DRAFT

ENVIRONMENTAL ASSESSMENT

for

Lease of Land for Energy Generation and Storage, Resiliency, Reliability, and Security

at

Joint Base Pearl Harbor-Hickam, Hawaii

April 2024

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EXECUTIVE SUMMARY

ES.1 Proposed Action

Commander Joint Base Pearl Harbor-Hickam (JBPHH) (hereinafter, jointly referred to as the Navy) proposes to lease United States Department of the Navy land to a commercial developer to construct and operate renewable energy infrastructure on two separate sites (up to 25 acres total) at JBPHH, Oahu, Hawaii. One site would house a biofuel-powered Firm Renewable Generation (FRG) plant and one site would house a photovoltaic (PV) solar generating system. Both sites would house a lithium-ion battery energy storage system (BESS). Additionally, the sites would be connected to the existing Hawaiian Electric Company (HECO) electric infrastructure. The land would be leased for up to 37 years. After the terms of the lease expire, the Navy and the lessee would consider a range of options, including renewing the agreement and lease or decommissioning the system.

The Proposed Action would be located at JBPHH, situated on the eastern shore of Pearl Harbor on the south side of the island of Oahu, Hawaii (Figure ES-1). JBPHH consists of Hickam Air Force Base and the Naval Station Pearl Harbor, which merged into a joint base in October 2010 (DON, 2020). The Proposed Action study area depicted in Figure ES-1 indicates the area where construction could occur and correlates to locations assessed in this Environmental Assessment (EA).

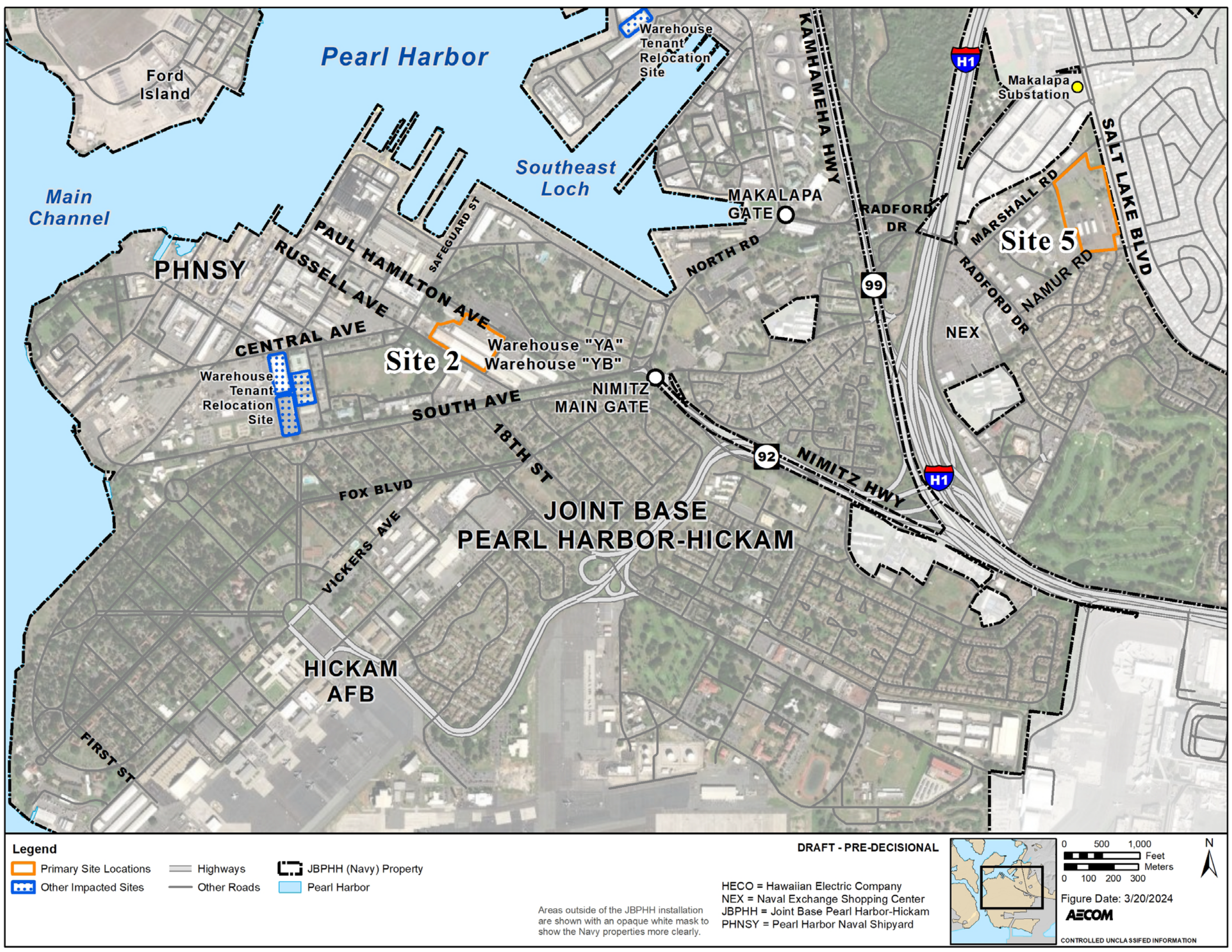

Figure ES-1 Site Location Map

ES.2 Purpose of and Need for the Proposed Action

The purpose of the Proposed Action is to generate and store renewable energy in order to improve energy security, strategic flexibility, and energy resiliency at JBPHH. The proposed power generation facilities would provide renewable energy to the HECO power grid, which would greatly improve electrical resiliency and reliability for the Navy and HECO customers on Oahu. It would also serve as backup energy for JBPHH in the case of a power outage to improve resiliency on the base. It would enable HECO to move cheaper, cleaner energy to where it is needed, both on- and off-base, which supports the installation's renewable energy goals while contributing to the Hawaii Clean Energy Initiative's goal of generating 100 percent of Hawaii's energy from renewable sources by 2045 (Hawaii Revised Statutes Section 196-10.5).

The need for the Proposed Action is to address the Navy's critical energy security gaps by providing energy resiliency to the entire base in the event of a grid outage. JBPHH's aging (average age of over 50 years), undersized infrastructure and overloaded distribution system also impact reliability. The project would improve the energy diversity and resiliency at JBPHH, which would ensure that the base is prepared for future natural or human-caused disruptions.

ES.3 Alternatives Considered

Alternatives were developed for analysis based on a specific set of alternative screening factors. Site characteristics were identified to analyze power plant location compatibility, including energy production and storage capacity and transmission/distribution capabilities. The Navy is considering one action alternative, the Proposed Action Alternative, which meets the purpose of and need for the Proposed Action, and a No Action Alternative. Under the Proposed Action Alternative, the Navy would issue a lease of up to 25 acres of land and the related granting of an interconnection easement on JBPHH to a designated lessee. The lessee would construct, operate, and maintain a 103-megawatt (MW)-capacity FRG Plant with a collocated BESS of up to 50 MW/100 megawatt hour (MWh) at Site 2. A new, underground 46 kilovolt (kV) electrical transmission backbone would connect the new FRG Plant to existing HECO substations located on JBPHH. A 6 MW PV system would be collocated with a 6 MW/24 MWh BESS at Site 5. Under the No Action Alternative, a lease would not be executed and the FRG Plant and BESS, PV system and BESS, and the 46 kV electrical transmission backbone would not be constructed.

ES.4 Summary of Environmental Resources Evaluated in the EA

The National Environmental Policy Act, Council on Environmental Quality regulations, and Navy instructions for implementing the National Environmental Policy Act specify that an EA should address those resource areas potentially subject to impacts. In addition, the level of analysis should be commensurate with the anticipated level of environmental impact.

The following resource areas are addressed in this EA: air quality and greenhouse gases (GHGs), noise, cultural resources, biological resources, visual resources, noise, and transportation. As the Proposed Action fall under the Navy De Minimis Activities under the Coastal Zone Management Act, a consistency determination has been made. The following resource areas are not evaluated in detail in this EA because their potential impacts are considered insignificant, negligible, or nonexistent: water, geology, soils, land use, airspace, infrastructure, public health and safety, hazardous materials and wastes, socioeconomics, recreation, and environmental justice.

ES.5 Summary of Potential Environmental Consequences of the Alternatives and Major Mitigating Actions

This EA evaluates potential impacts under the No Action Alternative and the Proposed Action Alternative including impacts from in-kind consideration projects.

The No Action Alternative would not change existing site conditions. No construction would occur on the sites. As a result, the No Action Alternative would have no construction impacts. The No Action Alternative would not provide energy for off-base (public) consumption and would neither contribute to HECO and the State of Hawaii's (SOH's) energy resiliency goals nor provide energy resiliency for JBPHH.

The following impacts are anticipated from the Proposed Action Alternative.

Air Quality and Greenhouse Gases: Construction phase air pollutant emission sources include fuel-burning equipment, vehicles, and land disturbance. Elevated particulate matter concentrations are expected immediately downwind of earthwork activity, but because best management practices (BMPs) and standard operating procedures (SOPs) would be applied during the construction process, visible fugitive dust plumes are unlikely to occur outside of the activity area. Potential exposure to elevated pollutant concentrations would be most intense and occur at a higher probability in years 2 and 3 of construction at Site 2, year 1 of construction at Site 5, and years 1 and 2 of construction of the electrical transmission backbone. Base residential housing immediately to the south of Site 2, base residential housing immediately adjacent to and to the south of Site 5, and off-base residential housing to the east of Site 5 could be impacted. Construction phase emissions of criteria pollutants and hazardous air pollutants (HAPs) would not cause significant impacts on air quality because they are temporary with a low magnitude of emissions, and would not change the area's attainment status or appreciably increase human health risks in areas where sensitive receptors and/or public presence are anticipated.

Emissions during the operations phase of the project would primarily be generated by energy production at Site 2. FRG Plant equipment, including emissions controls, would be operated and maintained according to manufacturer specifications. Equipment subject to air permitting requirements would be covered under a new Title V permit issued to the lessee as a separate source from JBPHH. The PV system and the BESS at Site 5 would have minimal operational emissions. Operational emissions of criteria pollutants emitted by the proposed power plant would be in compliance with the National Ambient Air Quality Standards (NAAQS)/SOH Ambient Air Quality Standards (SAAQS). Ambient air concentrations of any hazardous air pollutant are anticipated to comply with limits established by HAR 11-60.1-179. Operational emissions from on-road traffic would be insignificant compared to current daily traffic counts at the nearby air monitors, based on an assumed number of delivery trucks and employee vehicles per day associated with the proposed new FRG Plant at Site 2. A qualitative impact assessment indicated that HAPs emitted during the operations phase would not appreciably increase human health risks in areas where sensitive receptors and/or public presence are anticipated.

Estimated GHG emission increases over the 35 months of construction and the annual operation of the FRG plant would not interfere with Hawaii's statewide goal to be carbon net-negative by 2045. The potential for the Proposed Action to interact with climate change was assessed under each resource area within this EA. In summary, implementation of the Proposed Action would have less than significant impacts to air quality and GHGs.

Cultural Resources: The Proposed Action would alter the Pearl Harbor National Historic Landmark (PHNHL) through the construction of new facilities, demolition of three historic properties, and reuse of six historic properties, all of which contribute to the PHNHL District. Viewsheds within the larger PHNHL District also would be altered as a result of new construction. The Proposed Action would result in minor, permanent, and irreversible impacts to historic architectural resources. Section 106 consultation is happening concurrently with this EA. The EA findings will therefore be updated in the Final EA with information pertaining to the results of Section 106 consultation, including mitigation requirements for adverse effects on historic properties.

The Proposed Action does not include any activities that would alter resources of importance to Native Hawaiians, because no areas with identified culturally important resources exist within the Proposed Action areas. Therefore, no impacts to cultural resources important to these groups would occur.

The Navy would follow procedures outlined in Navy SOPs for Archaeological Treatment Protocols in the JBPHH Integrated Cultural Resources Management Plan in the event of an inadvertent discovery of cultural resources or remains (Table 2.7-1).

The Proposed Action would result in adverse effects on historic properties pursuant to Section 106 of the National Historic Preservation Act (NHPA). Adverse effects to historic properties would be resolved through consultation and implementation of mitigation pursuant to NHPA Section 106 (see Table 2.7-1 and Appendix D for more detail). Therefore, the Proposed Action would result in a less than significant impact on cultural resources.

Biological Resources: Site 2 is currently developed with two warehouses and is in an urban setting with minimal vegetation. Site 5 has been previously disturbed and contains a baseball field, parking lot, and other impervious surfaces and a few small buildings, including the Quonset hut. The vegetation at Site 5 mostly consists of grasses with scattered non-native trees and shrubs. Some trees and shrubs would be removed from Site 5 for the PV system. Any minimally occurring wildlife on the sites would relocate to regions nearby with similar conditions.

No federally- or SOH-listed vegetative species are known to occur at Sites 2 and 5 or along the proposed electrical transmission backbone. No special-status animal species are expected to be affected by the construction and operation of the Proposed Action as these sites are disturbed and do not support habitat. No permanent loss of significant or critical terrestrial habitat would occur under the Proposed Action. As a BMP, pre-construction surveys for nesting birds would be undertaken at both sites to avoid impacts on breeding birds (Table 2.7-1). Therefore, the Proposed Action would not negatively affect habitat use by any threatened or endangered species. The mitigation measures described in Table 3.8-2 would further minimize potential impacts, so construction would have no adverse effects to habitat. Therefore, construction of the Proposed Action would have less than significant impacts to threatened or endangered species.

Daytime construction, demolition, and site clearance would generate temporary noise and other disturbances; however, avian and terrestrial species on JBPHH are already habituated to high levels of noise associated with vehicle traffic, aircraft noise, light, and port activities. Increases in noise levels from construction activities to the ambient noise environment would be negligible, short-term, and temporary. BMPs in Table 2.7-1 would be followed to ensure that fallout risk for seabirds and disturbance to Hawaiian hoary bats due to artificial lighting are minimized. BMPs to prevent ponding would be implemented to reduce attraction of waterbirds and shorebirds to the project areas, protecting them from risk of physical disturbance or strike. In addition, BMPs and SOPs would be implemented to prevent water quality degradation (Table 2.7-1 and Table 2.7-2). As a result, construction would have no adverse effects and impacts to biological resources would be less than significant.

No impacts to avian and terrestrial species are expected to occur during the operational phase of the Proposed Action as Site 2 is in an urban section of JBPHH and Site 5 mostly consists of grass that will be developed with a PV system. The FRG plant at Site 2 would generate minimal noise during operations; noise impacts from the BESS at Site 5 would be mitigated (Table 3.8-2). The proposed operational activities at Site 5 would not result in substantial increased noise levels or loss of significant vegetation that supports avian and terrestrial animals and would utilize anti-glare technology to avoid creating additional light or glare that would attract or disorient avian species. Therefore, operations would have no adverse effects and impacts to biological resources would be less than significant.

No substantive effects on federally- and SOH-listed marine species or critical marine habitat are anticipated during construction or operation of the Proposed Action. Therefore, no adverse effects would occur to marine species and impacts would be less than significant.

Visual Resources: The Proposed Action Alternative would lead to changes in the landscape during construction at and around Sites 2 and 5. For both Sites 2 and 5, active construction activities would be contained within the fenced construction site. The fencing would include screening material to obstruct and minimize street views of heavy equipment, stockpile areas, and other facility demolition and construction activities.

The visual effects at Site 2 would be permanent due to the exhaust stacks. In general, the visual contrast level from the new FRG Plant facilities and structures at Site 2 would not be strong because the new FRG Plant would have the same building massing and scale as the two existing buildings In addition, keeping the historic rail line and mature shade trees would help maintain the historic landscape character in the area. The exhaust stacks would be painted an appropriate shade of blue to further reduce visual contrast between the exhaust stacks and the surrounding sky. Further consideration of potential impacts on the historic character of the area is provided under Cultural Resources and will be addressed through Section 106 consultation.

The installation of the ground-mounted PV panels at Site 5 would result in the permanent loss of approximately 5 acres of the baseball field and the removal of several shade trees, thereby altering the visual landscape at this site. The PV system would not obstruct any significant mountain and harbor views from public vantage points. From public vantage points along Salt Lake Boulevard, viewers would experience a high level of visual contrast from the landscape character alteration. Vegetation (e.g., hedges, trees) would be planted along the Site 5 fence line, reducing the visual contrast for viewers along Salt Lake Boulevard to a medium level of intensity. From vantage points at the neighborhood park and along Maluna Street, the intensity of visual contrast would be low to medium due to distance as well as structures and trees that obstruct the view of Site 5.

Lighting for worker activity and security during construction and operation of the facilities would add to existing lighting at Sites 2 and 5. The increased lighting at Site 5 is expected to include sources on the top of the PV mount structures. This lighting would be visible from public locations. This change would not substantially alter views or view quality due to broad distribution of light sources within JBPHH. Lighting at Site 2 would be more limited and lower in profile than lighting at Site 5. Views from public locations (Salt Lake Boulevard) and nearby residential housing would not be obstructed or substantially degraded to existing light sources within JBPHH. The project would follow the Dark Skies Instruction and follow best practices in coordination with United States Fish and Wildlife Service (see Section 3.3 for a related discussion).

Modern solar panels are constructed of dark-colored materials and are covered with anti-reflective coatings and are not expected to cause adverse impact from glare. In summary, with the implementation of BMPs and mitigation measures identified in Tables 2.7-1 and Table 3.8 2, respectively, the Proposed Action would result in less than significant impacts to visual resources during the construction and operation phase.

Noise: Construction activity and associated noise levels would vary at each location as the work progresses. Construction would result in short-term, intermittent noise impacts from the operation of heavy equipment, power and hand tools, and construction vehicles throughout the project area. Although short-term (less than 3 years), temporary adverse noise impacts are anticipated during construction, mufflers and vibratory or hydraulic drivers with shrouds would be used on construction equipment and vehicles to minimize noise impacts during these activities. A Construction Noise Permit from the SOH Department of Health (HDOH) (Hawaii Administrative Rules [HAR] 11-46) is not required because all construction would occur within JBPHH (federal jurisdictional) boundaries. Construction noise would not likely be audible to residents outside of JBPHH because of the distances between the construction noise sources and receptors and the relatively high background noise levels where off-site (public) receptors exist. A construction noise mitigation and management plan would be implemented in association with BMPs to reduce construction noise to less than significant impacts.

For long-term facility operations at Sites 2 and 5, noise predictions indicate potential noise impacts that exceed the HAR 11-46 criteria for Class A zoning districts (i.e., residential, public, and open space) of 55 decibels in the A-weighted scale (dBA) during the daytime and 45 dBA during the nighttime, which was used as the design criteria for the Proposed Action. At Site 2, operational noise sources would include the cooling radiator field for the FRG Plant facility and components associated with the BESS storage units. At Site 5, the only significant noise source would be the BESS unit. For noise receptors immediately adjacent to each site, preliminary modeling results indicate potential noise exceedances ranging from 3 to 16 dBA above the design criteria at Site 2 and 1 to 14 dBA at Site 5. The preliminary predicted noise levels from facility operations at each representative receptor as compared to the daytime and nighttime criteria are detailed in Appendix B.

The HDOH regulates excessive noise sources, including equipment related to operational noise and construction activities under Chapter 342F, Hawaii Revised Statutes (Noise Pollution) and HAR 11-46 (Community Noise Control). As a federal agency, the Navy considers HDOH noise provisions as local best practices and would exert best efforts to comply with applicable state noise regulations. The commercial developer has committed to meeting the HAR 11-46 criteria in the design for each facility under the Proposed Action. Proposed mitigation measures to reduce operational noise include noise barriers for the BESS units, low-noise fans, and other mechanical and operational mitigation solutions (see Table 3.8-2 and Appendix B for more detail). With these measures in place, the effects of operational noise on the surrounding sensitive receptors would be less than significant.

Transportation: The JBPHH roadway network in the vicinity of each site would be affected by the construction traffic related to the installation of the FRG Plant and PV panels at Sites 2 and 5, respectively, duct banks, transport of materials to and from the work sites, and construction employee-generated travel. Short-term construction effects to the transportation system may occur. These effects may include increasing user delay and travel times at both internal and external intersections when construction traffic travels to and from the site. The addition of vehicles and increase in user delay could create short-term, localized congestion. Additionally, congestion is anticipated where lanes would need to be closed due to construction adjacent to the roadway.

To minimize potential impacts during construction, the contractor would establish a construction traffic management plan (CTMP) that would include a list of lane/street closures and times as well as traffic control measures such as speed limit reduction, pavement markings, and flaggers to identify the appropriate work zone management strategies (BMP TRANS MGMT-2 Table 2.7-1). The CTMP would complement the traffic control plan to mitigate impacts that may arise during construction. Standard practices to protect construction workers, pedestrians, and motorists near roadways would address safe travel for vehicles near construction sites. With a Construction Traffic Plan and CTMP in place, no significant impacts on transportation are anticipated during the construction phase.

Parking for construction worker vehicles would be accommodated within site boundaries with an option for overflow parking in Parking Lot D, pending coordination with the Navy. Utilization of on-street parking is not anticipated.

The operation of the facilities is not anticipated to create long-term impacts to the transportation network. The addition of six to eight vehicles during the peak hour periods for the worker trips to and from Site 2 and up to 15 trucks per day for fuel delivery is expected to add minimal additional traffic volume on the roadways and at key intersections. The long-term operational impacts would be similar to those of the No Action Alternative. Therefore, no significant impacts would occur.

ES.6 Public Involvement

Regulations from the Council on Environmental Quality direct agencies to involve the public in preparing and implementing National Environmental Policy Act procedures.

The Navy has prepared this Draft EA to inform the public of the Proposed Action and to allow the opportunity for public review and comment. The Draft EA review period began with a public Notice of Availability published in the *Honolulu Star-Advertiser* indicating the availability of the Draft EA. The Navy published a Notice of Availability of the Draft EA for three consecutive days in the *Honolulu Star-Advertiser* starting on April 3, 2024. The notice described the Proposed Action, solicited public comments on the Draft EA, provided dates of the public comment period, and announced the locations where public review copies are available. The Draft EA is available online at: https://pacific.navfac.navy.mil/About-Us/National-Environmental-Policy-Act-NEPA-Information. Comments received during the public comment period on the Draft EA will be considered in the Final EA. The Navy has initiated consultation with the U.S. Fish and Wildlife Service and Hawaii State Historic Preservation Officer. Correspondence with agencies will be included in the Final EA.

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Environmental Assessment

Lease of Land for Energy Generation and Storage, Resiliency, Reliability, and Security

at

Joint Base Pearl Harbor-Hickam, Hawaii

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Abbreviations and Acronyms

Acronym	Definition
§	Section
°F	degree Fahrenheit
µg/m^3	microgram per cubic meter
AAQS	ambient air quality standard
ACC	Ambulatory Care Center
ADP	Area Development Plan
AERMOD	Air Quality Dispersion Model
AES	Applied Energy Services
BESS	battery energy storage system
BIO	biological
BMP	best management practice
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CTMP	construction traffic management plan
CZMA	Coastal Zone Management Act
dB	decibel
dBA	decibel (A-weighted scale)

Acronym	Definition
DD	Decision Document
DLA	Defense Logistics Agency
DoD	Department of Defense
DON	Department of the Navy, United States
EA	Environmental Assessment
ECF	Entry Control Facility
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency, United States
ESA	Endangered Species Act
FE	federally endangered
FRG	Firm Renewable Generation
FT	federally threatened
FY	fiscal year
GHG	greenhouse gas
GIS	geographic information system
GWP	Global Warming Potential
H-1	Interstate Highway H-1
HAP	hazardous air pollutant

Acronym	Definition
HAR	Hawaii Administrative Rules
HART	Honolulu Authority for Rapid Transportation
HCEI	Hawaii Clean Energy Initiative
HDOH	State of Hawaii Department of Health
HDOT	State of Hawaii Department of Transportation
HECO	Hawaiian Electric Company
Hz	hertz
ICRMP	Integrated Cultural Resources Management Plan
IKC	in-kind consideration
IMF	Intermediate Maintenance Facility
IUR	Inhalation Unit Risk
JBPHH	Joint Base Pearl Harbor-Hickam
KOP	Key Observation Point
kV	kilovolt
LC	local conditions
LOS	level of service
LT	left turn
MBTA	Migratory Bird Treaty Act

Acronym	Definition
MERP	Modeled Emission Rates for Precursor
mph	mile per hour
MW	megawatt
MWh	megawatt hour
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NEX	Navy Exchange
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NRHP	National Register of Historic Places
OLM	Ozone Limiting Method
OPP	Oil Pollution Prevention
PA	Programmatic Agreement
PAH	polycyclic aromatic hydrocarbon
PHNHL	Pearl Harbor National Historic Landmark
PHNSY	Pearl Harbor Naval Shipyard

Acronym	Definition
PM_{10}	particulate matter less than or equal to 10 micrometers in aerodynamic diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 micrometers in aerodynamic diameter
PUCDP	Primary Urban Center Development Plan
PV	photovoltaic
RNG	renewable natural gas
ROD	Record of Decision
ROI	region of influence
RRFB	rectangular rapid-flashing beacons
SAAQS	State Ambient Air Quality Standards
SCADA	Supervisory and Control Data Acquisition
sec/veh	second per vehicle
SHPD	State Historic Preservation Division
SHPO	State Historic Preservation Office

Acronym	Definition
SIHP	State Inventory of Historic Places
SIOP	Shipyard Infrastructure Optimization Program
SIL	significant impact level
SO_2	sulfur dioxide
SOH	State of Hawaii
SOP	standard operating procedure
SPCC	Spill Prevention, Control, and Countermeasure
STP	standard temperature and pressure
TCP	traditional cultural property
tpy	ton per year
U.S.	United States
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service
UST	underground storage tank
VOC	volatile organic compound
WPF	Waterfront Production Facility

1 Purpose of and Need for the Proposed Action

1.1 Introduction

Commander Joint Base Pearl Harbor-Hickam (JBPHH) (hereinafter, jointly referred to as the Navy) proposes to lease United States (U.S.) Department of the Navy (DON) land to a commercial developer to construct and operate renewable energy infrastructure on two separate sites (up to 25 acres total) at Joint Base Pearl Harbor-Hickam (JBPHH), Oahu, Hawaii. One site would house a biofuel-powered Firm Renewable Generation plant and one site would house a photovoltaic (PV) solar generating system. Both sites would house a lithium-ion battery energy storage system (BESS). Additionally, the sites would be connected to the existing Hawaiian Electric Company (HECO) electric infrastructure. The land would be leased for up to 37 years. After the terms of the lease expire, the Navy and the lessee would consider a range of options, including renewing the agreement and lease or decommissioning the system.

The Navy proposes to lease land to a commercial developer to enhance energy resiliency and energy security at JBPHH and meet Navy renewable energy and resiliency goals. The term “energy resilience,” in accordance with 10 U.S. Code (U.S.C.) Section (§) 101, is the ability to avoid, prepare for, minimize, adapt to, and recover from anticipated and unanticipated energy disruptions in order to ensure energy availability and reliability to provide for mission assurance and readiness, and to execute or rapidly reestablish mission-essential requirements. The term “energy security” means having assured access to reliable supplies of energy and the ability to protect and deliver sufficient energy to meet mission-essential requirements as described in 10 U.S.C. § 2924 (3)(A). The Proposed Action would accomplish this by providing mutual benefits to the Oahu community and the Navy by improving island-wide power reliability, increasing renewable energy, meeting the DON mission requirements for energy resiliency, and minimizing impact on utility ratepayers.

The Navy has prepared this Environmental Assessment (EA) in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality Regulations, the federal regulations for implementing NEPA. The Navy has determined that the Hawaii Environmental Policy Act is not applicable as the Proposed Action is on federal land.

1.2 Background to this Action

Navy resiliency studies identified vulnerability at JBPHH with the single incoming commercial power generation from HECO, making JBPHH missions entirely dependent on HECO grid reliability. With the decommissioning of the Applied Energy Services (AES) Coal Plant, retiring power plants on the island, and other factors such as the reliability on imported petroleum, high electricity prices, and unreliable power supply, HECO and the Navy identified strategies to address energy generation on the island including on federal (Navy) property.

In 2015, the State of Hawaii (SOH) passed Act 97, which set a goal to generate 100 percent of the state’s energy from renewable sources by 2045. The purpose of the act is to ensure Hawaii eliminates its dependence on imported fuels and continues to grow the local renewable energy industry. Act 97 included statutes setting the renewable energy goals listed below:

- Forty percent of Hawaii’s net electricity sales by December 31, 2030
- Seventy percent of Hawaii’s net electricity sales by December 31, 2040
- One hundred percent of Hawaii’s net electricity sales by December 31, 2045

The SOH Public Utilities Commission directed HECO to modernize energy generation using renewable resources. In 2016, HECO developed the Power Supply Improvement Program to transition to 100 percent renewable energy by 2045. As part of the state's plans to meet the 2045 energy goals, the state mandated the decommissioning of the 180 megawatt (MW) AES Coal Plant, which serves approximately 15 percent of the power demand to Oahu, on September 1, 2022. In addition, HECO plans to retire aging units at its Waiau and Kahe power plants (2024–2028).

In October 2020, DON issued a request for proposal (RFP) for the lease of non-excess, underutilized land at JBPHH under the authority of 10 U.S.C. § 2667. The Navy's RFP was for an energy resilience project in accordance with SECNAVINST 4101.3A, the DON Energy Program. As part of the acquisition process, the Navy selected one prime contractor from the proposals received. The projects would help HECO ensure it has sufficient energy capacity via firm renewable energy to maintain reliability after the coal plant is decommissioned and as the utility's aging units are retired. Firm renewable energy, like biofuel and geothermal energy, is energy that can be continuously generated and is therefore constantly available, unlike weather-dependent energy, like solar and wind energy. In consideration of the need for Firm Renewable Generation to replace the firm generation being decommissioned at the AES Coal Plant, on May 4, 2022, HECO filed an RFP for firm renewable energy procurement on Oahu. HECO is seeking proposals to acquire 500 to 700 MW of energy from firm renewable energy resources as an important step toward reaching the state's renewable energy goals. The final RFP was issued by HECO on January 9, 2023, and the Developer was selected in the Final Award Group on December 1, 2023. The projects are expected to be online by 2029 and 2033.

