

Appendix B: GHG Analysis (Amon Creek)

Greenhouse Gas Emissions Analysis: Amon Creek Re-location

Methodology

- Calculate GHG emissions by project Phase through the equipment type, hours of equipment operation, fuel consumption rates specific to equipment type, and emissions factors by fuel volume.
- Quantify emissions estimates for (CO₂, CH₄, and N₂O) as well as CO₂e. Including sequestration from wetland creation.
- Using conservative estimates for equipment hours and fuel consumption rates.
- Emissions from the Proposed Project Alternative would be direct emissions during construction. There would be no operation and maintenance related emissions.
- Definition of Significance: Significant impacts would occur if proposed project activities produced quantities of GHG emissions that would prevent the federal GHG reduction goals from being met. The White House's (2021) greenhouse gas emission goal is to reduce U.S. greenhouse gas emissions 50-52% below 2005 levels by 2030. The state of Washington enacted statutory targets in 2020 to reduce GHG emissions by 45% by 2030, 70% by 2040, and 95% by 2050, all compared to 1990 levels. The targets also aim for net-zero GHG emissions by 2050.

Development of Equipment Types

Clearing and Grubbing → *Chain saws(gasoline), brush cutter/ string trimmers (gasoline), bulldozer(diesel), skid steer loader(diesel), excavator(diesel), dump truck(diesel), chipper/ shredder(diesel)*

Mulching and Spreading → *Woodchipper/ shredder (diesel), dump truck (diesel), front end loader(diesel), rake or grading bade attachment*

Turbidity Curtain and Bubble Curtain Placement and Removal → excavator(diesel), backhoe loader(diesel), skid steer(diesel), boat(gasoline), air compressor (gasoline)

Excavation and filling of channel → excavator (diesel), bulldozer (diesel), Backhoe loader (diesel), dump Truck (Diesel), compactor/ roller (Diesel).

Wetland benches/plantings → excavator (diesel), bulldozer (diesel), skid steer (diesel), dump truck (diesel), gas powered hand tools (gas), hydro-seeder (diesel), auger (diesel).

Sediment removal, placement of fill, and apex logs jams in-water → dredge (diesel), floating skid steer loader (diesel) excavator w/ floating tracks (diesel), rock barge (diesel), excavator on barge (diesel), marine crane (diesel), vibratory hammer(diesel).

Estimated Operation Hours for Equipment

Phase 1:

Clearing and Grubbing → *Chain saws(gasoline), brush cutter/ string trimmers (gasoline), bulldozer (diesel), skid steer loader(diesel), excavator(diesel), dump truck(diesel), chipper/ shredder(diesel).

Total hours: 72 hours work

Equipment	Est. Hours
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Chainsaws	15
Brush Cutters	15
Bulldozer	12
Skid Steer Loader	12
Excavator	58
Dump Truck	58
Chipper/Shredder	50

Temporary Bridge Install → crane (diesel), Excavator(diesel), skid steer loader (Diesel)

Total Hours: 40-hour work

Excavator	8
Bulldozer	6
Crane	10
Dump Truck	6
Skid Steer Loader	4
Backhoe	4
Compactor	2
Generator	0.5

TESC Measures Install → Mulching and Spreading → Woodchipper/ shredder (diesel), dump truck (diesel), front end loader(diesel), rake or grading bade attachment.

Total Hours: 21-hour work

Equipment	Est. Hours
Skid Steer	10
Small Dozer	8
Dump Truck	4
Front-End Loader	3
Generator	1

Turbidity Curtain and Bubble Curtain Placement → excavator(diesel), backhoe loader(diesel), skid steer(diesel), boat(gasoline), air compressor (gasoline)

Total Hours: 24 hours

Equipment	Est. Hours
Boat	24
Excavator	10
Backhoe	5
Skid Steer	4
Air Compressor	24
Support Vehicles	3

Excavation of New Amon Creek Channel → Excavation → excavator (diesel), bulldozer (diesel), Backhoe loader (diesel), dump Truck (Diesel), compactor/ roller (Diesel).

Total Time: 200 hours

Equipment	Est. Hours
Excavator	100
Bulldozer	100
Dump Truck	150
Front End Loader	100
Water Truck	50
Fuel Service Truck	20
Support Vehicles	20

Plug Installation → excavator (diesel), bulldozer(diesel), dump truck (diesel), skid steer (diesel), vibratory hammer (diesel).

Total Time: 5 hours

Equipment	Est. Hours
Excavator	3
Bulldozer	2
Dump Truck	2

Wetland Bench Creation → Wetland benches → excavator (diesel), bulldozer (diesel), skid steer (diesel), dump truck (diesel)

Total Hour: 30 hours

Equipment	Est. Hours
Excavator	20
Bulldozer	15
Dump Truck	10
Compactor	8

Phase 2:

Sediment removal, placement of fill, and apex logs jams in-water → dredge (diesel), floating skid steer loader (diesel) excavator w/ floating tracks (diesel), rock barge (diesel), excavator on barge (diesel), marine crane (diesel), vibratory hammer(diesel).

