Appendix F
Record of Non-Applicability (RONA)

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GENERAL CONFORMITY – RECORD OF NON-APPLICABILITY

Project/Action Name:	**OEI Solar Project**
Project/Action Point of Contact:	**Ryan Knapp** **(443) 878-0344** ryan.m.knapp7.ctr@army.mil
Begin Date (Anticipated): 8/5/24	**End Date (Anticipated): 8/5/25**

The Proposed Action includes construction and operation of a new approximately 10 MW solar PV panel field on former landfill cells on Fort Meade, Maryland.

Emissions for Construction:

Volatile Organic Compounds (VOC)	0.98 tons per year (tpy)
Nitrogen Oxides (NO_x)	6.64 tpy
Sulfur Oxides (SO_x)	0.01 tpy
Carbon Monoxide (CO)	4.42 tpy
Particulate Matter Less than 2.5 µm ($PM_{2.5}$)	0.64 tpy

Emissions for Emergency Generator Operation (If Applicable):

Volatile Organic Compounds (VOC)	1.34 tons per year (tpy)[(1)]
Nitrogen Oxides (NO_x)	2.35 tpy
Sulfur Oxides (SO_x)	0.002 tpy
Carbon Monoxide (CO)	10.13 tpy
Particulate Matter Less than 10 µm (PM_{10})	0.08 tpy

[(1)] Calculations performed using an estimate of 500 hours of run-time per year at maximum output.

General Conformity under the Clean Air Act, Section 176 has been evaluated for the project described above according to the requirements of 40 CFR 93, Subpart B. The requirements of this rule are not applicable to this project/action because the highest annual emissions from this project/action have been estimated to be under the applicability thresholds as below:

Conformity Threshold Rate	
VOC	25 tpy
NO_x	25 tpy
SO_x	100 tpy
CO	100 tpy
$PM_{2.5}$	100 tpy

Supporting documentation and emissions estimates are attached.

George Knight
Chief, Environmental Division

Date

RECORD OF NON-APPLICABILITY (RONA)
SUPPORTING DOCUMENTATION
For OEI Solar Project

The purpose of this documentation is to support General Conformity applicability determinations under the Clean Air Act, Section 176 for the proposed Office of Energy Initiatives (OEI) Solar Project located on Fort George G. Meade (FMMD), Anne Arundel County, Maryland. This document provides an estimate of worst-case emissions from the proposed construction and operation of a 10-Megawatt Photovoltaic solar field on a former landfill site on FMMD. The emission estimates for which this documentation was developed were based on the following assumptions:

Project Characteristics and Area Disturbed

- Construction and operation of a new approximately 10 MW solar PV panel field on a former landfill on Fort Meade.

- A total of up to approximately 20 acres would be cleared and grubbed.

- The LOD will be cleared of vegetation, topsoil, and unsuitable material in order to prepare the site for construction.

- A conservative estimate of a project duration of approximately 252 days (1 year) was used. (The Solar PEA estimates a 5-10 month construction window for a 10 MW project, to include a site preparation phase of relatively short duration followed by a longer assembly, testing, and start-up phase.)

Explanation of Assumptions:

Acreage: (based on information provided in the Solar PEA):

On average, seven acres of land are currently required to produce one MW of power (USAEC, 2016). Based on current technology, extrapolation indicates approximately 70 acres of land would be required for a 10 MW site. Solar PV technology generally requires flat or gently rolling terrain with unobstructed views of the sun; ground-disturbing activities typically include vegetation removal, grubbing, and grading necessary to establish a somewhat smooth surface for the placement of the solar PV arrays. When using a ballasted ground mounting, no ground penetration is required as ballasted mounting systems use weight to hold down the racking and modules.

Most sites would require the construction of security fencing, equipment shelters(s), distribution lines to the substation(s), transformer station, and an access road for maintenance activities and, when necessary, emergency vehicles. Similar ground-disturbing activities would be likely for these related infrastructure components. The extent of access road requirements would be affected by the size of the array field and topographic conditions; but, in general, all-weather gravel access roads may be expected around the site perimeter and between some of the rows of solar panels.

New solar PV projects would require the construction, operation, and maintenance of a transmission line to transmit the energy created from the solar array to the electrical grid. Transmission lines may be buried or be above ground and are located within a transmission corridor typically consisting of a 50-foot right-of-way. For buried transmission lines, a temporary trench would be dug, followed by replacement of the topsoil and vegetation. As an example, for a 115 kV line, the temporary trench required to lay the buried cable would be, on average, five feet wide by four feet deep. Construction of the new utility corridor(s) and any associated utilities easement with the local utility company for this action would be along existing road disturbance limits and within existing utilities easements, to the greatest extent possible, to minimize ground disturbance.

Duration of Construction:

The above-described construction requirements for a solar PV system would generally be divided into two phases, which include a site preparation phase of relatively short duration followed by a longer assembly, testing, and start-up phase. A 10 MW project would require approximately five to 10 months for both phases of construction, with variables including weather and site conditions, and larger projects would require proportionally longer construction time. To support construction activities, trucks and vehicles would be required to transport construction equipment, solar PV components, and installation equipment to the site, construction and demolition (C&D) waste and construction/installation equipment from the site; and, construction workers and appropriate inspectors to and from the site.

Routine maintenance, equipment monitoring, and as-needed repairs by the system operator would follow to ensure proper operation of the solar PV system, including vegetation control, snow removal, solar module washing, and periodic module/other equipment replacement.

Electrical energy is typically an on-demand resource that must be transmitted or consumed at the time of generation. In the case of solar PV, without some form of energy storage, the electricity from a solar array may only be produced and used during times when incident solar radiation is sufficient to produce electricity. ESSs augment the daylight-only limitation by converting solar derived from electrical energy into another form that retains its energy content for long periods of time. The most common form of energy storage is chemical batteries, in which electrical energy is converted into chemical energy (energy held in the bonds of the chemicals in the battery), and then back again as the electrical system needs it.

