APPENDIX I

Climate Impacts

Stantec

Memo

To:	Alaska Department of Transportation and Public Facilities, Northern Region 2301 Peger Rd., Fairbanks, AK 99709	From:	Stantec Consulting Services Inc. 725 East Fireweed Lane, Anchorage, AK 99503
Project/File:	Deadhorse Airport Improvements State Project No. NFAPT00549	Date:	April 25, 2023

Reference: Greenhouse Gas Emissions Estimate in Support of the Deadhorse Airport Improvement Draft Environmental Assessment

In support of the Deadhorse Airport Improvements Draft Environmental Assessment on the behalf of the project sponsor, State of Alaska Department of Transportation & Public Facilities (DOT&PF), Northern Region, Stantec was requested to estimate greenhouse gas (GHG) emissions associated with mobilization, material production, construction, and demobilization activities necessary for the proposed project.

GHG emissions were calculated using the following assumptions:

- Referenced models do not include potential emission premiums for construction in arctic environments. Such premiums must be independently applied.
- The proposed project will be completed within two calendar years.
- The equipment fleet mix, construction methods, and schedule presented in this analysis are only representative proxies for calculating estimates of the magnitude of emissions to be generated.

GHG emission estimates are based on:

- Input from industry experts,
- Readily accessible data from emission models,
- Equipment manufacturer specifications, and
- Feedback from DOT&PF and other stakeholders.

A summary of estimated GHG emissions for the proposed Deadhorse Airport Improvements project are included in the following pages.

Regards,

STANTEC CONSULTING SERVICES INC.

Estimated Project Combined CO2 & CO2e Emission Outputs*

Emission Source	1-Year Emissions (mt)	2-Year Emissions (mt)
Mob/Demobe	107.3	214.5
Material Production**	86.8	173.6
Material Haul	913.3	1,826.6
Construction***	1,033.4	2,066.7
TOTALS	**2,140.7**	**4,281.4**

Notes:

* Carbon dioxide (CO2) is the most prevalent greenhouse gas (GHG). On average, it represents more than 95 percent of the impact on climate change that comes from burning transportation fuels. Methane (CH4) and nitrous oxide (N2O) are other GHG assocated with fuel combustion. Because of its prevalence, some models measure CO2 emissions only, and will slightly underestimate GHG overall total. Emissions calculations including all GHG associated with fuel combustion are noted as a CO2 factor – where "e" stands as a CO2 equivalent of other GHGs that have been factored in. Referenced models 1 & 4 in this spreadsheet output only CO2 emissions; while referenced model 5 for asphalt construction yields CO2e as an output to capture GHGs associated asphalt processes.

** Material production includes crushing of aggregate and production of hot-mix asphalt required for asphalt paving.

*** Includes material site development and reclamation, construction of road embankments, fence installation, culvert placement, hot-mix asphalt paving, and all incidental construction.

Assumptions:

- No project specific camp facility will be required. Project contractor will utilize available commercial facilities for crew housing and support.
- Contractor will acquire all project fuels at Deadhorse from commercial sources and not require project-specific fuel haul on mobe.
- Referenced models do not include potential emission premiums for construction in arctic environments. Such premiums must be independently applied.
- Project will be completed within two calendar years. The equipment fleet mix, construction methods, and schedule presented in this analysis are only representative for calculating the magnitude of emissions to be generated. Equipment use and duration is generally conservative for this purpose and not intended to specify how a contractor would sequence the work over the construction period.

Reference Models and Input Data:

1 Mathers, J. et al. (2023). The Green Freight Handbook. A Practical Guide for Developing a Sustainable Freight Transportation Strategy for Business. Environmental Defense Fund. 67 pp. pdf. Accessed on 03/31/2023 online at https://supplychain.edf.org/resources/the-green-freight-handbook/.

2 J. S. Cole Heavy Equipment Rental Co. 2017. Hourly Fuel Consumption Tables. Accessed on 3/31/2023 at: https://www.jscole.com/fueltables.

3 Various Equipment Industry Specification Sheets (available on request)

4 U.S. Environmental Protection Agency. 2023. Greenhouse Gases Equivalencies Calculator - Calculations and References. Accessed on 3/31/2023 at: https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references.

