Alaska LNG Liquefaction Plant Construction Permit Application

Project Information Form Attachment 10:

Liquefaction Plant Additional Impacts Analysis

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As part of Prevention of Significant Deterioration (PSD) rules promulgated under 40 Code of Federal Regulations (CFR) 52.21 and adopted by reference in 18 Alaska Administrative Code (AAC) 50.040 with the changes indicated in 18 AAC 50.306, additional impacts analyses must be submitted to reviewing authorities as part of a PSD permit application. The Alaska Gasline Development Corporation (AGDC) provided the Alaska Department of Environmental Conservation (ADEC) with a protocol for the air quality and additional impact analyses required for the Alaska LNG Liquefaction Plant PSD permit application in *Liquefaction Facility Air Quality Modeling Report Supporting Resource Report No. 9* (Resource Report No. 9 Appendix D), dated October 11, 2016. The information in this document is being provided to supplement the information in Resource Report No. 9 Appendix D (Alaska LNG 2016) and to satisfy the requirements in 40 CFR 52.21(o). The following sections outline the results of the required analyses.

1. ADDITIONAL IMPACT ANALYSIS

This document describes the PSD analyses that assess potential impacts on soils, vegetation, and visibility in the project area caused by Liquefaction Plant emissions in combination with emissions from growth in the area due to the project. The additional impact analysis required in 40 CFR 52.21(o) consists of the following components:

- Growth Analysis: an analysis of the air quality impact predicted for the area as a result of general commercial, residential, industrial and other growth associated with the source or modification (40 CFR 52.21(o)(2));
- Soil and Vegetation Impact Analysis: a discussion of predicted ambient air quality impacts relative to soils and vegetation in the project impact area having significant commercial or recreational value (40 CFR 52.21(o)(1));
- Visibility Impairment Analysis: an estimate of the impacts due to source emissions on the visual quality in the area. This analysis is typically an assessment of plume blight and not regional haze (40 CFR 52.21(o)(1)).

1.1. Growth Analysis

The growth analysis consists of a projection of the associated industrial, commercial, and residential growth that is likely to occur in the area due to the Liquefaction Plant and an estimate of the emissions generated by that associated growth.

No industrial or commercial growth is likely to occur as the requirements for the project are expected to fit within the current infrastructure in the area. However, when fully operational, the Liquefaction Plant would employ approximately 300 people. Therefore, it is possible that the Project could lead to some residential growth in the area. However, this would be quite small considering the 2010 population in the project area was 12,612 (U.S. Census Bureau for Nikiski, Salamatof, and Kenai combined). Conservatively assuming that all 300 employees would be new residents to the area and the population of the area has not grown since 2010, the population would only increase about 2%. As such, emissions generated by associated residential growth would be equally low, and any additional air quality impacts due to residential growth in the area would be inconsequential. Therefore, additional impacts on air quality, soils, vegetation, and visibility due to growth associated with the project are described by the project and cumulative modeling and analyses described in this document and in Resource Report No. 9 Appendix D (Alaska LNG 2016).

1.2. Soils and Vegetation Impact Analysis

This analysis involves an assessment of the ambient air quality impacts on the soil and vegetation types found in the project area. South-Central Alaska region is diverse, including an area from the peaks of the Alaska Range to the coastal marshes of the Kenai Peninsula resulting in a wide range of soil and vegetation types. The project is located in the upper Kenai Peninsula, which is located in a transition zone between the maritime and continental zones with little to no permafrost. The area is characterized as a glaciated lowland containing areas of ground moraine and stagnant ice topography, drumlin fields, eskers, and outwash plains with rugged mountains located to the east. Soils consist of marine, glacial, alluvial, and volcanic ash deposits that have been altered by glacial action and erosion. The surface soils and features in the area have been created by several major glacial events, which included the deposition of marine sandy clay. Vegetation in the region includes over 19 forest types, 7 herbaceous types, and 6 shrub types growing from barren alpine regions to coastal salt marshes (Gallant et al. 1995).