A battery set with dimensions similar to a semi-truck trailer would typically be rated at several MW, and four to twelve hours of available capacity; this compared to the tens of acres (four-plus hectares) required for an equivalent solar PV array. ESSs of this size typically come in several modules that are mounted on concrete pads and interconnected. A large portion of the total ESS is the energy storage proper, but supporting equipment such as cooling systems, battery management systems, and power converters are also present. Connections between modules, both for energy transfer and communication, must be made, as well as the connection to a transformer which translates the output of the power converter to the appropriate system voltage.

A typical commercial or industrial fuel cell application, scalable up to several MWs, can be sited on modest footprints. For example, modularly designed 1-2 MW fuel cell system would require a site area of 4,000-4,500 ft2 (372-418 m2), or a total of approximately 0.1 acres (0.04 hectares)

(Doosan, 2014; Hydrogenics, 2013), with additional space requirements expected for supporting systems such as cooling, fuel storage, and switching/transmission as required.

Contractor and Equipment Assumptions

- Assumed forty contractor staff would be on-site for 252 working days to complete this work. Approximately 20% would commute to the site each day in a light duty diesel truck, with a round trip of 30 miles.

- Assumed two heavy duty diesel trucks would come to the site (again, 30-mile roundtrip) each construction day, to mobilize and demobilize the equipment.

- Assumed durations of operation for heavy equipment are explicitly identified in the Excel spreadsheet where air emissions are quantified for this project. This includes the following:

    - Estimated equipment to be used includes skid steer (bobcat), cement mixers, plate compactors, lifts, excavators, backhoes, asphalt pavers, paving equipment, graders and dumpers/tenders. The majority of construction machinery would not continuously operate for 8 hours per day for 12 months, but more likely operate for four hours per day; the frequency of use is reflected in the attached emissions calculation sheet. It was also assumed that for most equipment, only one or two of each type of machinery would be active at the site. However, it was assumed that three skid steers would be used 8 hours a day for one year (approximately 2,000 hours each per year).

Project Duration

- Assumed to be 252 working days, or one year, which will dictate contractor travel to the site, and the number of 8-hour days over which fugitive dust emissions will be generated as a result of the work performed.

- Operational emissions will result from the project (i.e., permanent air emissions sources from the generator).

Emissions

The emission calculations to quantify these values are presented in the Excel spreadsheet and were performed using methodology and information provided in the *Air Emissions Guide for Air Force Mobile Sources, U.S. Air Force Installations, June 2021, Air Emissions Guide for Air Force Transitory Sources, 2016, and Air Emissions Factor Guide to Air Force Stationary Sources, 2020.*

Construction Equipment Air Quality Emissions Factors

DIESEL FUEL - Criteria Pollutant Emission Factors for Non-Road Engines and Equipment - 2024

SCC	Equipment Description	Load Factor [a] (% Max Power)	BSFC [b] (lb/1000 hp-hr)	Emission Factors (lb/1,000 hp-hr)						
				CO	VOC	NO_x	SO_2	PM_{10} [d]	$PM_{2.5}$ [c,f]	CO_2e [g]
2270001060	Diesel Specialty Vehicle Carts	21	450	5.638	1.422	7.614	0.012	0.850	0.825	1440.020
2270002003	Diesel Pavers	59	380	0.433	0.073	1.763	0.008	0.079	0.077	1214.350
2270002006	Diesel Tampers/Rammers	43	1000	5.637	1.831	9.337	0.012	0.571	0.554	1300.218
2270002009	Diesel Plate Compactors	43	410	4.867	1.490	9.002	0.012	0.507	0.492	1300.485
2270002015	Diesel Rollers	59	390	0.667	0.108	2.328	0.008	0.111	0.107	1233.940
2270002018	Diesel Scrapers	59	370	0.483	0.066	1.145	0.008	0.071	0.069	1183.458
2270002021	Diesel Paving Equipment	59	390	0.913	0.180	2.776	0.009	0.148	0.144	1227.292
2270002024	Diesel Surfacing Equipment	59	380	1.593	0.251	4.477	0.009	0.220	0.214	1224.364
2270002027	Diesel Signal Boards/Light Plants	43	410	2.614	0.650	7.425	0.011	0.315	0.306	1293.794
2270002030	Diesel Trenchers	59	400	1.105	0.184	4.312	0.009	0.153	0.148	1273.741
2270002033	Diesel Bore/Drill Rigs	43	370	1.538	0.392	5.849	0.009	0.282	0.274	1190.574
2270002036	Diesel Excavators	59	380	0.226	0.045	0.957	0.008	0.045	0.044	1194.769
2270002039	Diesel Concrete/Industrial Saws	59	410	1.272	0.226	4.755	0.009	0.172	0.167	1305.098
2270002042	Diesel Cement & Mortar Mixers	43	390	2.971	0.758	7.291	0.010	0.464	0.450	1244.880
2270002045	Diesel Cranes	43	370	0.380	0.085	1.565	0.008	0.070	0.068	1175.751
2270002048	Diesel Graders	59	370	0.218	0.042	0.685	0.008	0.048	0.046	1185.407
2270002051	Diesel Off-highway Trucks	59	370	0.230	0.070	3.183	0.008	0.053	0.051	1183.453
2270002054	Diesel Crushing/Proc. Equipment	43	380	0.573	0.119	2.716	0.008	0.089	0.087	1203.298
2270002057	Diesel Rough Terrain Forklifts	59	390	0.922	0.112	2.661	0.009	0.156	0.151	1255.885
2270002060	Diesel Rubber Tire Loaders	59	370	0.570	0.095	2.006	0.008	0.099	0.096	1190.494
2270002066	Diesel Tractors/Loaders/ Backhoes	21	460	3.369	0.699	4.797	0.011	0.549	0.533	1467.169

