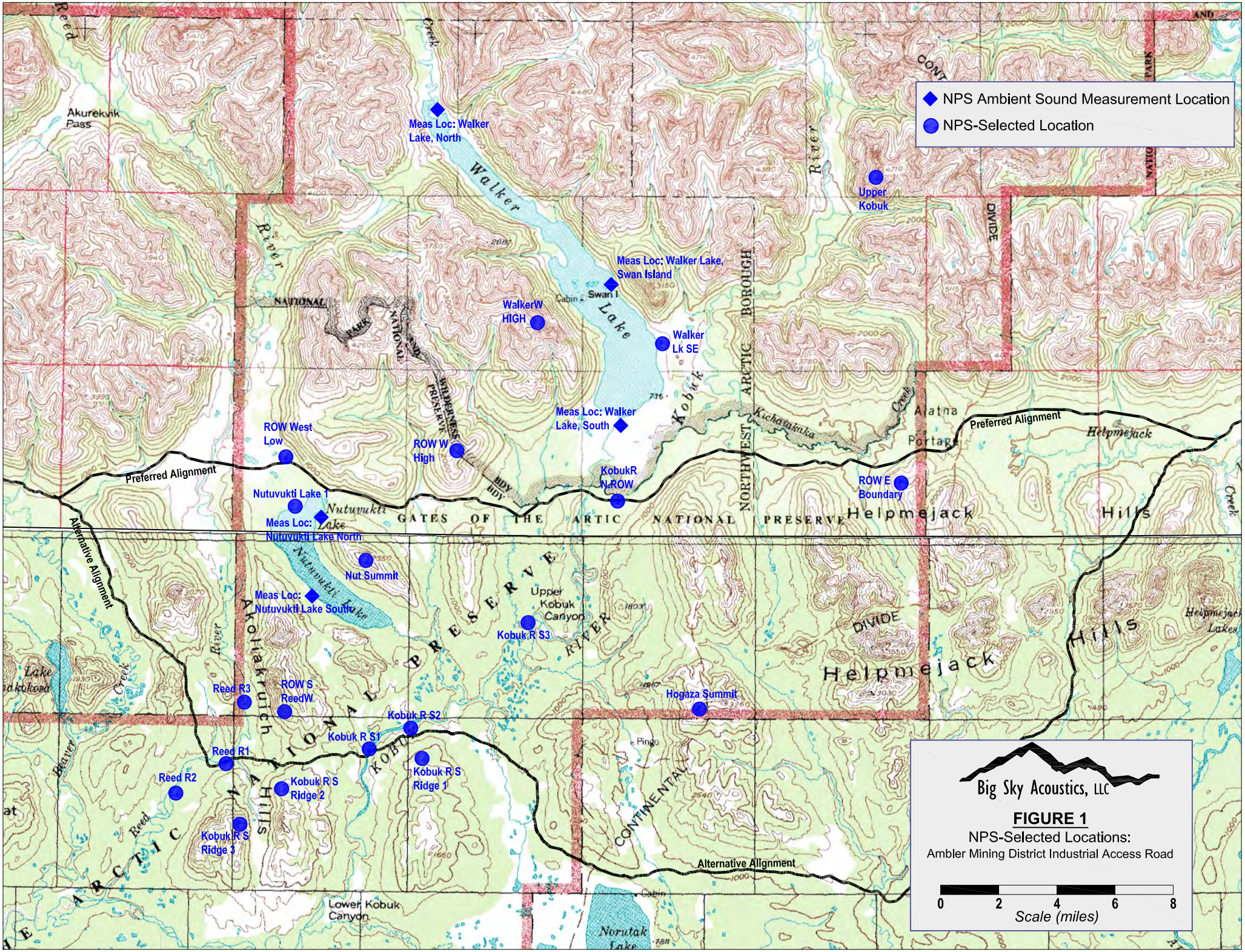
Weather Underground. 2014. Ambler, Alaska airport weather data, June – August 2014. Downloaded from www.wunderground.com.