1.2.1 Vegetation Impact

To assess if a project has the potential to cause deleterious effects to vegetation in the project area, a comparison of project impacts can be made to threshold screening values developed by the USEPA from available laboratory and field studies (USEPA 1980). These thresholds "represent the minimum concentrations at which adverse growth effects or tissue injury in exposed vegetation were reported" to occur for sensitive plant species.

However, because it is more convenient and more protective, for most vegetation, ADEC recommends that the Secondary NAAQS are protective of vegetation species in Alaska (ADEC 2016). Secondary NAAQS set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation and buildings. In the case of carbon monoxide (CO), the National Ambient Air Quality Standards (NAAQS) are significantly more stringent than these threshold screening values. Therefore, a project that demonstrates compliance with the NAAQS easily demonstrates compliance with USEPA's threshold screening values and indicates the project will not cause deleterious effects to vegetation. However, lichen species are particularly sensitive to sulfur dioxide (SO_2) since they lack roots and derive all growth requirements from the atmosphere (Treshow and Anderson 1989). A U.S. Forest Service study conducted in the Tongass National Forest in southeast Alaska suggests 13 micrograms per cubic meter ($\mu g/m^3$) as a worst-case sensitivity threshold for lichen species found there. While it is not known whether species of lichens found in the project impact area have the same sensitivity as those in the Tongass National Forest, the sensitivity threshold still provides a reasonable surrogate measure. Therefore, based on ADEC recommendations, the Secondary NAAQS will be supplemented with an annual SO_2 limit of 13 μg/m³. For CO, Primary NAAQS will be used for comparison and considered protective of vegetation in the absence of Secondary NAAQS.

Table 1 summarizes the vegetation impact analysis, which presents the totals of the cumulative modeled impact (project plus offsite sources) and background concentration at near-field locations as determined in Resource Report No. 9 Appendix D (Alaska LNG 2016). The results in Table 1 indicate that the total impact for all pollutants is below appropriate vegetation exposure levels for project area plant species. Similar to other cumulative analyses, these impacts also included project emissions that would not be required for modeling supporting PSD permitting. Therefore, these ambient air quality impacts are overstated and they are still not expected to result in adverse growth effects or tissue injury to vegetation in the project area.

Table 1: Vegetation Impact Analysis

Air Pollutant	Averaging Period	Modeled Impact[1] (μg/m³)	Maximum 1-Hour Fumigation Concentration (μg/m³)	Ambient Background Concentration (μg/m³)	Total Impact (μg/m³)	Vegetation Exposure Threshold (μg/m³)
Sulfur Dioxide	3-Hour[2]	50.6	5.7	5.0	61.3	1,300[6]
	Annual[3]	0.6	5.7	0.0	6.3	13[7]
Carbon Monoxide	1-Hour[2]	2,721	78.3	1,145	3,945	40,000[8]
	8-Hour[2]	1,071	78.3	1,145	2,294	10,000[8]
Nitrogen Dioxide	Annual[3]	20.4	34.1	2.60	57.1	100[6]
Particulate Matter less than 10 Microns	24-Hour[5]	23.9	5.0	40	68.9	150[6]
Particulate Matter less than 2.5 Microns	24-Hour[4]	6.4	5.0	12	23.4	35[6]
	Annual[3]	2.8	5.0	3.7	11.4	15[6]

Abbreviations:

μg/m³ = micrograms per cubic meter

Notes:

1 Value reported is the maximum AERMOD concentration found at near-field receptors and is equivalent to the impact shown in Resource Report No. 9 Appendix D (Alaska LNG 2016).