1.3 Location

The Proposed Action would be located at JBPHH, situated on the eastern shore of Pearl Harbor on the south side of the island of Oahu, Hawaii. JBPHH consists of Hickam Air Force Base and Naval Station Pearl Harbor, which merged into a joint base in October 2010 (DON, 2020). The Proposed Action study area depicted in Figure 2.4-1 indicates the area where construction could occur and correlates to locations assessed in this EA.

JBPHH is comprised of approximately 24,895 acres (10,075 hectares) of land and 68,081 acres (27,552 hectares) of water. JBPHH is one of the nation's most strategic naval installations. JBPHH's most important mission is coordinating the Navy's local support of the Commander Pacific Fleet. It provides logistic support including ship berthing, repair and maintenance, supply and storage, and public works support to the Navy operating forces in the region (CNRH, 2006).

1.4 Purpose of and Need for the Proposed Action

The purpose of the Proposed Action is to generate and store renewable energy in order to improve energy security, strategic flexibility, and energy resiliency at JBPHH. The proposed power generation facilities would provide renewable energy to the HECO power grid and backup energy to JBPHH, which would improve electrical resiliency and reliability for the Navy and HECO customers on Oahu. It would also enable HECO to move cheaper, cleaner energy to where it is needed, both on- and off-base, which supports the installation's renewable energy goals while contributing to the Hawaii Clean Energy Initiative's goal of generating 100 percent of Hawaii's energy from renewable sources by 2045 (Hawaii Revised Statutes § 196-10.5).

The need for the Proposed Action is to address the Navy's critical energy security gaps, in support of the Navy's responsibilities to 10 U.S.C. § 8062, by providing energy resiliency to the entire base in the event of a grid outage. JBPHH aging (average age of over 50 years), undersized infrastructure and overloaded distribution system also impact reliability. The project would improve the energy diversity and resiliency at JBPHH, which would ensure that the base is prepared for future natural or human-caused disruptions. The power generation facilities proposed would provide renewable energy to the HECO power grid, which would greatly improve electrical resiliency and reliability for HECO customers on Oahu, including the Navy.

> 10 U.S.C. § 8062: "The Navy shall be organized, trained, and equipped for the peacetime promotion of the national security interests and prosperity of the United States and for prompt and sustained combat incident to operations at sea. It is responsible for the preparation of naval forces necessary for the duties described in the preceding sentence except as otherwise assigned and, in accordance with integrated joint mobilization plans, for the expansion of the peacetime components of the Navy to meet the needs of war."
>
> Hawaii Revised Statutes Section 196-10.5 Hawaii Clean Energy Initiative (HCEI): HCEI is a framework of statutes and regulations supported by a diverse group of stakeholders committed to Hawaii's clean energy future. In 2014, HCEI renewed Hawaii's commitment to setting bold clean energy goals, including achieving the nation's first-ever 100 percent renewable portfolio standards by the year 2045.

1.5 Scope of Environmental Analysis

This EA includes an analysis of potential environmental impacts associated with the Proposed Action Alternative and the No Action Alternative. The primary environmental resources that are addressed in this EA are: air quality, greenhouse gases, cultural resources, biological resources, visual resources, noise, and transportation. The study area for each resource analyzed may differ due to how the Proposed Action interacts with or impacts the resource and may only include the construction footprint of a facility, or would expand to include areas that may be impacted by the Proposed Action.

1.6 Key Documents

Key documents are sources of information incorporated into this EA. Documents are considered to be key because of similar actions, analyses, or impacts that may apply to this Proposed Action. The Council on Environmental Quality guidance encourages incorporating documents by reference.

Documents incorporated by reference or relevant in part or in whole include:

- **Environmental Assessment for PV Systems at Joint Base Pearl Harbor-Hickam, Oahu, Hawaii (June 2015):** The EA analyzed a PV system that would provide up to 50 MW of electrical power in two phases. The electrical power generated by both phases of the project would be conveyed to HECO's electrical grid for public use.

- **Environmental Impact Statement (EIS) for the Schofield Generating Station Project at U.S. Army Garrison-Hawaii (October 2015):** The EIS analyzed the effects of the Army's granting of a lease on Schofield Barracks, and the Army's and the SOH Department of Land and Natural Resources' granting of easements to HECO for the construction and operation of a multifuel-capable 50 MW power plant and associated transmission line (Department of the Army, 2015).
- **EIS for Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility Dry Dock and Waterfront Production Facility:** As part of the Navy's Shipyard Infrastructure Optimization Program (SIOP), a new dry dock and associated production facility is being proposed for Pearl Harbor Naval Shipyard (PHNSY) and Intermediate Maintenance Facility. The new dry dock is needed to accommodate new classes of vessels. The production facility is required to increase efficiency by locating industrial spaces closer to a dry dock, thereby reducing the time and motion of the shipyard workforce (DON, 2022d).
- **JBPHH Ambulatory Care Center (ACC) EA:** The EA analyzed a Proposed Action to construct and operate a new consolidated health clinic located along Kuntz Avenue in the Hickam portion of JBPHH. The new ACC is a consolidated joint service facility replacing several existing facilities separately operated by the Navy, Air Force, and Army. The proposed ACC would be sustained and administered by the Defense Health Agency, a tenant at JBPHH (DON, 2022b).

1.7 Relevant Laws and Regulations

The Navy has prepared this EA based on federal and state laws, statutes, regulations, and policies pertinent to the implementation of the Proposed Action. A description of the Proposed Action's consistency with these laws, policies, and regulations, as well as the names of regulatory agencies responsible for their implementation, is presented in Chapter 5 (Table 5.1-1).

1.8 Public and Agency Participation and Intergovernmental Coordination

Regulations from the Council on Environmental Quality direct agencies to involve the public in preparing and implementing NEPA procedures.

The Navy has prepared this Draft EA to inform the public of the Proposed Action and to allow the opportunity for public review and comment. The Draft EA review period began with a public Notice of Availability published in the *Honolulu Star-Advertiser* indicating the availability of the Draft EA. The Navy published a Notice of Availability of the Draft EA for three consecutive days in the *Honolulu Star-Advertiser* starting on April 3, 2024. The notice described the Proposed Action, solicited public comments on the Draft EA, provided dates of the public comment period, and announced the locations where public review copies are available. The Draft EA is available online at: https://pacific.navfac.navy.mil/About-Us/National-Environmental-Policy-Act-NEPA-Information. Comments received during the public comment period on the Draft EA will be considered in the Final EA. The Navy has initiated consultation with the U.S. Fish and Wildlife Service and Hawaii State Historic Preservation Officer. Correspondence with agencies will be included in the Final EA.

2 Proposed Action and Alternatives

2.1 Proposed Action

The United States (U.S.) Department of the Navy (hereinafter, referred to as the Navy) proposes to lease land to a commercial developer to construct and operate renewable energy infrastructure at two separate sites (up to 25 acres total) at Joint Base Pearl Harbor-Hickam (JBPHH), Oahu, Hawaii. Site 2 would house a biofuel-powered Firm Renewable Generation (FRG) plant (10 acres) and Site 5 would house a photovoltaic (PV) solar generating system and battery energy storage system (BESS) (15 acres). Both sites would house a lithium-ion BESS. Additionally, the sites would be connected to the existing Hawaiian Electric Company (HECO) electric infrastructure. Construction of the renewable energy infrastructure would take approximately 2.5 years, with operations planned to begin in 2027.

To determine the lessee for this project, the Navy submitted a request for proposal (RFP) on October 15, 2020. As part of the RFP process, the Navy competitively selected a lessee to lease the sites. The lessee would develop, finance, operate, and maintain a system within the sites for the term of the lease (not to exceed 37 years). After the terms of the lease expire, the Navy and the lessee would consider a range of options, including renewing the agreement and lease or decommissioning the system. That decision would be determined through a separate NEPA document at a future date, as applicable. As consideration, the lessee would provide in-kind consideration (IKC) projects that directly support the Proposed Action and are needed to meet the purpose and need of the Proposed Action to provide energy resilience, which would enhance the installation's energy resilience posture. The developer would secure offtake agreements through available market opportunities. The proposed energy system would provide energy resiliency to the Navy in times of utility grid outage and/or power quality event.

2.2 Screening Factors

The National Environmental Policy Act's implementing regulations provide guidance on the consideration of alternatives to a federally proposed action and require rigorous exploration and objective evaluation of reasonable alternatives. Only those alternatives determined to be reasonable and to meet the purpose and need require detailed analysis.

2.2.1 Power Plant Location Screening Criteria

The Navy investigated 15 different sites on JBPHH for compatibility with an outlease to a developer to design energy production, storage capacity, and transmission/distribution capabilities. These capabilities must be compatible with the installation operational mission. To identify potential sites at JBPHH, a team conducted site visits and a thorough review of the Commander, Navy Region Hawaii Regional Integration Plan (CNRH, 2012b) and the JBPHH Installation Development Plan (CNRH, 2013). The screening criteria for site selection included: proximity to Station C (Navy Electrical Station), land size, Tsunami Evacuation Zone/Federal Emergency Management Agency Flood Zones, slope/topography, proximity to emissions and noise-sensitive land uses, conflict with/displacement of existing functions, environmental constraints, impact on cultural resources, impact on natural resources, proximity to major roadways/utilities, and developability. The 15 potential locations were analyzed against these site characteristics and ranked. After the Navy selected the 15 compatible sites, a power plant analysis and site selection study were developed to analyze, evaluate, and rank the sites. As a result, Site 2 was presented as the site location in the JBPHH Energy Generation and/or Storage, Resiliency, Reliability, and Security at JBPHH RFP outlease. Site 5 was presented in the JBPHH RFP to address HECO's new RFP for renewable and battery storage projects. Site 5 also ranked in the analysis among the top five preferred locations for the PV system. The results of site evaluations were presented in status briefs to Navy leadership and discussed extensively among Navy stakeholders.

The Navy released an RFP on October 15, 2020, for lease of non-excess real property at JBPHH under the authority of 10 United States Code (U.S.C.) § 2667. The Navy reviewed the proposals submitted in response to the RFP and then selected a lessee. The Navy and the lessee will enter into negotiations and ultimately sign a lease. Further details on the site selection screening criteria and site selection study are provided in Appendix J.

2.3 Lease Agreement

The Navy intends to use a real estate out-grant to ensure fair compensation for the use of Navy lands where renewable energy generation or storage would occur. For the Proposed Action, the lease facilitates on-base generation of renewable energy for on- and off-base consumption. Over the proposed lease term of up to 37 years, this project will be constructed, operated, and maintained via a third-party developer. The energy generated and stored at JBPHH would be provided to the local power grid via a power purchase agreement with HECO.

In accordance with 10 U.S.C. § 2667, out-grants (leases) shall ensure consideration (rent) is paid in an amount not less than the fair market value of the leasehold interest, either in cash or in-kind. The IKC proposed for this project (as described in Section 2.5.5) includes essential electrical infrastructure that would provide installation-wide, long-term energy resiliency in the case of an off-base grid outage and relocation of existing tenants. The project developer would be required to comply with all applicable federal, Department of Defense, state, and local regulations, policies, codes, and criteria including but not limited to: applicable United Facilities Criteria, National Electric Code, Institute of Electrical and Electronics Engineers, American National Standards Institute, National Fire Protection Association, and Leadership in Energy and Environmental Design. Additionally, the project developer would follow best management practices (BMPs), standard operating procedures (SOPs), and mitigation measures identified in this EA.

2.4 Description of Site Locations

Site 2 consists of approximately 10 acres of developed land and is located between Paul Hamilton Avenue and Russell Avenue (Figure 2.4-1). The land use is currently industrial, consisting of two warehouses (Warehouses YA and YB) and a small support facility (Warehouse 244) (Figure 2.5-1). Additionally, three fuel tanks (12,000-gallon D2 gas, 12,000-gallon unleaded gasoline, and 10,000-gallon flex fuel) and a wash rack are present on the site. Warehouse YA, constructed in 1941, is approximately 63,000 square feet. Warehouse YB, constructed in 1941, is approximately 97,000 square feet. Warehouse 244, constructed in 1943, is approximately 1,700 square feet. Remnants of a historic rail line run parallel to Russell Avenue and Warehouse YB. Mature trees line Russell Avenue, and several small trees and a large banyan tree grow on the site. Facilities 226, 283, 284, 393, and 394 would be used to relocate Defense Logistics Agency from Site 2 and Facility 452K would be used to relocate other tenants (see Warehouse Tenant Relocation Sites in Figure 2.4-1).

Site 5 is approximately 15 acres and is located at Salt Lake Boulevard and Namur Road (Figure 2.4-1). Currently, this location is used for the open storage of lumber and other materials. There are three metal storage structures (Facilities X31, 77, and 80), a storage facility (Facility 79), and an open field with a few non-native trees and an adjacent baseball field (Figure 2.5-3). A small administration facility (Facility 78) and restroom (Facility 59) are also on the site. The Proposed Action would not impact the Quonset hut (Facility X24) situated on the southeast corner of the property. Facility X31, constructed in 1946, is approximately 6,800 square feet. Facility 77, constructed in 1986, is approximately 6,900 square feet. Facility 80, constructed in 1995, is approximately 6,000 square feet. Facility 78, constructed in 1992, is approximately 700 square feet. Facility 79, constructed in 1994, is approximately 1,500 square feet.

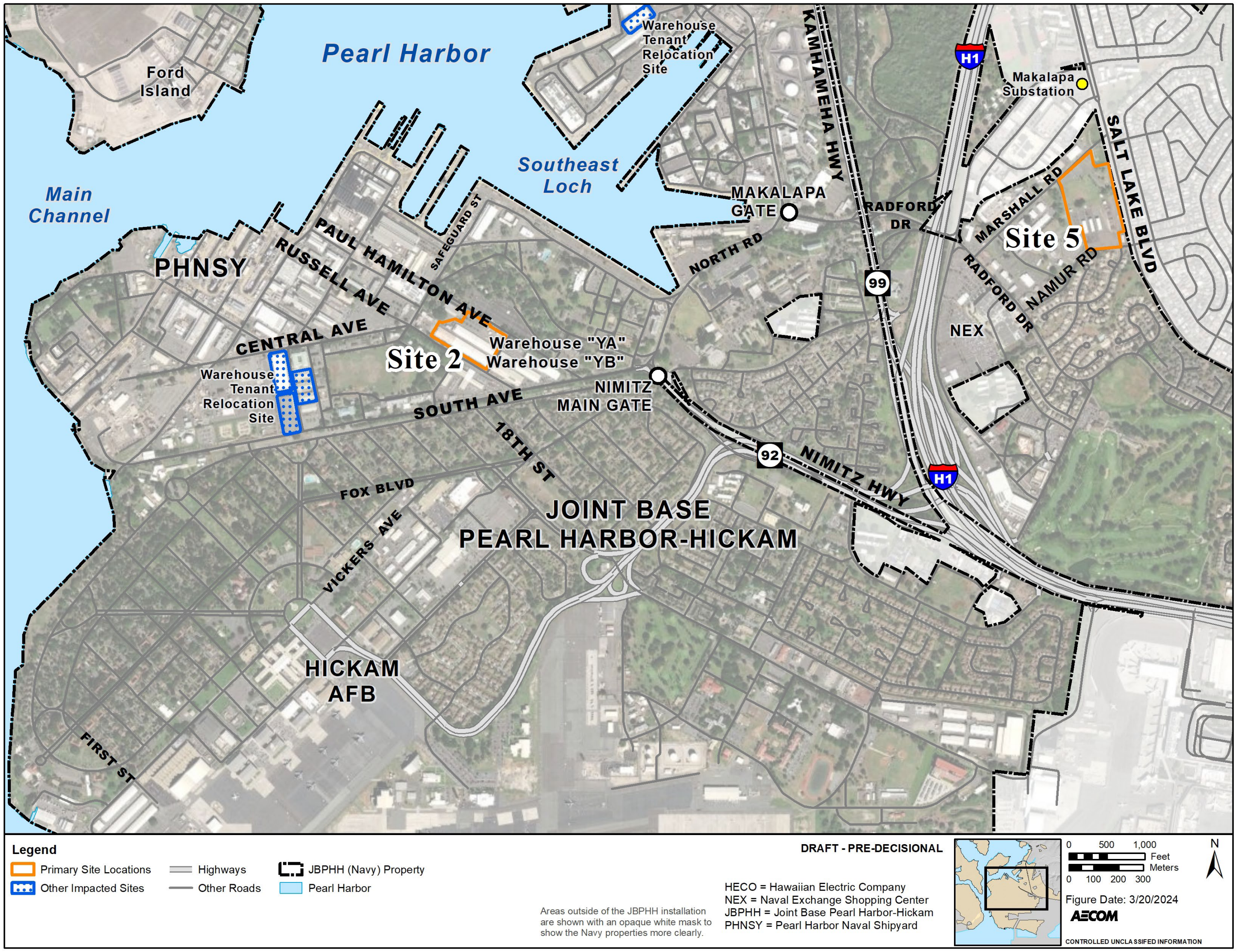

Figure 2.4-1 Site Locations

2.5 Alternatives Carried Forward for Analysis

Based on the reasonable alternative screening factors listed in Section 2.2.1 and meeting the purpose and need for the Proposed Action, one action alternative was identified and is analyzed within this EA.

2.5.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur. A lease would not be executed; the FRG Plant and BESS at Site 2, the PV system and BESS at Site 5, and the 46 kilovolt (kV) electrical transmission backbone would not be constructed; and the existing facilities at these sites would not be demolished. In the case of a natural or human-caused disaster event, JBPHH energy diversity and resiliency goals would not be achieved and the project would not contribute to the State of Hawaii's goal of reaching 100 percent renewable energy by 2045. The No Action Alternative would not meet the purpose of and need for the Proposed Action. However, as required by the National Environmental Policy Act, the No Action Alternative is carried forward for analysis in this EA. The No Action Alternative will be used to analyze the consequences of not undertaking the Proposed Action and will serve to establish a comparative baseline for analysis.

2.5.2 Proposed Action Alternative: Sites 2 and 5 Development

The Proposed Action includes the following:

- The Navy's lease of up to 25 acres of land and the related granting of an interconnection easement on JBPHH to a designated lessee to construct, operate, and maintain a 103-megawatt (MW)-capacity FRG Plant (Site 2) with a collocated BESS of up to 50 MW/100 megawatt hour (MWh) and 6 MW PV system with a 6 MW/24 MWh BESS (Site 5). The lease would be under the authority of 10 U.S.C. § 2667, "Leases: non-excess property of military departments and Defense Agencies." The interconnection easement property would be under the authority of 10 U.S.C. § 2668, "Easements for rights-of-way."
- The lessee's construction, ownership, operation, and maintenance of a 103-MW-capacity FRG Plant with a collocated BESS of up to 50 MW/100 MWh at Site 2 and 6 MW PV system with a 6 MW/24 MWh BESS at Site 5, and a 46 kV electrical transmission backbone to connect Site 2 to five HECO electrical substations located on JBPHH. Site 5 would be connected to the system using existing HECO electrical utility lines. The lessee would be the sole owner of the FRG Plant and the BESS.
- IKC projects including: the 46 kV Electrical Transmission Backbone; Defense Logistics Agency Relocation; Replace Protective Relays; Replace Live Front Equipment, Hickam; Protective Relay Coordination Study; and the Proposed Action Operations and Maintenance. Full descriptions of the IKC projects are provided in Section 2.5.6.

Under normal operating conditions, the electricity produced by the FRG Plant and BESS would supply power to HECO customers through the island-wide electrical grid. During power outages, output would be provided to JBPHH to meet mission requirements and would additionally support the grid up to its full capacity. This would eliminate the use of emergency generators, thereby improving efficiency and reducing equipment emissions. Construction projects would incorporate Leadership in Energy and Environmental Design and sustainable development concepts to achieve optimum resource efficiency, sustainability, and energy conservation.

2.5.3 Proposed Action Alternative: Site 2 FRG Plant and 50 MW/100 MWh BESS (10 acres)

Figure 2.5-1 presents a vicinity map showing the location of Site 2. Construction would begin in December 2024 and would be complete by October 2027. Site 2 would include the FRG Plant, biodiesel storage tanks, biomethane storage and offloading terminals, 50 MW/100 MWh BESS, and support facilities (Figure 2.5-2). The BESS would consist of 18 rows of nine battery stacks, with room for four additional stacks for future augmentation. The FRG Plant would use 100 percent renewable energy fuel sources such as biodiesel and biomethane (also known as renewable natural gas [RNG]) consistent with the Hawaii Renewable Energy Initiative and HECO requirements. The FRG Plant would be expected to primarily use RNG (biomethane) with biodiesel used as backup fuel. Running on RNG would reduce emissions and increase the capacity factor of the plant. The capacity factor is how often the plant operates at maximum power. The plant would be permitted for the worst-case scenario, i.e., to run on biodiesel only, without RNG startup. The FRG Plant would need to be available to operate 24 hours per day on any day of the year, up to the air permit limitations. HECO would control the dispatch (timely delivery) of the energy generated by the plant into the existing HECO system. The worst-case hourly emissions assume all 11 engines would undergo startups on biodiesel during the same hour and all 11 reciprocating generator sets would power the FRG Plant (Appendix A). These internal combustion engine generators would generate low and controllable emissions via selective catalytic reduction and include the ability of the FRG Plant to start itself without assistance from external utility sources (auxiliary power) and redundant design (11 generators to ensure no single point of failure exists). The FRG Plant would also entail an engine hall, exhaust stacks, and reagent tanks. All engines could operate simultaneously.

The FRG Plant would use both RNG (biomethane) and biodiesel. RNG would be generated on the North Shore of Oahu and trucked to Site 2. The RNG storage and supply yard at Site 2 would include six RNG unloading stations. RNG would be stored and distributed from mobile trailer tanks. The mobile trailers would pull up and connect to the unloading station, and then pick up an empty tank to refill. Each tank would have a capacity of 645,000 standard cubic feet. As a worst-case scenario, if the plant primarily runs on RNG at a 50 percent capacity factor, on average, up to 15 RNG fuel trucks per day would be needed to maintain sufficient fuel for the plant, and up to one truck every other day would be needed to maintain a backup fuel supply of RNG (Appendix A).

The conceptual site plan for Site 2 includes a biodiesel storage tank yard that would contain a fuel unloading station, approximately three storage tanks up to 40 feet tall (with a storage capacity of 1.5 million gallons total), a lube oil storage tank area up to 20 feet tall, a pump facility, and a containment berm that would be constructed around the storage tank yard.

Biodiesel would be transported from Washington State to Campbell Industrial Park on the west coast of Oahu via a fuel barge and then trucked to JBPHH as needed to maintain full fuel storage (up to 15 trucks per day). Biodiesel for the FRG Plant would be transported to the west coast of Oahu on existing fuel transport vessels, representing a minimal increase in the total volume of liquid fuel transported to Oahu. All fuel delivery and safety procedures would be followed during transport, delivery, and storage of biodiesel, including spill prevention and response planning, leak detection, and automatic shut-off. Assuming the plant operates at a consistent capacity factor throughout the year, this would equate to a barge every 3 weeks for biodiesel delivery.

Proposed support facilities at Site 2 include an engine hall approximately 50 feet tall, exhaust stacks approximately 110 feet tall, a cooling radiator field approximately 25 feet tall, a guard house, a workshop and warehouse, an administration facility, a control facility and two other support facilities, a fire facility, a compressor facility, a black start generator, and a fire tank. Perimeter fencing, lighting, noise mitigation, access roads, parking and service areas, walkways, storm water management, underground utility structures, access gates and fencing, and necessary grading would be included. For the electrical component, the site would include an air-insulated 46 kV substation for connection to the HECO grid, protection, and automation for the collection of power, all low-voltage switchgear, motor controls, panel boards, house-power transformers, and auxiliary load services.

A temporary staging area would be developed within the Site 2 boundary to accommodate construction equipment, materials, and other needs during the construction period. During construction, materials would be transported by truck from various on-island sources and from port deliveries to Site 2 where they would be stored, assembled (as necessary), and moved into place. Several smaller, non-native trees would be removed during construction; however, the mature trees along Russell Avenue and a large banyan tree would be retained. The construction site would be fenced, and dust barriers and other best management practices (BMPs) would be erected around active construction areas to minimize the effects of fugitive dust on adjacent land uses in the area. BMPs for soil erosion and sedimentation control would be implemented in accordance with project-specific drainage and erosion control plans, which would comply with applicable National Pollutant Discharge Elimination System requirements for construction-related activities.

The proposed construction would mostly occur in previously disturbed areas. Site 2 would include perimeter fencing, lighting, noise mitigation, access roads, parking and service areas, walkways, storm water management, underground utility structures, access gates and fencing, and necessary grading.

The two warehouses (Warehouses YA and YB) and the lubricant building (Warehouse 244) require demolition or disassembly prior to the start of construction (approximately 165,000 combined square feet). During construction, a non-profit company would deconstruct the facilities to reuse the building components and minimize landfilled waste. The fuel tanks and associated fuel dispensing pumps would remain in place to maintain uninterrupted availability to the motor pool. The fuel supply line to these tanks would be relocated prior to construction, and the wash rack currently located at Site 2 would be removed prior to construction. The mature trees and a historic rail line along Russell Avenue would remain undisturbed during the proposed construction and operations at Site 2. A vicinity map showing the location of Site 2 and the site design concept are presented in Figure 2.5-1 and Figure 2.5-2, respectively.

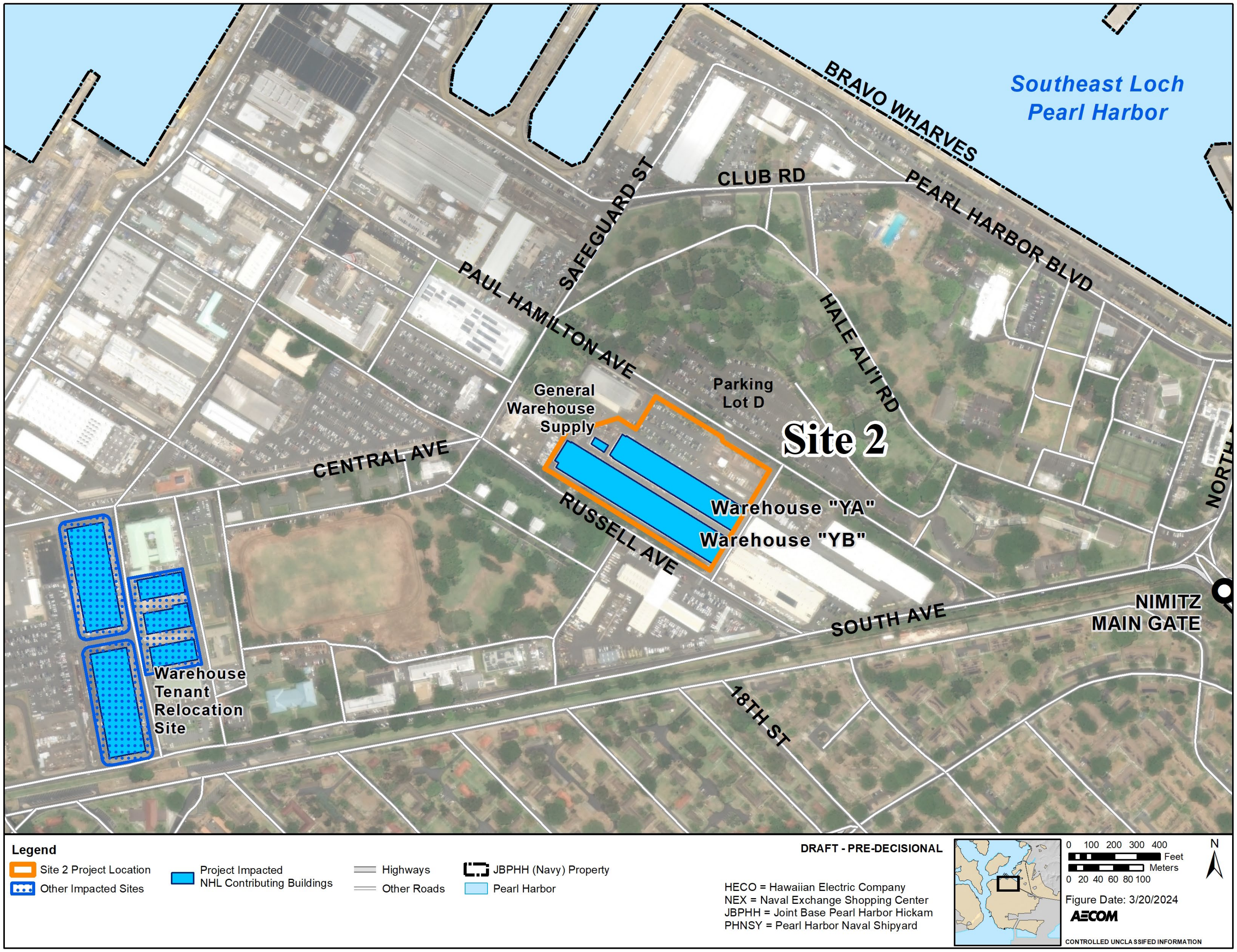

Figure 2.5-1 Site 2 Study Area

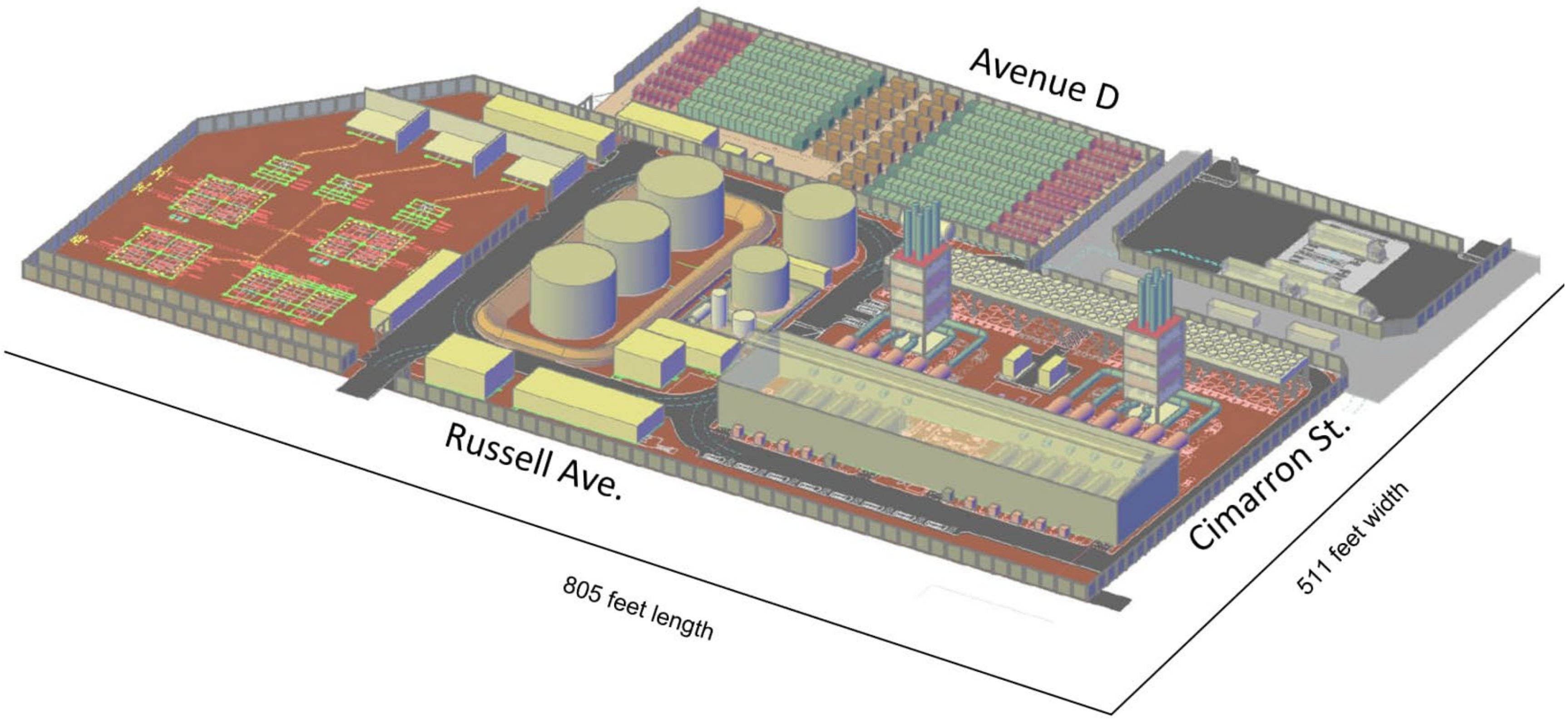

Figure 2.5-2 Site 2 Design Concept

2.5.4 Proposed Action Alternative: Site 5 6 MW PV System and 6 MW/24 MWh BESS (15 acres)

Site 5 would consist of a 6 MW solar PV system collocated with a 6 MW/24 MWh BESS. Construction would begin in December 2024 and would be complete by October 2026. The solar PV system would consist of approximately 10,950 modules in approximately 54 rows. The BESS would consist of three rows of 13 BESS units for a total of 39 BESS blocks, with each row of blocks including an inverter, step-up transformer, battery arrays, related heating, ventilation, air conditioning, and fire suppression.

