



CD8 Project

Air Quality Impact Analysis Report - Rev 02

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Executive Summary

Air quality impacts from oil and gas facilities on the North Slope have been well studied over the last 30+ years through the NEPA process, air quality permit modeling, and ambient air quality field measurements conducted at or near Alaska North Slope drill sites. These sources provide a robust set of data that informs analysis of potential impacts of the CD8 Project (Project).

Evaluating relevant available information (i.e., 11 recent permit and NEPA modeling analyses and monitoring data from 6 ambient air monitoring studies) clearly shows criteria air pollutants, volatile organic compounds (VOC) and hazardous air pollutants (HAPs) concentrations resulting from the emissions associated with drill site development and routine operations have been consistently below relevant health-based standards at the location of maximum impact, 100 m from the source. Furthermore, this record provides a more comprehensive understanding of the effects on air quality of drill site development on the North Slope compared to any individual project specific analysis because it shows how preconstruction model predictions compare to real world effects.

Applying these data results to the Project using a surrogate data approach, leads to the conclusion that direct and cumulative predicted concentrations of criteria air pollutants, VOCs and HAPs emissions will remain below applicable health-based standards during the entirety of the Project lifecycle. Furthermore, concentrations of criteria air pollutants from the Project are predicted to reach maximum ground level concentrations within 100 meters of activities and decrease exponentially from that point outward. By the time pollutants are transported to Nuiqsut (i.e., 3.4 kilometers from the Project), concentrations will be more than two orders of magnitude lower due to dispersion and negligible compared to the level of health-based standards. By approximately 5 kilometers from the source, Project impacts should be indistinguishable above normal background levels.



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1.0 Introduction

This Air Quality Impact Analysis (AQIA) evaluates the potential direct air quality impacts (direct impacts) associated with activities anticipated as part of the Project and cumulative air quality impacts (cumulative impacts) associated with Project interactions with other past, present, or reasonably foreseeable actions regionally. Impacts are assessed for all criteria air pollutants except lead; volatile organic compounds (VOC); and select hazardous air pollutants (HAPs). This analysis is intended to support the United States Army Corps of Engineers (USACE) in the National Environmental Act (NEPA) process.

2.0 Regulatory Background

The Clean Air Act (CAA) requires the U.S. Environmental Protection Agency (USEPA or EPA) to set National Ambient Air Quality Standards (NAAQS) to protect public health and the environment for six common pollutants referred to as criteria air pollutants. This analysis considers five criteria air pollutants: carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), particulate matter (PM, both fine PM_{2.5} and inhalable PM₁₀), and sulfur dioxide (SO₂).¹ In Alaska, the Alaska Department of Environmental Conservation (ADEC) has the authority to implement and enforce Alaska Air Quality Control Regulations (18 AAC 50) through an USEPA-approved State Implementation Plan. The Alaska Ambient Air Quality Standards (AAAQS) were promulgated in 18 AAC 50.010 and differ slightly from the NAAQS. For this analysis, they are combined using the more restrictive of the two and the NAAQS and AAAQS are used together as NAAQS/AAAQS.

The CAA also mandates that USEPA regulate 188 HAPs (also referred to as air toxics) that are known or suspected to cause serious health effects or adverse environmental effects (Title 42 U.S. Code § 7412). HAPs are a subset of VOCs. Health-based standards for these pollutants include Reference Exposure Levels (RELs), Acute Exposure Guideline Levels (AEGLs), or Reference Concentrations for Chronic Inhalation (RfCs).² These benchmarks represent exposure limits established by human health protection authorities, below which adverse health effects are not expected to occur, even for sensitive populations. Exceeding these levels does not indicate an adverse health impact, but an increase likelihood of that the health effect will occur (ADEC 2017a; USEPA 2023). This analysis considers select relevant HAPs: benzene, ethylbenzene, toluene, and xylene (BTEX); n-hexane; formaldehyde; acetaldehyde; ethylene glycol; and methanol. These HAPs were selected because past analysis has shown that they are the only HAPs emitted from drill sites at levels warranting review, or because of a specific USACE request.

Expected pollutant-specific concentrations attributable to this Project are compared to the relevant health-based standards (i.e. NAAQS/AAAQS and air toxics) described in **Section 6.0**.

¹ Lead was not included in this analysis because the EPA regulatory initiatives, including the removal of lead from motor vehicle gasoline, have significantly reduced airborne lead levels. Today, lead in the air is generally only a concern near direct emission sources of lead. Therefore, ambient lead concentrations are not considered in this analysis because the study area lacks major lead sources, and the Project is expected to produce negligible lead emissions.

² RELs represent concentrations at or below, for which no adverse health effects are expected. AEGLs define specific airborne chemical concentrations at which health effects may occur. RfCs estimate continuous exposure levels that are unlikely to cause adverse health effects over a lifetime, including for sensitive populations (USEPA 2025a).



There are other federal and state air quality regulations that may apply to the Project, including, but not limited to, the New Source Performance Standards (40 CFR 60), the National Emission Standards for Hazardous Air Pollutants (40 CFR 63), the Title I Preconstruction permit program (40 CFR 51, 52), the Title V Operating Permit program (40 CFR 70, 71), the Mandatory Reporting of Greenhouse Gases (40 CFR 98), and ADEC minor source permitting (18 AAC 50.502–560). Applicability to these programs and requirements are outside the scope of this analysis which is limited to an air quality impact assessment.

3.0 Methodology

The Project's development and operational profile is consistent with the design practices of most drill sites constructed across the North Slope for decades, and certainly those recently developed within 30 miles of the Project. Specifically, it aligns with drill site projects evaluated in five recent NEPA Environmental Impact Statement (EIS) documents, six permits issued over the past decade, and with drill sites at which air quality field measurements have been conducted for over 30 years. Accordingly, this analysis evaluates anticipated direct impacts and cumulative impacts from the Project using surrogate data from analogous North Slope developments. This analysis generates minimal new data. It relies on existing, applicable sources of quantitative information to draw conclusions about the Project and generate project-specific predictions in some cases.

Indirect impacts to air quality are excluded from this analysis because they occur beyond the study area and cannot be reliably quantified. Moreover, indirect impacts are expected to be smaller than direct impacts and offer limited value in evaluating the Project or informing public understanding.

3.1 Surrogate Data Approach

Surrogate data from analogous developments was utilized to estimate potential pollutant concentrations attributable to the Project. This approach has been used for past NEPA analyses and was described in the 2020 NPR-A Integrated Activity Plan (IAP) and EIS as follows:

“The Willow MDP [Master Development Plan] is located in the NPR-A ‘high development potential zone.’ It is also the most current and comprehensive example of a hypothetical project in the NPR-A. The IAP/EIS is analyzing impacts from a hypothetical future development, and the Willow Draft EIS proposal is still representative of a potential development in the NPR-A. Thus, the near-field air quality modeling conducted for the Willow Draft EIS was used as a surrogate to represent a hypothetical future development in the NPR-A.” (BLM 2020)

Additionally, the 2020 NPR-A IAP and EIS state:

“The proposed Willow project includes five drill pads, a CPF [central processing facility], airstrip, gravel mine, gravel roads, pipeline, and other features; therefore, the near-field impacts from individual future developments in the NPR-A are expected to be comparable to or less than impacts from the Willow project, and the Willow EIS near-field analysis results are used as a surrogate for the near-field analysis for the NPR-A IAP.” (BLM 2020)

The BLM assessment for the NPR-A IAP and EIS supports the use of existing data, such as the Willow EIS pollutant concentration estimates, as surrogates for other developments. This analysis uses a similar surrogate data approach, using Willow EIS estimates as well as other



recent and relevant data sources (see **Section 4.0**) to evaluate potential air quality pollutant concentrations attributable to the proposed Project.

3.2 Data Types and Sources

This AQIA uses two different types of data from existing studies and sources: (1) modeling conducted for NEPA analyses (NEPA modeling) and modeling performed to obtain air quality construction permits (permit modeling), and (2) ambient air quality field measurements (ambient air quality monitoring) conducted at or near Alaska North Slope drill sites. These types of data have inherent differences that influence interpretation of their results.

Model-predicted concentrations of criteria air pollutants and HAPs, whether for NEPA analyses or permitting, are typically more conservative (i.e., predicts higher emissions) than ambient air quality field measurements. The primary reason is because dispersion modeling simplifies complex, time-varying activities into steady-state scenarios that assume continuous emissions under all meteorological conditions. For example, intermittent emission sources, such as drill site construction and well drilling and completion, operate sporadically, vary in intensity, and may not coincide spatially or temporally. Dispersion models assume a steady-state scenario with constant emissions which can lead to overestimation of short-term pollutant concentrations attributable to these intermittent emission sources.

Additionally, because modeling simulates worst-case emissions with every meteorological condition and a worst-case background value, it underrepresents the true variability and low probability that these situations will occur together. The typical dispersion modeling approach evaluates steady-state scenarios subject to all meteorological conditions; therefore, it includes uncommon instances where ambient background concentrations are high due to non-modeled sources such as natural dust and regional wildfires. In most cases, to simplify the modeling, project emissions are combined with a single worst-case (high) ambient background to produce modeled results. This simplified, and common approach can transform relatively small project contributions into large predicted total pollutant concentrations, making a rare scenario look typical.³ Consequently, modeled results often reflect improbable combinations of peak emissions and worst-case meteorological conditions, producing higher predicted concentrations than more sophisticated and realistic approaches will produce. This concept is highlighted when an atypical modeling approach, such as integrating a Monte Carlo randomization, is applied to standard dispersion modeling.⁴

In contrast, ambient air quality field measurements more accurately capture the dynamic nature of activities and atmospheric conditions, but their conclusions are generally applicable to smaller spatial areas. As a result, ambient air quality measurements typically show lower pollutant concentrations than model-predicted concentrations because ambient field measurements reflect actual conditions at a fixed location over time. Monitoring sites are generally selected to

³ These biases are most pronounced in evaluations of 1-hour and 24-hour particulate matter concentrations. For example, at the GMT1/MT6 drill site (Permit No. AQ1484MSS01), short-term PM₁₀ concentrations were predicted to reach 100% of the ambient standard, yet nearly 45% of that total was attributable to the background concentration.

⁴ This modeling bias is illustrated in the Alaska Oil and Gas Technical Subgroup (AOGTS) Monte Carlo application of a standard dispersion model (Appendix C of ADEC 2017b). The Monte Carlo approach evaluates the probability of pairing intermittent emissions with worst-case meteorology, producing a distribution of expected elevated concentrations rather than a single maximum value. Results showed that predicted concentrations ranged from 65% to 90% of the ambient standard, depending on whether the analysis focused on typical (50th to 75th percentile) or extreme (100th percentile) scenarios. Notably, even the 100th percentile Monte Carlo predictions were lower than those produced by standard regulatory prediction approaches.



experience the highest pollutant concentrations (monitoring locations are typically located on the gravel drill site) and measured values rarely exceed model predictions. Monitoring can occasionally show higher measured pollutant concentrations than modeling, but generally only when monitoring captures sources that are not modeled, such as wildfires and extreme windblown dust events.

3.3 Study Area

For the purposes of this AQIA, a study area was defined to evaluate the expected location and magnitude of direct effects of the Project. The study area is set such that Project effects would occur within it. Within the study area, sensitive receptors are identified and estimated air quality concentrations at those locations are also evaluated.

The defined study area for this AQIA is limited to approximately 5 kilometers (km) from the Project location (edge of pad) and includes regionally sensitive locations in and around the community of Nuiqsut (3.4 km from the proposed pad edge). Maximum predicted concentrations are expected to occur within 100 meters (m) from the Project location and are expected to drop exponentially with distance from the source to near-background levels by the edge of the study area. The study area boundary is based on regulatory considerations and practical constraints where the Project could potentially affect air quality. Modeling domains from surrogate data sources were reviewed, and it was determined that a 5-km study area for this Project's analysis provides an appropriately conservative scope to characterize Project effects.⁵

The area of maximum predicted concentrations was determined based on the location of activities during the Project lifecycle and the physics used to develop algorithms underlying USEPA-approved dispersion models. While construction effects may occur at various locations within the Project area (e.g., along pipeline and road corridors), the highest concentrations are expected at the Project location (gravel pad), where overlapping activities from multiple construction sources are most likely to occur. Pollutant transport and dispersion depend on many factors, including atmospheric conditions, release characteristics, and terrain. Regardless, the highest predicted concentrations will occur within one to five times the release height from the source and decrease rapidly from there (Turner 1970). Following this principle, the Project emission source release height would result in maximum predicted concentrations within 100 m of the Project location with concentrations dropping exponentially thereafter.