2 Value reported is the highest, second highest concentration of the values determined for each of the 5 modeled years.

3 Value reported is the maximum annual average concentration for the 5-year period.

4 Value reported is the 98th percentile averaged over the 5-year period.

5 Value reported is the highest, 6th highest concentration over the 5-year period.

6 Secondary NAAQS – Recommended by ADEC as the appropriate limit to protect against damage to crops and vegetation.

7 Threshold determined by ADEC to be applicable to lichens which may exist in the project area (ADEC 2016).

8 Primary NAAQS are used for comparison in the absence of Secondary NAAQS.

1.2.2 Soils Impact

According to USEPA (1980), there is little information available on the effects of air pollutants on soils. Deposition of trace elements may have some effect on soils, but "secondary effects of the pollutant appear to impact the soil system more adversely than the addition of the pollutant itself to the soil. For instance, damaging or killing vegetative cover could lead to increased solar radiation, increased soil temperatures, and moisture stresses," in addition to increased runoff and erosion. Thus, impacts on nearby soils were evaluated by determining the potential effect of project emissions on vegetation. As discussed in the previous section, vegetation impacts were found to be below applicable vegetation exposure thresholds. Therefore, impacts to soils in the project area are expected to be insignificant.

1.3. Visibility

The visibility impairment assessment involves a plume blight analysis to determine the impacts of a proposed project's emissions on the visual quality of an area. Plume impairment is generally defined as the pollutant loading of a portion of the atmosphere such that it becomes visible, by contrast or color difference, against a viewed background such as a landscape feature or the sky. The evaluation criteria for plume impairment are the color difference index (ΔE) and plume contrast (Cp). This air quality related value is generally applied at near-field (approximately less than 50 kilometers [km]) locations and modeled using the Level 1 or Level 2 VISCREEN screening model or the PLUVUE II model, if more information is required.

This near-field plume visibility analysis was conducted to evaluate the extent of visibility of plumes associated with the Liquefaction Plant in Kenai National Wildlife Refuge (Kenai NWR) which is the nearest National Conservation Lands area close enough to be reasonably modeled with a near-field model. While there is no requirement to conduct the modeling on National Conservation Lands, it was done because it provides a convenient area for developing model inputs.

Impacts were predicted using USEPA's VISCREEN model. VISCREEN is a screening-level plume visibility model recommended in USEPA's Workbook for Plume Visual Impact Screening and Analysis (The Visibility Workbook, USEPA 1992). This model simulates the dispersion and optical characteristics of an elevated emission source plume. It incorporates the straight-line Gaussian dispersion of primary particulate as well as the transformation of primary pollutants (nitrogen oxides [NO_x]). It then computes the scattering of direct sunlight due to airborne pollutants. For a given time of day, wind speed, atmospheric stability, background visual range, and ozone concentration, the model computes light intensity at various visible wavelengths for lines-of-sight through the plume centerline. By comparing the light intensity reaching an observer both with and without the source present, the model computes visibility parameters that can be used to gauge whether or not a plume might be visible against a background sky or terrain.

Inputs required by VISCREEN include:

- Observer distance from source;
- Meteorological conditions (wind speed and atmospheric stability);
- Background visual range;

- Background ozone concentration; and
- Emission rates of NO_x and primary particulate (elemental carbon and primary sulfate are optional emission rates).

Observer locations chosen for the VISCREEN analysis included the closest boundary of the Kenai NWR (the most conservative observer location as suggested by the Visibility Workbook) and Skilak Lake (a popular visitor destination within the refuge). Kenai NWR is located approximately 10 km from the Liquefaction Plant, and Skilak Lake is located approximately 52 km from the Liquefaction Plant. As was done for Resource Report No. 9 Appendix D (Alaska LNG 2016), both were assessed using a Level 2 screening analysis, as described the Visibility Workbook. Unless otherwise mentioned, default VISCREEN settings were utilized.