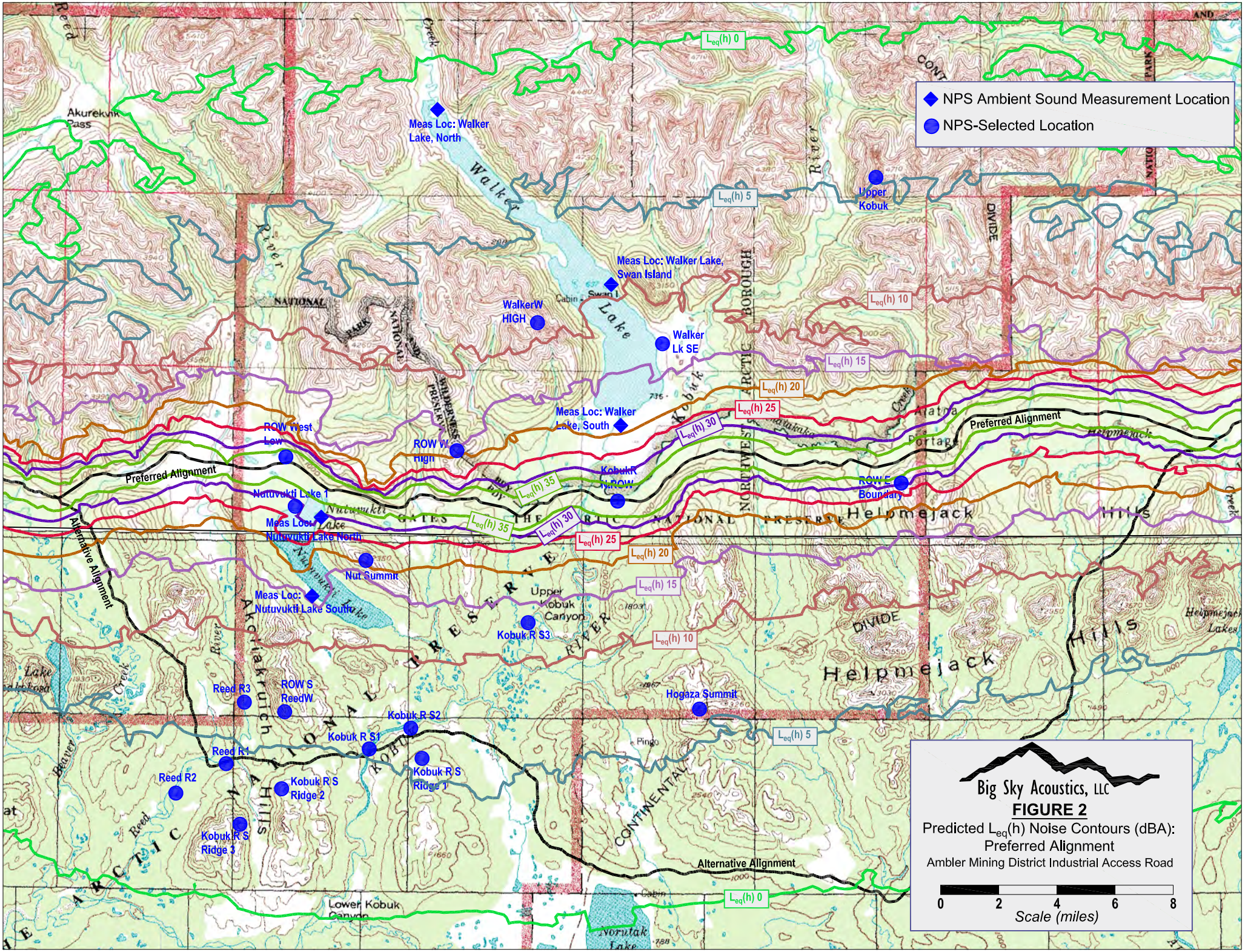
9.0 STANDARD OF CARE

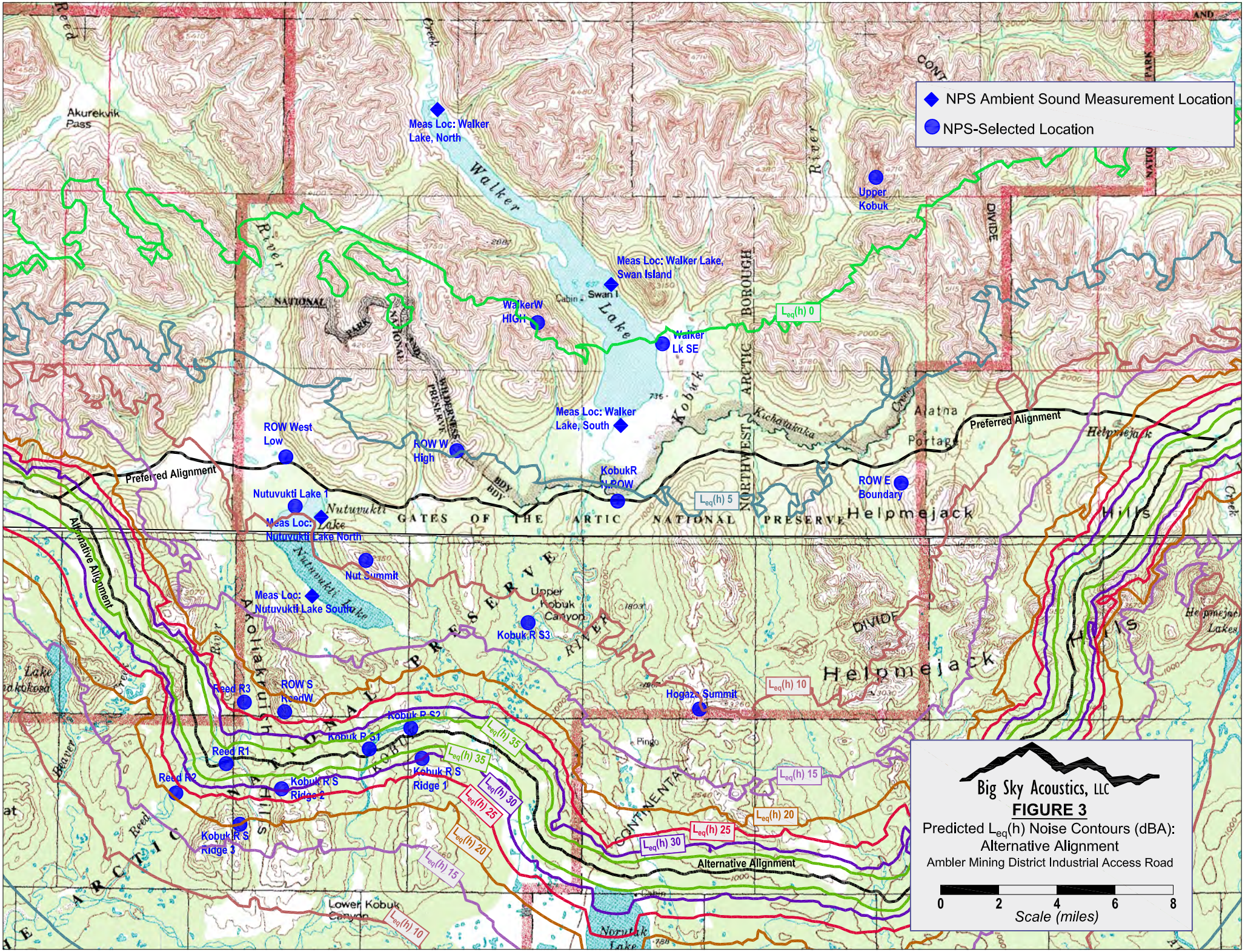
To complete this report, BSA has endeavored to perform its services consistent with the professional skill and care ordinarily provided by acoustical consultants practicing in similar markets and under similar project conditions. BSA is fully experienced and properly qualified to perform acoustical consulting services. However, acoustical consulting services as offered and engaged in by BSA does not include “engineering” or “practice of engineering” or the “practice or offer to practice engineering” as these phrases are defined under Montana or Alaska law.

BSA makes no warranty, either expressed or implied, as to the professional services it has rendered to complete this report. For the completion of this report, BSA has used data provided by DOWL, Inc. and the National Park Service in performing its services, and is entitled to rely upon the accuracy and completeness thereof. Therefore, if the information and assumptions used to create this report change, then the sound analysis and/or the recommended mitigation measures may need to be reevaluated.

FIGURES


NPS Ambient Sound Measurement Location
NPS-Selected Location
Meas Loc: Walker Lake, North
Upper Kobuk
Meas Loc: Walker Lake, Swan Island
WalkerW HIGH
Walker Lk SE
Meas Loc: Walker Lake, South
ROW West Low
ROW W High
KobukR N.ROW
ROW E Boundary
Nutuvukti Lake 1
Meas Loc: Nutuvukti Lake North
Nut Summit
Meas Loc: Nutuvukti Lake South
Upper Kobuk Canyon
Kobuk R S3
Hogaza Summit
Reed R3
ROW S ReedW
Kobuk R S2
Kobuk R S1
Reed R1
Kobuk R S Ridge 1
Reed R2
Kobuk R S Ridge 2
Kobuk R S Ridge 3
Preferred Alignment
Alternative Alignment
Alternative Alignment
Big Sky Acoustics, LLC
FIGURE 1
NPS-Selected Locations:
Ambler Mining District Industrial Access Road
0 2 4 6 8
Scale (miles)


NPS Ambient Sound Measurement Location
NPS-Selected Location
Meas Loc: Walker Lake, North
Meas Loc: Walker Lake, Swan Island
Meas Loc: Walker Lake, South
Meas Loc: Nutuvukti Lake North
Meas Loc: Nutuvukti Lake South
Upper Kobuk
WalkerW HIGH
Walker Lk SE
ROW West Low
ROW W High
KobukR N ROW
ROW E Boundary
Nutuvukti Lake 1
Nut Summit
Kobuk R S3
Hogaza Summit
Reed R3
ROW S ReedW
Kobuk R S2
Kobuk R S1
Kobuk R S Ridge 1
Reed R1
Reed R2
Kobuk R S Ridge 2
Kobuk R S Ridge 3
Preferred Alignment
Alternative Alignment
$L_{eq}(h)$ 0
$L_{eq}(h)$ 5
$L_{eq}(h)$ 10
$L_{eq}(h)$ 15
$L_{eq}(h)$ 20
$L_{eq}(h)$ 25
$L_{eq}(h)$ 30
$L_{eq}(h)$ 35
Big Sky Acoustics, LLC
FIGURE 2
Predicted $L_{eq}(h)$ Noise Contours (dBA):
Preferred Alignment
Ambler Mining District Industrial Access Road
0 2 4 6 8
Scale (miles)


NPS Ambient Sound Measurement Location
NPS-Selected Location
Meas Loc: Walker Lake, North
Upper Kobuk
Meas Loc: Walker Lake, Swan Island
WalkerW HIGH
Walker Lk SE
Meas Loc: Walker Lake, South
ROW West Low
ROW W High
KobukR N.ROW
ROW E Boundary
Nutuvukti Lake 1
Meas Loc: Nutuvukti Lake North
Nut Summit
Meas Loc: Nutuvukti Lake South
Kobuk R S3
Hogaza Summit
Reed R3
ROW S ReedW
Kobuk R S2
Kobuk R S1
Reed R1
Reed R2
Kobuk R S Ridge 2
Kobuk R S Ridge 1
Kobuk R S Ridge 3
Preferred Alignment
Alternative Alignment
Alternative Alignment
Walker Lake
Kobuk River
Nutuvukti Lake
Akurekvik Pass
Upper Kobuk Canyon
Lower Kobuk Canyon
Helpmejack Hills
Alatna Portage
GATES OF THE ARTIC NATIONAL PRESERVE
NORTHWEST ARCTIC BOROUGH
Big Sky Acoustics, LLC
FIGURE 3
Predicted $L_{eq}(h)$ Noise Contours (dBA): Alternative Alignment
Ambler Mining District Industrial Access Road
0 2 4 6 8
Scale (miles)

