APPENDIX F

ESTIMATED PROJECT CO2 EMISSION OUTPUTS

Page

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:	Noatak Airport Relocation	Date:	April 25, 2023

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

In support of the 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 the mobilization, material production, construction, and demobilization activities necessary for the proposed Noatak Airport Relocation 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 three 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.

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 Noatak Airport Relocation 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)	3-Year Emissions (mt)
Mob/Demobe	1012.3	3036.9
Material Production**	599.2	1797.7
Material Haul	321.3	963.8
Construction***	1027.5	3082.4
TOTALS	**2960.3**	**8880.8**

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.

** Material production includes crushing of aggregate for subbase and surface course.

*** Includes material site development and reclamation, airport and road embankment construction, aggregate surfacing, culvert placement, bridge construction, SREB construction, construction camp operations, and all incidental construction.

Assumptions:

- Referenced models do not include potential emission premiums for construction in arctic environments. Such premiums must be independently applied.
- Project will be completed within three 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.

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* . 7 pp. pdf. Accessed on 3/31/2023 at: https://www.researchgate.net/publication/296573614_Fuel_consumption_and_engine_load_factors_of_equipment_in_quarrying_of_crushed_stone

7 Jansen, R. and Rohraff, D. (2023). Case Study: Powering a Remote Remediation Camp With Diesel, Renewables and Energy Storage. Accessed on 4/18/2023 at: https://energyandmines.com/2015/10/case-study-powering-a-remote-remediation-camp-with-diesel-renewables-and-energy-storage/.

8 Crowley Fuels Co., phone conversation on March 15, 2023.

Estimated Total Project Mobilization and Demobilization CO2 Emission Output - Barge Effort

Loading/Unloading Barge Emissions											
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)	No. Shifts per Day (ea)	Single Load or Unload Duration (days)	Load and Unload Activities (ea)	Fuel Use (gal)	CO2 Emissions[4] (mt)
1	Cat 966 Loader	325	242.4	4.7	3.29	10	2	7	4	1,842	18.8
1	Cat 988 Loader	580	432.5	13.9	9.73	10	2	7	4	5,449	55.5
4	Cat P30000 Forklift	148	110.4	4.9	3.43	10	2	7	4	7,683	78.2
4	Mobile Light (Kohler KD1003- diesel est.)	24	17.9	0.5	0.35	10	2	7	4	784	8.0
2	Kohler 45kW generator (55REOZT4 est.)	74	55.2	2.5	1.75	10	2	7	4	1,960	20.0
									TOTAL	**17,718**	**180.5**

150-foot, Ocean-going Tug Emissions				
Seattle to Red Dog Mine Port One-Way Duration[8] (days)	One-Way Fuel Use[8] (gal)	One-Way Trips (ea)	Total Fuel Use (gal)	CO2 Emissions[4] (mt)
20	3,200	4	12,800	130.3
			TOTAL	**130.3**

Conversions:

- 1 HP = 0.7457 kWh
- 10,180g CO2 emitted per 1 gal diesel used.[4]

Estimated Total Project Mobilization and Demobilization CO2 Emission Output - Gravel Road Effort