The USEPA Visibility Workbook indicates that the highest modeled plume visibility impairment is associated with plume-observer geometry where the wind vector carries the plume centerline 11.25° on either side of the line between the plant and the observer. Thus, one wind vector to left and one to the right of the observer location were simulated. Following the methods described in the Visibility Workbook, the wind speed and atmospheric stability class for the 22.5° wind direction sector for each observer that corresponds to the one percent worst-case probability was applied. Wind speed and stability class categories and frequencies were based on the same meteorological data set used for the near-field modeling analyses described in Resource Report No. 9 Appendix D (Alaska LNG 2016): 2008-2012 meteorological data from the nearby Kenai NWS station. Table 2 summarizes the one percent worst-case meteorological conditions applied in the visibility analysis.

Background visual range was determined by averaging the 12 months of average monthly visual range values measured in nearby Tuxedni National Wildlife Refuge (Table 10, USDOI [2010]).

Table 2: Summary of Worst-Case Meteorological Conditions Applied In Visibility Analysis

VISCREEN Analysis	Observer Location	Wind Sectors Analyzed (degrees)	Stability Class	Wind Speed (m/s)
Compressor Turbines	Closest Park Boundary	258.75 to 281.25	D	3
	Skilak Lake	281.97 to 304.47	D	4
Power Generators	Closest Park Boundary	258.75 to 281.25	D	3
	Skilak Lake	281.75 to 304.25	D	4
Low Pressure (LP) Flare	Closest Park Boundary	259.05 to 281.55	D	3
	Skilak Lake	281.55 to 304.05	D	4
Wet/Dry Flares	Closest Park Boundary	258.75 to 281.25	D	3
	Skilak Lake	281.65 to 304.15	D	4
Marine Sources	Closest Park Boundary	258.75 to 281.25	D	3
	Skilak Lake	280.65 to 303.15	D	4

Emission rates used as inputs were based on the short-term primary NO_x, primary particulate matter (PM), and primary elemental carbon emissions estimated from the Liquefaction Plant. For the Low Pressure Flare and Wet and Dry Flares, maximum flaring events, which may occur during upset and startup scenarios, will occur less than once per year. If one does occur, it should occur for less than 30 minutes. Therefore, modeled emissions associated with maximum relief events were based on 30 minutes per day every day of the year. Recognize that these are very short-lived events, and the probability is very low that these transient events will occur simultaneously with the modeled one percent worst-case probability meteorology conditions.

Also note that VISCREEN assumes that 10% of NO_x emissions are initially converted to NO_2, either within the source stack or within the first kilometer of plume transport. In addition, the default VISCREEN ozone background value of 40 ppbv was assumed and is consistent with measurements collected at Denali National Park and used for other long-range and near-field assessments described in Resource Report No. 9 Appendix D (Alaska LNG 2016).

There will be several emission source types at the Liquefaction Plant, and many would have different stack parameter characteristics. Furthermore, some sources would also be large distances apart. Rather than conservatively assume all of these emissions are emitted as a single plume, it was assumed that the plumes from many of these sources would not combine into a single plume and were assessed separately. Therefore, an assessment was conducted to determine which plumes would and would not likely combine. Stack velocities, heights, temperatures, and distances were considered in this analysis. A total of five separate plumes were conservatively identified. Table 3 summarizes the sources that were combined into each of these plumes with justifications. A specific VISCREEN analysis was performed on each of these plumes to obtain more representative visibility degradation estimations at the observer locations.

The results of the visibility impairment analysis are presented in Table 4 and Table 5. The nearest Class I area is Tuxedni NWR, located at 86 km from the Liquefaction Plant. Because there are no Class I areas located within the maximum range of the VISCREEN model (50 km), there are no criteria available to assess visibility impairment at the Liquefaction Plant. Therefore, these results are presented for informational purposes only to satisfy the requirement for a visibility impairment analysis in 40 CFR 52.21(o)(1).