A staging area would be developed on the northwest parking lot of the site to accommodate construction equipment, materials, and other needs during the construction period. During construction, materials would be transported by truck from various on-island sources and from port deliveries to Site 5, where they would be stored, assembled (as necessary), and moved into place. The construction site would be fenced, dust barriers would be erected around active construction areas, and other BMPs would be implemented to minimize the effects of fugitive dust on adjacent land uses in the area. During site preparation, surface vegetation in the areas to be developed would be cleared and grubbed (i.e., roots and stumps extracted) and the ground would be excavated and compacted where load-bearing foundations are proposed. BMPs for soil erosion and sedimentation control would be implemented in accordance with project-specific drainage and erosion control plans, which would comply with applicable National Pollutant Discharge Elimination System requirements for construction-related activities. The site would require minimal grading to accommodate the PV systems; therefore, no net increase of impervious surface would be added to this site.

Site 5 would include perimeter fencing, lighting, noise mitigation, access roads, parking, service areas, walkways, storm water management, underground utility structures, access gates and fencing, and necessary grading. No emergency generators are proposed at Site 5. Perimeter fencing would allow for a driveway for workers to access Facility X24.

Site 5 would interconnect to the HECO distribution system via an existing overhead distribution line on Namur Road. For the electrical component, the site would include an air-insulated 46 kV substation, protection, automation for collection of power, step-up transformation to 46 kV, all low-voltage switchgear, panel boards, house-power transformers, and auxiliary load services.

Three existing metal storage structures (Facilities X31, 77, and 80), and Facilities 59, 78, and 79 would be deconstructed and removed during construction by a non-profit company to reuse the building components and minimize landfilled waste. A vicinity map showing the location of Site 5 and the site general layout are presented in Figure 2.5-3 and Figure 2.5-4, respectively.

Figure 2.5-3 Site 5 Study Area

Figure 2.5-4 Site 5 General Layout

2.5.5 Proposed Action Operations and Maintenance

The selected lessee would be responsible for the operations and maintenance of Sites 2 and 5 and the IKC project sites through the duration of the lease. At the FRG Plant, personnel would be on-site 24 hours per day each day of the year. Staffing for the FRG Plant at Site 2 would be six to eight personnel during a normal shift and approximately two to four personnel overnight. The PV and BESS at Site 5 would not require permanent, full-time staffing for operations.

Routine maintenance on monthly and annual bases would occur per manufacturer specifications on the FRG Plant and associated facilities, the BESS, and PV system. Both Sites 2 and 5 would be inspected periodically to maintain safe site conditions and to enact emergency operations if unsafe conditions arise, such as risk of fire or mechanical or other equipment failure. Maintenance would include the use of emissions-generating equipment that would have negligible impacts.

2.5.6 Proposed Action Alternative: In-Kind Consideration Projects

IKC projects are facility upgrades that the Navy would accept in lieu of paying rent in cash at Sites 2 and 5. With a focus on energy security and resilience to enhance energy security, in lieu of the lessee paying rent in cash, the lessee would provide IKC through the development, delivery, and performance of electrical infrastructure upgrades, other proposed measures to increase energy resilience, or relocation of existing tenants to support the Proposed Action at Site 2. IKC technologies from past projects or existing technologies would be included in the Proposed Action that employ a fast-switching and control design which, during a grid disruption, would provide the installation with continuous access to reliable and quality power with islanding and black start capabilities. These IKC projects are described in detail below.

2.5.6.1 46 kV Electrical Transmission Backbone

A 46 kV electrical transmission backbone connecting Site 2 to the four existing and one proposed HECO substations on JBPHH is the most detailed IKC project. Construction would begin in December 2024 and would be complete by February 2027. The new HECO or lessee-owned 46 kV electrical transmission backbone would originate at Site 2, where the FRG Plant assets would interconnect with HECO in the existing Puuloa Substation adjacent to the proposed FRG Plant. This interconnection would be at a new, outdoor ring-bus 46 kV substation. The 46 kV electrical transmission backbone would then connect to the other substations located on and around the base. The substations connected by the 46 kV electrical transmission backbone include Puuloa Substation, Kuahua Substation, Hickam Front Substation, Mamala Substation, and the proposed Waimomi Substation. These existing Navy-owned substations are connected to the HECO substations and energy generated from the FRG Plant would connect to the existing HECO system through the 46 kV electrical transmission backbone. The electrical transmission backbone would consist of six power and two fiber circuits in each duct bank to ensure power and communication transmittal throughout the base. The electrical transmission backbone feeder would consist of a new underground conductor connecting each 46 kV substation within the Hickam, Pearl Harbor, and Honolulu regions inside the installation. At each of the substations, the new transmission feeder would terminate at a circuit breaker or switch, with associated protection and control to provide manual or automatic source selection between the existing HECO feed and the base energy supply in response to contingency events. Under normal conditions, the 46 kV electrical transmission backbone would be isolated from the JBPHH stations and portions of it would be used to deliver power from the generation sites to HECO. In the event of a HECO transmission system fault or power quality event, the affected system(s) would instantaneously switch over to the new 46 kV electrical transmission backbone and the related base assets to provide continuity of service to JBPHH.

The 46 kV electrical transmission backbone would be installed using a combination of open trench, trenchless horizontal direction drilling, and micro-tunnel drilling to minimize impact on site infrastructure and reduce the need for site restoration and disruption during implementation. Launch and receiving shafts for the installation of the electrical transmission backbone would be located in parking lots and open areas to avoid traffic disruptions, approximately every 1,000 linear feet along the transmission route. Sheet piles would be installed up to 40 feet deep at the construction shafts where the microtunneling equipment would be inserted into the ground. All sheet pile locations would be predrilled prior to the installation of the sheet piles.

2.5.6.2 Defense Logistics Agency Relocation

The Proposed Action would result in the demolition of Warehouses YA and YB at Site 2. The Defense Logistics Agency (DLA) currently uses these facilities for materials storage. The lessee would be required to provide new shelving systems in Facilities 226, 283, 284, 393, and 394, construct two concrete pads (approximately 30 feet wide by 200 feet long and 30 feet wide by 225 feet long) outside of Facility 393, and provide storage. To make room for the DLA in Facilities 393 and 394, other tenants would be relocated to Facility 452K. This action is not considered in this IKC project. The DLA would be responsible for relocating DLA materials from Warehouses YA and YB to Facilities 226, 283, 284, 393, and 394. The DLA relocation would occur approximately between May 2024 and May 2025.

2.5.6.3 Replace Protective Relays

As part of the IKC projects, the Proposed Action would also replace electromechanical protective relays at the base with state-of-the-art solid state relays. These actions would not include any ground-disturbing activities and would only consist of replacing electrical components in facilities on base that are currently used for this purpose. No new facilities would be used for this portion of the Proposed Action. Portions of the existing Supervisory and Control Data Acquisition (SCADA) system would be replaced to allow data acquisition and control of the new solid state relays. The method of construction would be replacement of existing switchgear doors with new solid state relays mounted in the new doors, replacement of existing SCADA devices and enclosures with equipment to support the solid state relays, and reprogramming of existing SCADA software, as necessary. All work would be accomplished within existing substations at the base. Each electrical station will take approximately 1 year to complete the replacements from the start of design to the completion of the installation. Construction would begin in fiscal year (FY) 2025. The following is a list of potential substations:

- Station G, Facility 826, Naval Station
- Station K, Facility 42, South Avenue
- Station L, Facility 46, Naval Station
- Station T, Facility 830, Ford Island
- Station TD, Facility 833, Ford Island
- Wastewater Treatment Plant Switchgear, JBPHH

2.5.6.4 Replace Live Front Equipment, Hickam

The Proposed Action would replace live front equipment in 19 transformer stations and one switch on Hickam Field. Live front equipment exposes personnel to potential energized parts. Replacing live front equipment with “dead front” equipment would enhance personnel safety by reducing exposure to live parts and arc flash. Liquid-filled transformers would be removed and disposed. All liquid-filled equipment insulating oil has been tested and determined to be non-polychlorinated biphenyls. All work is anticipated to be within the existing transformer station footprint and electrical connections made in existing manholes/handholes or terminal equipment enclosures. Construction would begin in FY25.

2.5.6.5 Protective Relay Coordination Study

The Proposed Action would include the development of a protective relay coordination study for the JBPHH Electrical Distribution System, reflecting the replacement of existing electromechanical relays with new solid state relays. Results of the study may require reprogramming of solid relays. No ground-disturbing activities would be associated with this study.

2.5.6.6 Replace Electrical Handholes

The Proposed Action would include repair and replacement of deteriorated electrical distribution handholes on JBPHH. Construction would begin in FY25.

2.6 Alternatives Considered but Not Carried Forward for Detailed Analysis

The following alternative was considered, but not carried forward for detailed analysis in this EA as it did not meet the purpose and need for the project and did not satisfy the reasonable alternative screening factors presented in Section 2.2 and Appendix J.

2.6.1 Navy Construct, Owns, and Operates On-Site Renewable Energy Generation Facilities

Under this alternative, the Navy would construct, own, and operate renewable energy power generation facilities and associated infrastructure at JBPHH. The facilities would not supply power to all Oahu customers but would serve only JBPHH. This alternative would guarantee that power could be reliably delivered to support Navy operations during an emergency, alleviating the energy threats to the installations and enhancing energy security. It would not provide additional power to the local communities or the energy security benefits for the island. This alternative is not a viable option because while this alternative would support the Navy's mission, it is not economically feasible and would not meet the Department of Defense-HECO Energy Partnership Charter arrangement with HECO to supply power to the community. Therefore, this alternative does not satisfy the purpose and need for the Proposed Action and was not further evaluated.

2.7 Best Management Practices and Standard Operating Procedures Included in the Proposed Action

This section presents an overview of the BMPs and SOPs that would be incorporated into the Proposed Action. BMPs are existing policies, practices, and measures that the Navy would adopt to reduce the environmental impacts of designated activities, functions, or processes. BMPs include actions required by federal or state laws or regulations. The recognition of the general management measures prevents unnecessarily evaluating impacts that are unlikely to occur. Although BMPs mitigate potential impacts by avoiding, minimizing, or reducing/eliminating impacts, BMPs are distinguished from potential mitigation measures because BMPs are (1) existing requirements for the Proposed Action, (2) ongoing, regularly occurring practices, or (3) not unique to this Proposed Action.

SOPs are regulatory, required, and formal written guidelines or instructions for incident response that typically include both operational and technical components. SOPs ensure proper handling and management of equipment and processes by establishing step-by-step guidelines to follow to prevent accidents, reduce errors, and ensure consistency. SOPs are linked to a specific ordinance, guidance document, or protocol.

Table 2.7-1 includes a list of BMPs and Table 2.7-2 includes a list of SOPs. Mitigation measures are discussed separately in Chapter 3, Table 3.8-2.

Table 2.7-1 Best Management Practices

BMP	Description	Impacts Reduced/Avoided
HAZ MGMT-1	Hazardous materials would be identified and remediated in compliance with all applicable regulations prior to demolition or renovation. Compliance with regulations would be included in any construction, demolition, or renovation contract language and construction specifications. Additionally, prior to construction work, it is recommended to consult with the appropriate Navy Remedial Project Manager for the current remediation status of the Installation Restoration Program site. No intrusive or construction activities would occur without the knowledge and concurrence of the Navy Environmental Restoration Program.	Impacts on public health and safety
HAZ MGMT-2	Pesticides: Soil under and around any facility may contain pesticide chemicals such as chlordane, dieldrin, or aldrin. Soil removed from under and within 3 feet of a facility, down to a depth of 2 feet, would be tested for pesticides, and either reused as approved by the Installation Environmental Office and/or disposed of off government property at a permitted facility.	Impacts on public health and safety
AQ-1	Use propane or electric-powered equipment, including vehicles, to the extent practical. To the extent practical, use on-site renewable electricity generation and/or grid-based electricity rather than diesel-powered generators or other equipment. Where feasible, support and/or implement the use of clean, renewable energy resources to meet additional power requirements. These actions include installing photovoltaics on new buildings and existing facilities.	Impacts on air quality, GHGs, and public health and safety
WATER MGMT-1	Erosion Avoidance Practice: Any soil exposed near water as part of the project would be protected from erosion (e.g., with plastic sheeting, filter fabric) after exposure and stabilized as soon as practicable (e.g., with vegetation matting, hydroseeding).	Impacts to water resources
WATER MGMT-2	General Construction – Petroleum, Oils, and Lubricants: • All equipment would be inspected daily by the contractor. If a leak is detected, then the contractor would immediately notify the JBPHH Environmental Division and construction Contracting Officer's Representation, and the equipment would be removed from the construction area, would not be used until the leak is repaired and equipment cleaned, and would only be returned once it is repaired and fully operational. • Wash water resulting from washdown of equipment or work areas would be contained for proper disposal and shall not be discharged unless authorized. • Equipment that enters surface waters would be maintained to prevent any visible sheen from petroleum products. • No oil, fuels, or chemicals would be discharged to surface waters or onto land where a potential exists for re-entry into surface waters to occur. • No cleaning solvents or chemicals used for tools or equipment cleaning would be discharged to ground or surface waters. • When possible, hydraulic fluids would be vegetable-based.	Impacts to water quality

Table 2.7-1 Best Management Practices

BMP	*Description*	*Impacts Reduced/Avoided*
WATER MGMT-3	BMPs applied near the project area would include filter socks around perimeters and filter fabric inside any storm drains to prevent pollutants from getting into the MS4. Any sediment stockpile would require filter socks and be frequently watered down using a water truck, or include use of plastic tarps, for dust control. At contractor staging areas, BMPs would include stabilized construction entrance and exits, boundary fencing with fabric, filter socks around perimeter, and/or silt fencing.	Minimize pollutants in storm water flows
WATER MGMT-4	Low-impact development techniques such as bioretention, vegetated swales, and/or vegetated filter strips would be used during construction. Features such as underground chambers and pervious pavement should be considered as low-impact development for water management beyond the construction period.	Minimize pollutants in storm water flows
WATER MGMT-5	Any detention basins used would be covered to avoid attracting birds.	Minimize attraction of birds
CULT MGMT-1	Subsurface fishponds would be avoided during electrical transmission backbone installation excavation and tunneling.	Impact avoidance/effective to eliminate or reduce the potential effect
TERR BIO MGMT-2	Pre-construction surveys for birds and special-status species with the potential to occur would be conducted daily by a qualified biologist to ensure no species are present at Sites 2 and 5. A biological monitor would conduct nest surveys in the existing trees at each site and within 100 feet of Sites 2 and 5. Surveys would be repeated within 3 days of project initiation and after any subsequent delay of work of 3 or more days (during which the birds may attempt to nest). If a nest or active brood is found: • The Navy would contact the United States Fish and Wildlife Service (USFWS) within 48 hours for further guidance. • A 100-foot buffer would be established and maintained around all active nests and/or broods until the chicks/ducklings have fledged. No potentially disruptive activities or habitat alteration would occur within this buffer. If a pueo (Hawaiian short-eared owl) is spotted on the ground during pre-construction surveys, a nest survey would commence within 656 feet (200 meters) of the observed pueo. If a nest is discovered, a 656-foot (200-meter) buffer would be erected to protect the nest. The use of loud equipment would not occur within 1,640 feet (500 meters) of the known nest until chicks have fledged (DON, 2022d). A biological monitor that is familiar with the species' biology would be present at Sites 2 and 5 during all construction or earth-moving activities until the chicks/ducklings fledge to ensure that waterbirds and nests are not adversely impacted.	Minimize disturbance to sensitive species and bird nesting, in conformance with the Migratory Bird Treaty Act

Table 2.7-1 Best Management Practices

BMP	*Description*	*Impacts Reduced/Avoided*
TERR BIO MGMT-4	Native vegetation would be used as practicable and as recommended by agencies for revegetation efforts.	Impacts from introduction of invasive species
TERR BIO MGMT-5	No proposed fencing would use barbed wire that could entangle foraging Hawaiian hoary bats.	Minimize Hawaiian hoary bat entanglement
TERR BIO MGMT-6	Any new windows for any facility at Sites 2 and 5 would include design features to minimize bird attraction, including tinted glass or film with a visible light transmittance value of 30% or less (inside to outside).	Minimize attraction of birds
VISUAL-1	Modern solar panels are constructed of dark-colored materials and are covered with anti-reflective coatings. These materials reflect as little as two percent of incoming sunlight, about the same as water and less than soil or wood shingles.	Avoid glare that would impact residential properties in the vicinity of Site 2
TRANS MGMT-1	A CTMP would be developed to direct traffic through areas where project construction work and worker safety areas create temporary traffic delays. As part of this plan, the construction manager would review and use the construction schedule to manage the construction workers' arrival and departure times, reducing impacts to peak hour traffic. The CTMP would complement the traffic control plan and identify appropriate work zone management strategies.	The CTMP would effectively reduce worker safety risks, manage temporary lanes, and manage worker arrival and departure times.
ENERGY MGMT-1	Upgrades to infrastructure and utilities would be designed to meet LEED standards and criteria and would be consistent with low-impact development.	Energy, Air Quality, GHGs, Environmental Justice, Infrastructure, and Utilities

Key: BIO = biological; BMP = best management practice; CTMP = construction traffic management plan; HDOH = Department of Health, State of Hawaii; ESA = Endangered Species Act; GHG = greenhouse gas; HAZ = hazardous; LEED = Leadership in Energy and Environmental Design; MBTA = Migratory Bird Treaty Act; MGMT = management; MS4 = municipal separate storm sewer system; SOH = State of Hawaii; TERR = terrestrial; TRANS = transportation; USFWS = United States Fish and Wildlife Service.

Table 2.7-2 Standard Operating Procedures

Procedure	*Anticipated Benefit/ Evaluating Effectiveness*	*Implementing and Monitoring*	*Responsibility*	*Authority of Requirement*
Water				
Implementation of SOPs for fuel storage.	Reduced/avoided impacts from fuel transportation and storage activities	SOPs for fuel storage would comply with OPP Regulations, including the EPA SPCC requirements under Section 311 of the CWA. Includes immediate cleanup of any leaks or spills, proper storage including a containment berm, and disposal of hazardous materials to avoid, contain, and prevent contamination of water resources.	Construction contractor	Navy Section 311 of the CWA
NPDES Permit Requirements.	Reduced/avoided impacts to water resources	All requirements of the NPDES permit for the discharge of storm water associated with construction activity, including a storm water pollution prevention plan, would be implemented.	Construction contractor	NPDES
Implementation of a storm water pollution prevention plan during construction and a storm water management plan during operations.	Reduced/avoided impacts to water resources	Design details for Sites 2 and 5 would include the storm water conveyance and management systems needed to handle incremental increases in storm water. Storm Water Pollution Prevention Plan: Prior to any ground-disturbing activities, the Navy would establish compliance with the planning requirements and permit conditions contained in the Notice of General Permit Coverage for discharges of storm water associated with construction activities. The construction contractor would prepare and implement a construction storm water pollution prevention plan that would include, but not be limited to, the following reasonable precautions: (1) Use of water or suitable chemicals for the control of fugitive dust in the demolition of existing buildings or structures, the construction operations, the grading of roads, or the clearing of land. (2) Application of asphalt, water, or suitable chemicals on roads, material stockpiles, and other surfaces that may be sources of fugitive dust. (3) Covering of all moving, open-bodied trucks transporting materials that may be sources of fugitive dust. (4) Maintenance of roadways in a clean manner. (5) Prompt removal of earth or other materials from paved streets that have been transported there by trucking, earth-moving equipment, erosion, or other means. All BMPs and other appropriate control measures specified in both the permit and storm water pollution prevention plan would be implemented, monitored, and submitted to the Navy for regular review. In the event of changes to the information submitted in the Notice of Intent form associated with the Notice of General Permit Coverage application	Construction contractor	National Pollutant Discharge Elimination System Section 438 of the Energy Independence and Security Act, United Facilities Criteria 3-210-10

Table 2.7-2 Standard Operating Procedures

Procedure	*Anticipated Benefit/ Evaluating Effectiveness*	*Implementing and Monitoring*	*Responsibility*	*Authority of Requirement*
		process, such as expanded staging areas or construction work outside of the project limits, a new Notice of General Permit Coverage shall be required. A storm water management plan would be developed to consider runoff generated from new impermeable surfaces resulting from the Proposed Action and would be consistent with low-impact development.		
Soils				
Adherence to JBPHH Soils Policy.	Reduced/avoided impacts from construction and operations activities	Implementation of anticipated engineering and design details and SOPs during and after construction in compliance with the JBPHH Soils Policy. Selected examples include: Site soils would be tested for pesticides and other anticipated contaminants. Management and disposal of contaminated soils would adhere to all applicable regulations. Erosion control plans would be prepared and followed. Water would be used for dust control.	Construction contractor	JBPHH Soils Policy (DON, 2022)
Public Health and Safety				
Implementation of anticipated air quality engineering and design details and SOPs during construction.	Reduced/avoided impacts from construction activities	SOPs designed to meet regulatory requirements for air quality would reduce air emissions and support compliance with public safety standards for construction sites.	Construction contractor	EPA
Implementation of anticipated public health and safety engineering and design details and SOPs during construction.	Reduced/avoided impacts from operations activities	Operational SOPs would be implemented to reduce impacts to public health and safety, including ensuring that all access is authorized and adding adequate security fencing and lighting during both the construction and operational phases.	Project design	EPA

Table 2.7-2 Standard Operating Procedures

Procedure	*Anticipated Benefit/ Evaluating Effectiveness*	*Implementing and Monitoring*	*Responsibility*	*Authority of Requirement*
Hazardous Materials and Wastes				
Implementation of anticipated SOPs during construction and operations.	Reduced/avoided impacts to public health and safety from construction and operations activities	Use of secondary containment berms or catchment basins would minimize the impact of an accidental release of fuels or other hazardous materials and wastes. Absorbent pads, spill kits, and containment booms would be stored on-site for response to accidental releases. All construction workers would be trained on spill prevention and notification measures in accordance with DoD pollution control requirements to reduce the potential for accidental spills.	Construction contractor	OPP Regulations including SPCC requirements under Section 311 of the CWA, Resource Conservation and Recovery Act, 42 U.S.C. § 6901 et seq., and 49 Code of Federal Regulations (CFR) 100–185
Design, development, and implementation of a spill prevention and response plan.	Reduced/avoided impacts from construction and operations activities	The EPA SPCC rule would be followed during construction and operations, including implementation of a Spill Prevention and Response Plan (EPA, 2023b). Spill Prevention and Response Plan: • Training in proper handling of used oil or hazardous substances, aboveground fixed tank construction, inspection and drainage of impervious secondary containment berms/systems, good housekeeping practices, engineering controls such as containments during painting, daily inspections, and drainage control would be provided prior to initiating work. • Refueling of equipment would be permitted only at approved fueling facilities and at least 50 feet from the water. A contingency plan to control petroleum products accidentally spilled during the project would be developed. Absorbent pads and containment booms would be stored on-site, if appropriate, to facilitate cleanup of accidental petroleum releases.	Construction contractor	Navy's Hazardous Material Control and Management Program and Hazardous Waste Minimization Program (42 U.S.C. §133)

Table 2.7-2 Standard Operating Procedures

Procedure	*Anticipated Benefit/ Evaluating Effectiveness*	*Implementing and Monitoring*	*Responsibility*	*Authority of Requirement*
Air Quality				
Design, development, and implementation of a dust control plan. The following are common precautions that can be implemented as conditions required to minimize fugitive dust.	Reduced/avoided impacts from construction activities	During ground disturbance, water would be used for dust control, along with the implementation of a storm water pollution prevention plan, erosion control plan, environmental mitigation plans, and/or health and safety plan to minimize potential impacts. A dust control plan would be designed, developed, and implemented to meet HAR 11-60.1-33. • Use water in the demolition of existing structures, construction operations, and grading or clearing of land. • Apply water on roads. • Whenever feasible, pave ingress and egress points to the site. • Establish and monitor speed limits for project rights-of-way. • Cover all moving, open-bodied trucks transporting dusty materials. • Promptly remove soil or other carry out materials from roads adjacent to the site. • Install dust screens or wind barriers around the construction site. • During earth-moving activities, pre-apply and re-apply water as necessary to maintain soils in a damp condition, limit the amount of exposed areas through planning and timing of project phases, and cover temporarily exposed areas with mulch. • Stabilize stockpile materials. • Keep stockpiles wet or damp as needed. • Cover non-dredge stockpile when not in use. • Stockpiles shall have engineered slopes or benches to keep their height as low as possible. • Add or remove material from downwind portion of stockpile. • For on-site trucks: o Provide water while loading and unloading to prevent fugitive dust. o Maintain at least 6 inches (15 centimeters) of freeboard on haul vehicles. Level the height of load. o Limit vehicular speed while traveling on-site. o Cover loads while travelling. o Install a gravel pad and grizzly (i.e., rumble grate) at exit. o Reduce carry out with a tire wash or spray system.	Construction contractor	HAR 11-60.1-33

Table 2.7-2 Standard Operating Procedures

Procedure	***Anticipated Benefit/ Evaluating Effectiveness***	***Implementing and Monitoring***	***Responsibility***	***Authority of Requirement***
Cultural Resources				
Adherence to Navy SOPs for Archaeological Treatment Protocols.	Adherence to previously established protections and protocol to eliminate or reduce the potential effect	Follow procedures outlined in Navy SOPs for Archaeological Treatment Protocols in the JBPHH ICRMP in the event of an inadvertent discovery of cultural resources or remains. These SOPs include ensuring that the ground disturbing activities would only occur to the known depth of fill, monitoring excavation, conducting investigations in areas with known subsurface sites, and collecting data to inform the SHPO and update the ICRMP GIS database.	Commercial developer	Navy
Adherence to Section 106 PA where applicable.	Effective to address non-compliance	Adherence to the PA to previously established protections and protocols.	Navy	SHPD/Section 106

Key: BMP = best management practice; CFR = Code of Federal Regulations; CWA = Clean Water Act; DoD = Department of Defense; EPA = Environmental Protection Agency, United States; GIS = geographic information system; HAR = Hawaii Administrative Rules; ICRMP = Integrated Cultural Resources Management Plan; NPDES = National Pollutant Discharge Elimination System; OPP = Oil Pollution Prevention; PA = Programmatic Agreement; SHPD = State Historic Preservation Division; SHPO = State Historical Preservation Office; SPCC = Spill Prevention, Control, and Countermeasure.

3 Affected Environment and Environmental Consequences

This chapter presents a description of the environmental resources and baseline conditions that could be affected from implementing any of the alternatives, and an analysis of the potential direct, indirect, and cumulative effects and reasonably foreseeable future actions of each alternative.

All potentially relevant environmental resource areas were initially considered for analysis in this Environmental Assessment (EA). In compliance with the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ), and United States (U.S.) Department of the Navy (Navy) guidelines, the discussion of the affected environment (i.e., existing conditions) focuses only on those resource areas potentially subject to impacts. Additionally, the level of detail used in describing a resource is commensurate with the anticipated level of potential environmental impact.