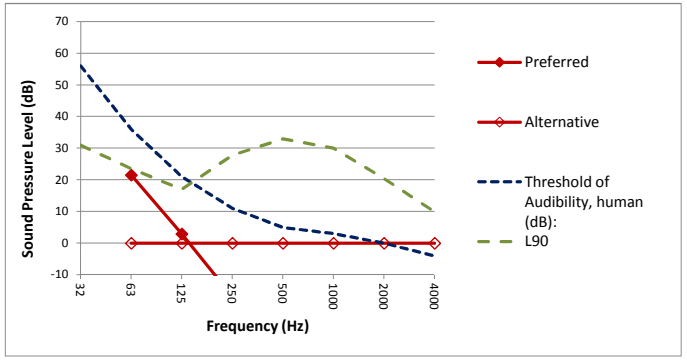
APPENDIX A

Sound Level Data and Graphs at NPS-Selected Locations

Location: Measurement Location: Walker Lake, North

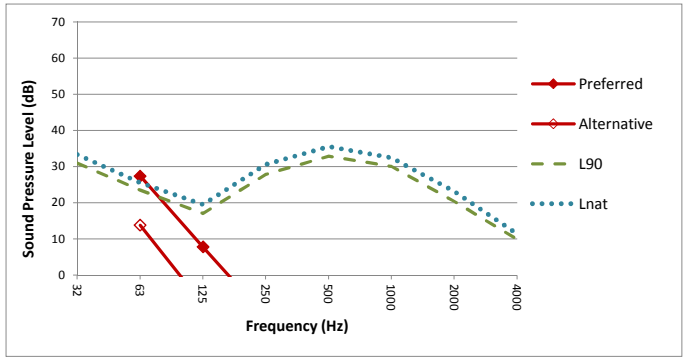
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		22	3	-17	-38				-4	No	
	Alternative		Too low	Too low	Too low	Too low	Too low	Too low	Too low	Too low	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Average of NPS Measurements at this location (dB):	L90	31	24	17	28	33	30	20	10	33		



Comparison to Measured Ambient Noise Levels

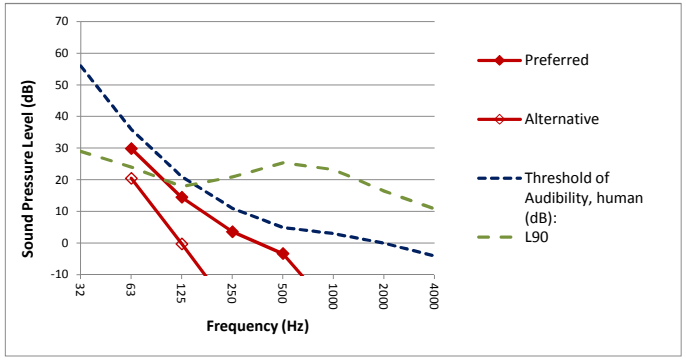
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		27	8	-11	-30				2	-31	-34
	Alternative		14	-8	-32	-57				-12	-45	-48
Average of NPS Measurements at this location (dB):	L90	31	24	17	28	33	30	20	10	33		
	Lnat	33	26	20	31	36	32	23	11	36		



Location: Measurement Location: Walker Lake, Swan Island

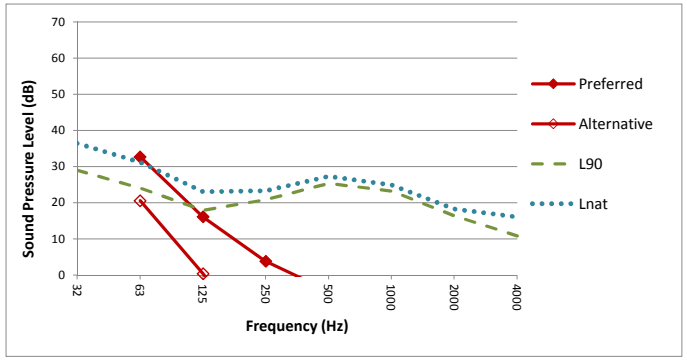
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		30	15	4	-3	-22			6	No	
	Alternative		21	0	-22	-43				-5	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Average of NPS Measurements at this location (dB):	L90	29	24	18	21	25	23	16	11	27		



Comparison to Measured Ambient Noise Levels

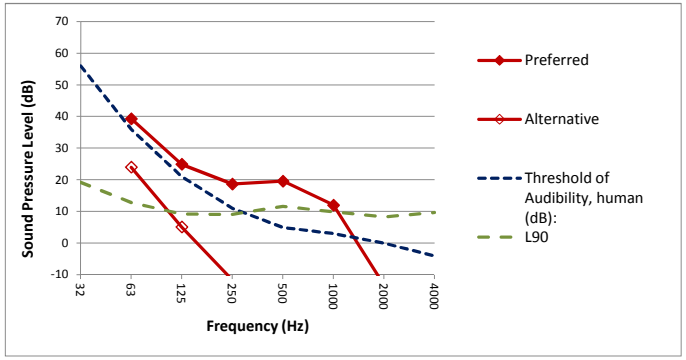
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		33	16	4	-4	-24			8	-19	-21
	Alternative		21	0	-23	-45				-5	-32	-34
Average of NPS Measurements at this location (dB):	L90	29	24	18	21	25	23	16	11	27		
	Lnat	36	31	23	23	27	25	18	16	29		



Location: Measurement Location: Walker Lake, South

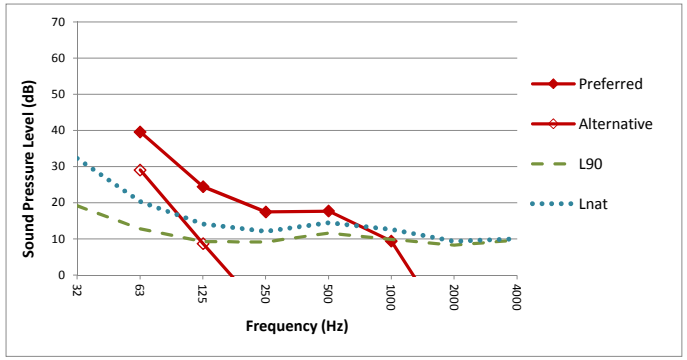
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		39	25	19	20	12	-13		20	Yes	very faint
	Alternative		24	5	-12	-26	-59			-2	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Average of NPS Measurements at this location (dB):	L90	19	13	9	9	12	10	8	10	17		



Comparison to Measured Ambient Noise Levels

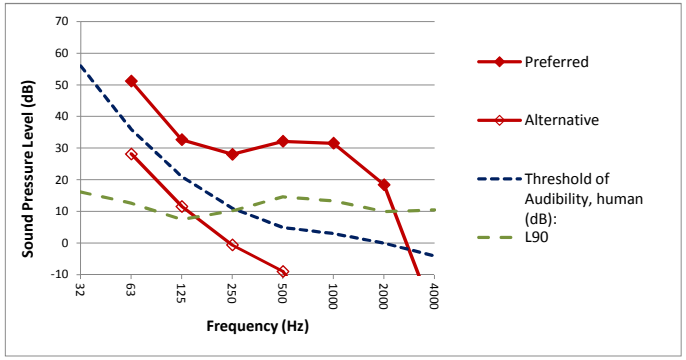
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		40	25	18	18	9	-18		19	2	1
	Alternative		29	9	-11	-27	-62			3	-14	-15
Average of NPS Measurements at this location (dB):	L90	19	13	9	9	12	10	8	10	17		
	Lnat	32	20	14	12	14	13	9	10	18		



Location: Measurement Location: Nutuvukti Lake North

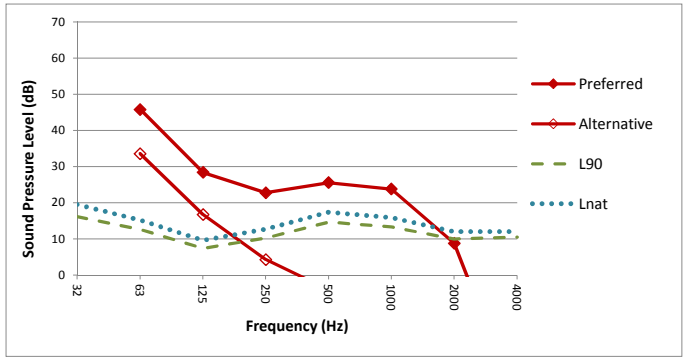
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		51	33	28	32	32	19	-23	35	Yes	faint
	Alternative		28	12	-1	-9	-31			3	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Average of NPS Measurements at this location (dB):	L90	16	13	7	10	15	13	10	11	19		