5 Feng Ma et al. (2016). Greenhouse Gas Emissions from Asphalt Pavement Construction: A Case Study in China. Int. Jour. Environ. Res. Public Health. March 13(3): 351. Accessed on 03/30/2023 at https://www.mdpi.com/1660-4601/13/3/351.

6 Klanfar, M. et al. (2016). *Fuel Consumption and Engine Load Factors of Equipment in Quarrying of Crush Stone* . Technical Gazette 23, 1(2016), 163-1697 pp. pdf.

Estimated Total Project Mobilization and Demobilization CO2 Emission Output

No.	Equipment Hauled or Hauling Feight	Equipment Weight (lbs)	Total Weight (tons)	Fairbanks to Deadhorse Distance (miles)	No. of Trips (ea)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)
1	Large grader (Cat 24 for est.)	161,700	80.9	500	2	80,850	13.1
2	D-6 size dozers on spread	51,333	51.3	500	2	51,333	8.3
1	D-8 size dozer in pit	88,000	44.0	500	2	44,000	7.1
1	Cat 966 Loader	48,000	24.0	500	2	24,000	3.9
1	Cat 988 Loader	112,574	56.3	500	2	56,287	9.1
2	Excavators (100 to 150HP) Cat. 320 est.	48,300	48.3	500	2	48,300	7.8
2	Compactors (Cat. CS54 est.)	23,265	23.3	500	2	23,265	3.8
4	Mobile Light (Kohler KD1003- Diesel)	1,800	3.6	500	2	3,600	0.6
2	6" pump (United Rent PP66S14 - J.D. Diesel)	4,600	4.6	500	2	4,600	0.7
2	Kohler 45kW generator (55REOZT4)	4,941	4.9	500	2	4,941	0.8
2	Intl. HV 10 yd. dump truck	27,000	27.0	500	2	27,000	4.4
10	Smithco SX side dump trailer	15,000	75.0	500	2	75,000	12.2
15	35+ ton low-boy	25,000	187.5	500	2	187,500	30.4
50	Semi tractors	10,000	250.0	500	2	250,000	40.5
45	Flatbed trailers*	12,000	270.0	500	2	270,000	43.7
8	Ford F-250 pickup (hauled)	7,000	28.0	500	2	28,000	4.5
2	Water Truck 2000 gal.	17,000	17.0	500	2	17,000	2.8
1	Gross Weight Fence Material	40,000	20.0	500	1	10,000	1.6
1	Gross Weight Culverts	413,750	206.9	500	1	103,438	16.8
					TOTALS	**1,309,114**	**212.1**

* 40 of 45 listed flatbed trailers will be tandem hauled (2 each) by 20 single semi-tractors

No.	Truck Type	Fairbanks to Deadhorse Distance (miles)	No. of Trips (ea)	Fuel Consumption Rate (mpg)	Fuel Use (gal)	CO2 Emissions[4] (mt)
1	Shop/Service Truck	500	2	12	83.3	0.8
1	Fuel Truck (5000 gal)	500	2	12	83.3	0.8
1	Flatbed 3 Ton Truck	500	2	12	83.3	0.8
					TOTAL	**2.4**

Conversions:

- 162g CO2 emitted per 1 ton-mile hauled.[1]
- 10,180g CO2 emitted per 1 gal diesel used.[4]

Estimated Total Project Material Production CO2 Emission Output

Material Type	Weight (ton)	Weight (mt)	CO2e Emissions[5] (mt)
CABC	6,210	5,632	32.9
CASC	24,300	22,040	128.7
HMA*	2,270	2,059	12.0
		TOTAL	**173.6**

Conversions:

- 1 ton = 0.907 metric ton
- 5.84kg C02e emitted per 1 metric ton of crushed aggregate.[5]
- 19.04kg CO2e emitted per 1 metric ton of hot-mix asphalt produced (aggregate, drying, batching).[5]

Abbreviations:

CABC	Crushed Aggregate Base Course
CASC	Crushed Aggregate Surface Course
HMA	Hot-Mix Asphalt

Notes:

* An "Arctic Factor" of 150% was applied to the 19.04kg CO2e emitted per 1 metric ton hot-mix asphalt conversion rate to account for small batch sizes and enviromental conditions.
19.04kg x 1.50 = 28.56kg

Estimated Total Project Material Haul CO2 Emission Output

Borrow (ton)	CABC (ton)	CASC (ton)		(ton)	Side Dump Trailer Volume (cy)	Full Side Dump Trailer Weight (ton)	Empty Side Dump Trailer Weight (ton)	Tractor Weight (ton)	Material Source to Project Site (miles)
1,430,000	6,210	24,300	HMA	2,270	24	48	8	5	5

Side Dump	Total Material Weight (ton)	Total Material Volume (cy)	Haul Trips (ea)	Haul Weight (ton)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)
Full	1,462,780	731,390	30,475	61	9,294,748	1,505.7
Empty	0	0	30,475	13	1,980,848	320.9
				TOTALS	**11,275,596**	**1,826.6**

Conversions:

- 1 cy = 2 ton
- 162g CO2 emitted per 1 ton-mile hauled.[1]

Abbreviations:

CABC	Crushed Aggregate Base Course
CASC	Crushed Aggregate Surface Course
HMA	Hot-Mix Asphalt

Estimated Total Construction CO2 Emission Output

No.	Equipment	Power Output (HP)	Power Output (kWh)	Hourly Fuel Consumption[2,3] (gal/hr)	Reduced* Hourly Fuel Consumption[6] (gal/hr)	Shift Duration (hr)	Construction Season (days)	No. of Seasons (ea)	Fuel Use (gal)	CO2 Emissions[4] (mt)
1	Large grader (Cat 24 est.)	535	398.9	13.8	9.66	10	120	2	23,184	236.0
2	D-6 size dozers on spread	219	163.3	7.6	5.32	10	120	2	25,536	260.0
1	D-8 size dozer in pit	354	264.0	11.7	8.19	10	120	2	19,656	200.1
1	Cat 966 Loader	325	242.4	4.7	3.29	10	120	2	7,896	80.4
1	Cat 988 Loader	580	432.5	13.9	9.73	10	120	2	23,352	237.7
2	Excavators (Cat. 320 est.)	148	110.4	4.9	3.43	10	120	2	16,464	167.6
2	Compactors (Cat. CS54 est.)	131	97.7	3.5	2.45	10	120	2	11,760	119.7
8	F-250 Pickup	-	-	1.0	0.70	10	120	2	13,440	136.8
1	Shop/Service Truck	-	-	1.5	1.05	10	120	2	2,520	25.7
1	Fuel Truck	-	-	2.0	1.40	10	120	2	3,360	34.2
1	Flatbed 3 Ton Truck	-	-	1.5	1.05	10	120	2	2,520	25.7
2	Water Truck 2000 gal.	-	-	1.5	1.05	10	120	2	5,040	51.3
4	Mobile Light (Kohler KD1003- diesel est.)	24	17.7	0.5	0.35	10	120	2	3,360	34.2
2	6" pump (United Rent PP66S14 - J.D. diesel est.)	173	129.0	6.8	4.76	12	120	2	27,418	279.1
2	Kohler 45kW generator (55REOZT4 est.)	74	55.2	2.5	1.75	12	120	2	10,080	102.6
								TOTALS	**195,586**	**1,991.1**

ASPHALT PAVING ACTIVITES ONLY			
Material Type	**Weight (ton)**	**Weight (mt)**	**CO2e Emissions[5] (mt)**
HMA**	2,270	2,059	75.6
		TOTAL	**75.6**

Conversions:

- 1 HP = 0.7457 kWh
- 10,180g CO2 emitted per 1 gal diesel used.[4]
- 24.47kg CO2e emitted per 1 metric ton hot-mix asphalt placed (mix, laydown, and compaction).[5]

Notes:

* Hourly fuel consumption was reduced by 30% to account for equipment not utilizing full power output throughout the entire duration of construction activities.

** An "Arctic Factor" of 150% was applied to the 24.47kg CO2e emitted per 1 metric ton hot-mix asphalt conversion rate to account for small batch sizes and enviromental conditions.
24.47kg x 1.50 = 36.71kg