Gravel Road Haul Emissions							
No.	Equipment Hauled or Hauling Feight	Equipment Weight (lbs)	Total Weight (ton)	Port to Snow Road Distance (miles)	No. of Trips (ea)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)
1	Large grader (Cat 24 for est.)	161,700	80.85	40	2	6,468	1.0
2	D-6 size dozers on spread	51,333	51.33	40	2	4,107	0.7
1	D-8 size dozer in pit	88,000	44.00	40	2	3,520	0.6
1	Cat 966 Loader	48,000	24.00	40	2	1,920	0.3
1	Cat 988 Loader	112,574	56.29	40	2	4,503	0.7
4	Cat P30000 Forklift	41,000	82.00	40	2	6,560	1.1
1	Skid Steer (Cat 277)	9,000	4.50	40	2	360	0.1
2	Excavators (100 to 150HP) Cat. 320 est.	48,300	48.30	40	2	3,864	0.6
2	Compactors (Cat. CS54 est.)	23,265	23.27	40	2	1,861	0.3
4	Mobile Light (Kohler KD1003- Diesel)	1,800	3.60	40	2	288	0.0
2	6" pump (United Rent PP66S14 - J.D. Diesel)	4,600	4.60	40	2	368	0.1
2	Kohler 45kW generator (55REOZT4)	4,941	4.94	40	2	395	0.1
3	Heaters	40	0.06	40	2	5	0.0
2	Intl. HV 10 yd. dump truck	27,000	27.00	40	2	2,160	0.3
2	ATV Water Truck (Volvo A25)	43,000	43.00	40	2	3,440	0.6
3	ATV Rock Truck (Volvo A40)	68,900	103.35	40	2	8,268	1.3
1	Tucker SnoCat w/blade & drag	15,000	7.50	40	2	600	0.1
3	Smithco SX side dump trailer	15,000	22.50	40	2	1,800	0.3
6	35+ ton low-boy	25,000	75.00	40	16	48,000	7.8
6	Semi tractors	10,000	30.00	40	16	19,200	3.1
3	Ford F-250 pickup (hauled)	7,000	10.50	40	2	840	0.1
1	Gross Weight 26' x 50' SREB Materials	52,000	26.00	40	1	1,040	0.2
1	Gross Weight Culverts	10,000	5.00	40	1	200	0.0
1	Gross Weight 20' x 150' Bridge Materials	450,000	225.00	40	1	9,000	1.5
1	Gross Weight Electrical Materials	20,000	10.00	40	1	400	0.1
2	50-ton Crane (RTC 8050)	74,000	74.00	40	2	5,920	1.0
40	Conex (Construction Camp)	8,500	170.00	40	2	13,600	2.2
6	Case Steiger Tractor w/trailers	55,000	165.00	40	2	13,200	2.1
						TOTAL	**26.3**

Estimated Total Project Mobilization and Demobilization CO2 Emission Output - Gravel Road Effort

Gravel Road Haul Support Vehicle Emissions						
No.	Truck Type	Port to Snow Road Distance (miles)	No. of Trips (ea)	Fuel Consumption Rate (mpg)	Fuel Use (gal)	CO2 Emissions[4] (mt)
1	Shop/Service Truck	40	6	12	20.0	0.2
1	Fuel Truck (5000 gal)	40	6	12	20.0	0.2
1	Flatbed 3 Ton Truck	40	6	12	20.0	0.2
					TOTAL	**0.6**

Conversions:

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

Estimated Total Project Mobilization and Demobilization CO2 Emission Output - Snow Road Effort