3.4 Project Lifecycle

For the purposes of air quality analysis, the proposed Project includes two main project lifecycle phases: a short-term drill site development phase followed by long-term routine operations. Drill site development is further divided into drill site construction and well drilling and completion activities. A detailed review of the emissions and individual activities associated with these activities are provided in the CD8 Project Emissions Inventory Technical Supporting Document (Sections 2.1 through 2.3 in CPAI 2025b).

Analysis of potential Project effects on air quality are evaluated for each of these project lifecycle phases, mirroring analyses in surrogate data sources. However, many project lifecycle

⁵ This domain is consistent with locations USEPA refers to as locations that will experience a significant concentration gradient in predicted concentrations from the project in 40 CFR 51 Appendix W, Section 8.3, published January 17, 2017.



phases commonly overlap and thus these activities are evaluated both individually and in combination using existing modeling and monitoring data.

4.0 Existing Data Sources

The most relevant sources for evaluating the Project were identified from a comprehensive existing dataset, including surrogates from 11 NEPA modeling analyses and modeling supporting construction permitting, and data from 6 ambient air quality monitoring programs. The selected NEPA and permitting modeling analyses share the following key characteristics:

- Location – Conducted for projects on the Alaska North Slope;
- Scope – Address one or more drill site development activities (drill site construction, well drilling, well completion) and/or and routine operations; and
- Recency – Projects that have undergone a NEPA review or air quality construction permitting within the last 15 years, and any credible monitoring program.

Unlike NEPA review and permitting processes, monitoring programs – regardless of their age – remain relevant as long as the data were collected with documented precision and accuracy under an established quality assurance framework. This is because data collection methodologies and standards of review have changed very little over time.

4.1 National Environmental Policy Act Modeling Analyses

Over the past decade, numerous NEPA documents for oil and gas projects have included detailed analyses of ambient air quality pollutant concentrations from these activities.

Appendix A, Table A-1, summarizes five recent and relevant NEPA modeling analyses that inform evaluation of potential Project effects.

All analyses are west of the Colville River, except for the Nanushuk Project, which is the closest to this Project and just outside the study area. The scope of these analyses is very similar to that of the Project. The GMT1 and GMT2 projects represent single drill site development and operation comparable to the Project. The Nanushuk EIS, Willow EIS, and the NPR-A IAP and EIS all represent development that is much bigger in size and scope, thus scenarios modeled are conservatively representative (i.e., more impactful) of the same activities planned for the Project. Therefore, the modeled scenarios and pollutant concentrations predicted from these are expected to be greater than those expected from the Project.

4.2 Permitting Modeling Analyses

Four drill sites and two drilling-specific permitting actions have authorized activities nearly identical to those planned for the Project. **Appendix A, Table A-2**, summarizes the selected recent and relevant permit modeling analyses that inform evaluation of potential Project effects.⁶ Information presented is drawn from the State of Alaska's Technical Analysis Reports (TARs) and permittees' applications.⁷

⁶ The ConocoPhillips Alaska, Inc. (CPAI) permit for the CD5 drill site is included despite being older, as there have been no significant changes to modeling protocols or regulatory guidance that would affect its relevance.

⁷ In all cases, permit actions were reviewed and issued by ADEC under the Air Quality Control (AQC) Minor Stationary Source (MSS) Air Quality Permit Program, as outlined 18 AAC 50 Article 5.



The four drill site permitting actions (CD5, DS-2S, GMT1/MT6, and GMT2/MT7) are for sites located within approximately 20 miles of the Project. Each site has comparable well counts, drill site configurations, and source inventories to those of the Project. Consequently, the modeled scenarios used to support the drill site permitting are highly representative of the Project conditions, and the model-predicted concentrations documented for these drill sites are comparable to those expected from the Project.

The two drilling-specific permits authorize operations at a typical North Slope drill site using either a large diesel-fired drill rig and associated equipment (Minor General 2 [MG2] permit) or a large diesel- and gas-fired drill rig and associated equipment (Doyon 26 Drill Rig Portable Oil and Gas Operations [POGO]). Development of these permits required predicting concentrations downwind of drilling wells at a representative drill site, incorporating emissions from a typical inventory of stationary sources. These permits are expected to be used for drilling activities associated with the Project; therefore, the model-predicted concentrations documented for these permits are considered representative of those anticipated for the Project.

4.3 Ambient Air Quality Monitoring

Ambient air quality monitoring has been conducted at or near Alaska North Slope drill sites for more than 30 years, providing over 100 cumulative years of data. These programs consistently report pollutant concentrations in the low to moderate range, with occasional PM₁₀ measurements above the level of the NAAQS/AAQS attributable to natural events such as windblown dust and wildfires rather than anthropogenic emissions. These concentrations are representative of developed areas on the North Slope and serve as a conservative surrogate for undeveloped areas. Monitoring has measured pollutant concentrations resulting from all major drill site lifecycle activities.

Appendix A, Table A-3, presents the scale and scope of monitoring, primarily based on a summary published by ADEC and last updated in 2018 (ADEC 2025). Information on monitoring conducted since 2018 is based on information provided by CPAI and Hilcorp Alaska.

While not operated at an Alaska North Slope drill site, the Nuiqsut monitoring station, located approximately 3.4 km from the Project and within the AQIA study area, is situated among regional oil and gas development on the North Slope. It is generally downwind of several large facilities within the Kuparuk River Unit, the Pikka Unit, as well as more distant sources located within the Prudhoe Bay Unit. This location ensures the station measures regional pollutant concentrations from small and large stationary sources, mobile transportation sources, and activities associated with oil and gas development. These include emissions from processing facilities, power stations, drill rigs, well servicing operations, and other temporary or mobile sources supporting development and maintenance. Therefore, this monitoring station is a good indicator of background pollutant concentrations as it measures the effects from biogenic sources, unidentified sources, and global emissions transported across the North Slope, in addition to those described previously.

All sites listed in **Appendix A, Table A-3** provide valuable context for characterizing existing conditions and assessing potential Project effects. However, several locations (CD1, Pad A, DS-1F, CD3, and CD5) are particularly relevant as their data has supported NEPA analyses and permit modeling, and they were also used to represent pollutant concentrations in the AQIA



supporting ADEC's MG2 permit for POGO on the North Slope.⁸ These measurements are detailed in Section 3.13 of the Ambient Demonstration for the North Slope POGO Simulation (ADEC 2017b). **Appendix A, Table A-4**, provides additional details about these monitoring sites and the data collected demonstrating the extent of information that exists and can be used to understand the effects of drill site development and routine operations.

5.0 Data Findings

NEPA modeling, permit modeling and ambient air quality monitoring has shown that pollutant concentrations in the vicinity of North Slope oil and gas operations will be less than health-based standards and often much lower than the standards for all evaluated project sources (evaluated sources). Furthermore, air quality measurements at sensitive receptors in and around the community of Nuiqsut consistently indicate that predicted pollutant concentrations from oil and gas activities are not discernible above background levels, and do not present a threat to air quality.

5.1 Direct Impacts

5.1.1 NEPA and Permit Modeling

As described in **Section 3.2**, results of dispersion modeling, whether from NEPA analysis or permitting efforts, are typically conservative. Review of modeling from five NEPA analyses and six permitting efforts have shown that concentrations of criteria air pollutants and HAPs are consistently predicted to be below the NAAQS/AAQs and air toxics health-based standards, for drill site development (construction and well drilling and completion) and during routine operations. Maximum predicted pollutant concentrations from all evaluated sources occurred within the first 100 m of sources, and predicted concentrations were not discernible above background levels more than 5 km from the source.

5.1.1.1 Criteria Air Pollutants

Specific findings from evaluated sources for each drill site development activity and the routine operations phase are described in this section for criteria air pollutants.

Drill Site Construction

Evaluation of the effects of drill site construction on air quality is based on NEPA modeling data sources as permit modeling only addresses drill site construction activities using a surrogate data approach. This omission does not imply that ADEC considers these activities unimportant; rather, there is reasonable assurance that predicted pollutant concentrations from this temporary phase do not pose a public health risk. Additionally, the worst-case scenarios quantified in permit modeling (i.e., routine operations with concurrent drilling and maintenance) are considered representative of pollutant concentrations predicted from overall drill site development inclusive of drill site construction.

For all evaluated sources, NEPA modeling analyses found that maximum short- and long-term criteria air pollutant concentrations from drill site construction are predicted to be below the health-based standards. Maximum predicted concentrations occurred within the first 100 m of

⁸ Relevant station information, measured concentrations, and analysis of pollutants (CO, NO₂, PM_{2.5}, PM₁₀, and SO₂) are included in two presentations prepared by the Alaska Oil and Gas Technical Subgroup (AOGTS) as part of the MG2 permit development process (AOGTS 2014a, 2014b).



evaluated sources and predicted concentrations were not discernible above background levels more than 5 km from evaluated sources. **Table 1** summarizes pollutant concentrations at the location of the maximum predicted concentrations.

As shown in **Table 1**, there is a probability that predicted daily PM_{2.5} concentrations could approach the standards. However, given the inherent tendency of model predictions paired with background concentrations to overestimate impacts, these elevated values are upper bounds rather than typical conditions. Elevated short-term PM_{2.5} values arise as much from elevated background concentrations as they do from drill site emissions. This conservatism inherent to project predicted pollutant concentrations resulting from pairing worst-case background concentrations with model-predicted concentrations every day of the year is demonstrated in **Table 1**.

Predicted SO₂ concentrations are generally the lowest of all pollutants because the analyses summarized in **Table 1** assume combustion of fuel with less than 15 parts per million by weight (ppmw) sulfur (Ultra-Low Sulfur Diesel) in all equipment. If equipment allowed to use higher-sulfur fuel—such as heaters and boilers—were instead supplied with product from a North Slope topping plant, predicted SO₂ concentrations would increase, but are expected to remain under the health-based standards based on results documented during the well drilling and completion activity and during routine operations.



Table 1: Drill Site Construction – Predicted Criteria Air Pollutant Modeling Results

Project	AQIA Maximum Predicted Concentrations ¹ (% of NAAQS/AAQS)											Location in Relevant Analysis
	NO ₂		CO		SO ₂				PM ₁₀	PM _{2.5}		
	1-hr	Ann.	1-hr	8-hr	1-hr	3-hr	24-hr	Ann.	24-hr	24-hr	Ann.	
Willow Final Supplemental Environmental Impact Statement (SEIS)	70%	21%	27%	39%	7%	1%	3%	2%	33%	53%	34%	Willow MDP Final SEIS, Table 3.3.16, Construction Activity Domain Maximum (BLM 2023)
GMT2 Final SEIS	88%	25%	3%	13%	17%	3%	6%	1%	53%	74%	24%	GMT2 Final SEIS, Section 4.2.3.2, Table 84, Construction (BLM 2018)
GMT1 Final SEIS	82%	34%	8%	23%	6%	2%	2%	1%	75%	99%	62%	GMT1 Final SEIS, Section 4.2.3.2, Table 4.2-14, Access Road and Pad Construction (BLM 2014)
Nanushuk Final EIS	⊗	32%	⊗	⊗	4%	0.4%	1%	0.4%	20%	57%	16%	Nanushuk Final EIS Appendix V, Table 6-1, Construction and Drilling (USACE 2018)
2020 NPR-A IAP and Final EIS	84%	24%	5%	17%	5%	1%	3%	3%	80%	64%	44%	2020 NPR-A IAP and Final EIS, Section 3.2.2, Table 3-3, Construction Activity (BLM 2020)
Table Notes:												
1. Except for the Nanushuk Final EIS, “AQIA Maximum Predicted Concentrations Results” are the summation of a project-only predicted pollutant concentrations and an ambient background concentration. The ambient background can be a large part of the total predicted concentration particularly with short-term particulate cases, which causes AQIA Maximum Predicted Concentrations to be a high percentage of the standard even when activity-only effects are a small fraction of the standard.												