Comparison to Measured Ambient Noise Levels

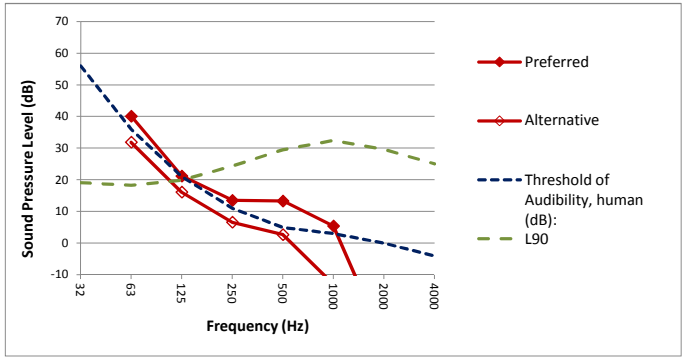
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		46	28	23	26	24	9	-36	28	9	7
	Alternative		34	17	4	-4	-25			9	-10	-12
Average of NPS Measurements at this location (dB):	L90	16	13	7	10	15	13	10	11	19		
	Lnat	20	15	10	13	17	16	12	12	21		



Location: Measurement Location: Nutuvukti Lake South

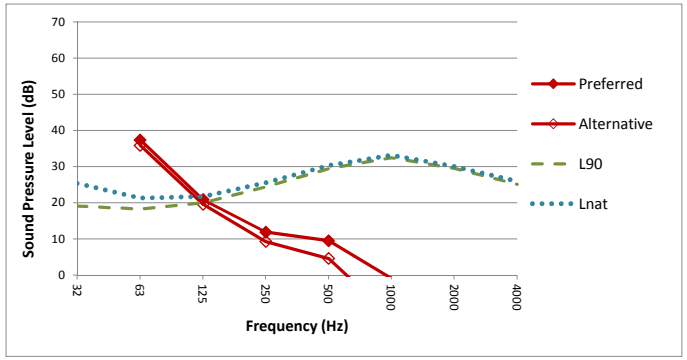
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		40	21	14	13	5	-31		17	Yes	very faint
	Alternative		32	16	7	3	-13	-64		8	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Average of NPS Measurements at this location (dB):	L90	19	18	20	24	29	32	30	25	36		



Comparison to Measured Ambient Noise Levels

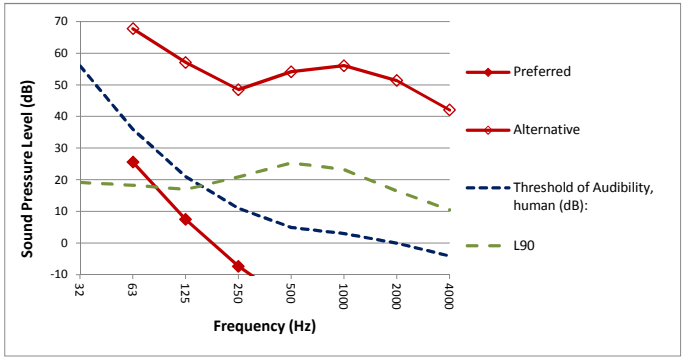
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		37	21	12	10	-1	-40		14	-22	-23
	Alternative		36	20	9	5	-12	-62		12	-24	-25
Average of NPS Measurements at this location (dB):	L90	19	18	20	24	29	32	30	25	36		
	Lnat	25	21	22	26	30	33	30	26	37		



Location: Reed R1

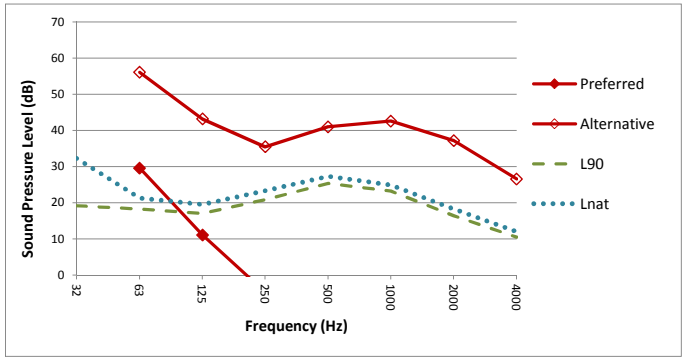
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		26	8	-7	-19	-48			0	No	
	Alternative		68	57	49	54	56	51	42	59	Yes	moderate
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

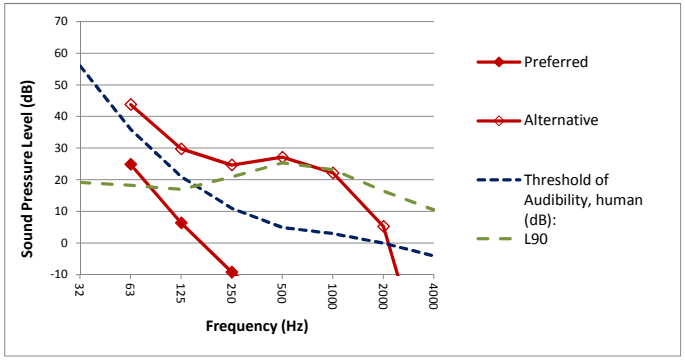
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		30	11	-5	-17	-47			4	-24	-26
	Alternative		56	43	36	41	43	37	27	45	17	15
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Reed R2

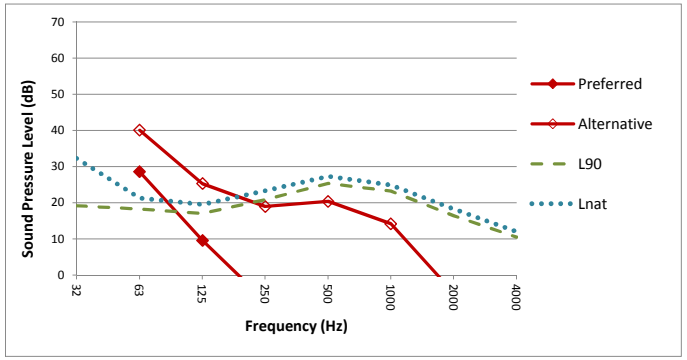
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		25	6	-9	-22	-52			-1	No	
	Alternative		44	30	25	27	22	5	-49	27	Yes	faint
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

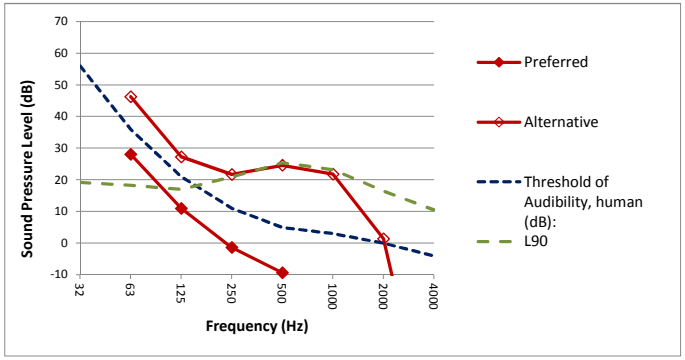
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		29	10	-7	-21	-53			3	-25	-27
	Alternative		40	25	19	20	14	-5		21	-7	-9
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Reed R3

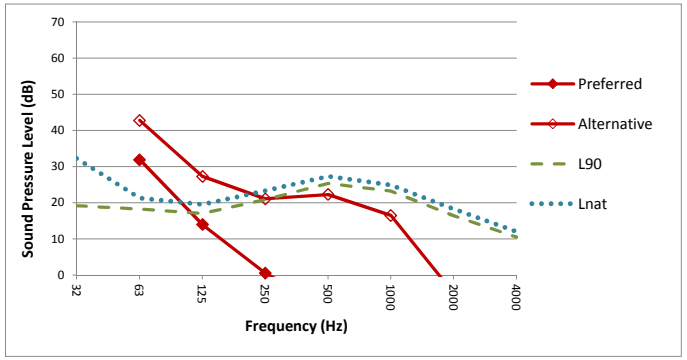
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		28	11	-1	-9	-32			3	No	
	Alternative		46	27	22	25	22	1	-68	26	Yes	faint
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