Snow Road Haul Emissions							
No.	Equipment Hauled or Hauling Feight	Equipment Weight (lbs)	Total Weight (ton)	Port to Snow Road Distance (miles)	No. of Trips (ea)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)
1	Large grader (Cat 24 for est.)	161,700	80.85	28	2	4,528	0.73
2	D-6 size dozers on spread	51,333	51.33	28	2	2,875	0.47
1	D-8 size dozer in pit	88,000	44.00	28	2	2,464	0.40
1	Cat 966 Loader	48,000	24.00	28	2	1,344	0.22
1	Cat 988 Loader	112,574	56.29	28	2	3,152	0.51
4	Cat P30000 Forklift	41,000	82.00	28	2	4,592	0.74
1	Skid Steer (Cat 277)	9,000	4.50	28	2	252	0.04
2	Excavators (100 to 150HP) Cat. 320 est.	48,300	48.30	28	2	2,705	0.44
2	Compactors (Cat. CS54 est.)	23,265	23.27	28	2	1,303	0.21
4	Mobile Light (Kohler KD1003- Diesel)	1,800	3.60	28	2	202	0.03
2	6" pump (United Rent PP66S14 - J.D. Diesel)	4,600	4.60	28	2	258	0.04
2	Kohler 45kW generator (55REOZT4)	4,941	4.94	28	2	277	0.04
3	Heaters	40	0.06	28	2	3	0.00
2	Intl. HV 10 yd. dump truck	27,000	27.00	28	2	1,512	0.24
2	ATV Water Truck (Volvo A25)	43,000	43.00	28	2	2,408	0.39
3	ATV Rock Truck (Volvo A40)	68,900	103.35	28	2	5,788	0.94
1	Tucker SnoCat w/blade & drag	15,000	7.50	28	2	420	0.07
3	Smithco SX side dump trailer	15,000	22.50	28	2	1,260	0.20
6	35+ ton low-boy (not hauled up snow road)	25,000	75.00	28	0	0	0.00
6	Semi tractors	10,000	30.00	28	2	1,680	0.27
3	Ford F-250 pickup (hauled)	7,000	10.50	28	2	588	0.10
1	Gross Weight 26' x 50' SREB Materials	52,000	26.00	28	1	728	0.12
1	Gross Weight Culverts	10,000	5.00	28	1	140	0.02
1	Gross Weight 20' x 150' Bridge Materials	450,000	225.00	28	1	6,300	1.02
1	Gross Weight Electrical Materials	20,000	10.00	28	1	280	0.05
2	50-ton Crane (RTC 8050)	74,000	74.00	28	2	4,144	0.67
40	Conex (Construction Camp)	8,500	170.00	28	2	9,520	1.54
6	Case Steiger Tractor w/trailers	55,000	165.00	28	11	50,820	8.23
						TOTAL	**17.73**

Estimated Total Project Mobilization and Demobilization CO2 Emission Output - Snow Road Effort

Snow Road Construction Emissions									
No.	Equipment	Power Output (HP)	Power Output (kWh)	Hourly Fuel Consumption (gal/hr)	Shift Duration (hr)	Construction Duration (days)	No. of Seasons (ea)	Fuel Use (gal)	CO2 Emissions[4] (mt)
6	Case Steiger Tractor w/trailers	535	398.9	7.8	24	30	4	135,000	1,374.3
1	Fuel Truck (5000 gal)	219	163.3	1.7	24	30	4	4,800	48.9
2	Tucker SnoCat w/blade & drag	354	264.0	2.1	24	30	4	12,000	122.2
2	ATV Water Truck (Volvo A25)	325	242.4	2.4	24	30	4	13,800	140.5
3	ATV Rock Truck (Volvo A40)	580	432.5	2.4	24	30	4	20,700	210.7
2	Cat 966 Loader	148	110.4	2.2	24	30	4	12,600	128.3
1	Skid Steer (Cat 277)	131	97.7	0.9	24	30	4	2,700	27.5
3	Ford F-250 pickup (hauled)	-	-	1.0	24	30	4	9,000	91.6
1	20-Person Construction Camp	-	-	4.2	24	30	4	12,000	122.2
4	Mobile Light (Kohler KD1003- Diesel)	-	-	0.8	24	30	4	9,600	97.7
3	Heaters	-	-	2.0	24	30	4	17,100	174.1
1	D-6 size dozers on spread	24	17.7	2.7	24	30	4	7,800	79.4
1	Shop/Service Truck	173	129.0	1.4	24	30	4	3,900	39.7
1	Envirocvac	74	55.2	0.8	24	30	4	2,400	24.4
							TOTALS	**263,400**	**2,681.5**

Conversions:

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

Notes:

- Emissions produced from support vehicles needed during snow road haul are neglible. Table was omitted from emissions calculation.

Estimated Total Project Material Production CO2 Emission Output

Material Type	Weight (ton)	Weight (mt)	CO2e Emissions[5] (mt)
Subbase	247,000	224,029	1,308.3
CASC	92,400	83,807	489.4
		TOTAL	**1,797.7**

Conversions:

- 1 ton = 0.907 metric ton
- 5.84kg C02e emitted per 1 metric ton of crushed aggregate.[5]

Abbreviations:

CASC Crushed Aggregate Surface Course

Estimated Total Project Material Haul CO2 Emission Output

Borrow (ton)	Subbase (ton)	CASC (ton)	Material Source to Project Site (mi)
1,116,000	247,000	92,400	2