"Significance," as used in NEPA, requires considerations of both context and intensity. Context means that the significance of an action must be analyzed under several perspectives such as society as a whole, the affected region, the affected interests, and the locality. Significance varies with the setting of a proposed action. For instance, in the case of a site-specific action, significance usually would depend on the effects in the locale rather than in the world as a whole, such as proximity to unique or sensitive resources or vulnerable communities. Both short- and long-term effects are relevant, as are beneficial and adverse effects, effects on public health and safety, and effects that would violate federal, state, tribal, or local law protecting the environment. Intensity refers to the severity or extent of the potential environmental impact, which can be thought of in terms of the potential amount of the likely change. CEQ regulations requires agencies to assess the intensity of effects from an action and to provide a list of factors, some or all of which may apply to any given action, for agencies to consider in relation to one another (CEQ, 2023). In general, the more sensitive the context, the less intense a potential impact needs to be in order to be considered significant. Likewise, the less sensitive the context, the more intense a potential impact needs to be in order to be considered significant.

This section includes detailed analysis of the following disciplines: air quality and greenhouse gases (GHGs), cultural resources, biological resources, visual resources, noise, and transportation. Other disciplines addressed with less detail because negligible effects are expected are: water resources, geological and topographic resources, soils, land use, airspace, infrastructure and utilities, public health and safety, hazardous materials and wastes, socioeconomics, recreation, and environmental justice.

3.1 Resources with Negligible Impacts

Potential impacts to the following resource areas under the Proposed Action Alternative are considered to be negligible or non-existent:

- Water Resources
- Geology and Topography Resources
- Soils
- Land Use
- Airspace
- Infrastructure and Utilities
- Public Health and Safety
- Hazardous Materials and Wastes

- Socioeconomics
- Recreation
- Environmental Justice

Potential impacts on these resources are discussed in more detail in Appendix I. They are not analyzed further in this EA.

3.2 Air Quality, Greenhouse Gases, and Climate Change

This section evaluates potential impacts to air quality, the contribution of GHG emissions, and climate change effects that could result from implementation of the Proposed Action. A region's air quality is influenced by many factors, including the type and amount of pollutants and how they are emitted into the atmosphere, the size and topography of the air basin, and the local meteorological conditions.

Most air pollutants originate from human-made sources, including mobile sources (e.g., fuel-burning vehicles) and stationary sources (e.g., concrete batch plants, refineries, power plants), as well as indoor sources (e.g., some building materials and cleaning solvents). Air pollutants are also released from natural sources such as volcanic eruptions and forest fires. Air quality in a given location is defined by the concentration of various pollutants in the atmosphere. A description of the regulatory setting for air quality is included in Appendix H.

3.2.1 Affected Environment

The State of Hawaii (SOH) operates air monitoring stations on Oahu, four of which (Kapolei, Pearl City, Sand Island, and Honolulu) are located in relative proximity to Joint Base Pearl Harbor-Hickam (JBPHH). Based on this ambient air monitoring data, the U.S. Environmental Protection Agency (EPA) has classified the SOH as being in attainment of the federal standards. In addition, pollutant concentrations within the state comply with the State Ambient Air Quality Standards (SAAQS), which are more stringent than National Ambient Air Quality Standards (NAAQS).

3.2.1.1 Criteria Pollutants

As shown in Table 3.2-1, recent SOH Department of Health (HDOH)-published design values based on current ambient monitoring levels (2019–2021) for Honolulu are below the most stringent ambient air quality standards (AAQS). A design value is a statistic that describes the air quality status of a given location relative to the level of the NAAQS. Design values are computed and published annually by EPA's Office of Air Quality Planning and Standards and reviewed in conjunction with the EPA Regional Offices.

Table 3.2-1 Comparison of 2019–2021 Honolulu Design Values with AAQS

Pollutant	*Averaging Time*	*Most Stringent AAQS*	*Maximum Design Values (Station)*	*% of AAQS*
CO	• 1-hour • 8-hour	• 9 ppm (State) • 4.4 ppm (State)	• 0.9 ppm (Honolulu) • 0.7 ppm (Honolulu)	• 10 • 16
NO_2	• 1-hour • Annual	• 0.100 ppm (NAAQS) • 0.04 ppm (State)	• 0.025 ppm (Kapolei) • 0.004 ppm (Kapolei)	• 25 • 10
PM_{10}	• 24-hour • Annual	• 150 µg/m^3 (NAAQS) • 50 µg/m^3 (State)	• 24.7 µg/m^3 (Honolulu) • 10.4 µg/m^3 (Honolulu)	• 16 • 21
$PM_{2.5}$	• 24-hour • Annual	• 35 µg/m^3 (NAAQS) • 12 µg/m^3 (NAAQS)	• 6.2 µg/m^3 (Pearl City) • 3.2 µg/m^3 (Pearl City)	• 18 • 27

Table 3.2-1 Comparison of 2019–2021 Honolulu Design Values with AAQS

Pollutant	*Averaging Time*	*Most Stringent AAQS*	*Maximum Design Values (Station)*	*% of AAQS*
O_3	8-hour	0.07 ppm (NAAQS)	0.048 ppm (Kapolei)	69
SO_2	• 1-hour • 3-hour • 24-hour • Annual	• 0.075 ppm (NAAQS) • 0.5 ppm (State) • 0.14 ppm (State) • 0.03 ppm (State)	• 0.003 ppm (Honolulu) • 0.002 ppm (Honolulu) • 0.001 ppm (Honolulu) • 0.0002 ppm (Honolulu)	• 4 • 0.4 • 1 • 0.7
Pb[(1)]	Rolling 3-month	0.15 µg/m³ (NAAQS)	0.036 µg/m³ (Kapolei)	24

Note: Lead data are from 2018. Lead monitoring ended on December 31, 2018, with EPA approval.
Key: µg/m³ =microgram per cubic meter; AAQS = ambient air quality standards; CO = carbon monoxide; mg/m³ = milligram per cubic meter; EPA = Environmental Protection Agency, United States; NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; PM_{10} = particles with aerodynamic diameters less than or equal to a nominal 10 micrometers; $PM_{2.5}$ = particles with aerodynamic diameters less than or equal to a nominal 2.5 micrometers; Pb = lead; ppm = part per million; O_3 = ozone; SO_2 = sulfur dioxide.
Sources: HDOH (2016; 2020a; 2020b; 2020c; 2021a; 2021b; 2022) (Hawaii Air Quality Data Books).

3.2.1.2 Hazardous Air Pollutants/Air Toxics

Ambient monitoring of air toxics has been performed through various programs and efforts led by EPA, state, and/or local air agencies. Air toxics monitoring data are available from EPA (2023a). Ambient air toxics monitoring data for Honolulu are available for select HAPs and various years. The most recent data year is 2010 for non-metal HAPs and 2022 for metal HAPs monitored. The most recent data, exposure values, inhalation unit risk, and individual pollutant non-cancer hazard and lifetime cancer risk are presented in Table 3.2-2 and Table 3.2-3. Assuming exposure at levels of monitored ambient concentrations, all of the calculated individual pollutant non-cancer hazard quotients are below 1 for acute and chronic exposure. If exposure concentrations are equivalent to 2010 ambient monitoring data, individual screening level incremental lifetime cancer risks for acetaldehyde, benzene, chromium, and formaldehyde exceed 1×10^{-6} (1 in one million). Current concentrations of most HAPs are not expected to be significantly greater than the most recent monitoring data due to the EPA's strategy to reduce HAPs.

Table 3.2-2 Honolulu Ambient Monitoring Data for Air Toxics and Acute Exposure

Air Pollutant[(1)]	*Concentration (µg/m³) and Data Year[(1)]*		*Exposure Value (µg/m³)[(2)]*	*Non-Cancer Hazard Quotient[(3)]*
Acetaldehyde	2.74005	2010	470	0.006
Arsenic $PM_{2.5}$ LC	0	2022	—	—
Benzene	2.6531	2010	27	0.098
Beryllium (TSP) STP	0.1 ng/m³	2010	25,000 ng/m³	0.000004
1,3-Butadiene	0	2010	660	0
Cadmium (TSP) STP	0.0003	2010	0.030	0.010
Cadmium $PM_{2.5}$ LC	0.026	2022	—	—
Carbon tetrachloride	0	2010	1,900	0
Chloroform	0	2010	150	0
Chromium (TSP) STP	0.011	2010	2,500	0.000004
Chromium $PM_{2.5}$ LC	0.009	2022	—	—
Dichloromethane	0.93841	2010	—	—

Table 3.2-2 Honolulu Ambient Monitoring Data for Air Toxics and Acute Exposure

Air Pollutant[(1)]	*Concentration (µg/m³) and Data Year*[(1)]		*Exposure Value (µg/m³)*[(2)]	*Non-Cancer Hazard Quotient*[(3)]
1,2-Dichloropropane	0	2010	92	0
Formaldehyde	2.67905	2010	49	0.055
Manganese (TSP) STP	0.015	2010	50,000	0.0000003
Manganese $PM_{2.5}$ LC	0.011	2022	—	—
Nickel (TSP) STP	0.015	2010	0	0.075
Nickel $PM_{2.5}$ LC	0.007	2022	—	—
Tetrachloroethylene	0	2010	41	0
Trichloroethylene	0	2010	410,000	0
Vinyl chloride	0	2010	1,300	0

Notes:
(1) Source = EPA Air Data website (EPA, 2023c); maximum 24-hour concentration for the most recent data year listed.
(2) Source = Lowest found in EPA Acute Dose-Response Assessment Table (2018) and Agency for Toxic Substances and Disease Registry Minimal Risk Levels for acute inhalation; assumed chromium (III) for exposure value of chromium (TSP); "—" = No exposure value found.
(3) Assuming exposure to ambient concentration, Non-Cancer Hazard Quotient (unitless) = Concentration (µg/m³) ÷ Exposure Value (µg/m³); "—" = No exposure value/not calculated.
Key: µg/m³ = microgram per cubic meter; EPA = Environmental Protection Agency, United States; LC = local conditions; $PM_{2.5}$ = particles with aerodynamic diameters less than or equal to a nominal 2.5 micrometers; STP = standard temperature and pressure; TSP = total suspended particulate.

Table 3.2-3 Honolulu Ambient Monitoring Data for Air Toxics and Chronic Exposure

Air Pollutant	*Concentration (µg/m³) and Data Year*[(1)]		*Exposure Value (µg/m³)*[(2)]	*Inhalation Unit Risk*[(2)] *(1/[µg/m³])*	*Non-Cancer Hazard Quotient*[(3)]	*Cancer Risk*[(4)] *(× 10^{-6})*
Acetaldehyde	1.67736	2010	9	2.20E—06	0.186	3.7
Arsenic $PM_{2.5}$ LC	0	2022	—	—	—	—
Benzene	0.61339	2010	30	7.80E—06	0.020	4.8
Beryllium (TSP) STP	0.03 ng/m³	2010	20 ng/m³	2.40E—03	0.002	0.1
1,3-Butadiene	0	2010	2	3.00E—05	0	0
Cadmium (TSP) STP	0.00003	2010	0.01	1.80E—03	0.003	0.1
Cadmium $PM_{2.5}$ LC	0.0012	2022	—	—	—	—
Carbon tetrachloride	0	2010	100	6.00E—06	0	0
Chloroform	0	2010	98	—	0	—
Chromium (TSP) STP	0.00288	2010	0.1	0.012	0.029	34.6
Chromium $PM_{2.5}$ LC	0.00083	2022	—	—	—	—
Dichloromethane	0.01617	2010	—	—	—	—
1,2-Dichloropropane	0	2010	9	—	0	—
Formaldehyde	1.58692	2010	9.8	1.30E—05	0.162	20.6
Manganese (TSP) STP	0.00593	2010	0.3	—	0.020	—
Manganese $PM_{2.5}$ LC	0.00063	2022	—	—	—	—
Nickel (TSP) STP	0.00253	2010	0.09	—	0.028	
Nickel $PM_{2.5}$ LC	0.00145	2022	—	—	—	—
Tetrachloroethylene	0	2010	41	—	0	—

Table 3.2-3 Honolulu Ambient Monitoring Data for Air Toxics and Chronic Exposure

Air Pollutant	*Concentration (μg/m³) and Data Year[(1)]*		*Exposure Value (μg/m³)[(2)]*	*Inhalation Unit Risk[(2)] (1/[μg/m³])*	*Non-Cancer Hazard Quotient[(3)]*	*Cancer Risk[(4)] (× 10^{-6})*
Trichloroethylene	0	2010	2	4.10E—06	0	0
Vinyl chloride	0	2010	100	8.80E—06	0	0

Notes:
(1) Source = EPA Air Data website (EPA, 2023c); mean 24-hour concentration for the most recent data year listed.
(2) Source = EPA Chronic Dose-Response Assessment Table (2018) or Agency for Toxic Substances and Disease Registry Minimal Risk Levels for chronic (intermediate if no chronic) inhalation; assumed chromium (VI) for exposure value and IUR of chromium (TSP) STP; "—" = No exposure value found.
(3) Assuming exposure to ambient concentration, Non-Cancer Hazard Quotient (unitless) = Concentration (μg/m3) ÷ Exposure Value (μg/m3); "—" = No exposure value/not calculated. Assuming exposure to ambient concentration.
(4) Screening-Level Lifetime Cancer Risk (in one million) = Concentration (μg/m³) × IUR (1/(μg/m³)) × 106/million; "—" = No IUR/not calculated.
Key: μg/m³ = microgram per cubic meter; EPA = Environmental Protection Agency, United States; IUR = Inhalation Unit Risk; LC = local conditions; ng/m³ = nanograms per cubic meter; $PM_{2.5}$ = particles with aerodynamic diameters less than or equal to a nominal 2.5 micrometers; STP = standard temperature and pressure; TSP = total suspended particulate.

3.2.1.3 Emissions Inventory

The most recent criteria pollutant, GHG, and HAP emissions inventory for Hawaii is shown in Table 3.2-4. Volatile organic compounds (VOCs) and nitrogen oxides (NO_x) emissions are used to represent ozone generation because they are precursors of ozone. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) represent the dominant GHGs. To understand the relative level of significance compared to City and County of Honolulu emissions or state-wide emissions, emissions from existing JBPHH sources are also included in Table 3.2-4. These emissions represent actual emissions from 2019. JBPHH is subject to and is a major source for the National Emission Standards for Hazardous Air Pollutants emissions for shipbuilding and ship repair (surface coating).

Table 3.2-4 Hawaii Air Emissions Inventory (2017) and 2019 JBPHH Stationary Source Emissions

Location	*NO_x[(2)] (tpy)*	*VOC[(2)] (tpy)*	*CO[(2)] (tpy)*	*SO_2[(2)] (tpy)*	*PM_{10}[(2)] (tpy)*	*$PM_{2.5}$[(2)] (tpy)*	*HAP[(2)] (tpy)*	*CO_2e (tpy)[(2)]*
City and County of Honolulu [(1)]	25,504	20,560	89,210	13,159	14,961	4,390	3,528	2,175,212
2019 JBPHH Stationary Sources[(3)]	0.1	11.7	0.0	0.0	0.0	0.0	11.1	—

Notes:
(1) The City and County of Honolulu is a consolidated city-county. The city-county includes the island of Oahu, as well as several minor outlying islands, including all of the Northwestern Hawaiian Islands (islands beyond Niihau) except Midway Atoll. Emissions are virtually entirely associated with the island of Oahu.
(2) Biogenic (vegetation and soil) and wildfire emissions are excluded from the totals.
(3) From JBPHH PHNSY Dry Dock and WPF Final EIS (https://www.pearlharbordrydockeis.org/).
Key: CO_2e = carbon dioxide equivalent; EIS = Environmental Impact Statement; HAP = hazardous air pollutant; JBPHH = Joint Base Pearl Harbor-Hickam; NO_x = nitrogen oxides; PHNSY Dry Dock and WPF = Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility Dry Dock and Waterfront Production Facility; PM_{10} = particles with aerodynamic diameters less than or equal to a nominal 10 micrometers; $PM_{2.5}$ = particles with aerodynamic diameters less than or equal to a nominal 2.5 micrometers; SO_2 = sulfur dioxide; tpy = ton per year; VOC = volatile organic compounds; "—" = Not reported.
Source: EPA (2017).

Although JBPHH operates air emission sources that are exempt from permitting (e.g., mobile sources such as forklifts, automobiles, trucks, cranes), the base maintains five HDOH Title V permits and a noncovered source permit for equipment located at an industrial wastewater pre-treatment plant:

- **Permit 0209-01-C:** Fuel-loading facilities
- **Permit 0105a-01-C:** Shipbuilding and ship repair operations
- **Permit 0105b-01-C:** Shipbuilding and ship repair operations
- **Permit 0105e-01-C:** Combustion turbines, industrial waste treatment complex
- **Permit 0105e-03-C:** Six air curtain incinerators
- **NSP No. 0109-04-N:** Two boiler/burners and waste gas burner at Fort Kamehameha Wastewater Treatment Plant

3.2.1.3.1 HAPs Exposure Based on Emissions Inventory

To help understand where health risks may be elevated from exposure to air toxics, EPA developed the 2019 Air Toxics Screening Assessment (AirToxScreen) tool (EPA, 2019), a screening tool that calculates outdoor air toxics concentrations and risk estimates with the use of chemical transport and dispersion models and the 2017 National Emissions Inventory. Accounting for emission quantities and varying degrees of effects by pollutant, the 2019 AirToxScreen results can assist in identifying HAPs and source types of greatest concern for assessing toxic air pollutant impacts from a proposed action.

The 2019 AirToxScreen results include the lifetime cancer risk and chronic non-cancer hazard exposure for Honolulu. The individual pollutants with the top 10 estimated lifetime cancer risk and chronic non-cancer hazard quotients are shown in Table 3.2-5. Lifetime cancer risks exceed 1×10^{-6} for the following HAPs: formaldehyde and carbon tetrachloride. Because all non-cancer hazard quotients are below 1, adverse non-cancer effects from HAPs are unlikely.

Table 3.2-5 2019 AirToxScreen – Top 10 Cancer Risk and Chronic Hazard Quotient for City and County of Honolulu

Air Pollutant	*Cancer Risk[(1)] ($\times 10^{-6}$)*	*Non-Cancer Hazard Quotient[(1)]*
Formaldehyde	8.78	0.069
Carbon Tetrachloride	2.16	—
Benzene	0.82	—
Acetaldehyde	0.58	0.029
1,3-Butadiene	0.41	0.007
Naphthalene	0.27	—
Ethylbenzene	0.23	—
Chromium VI (Hexavalent)	0.19	—
Nickel Compounds	0.17	0.008
PAH_POM	0.13	—
Benzopyrene	—	0.029
Acrolein	—	0.015
Trichloroethylene	—	0.004

Table 3.2-5 2019 AirToxScreen – Top 10 Cancer Risk and Chronic Hazard Quotient for City and County of Honolulu

Air Pollutant	*Cancer Risk(1) (× 10^{-6})*	*Non-Cancer Hazard Quotient(1)*
Diesel PM	—	0.014
Xylenes (Mixed Isomers)	—	0.004
Methyl Bromide (Bromomethane)	—	0.013

Note: (1) Only top 10 cancer risk and non-cancer hazard quotient values are presented.
Key: "—" = Not a top 10/not shown; PAH_POM = polycyclic aromatic hydrocarbon, polycyclic organic matter; PM = particulate matter.
Source: EPA (2023c); 2019 AirToxScreen (EPA, 2019).

Table 3.2-6 identifies the City and County of Honolulu level of emissions for the 10 primary HAP pollutants for the most recent reportable year and their weighting by percentage relative to total HAP emissions for the year. All are predominantly emitted by mobile sources, with the exception of methanol and ethylene glycol, which are generated primarily from solvent use (EPA, 2017).

Table 3.2-6 Total City and County of Honolulu Emissions from the Top 10 HAPs for 2017

HAP(1)	*Emissions (tpy)*	*% of Total HAPs*
Toluene	914	26
Xylenes	519	15
Methanol	492	14
2,2,4-Trimethylpentane	323	9
Hexane	248	7
Benzene	219	6
Formaldehyde	170	5
Ethyl Benzene	131	4
Acetaldehyde	92	3
Ethylene Glycol	76	2
City and County of Honolulu Total HAP Emissions(2)	3,528	100

Notes:
(1) HAP emissions represent emissions resulting from human activities and exclude biogenic and wildfire emissions.
(2) Total HAP emissions include all HAPs reported in the 2017 National Emission Inventory, January 2021 version.
Key: HAP = hazardous air pollutant; tpy = ton per year.
Source: EPA (2017).

3.2.1.4 Greenhouse Gas Emissions

GHGs can remain in the atmosphere for different amounts of time, ranging from a few years to thousands of years. All of these gases remain in the atmosphere long enough to become well mixed, meaning that the amount that is measured in the atmosphere is roughly the same all over the world regardless of the source of the emissions. The Global Warming Potential (GWP) allows the comparison of the global warming impacts of different gases. Specifically, a GWP is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time. CO_2 has a GWP of 1 and serves as a baseline for other GWP values. CO_2 remains in the atmosphere for a very long time; changes in atmospheric CO_2 concentrations persist for thousands of years. The larger the GWP, the more that a given gas warms the Earth compared to CO_2 over that time, which is most commonly defined as 100 years.

3.2.1.5 Climate and Predictable Environmental Trends Associated with Climate Change

The climate in Hawaii is considered subtropical. Hawaii County has a mild climate due in part to its location within the trade-wind zone. The climate has low variability, with an annual variation in mean monthly temperature of about 9 degrees Fahrenheit (°F) in locations at sea level. The mean monthly temperatures range from 71.2°F in February to 76.5°F in September. Precipitation ranges from 30 inches in leeward areas to 300 inches annually in upper windward areas. Precipitation averages around 7 inches per month in May to over 14 inches per month in November (NOAA, 2023a).

Climate change is defined by the Hawaii Climate Change Mitigation and Adaptation Commission as "a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties that persist for an extended period, typically decades or longer" (Hawaii Climate Change Mitigation and Adaptation Commission, 2023).

The climate in Hawaii is getting warmer. In areas at an elevation over 2,600 feet above sea level, temperature has increased by 0.48°F per decade over the last 30 years, which is faster than the global warming rate. Some model projections for the late 21st century indicate that surface air temperature over land will increase by 1.8°F to 7.2°F, with the greatest warming at the highest elevations and on leeward sides of the major islands (City and County of Honolulu Climate Change Commission, 2018). Under continued strong GHG emissions, high elevations above 9,800 feet are predicted to reach up to 7.2°F to 9°F warmer temperatures by the late 21st century (City and County of Honolulu Climate Change Commission, 2018).

Precipitation rates are also changing. Rainfall has declined significantly over the past 30 years, with increasing variation in rainfall patterns on each Hawaiian Island (NOAA, 2023a). Hawaii is experiencing fewer but more intense rain events. Modeling results show an anticipated decrease in rainfall in response to climate change. This is in part due to a decrease of prevailing northeasterly trade winds, which drive precipitation landward.

Sea level is rising at increasing rates due to global warming of the atmosphere and oceans as well as melting of the glaciers and ice sheets (Hawaii Climate Change Mitigation and Adaptation Commission, 2023). Based on the National Oceanic and Atmospheric Administration's Sea Level Rise Viewer (NOAA, 2023b), the locations of Sites 2 and 5 and the proposed in-kind consideration (IKC) projects, including the electrical transmission backbone, are not in areas currently experiencing flooding (including high-tide flooding) or other effects of sea level rise. Site 2 and the location of the proposed electrical transmission backbone are situated in areas considered to have a medium vulnerability level to sea level rise in the future. Site 5 is in an area considered to have a high vulnerability level to sea level rise but is not considered a low-lying area. Sites 2 and 5 do not occur in areas of high or low confidence of anticipated impacts due to sea level rise.

Predictable environmental trends associated with climate change and the potential impacts are identified in Table 3.2-7.

Table 3.2-7 Predictable Environmental Trends Associated with Climate Change

Predictable Trend	***Potential Impacts***
Rising global temperatures (air/ocean)	Cultural Resources: Not applicable. No reasonably close causal relationship to cultural resources identified. Biological Resources: The rise in global temperatures is causing instability in marine and terrestrial ecosystems, threatening prey availability for Hawaii's seabirds and migratory shorebirds. Additionally, rising temperatures will aid the spread of some invasive species. Visual: Not applicable. No reasonably close causal relationship to visual resources identified. Noise: Not applicable. No reasonably close causal relationship to noise identified. Transportation: Not applicable. No reasonably close causal relationship to traffic identified.
Change in precipitation patterns	Air Quality: A decrease in precipitation will lead to drier soil conditions, increasing the frequency of windblown dust events. Cultural Resources: Not applicable. No reasonably close causal relationship to cultural resources identified. Biological Resources: Changes in precipitation patterns would impact the diverse microclimates of the Hawaiian Islands, alter vegetation communities and habitat suitability for wildlife, and aid the spread of some invasive species. Visual: Not applicable. No reasonably close causal relationship to visual resources identified. Noise: Not applicable. No reasonably close causal relationship to noise identified. Transportation: Not applicable. No reasonably close causal relationship to traffic identified.
Increased frequency and/or intensity of extreme weather events	Cultural Resources: Impacts are expected to cause damage and destruction to cultural resources. Hurricanes may damage cultural resources, including buildings and structures that contribute to the PHNHL District or other historic properties by destroying character-defining features and diminishing integrity. Biological Resources: Extreme weather events have the potential to destroy rare and endangered populations of plants and wildlife that have small population ranges and strict habitat requirements. Visual: Increased frequency and/or intensity of extreme weather events could cause damage and destruction to buildings and natural vegetation that contribute to the characteristic landscape of PHNSY & IMF, including historic and cultural resources. Noise: Not applicable. No reasonably close causal relationship to noise identified. Transportation: Not applicable. No reasonably close causal relationship to traffic identified.

Table 3.2-7 Predictable Environmental Trends Associated with Climate Change

Predictable Trend	*Potential Impacts*
Rising sea levels and associated storm surge	Cultural Resources: Impacts are expected to cause damage and destruction to cultural resources. Flooding may damage cultural resources, including buildings, facilities, and structures that contribute to the PHNHL District or other historic properties by destroying character-defining features and altering significant aspects of integrity. Biological Resources: Rising sea levels have the potential to erode coastlines that provide foraging habitat for migratory bird species and nesting habitat for some seabird species. Rising sea levels have the potential to increase the salinity up streams and rivers, impacting those freshwater ecosystems. Visual: Impacts from rising sea levels and storm surges could cause damage and destruction to buildings that contribute to the characteristic landscape of PHNSY & IMF, including historic and cultural resources. Noise: Not applicable. No reasonably close causal relationship to noise identified. Transportation: Sea level rise could potentially impact the Pearl Harbor Bikeway as an alternative transportation mode to JBPHH. Water tables could also increase, potentially impacting roadway subgrades of major arterial routes such as Kamehameha Highway.
Ocean acidification	Cultural Resources: Impacts are expected to cause degradation to underwater cultural resources, including shipwrecks. Biological Resources: Ocean acidification is causing instability in marine ecosystems, threatening prey availability for Hawaii's seabirds and migratory shorebirds. Visual: Not applicable. No reasonably close causal relationship to visual resources identified. Noise: Not applicable. No reasonably close causal relationship to noise identified. Transportation: Not applicable. No reasonably close causal relationship to traffic identified.

Key: IMF = Intermediate Maintenance Facility; JBPHH = Joint Base Pearl Harbor-Hickam; PHNHL = Pearl Harbor National Historic Landmark; PHNSY = Pearl Harbor Naval Shipyard.

3.2.2 Environmental Consequences

Effects on air quality are based on estimated direct and indirect emissions associated with the Proposed Action. The region of influence (ROI) for assessing air quality impacts includes the south side of the island of Oahu in the City and County of Honolulu, where JBPHH is located adjacent to Pearl Harbor. The ROI and the sensitive receptors near each site under the Proposed Action Alternative are depicted in Figure 3.2-1. As shown in Figure 3.2-1, several parks and recreational areas, residential housing, and schools are present near Sites 2 and 5.