SCC	Equipment Description	Load Factor [a] (% Max Power)	BSFC [b] (lb/1000 hp-hr)	Emission Factors (lb/1,000 hp-hr)						
				CO	VOC	NO_x	SO_2	PM_{10} [d]	$PM_{2.5}$ [e,f]	CO_2e [g]
2270002069	Diesel Crawler Tractor/Dozers	59	370	0.410	0.068	1.607	0.008	0.072	0.070	1190.046
2270002072	Diesel Skid Steer Loaders	21	480	6.530	1.357	8.149	0.012	1.016	0.985	1529.685
2270002075	Diesel Off-Highway Tractors	59	370	0.711	0.123	3.411	0.008	0.107	0.104	1183.380
2270002078	Diesel Dumpers/Tenders	21	470	6.628	1.541	8.274	0.012	1.003	0.973	1508.951
2270002081	Diesel Other Construction Equipment	59	370	1.093	0.157	2.771	0.009	0.156	0.151	1185.510
2270003010	Diesel Aerial Lifts	21	480	5.828	1.246	8.146	0.012	0.803	0.779	1531.533
2270003020	Diesel Forklifts	59	400	0.198	0.045	2.312	0.008	0.031	0.030	1265.586
2270003030	Diesel Sweepers/Scrubbers	43	380	0.341	0.068	1.819	0.008	0.060	0.058	1219.331
2270003040	Diesel Other General Industrial Equipment	43	380	0.534	0.105	2.134	0.008	0.102	0.099	1205.563
2270003050	Diesel Other Material Handling Equipment	21	440	3.265	0.837	5.740	0.011	0.550	0.534	1414.122
2270003060	Diesel AC\Refrigeration	43	410	0.763	0.195	5.868	0.009	0.079	0.077	1301.607
2270003070	Diesel Terminal Tractors	59	380	0.123	0.029	0.710	0.008	0.028	0.027	1199.663
2270004031	Diesel Leaf blowers/Vacuums	43	410	5.197	1.468	10.116	0.011	0.751	0.729	1299.052
2270004036	Diesel Snow blowers	43	370	0.888	0.221	3.372	0.005	0.151	0.146	682.553
2270004046	Diesel Front Mowers	43	410	2.511	0.597	7.540	0.011	0.348	0.337	1301.043
2270004056	Diesel Lawn & Garden Tractors	43	410	3.237	0.764	8.123	0.012	0.381	0.370	1301.003
2270004066	Diesel Chippers/Stump Grinders	43	380	2.042	0.452	6.089	0.010	0.367	0.356	1215.866
2270004071	Diesel Commercial Turf Equipment	43	400	0.856	0.192	3.904	0.009	0.116	0.113	1263.302
2270004076	Diesel Other Lawn & Garden Equipment	43	410	3.329	0.744	8.308	0.011	0.549	0.533	1293.361
2270005010	Diesel 2-Wheel Tractors	59	410	5.453	1.841	9.219	0.012	0.530	0.515	1313.074
2270005015	Diesel Agricultural Tractors	59	380	1.794	0.306	4.542	0.009	0.304	0.295	1211.403
2270005020	Diesel Combines	59	370	2.318	0.546	6.648	0.010	0.481	0.466	1185.487
2270005025	Diesel Balers	59	400	4.484	0.829	7.966	0.010	0.655	0.635	1269.967
2270005030	Diesel Agricultural Mowers	59	410	5.202	0.664	6.952	0.011	0.775	0.752	1313.158
2270005035	Diesel Sprayers	59	380	2.724	0.630	6.531	0.010	0.451	0.438	1195.936

SCC	Equipment Description	Load Factor [a] (% Max Power)	BSFC [b] (lb/1000 hp-hr)	Emission Factors (lb/1,000 hp-hr)						
				CO	VOC	NO_x	SO_2	PM_{10} [d]	$PM_{2.5}$ [e,f]	CO_2e [g]
2270005040	Diesel Tillers > 6 HP	59	370	2.968	0.472	6.399	0.010	0.378	0.367	1186.691
2270005045	Diesel Swathers	59	400	4.766	0.744	7.874	0.011	0.719	0.697	1284.529
2270005055	Diesel Other Agricultural Equipment	59	380	2.370	0.450	5.586	0.010	0.420	0.408	1196.464
2270005060	Diesel Irrigation Sets	43	390	1.072	0.201	3.556	0.009	0.198	0.192	1235.252
2270006005	Diesel Generator Sets	43	390	2.308	0.553	6.454	0.010	0.375	0.364	1254.291
2270006010	Diesel Pumps	43	390	2.410	0.566	6.443	0.010	0.403	0.391	1253.341
2270006015	Diesel Air Compressors	43	400	0.962	0.168	3.863	0.009	0.154	0.150	1266.179
2270006020	Diesel Gas Compressors	43	410	0.205	0.044	2.965	0.009	0.033	0.032	1301.567

Notes:

a. Load factor and activity data obtained from EPA Office of Transportation Air Quality and were derived from *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling*, EPA 420-R-10-016, NR-005d, July 2010.

b. BSFC and emission factors obtained from EPA Office of Transportation Air Quality and were derived from *Exhaust Emission Factors for Nonroad Engine Modeling: Spark-Ignition*, EPA 420-R-019, NR-010e, December 2005, and *Exhaust Emission Factors for Nonroad Engine Modeling: Compression-Ignition*, EPA 420-P-04-009, NR-009c, April 2004. The emission factors are composite emission factors that represent the national mix of model years and technology types believed to be in existence in 2007. They represent in-use emissions and consider NONROAD model deterioration and transient adjustment factors across all model years.

c. Activities for off-road motorcycles and all-terrain vehicles are in units of miles per year instead of hours per year.

d. PM10 is assumed to be equivalent to total PM for gasoline engines.

e. For gasoline engines, $PM_{2.5}$ is assumed to be 92% of the PM_{10} value.

f. For LPG and CNG engines, all PM is assumed to be $PM_{2.5}$.

g. The Carbon Dioxide Equivalent (CO_2e) emission factors are the total of CO_2 and CH_4 converted to equivalent CO_2 (CO_2e) using a global warming potential (GWP) value of 25 for CH_4. The converted CH_4 value was added to the CO_2 emission factor and presented as a CO_2e emission factor in units of lb/1000lb. Calculations were made using the stated BSFC, the fuel density in Table 3-1, and if the fuel was not stated, it was assumed to be gasoline. N_2O is not included in these calculations because there is no N_2O pollutant output for the NONROAD module within MOVES2014b.