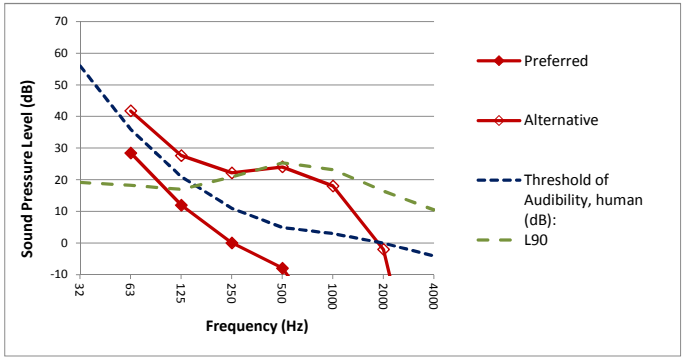
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		32	14	1	-9	-32			7	-21	-23
	Alternative		43	27	21	22	17	-5	-74	23	-5	-7
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: ROW S, ReedW

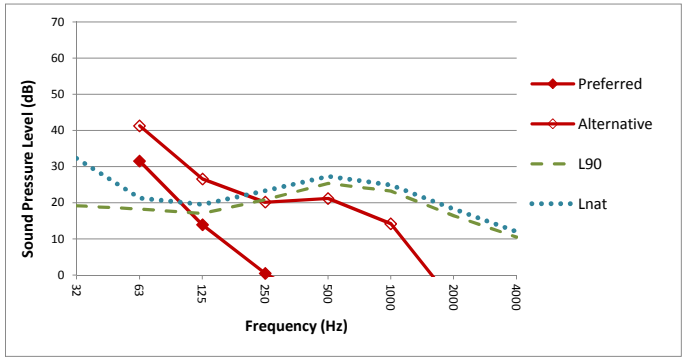
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		29	12	0	-8	-30			4	No	
	Alternative		42	28	22	24	18	-2	-69	24	Yes	faint
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

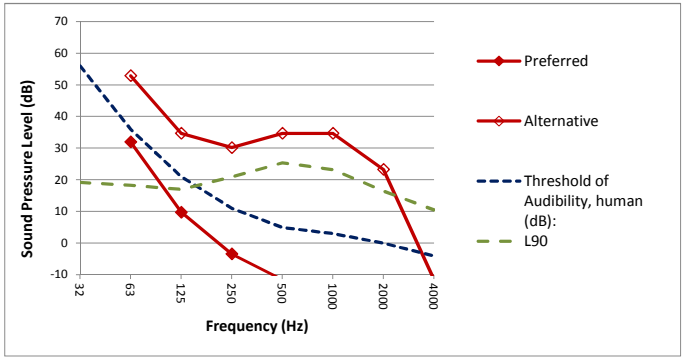
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		32	14	1	-9	-32			6	-22	-24
	Alternative		41	27	20	21	14	-8		22	-6	-8
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Kobuk R S, Ridge 1

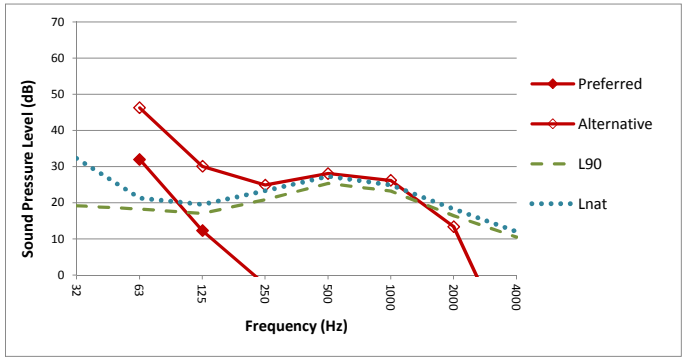
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		32	10	-3	-12	-33			6	No	
	Alternative		53	35	30	35	35	23	-12	37	Yes	faint
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

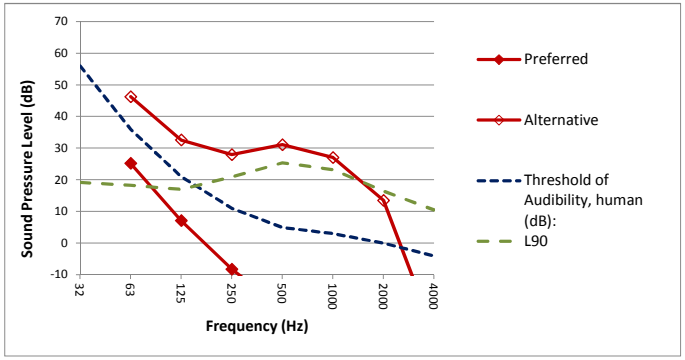
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		32	12	-3	-13	-37			6	-22	-24
	Alternative		46	30	25	28	26	13	-24	30	2	0
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Kobuk R S, Ridge 2

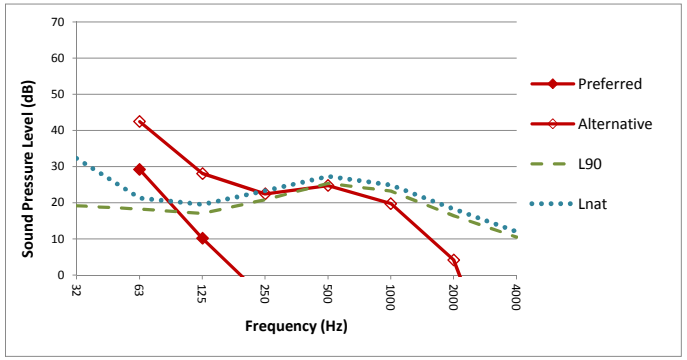
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		25	7	-8	-21				0	No	
	Alternative		46	33	28	31	27	14	-28	31	Yes	faint
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

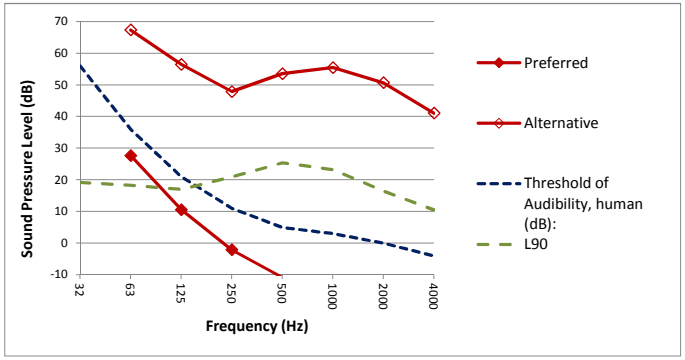
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		29	10	-7	-21	-52			4	-24	-26
	Alternative		43	28	23	25	20	4	-41	25	-3	-5
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Kobuk R S1

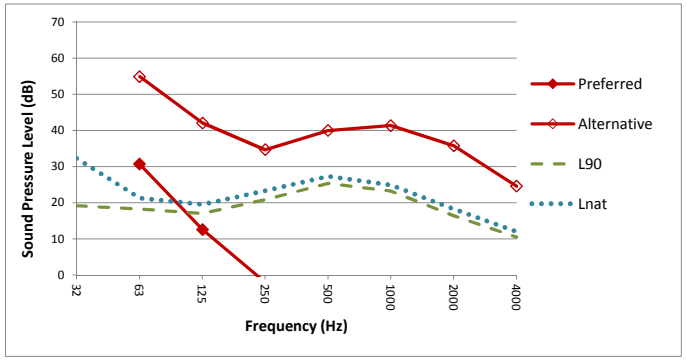
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		28	11	-2	-11	-34			3	No	
	Alternative		67	57	48	54	56	51	41	58	Yes	moderate
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

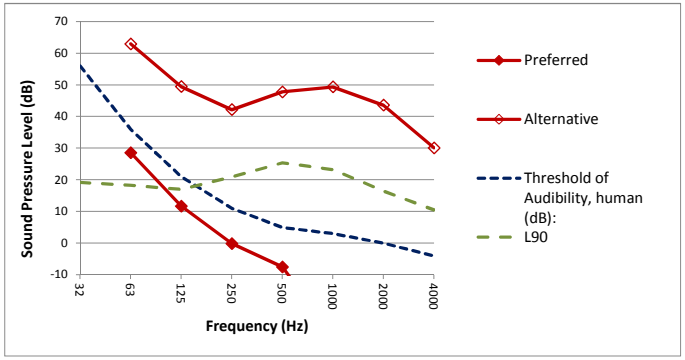
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		31	13	-2	-13	-38			5	-23	-25
	Alternative		55	42	35	40	41	36	25	44	16	14
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Kobuk R S2