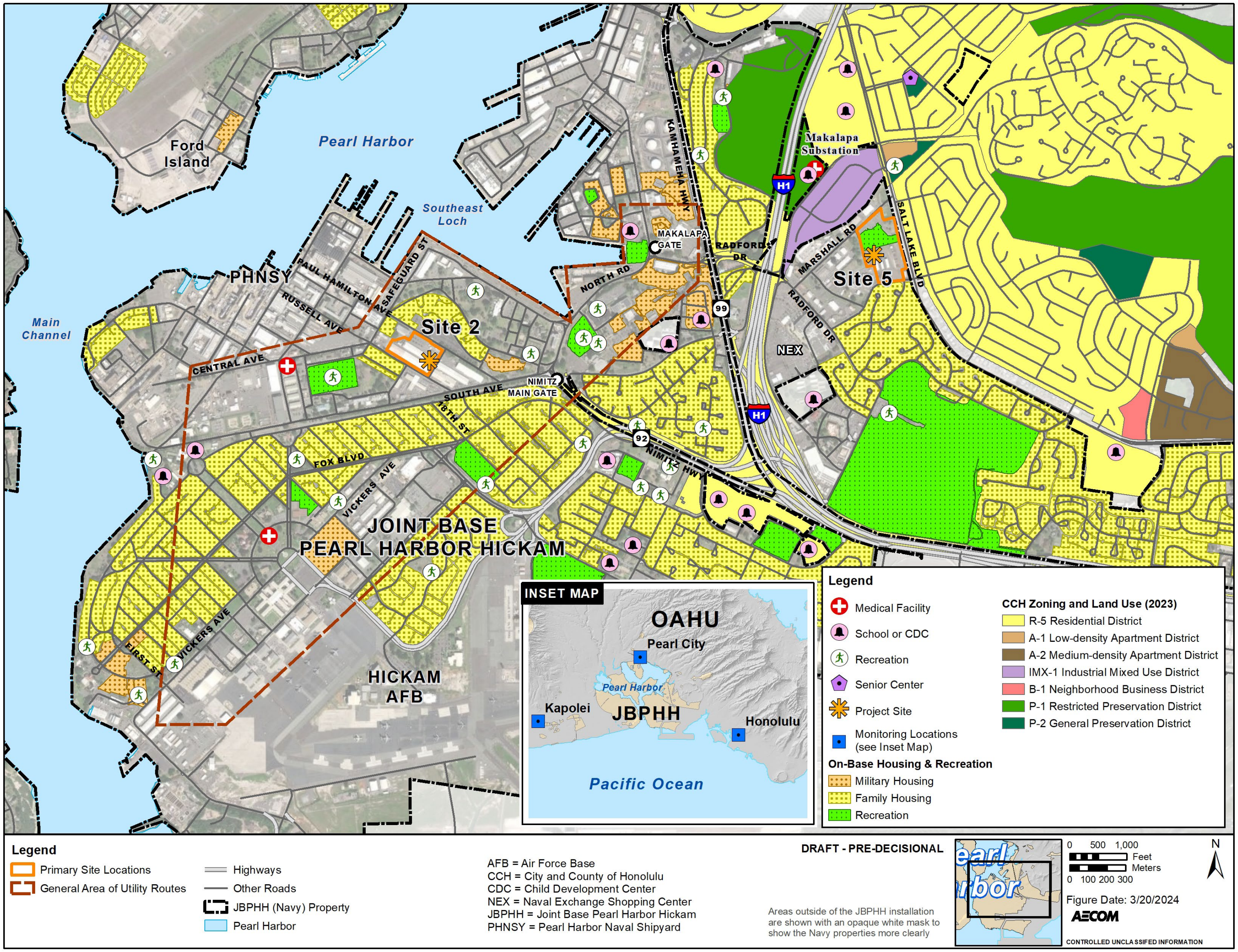

Figure 3.2-1 ROI and Sensitive Land Uses around Sites 2 and 5

To assess air quality impacts from emissions released as a result of the construction, a qualitative analysis was performed. This analysis evaluated expected locations of pollutant plumes and receptors to determine whether they overlap in order to inform on exposure potential and how the exposure compares to ambient air quality limits and threshold values. Construction duration and how changes in pollutant concentrations would affect design concentrations are considered. For example, the 1-hour nitrogen dioxide (NO_2) NAAQS is based on a 3-year average, but if Proposed Action Alternative activities do not occur for the entire duration of the 3-year period, then the period of no activity would lower the 3-year average. Therefore, the duration and intensity of pollutant exposure within the adjacent neighborhood of each localized activity area were considered in evaluating air quality impacts from the proposed temporary construction activities. The qualitative impact assessment methodology assumes the following:

- Construction of the project would comply with Hawaii Administrative Rules (HAR) Section 11-60.1-33 such that visible fugitive dust plumes would be unlikely occur outside of the activity area.
- Elevated pollutant concentrations are expected immediately downwind of pollutant release; therefore, the analysis focuses on the area influenced by local wind patterns.
- Potential impacts from exposure related to additional on-road traffic associated with the Proposed Action Alternative are based on historical 24-hour traffic volumes (Table 3.2-8) and the anticipated addition of expected traffic volume contributed by the Proposed Action Alternative to estimate total anticipated 24-hour traffic volumes.

To assess air quality impacts from emissions released during operations, a quantitative analysis through air dispersion modeling and comparisons to published air quality standards and toxic risk factors was performed for the stationary sources at Site 2 (see application and supplemental submittal in Appendix A). Considering the risk estimated from 2010 monitoring data (Table 3.2-2 and Table 3.2-3) and the 2019 AirToxScreen (Table 3.2-5), the five HAPs of concern in Honolulu are acetaldehyde, benzene, carbon tetrachloride, chromium, and formaldehyde. The HAPs considered for the HAPs analysis from the above subset are acetaldehyde, benzene, and formaldehyde. Carbon tetrachloride and chromium would not be significantly emitted from the operations of the new Wärtsilä engines at Site 2. Additional HAPs were also evaluated (Appendix A).

With the exception of the electrical transmission backbone, the IKC projects would not require any ground-disturbing construction activities and would result in minor air emissions. Therefore, they are not analyzed further in this section.

3.2.2.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and no change would occur to baseline air quality. Therefore, no impacts to air quality would occur with implementation of the No Action Alternative.

3.2.2.2 Proposed Action Alternative

Air quality impacts would occur during the construction and operation phases. The project would require a new, separate Title V permit and would be permitted under the lessee.

3.2.2.2.1 Construction Impacts

During construction, the primary source of emissions would be fuel-burning equipment, vehicles, and land disturbance. While construction of the project would comply with HAR 11-60.1-33 such that visible fugitive dust plumes would not likely occur outside of the activity area, elevated pollutant concentrations are expected at receptors immediately downwind of activities.

The expected maximum road traffic additions from the Proposed Action Alternative are approximately 141 construction workers commuting per day between Site 2, Site 5, and the electrical transmission backbone area and 59 truck trips per day for transporting construction material. Existing 24-hour traffic volume at JBPHH Nimitz Gate is approximately 21,173 per the PHNSY & Intermediate Maintenance Facility (IMF) Decision Document (DD) and Waterfront Production Facility (WPF) Final Environmental Impact Statement (EIS). The construction traffic associated with the PHNSY & IMF Dry Dock and WPF at JBPHH was conservatively estimated as 1,450 vehicles per day. If these proposed projects overlap, then additional construction road traffic would be 1,650 (200 plus 1,450). Because the expected combined traffic volumes during construction, assuming project overlap, would not exceed the traffic volumes occurring at the monitoring sites (Table 3.2-8), it is reasonable to conclude that the expected air quality impacts during construction from on-road mobile sources would be no greater than the ambient design values and/or concentrations (criteria pollutant and HAPs) measured at the monitors. For the same reasoning, it is reasonable to assume that air quality impacts during construction from on-road mobile sources would be no greater than the HAPs' associated health risks calculated for the monitoring sites (Appendix A). Therefore, anticipated air quality impacts from on-road mobile sources would not interfere with the attainment of AAQS or appreciably increase human health risk from HAP exposure in areas where sensitive receptors and/or public presence are anticipated.

Table 3.2-8 Average Daily Traffic Counts for Monitoring Stations

Monitoring Station	*Street*	*2021 Average Daily Traffic Count*
Honolulu	• Punchbowl Street • S. Beretania Street • Vineyard Street • Total	• 34,400 • 17,410 • 24,200 • 76,010
Kapolei	• Kalaeloa Boulevard • Lauwiliwili Street • Total	• 34,200 • < 5,000 • No more than 39,200
Pearl City	• Kamehameha Highway • Lehua Avenue • 4th Street • Total	• 27,144 • 10,100 • < 2,000 • No more than 39,244

Key: N/A = not applicable.
Sources: HDOH (2021a); HDOT (2023).

Table 3.2-9 provides emission estimates for criteria pollutants and HAPs from proposed construction activity by year. Construction emissions include non-road equipment, on-road vehicles, and fugitive dust generation from land disturbance. As shown in Table 3.2-9, the annual construction NO_x, carbon monoxide (CO), sulfur dioxide (SO_2), particles with aerodynamic diameters less than or equal to a nominal 10 micrometers (PM_{10}), and particles with aerodynamic diameters less than or equal to a nominal 2.5 micrometers ($PM_{2.5}$) emissions are greater than 2019 JBPHH actual stationary source emissions but significantly less than total emissions from City and County of Honolulu.

On-road vehicles can operate on the roads surrounding each site location. Based on the roads most likely to be accessed by construction vehicles, base residential housing immediately to the south of Site 2, base residential housing immediately adjacent to the south of Site 5, and off-base residential housing to the east of Site 5 could be impacted. Other nearby sensitive receptors include multiple parks, recreational areas, and schools. The nearest sensitive/public receptors are areas within JBPHH adjacent to the study area, including military housing, with the nearest residence being within approximately 170 feet of Site 2 and approximately 50 feet of Site 5. These locations are shown in Figure 3.2-2 and Figure 3.2-3.

Indirect emissions from off-Oahu construction supply delivery activities under the Proposed Action cannot be accurately estimated at this time but the impacts from these construction-related emissions, given their release is mostly during open ocean transit, are not expected to interfere with the attainment of AAQS or appreciably increase human health risk from HAP exposure in areas where sensitive receptors and/or public presence are anticipated.

Table 3.2-9 Total Air Pollutant Emission Estimates from Proposed Construction Activity by Year

Location of Activity by Year	*Emissions (tpy)*						
	VOCs	*CO*	*NO_x*	*SO_x*	*PM_{10}*	*$PM_{2.5}$*	*HAPs(1)*
Year 1							
Site 2	0.03	0.44	0.25	4.87E-04	4.0	0.41	0.01
Site 5	0.09	0.93	0.85	9.40E-04	21.1	2.2	0.04
Electrical Transmission Backbone	0.32	2.5	3.7	3.94E-03	3.10	0.48	0.14
Total	**0.45**	**3.9**	**4.8**	**0.01**	**28.2**	**3.1**	**0.19**
Year 2							
Site 2	0.16	2.1	1.2	2.37E-03	19.5	2.0	0.06
Site 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Electrical Transmission Backbone	0.28	2.2	3.2	3.40E-03	2.67	0.42	0.12
Total	**0.44**	**4.3**	**4.4**	**0.01**	**22.2**	**2.4**	**0.19**
Year 3							
Site 2	0.15	2.0	1.1	2.19E-03	18.0	1.9	0.06
Site 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Electrical Transmission Backbone	0.01	0.07	0.11	1.13E-04	0.09	0.01	4.05E-03
Total	**0.16**	**2.0**	**1.2**	**2.30E-03**	**18.1**	**1.9**	**0.06**
Existing Sources							
City and County of Honolulu (2)	20,560	89,210	25,504	13,159	14,961	4,390	3,528
2019 JBPHH Stationary Sources(3)	11.7	0.0	0.1	0.0	0.0	0.0	11.1

Notes:
Scientific notation is used for values that are hundredths of a ton or less to show the emissions for that pollutant are not zero.
Includes benzene, ethanol, formaldehyde, acetaldehyde, acrolein, 1,3-butadiene, ethylbenzene, hexane, toluene, xylene, and naphthalene.
Key: VOC = volatile organic compound; CO = carbon monoxide; DD = decision document; EIS = Environmental Impact Statement; JBPHH = Joint Base Pearl Harbor-Hickam; NO_x = nitrogen oxides; SO_x = sulfur oxides; PHNSY Dry Dock and WPF = Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility Dry Dock and Waterfront Production Facility; PM_{10} = particles with aerodynamic diameters less than or equal to a nominal 10 micrometers; $PM_{2.5}$ = particles with aerodynamic diameters less than or equal to a nominal 2.5 micrometers; CO_2 = carbon dioxide, CH_4 = methane, N_2O = nitrous oxide; HAP = hazardous air pollutant; tpy = ton per year.
(1) Includes benzene, ethanol, formaldehyde, acetaldehyde, acrolein, 1,3-butadiene, ethylbenzene, hexane, toluene, xylene, and naphthalene.
(2) 2017 Hawaii Air Emissions Inventory
(3) Source: DON (2022d) (https://www.pearlharbordrydockeis.org/).

Table 3.2-10 summarizes potential air quality impacts from construction activities. Additional details on the emission calculations are provided in Appendix A. The construction phase impacts on air quality would not be considered significant because they are temporary with a low magnitude of emission rates (as detailed in Appendix A); such impacts would not change the area's attainment status or appreciably increase human health risks in areas where sensitive receptors and/or public presence are anticipated.

Table 3.2-10 Construction-Related Air Quality Impacts

Construction Area	***Potential Air Quality Impacts***
Site 2, Site 5, and Electrical Transmission Backbone	• Fugitive dust at ground level would be generated by on-site trucks transporting materials and construction equipment. Fugitive dust plumes would not occur outside of the activity area to comply with the HAR for fugitive dust SOPs. Emissions would result primarily from the combustion of fuels with emissions released from equipment exhaust stacks. • Construction activities would fluctuate throughout the day and from day to day. Wind conditions would vary throughout the day while construction sources would move around the site such that potential pollutant concentration increases would not persist in any single location. The nearest location of sensitive/public receptors are areas within JBPHH adjacent to the study area, including military housing, with the nearest residence being within approximately 170 feet of Site 2 and approximately 50 feet of Site 5. Potential exposure to elevated pollutant concentrations would be most intense and occur at a higher probability in years 2 and 3 of construction at Site 2, year 1 of construction at Site 5, and years 1 and 2 of construction of the electrical transmission backbone. • Based on the magnitude of emission rates (as detailed in Appendix A), the temporary duration of emission-generating activities, and fluctuating wind directions, anticipated air quality impacts are not expected to interfere with the attainment of NAAQS/SAAQS or appreciably increase human health risks in areas where sensitive receptors and/or public presence are anticipated.

Key: AAQS = ambient air quality standard; HAR = Hawaii Administrative Rules; JBPHH = Joint Base Pearl Harbor-Hickam; NAAQS = National Ambient Air Quality Standards; SAAQS = State Ambient Air Quality Standards; SOP = standard operating procedure.

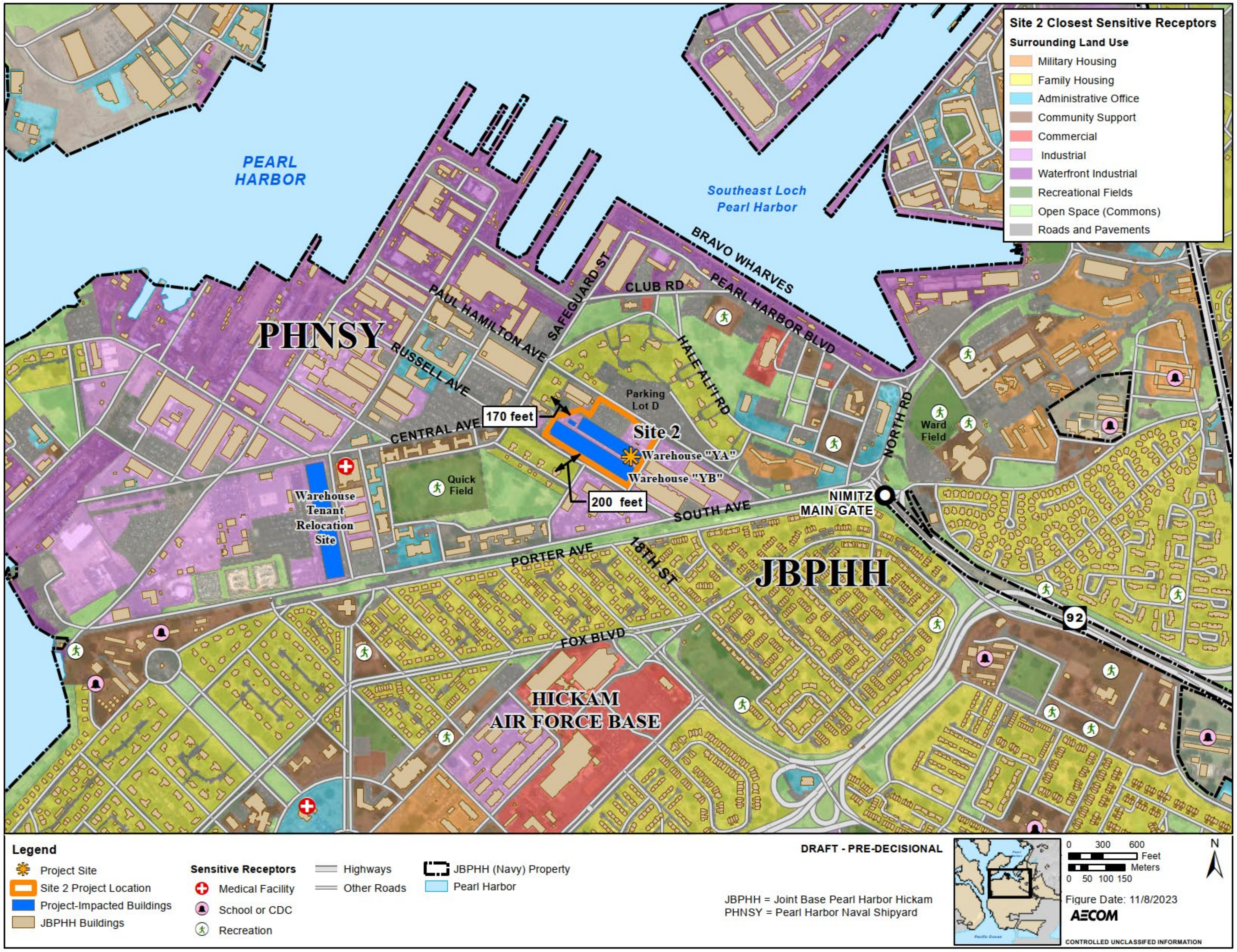

Figure 3.2-2 Site 2 Closest Sensitive Receptors

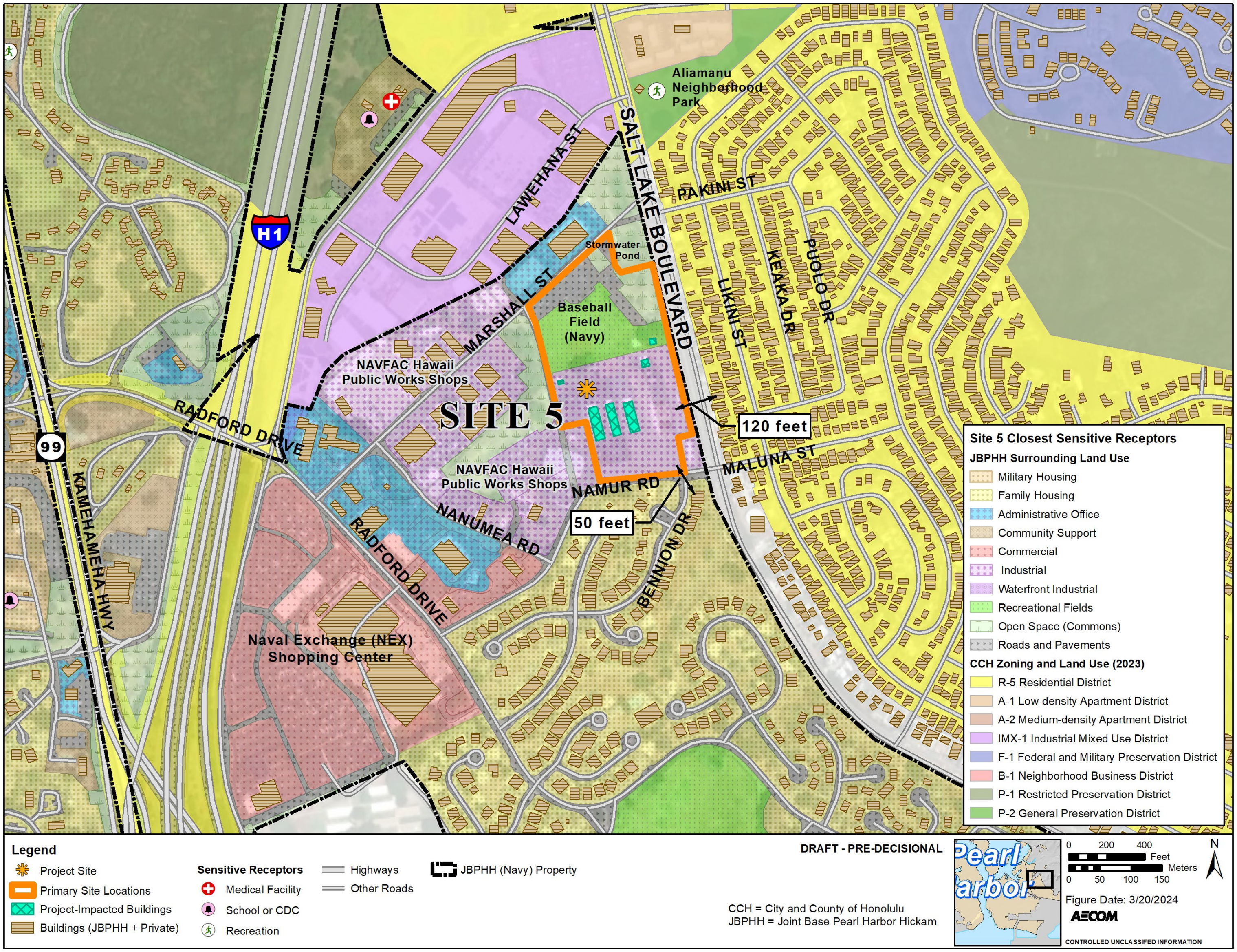

Figure 3.2-3 Site 5 Closest Sensitive Receptors

3.2.2.2.2 Operational Impacts

Emissions during the operations phase of the project would primarily be generated at the proposed Firm Renewable Generation (FRG) Plant at Site 2. FRG Plant equipment, including emissions controls, would be operated and maintained according to manufacturer specifications. Equipment at Site 2 subject to air permitting requirements would be covered under a new Title V permit issued to the lessee and as a separate source from JBPHH. Site 5, the location of the photovoltaic (PV) system and battery energy storage system (BESS), would have minimal operational emissions.

During a grid outage, the plant would provide power to JBPHH through the electrical transmission backbone and existing Hawaiian Electric Company (HECO) substations, enhancing its energy security and resiliency and supporting national security. This would eliminate the need for individual emergency generators, reducing the air emissions produced during an outage and improving the air quality in the immediate vicinity of the current emergency generators.

The FRG Plant and emergency generators are designed to be fuel-flexible; the primary fuels for the engine generators would be renewable natural gas (RNG) and biodiesel. Each dual-fueled generator would be equipped with an emission control system for NO_x emissions control and oxidation catalysts to control CO, VOCs, and HAP emissions; a continuous emissions monitoring system; and associated support equipment.

Other equipment and facilities to be constructed include water treatment facilities, fire protection and emergency services, a new 46 kilovolt (kV) air-insulated switchgear switchyard, other electrical switchgear and transformers, and an operations and maintenance building. The emergency diesel generator and emergency fire pump engine would be constructed adjacent to the reciprocating engines and each would operate with a limit not to exceed 500 hours per year. All reciprocating engines, including the emergency generator and fire pump engine, would comply with National Emission Standards for Hazardous Air Pollutants, 40 CFR Part 63, Subpart ZZZZ, and Standards of Performance for New Stationary Sources, 40 CFR Part 60, Subpart IIII.

Stationary sources of the proposed FRG Plant are subject to the requirements of a covered source permit, which would be requested by the lessee and issued by the HDOH Clean Air Branch. The lessee would be operating in compliance with all permit conditions. Per the Best Available Control Technology (BACT) analysis conducted for the engines for NO_X, CO, VOC, PM_{10}, and $PM_{2.5}$, controls of these pollutant emissions include using low-NO_X emitting equipment and add-on controls, applying good combustion practices and oxidation catalyst, and burning exclusively renewable natural gas with a maximum sulfur content of 5 parts per million by volume and biodiesel with a maximum sulfur content of 15 parts per million.

Table 3.2-11 and Table 3.2-12 provide stationary source emission estimates for criteria pollutants and HAPs from the proposed FRG Plant. For the proposed engines, Table 3.2-10 presents the maximum annual project emissions based on the worst-case combination of operating scenarios for each pollutant (100 percent RNG operations, RNG startups and biodiesel operations, or 100 percent biodiesel operations). These total emissions account for assumed operational hour limits based on fuel type. For the proposed engines, as detailed in the permit application, when assuming 100 percent RNG, hours are assumed to not exceed 8,395 per year. When assuming startup using RNG and then switching to biodiesel, hours are assumed to not exceed 3,796 hours per year. When assuming 100 percent biodiesel, hours are assumed to not exceed 2,920 hours per year. For the emergency generator and fire pump engine, 500 hours per year operation were assumed for each equipment.

Table 3.2-11 Estimated Criteria Air Pollutant Emissions from the Proposed Power Plant

Equipment	Emissions (tpy)					
	VOCs	CO	NO_x	SO_x	PM_{10}	$PM_{2.5}$
11 × 20V34DF Engines, Maximum, Any Operating/Fuel Scenario	116.4	131.5	239.6	2.9	94.8	94.8
Emergency Generator	0.02	0.2	3.3	0.003	0.01	0.01
Emergency Fire Pump Engine	0.03	0.3	0.5	0.001	0.02	0.02
Total	**116.5**	**132.0**	**243.4**	**2.9**	**94.8**	**94.8**

Key: CO = carbon monoxide; NO_x = nitrogen oxides; PM_{10} = particles with aerodynamic diameters less than or equal to a nominal 10 micrometers; $PM_{2.5}$ = particles with aerodynamic diameters less than or equal to a nominal 2.5 micrometers.

Table 3.2-12 Estimated HAP Emissions from New Wärtsilä Engines

Pollutant	100% RNG Operation	RNG Startups/ Biodiesel Operation	100% Biodiesel Operation
	Emissions [all engines] (tpy)		
Acetaldehyde	1.0	0.05	0.02
Acrolein	0.11	0.01	0.01
Benzene	0.41	0.70	0.56
1,3-Butadiene	0.70	0.02	—
Ethylbenzene	0.14	0.05	0.04
Formaldehyde	9.2	2.5	1.9
Hexane	—	0.009	0.01
Naphthalene	0.05	0.11	0.09
PAHs (as B(a)P)	0.00	0.0004	0.00
Toluene	0.45	0.26	0.21
Xylene	1.2	0.21	0.15
Total HAPs	**13.3**	**4.0**	**3.0**

Key: HAP = hazardous air pollutant; PAH = polycyclic aromatic hydrocarbon; RNG = renewable natural gas.

To determine potential air quality impacts from the emissions of the criteria pollutants and determine whether the project would comply with all NAAQS/SAAQS as required for the air permit application, air dispersion modeling was conducted for multiple engine operating scenarios (varying loads and fuel use) to ensure a worst-case scenario was analyzed.

Initial modeling was conducted to compare maximum modeled project concentrations against significant impact levels (SILs). SILs are EPA-defined concentrations that are used to determine whether a change in emissions would contribute to an exceedance of a NAAQS. If maximum modeled concentrations are below applicable SILs, then impacts from the modeled activities would not contribute to an exceedance of a NAAQS and no further analysis is required. If maximum modeled concentrations are equal to or greater than applicable SILs, then a cumulative impact analysis is required that accounts for combined contributions from other sources and the new sources under the Proposed Action Alternative. As detailed in Appendix A, modeled concentrations of sulfur dioxide and CO are below their SILs, indicating impacts from the proposed facility would not contribute to an exceedance of a NAAQS/SAAQS. Ozone modeling is not necessary for the proposed activities with this magnitude of emissions.

Cumulative modeling was necessary for NO_x (as NO_2), PM_{10}, and $PM_{2.5}$ and was performed for multiple potential operating combinations to ensure the worst-case scenario concentrations are captured for each pollutant. These scenarios include operating on RNG and biodiesel at 100 percent each, and startups with RNG and then switching to biodiesel. The modeled emissions include startup emissions and emissions from minimum load to full load conditions under each scenario. Additionally, in this cumulative modeling, to ensure compliance with the NAAQS/SAAQS, modeled design concentrations are added to representative background concentrations, along with secondary $PM_{2.5}$ concentrations. The representative background concentration includes the impact of other nearby and distant stationary, area, and mobile sources and secondary $PM_{2.5}$ accounts for $PM_{2.5}$ formed in the atmosphere through reaction, coagulation, or nucleation of chemicals after initial emissions are released. This cumulative impact concentration is then compared to the appropriate NAAQS/SAAQS. As shown in Table 3.2-13, the cumulative modeling demonstrated compliance with the NAAQS/SAAQS. Appendix A includes details of the operating emission calculations and the air dispersion modeling analysis for the proposed new FRG Plant at Site 2, as well as isopleth plots of the maximum 1-hour NO_2 and 24-hour $PM_{2.5}$ modeled concentrations within the areas around Site 2. Maximum concentrations were found immediately southeast of Site 2, north of South Avenue. Test modeling was further conducted separately from the permit application at elevated receptors, such as open windows and air intakes of multi-floor residences and occupied buildings. The modeling results show that no exceedances of the NAAQS/SAAQS would occur at these elevated receptors.

Biofuel for the FRG plant would represent an incremental increase in fuel amounts delivered on existing fuel transport vessels. The associated increase in air pollutants from ship transport cannot be accurately estimated given the uncertainty of Hawaii's consumption demand but are expected to be minimal. The increase of emissions from the Proposed Action, given their release is mostly during open ocean transit, are not expected to interfere with the attainment of AAQS or appreciably increase human health risk from HAP exposure in areas where sensitive receptors and/or public presence are anticipated.