Well Drilling and Completion

Existing NEPA analyses modeled well drilling and completion together due to their close timing and/or overlap in the drill site development phase. In permit modeling analyses completed since 2017, well completion activities are generally represented through background concentrations using ambient air quality monitoring data from CD1 and CD5 rather than through direct modeling.

All modeling analyses indicate that both maximum short- and long-term concentrations of criteria air pollutants from well drilling and completion activities are predicted to be below the health-based standards within 100 m of the source. Furthermore, predicted concentrations are not distinguishable from background levels beyond approximately 5 km. **Table 2** summarizes pollutant concentrations at the location of maximum predicted concentration.

Table 2 demonstrates that permit modeling results are consistently higher than NEPA modeling results and should be regarded as an upper bound on potential impacts rather than an achievable outcome. This difference arises because permit modeling is designed to provide applicants with maximum operational flexibility, accommodating the broadest range of potential scenarios without necessitating future permit modifications. As a result, permit modeling often assumes operating conditions that are atypical and unlikely under normal circumstances. For instance, emissions may be calculated based on continuous, full-load engine operation, even when actual plans involve intermittent use at variable loads. In contrast, NEPA modeling generally reflects more realistic operating conditions, offering a more probable assessment of anticipated impacts.

This bias is particularly pronounced for predictions documented for the MG2 permit and the Doyon 26 Drill Rig POGO permit. Both are based on modeling operating limits specifically set to achieve but not exceed the NAAQS/AAQS. Therefore, these results should not be considered typical, but an extreme upper limit.

Table 2 indicates that predicted short- and long-term concentrations are generally higher than those associated with drill site construction. This is primarily due to increased emissions from well drilling and completion activities. However, these concentrations are still expected to remain below applicable standards. Similar to drill site construction, short-term PM_{10} concentrations and long-term $PM_{2.5}$ concentrations are elevated as a percentage of the standard compared to other pollutants. This is largely attributable to higher background concentrations combined with project-related emissions.

The effect of combusting higher-sulfur diesel fuel sourced from a North Slope topping plant can be evaluated using the values presented in **Table 2**. For the CD5 and DS-2S projects, predicted concentrations assumed reciprocating engines combusted fuel containing less than 15 ppmw sulfur (Ultra-Low Sulfur Diesel), while heaters and boilers utilized fuel from a North Slope topping plant with sulfur content up to 1,500 ppmw. Consequently, predicted SO_2 concentrations for these projects are approximately five times greater than those for projects such as Willow, GMT2, or GMT1, which relied exclusively on combusting Ultra-Low Sulfur Diesel. Despite this increase, except for the shortest averaging period, predicted SO_2 concentrations for all evaluated projects are well below 50% of the NAAQS/AAQS, regardless of fuel sulfur content.



Table 2: Well Drilling and Completion Activities - Predicted Criteria Pollutant Modeling Results

Project	AQIA Maximum Predicted Concentration Results ¹ (% of NAAQS/AAQs)											Location in Relevant Analysis
	NO ₂		CO		SO ₂				PM ₁₀	PM _{2.5}		
	1-hr	Ann.	1-hr	8-hr	1-hr	3-hr	24-hr	Ann.	24-hr	24-hr	Ann.	
Willow Final SEIS ²	84%	29%	29%	46%	18%	3%	6%	3%	56%	84%	51%	Willow MDP Final SEIS, Table 3.3.16, Max of Pre-drilling or Developmental Drilling Domain Maximum (BLM 2023)
GMT2 Final SEIS	88%	36%	4%	14%	17%	3%	6%	1%	89%	74%	35%	GMT2 Final SEIS, Section 4.2.3.2, Table 84, Max of Developmental Drilling or Infill Drilling (BLM 2018)
GMT1 Final SEIS	73%	42%	6%	17%	6%	2%	3%	1%	77%	83%	67%	GMT1 Final SEIS, Section 4.2.3.2, Table 4.2-14, Infill Drilling (BLM 2014)
Nanushuk Final EIS ²	⊗	32%	⊗	⊗	69%	10%	20%	8.5%	22%	81%	17.5%	Nanushuk Final EIS Appendix V, Table 6-1, Max of Construction and Drilling or Drilling and Operations (USACE 2018)
2020 NPR-A IAP and Final EIS ²	91%	27%	7%	23%	14%	2%	4%	5%	66%	70%	49%	2020 NPR-A IAP and Final EIS, Section 3.2.2, Table 3-3, Development Drilling Activity (BLM 2020)
GMT1 / MT6 Drill Site Permit No. AQ1484MSS01	⊗	80%	⊗	⊗	17%	4%	6%	6%	99%	⊗	99%	GMT1/MT6 Permit No. AQ1484MSS01, TAR, Appendix B, Table 3. (ADEC 2018b)
CD5 Drill Site Permit No. AQ0945MSS01 ²	⊗	40%	⊗	⊗	⊗	16%	38%	27%	68%	⊗	⊗	Addendum I to the CD5 Minor Permit Application – Alternate Drill Rigs for CPAI, Tables 6-1 and 6-2, Max of Doyon 15 or Doyon 141 Drill Rigs scenarios (CPAI 2005a)
DS-2S Drill Site Permit No. AQ1429MSS01	⊗	94%	⊗	⊗	99%	15%	27%	13%	85%	⊗	53%	DS-2S Permit No. AQ1429MSS01, Appendix B, Table 4. (ADEC 2015)
MG2 permit	100%	32%	7%	25%	88%	16%	39%	15%	93%	66%	48%	North Slope POGO Simulation Final Modeling Report, Table 13 and Figures 10a and 10b, maximum results for 14.7 (~15) kgal/day fuel consumption limit (isolated pad) [for the MG2 permit] (ADEC 2017b)
Doyon 26 Drill Rig POGO Permit No. AQ1552MSS02	⊗	92%	⊗	⊗	85%	11%	29%	11%	100%	⊗	58%	Doyon 26 Drill Rig POGO Permit No. AQ1552MSS02, Appendix B, Table 1 (ADEC 2021a)
Table Notes: 1. Except for the Nanushuk Final EIS, “AQIA Maximum Predicted Concentration Results” are the summation of a project-only predicted pollutant concentrations and an ambient background concentration. The ambient background can be a large part of the total predicted concentration particularly with short-term particulates, which causes AQIA Maximum Predicted Concentration Results to be a high percentage of the standard even when activity-only effects are a small fraction of the standard. 2. Includes well completion activities.												



Routine Operations

Predicted pollutant concentrations during routine operations are generally comparable to those estimated for well drilling and completion activities. This outcome appears counterintuitive given the lower emission levels typically associated with routine operations. However, the similarity is attributable to simplified modeling assumptions rather than actual conditions, as confirmed by field measurements. All modeling analyses found that maximum short- and long-term criteria air pollutant concentrations from routine operations of a drill site are predicted to be below the health-based standards and occur within the first 100 m of the source. Furthermore, predicted concentrations are not distinguishable from background levels beyond approximately 5 km.

Table 3 summarizes pollutant concentrations at the location of maximum predicted pollutant concentration, which was often the edge of the drill site gravel pad.

As previously described, permit modeling results presented in **Table 3** represent an upper bound rather than an achievable outcome because permit modeling is designed to provide applicants with maximum operational flexibility. Also consistent with previous discussions, daily predicted PM₁₀ concentrations and long-term PM_{2.5} concentrations are elevated as a percentage of the standard compared to other pollutants as much due to elevated background concentrations as project-related emissions.

The level of SO₂ concentrations during routine operations are linked to the assumed sulfur content of the diesel fuel combusted in portable heaters and boilers. Once again, this is apparent in the 1-hour SO₂ concentration predicted in support of the DS-2S Drill Site permit. Those predicted concentrations are the result of modeling the continuous operation of diesel fueled heaters and boilers during routine operations. In practice, diesel combustion during routine operations is typically minimal and diesel fuel sulfur content is not expected to play a role. Therefore, any apparent correlation between sulfur content and model-predicted concentrations reflects conservative, worst-case assumptions applied to simplify compliance demonstrations for permit modeling.

5.1.1.2 Secondarily Formed Criteria Air Pollutants

For secondarily formed components of PM_{2.5} and O₃, the USEPA provides a standard approach for evaluating the magnitude of the formation (USEPA 2022). Using that approach, typical drill site emissions,⁹ and data published on the USEPA Support Center for Regulatory Atmospheric Modeling (SCRAM) Modeled Emission Rates for Precursors (MERPs) View Qlik platform (USEPA 2025b), the distance to the location of maximum predicted secondary O₃ and PM_{2.5} concentrations from a typical drill site is expected to occur within 20 m of the drill site. The maximum secondary ozone concentration will be less than 1 part per billion on an 8-hour averaging period and less than 0.1 micrograms per cubic meter (µg/m³) for secondary PM_{2.5} irrespective of averaging period. These predicted concentrations are negligible compared to regional background levels and direct predicted pollutant concentrations described in **Section 5.1.1.1**. Therefore, concentrations of secondarily formed components of PM_{2.5} and O₃ are negligible at all locations and throughout the entire drill site lifecycle.

⁹ Based on the various NEPA and permitting analyses reviewed, typical drill site emissions will be less than 100 tpy NO_x, 10 tpy SO₂, and 100 tpy VOC irrespective of drill site development activity or routine operations phase.



Table 3: Relevant Project Routine Operations Activity Predicted Criteria Air Pollutant Modeling Results

Project	AQIA Maximum Predicted Concentration Results ¹ (% of NAAQS/AAQS)											Location in Relevant Analysis
	NO ₂		CO		SO ₂				PM ₁₀	PM _{2.5}		
	1-hr	Ann.	1-hr	8-hr	1-hr	3-hr	24-hr	Ann.	24-hr	24-hr	Ann.	
Willow Final SEIS	86%	29%	29%	44%	18%	3%	6%	3%	55%	84%	51%	Willow MDP Final SEIS, Table 3.3.16, Routine Operations Domain Maximum (BLM 2023)
GMT2 Final SEIS	79%	33%	4%	14%	17%	3%	6%	1%	73%	74%	33%	GMT2 Final SEIS, Section 4.2.3.2, Table 84, Infill Drilling (BLM 2018)
GMT1 Final SEIS	87%	42%	6%	17%	6%	2%	3%	1%	77%	83%	67%	GMT1 Final SEIS, Section 4.2.3.2, Table 4.2-14, Max of Infill Drilling or Well Intervention (BLM 2014)
Nanushuk Final EIS	⊗	32%	⊗	⊗	69%	10%	20%	8.5%	22%	81%	17.5%	Nanushuk Final EIS Appendix V, Table 6-1, Drilling and Operations (USACE 2018)
2020 NPR-A IAP and Final EIS	89%	26%	7%	23%	4%	2%	4%	4%	66%	69%	45%	2020 NPR-A IAP and Final EIS, Section 3.2.2, Table 3-3, Routine Operations (BLM 2020)
GMT2 / MT7 Drill Site Permit No. AQ1503MSS01	⊗	54%	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	GMT2/MT7 Permit No. AQ1503MSS01, TAR, Appendix B, Table 5 (ADEC 2021b);
GMT1 / MT6 Drill Site Permit No. AQ1484MSS01	⊗	80%	⊗	⊗	17%	4%	6%	6%	99%	⊗	99%	GMT1/MT6 Permit No. AQ1484MSS01, TAR, Appendix B, Table 3. (ADEC 2018b)
CD5 Drill Site Permit No. AQ0945MSS01	⊗	40%	⊗	⊗	⊗	16%	38%	27%	68%	⊗	⊗	Addendum I to the CD5 Minor Permit Application – Alternate Drill Rigs for CPAI, Tables 6-1 and 6-2, Max of Doyon 15 or Doyon 141 Drill Rigs scenarios (CPAI 2005a)
DS-2S Drill Site Permit No. AQ1429MSS01	⊗	94%	⊗	⊗	99%	15%	27%	13%	85%	⊗	53%	DS-2S Permit No. AQ1429MSS01, Appendix B, Table 4. (ADEC 2015)

Table Notes:

- Except for the Final Nanushuk EIS, "AQIA Maximum Predicted Concentration Results" are the summation of a project-only predicted pollutant concentrations and an ambient background concentration. The ambient background can be a large part of the total predicted concentration particularly with short-term particulate cases, which causes AQIA Maximum Predicted Concentration Results to be a high percentage of the standard even when activity-only effects are a small fraction of the standard.