Table 3: Summary Combined Plume Emission Sources

Source Plume	Source Emissions Included in Plume	Justification for Combining Sources
Compressor Turbines	6 Compressor Turbine	Identical source types. Distances apart range from approximately 0.1 to 0.5 kilometers.
Power Generators	4 Power Generators + Firewater Pump + Aux Compressor	The Power Generators are located in the same general vicinity of each other. The Firewater Pump and Aux Compressors are also nearby and have stack parameters which suggest potential for combining with Power Generator plumes.
Low Pressure (LP) Flare	2 LP Flares + Thermal Oxidizer	The two LP flares are nearby each other. The Thermal Oxidizer is also conservatively included with the LP flares as it is nearby source.
Wet/Dry Flares	2 Wet Flares + 2 Dry Flares	All four of these flares are nearby each other and have similar stack parameters.
Marine Sources	North Carrier + South Carrier + Support Tugs	Though exact locations of these sources is unknown, they were conservatively combined into a single plume.

Table 4: Viscreen-Predicted Impacts Inside Kenai NWR (Sky Background)

Source Plume	Observer Location	Scattering Angle (degrees)	Modeled Perceptibility (ΔE)	Modeled Contrast (Cp)
Forward Scatter				
Compressor Turbines	Closest Park Boundary	10	1.30	-0.02
	Skilak Lake	10	0.39	-0.01
Power Generators	Closest Park Boundary	10	0.38	-0.01
	Skilak Lake	10	0.12	0.00
LP Flare + Thermal Oxidizer	Closest Park Boundary	10	0.24	0.00
	Skilak Lake	10	0.12	0.00
Wet/Dry Flares	Closest Park Boundary	10	0.69	-0.01
	Skilak Lake	10	0.40	0.00
Marine Sources	Closest Park Boundary	10	0.91	-0.01
	Skilak Lake	10	0.33	-0.01
Backward Scatter				
Compressor Turbines	Closest Park Boundary	140	2.39	-0.07
	Skilak Lake	140	0.86	-0.03
Power Generators	Closest Park Boundary	140	0.66	-0.02
	Skilak Lake	140	0.24	-0.01
LP Flare + Thermal Oxidizer	Closest Park Boundary	140	1.04	-0.03
	Skilak Lake	140	0.45	-0.01
Wet/Dry Flares	Closest Park Boundary	140	2.23	-0.10
	Skilak Lake	140	1.40	-0.04
Marine Sources	Closest Park Boundary	140	0.78	-0.02
	Skilak Lake	140	0.24	-0.01

Table 5: Viscreen-Predicted Impacts Inside Kenai NWR (Terrain Background)

Source Plume	Observer Location	Scattering Angle (degrees)	Modeled Perceptibility (ΔE)	Modeled Contrast (Cp)
Forward Scatter				
Compressor Turbines	Closest Park Boundary	10	5.63	0.02
	Skilak Lake	10	2.15	0.03
Power Generators	Closest Park Boundary	10	1.61	0.01
	Skilak Lake	10	0.60	0.01
LP Flare + Thermal Oxidizer	Closest Park Boundary	10	3.27	0.01
	Skilak Lake	10	1.18	0.01
Wet/Dry Flares	Closest Park Boundary	10	9.80	0.04
	Skilak Lake	10	3.65	0.04
Marine Sources	Closest Park Boundary	10	0.68	0.00
	Skilak Lake	10	0.46	0.01
Backward Scatter				
Compressor Turbines	Closest Park Boundary	140	0.46	0.00
	Skilak Lake	140	0.75	0.02
Power Generators	Closest Park Boundary	140	0.12	0.00
	Skilak Lake	140	0.21	0.01
LP Flare + Thermal Oxidizer	Closest Park Boundary	140	0.23	0.00
	Skilak Lake	140	0.39	0.01
Wet/Dry Flares	Closest Park Boundary	140	0.76	0.01
	Skilak Lake	140	1.25	0.03
Marine Sources	Closest Park Boundary	140	0.11	0.00
	Skilak Lake	140	0.20	0.01

2. REFERENCES

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