Table 3.2-13 NAAQS/SAAQS Compliance during Operations

Pollutant(1,5)	*Averaging Period(1)*	*Modeled Years*	*Controlling Scenario*	*Description*	*Modeled Maximum Ground Level Concentration (GLC_{max}) (µg/m³)*	*Secondary $PM_{2.5}$ Conc.(2) (µg/m³)*	*Background Conc.(3) (µg/m³)*	*Cumulative Impact(4) (µg/m³)*	*NAAQS/ SAAQS (µg/m³)*	*Below NAAQS/ SAAQS?*
Biodiesel – Maximum Scenario										
NO_2[5]	1-hr	2017–2021	Startup	Project Only – OLM – (H8H averaged over 5 years)	125.5	—	56.4	181.9	188 (100 ppb)	Yes
NO_x as NO_2	Annual	2017–2021	Min Load	Project Only (maximum across 5 years)	7.27	—	7.5	14.8	100 (NAAQS) 70 (SAAQS)	Yes
$PM_{2.5}$	24-hr	2017–2021	Min Load	Project Only (H8H averaged over 5 years)	20.05	0.291	12.0	32.3	35	Yes
	Annual	2017–2021	Min Load	Project Only (maximum across 5 years)	2.51	0.016	3.6	6.1	12	Yes
PM_{10}	24-hr	2017–2021	Min Load	Project Only (H1H across 5 years)	25.27	0.291	36.0	61.6	150	Yes
	Annual	2017–2021	Min Load	Project Only (maximum across 5 years)	3.03	0.016	14.4	17.4	50	Yes

Table 3.2-13 NAAQS/SAAQS Compliance during Operations

Pollutant(1,5)	*Averaging Period(1)*	*Modeled Years*	*Controlling Scenario*	*Description*	*Modeled Maximum Ground Level Concentration (GLC_{max}) (µg/m³)*	*Secondary $PM_{2.5}$ Conc.(2) (µg/m³)*	*Background Conc.(3) (µg/m³)*	*Cumulative Impact(4) (µg/m³)*	*NAAQS/ SAAQS (µg/m³)*	*Below NAAQS/ SAAQS?*
RNG – Maximum Scenario										
NO_2[5]	1-hr	2017–2021	Startup	Project Only – OLM – (H8H averaged over 5 years)	78.6	—	56.4	135.0	188 (100 ppb)	Yes
NO_x as NO_2	Annual	2017–2021	Min Load	Project Only (maximum across 5 years)	2.53	—	7.5	10.0	100 (NAAQS) 70 (SAAQS)	Yes
$PM_{2.5}$	24-hr	2017–2021	Min Load	Project Only (H8H averaged over 5 years)	7.68	0.291	12.0	20.0	35	Yes
	Annual	2017–2021	Min Load	Project Only (maximum across 5 years)	2.55	0.016	3.6	6.2	12	Yes
PM_{10}	24-hr	2017–2021	Min Load	Project Only (H1H across 5 years)	11.02	0.291	36.0	47.3	150	Yes
	Annual	2017–2021	Min Load	Project Only (maximum across 5 years)	3.08	0.016	14.4	17.5	50	Yes
Biodiesel – Full Load Scenario										
NO_2[5]	1-hr	2017–2021	Full Load	Project Only – OLM – (H8H averaged over 5 years)	57.1	—	56.4	113.5	188 (100 ppb)	Yes
NO_x as NO_2	Annual	2017–2021	Full Load	Project Only (maximum across 5 years)	3.45	—	7.5	11.0	100 (NAAQS) 70 (SAAQS)	Yes

Table 3.2-13 NAAQS/SAAQS Compliance during Operations

Pollutant[1,5]	*Averaging Period[1]*	*Modeled Years*	*Controlling Scenario*	*Description*	*Modeled Maximum Ground Level Concentration (GLC_{max}) (μg/m³)*	*Secondary $PM_{2.5}$ Conc.[2] (μg/m³)*	*Background Conc.[3] (μg/m³)*	*Cumulative Impact[4] (μg/m³)*	*NAAQS/ SAAQS (μg/m³)*	*Below NAAQS/ SAAQS?*
$PM_{2.5}$	24-hr	2017–2021	Full Load	Project Only (H8H averaged over 5 years)	14.78	0.291	12.0	27.1	35	Yes
	Annual	2017–2021	Full Load	Project Only (maximum across 5 years)	1.20	0.016	3.6	4.8	12	Yes
PM_{10}	24-hr	2017–2021	Full Load	Project Only (H1H across 5 years)	23.16	0.291	36.0	59.5	150	Yes
	Annual	2017–2021	Full Load	Project Only (maximum across 5 years)	1.44	0.016	14.4	15.8	50	Yes
RNG – Full Load Scenario										
NO_2[5]	1-hr	2017–2021	Full Load	Project Only – OLM – (H8H averaged over 5 years)	9.4	—	56.4	65.8	188	Yes
NO_x as NO_2	Annual	2017–2021	Full Load	Project Only (maximum across 5 years)	1.72	—	7.5	9.2	100 (NAAQS) 70 (SAAQS)	Yes
$PM_{2.5}$	24-hr	2017–2021	Full Load	Project Only (H8H averaged over 5 years)	6.86	0.291	12.0	19.1	35	Yes
	Annual	2017–2021	Full Load	Project Only (maximum across 5 years)	1.73	0.016	3.6	5.4	12	Yes

Table 3.2-13 NAAQS/SAAQS Compliance during Operations

Pollutant(1,5)	*Averaging Period(1)*	*Modeled Years*	*Controlling Scenario*	*Description*	*Modeled Maximum Ground Level Concentration (GLC_{max}) (μg/m³)*	*Secondary $PM_{2.5}$ Conc.(2) (μg/m³)*	*Background Conc.(3) (μg/m³)*	*Cumulative Impact(4) (μg/m³)*	*NAAQS/ SAAQS (μg/m³)*	*Below NAAQS/ SAAQS?*
PM_{10}	24-hr	2017–2021	Full Load	Project Only (H1H across 5 years)	10.80	0.291	36.0	47.1	150	Yes
	Annual	2017–2021	Full Load	Project Only (maximum across 5 years)	2.09	0.016	14.4	16.5	50	Yes

Key: AERMOD = American Meteorological Society/Environmental Protection Agency Regulatory Model HDOH = State of Hawaii Department of Health; NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; NO_x = nitrogen oxides; OLM = Ozone Limiting Method; PM_{10} = particles with aerodynamic diameters less than or equal to a nominal 10 micrometers; $PM_{2.5}$ = particles with aerodynamic diameters less than or equal to a nominal 2.5 micrometers; RNG = renewable natural gas; SAAQS = State Ambient Air Quality Standards.

(1) A NAAQS analysis is only required for pollutants and averaging periods with project impacts greater than or equal to the corresponding SIL.

(2) Secondary $PM_{2.5}$ concentrations are estimated using EPA's Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the Prevention of Significant Deterioration Permitting Program (EPA-454/R-19-003), dated April 2019. The lowest (worst-case) MERPs for the West and Northwest climates zones from Table 4-1 were selected.

(3) The background concentrations are based on HDOH monitoring data: NO_2 concentrations are from the Kapolei monitor, $PM_{2.5}$ and PM_{10} concentrations are from the Pearl City monitor.

(4) The cumulative impact includes impacts from the project sources (including secondary $PM_{2.5}$, as appropriate) plus the background concentration.

(5) AERMOD's OLM Option is used to output NO_2 impacts from modeled NO_X emissions.

HAP emissions from the proposed new FRG Plant are below 10 tpy for any single HAP and maximum total HAP emissions are below 25 tpy. These emissions are below major source thresholds, designating the proposed FRG Plant as a minor area source of HAPs. A detailed HAP assessment and comparison of modeled concentrations with SOH Department of Transportation (HDOT) significance thresholds are provided in Appendix A. The results of this analysis indicate that HAPs are below the applicable significance thresholds under all operating scenarios and individual lifetime excess cancer risk from the project is well below 10 in one million under all evaluated operating scenarios.

Operational emissions from on-road traffic would be minimal and based on an assumed number of delivery trucks and employee vehicles per day associated with the proposed new FRG Plant at Site 2. Emissions associated with idling, driving, and starts were accounted for at Site 2. A summary of total daily emissions at Site 2 is included in Table 3.2-14 with details on calculations provided in Appendix A. Emissions calculations assume a total of 23 truck trips per day. This increased level of truck trips is insignificant compared to current daily traffic counts at the nearby air monitors (Table 3.2-8) and existing traffic volume at JBPHH Nimitz Gate (approximately 21,173). Daily traffic is not expected at the PV system or BESS, and it is anticipated that one vehicle trip per month would likely occur during routine maintenance. Given the minimal number of new vehicle trips, no appreciable operational emissions would occur at Site 5.

Table 3.2-14 Estimated Air Pollutant Emissions from Proposed Daily On-Road Vehicles

Location of Activity	*Emissions (tons per day)*						
	VOCs	*CO*	*NO_x*	*SO_x*	*PM_{10}*	*$PM_{2.5}$*	*HAPs*[1]
Site 2	6.21E-05	8.98E-04	5.93E-04	1.01E-06	5.08E-05	2.85E-05	1.19E-05

Notes:
Scientific notation is used for values that are hundredths of a ton or less to show the emissions for that pollutant are not zero.
Includes benzene, ethanol, formaldehyde, acetaldehyde, acrolein, 1,3-butadiene, ethylbenzene, hexane, toluene, xylene, and naphthalene.
Key: VOC = volatile organic compounds; CO = carbon monoxide; NO_x = nitrogen oxides; SO_x = sulfur oxides; PM_{10} = particles with aerodynamic diameters less than or equal to a nominal 10 micrometers; $PM_{2.5}$ = particles with aerodynamic diameters less than or equal to a nominal 2.5 micrometers; HAP = hazardous air pollutant; tpy = ton per year.

3.2.2.2.3 Combined Construction and Operational Emissions Impacting Air Quality and Greenhouse Gases

A summary of total emissions from the Proposed Action Alternative impacting air quality and GHGs is provided in Table 3.2-15.

Table 3.2-15 Estimated Proposed Action Air Pollutant Emissions

Activity	*Location of Activity*	*Emissions (tpy)*									
		VOCs	*CO*	*NO_x*	*SO_x*	*PM_{10}*	*$PM_{2.5}$*	*CO_2*	*CH_4*	*N_2O*	*HAPs[1, 2]*
Construction	Site 2	0.34	4.5	2.5	0.01	41.5	4.3	1,404	0.03	0.01	0.14
	Site 5	0.09	0.93	0.85	0.00	21.1	2.2	257.9	0.01	0.00	0.04
	Electrical Transmission Backbone	0.61	4.8	7.0	0.01	5.86	0.91	2,255	0.04	0.02	0.27
	Total	**1.0**	**10.2**	**10.4**	**0.01**	**68.5**	**7.4**	**3,916**	**0.08**	**0.03**	**0.44**
Operations (per year)	Site 2 – FRG Plant (maximum scenario)	116.5	132.0	243.4	2.9	94.8	94.8	420,822	7.9	0.8	13.3
	Site 2 – Vehicular Traffic	6.21E-05	8.98E-04	5.93E-04	1.01E-06	5.08E-05	2.85E-05	0.25	5.89E-06	1.65E-06	1.19E-05
	Total	**116.5**	**132.0**	**243.4**	**2.9**	**94.8**	**94.8**	**420,822**	**7.9**	**0.8**	**13.3**

Notes:
Scientific notation is used for values that are hundredths of a ton or less to show the emissions for that pollutant are not zero.
(1) Construction and operational vehicular traffic HAPs include benzene, ethanol, formaldehyde, acetaldehyde, acrolein, 1,3-butadiene, hexane, toluene, xylene, and naphthalene.
(2) FRG Plant HAPs includes acetaldehyde, acrolein, benzene, 1,3-butadiene, ethylbenzene, formaldehyde, hexane, naphthalene, PAHs, toluene, and xylene.
Key: VOC = volatile organic compound; CO = carbon monoxide; FRG = Firm Renewable Generation; NO_x = nitrogen oxides; SO_x = sulfur oxides; PAH = polycyclic aromatic hydrocarbon; PM_{10} = particles with aerodynamic diameters less than or equal to a nominal 10 micrometers; $PM_{2.5}$ = particles with aerodynamic diameters less than or equal to a nominal 2.5 micrometers; CO_2 = carbon dioxide, CH_4 = methane, N_2O = nitrous oxide; HAP = hazardous air pollutant; tpy = ton per year.

3.2.2.2.4 Greenhouse Gases

GHG emissions generated from the construction and operation of the Proposed Action contribute to the global atmosphere, regardless of the specific location within the ROI that they are produced. Total GHG emissions exclusively generated within Hawaii as a result of the 35-month construction activities are estimated to be approximately 3,928 tons (3,563 metric tons) of a carbon dioxide equivalent (CO_2e). See Appendix A for calculations.

Once the proposed FRG Plant is operational, routine activities would generate approximately 421,256 tons (382,157 metric tons) of CO_2e each year. This assumes the maximum potential operational emissions. The vast majority of these emissions are from the maximum potential operations of the Wärtsilä generators. Vehicular traffic associated with the operation of Site 2 would generate 0.25 tons (0.23 metric tons) of CO_2e per year, with calculations detailed in Appendix A.

Switchgear may contain sulfur hexafluoride, a GHG, but emissions would only occur if there were a leak and would be minimal as any leaks would be promptly repaired.

Regarding potential GHG emissions from transportation of biofuel from Washington State, fuel delivery has been qualitatively assessed for potential GHG emissions. Liquid fuel is already being shipped to Oahu in large quantities. Biodiesel for the FRG Plant would be transported on existing fuel transport vessels, representing a minor increase in the total volume of liquid fuel transported to Oahu and in emissions from the associated vessels. RNG is proposed to be generated on the North Shore of Oahu and trucked to the site; GHGs associated with delivery of RNG are included in the vehicular traffic impact calculation above.

As of 2017, the statewide GHG emission limit of 15.28 million metric tons CO_2e had been reached (Table 3.2-4). Statewide GHG projections of 11.66, 10.96, and 8.88 million metric tons CO_2e for 2020, 2025, and 2030, respectively, indicate that Hawaii met its statewide GHG emissions limit in 2020 and will continue to meet the limit in 2025 and 2030 as projected by the SOH (HDOH, 2023). Based on this, the estimated GHGs increase over the 35 months of construction and the annual operation of the FRG Plant would not interfere with Hawaii's statewide goal to be carbon net-negative by 2045.

The Proposed Action also complies with directives under the new Navy Climate Action 2030. The proposed FRG Plant would assist the Navy in building climate resilience by ensuring the forces, systems, and facilities can continue to operate effectively to achieve the mission during changing climate conditions and impacts.

3.2.2.2.5 Climate Change

Predictable environmental trends associated with climate change and the potential impacts are identified in Table 3.2-7. Once construction is complete, climate change could impact the proposed infrastructure, equipment operation, and power generating system. More intense precipitation events, drought, flooding, or saltwater intrusion all have the potential to impact the performance of the battery storage and power generation with potential interruption of worker's commuting, material transporting, and routine power supply operation. Consideration of the potential for the Proposed Action to interact with climate change has been included in each of the assessed resource areas within this EA.

3.2.2.2.6 Summary

Implementation of the Proposed Action Alternative would not result in significant impacts to air quality. Anticipated air quality impacts from construction and operational activities are not expected to interfere with the attainment of AAQS, cause noncompliance with applicable ambient air HAP concentrations, or appreciably increase human health risks from HAP exposure in areas where sensitive receptors and/or public presence are anticipated. Estimated GHG emission increases over the 35 months of construction and the annual operation of the FRG Plant would not interfere with Hawaii's statewide goal to be carbon net-negative by 2045.

3.3 Cultural Resources

This section evaluates potential impacts to cultural resources that could result from implementation of the Proposed Action. Cultural resources are subject to consideration under NEPA, the National Historic Preservation Act (NHPA), the Archaeological Resources Protection Act, and implementing regulations. Cultural resources include historic properties as defined under the NHPA to include districts, sites, buildings, structures, or objects that are listed or eligible for listing in the National Register of Historic Places (NRHP). Additionally, traditional cultural properties (TCPs) are historic properties with cultural and religious significance. Under NEPA, consideration of cultural resource impacts may also include properties that do not meet NRHP criteria, such as places of cultural significance, traditional named places, places associated with moolelo (Hawaiian traditional stories), or significant viewsheds. The Navy is coordinating its NEPA review with the NHPA Section 106 process, pursuant to the 2012 Programmatic Agreement for project actions (CNRH, 2012a). A description of the regulatory setting for cultural resources is included in Appendix H.

3.3.1 Affected Environment

The Navy has conducted inventories of cultural resources at JBPHH to identify historic properties that are listed or potentially eligible for listing in the NRHP within the environment potentially affected by the Proposed Action Alternative (Allen, 2005; DON, 2008; 2011; WCP, HHF, and Mason, 2014; Vernon, Orr, and Collins, 2016; SEARCH, 2016).

The ROI for cultural resources includes potential indirect visual effects to the Pearl Harbor National Historic Landmark (PHNHL) District as a whole, whereas areas of direct effects within Sites 2 and 5 and the electrical transmission backbone area comprise 25 acres where direct construction activities would take place (Figure 3.3-1).

3.3.1.1 Archaeological Resources

Three archaeological sites, all buried traditional Hawaiian fishponds—Loko Pohaku (State Inventory of Historic Places [SIHP] 50-80-13-0098), Loko Wailolokai (50-80-13-0099), and Loko Wailolowai (50-80-13-0100)—overlap with the Proposed Action areas for the utility transmission lines (Table 3.3-1). These fishponds were filled in during the 20th century as part of land reclamation efforts. Allen (2005) evaluated all of the fishponds at Hickam Air Force Base as eligible for listing in the NRHP under Criteria A and D.

Four previous archaeological investigations were conducted within the Proposed Action area (Anderson, 1995; Athens et al., 2000; Magnuson, 2001; Hammatt, Shideler, and McDermott, 2013). Anderson (1995) conducted monitoring of a sewer installation project (MILCON P-115) and documented fishpond deposits associated with Loko Wailolowai (SIHP 50-80-13-0100).

Athens (2000) completed paleoenvironmental coring at 18 buried and 3 extant fishponds on Navy lands at Pearl Harbor. Fishpond sediments were identified at 8 of the 21 fishponds tested, including Loko Pohaku (SIHP 50-80-13-0098), Loko Wailolokai (50-80-13-0099), and Loko Wailolowai (50-80-13-0100). Two paleoenvironmental cores were completed at each of the above fishponds and possible fishpond deposits were identified below 2.90–3.42 meters (9.51–11.22 feet) of fill. Radiocarbon data obtained from the fishponds provided estimated ages of later than A.D. 1436–1636 for Loko Pohaku, sometime in the first millennium for Loko Wailolokai, and later than A.D. 1214–1412 for Loko Wailolowai.

Magnuson (2001) conducted monitoring during backhoe excavation of underground storage tanks (USTs) at Hickam Air Force Base. Intact natural sediments were observed at 8 of the 41 UST sites, and likely fishpond soil from Loko Lelepaua was observed at 1 UST site several hundred meters southwest of the Proposed Action area. No additional traditional Hawaiian cultural material or deposits were encountered.

Hammatt, Shideler, and McDermott (2013) completed an archaeological inventory survey for the Honolulu High-Capacity Transit Corridor Project from Kalaloa Drive to Middle Street. Testing revealed remnants of a mid-20th century roadway network (SIHP 50-80-13-7420) and remnants of a World War II military warehouse and related infrastructure and roads (50-80-13-7421), but no findings or sites were identified within the Proposed Action Alternative area.

Table 3.3-1 Previously Recorded Archaeological Sites Within the Proposed Action Area

Site 50-80-13-	*Type*	*Function and Affiliation*	*Description*	*NRHP Eligibility*	*References*
0098	Fishpond	Aquaculture/ Traditional Hawaiian	McAllister (1933, 102) noted Loko Pohaku (also Pahakea) had covered 2.5 acres; buried.	NRHP eligible under Criteria A and D	McAllister (1933); Sterling and Summers (1978); Klieger (1995); Athens (2000)
0099	Fishpond	Aquaculture/ Traditional Hawaiian	Loko Wailolokai (buried; McAllister 1933:102) was very small and was also known as Waihilikai and Wailiiokai.	NRHP eligible under Criteria A and D	McAllister (1933); Sterling and Summers (1978); Klieger (1995); Athens (2000)
0100	Fishpond	Aquaculture/ Traditional Hawaiian	McAllister (1933, 102) considered Loko Wailolowai (buried) a possible fishpond site.	NRHP eligible under Criteria A and D	McAllister (1933); Sterling and Summers (1978); Klieger (1995); Anderson (1995); Athens (2000)

Key: NRHP = National Register of Historic Places.

3.3.1.2 Architectural Resources

Architectural resources in the ROI include the PHNHL District and other historic properties, many of which are individually eligible and contribute to the PHNHL (Table 3.3-2 and Figure 3.3-1).

The Proposed Action area includes locations within the Main Base area of the PHNHL. Much of the U.S. Naval Base Pearl Harbor, established in 1898, was designated a National Historic Landmark (NHL) district in 1964 (with nomination updates in 1972, 1974, and 1978) for its strategic importance related to the Pacific and the U.S. annexation of Hawaii, and its critical role in World War II (Levy, 1978). The PHNHL District boundary includes “those waters and lands historically, intimately, and directly associated with its function” as an active naval base with the mission to support the Pacific fleet (Apple, 1974). Extending from West Loch naval magazines to Nimitz Gate and from Pearl City Peninsula to beyond the harbor channel, the PHNHL District encompasses more than 16 square miles of land and water around Pearl Harbor that historically has been used by the U.S. Navy and is part of JBPHH today. The 2011 Pearl Harbor Naval Complex Cultural Landscape Report identifies the period of significance for the PHNHL as 1902–1965, beginning with the initial dredging of the channel to provide large vessel access to Pearl Harbor in 1902 and ending with the establishment of a naval Cold War fleet in the Pacific (DON, 2011). Contributing resources to the PHNHL are historic properties.

The Main Base area is diverse and includes residential areas, warehouses, and industrial facilities along the south and east waterfronts of East Loch, PHNSY & IMF, historic facilities on Merry Point and Kuahua Peninsula, the Port Ops signal tower, the Marine Barracks, the Hale Alii Historic Officer Housing Area, and many other contributors to the PHNHL District.

Site 2 lies within the PHNHL District boundary across Central Avenue from the Shipyard and across Russell Avenue from the Marine Barracks. The site encompasses two warehouse facilities (Warehouses YA and YB) that are NRHP-listed as contributing resources to the PHNHL District. In the area surrounding Site 2 are industrial facilities to the north, the Marine Barracks and Marine officers’ quarters to the west and south across Russell Avenue, and the Hale Alii officers’ quarters to the northeast. The historic Marine officers’ quarters, a group of flat-roofed, neoclassical residences, are shielded from the road and warehouses by a tall and dense hedge and trees. Remnants of the NRHP-eligible Shipyard Railway System are present in Site 2 and run parallel to Russell Avenue southwest of Warehouses YA and YB; fragments of the rail system are present in other locations in the ROI as well (Rail Study [CNRH, 2016]).

Site 5 lies outside the PHNHL and does not encompass any NRHP-eligible architectural resources. The Lumber Shed (Facility X31), built in 1946, is not associated with the PHNHL and has been determined not eligible for listing in the NRHP (DON, 2008). An adjacent NRHP-eligible Quonset hut (Facility X24) is not within the Proposed Action area at Site 5.

The IKC projects include the proposed 46 kV electrical transmission backbone, interior modifications to Facilities 226, 283, 284, 393, and 394, replacement of the substation protective relays, and replacement of the live front equipment at 19 transformer stations and at Hickam Field. The only proposed ground-disturbing activity associated with IKC projects within the PHNHL District is the installation of the electrical transmission backbone. While Facilities 226, 283, 284, 393, and 394 are listed as contributing to the NHL as described in Table 3.3-2, only interior shelving would be replaced/upgraded.

Table 3.3-2 Previously Recorded Architectural Resources Within the Proposed Action Area

Facility	*Description*	*Project Site and NRHP Status*
Warehouse YA	Originally known as "Storehouse YA," the facility contributes to the PHNHL District. Constructed in 1941, the one-story building measures approximately 626 feet long, 101 feet wide, and 24 feet tall. Character-defining features include a gable roof with overhanging eaves, wood fascia over paired rafters, corrugated metal cladding, large-scale sliding wood doors with wood and louvered panels, and triple six-over-six, double-hung wood windows. The warehouse was determined to be a distinctive building type due to its large size.	Site 2, Contributing to PHNHL
Warehouse YB	Originally known as "Storehouse YB," and also known as General Warehouse Supply, the facility contributes to the PHNHL District. Constructed in 1941, the one-story building is approximately 801 feet long, 121 feet wide, and 24 feet high. Character-defining features include a gable roof with shed roof extension over the south side, overhanging eaves, wood fascia over paired rafters, corrugated metal cladding, and sliding wood doors with louver panels. The warehouse was determined to be a distinctive building type due to its large size.	Site 2, Contributing to PHNHL
Warehouse 226	Originally known as a "Defense Battalion Warehouse" in the Marine Barracks area (or Marine Corps Reservation), the facility contributes to the PHNHL District. Constructed in 1943, this is a one-story steel frame warehouse built during World War II and is one of the original groupings of five storehouses; it is currently part of a row of identical warehouses with Warehouses 283 and 284. Exterior siding and roofing are corrugated metal; it has a gable roof and round roof vents along the ridge. Large sliding doors with a metal frame are covered by corrugated metal, and a concrete loading dock is present along north side.	Site 2, Contributing to PHNHL
Facility 244	Originally known as the Lubrication Building, also known as the General Warehouse, the facility is a contributing resource to the PHNHL District. Constructed in 1943, the one-story building is approximately 65 feet long, 26 feet wide, and 18 feet high. Character-defining features include a gable roof with overhanging eaves, wood fascia, corrugated metal cladding, and four structural bays. The building is the only extant type from the World War II period within the PHNHL.	Site 2, Contributing to PHNHL
Warehouse 283	Originally known as a "Defense Battalion Warehouse" in the Marine Barracks area, the facility contributes to the PHNHL District and was constructed in 1940 as part of the pre-war and World War II expansion of the oldest Marine garrison in Hawaii. This is one of the original groupings of five storehouses; it is currently part of a row of identical warehouses with Warehouses 226 and 284. It is a large warehouse building with a concrete slab foundation and steel structure. The exterior siding and roofing are corrugated metal. Gable roofs have round roof bents along the ridge.	Site 2, Contributing to PHNHL
Warehouse 284	Originally known as a "Defense Battalion Warehouse" in the Marine Barracks area, the facility contributes to the PHNHL District and was constructed in 1940 as part of the pre-war and World War II expansion of the oldest Marine garrison in Hawaii. This is one of the original groupings of five storehouses; it is currently part of a row of identical warehouses with Warehouses 226 and 283. It is a large warehouse building with a concrete slab foundation and steel structure. The exterior siding and roofing are corrugated metal. Gable roofs have round roof bents along the ridge.	Site 2, Contributing to PHNHL

Table 3.3-2 Previously Recorded Architectural Resources Within the Proposed Action Area

Facility	***Description***	***Project Site and NRHP Status***
Storehouse General NSC/X02 (Facility 393)	Originally known as the Pipe and Hardware Storehouse, the facility contributes to the PHNHL District and is located outside and to the west of Site 2 between South and Central avenues. Constructed in 1943, the two-story building measures approximately 456 feet long, 152 feet wide, and 40 feet tall. Character-defining features include a low-slope gable roof with overhanging eaves, a thin wood fascia, exposed rafters, and wood sheathing; corrugated metal panel cladding; large-scale sliding six-panel wood doors; large-scale, wood-frame mesh sliding doors; two-over-two, double-hung wood sash and three-lite hopper windows; and concrete truck ramps leading to the second floor. Facility 393 and 394 reflect distinct design types for the period of construction and are the only two facilities within the PHNHL with ramps between the first and second floors.	Not within Sites 2 and 5, contributing to PHNHL
Battery Shop (Facility 394)	Originally known as the Ordinance Group Building, the facility contributes to the PHNHL District and is located outside and to the west of Site 2 between South and Central avenues. Constructed in 1945, the two-story building is approximately 456 feet long, 152 feet wide, and 40 feet high. Character-defining features include a low-slope gable roof with overhanging eaves, a thin wood fascia, exposed rafters, and wood sheathing; corrugated metal panel cladding; large-scale sliding six-panel wood doors; large-scale, wood-frame mesh sliding doors; two-over-two, double-hung wood sash and three-lite hopper windows; and concrete truck ramps leading to the second floor. Facility 394 and 393 reflect distinct design types for the period of construction and are the only two facilities within the PHNHL with ramps between the first and second floors.	Not within Sites 2 and 5, contributing to NHL
Sorting Assembly Warehouse (Facility 452K)	The Sorting Assembly Warehouse (Facility 452K) is located within the NHL on Kuahua Peninsula and was originally referred to as Facility K-D/Storehouse. Constructed in 1941, the one-story building is approximately 353 feet long, 101 feet wide, and 24 feet high. Character-defining features include corrugated metal panel cladding, timber columns on poured-in-place concrete footings, gable roof with overhanging eaves and clipped rafter ends, wood sliding doors, and metal sash sliding windows. Substantial alterations include the removal of the original roof ventilators and a replacement roof and windows.	Not within Sites 2 and 5, contributing to NHL
Shipyard railway system remnants	Historic railroad tracks are present to the southwest of Warehouses YA and YB. Narrow-gauge rail tracks are also present to the west and north of Facility 244. Historically, the rail lines were on Avenue D, which was the main line in 1912, connecting Pearl Harbor with the Oahu Railway and Land (O.R.&L.) Rail Line outside of the facility (Rail Study 2.4-14 [CNRH, 2016]). The rail lines along the south elevation of Warehouses YA and YB were extended to the east in 1942 to serve the recently built Facilities 165 and 166 (Rail Study 2.4-17 [CNRH, 2016]). Historic railroad tracks are also to the north of Facility 394 along Central Avenue. Eleven subsurface railroad track remnants are also present further to the northwest in a triangular parcel between Central Avenue and Ingersoll Avenue (Rail Study 2.4-90 [CNRH, 2016]). The Central Avenue line was built in 1919 and a small spur was constructed in 1942 to direct railcars to a repair shop north of Central Avenue. The extant rail sections are consistent with the narrow-gauge rail used throughout PHNSY and Intermediate Maintenance Facility. The Shipyard railway system was determined eligible for the NRHP under Criteria A and C for its role in supporting the construction of the Navy Yard and maintenance of naval vessels during World War II and its unique engineering qualities. The railway system was determined to be a possible contributing element to a larger historic district; however, specific segments were determined not eligible for the NRHP when evaluated as individual structures (Rail Study 2.5.3-5 [CNRH, 2016]).	Site 2 and other locations; Contributing to NHL

Key: NHL = National Historic Landmark; O.R.&L. = Oahu Railway and Land; PHNHL = Pearl Harbor National Historic Landmark; PHNSY = Pearl Harbor Naval Shipyard.