5.1.1.3 Hazardous Air Pollutants

Evaluation of the effect of drill site development and routine operation on ambient concentrations of HAPs is based on NEPA modeling data sources. Permit modeling does not include modeled prediction of HAP concentrations because ADEC has reasonable assurance that emissions from sources as small as those reviewed do not pose a public health concern and require no further analysis.

At this point in time, the scope of modeling efforts has been limited to predicting concentrations of BTEX, n-hexane, and formaldehyde, as it has been previously determined that these are the only HAPs emitted from drill sites at levels warranting modeling review. However, these predictions can also serve as surrogates for other similar compounds; e.g., because formaldehyde and acetaldehyde originate from the same sources, predicted formaldehyde concentrations can be used as a proxy for acetaldehyde.

All NEPA modeling analyses found that maximum short- and long-term HAPs concentrations from drill site development and routine operations are predicted to be below the health-based standards within the first 100 m of the source. Furthermore, predicted concentrations are not distinguishable from background levels beyond approximately 5 km, suggesting negligible effects on Nuiqsut. **Table 4** summarizes pollutant concentrations at the location of maximum predicted concentration, which is often the edge of the drill site gravel pad. The modeling results summarized do not include ambient background concentrations, as no ambient background levels exist for HAPs, and the short lifetime of HAPs leaves all areas with a background concentration of zero except those very close to a source.

In most cases, the concentrations summarized in **Table 4** were derived from a single modeling scenario representing the worst-case conditions across all phases of drill site development and routine operations. This approach is appropriate because predicted HAP concentrations from oil and gas development are typically well below health-based standards, as confirmed by field measurements.

All NEPA HAP modeling included a cancer risk screening analysis for acute and chronic exposure to carcinogenic HAPs. However, these analyses were not applied consistently across projects and were conducted at large distances. Therefore, these project-specific analyses do not provide meaningful insight for evaluating potential Project effects. However, predicted HAP concentrations summarized in **Table 4** can be used to develop a project-specific assessment at any sensitive receptor location.



Table 4: Summary of HAP / Air Toxics Model Predicted Concentrations as a Relative Percentage from Relevant NEPA Project Analyses

Project	AQIA Maximum Predicted Concentration Results ¹ (% of Relevant Reference Level or Concentration)																		Location in Relevant Analysis
	Benzene			Ethylbenzene			Formaldehyde			n-hexane			Toluene			Xylene			
	1-hr	8-hr	Ann.	1-hr	8-hr	Ann.	1-hr	8-hr	Ann.	1-hr	8-hr	Ann.	1-hr	8-hr	Ann.	1-hr	8-hr	Ann.	
Willow Final SEIS	37%	0.02%	1%	0.2%	0.1%	3%	11%	0.4%	0.06%	0.006%	0.004%	2%	0.6%	0.008%	0.02%	2%	0.06%	13%	Willow MDP Final SEIS, Table 3.3.17, Analysis Area Results (BLM 2023)
GMT2 Final SEIS	5%	⊗	4%	0.005%	⊗	0.02%	19%	⊗	3%	0.3%	⊗	0.5%	0.2%	⊗	0.02%	0.3%	⊗	0.8%	GMT2 Final SEIS, Section 4.2.3.2, Table 87, Maximum Scenario (BLM 2018)
GMT1 Final SEIS	0.3%	⊗	0.2%	0.0001%	⊗	0.0002%	3%	⊗	0.5%	0.02%	⊗	0.07%	0.007%	⊗	0.0006%	0.005%	⊗	0.02%	GMT1 Final SEIS, Section 4.2.3.2, Table 4.2-17 (BLM 2014)
Nanushuk Final EIS	0.2%	⊗	0.4%	0.00003%	⊗	0.0003%	8%	⊗	2%	0.0003%	⊗	0.01%	0.004%	⊗	0.0009%	0.004%	⊗	0.03%	Nanushuk Final EIS Appendix V, Tables 6-3 and 6-5, Max. Modeled (USACE 2018)
2020 NPR-A IAP and Final EIS	48%	0.03%	1%	0.2%	0.2%	0.8%	2%	0.04%	0.3%	0.008%	0.005%	3%	0.1%	0.01%	0.02%	3%	0.08%	15%	NPR-A IAP and Final EIS, Section 3.2.2, Table 3-4 (BLM 2020)
Table Notes:																			
1. Predicted concentrations represent either the predicted concentrations during routine operations or the maximum of modeled-predicted concentrations from each modeled scenario.																			



5.1.2 Ambient Air Quality Monitoring

As described in **Section 4.3**, results of ambient air quality monitoring provide observed concentration data from locations at or near Alaska North Slope drill sites. Monitoring data captures the dynamic nature of activities and atmospheric conditions. Review of monitoring data have shown that criteria air pollutants and HAPs have remained below the NAAQS/AAQs and the RELs/AEGLs/RfCs respectively for drill site development and during routine operations.

5.1.2.1 Criteria Air Pollutants

Analysis of air quality data collected throughout the lifecycle of a drill site provides insight into conditions on and around a drill site. Monitoring results indicate that pollutant concentrations associated with well drilling activities occasionally approach short-term NAAQS/AAQs at the monitoring station but do not exceed them. Elevated concentrations observed during drilling and completion activities return to baseline levels once these activities conclude, and long-term averages remain largely unaffected due to their temporary nature.

The CD5 monitoring program is particularly well suited for characterizing existing conditions and assessing potential pollutant concentrations from drill site emissions. Its significance lies in continuous operation from initial development through long-term production. Early in the monitoring program (October 2015 – December 2017), measurements were collected during well drilling and completion activities when significant well development occurred. During this period, 20 wells were drilled and 10 were completed using hydraulic fracturing. **Table 5** summarizes measurements from this timeframe, based on the methodology outlined in **Table 6**. All approaches were designed to produce conservative estimates for comparison against applicable standards.

Except for 1-hour NO₂, all values were well below the NAAQS/AAQs at the monitoring station location. The elevated 1-hour NO₂ measurements were clearly attributable to drilling and completion activities occurring on the pad based on magnitude and wind direction. Short-term CO and SO₂ measurements were certainly influenced by the same activities, but this is not obvious because maximum measured concentrations remained a small fraction of the NAAQS/AAQs despite the influence. This suggests that CO and SO₂ emissions from a well drilling and completion activity do not pose a concern for air quality.

Consistent with NEPA and permit modeling predictions 1-hour NO₂ measurements approached 90% of the NAAQS/AAQs threshold without exceeding it. In contrast, measured daily PM_{2.5} concentrations remained below 30% of the short-term standard and were significantly lower than modeled estimates. This difference between the two sets of measurements is likely due to conservative emission factors and elevated background concentrations used in PM_{2.5} modeling.

Importantly, these measurements reveal a dynamic not evident in maximum model-predicted concentrations: pollutant levels return to baseline levels when wind direction shifts or initial developmental drilling and well completion activities conclude. Since developmental drilling and well completion activities concluded in 2018, transient and elevated measurements have decreased, and current values at the monitoring station are generally less than 50% of short-term and less than 20% of long-term NAAQS/AAQs thresholds. Routine operations at CD5 now show concentrations consistent with those at Nuiqsut and comparable to regional background levels. **Table 7** compares CD5 and Nuiqsut data for 2022 (CPAI 2023a, 2023b), showing that both short-term and long-term measurements at Nuiqsut reflect regional baseline conditions and are not significantly influenced by local activities (i.e., drill site development). This trend holds for all pollutants except that PM₁₀ and PM_{2.5} concentrations at Nuiqsut are



consistently higher than at CD5, likely due to larger particulate matter sources near Nuiqsut, such as exposed Colville River banks.

Table 5: Summary of Measurements on the CD5 Drill Site October 2015 – December 2017

Pollutant	Averaging Period	Measured Concentration ($\mu\text{g}/\text{m}^3$)	(% of NAAQS/AAQs)	Standard Deviation ($\mu\text{g}/\text{m}^3$)
NO ₂	1-hour	169	90.2	46.0
	Annual	20.6	20.6	
CO	1-hour	1,285	3.21	165
	8-hour	897	8.97	
SO ₂	1-hour	4.7	2.4	1
	3-hour	139	10.7	
	24-hour	6.1	1.7	
	Annual	0.5	0.7	
PM ₁₀	24-hour	122	81.6	11.9
PM _{2.5}	24-hour	8.7	25	3.9
	Annual	2	17	



Table 6: Calculation Methodology Associated with Measured Concentrations Provided in Table 5

Pollutant	Averaging Period	Methodology for Calculating the Measured Concentration
NO ₂	1-hour	98 th percentile of all valid hourly NO_x measurements collected from October 2015 through December 2017.
	Annual	Average of all valid hourly NO_x measurements collected from October 2015 through December 2017.
CO	1-hour	Maximum of all valid hourly measurements collected from October 2015 through December 2017.
	8-hour	Maximum of all 8-hour rolling averages calculated using all valid hourly measurements collected from October 2015 through December 2017.
SO ₂	1-hour	99 th percentile of all valid hourly measurements collected from October 2015 through December 2017.
	3-hour	Maximum of all 3-hour rolling averages calculated using all valid hourly measurements collected from October 2015 through December 2017.
	24-hour	Maximum of all 24-hour rolling averages calculated using all valid hourly measurements collected from October 2015 through December 2017.
	Annual	Average of all valid hourly measurements collected from October 2015 through December 2017.
PM ₁₀	24-hour	Maximum of all 24-hour rolling averages calculated using all valid hourly measurements collected from October 2015 through December 2017.
PM _{2.5}	24-hour	98 th percentile of all 24-hour rolling averages calculated using all valid hourly measurements collected from October 2015 through December 2017.
	Annual	Average of all valid hourly measurements collected from October 2015 through December 2017.



Table 7: CD5 Drill Site and Nuiqsut Station Comparison of Pollutant Measurements during Calendar Year 2022

Pollutant	Averaging Period	Measured Concentration (% of NAAQS/AAQS)	
		CD5	Nuiqsut
NO ₂	1-hour	26.4	25.6
	Annual	3.8	3.8
CO	1-hour	0	2.9
	8-hour	0	0
SO ₂	1-hour	2.5	3.3
	3-hour	0	0
	24-hour	0	0
	Annual	0	0
PM ₁₀	24-hour	26.7	40
PM _{2.5}	24-hour	20	20
	Annual	15.8	21.7

5.1.2.2 Volatile Organic Compounds and Hazardous Air Pollutants

Discrete VOC sampling at CD4/CD1 and Putu 2 along with continuous VOC monitoring at CD1, provides the most relevant data for characterizing ambient VOC (including HAPs) levels for the Project. These locations reflect activities like those anticipated at the Project.

Overall, measurements across these locations have consistently shown low concentrations of both total VOCs and individual VOC constituents, many of which are classified as HAPs. Since the program's inception in 2014, 796 VOC detections have been recorded from sampling at CD4 and CD1. Of these, only benzene and ethylbenzene (October 2022 at CD1), and 2-propanol (isopropyl alcohol) (April 2019 at CD1), exceeded applicable ADEC/USEPA health-based standards. 2-propanol was also detected above health-based standards in some samples at the CD4 and CD1 sampling locations and chloroform at the CD4 sampling location; however, these results are considered unreliable due to potential laboratory contamination or lack of confirmation in duplicate samples (CPAI 2025a). At the Putu 2 exploratory drill site, 19 VOC detections were recorded during the 2018 drilling campaign, none of which exceeded applicable USEPA/ADEC health-based standards detailed in the semi-annual monitoring report (CPAI 2025a).