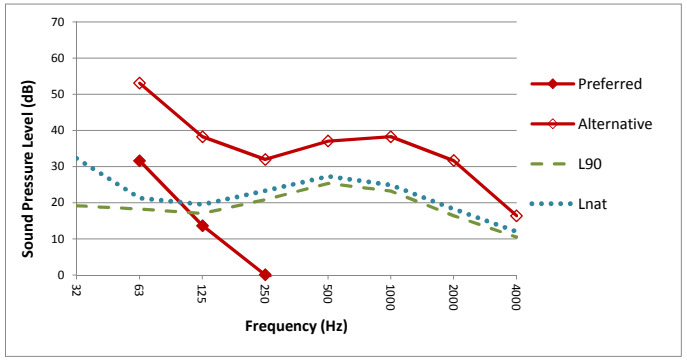
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		29	12	0	-8	-29			4	No	
	Alternative		63	50	42	48	49	44	30	52	Yes	moderate
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

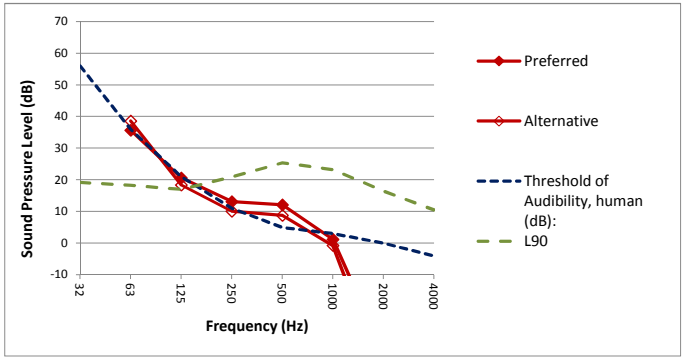
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		32	14	0	-9	-32			6	-22	-24
	Alternative		53	38	32	37	38	32	16	41	13	11
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Kobuk R S3

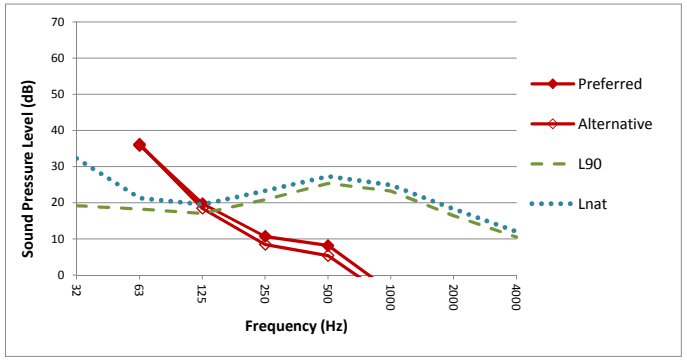
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		36	21	13	12	1	-35		14	Yes	very faint
	Alternative		39	18	10	9	-1	-43		14	Yes	very faint
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

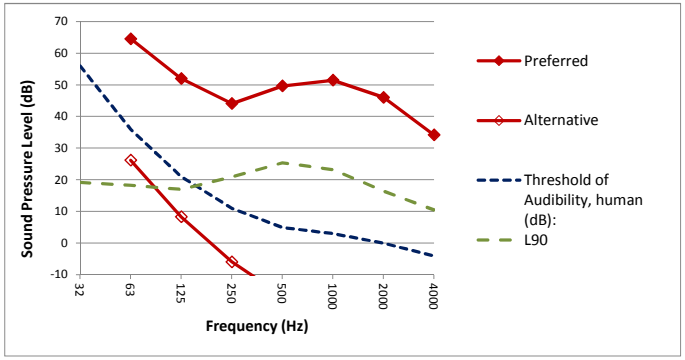
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		36	20	11	8	-4	-43		12	-16	-18
	Alternative		36	19	9	5	-7	-50		12	-16	-18
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: KobukR, N. ROW

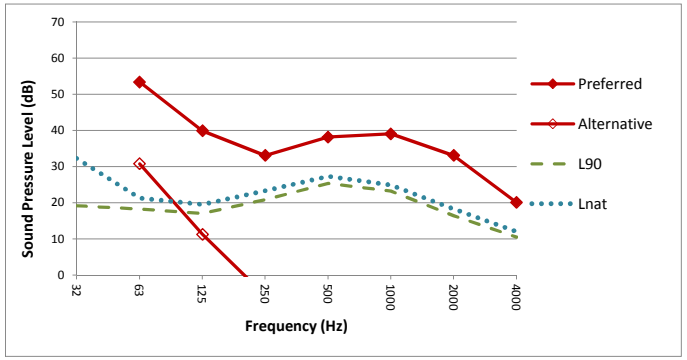
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		65	52	44	50	52	46	34	54	Yes	moderate
	Alternative		26	8	-6	-17	-44			1	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

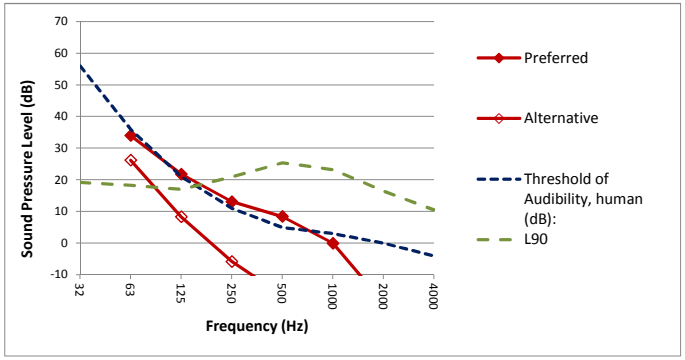
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		53	40	33	38	39	33	20	42	14	12
	Alternative		31	11	-6	-18	-47			5	-23	-25
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: ROW W, high

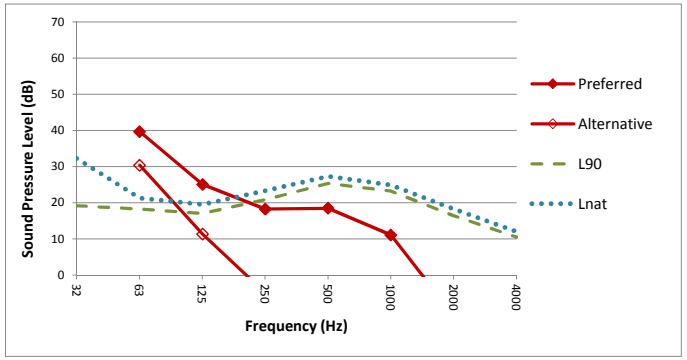
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		34	22	13	8	0	-19	-80	12	Yes	very faint
	Alternative		26	8	-6	-17	-44			1	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

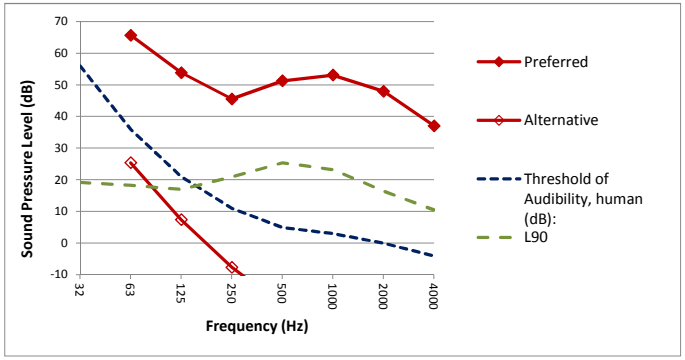
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		40	25	18	19	11	-11		19	-9	-11
	Alternative		30	11	-5	-18				5	-23	-25
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: ROW West, low