COMPRESSED NATURAL GAS - Criteria Pollutant Emission Factors for Generators - 2024

SCC	Equipment Description	Load Factor [a] (% Max Power)	BSFC [b] (lb/1000 hp-hr)	Emission Factors (lb/1,000 hp-hr)						
				CO	VOC	NO_x	SO_2	PM_{10} [d]	$PM_{2.5}$ [e,f]	CO_2e [g]
2268006005	CNG Generator Sets	68	490	30.211	3.995	7.009	0.006	0.124	0.124	1533.727

Notes:

a. Load factor and activity data obtained from EPA Office of Transportation Air Quality and were derived from *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling*, EPA 420-R-10-016, NR-005d, July 2010.

b. BSFC and emission factors obtained from EPA Office of Transportation Air Quality and were derived from *Exhaust Emission Factors for Nonroad Engine Modeling: Spark-Ignition*, EPA 420-R-019, NR-010e, December 2005, and *Exhaust Emission Factors for Nonroad Engine Modeling: Compression-Ignition*, EPA 420-P-04-009, NR-009c, April 2004. The emission factors are composite emission factors that represent the national mix of model years and technology types believed to be in existence in 2007. They represent in-use emissions and consider NONROAD model deterioration and transient adjustment factors across all model years.

c. Activities for off-road motorcycles and all-terrain vehicles are in units of miles per year instead of hours per year.

d. PM10 is assumed to be equivalent to total PM for gasoline engines.

e. For gasoline engines, $PM_{2.5}$ is assumed to be 92% of the PM_{10} value.

f. For LPG and CNG engines, all PM is assumed to be $PM_{2.5}$.

g. The Carbon Dioxide Equivalent (CO_2e) emission factors are the total of CO_2 and CH_4 converted to equivalent CO_2 (CO_2e) using a global warming potential (GWP) value of 25 for CH_4. The converted CH_4 value was added to the CO_2 emission factor and presented as a CO_2e emission factor in units of lb/1000lb. Calculations were made using the stated BSFC, the fuel density in Table 3-1, and if the fuel was not stated, it was assumed to be gasoline. N_2O is not included in these calculations because there is no N_2O pollutant output for the NONROAD module within MOVES2014b.

Fugitive Dust from Site Preparation for OEI Solar Project

Description:

Total disturbed area (square feet):	871,200
Total disturbed area (acres):	20.000
Assumed number of 8-hr work days:	130

Equation for Fugitive Dust Emissions (PM_{10})

E_{PM10} (lb/yr) = 20 (lb/acre day) * GA (acres) * WD (days)

Where:

20 = factor converting acre-day to lb
GA = grading area (acres)
WD = work days

Calculation

E_{PM10} =	52000.00	lb/yr
	2.60E+01	tpy

Assumptions

1. Construction of a 10 MW solar array on a closed landfill. LOD will be cleared of all vegetation, topsoil, and unsuitable material. Acreage of clearing/grubbing estimated at 104 acres.
2. Convert acres to square feet: 20*43560
3. It was conservatively assumed that $PM_{10} = PM_{2.5}$.
4. Assumed a six-month site preparation window (127.5 hours rounded up to 130 for a conservative estimate.)

Source of Equation

Air Emissions Guide to Air Force Transitory Sources, July 2016, Section 4, Equation 4.4.

<u>Area of disturbance:</u>

Closed landfill cells add up to approximately 81 acres, but the assumption is that the landfill cap would not be graded, and a ballasted system would be used to install the panels in order to avoid penetrating the clay soil cap; therefore, the acreage of the landfill cells, where the panels would be installed, was not included in the site preparation acreage calculations. An access road connecting an existing dirt road to the closest point of the array field would be approximately 3 acres of surface area; a transmission corridor using existing utility rights of way and/or road shoulders was approximated to be between 7,193 linear feet to 8,696 linear feet long by 25 feet wide (4.13-4.99 acres); plus, up to an additional 1.75 acre (approximate) would be impacted to construct concrete pads for the battery facility(ies). The width of disturbance for the utility corridor was conservatively estimated at 25 feet (5-foot-wide trench, with an approximately 10-foot-wide work area for equipment and temporarily side cast material, rounded up to 25 feet for a conservative estimate). These components (i.e., the access road, utility pathway and battery system) add up to 13.8 acres. This was rounded up to 20 acres to allow flexibility in project design and to provide a conservative estimate of potential area disturbed during site preparation.

Personal Vehicle Emissions for OEI Solar Project

Personal Vehicles	Number of Vehicles	Calendar Years	Emissions Factors (grams/mile)						
			CO	NOx	VOC	PM_{10}	$PM_{2.5}$	SOx	CO_{2e}
Heavy-Duty Vehicles (8,501 + lbs)	2	2024 & 25	0.079	0.336	0.013	8.25E-0	7.59E-03	1.70E-03	201.618
Light-Duty Trucks (0-8,500 lbs)	16	2024 & 25	0.186	0.013	0.002	1.67E-04	1.53E-04	1.63E-04	4.78E-04

Personal Vehicles	Number of Days	Number of Vehicles	Miles/Day	Emissions (lbs/year)						
				CO	NOx	VOC	PM_{10}[1]	$PM_{2.5}$[1]	SOx	CO_{2e}
Heavy Duty Diesel Trucks	252	2	30	2.63	11.20	0.43	275.0	0.253	0.057	6720.74
Light Duty Diesel Trucks	252	16	30	49.60	3.47	0.53	0.04	0.041	0.043	0.127

Assumptions:

- Approximately 40-80 contractors on-site on any one day, approximately 20% driving light duty diesel trucks.
- Assume 2 heavy duty trucks for material and equipment hauling for the duration of the project.
- The project duration is approximately 252 days, which is one year of work.
- Average round trip is 30 miles/day.

Source: Emissions factors and methodology from Air Emissions Factor Guide to Air Force Mobile Sources, June 2021, Section 5, Table 5-22, specific to year 2024 and in Maryland.