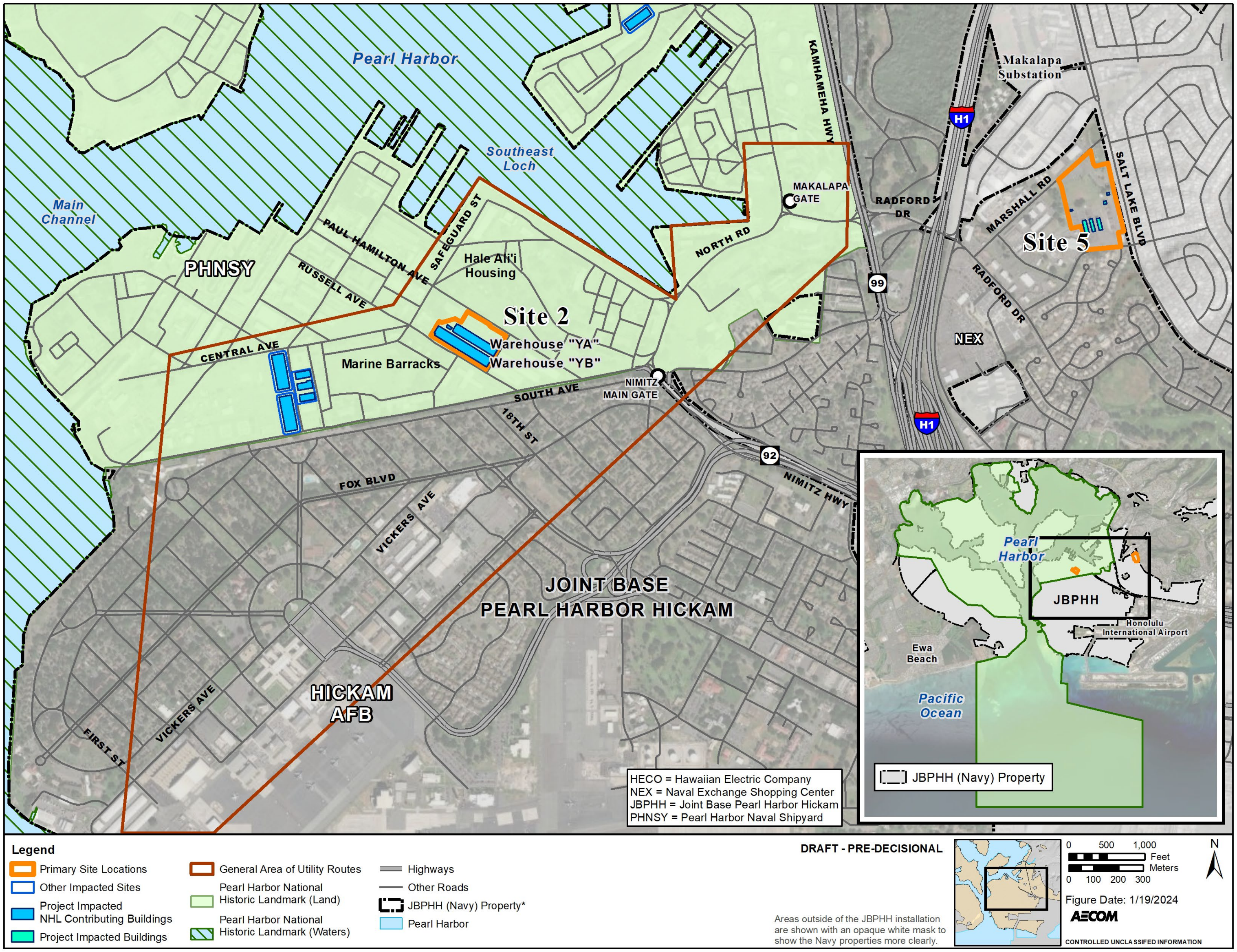

Figure 3.3-1 Region of Influence and Contributing Resources to the PHNHL in the Proposed Action

3.3.1.3 Resources of Importance to Native Hawaiians

Guidance for identifying TCPs is provided in NRHP Bulletin 38, *Guidelines for Evaluating and Documenting Traditional Cultural Properties* (Parker and King, 1998). Bulletin 38 defines a TCP as a historic place or property such as a site, district, building, structure, or object that possesses integrity, meets criteria for the NRHP, and is associated with the cultural practices and beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of that community.

Several locations in the Pearl Harbor area are associated with traditional Hawaiian place names, but no TCPs have been designated in the ROI (Allen, 2005; Vernon, Orr, and Collins, 2016). As one of four remaining fishponds in Pearl Harbor, the Loko Ia Paaiau fishpond is being evaluated as a potential TCP. The three other extant fishponds in the ROI are Loko Pamoku and NRHP-listed Loko Okiokilepe north of Iroquois Point, and Loki Laulaunui in West Loch. None of the extant fishponds are within the Proposed Action areas.

Other potential resources of importance to Native Hawaiians (e.g., resources that may not meet NRHP eligibility criteria but are otherwise valued by the Hawaiian community) have not been identified in previous studies, which have focused on traditional place names and histories (Allen, 2005; Vernon, Orr, and Collins, 2016). Oral traditions and early historical documents attest to Pearl Harbor's significance as a culturally and spiritually important feature of Oahu for Native Hawaiians in the pre-contact period. On its shores, especially the Ewa side, settlements flourished, and the harbor waters offered abundant resources such as many types of fish and shellfish. Taro ponds (kalo loi), salt ponds (paakai), and aquacultural fishponds (loko ia) were built and maintained along the harbor shoreline. Traditional uses of the harbor persisted after European contact, although they were diminished. In the 19th century, ranching, rice farming, sugarcane cultivation, and other commercial uses were introduced to the harbor vicinity. While the rise of international maritime commerce resulted in major physical changes to other harbors such as Honolulu Harbor, the reefs at the mouth of Pearl Harbor prevented large vessel access, with canoes and small traditional vessels remaining predominant on harbor waters until military development at the turn of the 20th century (Van Tilburg, 2003). Mid- to late-20th century military development of Pearl Harbor significantly modified the traditional Hawaiian landscape through land reclamation, dredging, construction, and other large-scale development activities.

3.3.2 Environmental Consequences

Analysis of potential impacts to cultural resources considers temporary, permanent, reasonably foreseeable, and cumulative impacts. The assessment of potential impacts to cultural resources is based primarily on the Criteria of Adverse Effects contained in 36 CFR 800.5. Actions that affect the integrity of a historic property are potential adverse effects. Impacts may be the result of physically altering, damaging, or destroying all or part of a resource; altering characteristics of the surrounding environment that contribute to the importance of the resource; or introducing visual, atmospheric, or audible elements that are out of character for the period the resource represents (thereby altering the setting).

The impacts on types of cultural resources defined above (archaeological sites, architectural resources, and TCPs) are analyzed together for each alternative in the following discussion.

3.3.2.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur. No FRG, BESS, or PV system would be constructed and no underground infrastructure would be installed as the IKC 46 kV electrical transmission backbone project would not occur. No other project elements would involve ground-disturbing activities.

3.3.2.1.1 Archaeological Resources

No ground disturbance would be associated with the No Action Alternative; therefore, no impacts would occur to subsurface archaeological resources.

3.3.2.1.2 Architectural Resources

Under the No Action Alternative, there would be no impacts to the PHNHL.

Under the No Action Alternative, uses in Warehouses YA and YB are not relocated to Facilities 226, 283, 284, 393, 394, and 452K; those facilities would continue to be used by the current tenants and would not be demolished. Under the No Action Alternative, the remnant rail tracks would not be altered. Therefore, there would be no significant impacts to these resources.

3.3.2.1.3 Resources of Importance to Native Hawaiians

The No Action Alternative does not include any activities that would alter resources of importance to Native Hawaiians, because no areas with identified culturally important resources exist within the Proposed Action areas.

3.3.2.1.4 Summary of Impacts under No Action Alternative

No impacts to cultural resources would occur with implementation of the No Action Alternative.

3.3.2.2 Proposed Action Alternative

The Proposed Action Alternative would result in changes to cultural resources through the demolition and alteration of historic properties, new construction within the PHNHL District, and alterations to the setting of contributing resources within the district. Project actions would be permanent and would result in adverse effects to historic properties pursuant to Section 106 of the NHPA. Measures to resolve adverse effects to historic properties would be defined through consultation with the Advisory Council on Historic Preservation, State Historic Preservation Officer, and historic preservation stakeholders under Section 106 pursuant to the 2012 Programmatic Agreement (see MM CULT MGMT-1 in Table 3.8-2). The final EA will summarize the contents of the MOA.

3.3.2.2.1 Archaeological Resources

Construction Impacts

No impacts to known archaeological resources are anticipated from construction-period activities as a result of the Proposed Action Alternative. Ground disturbance would occur as a result of the installation of the PV system at Site 5. Ground disturbance would occur as part of demolition of existing facilities and construction of the FRG Plant at Site 2 and at Site 5. The solar panels at Site 5 would be installed with standard panel screws and thus no substantive ground disruption would occur. No known archaeological resources are present at Site 2 or Site 5, though ground disturbance raises the possibility for inadvertent discoveries. The Navy would follow procedures outlined in Navy SOPs for Archaeological

Treatment Protocols in the JBPHH Integrated Cultural Resources Management Plan in the event of an inadvertent discovery of cultural resources or remains (Table 2.7-1). These SOPs include ensuring that the ground-disturbing activities would only occur to the known depth of fill, monitoring excavation, conducting investigations in areas with known subsurface sites, and collecting data to inform the State Historic Preservation Officer and to update the Integrated Cultural Resources Management Plan geographic information system database. With the implementation of the best management practices (BMPs) listed in Table 2.7-1 (BMP CULT MGMT-1) and SOPs listed in Table 2.7-2, no significant effects would occur.

The 46 kV electrical transmission backbone is proposed to be underground and would be installed via trenching, horizontal directional drilling and microtunneling. For the Proposed Action Alternative, the known cultural resource sites (50-80-13-0098, 0099, and 0100) are all buried fishponds that are located below 2.90–3.42 meters of fill that could be impacted as a result of the installation of the electrical transmission backbone. These sites would only be affected by ground-disturbing work that extends through the fill into the fishpond sediments. Avoidance may be accomplished via directional drilling. If avoidance is not possible, then mitigation actions would be identified in Section 106 consultation (Table 3.8-2). Therefore, any impacts to archaeological resources would be reduced to a less than significant level through the Section 106 process.

Operational Impacts

No additional ground-disturbing activities to archaeological resources would occur once construction is complete and the sites are operational. Therefore, no impacts to archaeological resources would occur from operations. No significant long-term local impacts to archaeological resources would occur with implementation of the Proposed Action Alternative.

3.3.2.2.2 Architectural Resources

Construction Impacts

The Proposed Action Alternative would alter the PHNHL through the construction of new facilities, demolition of three historic properties, and reuse of six historic properties (Table 3.3-3), all of which contribute to the PHNHL District. Viewsheds within the larger PHNHL District also would be altered as a result of new construction. These construction impacts to cultural resources are potentially significant, long-term, local, and regional in nature. Consultation under Section 106 will address measures to avoid, minimize, and mitigate effects. Measures to minimize impacts to the PHNHL could include massing, screening, and using compatible color schemes. Measures to mitigate impacts associated with demolition of three historic properties could include detailed documentation, development of interpretive exhibits, and actions to improve the condition of other historic properties (see MM CULT MGMT-1 in Table 3.8-2).

The construction of the FRG Plant at Site 2 would require the demolition or disassembly and removal of Warehouses YA, YB, and 244. As mentioned above, the demolition would result in adverse effects to historic properties. The other five proposed IKC projects (Defense Logistics Agency [DLA] Relocation; Replace Protective Relays; Replace Live Front Equipment, Hickam; Protective Relay Coordination Study; and Replace Electrical Handholes) would involve replacement of equipment for existing infrastructure and a desk-based study, and would not impact cultural resources.

The addition of the FRG Plant at Site 2 would alter the PHNHL District with new construction. The FRG Plant would replace large-scale historic warehouse buildings with an industrial facility, and the addition of exhaust stacks as part of the FRG Plant would alter the setting of the PHNHL District. The exhaust stacks may measure up to 110 feet in height.

The Navy has conducted a visual analysis of project effects to the PHNHL with 12 Key Observation Points (KOPs) to evaluate impacts to the PHNHL District including housing areas (e.g., Hale Alii Historic Officer Housing Area), the USS Arizona Memorial, the USS Missouri, and other key locations. The analysis is included in Appendix D. The KOPs can also be found in Section 3.5. Of the 12 KOPs analyzed, 9 KOPs would result in no visual changes to the PHNHL that would diminish the NHL's integrity of setting, feeling, or association. Minor visual changes would result in the foreground at KOP 2 at Russell Avenue (west) that would alter the setting, feeling, and association of the NHL. KOP 5 (Paul Hamilton Avenue east) KOP 10 (Paul Hamilton Avenue west) would result in visual changes that would alter the PHNHL's historical setting, feeling, and association and KOP 11 (Russell Avenue east) would result in visible changes in the foreground that would alter setting, feeling, and association.

Facilities 226, 283, 284, 393, 394, and 452K would be used to relocate tenant operations from the demolished facilities at Site 2. This is part of the IKC projects and would require minor interior upgrades with the installation of new shelving. As stated above, this action would not adversely affect these historic properties. Furthermore, the action would continue and sustain the use of these historic buildings, thus providing a beneficial impact on historic properties within the PHNHL. No impacts to these facilities would occur.

As the PHNHL is located within an active military installation, noise is an expected part of the area. Two groups of NHL-contributing historic housing stand near Site 2, the Marine Officers' Quarters and the Hale Alii Officers' Quarters. Although these housing areas convey a park-like residential setting juxtaposed to the industrial installation, they are adjacent to industrial facilities, and a sense of quiet is not an aspect of their historic significance. Construction activities would follow a noise mitigation and management plan to reduce noise to the surrounding area (see MM NOISE-1 in Table 3.8-2). Short-term intermittent noise from pile driving and other construction activities would be temporary and would not result in adverse effects to cultural resources. Lighting for worker activity and security during the construction of the facilities would add to existing lighting at Site 2, following the Dark Skies Instruction, and follow best practices in coordination with U.S. Fish and Wildlife Service (USFWS).

The Proposed Action Alternative construction of the FRG and 46 kV electrical transmission backbone as part of the IKC projects would not disturb the historic rail line remnants along Russell Avenue that contribute to the PHNHL. No impacts to these remnants would occur.

The Proposed Action at Site 5 and the installation of the 46 kV electrical transmission backbone would not involve demolition or alteration of historic architectural resources. The NRHP-eligible Quonset hut (Facility X24) would not be demolished or altered under the Proposed Action at Site 5. No impacts would occur as a result of the construction activities at Site 5.

Table 3.3-3 Summary of Impacts to Historic Properties

Facility	*No Action Alternative*	*Proposed Action Alternative*
Warehouse YA	No impacts.	Adverse. Demolition or disassembly and removal of building.
Warehouse YB	No impacts.	Adverse. Demolition or disassembly and removal of building.
General Warehouse (Facility 244)	No impacts.	Adverse. Demolition or disassembly and removal of building.
Storehouse General NSC/X02 (Facility 393)	No impacts.	Not Adverse. Introduction of new use with relocation of tenants from Site 2 buildings with minor interior alterations.
Battery Shop (Facility 394)	No impacts.	Not Adverse. Introduction of new use with relocation of tenants from Site 2 buildings with minor interior alterations.
Sorting Assembly Warehouse (Facility 452K)	No impacts.	Not Adverse. Introduction of new use with relocation of tenants from Site 2 buildings with minor interior alterations.
Warehouse 226	No impacts.	Not Adverse. Introduction of new use with relocation of tenants from Site 2 buildings with minor interior alterations.
Warehouse 283 (Maintenance Shop)	No impacts.	Not Adverse. Introduction of new use with relocation of tenants from Site 2 buildings with minor interior alterations.
Warehouse 284 (Storehouse)	No impacts.	Not Adverse. Introduction of new use with relocation of tenants from Site 2 buildings with minor interior alterations.
Shipyard railway system remnants	No impacts. No actions with potential for disturbance to remnant rail tracks.	None. Rail tracks along Russell Avenue at Site 2 are not in area of disturbance for FRG Plant construction.
PHNHL	No impacts.	Adverse. Demolition of three contributing resources and addition of new construction. Impacts from new construction reduced by proposed new facility's massing and scale being comparable to nearby warehouses and the industrial character of the Shipyard area. Visual changes from 3 KOPs would alter the NHL's setting, feeling, and association. Existing vegetation would continue to screen visibility from Marine Barracks and Hale Alii housing areas. Beneficial impact from existing uses relocated to other contributing buildings.

Key: FRG = Firm Renewable Generation; KOP = Key Observation Point; NHL = National Historic Landmark; PHNHL = Pearl Harbor National Historic Landmark.

Operational Impacts

No further construction activities to architectural resources would occur once construction is complete and the sites are operational. The noise technical study in Appendix B includes an analysis of sensitive receptor sites associated with the Hale Alii Officer Housing areas in the PHNHL District. Although these areas are subject to existing noise from the adjacent shipyard, the Proposed Action would increase operational noise that would be noticeable during the daytime and nighttime in these areas. BMPs would be employed to reduce noise levels to within the HAR 11-46 criteria for Class A zoning districts; therefore, the resulting operational noise would have no adverse impacts to historic properties in the PHNHL District. Lighting for worker activity and security during operation of the facilities would add to existing lighting at Site 2, following the Dark Skies Instruction, and follow best practices in coordination with USFWS.

3.3.2.2.3 Resources of Importance to Native Hawaiians

The Proposed Action Alternative does not include any activities that would alter resources of importance to Native Hawaiians, because no areas with identified culturally important resources exist within the Proposed Action areas. Therefore, no impacts to cultural resources important to these groups are anticipated.

3.3.2.2.4 Impacts of Climate Change on Cultural Resources

Predictable environmental trends associated with climate change and the potential impacts in the ROI are identified in Table 3.2-7. Likely impacts of climate change in the ROI include higher intensity of storms, sea level rise, and ocean acidification. The Proposed Action is not expected to interact with these new trends in a manner that would produce additional adverse effects on the PHNHL District's historic setting or result in the loss of the PHNHL District's overall historic integrity.

3.3.2.2.5 Summary of Impacts to Cultural Resources under the Proposed Action Alternative

No significant impacts would occur to archaeological resources or resources of importance to Native Hawaiians.

The project would have an adverse effect on historic properties pursuant to Section 106 of the NHPA. Section 106 consultation is happening concurrently with this EA. This section and MM CULT MGMT-1 in Table 3.8-2 will be updated in the Final EA with information pertaining to the results of Section 106 consultation, including mitigation requirements. Through consultation and implementation of mitigation pursuant to Section 106, the Navy will resolve effects to historic properties. Therefore, the Proposed Action would result in a less than significant impact on cultural resources.

3.4 Biological Resources

Biological resources include living, native, or naturalized plant and animal species and their habitats. This analysis focuses on species that are important to the function of ecosystems or protected under federal or state law. Habitat is defined as the resources and conditions present in an area that support a plant or animal. Biological resources are divided into the following categories: vegetation, wildlife (including Migratory Bird Treaty Act [MBTA] species), and special status species (state and federal Endangered Species Act [ESA]-listed species).

The ROI for biological resources includes the project area as well as the regions near the project area boundaries that may experience noise, visual, other physical, or indirect impacts resulting from the Proposed Action. With the exception of the electrical transmission backbone, the IKC projects would not require any ground- or vegetation-disturbing activities and would have minor noise or air emissions. Therefore, they are not analyzed further in this section.

Potential stressors analyzed for wildlife and special status species are identified in Appendix C. The regulatory setting and parameters for each category of biological resources are described in Appendix H.

3.4.1 Marine Biological Resources

A description of the regulatory setting for marine biological resources is included in Appendix H.

No in-water activity is planned as part of the construction of the Proposed Action and no impacts on marine species are anticipated. Sites 2 and 5 drain to the East Loch, which flows into Pearl Harbor. Proposed activities occurring near the shoreline would consist of demolition and construction activities on impervious surfaces and, as such, would be subject to permit conditions, including the National Pollutant Discharge Elimination System, as well as the BMPs and SOPs listed in Table 2.7-1 (WATER MGMT-3 and 4) and Table 2.7-2, respectively. These measures would minimize the potential for any water runoff into the marine environment at JBPHH.

No marine activities would take place as a result of the Proposed Action. Biofuel for the FRG Plant would be transported to the west coast of Oahu on existing fuel transport vessels, representing a minor increase in the total volume of liquid fuel transported to Oahu. Therefore, the Proposed Action would have no effects on marine ESA-listed species or Marine Mammal Protection Act-listed species. No effects to the seabed or Essential Fish Habitat are anticipated as a result of the Proposed Action.

Impacts to marine biological resources would be less than significant and therefore are not analyzed further in this EA.

3.4.2 Affected Environment

The following discussion provides a description of existing conditions for biological resources within the ROI. The Proposed Action sites are in a developed region and are surrounded by developed sites and active roadways. The combination of the urban environment, relatively intensive human activity, and roadway traffic and noise limit the biodiversity, population size, habitat values, and the presence of special status species at both Sites 2 and 5 as well as along the electrical transmission backbone.

3.4.2.1 Vegetation

The project area consists entirely of built or modified landscape with no notable ecological communities on or adjacent to the construction sites. A large portion of the project area is heavily disturbed and vegetated with non-native lawn grasses and ornamental landscaping. Several small, non-native trees exist at Site 2, with mature trees along the south perimeter. Site 5 consists of an open field with a few mature non-native trees, and the electrical utility development regions contain some non-native ornamental plants.

The majority of the ROI is largely developed and has relatively little unmanaged vegetation. The managed landscaped areas occur mostly around housing and facilities, main roads, and recreational areas. Extensive areas of weedy vegetation are periodically maintained. Most of the vegetation within the ROI is managed grass and planted trees including monkeypod (*Samanea saman*), date palm (*Phoenix dactylifera*), fan palm (*Livistona chinensis*), royal palm (*Roystonea regia*), banyan (*Ficus microcarpa*), silk oak (*Grevillea robusta*), milo (*Thespesia populnea*), rainbow shower tree (*Cassia* x *nealiae*), and coconut palm (*Cocos nucifera*).

3.4.2.2 Wildlife

Wildlife found in the ROI consists of bird, reptile, mammal, and invertebrate species consistent with those found in a developed and urbanized environment (DON, 2022d). The species with potential to occur are anticipated to traverse across the project areas. The most common birds observed around JBPHH Main Base are introduced species such as common waxbill (*Estrilda astrild*), warbling white-eye (*Zosterops japonicus*), chestnut munia (*Lonchura atricapilla*), common myna (*Acridotheres tristis*), and red-vented bulbul (*Pycnonotus cafer*) (Hamer Environmental, 2016). Common reptiles include the house gecko (*Hemidactylus frenatus*), mourning gecko (*Lepidodactylus lugubris*), and Indo-Pacific gecko (*Hemidactylus garnotii*) (DON, 2021). Invasive species that are a concern at JBPHH include domestic/feral cats (*Felis catus*), rats (*Rattus* spp.), mongoose (*Herpestes javanicus*), and coconut rhinoceros beetle (*Oryctes rhinoceros*) (DON, 2021).

Nearly all migratory and resident birds present in the Hawaiian Islands, and all resident seabirds, are protected under the MBTA. A variety of shorebirds, waterbirds, and seabirds use habitat within the ROI such as sandpipers (*Calidris* spp.), plovers (*Pluvialis* spp.), yellowlegs (*Tringa* spp.), godwits (*Limosa* spp.), ducks (*Anas* spp. And *Aythya* spp.), gulls (*Larus* spp.), Caspian tern (*Hydroprogne caspia*), least tern (*Sternula antillarum*), wedge-tailed shearwater (*Puffinus pacificus*), and great frigatebird (*Fregata minor*) (DON, 2021).

3.4.2.3 Special Status Species

Special status species with the potential to occur in the ROI are listed in Table 3.4-1 and are identified by their common name, Hawaiian name, and regulatory status. See Appendix C for a complete list of ESA-listed species with the potential to occur in the ROI.

Table 3.4-1 Special Status Species Known to Occur or with Potential to Occur in the Region of Influence

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status*
Birds			
Anas wyvilliana	Hawaiian duck	Koloa moali	FE, SE
Fulica alai	Hawaiian coot	Alae keokeo	FE, SE
Gallinula galeata sandvicensis	Hawaiian gallinule	Alae ula	FE, SE
Himantopus mexicanus knudseni	Hawaiian stilt	Aeo	FE, SE
Oceanodroma castro	Band-rumped storm petrel	Ake ake	FE, SE
Pterodroma sandwichensis	Hawaiian petrel	Uau	FE, SE
Puffinus auricularis newelli	Newell's shearwater	Ao	FT, ST
Asio flammeus sandwichensis	Hawaiian short-eared owl	Pueo	SE
Gygis alba	White tern	Manu o Ku	SE
Terrestrial Mammals			
Lasiurus cinereus semotus	Hawaiian hoary bat	Opeapea	FE, SE

Notes: Selections for Regulatory Status column include: FE = federal endangered, SE = state endangered, FT = federally threatened, and ST = state threatened.
Source: DON (2022b).

Four ESA-listed endangered waterbird species are found in the ROI: Hawaiian duck or koloa (*Anas wyvilliana*), Hawaiian common moorhen or alae ula (*Gallinula chloropus sandvicensis*), Hawaiian coot or alae keokeo (*Fulica alai*), and Hawaiian black-necked stilt or aeo (*Himantopus mexicanus knudseni*) (DON, 2021; NAVFAC Pacific, 2006; eBird, 2021). No known suitable foraging habitat exists within the project area for these species. Some suitable foraging habitat is within the ROI; however, it is limited due to the area being highly developed and the predominance of invasive plant species. Observations of waterbirds and shorebirds may be more prevalent during occasional ponding after significant rainfall.

Three ESA-listed seabirds have the potential to traverse through the ROI: the endangered band-rumped storm petrel or ake ake (*Oceanodroma castro*), the endangered Hawaiian petrel or uau (*Pterodroma phaeopygia sandwichensis*), and the threatened Newell's shearwater or ao (*Puffinus auricularis newelli)* (DON, 2021). While these species are uncommon in the ROI and not known to use the project area, seabirds may be attracted to artificial lights.

The ESA-listed endangered Hawaiian hoary bat or opeapea (*Lasiurus cinereus semotus*) is considered ubiquitous on Oahu. The south perimeters of Sites 2 and 5 contain potentially suitable hoary bat habitat for roosting, foraging, and pupping.

Two SOH-listed endangered endemic birds are present: the white (fairy) tern (*Gygis alba*) or manu o Ku, a seabird, and the Hawaiian short-eared owl (*Asio flammeus sandwichensis*) or pueo, a raptor (DON, 2021). Some suitable foraging habitat exists within the ROI for both the white tern and the pueo, with some additional suitable year-round nesting habitat for the white tern within the project area (mature, open-canopy trees, with two peaks in egg-laying occurring in March and October) (VanderWerf and Downs, 2018).

3.4.3 Environmental Consequences

3.4.3.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and no changes would occur to biological resources. Therefore, no impacts to biological resources would occur with implementation of the No Action Alternative.

3.4.3.2 Proposed Action Alternative

The ROI for the analysis of effects to biological resources associated with the Proposed Action Alternative includes areas that would experience active demolition, construction, or operational activities. This includes Site 2 (including Options 1 and 2), Site 5, and the proposed 46 kV electrical transmission backbone as part of the IKC projects.

3.4.3.2.1 Vegetation

Construction Impacts

Vegetated portions of the Proposed Action area consist of mostly planted non-native landscape material, and no notable ecological communities occur on or adjacent to these areas.

Site 2: Construction would occur mostly in an urbanized section of the base and includes two existing warehouses and paved parking lots. Several small, non-native trees would be removed at this location. Therefore, construction impacts to vegetation at Site 2 from either option would be less than significant.

Site 5: Site preparation and construction activities would require clearing of the 15-acre site that is vegetated with non-native shrubs, trees, and grasses. No impacts to native plant communities would occur. Therefore, construction impacts to vegetation at Site 5 would be less than significant.

IKC Electrical Transmission Backbone Development: The new 46 kV electrical transmission backbone would originate at Site 2 and connect to other substations located on and around the base. Vegetation along this alignment consists entirely of non-native grasses, trees, and scattered shrubs. The electrical transmission backbone would be installed via horizontal directional drilling and microtunneling where feasible, reducing impacts to surface vegetation and root systems. No impacts to native plant communities would occur. Therefore, construction impacts to vegetation as a result of installing the electrical transmission backbone would be less than significant.

As Sites 2 and 5 do not contain native plant communities and loss of vegetation due to the project is minimal, the Proposed Action construction phase would have no significant impacts to vegetation.

Operational Impacts

Operational activities at Sites 2 (including Options 1 and 2) and 5, and along the IKC electrical transmission backbone, would consist of maintenance of existing vegetation at Site 5. As stated above, vegetation is mostly non-native and sparse in these areas. No further ground-disturbing activities would occur once construction is complete and the sites are operational. No long-term impacts to vegetation at these sites would occur with implementation of the Proposed Action Alternative.

To prevent human-caused erosion over time, the Proposed Action Alternative would include landscape treatment consisting of planting, protective fencing, and walkways. The project design BMPs in Table 2.7-1 (BMP WATER MGMT-1) and SOPs described in Table 2.7-2 related to storm water management would be implemented to manage storm water volumes and avoid any potential flooding or ponding at and near the project area. Therefore, minimal change would occur to the type and volume of water affecting vegetation in the project area. Installation personnel would continue to manage nearby habitats according to the Integrated Natural Resources Management Plan (DON, 2019a). For these reasons, the Proposed Action Alternative operations would have less than significant impacts to vegetation.

3.4.3.2.2 Wildlife

Potential stressors analyzed for wildlife and special status species are identified in Table C-1 in Appendix C and include noise disturbance, physical disturbance and strikes, entanglement, secondary stressors, glare, light disturbance, and emissions. With regard to all wildlife that may be present during construction or operations, the facilities proposed for demolition and construction are in highly developed areas with largely unsuitable habitat where wildlife is not likely to be present and the potential stressors would likely have a marginal effect, if any.

Construction Impacts

Construction could result in potential stressors including noise disturbance, physical disturbance and strikes, secondary stressors (loss of habitat and/or water quality), and emissions with the potential to affect wildlife.