Based on the measurements discussed, VOC and HAP concentrations at drill sites during development and routine operations have remained below health-based standards near the source. Given atmospheric dispersion characteristics, concentrations measured close to emission sources will represent the highest levels, with values at least two orders of magnitude lower at locations 4 km downwind. This conclusion is further supported by historical data from the Putu 2 exploratory program, which was situated at a comparable distance from Nuiqsut and did not result in concentrations exceeding applicable thresholds.



5.2 Cumulative Impacts

Cumulative air quality impacts arise when the project under review interacts with other past, present, or reasonably foreseeable actions. Typically, sources must be both substantial in scale and located close enough to the reviewed project for meaningful interaction to occur. These types of sources can be categorized as follows using USEPA approaches (40 CFR Part 51, Appendix W, USEPA 2017):

- **Nearby Sources:** All sources in the vicinity of the source under consideration that also cause a significant concentration gradient in the vicinity of the source under consideration, which are those not likely to be characterized adequately by background measurements due to the high degree of variability of the concentrations resulting from the source's emissions.
- **Other Sources:** That portion of the cumulative concentration attributable to all other sources (e.g., natural sources, minor and distant major sources) that are adequately characterized by ambient monitoring data.

A critical step in developing the cumulative analysis is determining which sources to include and how to categorize them. This distinction is particularly important because all NEPA modeling and permit modeling used to support this analysis, as presented in **Section 5.1.1**, incorporates ambient background concentrations. These background concentrations represent the combined pollutant concentrations attributable to existing Other Sources.

Determination of whether predicted pollutant concentrations from reasonably foreseeable projects should be included as Nearby Sources in the analysis presents a unique consideration. Two screening approaches are commonly used to make this determination:

1. The Federal Land Manager Guidance (FLM 2010) recommends evaluating the ratio of reasonably foreseeable project emissions (Q) to the distance (d) from the project.
2. The USEPA approach compares the predicted concentrations from reasonably foreseeable projects to Significant Impact Levels. If the reasonably foreseeable project does not produce concentrations above the Significant Impact Levels within the project study area, it is considered non-interactive. The distance at which a reasonably foreseeable project no longer produces concentrations above the Significant Impact Levels is referred to as the Radius of Influence (ROI).

Recently permitted sources that have not yet been constructed, as well as reasonably foreseeable projects, are summarized and classified in **Table 8** for consideration in the Project cumulative analysis. As shown in the table, these projects are not Nearby Sources, based on the Q/d screening test, the estimated ROI, or both, and are not expected to interact with the Project in any material way. Therefore, the predicted concentrations described in **Section 5.1.1** are sufficient to support public understanding, inform decision-making, and evaluate potential environmental consequences.

The cumulative dispersion modeling analyses conducted with AERMOD as part of the Willow MDP Final SEIS and the NPR-A IAP/EIS, respectively, support this conclusion. The cumulative pollutant concentrations of the Project, in combination with reasonably foreseeable projects, were previously included in dispersion modeling conducted in the Willow MDP Final SEIS. The cumulative modeling predicted cumulative concentrations of criteria air pollutants and the six selected HAPs within both the Willow MDP Project area and at the community of Nuiqsut (BLM 2023, Appendix E.3B.1, p. 3-19). The receptor at Nuiqsut is within the Project study area and useful for characterizing predicted cumulative pollutant concentrations for the Project. Results



indicate that all cumulative air quality concentrations would remain below applicable thresholds for all Willow MDP Final SEIS alternatives (BLM 2023, Appendix E.3B.1, p. 2-81).

This finding is particularly relevant to the CD8 cumulative air quality assessment because the predicted concentrations at Nuiqsut account for existing sources, reasonably foreseeable developments, and emissions from the CD8 drill site. Accordingly, the results are directly applicable to this assessment and indicate that cumulative concentrations are predicted to remain below health-based standards and screening thresholds at Nuiqsut and throughout the modeled domain.

The regional photochemical modeling analysis supporting the Willow MDP SEIS and the NPR-A IAP/EIS incorporated emissions estimates from a comprehensive set of sources, both anthropogenic and naturally occurring, and accounted for existing and a number of reasonably foreseeable projects.¹⁰ However, the regional analysis was conducted prior to the AERMOD-based dispersion modeling described above and did not account for smaller developments such as CD8, as these were not reasonably foreseeable at the time. Nevertheless, the analysis clearly demonstrates the limited spatial extent of predicted concentrations from both large-scale and smaller regional oil and gas developments. Cumulative predicted concentrations were evaluated for criteria air pollutants (excluding lead). The NPR-A IAP/EIS regional modeling domain encompassed the entire NPR-A, as well as portions of the Arctic National Wildlife Refuge, Gates of the Arctic National Park and Preserve, and Noatak National Preserve. Similarly, the Willow MDP Final SEIS regional modeling domain was extensive, covering approximately 300 km in the north–south direction and more than 300 km east–west. This area included parts of the Arctic National Wildlife Refuge, Gates of the Arctic National Park and Preserve, and Noatak National Preserve.

For the Willow MDP Final SEIS, the predicted air quality concentrations due to all cumulative sources on the project domain were below ambient air quality thresholds (BLM 2023, Appendix E.3B.1, Page 5-1). Similarly, the predicted air quality concentrations in the NPR-A IAP/EIS Alternative D high development scenario were lower than AAAQS/NAAQS everywhere in the modeling domain.

Although neither of these regional assessments included modeling the Project as a source explicitly, they incorporated substantial reasonably foreseeable development and, importantly, demonstrated that the ROI for a large development such as the Willow MDP does not extend beyond approximately 2 km (one grid cell from the source). This finding reinforces the conclusion that reasonably foreseeable projects are too distant to interact with the Project and would not alter the predicted pollutant concentrations described in **Section 6.1**.

¹⁰ A comprehensive list of existing sources and reasonably foreseeable projects for Willow MDP SEIS can be found in Table 2.2-2 of the SEIS and on page 2-83 of Appendix E.3B.1 (BLM 2023); and for NPR-A IAP/EIS can be found in Figure H-13, Page H-49 (BLM 2020).



Table 8: Recently Permitted and Reasonably Foreseeable North Slope Projects

Project and Location	d (km)	Q (tpy)	ROI	Classification
ConocoPhillips Alaska, Inc. - Willow Operations Center	40	310	< 5	Permitted; Under Construction
ConocoPhillips Alaska, Inc. - Willow Central Facility	40	458	< 5	Permitted; Under Construction
ConocoPhillips Alaska, Inc. - Willow BT1 Drill Site	41	90	< 5	Reasonably Foreseeable
ConocoPhillips Alaska, Inc. - Willow BT2 Drill Site	43	90	< 5	Reasonably Foreseeable
ConocoPhillips Alaska, Inc. - Willow BT3 Drill Site	45	90	< 5	Reasonably Foreseeable
ConocoPhillips Alaska, Inc. - Greater Willow Potential Drill Site #1	> 30	90	< 5	Reasonably Foreseeable
ConocoPhillips Alaska, Inc. - Greater Willow Potential Drill Site #2	> 30	90	< 5	Reasonably Foreseeable
Oil Search Alaska, LLC, a Sub of Santos Ltd. - Pikka Development Nanushuk Processing Facility	11	447	< 10	Permitted; Operational in 2026
Oil Search Alaska, LLC, a Sub of Santos Ltd. - Nanushuk Operations Pad	12	252	< 10	Permitted; Operational in 2026
Oil Search Alaska, LLC, a Sub of Santos Ltd. - Nanushuk Drill Site B (formerly called DS2 in EIS)	10	239	< 5 – 10	Permitted; Ongoing Developmental Drilling, Operational in 2026
Oil Search Alaska, LLC, a Sub of Santos Ltd. – “Southern” Drill Site (formerly called DS3 in EIS)	3.7	100 – 200+	< 5	Reasonably Foreseeable

Table Notes:

- d = distance from CD8 Study Area which is 5 km outward from CD8
- Q = (NO_x + SO₂ + PM), tons per year (tpy) [stationary source emissions only where NO_x = Oxides of Nitrogen]. For Oil Search Alaska, LLC, a Sub of Santos Ltd. – “Southern” Drill Site, a range is provided because of the difference between what is documented in the EIS and what has been permitted for Drill Site B.
- ROI = Radius of Influence



6.0 CD8 Air Quality Assessment Conclusion

This AQIA evaluates potential air quality pollutant concentrations associated with emissions from the proposed Project during drill site development, including detailed evaluations of construction, well drilling and completion activities, and routine operations using the existing modeling and ambient air monitoring data described in **Section 5.0**.

6.1 Criteria Air Pollutants

Based on the analysis of data presented in **Section 5.0**, direct and cumulative predicted concentrations during the entirety of the Project lifecycle will remain below health-based standards. Elevated concentrations that may occur during short-term, high-activity periods do not pose a risk of exceeding NAAQS/AAQs. **Table 9** is a summary of the maximum predicted concentrations in comparison to NAAQS/AAQs estimated based on a review of data findings from existing data sources presented in **Section 5.0**. Included in **Table 9** is information to enhance understanding of the background contribution to the cumulative prediction. In keeping with standard practice for projects which are located more than a kilometer from other sources, contributions from nearby sources are not often provided separately because the contributions from nearby sources are inconsequential relative to project predicted concentrations and the background concentrations as discussed in **Section 5.2**.

The estimated maximum concentrations from across the three activities presented in **Table 1**, **Table 2**, and **Table 3** are represented in **Table 9**. Differences in the intended use of the predicted concentrations result in some datasets being more representative to the objective of **Table 9** than others. When comparing concentrations predicted across the three activities, several observations are relevant:

- 1) Drill site construction generally results in the lowest predicted concentrations across all activities because the emissions are spread over a larger area. Therefore, since maximum predicted concentrations across all drill site development activities are disclosed in **Table 9**, concentrations predicted during drill site construction received the least consideration in developing **Table 9**. As such, predicted concentrations for well drilling and completions (**Table 2**) and routine operations (**Table 3**) form the basis for the estimated maximum concentrations summarized in **Table 9**.
- 2) NEPA modeling and permit modeling and how they should be interpreted differently is distinguished in **Section 3.2**. Accordingly, when concentrations were evaluated for a project in the database with both NEPA modeling and permit modeling, the results of the NEPA modeling were given the most consideration. For example, the predicted results from the GMT1 and GMT2 SEIS modeling were considered more representative than those predicted for permit modeling.
- 3) Building on the prior consideration, as further described in Section 5.1.1.1, the “...*bias [associated with permit modeling] is particularly pronounced for predictions documented for the MG2 permit and the Doyon 26 Drill Rig POGO permit. Both are based on modeling operating limits specifically set to achieve but not exceed the NAAQS/AAQs. Therefore, these results should not be considered typical, but an extreme upper limit.*” Therefore, these results were considered less representative of the CD8 Project than those predicted for NEPA modeling.

These observations combined with the values presented in **Table 1**, **Table 2**, and **Table 3** lead to the values provided in **Table 9**. In general, for each pollutant, representative projects were identified and the maximum predicted concentrations for those representative projects from



Table 2, and **Table 3** were selected to represent the maximum estimate for the CD8 Project. Additional details for each pollutant and exceptions to this general methodology are discussed further below.

6.1.1 NO₂

Cumulative NO₂ predictions for the 1-hour averaging period in NEPA-based modeling varied from 73 to 91%, 138 to 170.2 µg/m³ respectively. In this case, Given the lack of distinctions among the contributing projects, the concentration of 170.2 µg/m³ reported in the 2020 NPR-A IAP and Final EIS was selected as the representative maximum estimate for the CD8 Project.