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TOTAL PROJECT CONSTRUCTION AND OPERATION EMISSIONS												
Construction Equipment	How many units	Hours per day	Days per week	Weeks per year	Usage (hrs)	Emissions (lbs) CO	NOx	VOC	PM_{10}	$PM_{2.5}$	SOx	CO_{2e} (tpy)
Diesel Plate Compactors	1	8	5	25	1000	858	1,587	263	89	87	2	1,300,485
Diesel Paving Equipment	1	8	5	25	1000	210	639	41	34	33	2	1,227,292
Diesel Excavators	2	8	5	25	2000	101	429	20	20	20	4	2,389,538
Diesel Cement & Mortar Mixers	1	8	5	25	1000	498	1,223	127	78	75	2	1,244,880
Diesel Graders	1	8	5	25	1000	48	150	9	10	10	2	1,185,407
Diesel Tractors/Loaders/ Backhoes	2	8	5	50	4000	1,302	1,854	270	212	206	4	5,868,676
Diesel Skid Steer Loaders	3	8	5	50	6000	3,949	4,929	821	614	596	7	9,178,110
Diesel Dumpers/Tenders	1	8	5	25	1000	654	817	152	99	96	1	1,508,951
Diesel Aerial Lifts	1	8	5	50	2000	1,175	1,642	251	162	157	2	3,063,066
Total Construction Equiment (tpy)						**4.4**	**6.6**	**1.0**	**0.7**	**0.6**	**0.01**	**13,483.2**
POVs - Contractors (tpy)						**0.026**	**0.007**	**0.000**	**0.138**	**0.0001**	**0.0001**	**3.36**
TOTAL - Construction Phase (tpy)						**4.42**	**6.64**	**0.98**	**0.80**	**0.64**	**0.01**	**13,486.56**
Nat Gas Generators (Operation Phase) (tpy)					**500**	**10.13**	**2.35**	**1.34**	**0.08**	**--**	**0.002**	**514.18**

Assumptions:

Source: The above estimates were calculated using the methodology and information provided in the Air Emissions Guide for Air Force Mobile Sources, U.S. Air Force Installations, June 2021, Air Emissions Guide for Air Force Transitory Sources, 2016, and Air Emissions Factor Guide to Air Force Stationary Sources, 2020.

1-year construction window = 250 work days; 250 days * 8 hrs/day = 2,000 hrs

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Calculations for RONA

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SOURCE: ***Nonroad Engine and Vehicle Emission Study--Report*****,**
U.S. EPA, November 1991 (Document: 21A-2001)

LATEST REVISION: **10/14/2023**

INSTRUCTIONS:

1. In general, the emissions factors should not be changed. Only diesel EFs are included. If gasoline-equipment EFs are needed, consult the *Study*.

2. Enter equipment usage (in hours) for the desired period into the EMISSIONS sheet. Typically, this would be annual usage. Multiplication factors (and a table) are provided for any seasonal calculations.