Total Hours: 189 hours

Equipment	Est. Hours
Excavator	86
Dredge	8
Bulldozer	2

Rock Barge	24
Marine Crane	70
Vibratory Hammer	40

Fish Salvage in Old Channel → portable pump (gas), hand tools (gas)

Total Hours: 34

Equipment	Est. Hours
Pump	20 hours
Hand Tools	8

Plug Removal → excavator (diesel), bulldozer(diesel), dump truck (diesel), skid steer (diesel), vibratory hammer (diesel).

Total Time 12 hours

Equipment	Est. Hours
Excavator	6
Backhoe	3
Skid Steer	2
Vibratory Hammer	1

Phase 3:

Water discharge to upland area → pump (gas), generator (diesel)

Total Hours: 18

Equipment	Est. Hours
Pump	18
Generator	2

Filling in of old channel → → excavator (diesel), bulldozer (diesel), Backhoe loader (diesel), dump Truck (Diesel), compactor/ roller (Diesel).

Total Hours: 200 hours

Equipment	Est. Hours
Excavator	104
Bulldozer	52
Backhoe	144
Dump Truck	200
Compactor/ roller	37

Wetland/ riparian Plantings → stinger (gas), gas powered hand tools (gas), hydro-seeder (diesel), auger (diesel).

Total Hours: 20 hours

Equipment	Est. Hours
Stinger	12
Hand Tools	20
Hydro Seeder	12
Auger	7

TESC measures removal → excavator(diesel), backhoe loader(diesel), skid steer(diesel), boat(gasoline), air compressor (gasoline)

Total Hours:

Equipment	Est. Hours
Excavator	24
Backhoe Loader	10
Skid Steer	5
Boat	4
Air Compressor	24

Quantification of GHG Emissions

Emissions Factors for Fuel Types by Volume: Sourced from → Washington State Agency Greenhouse Gas Emissions Calculator

<https://ecology.wa.gov/getattachment/7973cad7-21c7-4f6c-ab57-c6513c85e3b2/2023StateAgencyGHGCalculator.xlsx>

Table 1. Emissions Factors for Fuel Types by Volume

Fuel	CO2 emission Factor (MT CO2/gallon)	CH4 emission factor (MT CH4/gallon)	N2O emission factor (MT N2O/gallon)
Gasoline	0.008959524	0.000000375	7.5E-08
Ethanol (E100)	0.005766667	9.24E-08	9.24E-09
Diesel	0.010228571	0.000000414	8.28E-08
Biodiesel (B100)	0.009421429	1.408E-07	1.408E-08
Propane	0.005738095	0.000000273	5.46E-08

Aviation gasoline	0.008309524	0.000000375	7.5E-08
Jet fuel	0.00975	0.000000405	8.1E-08

GHG Emissions Quantification:

Table 2. Quantification of Gross Proposed Project GHG Emissions

Equipment	Total Hours	Equipment Fuel Type	Average Fuel Rate (gal/hour)	Est. Fuel Quantity (Gallons)	CO2 (MT)	CH4 (MT)	N2O(MT)	CO2e (MT)
Chainsaw	15	Chainsaw (Gas)	0.5	7.5	0.0671964	2.813E-06	5.625E-07	0.067434366
Brush cutter	15	Brush Cutter (Gas)	1	15	0.1343929	5.625E-06	1.125E-06	0.134868732
Bulldozer	197	Bulldozer (Diesel)	8	1576	16.120229	0.0006525	0.0001305	16.17542703
Skid Steer	37	Skid Steer (Diesel)	3	111	1.1353714	4.595E-05	9.191E-06	1.139259137
Excavator	419	Excavator (Diesel)	12	5028	51.429257	0.0020816	0.0004163	51.60535983
Dump Truck	430	Dump Truck (Diesel)	9	3870	39.584571	0.0016022	0.0003204	39.72011586
Chipper/shredder	50	Chipper/Shredder (Diesel)	4	200	2.0457143	0.0000828	1.656E-05	2.052719166
Generator	3.5	Generator (Diesel)	3	10.5	0.1074	4.347E-06	8.694E-07	0.107767756
Front End Loader	103	Front End Loader (Diesel)	6	618	6.3212571	0.0002559	5.117E-05	6.342902222
Backhoe	166	Backhoe (Diesel)	4	664	6.7917714	0.0002749	5.498E-05	6.81502763
Crane	80	Crane (Diesel)	7	560	5.728	0.0002318	4.637E-05	5.747613664
Air compressor	48	Air Compressor (Diesel)	4	192	1.9638857	7.949E-05	1.59E-05	1.970610399