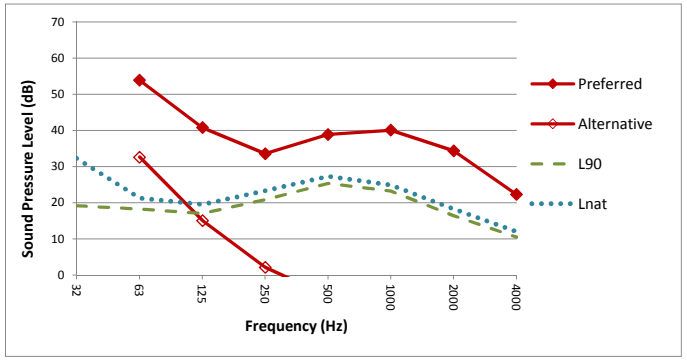
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		66	54	46	51	53	48	37	56	Yes	moderate
	Alternative		25	7	-8	-20	-49			0	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

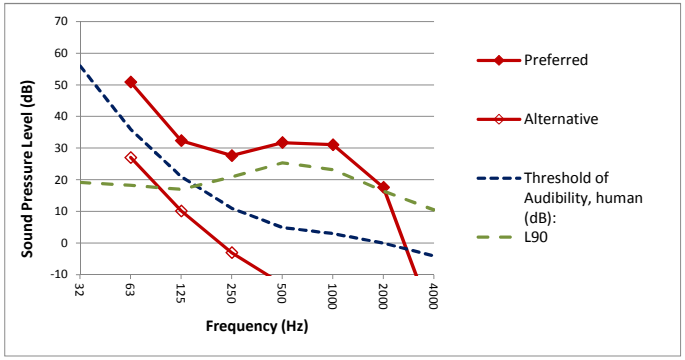
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		54	41	34	39	40	34	22	43	15	13
	Alternative		33	15	2	-6	-27			7	-21	-23
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Nutuvukti Lake 1

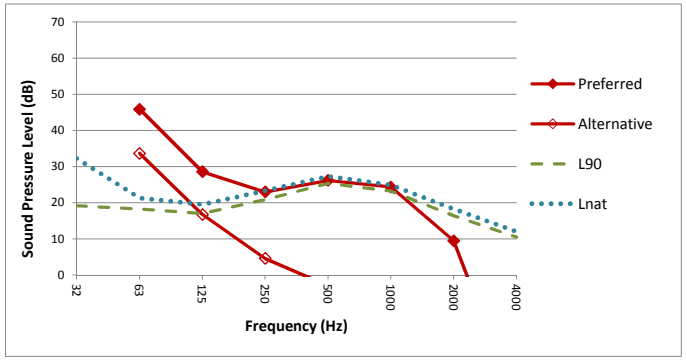
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		51	32	28	32	31	18	-25	34	Yes	faint
	Alternative		27	10	-3	-13	-37			2	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

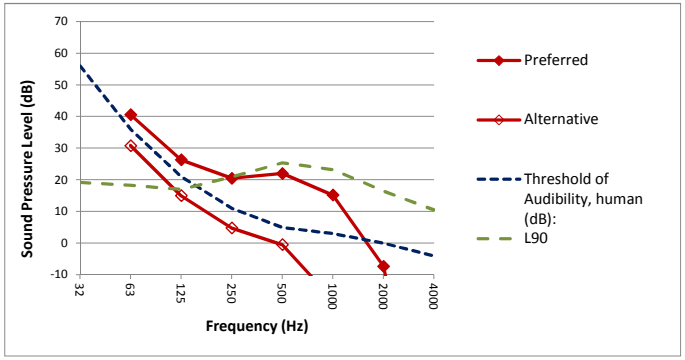
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		46	29	23	26	24	10	-36	28	0	-2
	Alternative		34	17	5	-3	-23			9	-19	-21
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Nut Summit

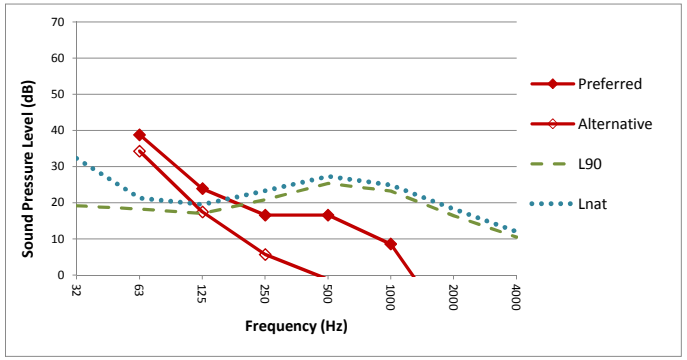
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		41	26	21	22	15	-7	-83	22	Yes	faint
	Alternative		31	15	5	-1	-18	-74		7	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

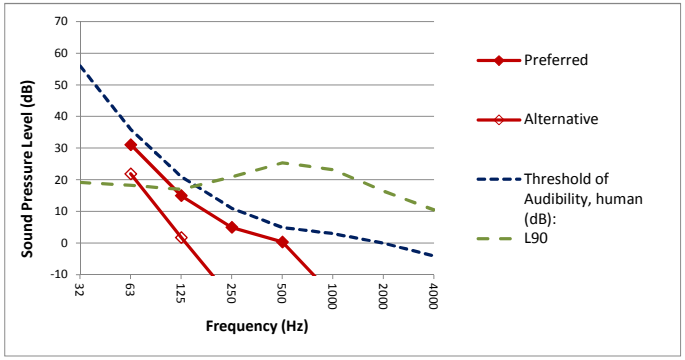
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		39	24	17	17	9	-16		18	-10	-12
	Alternative		34	18	6	-1	-20			9	-19	-21
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Walker W, high

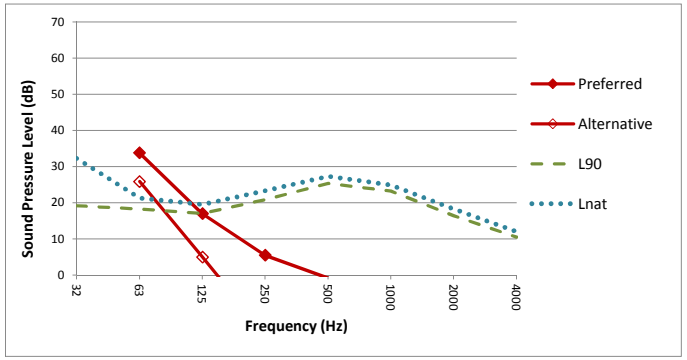
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		31	15	5	0	-17	-72		7	No	
	Alternative		22	2	-18	-36	-75			-4	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

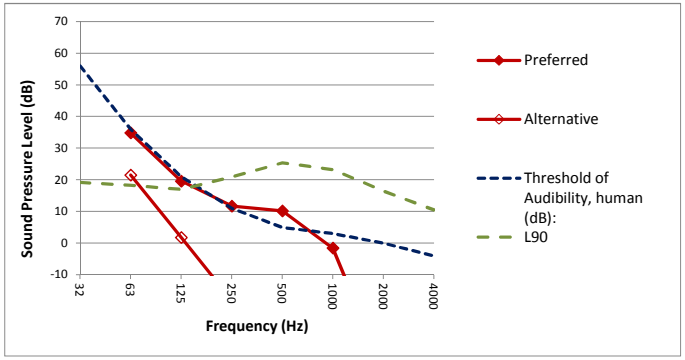
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		33.8	17	5.5	-0.8	-19			9	-19	-21
	Alternative		25.9	5	-16.3	-36.6				0	-28	-30
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Walker Lake SE

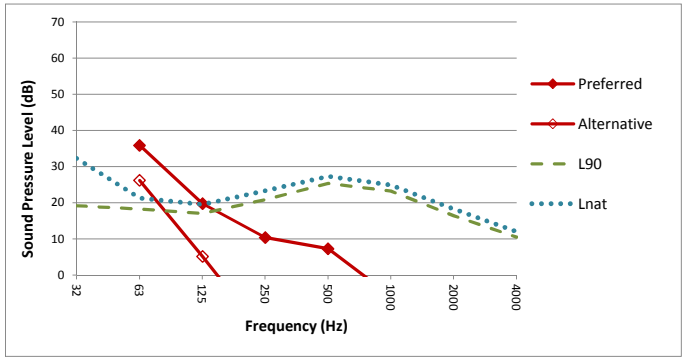
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		35	20	12	10	-2	-40		12	No	
	Alternative		22	2	-18	-38	-78			-4	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