SCC	Equipment Description	Load Factor [a] (% Max Power	BSFC [b] (lb/1000 hp-hr)	Emission Factors (lb/1000 hp-hr)							Emission Factors (lb/hr)						
				CO	NOx	VOC	PM10 [d]	PM2.5 [e,f]	SO2	CO2e [g]	CO	NOx	VOC	PM10 [d]	PM2.5 [e,f]	SO2	CO2e [g]
2270001060	Diesel Specialty Vehicle Carts	0.21	450	5.638	7.614	1.422	0.85	0.825	0.012	1440.02	0.533	0.719523	0.134379	0.080325	0.077963	0.001134	136.0819
2270002003	Diesel Pavers	0.59	380	0.433	1.763	0.073	0.079	0.077	0.008	1214.35	0.097	0.395265	0.016367	0.017712	0.017263	0.001794	272.2573
2270002006	Diesel Tampers/Rammers	0.43	1000	5.637	9.337	1.831	0.571	0.554	0.012	1300.218	2.424	4.01491	0.78733	0.24553	0.23822	0.00516	559.0937
2270002009	Diesel Plate Compactors	0.43	410	4.867	9.002	1.49	0.507	0.492	0.012	1300.485	0.858	1.587053	0.262687	0.089384	0.08674	0.002116	229.2755
2270002015	Diesel Rollers	0.59	390	0.667	2.328	0.108	0.111	0.107	0.008	1233.94	0.153	0.535673	0.024851	0.025541	0.024621	0.001841	283.9296
2270002018	Diesel Scrapers	0.59	370	0.483	1.145	0.066	0.071	0.069	0.008	1183.458	0.105	0.249954	0.014408	0.015499	0.015063	0.001746	258.3489
2270002021	Diesel Paving Equipment	0.59	390	0.913	2.776	0.18	0.148	0.144	0.009	1227.292	0.21	0.638758	0.041418	0.034055	0.033134	0.002071	282.3999
2270002024	Diesel Surfacing Equipment	0.59	380	1.593	4.477	0.251	0.22	0.214	0.009	1224.364	0.357	1.003743	0.056274	0.049324	0.047979	0.002018	274.5024
2270002027	Diesel Signal Boards/Light Plants	0.43	410	2.614	7.425	0.65	0.315	0.306	0.011	1293.794	0.461	1.309028	0.114595	0.055535	0.053948	0.001939	228.0959
2270002030	Diesel Trenchers	0.59	400	1.105	4.312	0.184	0.153	0.148	0.009	1273.741	0.261	1.017632	0.043424	0.036108	0.034928	0.002124	300.6029
2270002033	Diesel Bore/Drill Rigs	0.43	370	1.538	5.849	0.392	0.282	0.274	0.009	1190.574	0.245	0.930576	0.062367	0.044866	0.043593	0.001432	189.4203
2270002036	Diesel Excavators	0.59	380	0.226	0.957	0.045	0.045	0.044	0.008	1194.769	0.051	0.214559	0.010089	0.010089	0.009865	0.001794	267.8672
2270002039	Diesel Concrete/Industrial Saws	0.59	410	1.272	4.755	0.226	0.172	0.167	0.009	1305.098	0.308	1.150235	0.054669	0.041607	0.040397	0.002177	315.7032
2270002042	Diesel Cement & Mortar Mixers	0.43	390	2.971	7.291	0.758	0.464	0.45	0.01	1244.88	0.498	1.222701	0.127117	0.077813	0.075465	0.001677	208.7664
2270002045	Diesel Cranes	0.43	370	0.38	1.565	0.085	0.07	0.068	0.008	1175.751	0.06	0.248992	0.013524	0.011137	0.010819	0.001273	187.062
2270002048	Diesel Graders	0.59	370	0.218	0.685	0.042	0.048	0.046	0.008	1185.407	0.048	0.149536	0.009169	0.010478	0.010042	0.001746	258.7743
2270002051	Diesel Off-highway Trucks	0.59	370	0.23	3.183	0.07	0.053	0.051	0.008	1183.453	0.05	0.694849	0.015281	0.01157	0.011133	0.001746	258.3478
2270002054	Diesel Crushing/Proc. Equipment	0.43	380	0.573	2.716	0.119	0.089	0.087	0.008	1203.298	0.094	0.443794	0.019445	0.014543	0.014216	0.001307	196.6189
2270002057	Diesel Rough Terrain Forklifts	0.59	390	0.922	2.661	0.112	0.156	0.151	0.009	1255.885	0.212	0.612296	0.025771	0.035896	0.034745	0.002071	288.9791
2270002060	Diesel Rubber Tire Loaders	0.59	370	0.57	2.006	0.095	0.099	0.096	0.008	1190.494	0.124	0.43791	0.020739	0.021612	0.020957	0.001746	259.8848
2270002066	Diesel Tractors/Loaders/ Backhoes	0.21	460	3.369	4.797	0.699	0.549	0.533	0.011	1467.169	0.325	0.46339	0.067523	0.053033	0.051488	0.001063	141.7285
2270002069	Diesel Crawler Tractor/Dozers	0.59	370	0.41	1.607	0.068	0.072	0.07	0.008	1190.046	0.09	0.350808	0.014844	0.015718	0.015281	0.001746	259.787
2270002072	Diesel Skid Steer Loaders	0.21	480	6.53	8.149	1.357	1.016	0.985	0.012	1529.685	0.658	0.821419	0.136786	0.102413	0.099288	0.00121	154.1922
2270002075	Diesel Off-Highway Tractors	0.59	370	0.711	3.411	0.123	0.107	0.104	0.008	1183.38	0.155	0.744621	0.026851	0.023358	0.022703	0.001746	258.3319
2270002078	Diesel Dumpers/Tenders	0.21	470	6.628	8.274	1.541	1.003	0.973	0.012	1508.951	0.654	0.816644	0.152097	0.098996	0.096035	0.001184	148.9335
2270002081	Diesel Other Construction Equipment	0.59	370	1.093	2.771	0.157	0.156	0.151	0.009	1185.51	0.239	0.604909	0.034273	0.034055	0.032963	0.001965	258.7968
2270003010	Diesel Aerial Lifts	0.21	480	5.828	8.146	1.246	0.803	0.779	0.012	1531.533	0.587	0.821117	0.125597	0.080942	0.078523	0.00121	154.3785
2270003020	Diesel Forklifts	0.59	400	0.198	2.312	0.045	0.031	0.03	0.008	1265.586	0.047	0.545632	0.01062	0.007316	0.00708	0.001888	298.6783
2270003030	Diesel Sweepers/Scrubbers	0.43	380	0.341	1.819	0.068	0.06	0.058	0.008	1219.331	0.056	0.297225	0.011111	0.009804	0.009477	0.001307	199.2387
2270003040	Diesel Other General Industrial Equipment	0.43	380	0.534	2.134	0.105	0.102	0.099	0.008	1205.563	0.087	0.348696	0.017157	0.016667	0.016177	0.001307	196.989
2270003050	Diesel Other Material Handling Equipment	0.21	440	3.265	5.74	0.837	0.55	0.534	0.011	1414.122	0.302	0.530376	0.077339	0.05082	0.049342	0.001016	130.6649
2270003060	Diesel AC\Refrigeration	0.43	410	0.763	5.868	0.195	0.079	0.077	0.009	1301.607	0.135	1.034528	0.034379	0.013928	0.013575	0.001587	229.4733
2270003070	Diesel Terminal Tractors	0.59	380	0.123	0.71	0.029	0.028	0.027	0.008	1199.663	0.028	0.159182	0.006502	0.006278	0.006053	0.001794	268.9644
2270004031	Diesel Leaf blowers/Vacuums	0.43	410	5.197	10.116	1.468	0.751	0.729	0.011	1299.052	0.916	1.783451	0.258808	0.132401	0.128523	0.001939	229.0229
2270004036	Diesel Snow blowers	0.43	370	0.888	3.372	0.221	0.151	0.146	0.005	682.553	0.141	0.536485	0.035161	0.024024	0.023229	0.000796	108.5942
2270004046	Diesel Front Mowers	0.43	410	2.511	7.54	0.597	0.348	0.337	0.011	1301.043	0.443	1.329302	0.105251	0.061352	0.059413	0.001939	229.3739
2270004056	Diesel Lawn & Garden Tractors	0.43	410	3.237	8.123	0.764	0.381	0.37	0.012	1301.003	0.571	1.432085	0.134693	0.06717	0.065231	0.002116	229.3668
2270004066	Diesel Chippers/Stump Grinders	0.43	380	2.042	6.089	0.452	0.367	0.356	0.01	1215.866	0.334	0.994943	0.073857	0.059968	0.05817	0.001634	198.6725
2270004071	Diesel Commercial Turf Equipment	0.43	400	0.856	3.904	0.192	0.116	0.113	0.009	1263.302	0.147	0.671488	0.033024	0.019952	0.019436	0.001548	217.2879
2270004076	Diesel Other Lawn & Garden Equipment	0.43	410	3.329	8.308	0.744	0.549	0.533	0.011	1293.361	0.587	1.4647	0.131167	0.096789	0.093968	0.001939	228.0195
2270005010	Diesel 2-Wheel Tractors	0.59	410	5.453	9.219	1.841	0.53	0.515	0.012	1313.074	1.319	2.230076	0.445338	0.128207	0.124579	0.002903	317.6326
2270005015	Diesel Agricultural Tractors	0.59	380	1.794	4.542	0.306	0.304	0.295	0.009	1211.403	0.402	1.018316	0.068605	0.068157	0.066139	0.002018	271.5966
2270005020	Diesel Combines	0.59	370	2.318	6.648	0.546	0.481	0.466	0.01	1185.487	0.506	1.451258	0.119192	0.105002	0.101728	0.002183	258.7918
2270005025	Diesel Balers	0.59	400	4.484	7.966	0.829	0.655	0.635	0.01	1269.967	1.058	1.879976	0.195644	0.15458	0.14986	0.00236	299.7122
2270005030	Diesel Agricultural Mowers	0.59	410	5.202	6.952	0.664	0.775	0.752	0.011	1313.158	1.258	1.681689	0.160622	0.187473	0.181909	0.002661	317.6529
2270005035	Diesel Sprayers	0.59	380	2.724	6.531	0.63	0.451	0.438	0.01	1195.936	0.611	1.46425	0.141246	0.101114	0.0982	0.002242	268.1289
2270005040	Diesel Tillers > 6 HP	0.59	370	2.968	6.399	0.472	0.378	0.367	0.01	1186.691	0.648	1.396902	0.103038	0.082517	0.080116	0.002183	259.0546
2270005045	Diesel Swathers	0.59	400	4.766	7.874	0.744	0.719	0.697	0.011	1284.529	1.125	1.858264	0.175584	0.169684	0.164492	0.002596	303.1488
2270005055	Diesel Other Agricultural Equipment	0.59	380	2.37	5.586	0.45	0.42	0.408	0.01	1196.464	0.531	1.252381	0.10089	0.094164	0.091474	0.002242	268.2472
2270005060	Diesel Irrigation Sets	0.43	390	1.072	3.556	0.201	0.198	0.192	0.009	1235.252	0.18	0.596341	0.033708	0.033205	0.032198	0.001509	207.1518
2270006005	Diesel Generator Sets	0.43	390	2.308	6.454	0.553	0.375	0.364	0.01	1254.291	0.387	1.082336	0.092736	0.062888	0.061043	0.001677	210.3446
2270006010	Diesel Pumps	0.43	390	2.41	6.443	0.566	0.403	0.391	0.01	1253.341	0.404	1.080491	0.094918	0.067583	0.065571	0.001677	210.1853
2270006015	Diesel Air Compressors	0.43	400	0.962	3.863	0.168	0.154	0.15	0.009	1266.179	0.165	0.664436	0.028896	0.026488	0.0258	0.001548	217.7828
2270006020	Diesel Gas Compressors	0.43	410	0.205	2.965	0.044	0.033	0.032	0.009	1301.567	0.036	0.52273	0.007757	0.005818	0.005642	0.001587	229.4663