Boat	28	Boat (Gasoline)	8	224	2.0069333	0.000084	0.0000168	2.014039733
Vibratory Hammer	41	Vibratory Hammer (Diesel)	5	205	2.0968571	8.487E-05	1.697E-05	2.104037145
Hydro seeder	12	Hydro seeder (Diesel)	4	48	0.4909714	1.987E-05	3.974E-06	0.4926526
Stinger	12	Stinger (Gasoline)	2	24	0.2150286	0.000009	0.0000018	0.215789971
Auger	8	Auger (Diesel)	3	24	0.2454857	9.936E-06	1.987E-06	0.2463263
Compactor/roller	47	Compactor/Roller (Diesel)	5	235	2.4037143	9.729E-05	1.946E-05	2.41194502
Rock Barge	24	Rock Barge (Diesel)	20	480	4.9097143	0.0001987	3.974E-05	4.926525998
Hand Tools	28	Hand Tools	0.5	14	0.1254333	5.25E-06	1.05E-06	0.125877483

CO₂ equivalent (CO₂e) is a standard unit used to compare the global warming potential (GWP) of different greenhouse gases relative to carbon dioxide (CO₂). Since various gases have different abilities to trap heat in the atmosphere, CO₂e expresses the amount of any greenhouse gas in terms of the amount of CO₂ that would have the same global warming impact over a specific period, typically 100 years. CO₂e is calculated by multiplying the quantity of a given gas by its GWP value, which reflects its potency compared to CO₂ (Table 3).

Table 3. Global Warming Potential Factors

Global Warming Potentials (100 yr)	
CO ₂	1
CH ₄	25
N ₂ O	298

Total gross GHG emissions, solely from implementation of the Proposed Project, are estimated to be approximately **144.42 Metric Tons of CO₂e** (Table 2).

Using the NEAT TOOL which quantifies net emissions from the Proposed Action Alternative against the No Action Alternative's, while factoring in sequestration offsets from the creation of additional wetland habitat. The Proposed action is not expected to require operation and maintenance activities which would produce additional GHG emissions in the future. The estimated net emissions for the Proposed Project would be approximately **118 Metric Tons of CO₂e** (Figure 1).

Alternative 2 Amon Creek Relocation						
Pollutant Emissions (Clean Air Act)	Grams	Pounds	Metric Tons	Grams	Pounds	Metric Tons
Reactive Organic Gases aka Volatile Organic Compounds (ROG/VOC)	0	0	0	0	0	0
Carbon Monoxide (CO)	0	0	0	0	0	0
Sulfur Oxides (SOx)	0	0	0	0	0	0
Nitrous Oxides (NOx)	0	0	0	0	0	0
Particulate Matter - 2.5 micron (PM _{2.5})	0	0	0	0	0	0
Particulate Matter - 10 micron (PM ₁₀)	0	0	0	0	0	0
Lead - (Pb)	0	0	0	0	0	0
Greenhouse Gas Emissions (NEPA)						
Carbon Dioxide (CO ₂)	-112,091,385	-247,119	-112	-112,091,385	-247,119	-112
Methane (CH ₄)	9,024,932	19,897	9	9,024,932	19,897	9
Nitrous Oxide (N ₂ O)	14,152	31	0	14,152	31	0
Carbon Dioxide Equivalents (CO ₂ e)	117,749,095	259,593	118	117,749,095	259,593	118

Figure 1. NEAT Tool Net GHG Emissions

Social Costs

Social Costs of Greenhouse Gas Emissions in 2020 Dollars (\$)					
Alternative 1 - No Action Alternative	Construction Costs	O&M	Wetlands and Aquatic Habitat	Embodied Carbon	Total Social Costs by GHG
Carbon Dioxide (CO ₂)	\$0	\$0	\$0	\$0	\$0
Methane (CH ₄)	\$0	\$0	\$0	N/A	\$0
Nitrous Oxide (N ₂ O)	\$0	\$0	\$0	N/A	\$0
Total Social Costs By Activity	\$0	\$0	\$0	\$0	
Alternative 1 - No Action Alternative Gross Total					\$0
Alternative 1 - No Action Alternative Net Total					\$0

Social Costs of Greenhouse Gas Emissions in 2020 Dollars (\$)					
Alternative 2 Amon Creek Relocation	Construction Costs	O&M	Wetlands and Aquatic Habitat	Embodied Carbon	Total Social Costs by GHG
Carbon Dioxide (CO ₂)	\$18,710	\$0	-\$53,271	\$0	-\$34,561
Methane (CH ₄)	\$9	\$0	\$32,553	N/A	\$32,562
Nitrous Oxide (N ₂ O)	\$47	\$0	\$870	N/A	\$916
Total Social Costs By Activity	\$18,766	\$0	-\$19,848	\$0	
Alternative 2 Amon Creek Relocation Gross Total					-\$1,083
Alternative 2 Amon Creek Relocation Net Total					-\$1,083

Figure 2. NEAT Tool Net Social Costs for Proposed Project

The social cost of carbon (SCC) is a metric used to estimate the economic damages associated with an incremental increase in carbon dioxide emissions in a given year. It reflects the long-term impacts of carbon emissions on aspects like agricultural productivity, human health, property damages from increased flood risks, and changes in ecosystem services. By assigning a monetary value to these impacts, the SCC helps policymakers and organizations assess the benefits of reducing greenhouse gas emissions and inform climate-related decision-making. The estimated net social costs of implementing the Proposed Action Alternative over the No Action Alternative is **-\$1,083** (Figure 2).

References:

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