The magnitude of predicted annual NO₂ concentrations in NEPA-based modeling ranged from 27 to 42%, 27.3 to 42.2 µg/m³ respectively. Absent clear differentiators between representative projects, the concentration of 42.2 µg/m³ predicted for the GMT1 Final SEIS was considered conservatively representative of the CD8 project. In this case a safety margin of 17 µg/m³ (40% of the GMT1-derived maximum estimate) was applied resulting in estimated CD8 Project concentration of 60 µg/m³ when rounded to two significant digits.

6.1.2 CO

Estimating predicted CO concentrations for both the 1-hour and 8-hour averaging periods was focused on NEPA-based modeling largely because drill site CO emissions are rarely large enough to require permit modeling.

Predicted cumulative concentrations in NEPA-based modeling ranged from 4 to 29%, 1,600 to 11,736 µg/m³, respectively for the 1-hour averaging period and from 14 to 46%, 1,400 to 4,557 µg/m³, respectively for the 8-hour averaging period. Given the lack of distinctions among representative projects, the concentrations reported in the Willow Final SEIS—rounded appropriately—were selected as the representative estimate for the CD8 Project resulting in 12,000 and 5,000 µg/m³ for the 1-hour and 8-hour averaging periods, respectively.

6.1.3 SO₂

Predicted cumulative SO₂ concentrations show variability across projects resulting from differences between permit and NEPA-based modeling, the sulfur content of diesel used (i.e. Ultra-Low Sulfur Diesel versus Low End Point Diesel), and the amount of fuel combusted by stationary engines other than those on the drill rig. Generally, NEPA-based modeling was regarded as more representative of project predicted concentrations than permit based modeling for the reasons described above.

The Nanushuk Final EIS was not considered a representative project despite being NEPA-based modeling. The cumulative concentrations presented for the Nanushuk Final EIS were predicted from a scenario (Drilling and Operations – West Drill Rig) that included an unrepresentative inventory of stationary engines powering the pad and construction camps.

Predicted cumulative SO₂ concentrations for representative projects for the 3-hour, 24-hour, and annual averaging periods are minimal, ranging from 1 to 6% of the NAAQS/AAQs. For all averaging periods, concentrations reported in the Willow Final EIS were used as the conservatively representative estimates for the CD8 Project. Note that for annual SO₂, the Willow Final SEIS value of 3.4%, or 2.7 µg/m³ was used over the higher 2020 NPR-A IAP and Final EIS value of 4.8%, or 3.8 µg/m³. This is because the 2020 NPR-A IAP and Final EIS relied on earlier Willow modeling and was not considered in place of the Willow Final SEIS values.



- 1-hour = 40 $\mu\text{g}/\text{m}^3$ (Willow Final SEIS – rounded to 1 significant digit to add conservatism)
- 3-hour = 65 $\mu\text{g}/\text{m}^3$ (5% of the ambient standard)
- 24-hour = 22.3 $\mu\text{g}/\text{m}^3$ (Willow Final SEIS)
- Annual = 2.7 $\mu\text{g}/\text{m}^3$ (Willow Final SEIS)

6.1.4 PM_{10}

Assessing cumulative 24-hour PM_{10} predicted concentrations results in additional considerations due to the broad range of predicted project contributions and background concentrations across representative projects. In one instance, the dispersion model temporally paired background and project concentrations, preventing the two from being evaluated independently. Focusing again on NEPA modeling, cumulative predicted impacts ranged from 56 to 89%, 84.2 to 133.2 $\mu\text{g}/\text{m}^3$, respectively with background levels spanning 20 to 50 $\mu\text{g}/\text{m}^3$. To address this variability, the highest predicted concentration—66.4 $\mu\text{g}/\text{m}^3$ from the GMT1 Final SEIS—was combined with the highest background concentration across both NEPA and Permit modeling of 67.9 $\mu\text{g}/\text{m}^3$ (GMT1/MT6 Drill Site Permit No. AQ1484MSS01), yielding a total of 134 $\mu\text{g}/\text{m}^3$. This value was rounded up to two significant digits (140 $\mu\text{g}/\text{m}^3$) to incorporate a margin of safety. Such conservatism was implemented considering the CD8 Project's location near large sources of naturally occurring wind-blown fugitive dust.

6.1.5 $\text{PM}_{2.5}$

Estimating 24-hour $\text{PM}_{2.5}$ concentrations uses the same methodology applied for CO, which is using NEPA-based modeling as representative projects, since $\text{PM}_{2.5}$ emissions from drill sites are generally too small to necessitate permit modeling. The predicted 24-hour $\text{PM}_{2.5}$ concentrations showed minimal variation, ranging from 81 to 84%, 28.4 to 29.3 $\mu\text{g}/\text{m}^3$, respectively. To maintain a conservative approach for the CD8 Project, the 29.3 $\mu\text{g}/\text{m}^3$ predicted concentration from the Willow Final SEIS rounded up to the nearest whole number (30 $\mu\text{g}/\text{m}^3$) was selected as the representative estimate for the CD8 Project.

Evaluating annual $\text{PM}_{2.5}$ concentrations using the percent-of-standard values in **Table 2** and **Table 3** is challenging because the $\text{PM}_{2.5}$ NAAQS/AAQS decreased from 15 to 9 $\mu\text{g}/\text{m}^3$ over the 10-year period encompassing the reviewed projects. When the percentages are converted to concentrations using the standards in effect at the time, cumulative annual $\text{PM}_{2.5}$ levels ranged from 3.9 to 8.0 $\mu\text{g}/\text{m}^3$. Although Table 8 of revision 1 of the AQIA reported a maximum predicted concentration of 7.2 $\mu\text{g}/\text{m}^3$ for the CD8 Project, a re-evaluation indicates that a value of 8.0 $\mu\text{g}/\text{m}^3$, which is consistent with the concentration reported in the GMT1 Final SEIS, would be more appropriate as a representative estimate for the CD8 Project.

6.1.6 Further Discussion of Cumulative Criteria Pollutant Impacts

Pollutant concentrations resulting from Project emissions are predicted to reach a maximum within 100 meters of activities and decrease exponentially from that point outward. By approximately 5 kilometers from the source, Project impacts should be indistinguishable from background levels.

Modeling analysis for analogous drill sites indicates that air quality pollutant concentrations during the lifecycle of the Project are expected to be below the standards, even during well drilling and completion activities, with some probability that short-term pollutant concentrations could periodically approach the standard. Unlike short-term predictions, long-term



concentrations from drill site construction are predicted to remain well below applicable standards because higher-emitting activities are too brief to significantly influence long-term averages.

As discussed, expected SO₂ concentrations are influenced by the sulfur content of the fuel combusted. Analysis of the reviewed studies shows that combusting fuel from a North Slope topping plant in Project heaters and boilers could increase SO₂ concentrations attributable to the Project by up to a factor of five relative to analyses completed for Willow, GMT1, and GMT2 which relied exclusively on combusting Ultra-Low Sulfur Diesel. For the Project, it is anticipated that low-sulfur fuel will be the primary source, resulting in the concentrations presented in **Table 9**. However, if some fuel from a North Slope topping plant were combusted in heaters and boilers, SO₂ concentrations would still be in compliance with NAAQS/AAAQS.

Ambient air monitoring data generally corroborates modeled predictions, and it offers additional insight into real-world variability by demonstrating that although concentrations at specific locations may be temporarily elevated at locations on the drill site pad, such occurrences are brief and limited in duration. Based on a review of ambient air quality measurements collected at comparable drill sites, pollutant concentrations from the Project emissions will be indistinguishable from background levels during the majority of the Project lifecycle because large emitting activities will not be occurring.



Table 9: Estimated Maximum CD8 Project Pollutant Concentrations

Pollutant	Averaging Period	Estimated Project Concentration Including Nearby Sources ($\mu\text{g}/\text{m}^3$)	Ambient Background ($\mu\text{g}/\text{m}^3$)	Total ($\mu\text{g}/\text{m}^3$)	Total Rounded ($\mu\text{g}/\text{m}^3$)	% of NAAQS/AAQS	NAAQS/AAQS ($\mu\text{g}/\text{m}^3$)
NO ₂	1-hour	166.2 ¹		166.2	170	91%	188
	Annual	55	2.9	58	60	60%	100
CO	1-hour	1,435	10,301	11,736	12,000	30%	40,000
	8-hour	1,124	3,434	4,557	5,000	50%	10,000
SO ₂	1-hour	25.5	9	34.5	40	20%	196
	3-hour	55	10	65	65	5.0%	1,300
	24-hour	13	9.3	22.3	22.3	6.1%	365
	Annual	0.90	1.8	2.7	2.7	3.4%	80
PM ₁₀	24-hour	66.4	67.9	134	140	93%	150
PM _{2.5}	24-hour	22.30	7.0	29	30	86%	35
	Annual	5.83	2.2	8.0	8.0	89%	9

¹ Background values for NO₂ were included in the AERMOD modeling on an hourly basis and cannot be broken out separately from the project impact.



6.2 Volatile Organic Compounds and Hazardous Air Pollutants

Based on the analysis of data presented in **Section 5.0**, ambient pollutant concentrations resulting from direct and cumulative HAPs emissions during the entirety of the Project lifecycle will remain below health-based standards. **Table 10** summarizes the maximum predicted HAPs concentrations in comparison to the applicable RELs/AEGLs/RfCs. HAP concentrations resulting from Project emissions are predicted to reach a maximum within 100 meters of activities and decrease exponentially from that point outward. By the time pollutants are transported to Nuiqsut (i.e., 3.4 kilometers from the Project), concentrations will be more than two orders of magnitude lower due to dispersion and negligible compared to the level of health-based standards. By approximately 5 kilometers from the source, Project impacts should be indistinguishable from background levels.

Predicted HAP concentrations summarized in **Table 10** can be scaled to develop a CD8 Project-specific assessment at any sensitive receptor location. **Table 11** presents the results of an analysis of emissions from the Project conducted at Nuiqsut and shows the effects of predicted HAP concentrations at Nuiqsut will be orders of magnitude below the one-in-one-million cancer risk screening threshold.

Modeling analysis for analogous drill sites indicates that short- and long-term air quality concentrations attributable to the Project during the lifecycle of the Project are expected to be below the standards. Predicted concentrations are expected to remain below applicable standards at the source, which is not a location frequented by the public. More importantly, at locations commonly accessed by the public, concentrations are anticipated to be negligible – below detection limits – due to relatively low emission rates, substantial distance from the source, and short pollutant lifetimes. Consistent with this, a project-specific cancer risk analysis at Nuiqsut indicates that the risk from carcinogenic pollutants potentially emitted by the Project is approximately two orders of magnitude lower than the threshold that would trigger a more detailed review (i.e., less than 1 in 100 million).

Discrete VOC sampling corroborates modeled predictions and supports the conclusion that VOC and HAP concentrations are anticipated to remain health below health standards and screening levels at all locations within the study area.