a. Load factor and activity data obtained from EPA Office of Transportation Air Quality and were derived from *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling* , EPA 420-R-10-016, NR-005d, July 2010.

b. BSFC and emission factors obtained from EPA Office of Transportation Air Quality and were derived from *Exhaust Emission Factors for Nonroad Engine Modeling: Spark-Ignition* , EPA 420-R-019, NR-010e, December 2005, and *Exhaust Emission Factors for Nonroad Engine Modeling: Compression-Ignition* , EPA 420-P-04-009, NR-009c, April 2004. The emission factors are composite emission factors that represent the national mix of model years and technology types believed to be in existence in 2007. They represent in-use emissions and consider NONROAD model deterioration and transient adjustment factors across all model years.

c. Activities for off-road motorcycles and all-terrain vehicles are in units of miles per year instead of hours per year.

d. PM_{10} is assumed to be equivalent to total PM for gasoline engines.

e. For gasoline engines, $PM_{2.5}$ is assumed to be 92% of the PM_{10} value.

f. For LPG and CNG engines, all PM is assumed to be $PM_{2.5}$.

g. The Carbon Dioxide Equivalent (CO_2e) emission factors are the total of CO_2 and CH_4 converted to equivalent CO_2 (CO_2e) using a global warming potential (GWP) value of 25 for CH_4. The converted CH_4 value was added to the CO_2 emission factor and presented as a CO_2e emission factor in units of lb/1000lb. Calculations were made using the stated BSFC, the fuel density in Table 3-1, and if the fuel was not stated, it was assumed to be gasoline. N_2O is not included
in these calculations because there is no N_2O pollutant output for the NONROAD module within MOVES2014b.

Fugitive Dust from Site Preparation for OEI Solar Project

Description:	
Total disturbed area (square feet):	871,200
Total disturbed area (acres):	20.000
Assumed number of 8-hr work days:	130

Equation for Fugitive Dust Emissions (PM_{10})

E_{PM10} (lb/yr) = 20 (lb/acre day) * GA (acres) * WD (days)

Where:

20 = factor converting acre-day to lb
GA = grading area (acres)
WD = work days

Calculation

E_{PM10} = 52000.00 lb/yr
2.60E+01 tpy

Assumptions

1. Construction of a 10 MW solar array on a closed landfill. LOD will be cleared of all vegetation, topsoil, and unsuitable material. Acreage of clearing/grubbing estimated at 20 acres.
2. Convert acres to square feet: 20*43560
3. It was conservatively assumed that $PM_{10} = PM_{2.5}$.
4. Assumed a six-month site preparation window (127.5 hours rounded up to 130 for a conservative estimate.)

Source of Equation

Air Emissions Guide to Air Force Transitory Sources, July 2016, Section 4, Equation 4.4.