Side Dump Trailer Volume (cy)	Full Side Dump Trailer Weight (ton)	Empty Side Dump Trailer Weight (ton)	Semi Tractor Weight (ton)
24	56	8	5

Rock Truck Volume (cy)	Full Rock Truck Weight (ton)	Empty Rock Truck Weight (ton)
29	93	34

Haul Vehicle	Total Material Weight (ton)	Total Material Volume (cy)	Haul Trips (ea)	Haul Weight (ton)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)	Notes
Rock Truck - Full	1,116,000	558,000	18,980	93	3,539,694	573.4	Borrow only
Rock Truck - Empty	0	0	18,980	34	1,307,694	211.8	
Side Dump - Full	339,400	169,700	7,071	61	855,571	138.6	Subbase and CASC only
Side Dump - Empty	0	0	7,071	13	176,771	28.6	
					TOTAL	**952.4**	

Fuel (gal)	Fuel Tank Volume (gal)	Full Fuel Tank Fuel Weight (ton)	Empty Fuel Tank Weight (ton)	Weighted Avg. Haul Vehicle Weight (ton)	Barge Landing to Project Site (mi)
200,000	5,000	17.5	2.9	14	68

Fuel Tank	Total Material Weight (ton)	Total Material Volume (gal)	Haul Trips (ea)	Haul Weight (ton)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)	Notes
Full	1,400,000	200,000	20	35	47,178	7.6	Two tanks on one trailer
Empty	0	0	20	17	23,378	3.8	Two tanks on one trailer
					TOTAL	**11.4**	

Conversions:

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

Abbreviations:

CASC

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	3	34,776	354.0
2	D-6 size dozers on spread	219	163.3	7.6	5.32	10	120	3	38,304	389.9
1	D-8 size dozer in pit	354	264.0	11.7	8.19	10	120	3	29,484	300.1
1	Cat 966 Loader	325	242.4	4.7	3.29	10	120	3	11,844	120.6
1	Cat 988 Loader	580	432.5	13.9	9.73	10	120	3	35,028	356.6
2	Excavators (Cat. 320 est.)	148	110.4	4.9	3.43	10	120	3	24,696	251.4
2	Compactors (Cat. CS54 est.)	131	97.7	3.5	2.45	10	120	3	17,640	179.6
2	ATV Water Truck (Volvo A25)	240	179.0	6.2	4.34	10	120	2	20,832	212.1
3	F-250 Pickup	-	-	1.0	0.70	10	120	3	7,560	77.0
1	Shop/Service Truck	-	-	1.5	1.05	10	120	3	3,780	38.5
1	Fuel Truck (5000 gal)	-	-	2.0	1.40	10	120	3	5,040	51.3
1	Flatbed 3 Ton Truck	-	-	1.5	1.05	10	120	3	3,780	38.5
4	Mobile Light (Kohler KD1003- diesel est.)	23.7	17.7	0.5	0.35	10	120	3	5,040	51.3
1	6" pump (United Rent PP66S14 - J.D. diesel est.)	173	129.0	6.8	4.76	12	120	3	20,563	209.3
2	Kohler 45kW generator (55REOZT4 est.)	74	55.2	2.5	1.75	12	120	3	15,120	153.9
1	500kW generator (Construction Camp)	-	-	2.5	-	24	120	3	21,870	222.6
2	50-ton Crane (RTC 8050)	500	372.9	6.2	4.34	10	60	1	7,440	75.7
								TOTALS	**273,487**	**3,082.4**

Conversions:

- 1 HP = 0.7457 kWh
- 10,180g CO2 emitted per 1 gal diesel used.[4]

Notes:

- Hourly fuel consumption was reduced by 30% to account for equipment not utilizing full power output throughout the entire duration of construction activities.
- 100 person camp, (2) 500-kW generators @ 460L/day of diesel consumption. Assuming 50 person camp, (1) 500-kW generator @ 230L/day (60.75gal/day) of diesel consumption.[7]