Table 10: Estimated Project Air Toxics Pollutant Concentrations

Pollutant	Averaging Period	Estimated Maximum Project Concentration (µg/m³)	% of Standard	Standard (µg/m³)
Benzene	1-hour	64	5%	1,300 (Acute REL)
	8-hour	9.0	<1%	29,000 (8-hour AEGL)
	Annual	1.3	5%	30 (Non-Cancer Chronic RfC)
Ethylbenzene	1-hour	340	<1%	140,000 (Acute REL)
	8-hour	220	<1%	140,000 (8-hour AEGL)
	Annual	7.7	<1%	1,000 (RfC)
Formaldehyde	1-hour	10	20%	55 (Acute REL)
	8-hour	4.2	<1%	1,100 (AEGL)
	Annual	0.30	3%	9.8 (Non-Cancer Chronic RfC)
n-hexane	1-hour	1,300	<1%	390,000 (Acute REL)
	8-hour	550	<<1%	10,000,000 (8-hour AEGL)
	Annual	20	3%	700 (RfC)
Toluene	1-hour	62	<1%	37,000 (Acute REL)
	8-hour	26	<<1%	250,000 (8-hour AEGL)
	Annual	1.0	<<1%	5,000 (Non-Cancer Chronic RfC)
Xylene	1-hour	660	<1%	22,000 (Acute REL)
	8-hour	440	<1%	560,000 (8-hour AEGL)
	Annual	15	2%	100 (RfC)
Acetaldehyde	1-hour	3.2	<<1%	81,000 (8-hour AEGL)
	8-hour	1.3	<<1%	81,000 (8-hour AEGL)
	Annual	0.1	1%	9.00 (RfC)
Ethylene Glycol	1-hour	0	0%	NA
	8-hour	0	0%	NA
	Annual	0	0%	400 (RfC)
Methanol	1-hour	2,400	<1%	690,000 (1-hour AEGL)
	8-hour	1,500	<1%	350,000 (8-hour AEGL)
	Annual	56	<1%	20,000 (RfC)

Table Notes:

- Project concentration is estimated to 2 significant digits; includes the contribution from nearby sources and a background concentration. Values presented in this table are from projects most representative of the Project.
- For standards, refer to USEPA (2025a) and USEPA (2021):
 - REL: Reference Exposure Level (USEPA and the National Institute for Occupational Safety and Health)
 - AEGL: Acute Exposure Guideline Levels for Airborne Chemicals (USEPA)
 - RfC: Reference Concentration (USEPA)
- Acetaldehyde: Predicted concentrations are derived from formaldehyde predictions using a ratio of the emission factors documented by USEPA diesel fuel combustion (Table 3.4-3 in USEPA 2025c) for (2.52x10⁻⁵ compared to 7.89x10⁻⁵).
- Ethylene Glycol: The Project is not a source of Ethylene Glycol emissions.
- Methanol: Predicted concentrations are derived from Ethylbenzene predictions using a factor of 7, which is the ratio of Project Methanol emissions to Ethylbenzene emissions.



Table 11: Estimated Carcinogenic HAP Cancer Risk Near Nuiqsut

HAP	NEPA Analysis Resulting in the Maximum-Predicted HAP Concentration	Predicted Concentration Near the Project (µg/m³)	Diffusion estimate ratio at 4 km ¹	Estimated HAP Concentration Near Nuiqsut (µg/m³)	Cancer Unit Risk Factors (1/(µg/m³)) ²	Exposure Adjustment Factor ³	Estimated Cancer Risks Near Nuiqsut
Benzene	Final GMT2 SEIS	1.29	0.0067	0.0086	7.80E-06	0.43	2.88E-08
Ethylbenzene	Final Willow SEIS	7.7		0.051	8.28E-06		5.52E-08
Formaldehyde	Final GMT2 SEIS	0.3		0.0020	1.30E-05		1.12E-08
Total							9.52E-08
Table Notes:							
1. Based on a slightly unstable atmosphere typical of the North Slope maximum predicted HAP concentrations predicted for representative projects have been adjusted using diffusion estimates from Turner 1970 to estimate concentrations near the community of Nuiqsut, where at 4 km (approximate distance from CD8), concentrations are scaled by a ratio of 0.00001/0.0015 to estimate the predicted concentration at that distance.							
2. Values referenced from USEPA 2021.							
3. The exposure adjustment factor is the same as used in the Final Willow SEIS, which is based on a ratio of the projected exposure time (life of the project as 30 years) divided by 70 years.							



7.0 References

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**Appendix A:
Survey of Existing Air Quality Analyses
for Alaska North Slope Drill Sites**

Table A-1: Survey of Recent NEPA Analyses for Alaska North Slope Drill Sites

Project	Agency	Time Period	Activities Included in the Analysis					Discussion of Analysis	Location of Relevant Information in Analyses
			Drill Site Construction	Well Drilling	Well Completion	Routine Operations	Other		
GMT1 Final SEIS	BLM	2014	✓ (modeled)	✓ (modeled)	⊗ (not modeled)	✓ (modeled)	Access road construction; Gravel Mining; Operation of Nuiqsut Camps; Well Intervention	Predicted concentrations from drill site construction, well drilling and routine operations were estimated quantitatively using dispersion modeling to demonstrate compliance with air quality standards. Routine operations were represented in “infill drilling” and “well intervention” modeling scenarios. “Well intervention” activities were simulated using a coil tubing unit. Well completion were not explicitly modeled. Other activities were represented as non-modeled sources using ambient monitoring background data from CCP, Pad A, Endicott SDI, and Nuiqsut.	GMT1 Final SEIS, Section 4.2.3.2 Air Quality, Page 262 (BLM 2014); CPAI GMT1 Project Final Ambient Air Quality Impact Analysis, Section 2.2 (CPAI 2013)
GMT2 Final SEIS	BLM	2018	✓ (modeled)	✓ (modeled)	⊗ (not modeled)	✓ (modeled)	None	Predicted concentrations from drill site construction, well drilling and routine operations were estimated quantitatively using dispersion modeling to demonstrate compliance with air quality standards. Well drilling was represented in both “developmental” and “infill drilling” scenarios. Routine operations were represented in an “infill drilling” modeling scenario. Well completion were not explicitly modeled, but well “intervention activities” were included in both scenarios. Other activities were represented as non-modeled sources using ambient monitoring background data from Nuiqsut.	GMT2 Final SEIS, Section 4.2.3.2 Air Quality, Page 267; Near Field Air Quality Impacts Analysis for GMT2, Section 3 Emission Sources Modeled (Kleinfelder and Ramboll Environ. 2017)
Nanushuk Final EIS	USACE	2018	✓ (modeled)	✓ (modeled)	✓ (modeled)	✓ (modeled)	None	Predicted concentrations from drill site construction, well drilling, well completion and routine operations were estimated quantitatively using dispersion modeling to demonstrate compliance with air quality standards. Two scenarios were modeled: 1) drill site infrastructure construction and	Nanushuk Project FEIS Appendix V Alternative 2 AQIA (USACE 2018)



Table A-1: Survey of Recent NEPA Analyses for Alaska North Slope Drill Sites (Continued)

Project	Agency	Time Period	Activities Included in the Analysis					Discussion of Analysis	Location of Relevant Information in Analyses
			Drill Site Construction	Well Drilling	Well Completion	Routine Operations	Other		
								well drilling, and 2) well drilling and routine operations. Hydraulic fracturing equipment was included in both scenarios.	
2020 NPR-A IAP Final EIS	BLM	2020	✓ (modeled)	✓ (modeled)	✓ (modeled)	✓ (modeled)	Pre-Drilling Activities	Predicted concentrations from drill site construction, well drilling, well completion, and routine operations were estimated qualitatively to demonstrate compliance with air quality standards [analysis referenced 2019 Willow MDP Draft EIS modeling impacts as a surrogate for near-field analysis]. Well drilling activities were represented through both pre-drilling and developmental drilling modeling scenarios. Well completions were represented in a pre-drilling scenario.	Final 2020 NPR-A IAP and EIS, Section 3.2.2 Air Quality, Page 3-12 and Appendix H, Page H-37 (BLM 2020); Willow MDP Draft EIS, Appendix E.3, Air Quality Technical Support Document (BLM 2019)
Willow Final EIS and SEIS	BLM	2020 EIS; 2023 SEIS	✓ (modeled)	✓ (modeled)	✓ (modeled)	✓ (modeled)	Gravel Mining; Pre-Drilling Activities	Predicted concentrations from drill site construction, well drilling, well completion, and routine operations were estimated quantitatively using dispersion modeling to demonstrate compliance with air quality standards. Well drilling activities were represented through both pre-drilling and developmental drilling modeling scenarios; Well completions were represented in a pre-drilling scenario. Gravel mining was included in the construction scenario.	Willow MDP Final SEIS: Table 3.3.8. Summary of Near-Field Air Quality Impacts for Action Alternatives and Module Delivery Options and Appendix E.3B.1, Section 3.0 Nearfield Modeling Analyses (BLM 2023)

Table Notes:

1. Developmental drilling is typically referred to as the drilling phase that occurs during the initial drill site development.
2. Infill drilling is typically referred to as the drilling phase that occurs during routine operations; however, impacts to ambient air quality are not materially different.
3. Well intervention activities refer to activities typically considered well maintenance and well servicing and are not necessarily comparable to well completion activities that would occur during the development drilling phase.



Table A-2: Survey of Recent State Permit Analyses for Alaska North Slope Drill Sites

Project	Agency	Time Period	Activities Included in the Analysis					Discussion of Analysis	Location of Relevant Information in Analyses
			Drill Site Construction	Well Drilling	Well Completion	Routine Operations	Other		
CD5 Drill Site Permit No. AQ0945MSS01	ADEC	2006 (Original permit)	⊗ (not modeled)	✓ (modeled)	✓ (modeled)	✓ (modeled)	Well Servicing; Drill Rig/ Rig Camp	Predicted concentrations from well drilling, well completion, and routine operations activities were estimated quantitatively using dispersion modeling to demonstrate compliance with applicable air quality standards. Three scenarios were modeled, each using a different drill rig. Other activities/regional impacts were represented as non-modeled sources using ambient monitoring background data from Nuiqsut.	CD5 Permit No. AQ0945MSS01, Exhibit B (ADEC 2006); Final CD5 Minor Permit Application for CPAI (CPAI 2005b); Addendum I to the CD5 Minor Permit Application – Alternate Drill Rigs for CPAI (CPAI 2005a)
Doyon 26 Drill Rig POGO Permit No. AQ1552MSS02	ADEC	2021 (Current permit)	⊗ (not modeled)	✓ (modeled)	✓ (ambient background)	✓ (modeled)	None	Predicted concentrations from well drilling and routine operations activities were estimated quantitatively using dispersion modeling to demonstrate compliance with applicable air quality standards. Well completion impacts were represented as non-modeled sources using ambient monitoring background data from CD1.	Doyon 26 Drill Rig POGO Permit No. AQ1552MSS02, Appendix B (ADEC 2021a); Request for Revisions to AQC Minor Permit AQ1552MSS01, Rev. 1, Attachment E, AQIA (CPAI 2020a)
DS-2S Drill Site Permit No. AQ1429MSS01	ADEC	2015 (Original permit)	⊗ (not modeled)	✓ (modeled)	⊗ (not modeled)	✓ (modeled)	Drill Rig/ Rig Camp	Predicted concentrations from well drilling and routine operations activities were estimated quantitatively using dispersion modeling to demonstrate compliance with applicable air quality standards. Other activities were represented as non-modeled sources using ambient monitoring background data from DS-1F.	DS-2S Permit No. AQ1429MSS01, Appendix B (ADEC 2015); Minor Permit Application for KRU Drill Site 2S POGO, Attachment G AQIA (CPAI 2015)



Table A-2: Survey of Recent State Permit Analyses for Alaska North Slope Drill Sites (Continued)

Project	Agency	Time Period	Activities Included in the Analysis					Discussion of Analysis	Location of Relevant Information in Analyses
			Drill Site Construction	Well Drilling	Well Completion	Routine Operations	Other		
GMT1 / MT6 Drill Site Permit No. AQ1484MSS01	ADEC	2018 (Original permit)	⊗ (not modeled)	✓ (modeled)	✓ (ambient background)	✓ (modeled)	None	Predicted concentrations from well drilling and routine operations were estimated quantitatively using dispersion modeling to demonstrate compliance with air quality standards. Well completion were represented as non-modeled sources using ambient monitoring background data from CD1 and DS-1F.	GMT1/MT6 Permit No. AQ1484MSS01, TAR, Appendix B (ADEC 2018b); CPAI's application for GMT1/MT6, Attachment G AQIA (CPAI 2017); CD5 Permit No. AQ0945MSS07, TAR, Appendix B (ADEC 2020)
GMT2 / MT7 Drill Site Permit No. AQ1503MSS01	ADEC	2021 (Original and current permit)	⊗ (not modeled)	✓ (ambient background)	✓ (ambient background)	✓ (modeled)	None	Predicted concentrations from routine operations were estimated quantitatively using dispersion modeling to demonstrate compliance with air quality standards. Well drilling, and well completion were represented as non-modeled sources using ambient monitoring background data from CD1.	GMT2/MT7 Permit No. AQ1503MSS01, TAR, Appendix B (ADEC 2021b); CPAI's application for GMT2/MT7, Attachment F AQIA (CPAI 2020b)
Minor General 2 (MG2) Permit	ADEC	2018 (Original permit)	⊗ (not modeled)	✓ (modeled)	✓ (ambient background)	✓ (ambient background)	None	Predicted concentrations from well drilling were estimated quantitatively using dispersion modeling to demonstrate compliance with air quality standards. Well completion and routine operations were represented as non-modeled sources using ambient monitoring background data from CD1 and Pad A.	ADEC Minor General Permit 2 for POGOs (ADEC 2018a); North Slope POGO Simulation Final Modeling Report [for the MG2] (ADEC 2017b)

Table Notes:

1. Developmental drilling is typically referred to as the drilling phase that occurs during the initial drill site development.
2. Infill drilling is typically referred to as the drilling phase that occurs during routine operations; however, impacts to ambient air quality are not materially different. Well intervention activities refer to activities typically considered well maintenance and well servicing and are not necessarily comparable to well completion activities that would occur during the development drilling phase.