Personal Vehicle Emissions for OEI Solar Project

Personal Vehicles	Number of Vehicles	Calendar Years	Emissions Factors (grams/mile)						
			CO	NOx	VOC	PM_{10}	$PM_{2.5}$	SOx	CO_{2e}
Heavy Duty Diesel Trucks	2	2024 & 25	0.079	0.336	0.013	8.25E+00	7.59E-03	1.70E-03	201.618
Light Duty Diesel Trucks	16	2024 & 25	0.186	0.013	0.002	1.67E-04	1.53E-04	1.63E-04	4.78E-04

Personal Vehicles	Number of Days	Number of Vehicles	Miles/Day	Emissions (lbs/year)						
				CO	NOx	VOC	PM_{10}	$PM_{2.5}$	SOx	CO_{2e}
Heavy Duty Diesel Trucks	252	2	30	2.63	11.20	0.43	275.006	0.253	0.057	6720.748
Light Duty Diesel Trucks	252	16	30	49.60	3.47	0.53	0.04	0.041	0.043	0.127469

Assumptions:

- Approximately 40-80 contractors on-site on any one day, approximately 20% driving light duty diesel trucks.
- Assume 2 heavy duty trucks for material and equipment hauling for the duration of the project.
- The project duration is approximately 252 days, which is one year of work.
- Average round trip is 30 miles/day.

Source: Emissions factors and methodology from Air Emissions Factor Guide to Air Force Mobile Sources, June 2021, Section 5, Table 5-22; for year 2024 and specific to Maryland.

Potential to Emit (PTE) Calculations
OEI Solar Project Generator

Pollutant	Emissions Factor lb/hp-hr [2]		DIESEL PTE Rates [4]		NATURAL GAS PTE Rates [5]	
	DIESEL	NATURAL GAS	(lb/yr)	(tpy)	(lb/yr)	(tpy)
OEI Solar Project Emergency Generator [1]						
$PM/PM_{10}/PM_{2.5}$ [3]	0.000739	0.000248	495.5	0.2	166.28	8.31E-02
NO_X	0.006454	0.007009	4327.4	2.2	4699.53	2.35
VOC	0.000553	0.003995	370.8	0.2	2678.65	1.34
CO	0.002308	0.030211	1547.5	0.8	20256.48	10.13
SO_2	0.000010	0.000006	6.7	3.35E-03	4.02	2.01E-03
CO_2e	1.254291	1.533727	841002.1	420.5	1028363.95	514.18

VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
0.000927	0.000005	0.006656	0.004377	0.000001	0.000001			0.920156

[1] Generator supports continued operations during emergency/power outage.

[2] DIESEL - Emissions factors for PM, NOx, VOC, CO, and SO_2 are from U.S. EPA AP-42 Chapter 3.4 Table 3.4-1 for stationary gas turbines >600hp.
NATURAL GAS - Emission factors are from US Air Force Civil Engineer Center, Air Confirmity Applicability Model v5.0.
Both Diesel and Natural Gas emission factors were originally reported as lb/1,000 hp-hr; the emission factors shown have been divided by 1,000 to convert to lb/hp-hr.

[3] The PM emissions factor is the sum of PM_{10} + $PM_{2.5}$.

[4] PTE rates are calculated using data from manufacturer engine and generator specifications, U.S. EPA AP-42 emissions factors, EPA's General Conformity Training Modules: Appendix A Sample Emissions Calculations, and assumed maximum uncontrolled annual operating hours for the generator.

Operational Parameters

Parameter	Value
Fuel	ULSD [5]
Generator Rating, electrical (kWe)	1,000
Engine Rating (bhp)	1,341
Fuel Consumption (gal/hr)	
Operating Hours (hrs/yr)	500

[5] Ultra-light sulfur diesel will be used (assume sulfur content of 0.0015% by weight).

Conversions	
2,000	lb/ton
453.59	g/lb
1,000,000	Btu/MMBtu
1,020	Btu/scf

Assumptions:
Estimated operating hours of 500 hours per year based on recommendation per EPA memorandum (1995) titled Calculating Potential to Emit (PTE) for Emergency Generators. The EPA guidance addresses the fact that the theoretical PTE far exceeds those that would actually occur, as a result of inherent physical limitations and operational design features.

Total Air Emissions - OEI Solar Project

Construction Equipment	How many units	Hours per day	Days per week	Weeks per year	Usage (hrs)	Emissions (lbs) CO	NOx	VOC	PM_{10}	$PM_{2.5}$	SOx	CO_{2e} (tpy)
Diesel Plate Compactors	1	8	5	25	1000	858	1,587	263	89	87	2	1,300,485
Diesel Paving Equipment	1	8	5	25	1000	210	639	41	34	33	2	1,227,292
Diesel Excavators	2	8	5	25	2000	101	429	20	20	20	4	2,389,538
Diesel Cement & Mortar Mixers	1	8	5	25	1000	498	1,223	127	78	75	2	1,244,880
Diesel Graders	1	8	5	25	1000	48	150	9	10	10	2	1,185,407
Diesel Tractors/Loaders/ Backhoes	2	8	5	50	4000	1,302	1,854	270	212	206	4	5,868,676
Diesel Skid Steer Loaders	3	8	5	50	6000	3,949	4,929	821	614	596	7	9,178,110
Diesel Dumpers/Tenders	1	8	5	25	1000	654	817	152	99	96	1	1,508,951
Diesel Aerial Lifts	1	8	5	50	2000	1,175	1,642	251	162	157	2	3,063,066
Total Construction Equiment (tpy)						**4.4**	**6.6**	**1.0**	**0.7**	**0.6**	**0.01**	**13,483.2**
POVs - Contractors (tpy)						**0.026**	**0.007**	**0.000**	**0.138**	**0.0001**	**0.0001**	**3.36**
TOTAL - Construction Phase (tpy)						**4.42**	**6.64**	**0.98**	**0.80**	**0.64**	**0.01**	**13,486.56**
Nat Gas Generators (Operation Phase) (tpy)						**10.128**	**2.350**	**1.339**	**0.083**	--	**0.002**	**514.18**

Assumptions:

Source: The above estimates were calculated using the methodology and information provided in the Air Emissions Guide for Air Force Mobile Sources, U.S. Air Force Installations, June 2021, Air Emissions Guide for Air Force Transitory Sources, 2016, and Air Emissions Factor Guide to Air Force Stationary Sources, 2020.

1-year construction window = 250 work days

250 days * 8 hrs/day = 2,000 hrs