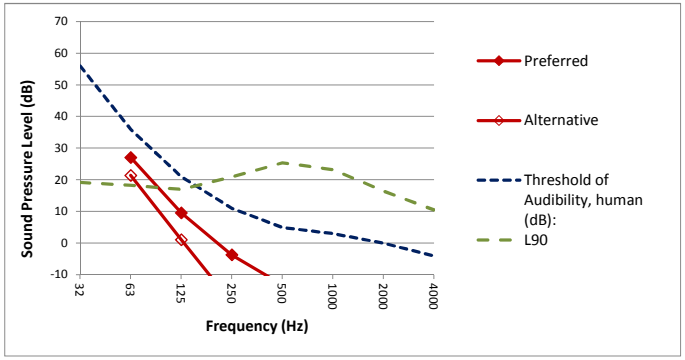
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		36	20	10	7	-6	-47		12	-16	-18
	Alternative		26	5	-17	-38				0	-28	-30
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Upper Kobuk

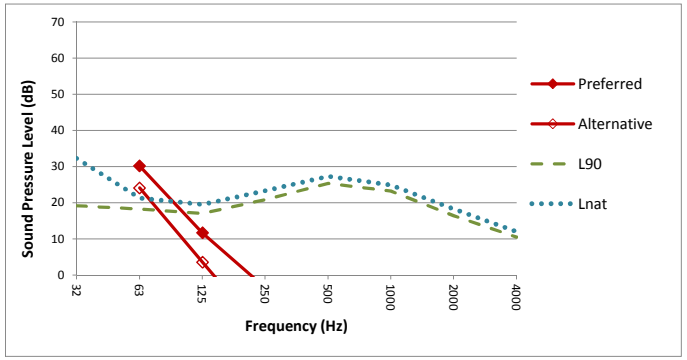
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		27	10	-4	-13	-38			2	No	
	Alternative		21	1	-19	-38	-79			-4	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

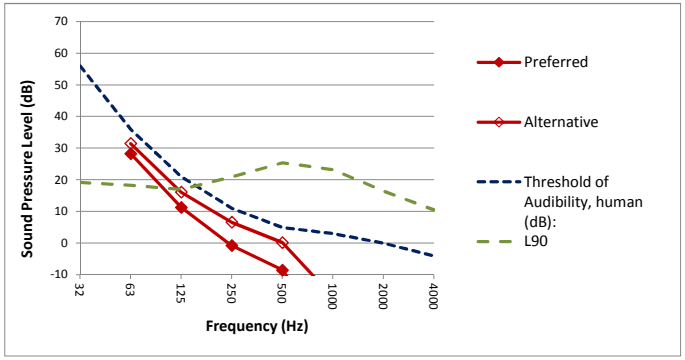
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		30	12	-4	-15	-43			5	-23	-25
	Alternative		24	4	-17	-36				-2	-30	-32
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: Hogaza Summit

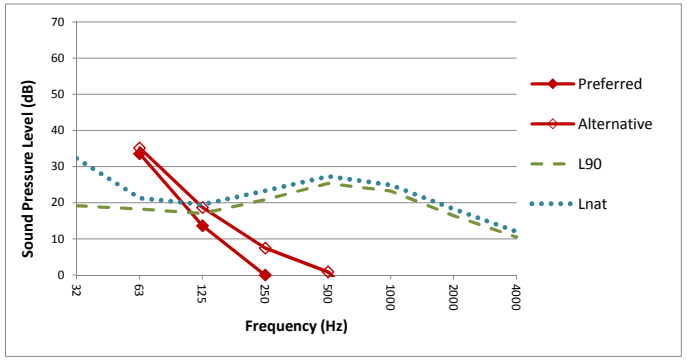
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		28	11	-1	-9	-31			3	No	
	Alternative		32	16	7	0	-17	-70		8	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

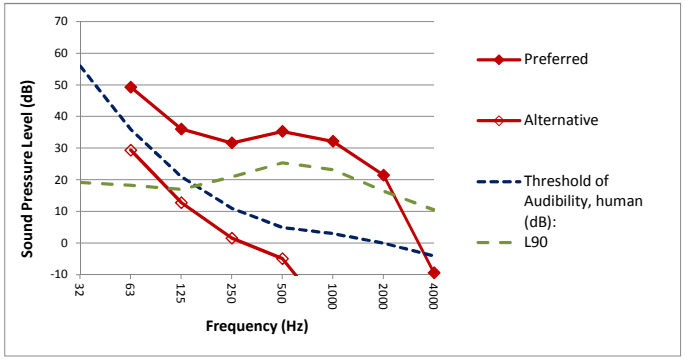
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		34	14	0	-9	-31			8	-20	-22
	Alternative		35	19	8	1	-17	-71		11	-18	-20
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		



Location: ROW E Boundary

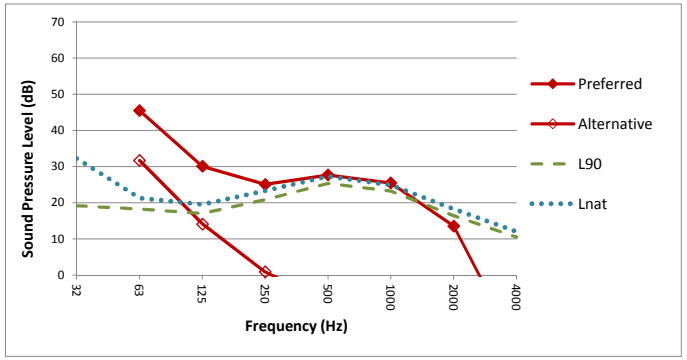
Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		49	36	32	35	32	22	-9	36	Yes	faint
	Alternative		29	13	2	-5	-25			5	No	
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

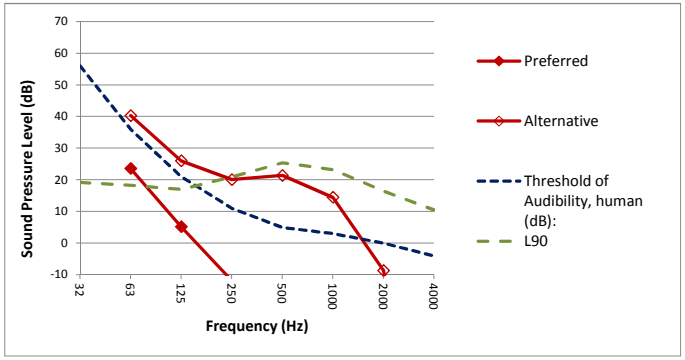
	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		46	30	25	28	26	14	-20	29	1	-1
	Alternative		32	14	1	-8	-29			7	-22	-24
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30		

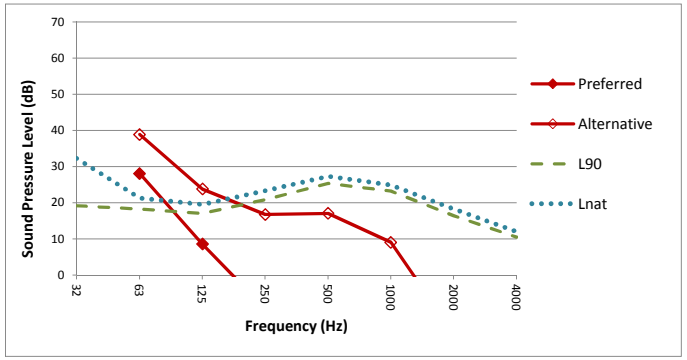


Location: Kobuk R S, Ridge 3

Audibility

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Audible?	Subjective Evaluation (Table 2-1)
Predicted Lmax of single truck pass-by (dB):	Preferred		24	5	-12	-27	-61			-2	No	
	Alternative		40	26	20	21	15	-9	-87	22	Yes	faint
Threshold of Audibility, human (dB):		56	36	21	11	5	3	0	-4			
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		



Comparison to Median Ambient Noise

	Alignment	Frequency (Hz) 32	63	125	250	500	1000	2000	4000	Total (dBA)	Difference vs. L90	Difference vs. Lnat
Predicted Leq(h) for hourly truck traffic (dB):	Preferred		28	9	-9	-25				2	-26	-28
	Alternative		39	24	17	17	9	-16		18	-10	-12
Median of NPS GAAR Measurements (dB):	L90	19	18	17	21	25	23	16	11	28		
	Lnat	32	21	20	23	27	25	18	12	30