Table A-3: Summary and Scope of Alaska North Slope Ambient Air Quality Monitoring Programs

Program Name	Date	Contributing Sources	Relevance to CD8
Shell Badami	2009-2010	Regional	Minimally Relevant: Monitoring conducted some distance from a combined drill site and production and operations center well away from other development.
Wainwright	2009-2013	Regional	Minimally Relevant: No oil and gas activity.
Nuiqsut	1999-present	Regional	Relevant: Excellent source of regional background.
DS-1F	1990-1992 2000-2002 2012-2013	- WD - RO - Regional	Very Relevant: Monitoring at an active drill site with data used to describe impacts from a drill site.
CD1	2012-2014	- WD - WC - RO - Regional	Very Relevant: Monitoring at an active drill site with data used to describe impacts from a combined drill site and production and operations center.
Endicott Satellite Drilling Island (SDI) and Main Production Island (MPI)	2007-2009	- WD - RO - Regional	Relevant: Monitoring conducted in the nearfield of a combined drill site and production and operations center.
A Pad	1988-present	- WD - RO - Regional	Very Relevant: Monitoring at an active drill site with data used to describe impacts from a drill site.
CCP	1988-present	Regional	Minimally Relevant: Monitoring in the near-field of a large stationary source with little near-field drill site activity.
Pt. Thomson	2009-2017	- WD - RO - Regional	Relevant: Monitoring conducted in the nearfield of a combined drill site and production and operations center.
Umiat	2013-2014	Regional	Minimally Relevant: No oil and gas activity.
CPF1	1990-1992 2022-2023	Regional	Minimally Relevant: Monitoring in the near-field of a large stationary source with little near-field drill site activity.
CD3	2011	- WD - WC	Very Relevant: Monitoring at an active drill site with data used to describe impacts from a drill site.
CD5	2015-present	- DSC - WD - WC - RO - Regional	Very Relevant: Monitoring at an active drill site with data used to describe impacts from a drill site.
DS-2N	2014	WD	Relevant: Monitoring at an active drill site conducted over a short period of time and collected with the objective of correlating measurements and model-predicted impacts from well drilling.



Table A-3: Summary and Scope of Alaska North Slope Ambient Air Quality Monitoring Programs (Continued)

Program Name	Date	Contributing Sources	Relevance to CD8
CD4/CD1 and Putu 2	2014-present	• DSC • WD • WC • RO • Regional	Very Relevant: VOC and HAP monitoring at active drill sites, and in the community of Nuiqsut.
<u>Contributing sources are defined as follows:</u>			
DSC Drill Site Construction WD Well Drilling WC Well Completion RO Routine Operations Regional Regional Sources			



Table A-4: Overview of Relevant North Slope Monitoring Programs

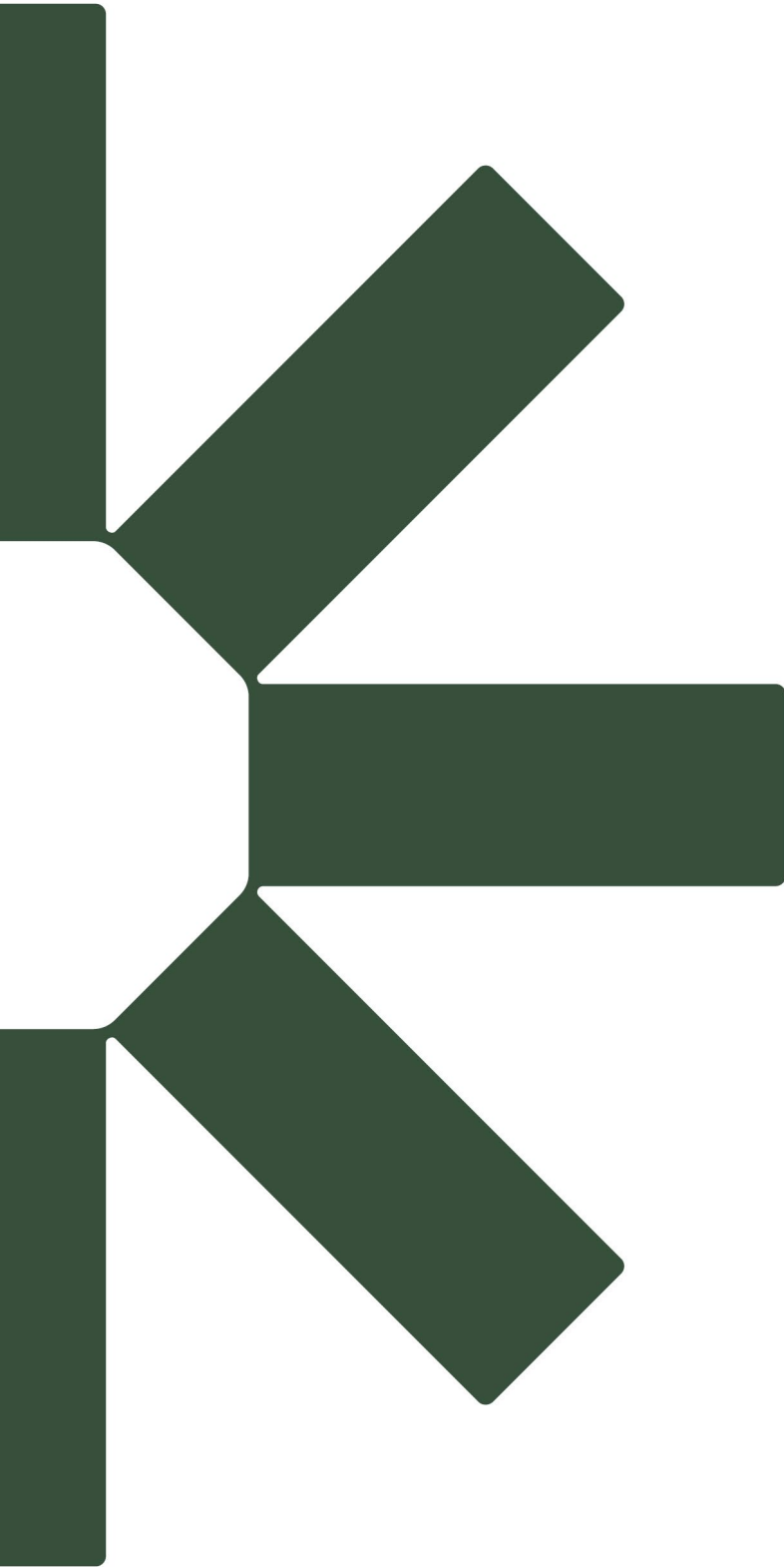
Monitoring Site and Location	Monitoring Period	Purpose	Location from Major Drill Site Activities	Pollutants Measured	Additional Notes
CD1 (Alpine field / Colville River Unit)	13 years and ongoing (October 2012 – current) [2 years of monitoring program are relevant to active drill site activities]	Pollutant concentrations measured during a 2-year period of monitoring program during active drill site activities were used to represent the impacts from hydraulic fracturing in the AQIA supporting ADEC's MG2 permit for POGO on the North Slope.	30 m from wellheads ¹	CO, NO ₂ , SO ₂ , PM _{2.5} , and PM ₁₀	Measured pollutant concentrations from 2-year period of monitoring program during active drill site activities are described in Section 3.13 in ADEC (2017b). Additional relevant station information and measured concentrations and analysis of measured pollutants included in AOGTS (2014a and 2014b).
Pad A (Prudhoe Bay Unit)	Active for over 30 years	Long-term dataset as a valuable source for characterizing air quality impacts from typical drill site activities - program including documentation of pollutant concentrations from well drilling, well completion, and routine operations.	Approximately 100 m of wellheads ¹ near the center of the A Pad drill site	NO ₂ and SO ₂	Pad A is also known as A Pad; Measurements from this location has been relied on to characterize pollutant concentrations resulting from activities at a typical drill site. Measurements are described in Section 3.13 in ADEC (2017b). Additional relevant station information and measured concentrations and analysis of these measured bellwether pollutants are included in AOGTS (2014a and 2014b).
DS-1F (Kuparuk River Unit)	Three separate one-year periods (1991-1992, 2001-2002, and 2012-2013)	The station was intentionally placed to minimize direct exposure to emissions from drill site activities. However, during the 2000-2002 monitoring period, several episodes were documented where emissions from well drilling activities impacted the measurements.	Approximately 70 m from the nearest wellhead ¹	NO ₂ and PM _{2.5}	Relevant station information, measured concentrations, and an analysis of these measured bellwether pollutants are included in AOGTS (2014a and 2014b).
CD3 (Alpine field / Colville River Unit)	Three-month winter period (February. – April 2011)	This monitoring effort was part of a targeted study designed to evaluate air quality impacts associated with an intensive, short-term well drilling and completion program. During this period, three wells were drilled by two rigs, and all were completed using hydraulic fracturing.	Approximately 90 m from the nearest wellhead ¹ and 70 m from the site's production heater	CO, NO ₂ , SO ₂ , PM _{2.5} , and PM ₁₀	Detailed station information, measured concentrations, and analyses of measured pollutants are documented in AOGTS (2014a and 2014b) and in the final monitoring program report prepared for the State of Alaska by an independent reviewer (ADEC 2012).



Table A-4: Overview of Relevant North Slope Monitoring Programs (Continued)

Monitoring Site and Location	Monitoring Period	Purpose	Location from Major Drill Site Activities	Pollutants Measured	Additional Notes
CD5 (Alpine field / Colville River Unit)	10 years and ongoing (October 2015 – current)	Monitoring station began collecting data shortly after the initiation of drill site construction and well drilling. Data from it has been used to record impacts from all phases of drill site development, as well as routine operational activities. The station provides a robust long-term dataset that characterizes air quality impacts associated with oil and gas development and operations west of the Colville River.	Approximately 70 m northeast of the nearest wellhead ¹ , downwind of these activities during southerly to westerly wind conditions	CO, NO ₂ , SO ₂ , PM _{2.5} , and PM ₁₀	None
CD4/CD1 and Putu 2 (Alpine field / Colville River Unit)	11 years and ongoing (2014 – current)	Collection of episodic VOC samples initiated to evaluate ambient concentrations of VOCs, including specific HAPs in the community of Nuiqsut. To assess potential impacts near active oil and gas operations, sampling was conducted at the CD4 drill site from 2014 through 2017 and subsequently shifted to Alpine CD1. During the 2018 exploration drilling campaign, sampling frequency increased near the Putu 2 drill site and within Nuiqsut from February through April 2018, coinciding with drilling activities (CPAI 2025a).	CD4/CD1 and Putu 2 sampling locations in proximity to drill site activities (conducted on drill site pad)	VOC and individual HAPs	In March 2022, continuous VOC monitoring was implemented at Nuiqsut and Alpine CD1 to provide real-time data that supplements the existing episodic sampling program (CPAI 2025a). While continuous monitoring does not measure individual HAPs – it offers valuable information between discrete sampling events. To date, continuous measurements have not revealed any findings beyond those identified through episodic sampling. Therefore, the analysis presented in the document focuses on the results from discrete VOC sampling.
Table Notes: 1. Wellheads are where drill site well drilling and completion activities occur.					





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