Regarding noise disturbance, the temporary duration of construction would vary across each site (durations detailed below) and would result in intermittent noise impacts from the operation of heavy equipment, power and hand tools, and construction vehicles throughout the project areas; noise levels would also vary as the work progresses (see Appendix B for sound source details).

All Sites: In all project areas, standing water could attract birds such as waterbirds and shorebirds to the project areas, putting them at risk for physical disturbance or strike. To minimize this attraction, construction activities would be managed to avoid creating temporary ponding in the project area, including covering any storm water detention basins at Sites 2 and 5. Regarding water quality (secondary stressor), construction activities would comply with National Pollutant Discharge Elimination System permit requirements under the existing storm water management plan, thereby minimizing impacts to water quality in the ROI. In addition, BMPs identified in Table 2.7-1 (BMP WATER MGMT-5), such as the use of bioretention techniques, vegetated swales and filter strips, and retention basins, would be implemented to further minimize impacts. Exhaust emissions (including gases and particulates) would occur from proposed construction-related activities at Site 2. The air quality analysis (Section 3.2) indicates no significant impacts to air quality; therefore, emissions are not anticipated to cause impacts to wildlife. Potential stressors including noise disturbance, physical disturbance and strikes, secondary stressors (water quality and ponding), and emissions would not result in significant impacts to wildlife for all project areas. Potential construction impacts for each project are analyzed individually below.

Site 2: Construction noise would occur at Site 2 and would last less than three years; however, because the area is already highly developed, the area provides minimal habitat value to wildlife. As stated previously, minimal vegetation that could function as wildlife habitat would be removed at Site 2 (secondary stressor). The existing vegetative habitat consists of several small, non-native trees, with the remainder of the site being previously disturbed and developed. Any minimally occurring wildlife would relocate to regions nearby with similar conditions. The measures described in Table 3.8-2 would further minimize any potential impacts, so construction would have no adverse effects to wildlife habitat. Therefore, construction of the Proposed Action at Site 2 would have less than significant impacts to wildlife and there would be no adverse effects to any migratory bird species protected under the MBTA.

Site 5: Noise at this site during construction would last approximately nine months and would result in intermittent noise impacts from the operation of heavy equipment, power and hand tools, and construction vehicles throughout the project area; noise levels would also vary as the work progresses (see Appendix B for sound source details). Noise is not anticipated to impact any wildlife that may be using the area. The landscaped areas at Site 5 provide minimal habitat for ground-nesting and foraging bird species and would require minimal grading to accommodate the PV system; therefore, no net increase of impervious surface would be added to this site that could contribute to changes in water quality or attract wildlife should ponding occur. Secondary stressors are not anticipated to have an adverse effect on wildlife. Therefore, construction of the Proposed Action at Site 5 would have less than significant impacts to wildlife and there would be no adverse effects to any migratory bird species protected under the MBTA.

IKC Electrical Transmission Backbone Development: For the construction of the 46 kV IKC electrical transmission backbone development, trenchless drilling would be used as much as possible to reduce surface disturbance. Construction noise for this project component would occur over two years and would result in intermittent noise impacts from the operation of heavy equipment, power and hand tools, and construction vehicles throughout the project area; noise levels would also vary as the work progresses (see Appendix B for sound source details). Noise is not anticipated to impact the minimal wildlife that may be present. Very little suitable wildlife habitat occurs along the existing roads; as such, secondary stressors are not likely to have effects on wildlife. Additionally, no new sources of light and/or glare would be used during construction of the electrical transmission backbone. Therefore, construction would have no significant impacts to wildlife and there would be no adverse effects to any migratory bird species protected under the MBTA.

Operational Impacts

Operations could result in potential stressors including noise disturbance, secondary stressors (water quality), glare, light disturbance, and emissions to wildlife. Impacts to wildlife habitat at Sites 2 and 5 could occur from the routine landscaping operations and maintenance; however, all activities involving removal, pruning, or trimming of existing trees and large shrubs during bird nesting would be avoided or monitored as specified in Table 2.7-1 and Table 3.8-2 to ensure compliance with the MBTA. The project operations at all sites would not introduce any new strike hazards; therefore, the Proposed Action Alternative operations would have less than significant impacts to wildlife due to strike. Potential operational impacts for each project area are analyzed individually below.

Site 2: Energy generation would generate noise during operations at Site 2. The noise analysis describes the anticipated levels and effects of such noise (Section 3.6). Considering the similarity of proposed operational noises to ongoing operational noise levels, and the reductions associated with proposed noise mitigation plans (see MM NOISE-1 in Table 3.8-2), the Proposed Action operations would have less than significant noise impacts to wildlife. Impacts to water resources used by wildlife (secondary stressor) include increased ponding of water on developed surfaces and contamination of water sources frequented by birds or mammalian species. The implementation of low-impact development techniques such as vegetated swales established during construction would remain beyond the construction period (Table 2.7-1). Additional low-impact development features for water management beyond the construction period would be implemented to further minimize potential pollutants entering storm water flows (Table 2.7-1). Impacts to seabirds and other migratory birds could occur from operational exterior lighting in the project area and from interior lighting through windows at the FRG Plant and PV system. Measures to avoid or minimize impacts are discussed in Table 2.7-1 as BMP TERR BIO MGMT-4 and include the installation of down-shielded lights, tinted windows, and a full cutoff feature that minimizes backlight, uplight, and glare. Such design features also include automatic motion sensor switches and controls on all lights visible to the outdoors. Procedures such as further limiting the use of night lighting during the seabird fledging period (primarily September through December) can reduce instances of fallout.

Emissions during the operations phase of the project would be primarily generated at the proposed FRG Plant at Site 2, as presented in Section 3.2. These calculations indicate no significant impact on air quality. A summary of total daily emissions at Site 2 is included in Table 3.2-10 with details on calculations provided in Appendix A.

Taking into consideration proposed BMPs, Site 2 operations would have less than significant impacts to wildlife and there would be no adverse effects to any migratory bird species protected under the MBTA.

Site 5: The Proposed Action at Site 5 involves covering much of the 15-acre site with PV panels, which would use anti-glare technology to avoid creating additional light or glare, such as dark-colored materials and anti-reflective coatings to prevent glare. The potential impacts and associated BMPs for artificial lighting and water resources would be the same for Site 5 as described above for Site 2 (see BMP TERR BIO MGMT-1 in Table 2.7-1). Additionally, revegetation at Site 5 would occur in a manner consistent with the JBPHH Installation Appearance Plan and Integrated Natural Resources Management Plan. At Site 5, the only significant noise source during operations would be the BESS unit. BMPs would be employed to reduce noise levels to within the HAR 11-46 criteria for Class A zoning districts; therefore, the resulting operational noise would have no adverse impacts on wildlife. Emissions during the operations phase of the project would be minimal at Site 5, as presented in Section 3.2. With the noted BMPs in place, Site 5 operations would have less than significant impacts to wildlife and there would be no adverse effects to any migratory bird species protected under the MBTA.

IKC Electrical Transmission Backbone Development: No operational impacts to wildlife would occur from the 46 kV IKC electrical transmission backbone, and there would be no adverse effects to any migratory bird species protected under the MBTA.

3.4.3.2.3 Special Status Species

Stressors and the corresponding impact analyses would apply to special status species as described above for non-listed species, with the addition of entanglement. The Proposed Action includes BMP TERR BIO MGMT-1, as described in Table 2.7-1, which requires a qualified biologist to perform pre-construction surveys for nesting birds no more than 14 days prior to start of construction, and daily monitoring to ensure that no bird species are present at Sites 2 and 5. If bird nests are found, construction would not start until the bird(s) have fledged. However, because these sites do not support high-quality habitat for any special status species, and because of the implementation of the Proposed Action BMPs in Table 2.7-1 and SOPs in Table 2.7-2, less than significant impacts to special status species are expected. Individually relevant impacts to species for construction and operations are further detailed as follows.

Construction Impacts

Construction noise disturbance, physical disturbance and strike, secondary stressors, light disturbance, and emissions could potentially affect special status species at Site 2, Site 5, and the IKC electrical transmission backbone development area. The construction impact analyses for these stressors described above for non-listed species would apply to special status species.

Waterbirds: No suitable habitat for ESA-listed waterbirds (Hawaiian duck, Hawaiian common moorhen, Hawaiian coot, and Hawaiian black-necked stilt) exists within Site 2, Site 5, or the IKC electrical transmission backbone development area. However, the ESA-listed waterbirds use shoreline habitat along Pearl Harbor (DON, 2021). The primary potential stressor to these species would be their attraction to the project area if ponding occurs, potentially resulting in unintended strike. Implementation of reduced traffic speeds in the construction zone, project-related BMPs (see BMP WATER MGMT-5 in Table 2.7-1) to reduce the risk of ponding, and pre-construction surveys would reduce the potential to impact these species. Given this and the BMPs described above for general wildlife, the Proposed Action may affect, but is not likely to adversely affect, ESA-listed waterbirds, and impacts to these species would be less than significant.

Seabirds: The ESA-listed seabirds (band-rumped storm petrel, Hawaiian petrel, and Newell's shearwater) are rarely seen at JBPHH and have not been recorded in the project areas (Site 2, Site 5, and the IKC electrical transmission backbone development area) (Young et al., 2019; Pyle and Pyle, 2017; DON, 2021). However, the primary potential stressor to these seabirds would be their attraction to artificial lights in the project area resulting in disorientation, injury, or death. BMP TERR BIO MGMT-4, VISUAL-1, and SOPs would be followed to ensure that impacts to seabirds from increased light and glare would not occur (Table 2.7-1 and Table 2.7-2). BMPs for general wildlife (Table 2.7-1) would reduce this risk to seabirds that may traverse the project area. Therefore, the Proposed Action would have no effect on ESA-listed seabirds.

Hawaiian Hoary Bat: The Hawaiian hoary bat has been confirmed to occur in the ROI and, while unconfirmed within the project area, the species has the potential to forage or pup at Site 2 and/or Site 5 (DON, 2021; NAVFAC Pacific, 2020). The primary potential stressors to the Hawaiian hoary bat are noise disturbance, loss of habitat (secondary stressor), and potential entanglement in fencing. As described in Section 3.6, construction would pose a temporary and negligible increase of noise in the project area.

Temporary and intermittent noise from construction may create an acoustic disturbance to Hawaiian hoary bats that may occur in the near vicinity of the project areas. Hawaiian hoary bats rely on sound to forage at night; however, no nighttime activities are proposed that would generate sound. Any resting bats (occurring during daytime) seeking to avoid an acoustic disturbance are already discouraged from use of the area due to the proximity to a developed area and minimal habitat, and are unlikely to be present (Voigt et al., 2018). Regarding habitat, when trimming or removal of vegetation greater than 15 feet is needed, it is required to occur outside of the Hawaiian hoary bat pupping season to the maximum extent possible (June 1–September 15) (DON, 2022b). If vegetation removal is proposed during the pupping season, DON consultation with USFWS is required (Table 2.7-2). The Proposed Action Alternative would incorporate a design feature to avoid the addition of barbed wire fencing that could entangle foraging Hawaiian hoary bats (TERR BIO MGMT-3). Artificial lighting can potentially alter essential bat behaviors such as foraging locations due to insect attraction to lights; however, disturbance to bats due to artificial lighting is not anticipated (Stone et al., 2015). Construction of the Proposed Action is expected to occur only during daytime hours. BMPs in Table 2.7-1, SOPs in Table 2.7-2, and mitigation measures in Table 3.8-2 for regulation of artificial lighting and noise mitigation, as well as SOPs targeting sediment control to reduce negative impacts from airborne particles during construction, would reduce potential impacts to bats. Therefore, the Proposed Action may affect, but is not likely to adversely affect, the Hawaiian hoary bat, and impacts to the species would be less than significant.

Pueo: Disturbance to habitat (secondary stressor) is the primary potential stressor for this species. Site 5 has some suitable foraging and nesting habitat for pueo. No suitable habitat exists at Site 2 or at the IKC electrical transmission backbone development area. As listed in BMP TERR BIO MGMT-1 (Table 2.7-1), if a pueo is spotted on the ground during pre-construction surveys, a nest survey would commence within 656 feet of the observed pueo. Pre-construction surveys and monitoring of any ground-nesting birds, as needed, would reduce the potential to impact the species. Given this and the BMPs described above for general wildlife, the Proposed Action would have less than significant impacts to pueo.

White Tern: Disturbance to habitat (secondary stressor) is the primary potential stressor for this species. Sites 2 and 5 have some trees that may be suitable for white tern nesting. No such trees occur at the IKC electrical transmission backbone development area. To the maximum extent practicable, tree-trimming activities would avoid the peak egg-laying/nesting months (March and October) and nest surveys would be conducted prior to tree removal, pruning, or trimming activities. If the tree scheduled for removal, pruning, or trimming is found to contain a nest, the tree would not be disturbed until the chicks have fledged (approximately 48 days) (see BMP TERR BIO MGMT-3 in Table 2.7-2). With SOPs from Table 2.7-2 in place, the Proposed Action would have less than significant impacts to the white tern.

Operational Impacts

Operational noise disturbance, light disturbance, entanglement, and glare could potentially affect special status species at Sites 2 and 5. The operational impact analyses for these stressors described above for non-listed species would apply to special status species (with the exception of entanglement, described below for Hawaiian hoary bat). Emissions could potentially affect special status species at Sites 2 and 5, as presented in Section 3.2. These calculations indicate no significant impact on air quality, and air emissions are expected to have less than significant impacts to wildlife. No operational impacts are anticipated from the IKC electrical transmission backbone development area.

Waterbirds: All project areas under the Proposed Action Alternative (Site 2, Site 5, and the IKC electrical transmission backbone development area) would effectively operate the same as existing conditions regarding potential for waterbird utilization or potential impacts (with the exception of emissions at Site 2 and glare at Site 5, described in the wildlife section above). With the implementation of water management BMPs to reduce risk of ponding (see BMP WATER MGMT-5 in Table 2.7-1), operations for the Proposed Action may affect, but are not likely to adversely affect, ESA-listed waterbirds, and impacts to these species would be less than significant.

Seabirds: All project areas under the Proposed Action Alternative (Site 2, Site 5, and the IKC electrical transmission backbone development area) would effectively operate the same as existing conditions regarding potential for seabird utilization or potential impacts (with the exception of emissions at Site 2 and glare at Site 5, described in the wildlife section above). With the implementation of BMPs detailed in Table 2.7-1 (BMP TERR BIO MGMT-1 – TERR BIO MGMT-4), operations for the Proposed Action may affect, but are not likely to adversely affect, ESA-listed seabirds, and impacts to these species would be less than significant.

Hawaiian Hoary Bat: All project areas under the Proposed Action Alternative (Site 2, Site 5, and the IKC electrical transmission backbone development area) would effectively operate the same as existing conditions regarding potential for Hawaiian hoary bat utilization or potential impacts (with the exception of emissions at Sites 2 and 5 and glare at Site 5, described in the wildlife section above). With the implementation of BMPs detailed in Table 2.7-1 (BMP TERR BIO MGMT-3), operations for the Proposed Action may affect, but are not likely to adversely affect, the ESA-listed Hawaiian hoary bat, and impacts to this species would be less than significant.

Pueo: Operations would not introduce any new potential impacts to this species throughout the project areas under the Proposed Action Alternative (Site 5) as the sites would effectively operate the same as existing conditions regarding potential for pueo utilization or potential impacts (with the exception of emissions at Sites 2 and 5 and glare at Site 5, described in the wildlife section above). Maintenance of surrounding vegetation where pueo have the potential to nest would not be altered from existing conditions. No BMPs are proposed specifically for this species as no adverse effects would occur. Therefore, operations under the Proposed Action would have less than significant impacts to this species.

White Tern: All project areas under the Proposed Action Alternative (Site 2, Site 5, and the IKC electrical transmission backbone development area) would effectively operate the same as existing conditions regarding potential for white tern utilization or potential impacts (with the exception of emissions at Sites 2 and 5 and glare at Site 5, described in the wildlife section above). With the implementation of BMPs in Table 2.7-1 and SOPs in Table 2.7-2, operations under the Proposed Action would have less than significant impacts to this species.

With the implementation of BMPs detailed in Table 2.7-1 and SOPs in Table 2.7-2, no significant impacts would occur to special status species during operations.

3.4.3.2.4 Impacts of Climate Change on Biological Resources

The predictable environmental trends would impact species and habitats over large time frames and geographic scales not directly associated with the Proposed Action. Climate change would likely have adverse effects to marine and terrestrial biological species, as detailed in Table 3.2-7. Implementation of BMPs in Table 2.7-1 and SOPs in Table 2.7-2 would limit or mitigate permanent adverse impacts to terrestrial species as a result of the Proposed Action, and the Proposed Action would not exacerbate impacts associated with climate change.

3.5 Visual Resources

This discussion of visual resources includes the natural and built features of the landscape visible from public views that contribute to an area's visual quality. Visual perception is an important component of environmental quality that can be impacted through changes created by various projects. Visual impacts occur as a result of the relationship between people and the physical environment. A description of the regulatory setting for visual resources is included in Appendix H.

3.5.1 Affected Environment

Pearl Harbor and historic facilities located within and adjacent to the harbor are important visual resources in the project vicinity that are visible to varying degrees from various public vantage points. Sensitive viewers are considered the public as well as on-base personnel and visitors that could have a heightened awareness of potential changes to the landscape. Sensitive viewers may include residents who value or are accustomed to the landscape or recreators or tourists who may seek out a specific view. Views from scenic overlooks and historically important viewpoints may be focal to the viewer experience and therefore are considered sensitive and of heightened importance. Views that are experienced from a stationary or sustained viewer location may hold greater sensitivity than those experienced episodically or while moving.

Site 2 is relatively flat and is surrounded by existing military facilities. Views of Site 2 from public vantage points are limited due to distance, as Site 2 is approximately 1,500 feet from both the JBPHH Nimitz Gate and the Hickam main gate at 19th Way. Site 2 is located between South Avenue and the heavy industrial PHNSY. Site 2 is surrounded by a mix of military housing, industrial, administrative, recreational, and commercial facilities. The area is characterized by light industrial uses including large warehouse-style facilities, open paved parking lots, and industrial facilities such as aboveground storage tanks. Three historic features wrap around Site 2: Historic Marine Officer Housing and Marine Barracks southwest of Site 2, a historic field west of the Marine Officer Housing and Marine Barracks, and Hale Alii Historic Officer Housing Area north to northeast of Site 2. The Marine Officer Housing and Marine Barracks and the Hale Alii Historic Officer Housing Area are landscaped with generous lawns and mature canopy trees, including one large banyan tree (*Ficus microcarpa*) on the north adjacent property near Warehouses YA and YB. These two areas along with the historic field form a green park-like environment around parts of Site 2.

Site 5 is slightly sloped with the higher side of the site located near Salt Lake Boulevard and the lower side near Namur Road. Residences are on the eastern side of Salt Lake Boulevard. Because many are higher than the street, residents can look across this busy highway into Site 5. Public views of Site 5 exist from Connie Chun Aliamanu Neighborhood Park northeast of the site and from public roadways and residences located southwest and east of the site. The northern part of Site 5 is developed with a ball field, a few supporting structures such as bleachers and a restroom, and a parking lot. The field, the field structures, and a few palm trees and canopy trees characterize this part of Site 5. The south part of Site 5 is primarily a partially paved, open storage yard with several storage structures. Utility poles are currently stored at various locations on the lot. A large Quonset hut is located immediately outside of the Site 5 PV system but within the same fenced area.

KOPs were established as representative viewing locations of the potentially affected landscape. Collectively, views experienced from the KOPs provide a representation of the characteristic landscape and its visual quality that could be affected by the Proposed Action. Twelve KOPs for Site 2 and three KOPs for Site 5 were identified for the analysis of visual impacts (Table 3.5-1). A brief description of the views from the KOPs are included in Table 3.5-2 (Site 2) and Table 3.5-3 (Site 5).

Table 3.5-1 Descriptions of Key Observation Points

KOP Number	*Location*	*Why This Location Was Selected*	*Sensitive Viewers*
KOP 1	Marine Barracks Quick Field near parade grounds	Proximity to Site 2 with minimal obstruction	Users of the Quick Field
KOP 2	Russell Avenue south of Safeguard Street	Proximity to Site 2 with minimal obstruction	Military staff and civilians (including visitors) traveling along Russell Avenue
KOP 3	Club Road at Safeguard Street	Proximity to Site 2 and Hale Alii Housing with minimal obstruction	Military staff and civilians (including visitors) traveling along the road
KOP 4	Hale Alii Officer Housing	Proximity to Site 2 and Hale Alii Housing with minimal obstruction	Residents and visitors of the housing area
KOP 5	Paul Hamilton Avenue	Proximity to Site 2 with minimal obstruction	Military staff and civilians (including visitors) traveling along the road
KOP 6	USS Missouri Museum	Potential view of Site 2 despite distance, close public viewpoint to project area	Museum visitors and staff
KOP 7	USS Arizona Memorial	Public viewpoint, potential distant view of Site 2, its own NHL	Memorial visitors and staff
KOP 8	Vicinity of Makalapa Gate	Near main access gate to JBPHH, proximity to frequently used, on base recreational field (Millican Field)	Military and civilians (including visitors) using Millican Field or passing North Road near Millican Field
KOP 9	Hut Avenue	Additional perspective of JBPHH features	Military staff and civilians (including visitors) traveling along the road
KOP 10	Intersection of Hale Alii Road and Safeguard Street	Proximity to Site 2 and Hale Alii Housing with minimal obstruction	Military staff and civilians (including visitors) traveling across the intersection
KOP 11	Intersection of Russell Avenue and South Avenue	Proximity to Site 2 with minimal obstruction	Military staff and civilians (including visitors) traveling across the intersection
KOP 12	JBPHH Main Gate	Public viewpoint, potential distant view of Site 2	Military and civilians (including visitors) passing the gate
KOP 13	Connie Chun Aliamanu Neighborhood Park	Public recreational area frequented by residents	Park users
KOP 14	Intersection of Salt Lake Boulevard and Maluna Street	Proximity to Site 5 along the arterial roadway Salt Lake Boulevard	People driving, biking, or walking by this intersection
KOP 15	Intersection of Maluna Street and Wanaka Street	Vantage point in the residential neighborhood upland from Site 5 at one of the main intersections where Site 5 is visible	People driving, biking or walking by this intersection

Key: JBPHH = Joint Base Pearl Harbor-Hickam; KOP = Key Observation Point; NHL = National Historic Landmark.

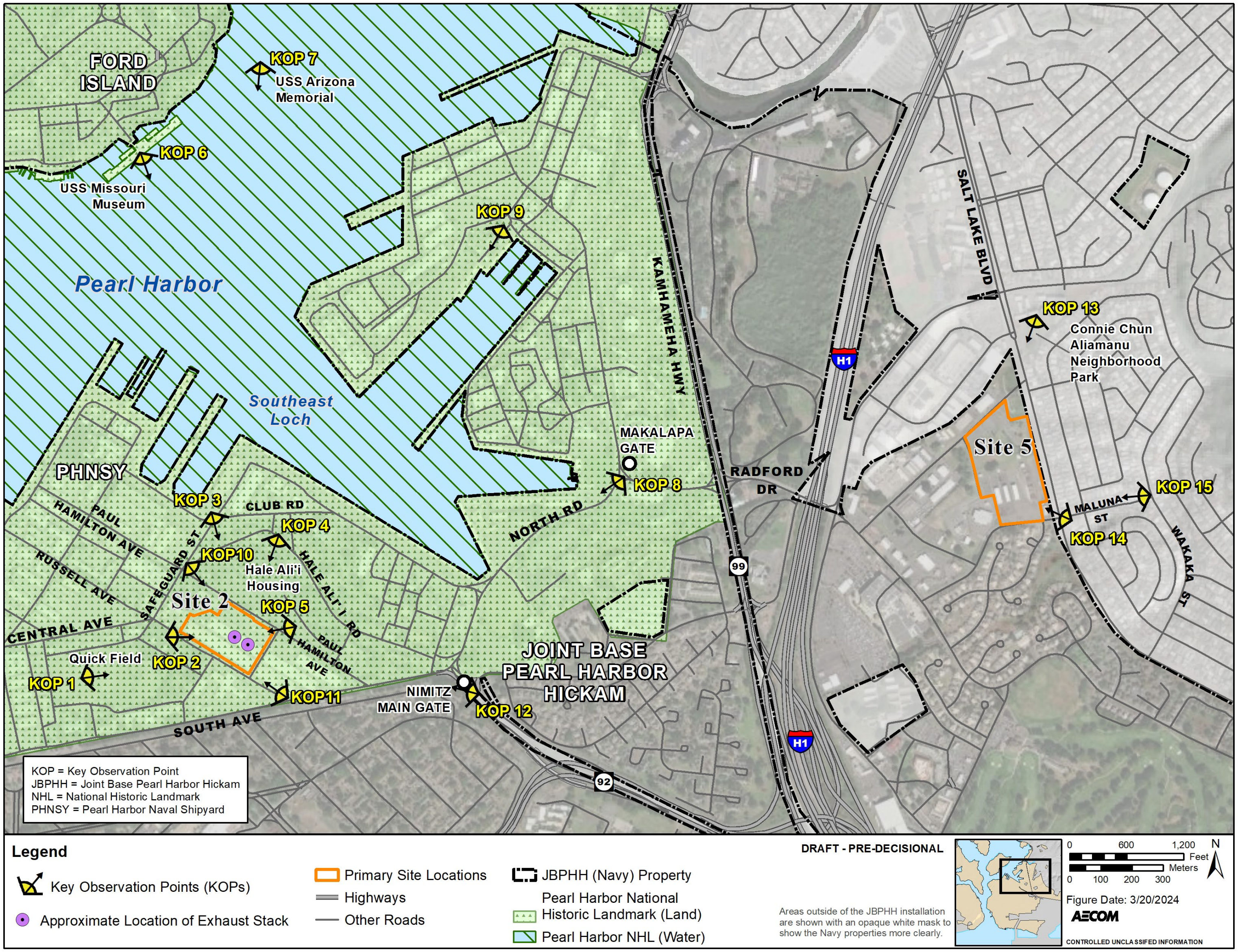

Figure 3.5-1 Key Observation Points (KOPs)

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	***Description of Existing Views Toward Site 2***
1	The historic Marine Barracks Quick Field view is characterized by a large, grassy, flat landform in the foreground, with green being the dominant color. The vegetation in the middle ground forms a relatively uniform tree line. Tall Norfolk pine trees protrude beyond the uniform canopy trees, creating more irregularity and making them the prominent vertical features in the viewshed. Buildings behind the tree line are barely visible from this KOP. Site 2 is not visible from this KOP.  *KOP 1: Existing view from Marine Barracks Quick Field toward Site 2 through the housing area off Russell Avenue.*

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	*Description of Existing Views Toward Site 2*
2	The view from KOP 2 is dominated by Russel Avenue, parked vehicles, power poles and transmission lines, and one-story warehouses. The presence of the monkeypod trees lining the roadway softens the view with their dark green color, shade, and natural forms and texture.  *KOP 2: Existing street views of Site 2 and the adjacent Russell Avenue south of Safeguard Street.*

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	***Description of Existing Views Toward Site 2***
3	The historic Hale Alii area is the main view from KOP 3 toward Site 2. The foreground view consists of a smooth, paved gray roadway and a narrow linear band of sidewalk along the road. The manicured lawn creates a bright green, park-like character in the middle ground. Mature monkeypod trees and tall palm trees add to the park-like setting. The historic housing buildings are indistinct in the background behind the trees. Site 2 is not visible from this KOP.  *KOP 3: Existing view from Club Road and Safeguard Street looking southeast toward Site 2 through Hale Alii.*

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	Description of Existing Views Toward Site 2
4	The relatively dense and mature vegetation of various types, heights, and hues of green are the prominent features looking toward Site 2 from KOP 4. Existing structures at Site 2 are not visible from this location.  *KOP 4: Existing view from Hale Alii toward Site 2.*

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	*Description of Existing Views Toward Site 2*
5	The view from KOP 5 is characterized by large flat, smooth, paved surface in the foreground and warehouse structures across the middle ground. The monkeypod trees and palm trees add natural texture and green colors to the otherwise industrial setting.  *KOP 5: Existing view from Paul Hamilton Avenue looking southwest with warehouse buildings at Site 2 in the background.*

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	***Description of Existing Views Toward Site 2***
6	Looking toward Site 2, the view from KOP 6 largely consists of relatively flat, dark blue harbor waters in the foreground. A gray, jagged band of maintenance shops and cranes form the middle ground shipyard view. Portal cranes, the Port Operations Signal Tower, and the exhaust stack at the shipyard power plant are relatively prominent in the background, as the tallest vertical features along the horizon.  *KOP 6: Existing view from USS Missouri Museum looking toward Site 2.*

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	*Description of Existing Views Toward Site 2*
7	Sky and large body of blue harbor waters comprise much of the view from KOP 7, offering this viewshed a blue tone with a flat and smooth texture, which is representative of common weather conditions. The shipyard in the distance forms a narrow dark band in the background. Along this area, portal cranes stand out as they protrude above other features along the horizon. Historic facilities and general massing of other shipyard shop buildings are evident, but details of individual buildings are not distinguishable from this KOP.  *KOP 7: Existing view from USS Arizona Memorial looking toward Site 2.*

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	*Description of Existing Views Toward Site 2*
8	The view from KOP 8 is characterized by flat, gray roadway surfaces and green-hued landscaped areas in both the foreground and middle ground. Field lights are the prominent vertical features in the middle and background. A few warehouse buildings are visible in the background behind the field lights and trees. Site 2 features are not visible from this KOP.  *KOP 8: Existing view from North Road near Makalapa Gate*.

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	*Description of Existing Views Toward Site 2*
9	Sky, hedges, street lights, and building roofs comprise most of the view from KOP 9. The upper portion of barracks are visible behind the hedges and houses. Site 2 features are not visible from this KOP.  *KOP 9: Existing view looking southwest from Hut Avenue.*

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	***Description of Existing Views Toward Site 2***
10	Paul Hamilton Avenue, extending from the foreground to the background, divides the view from KOP 10 into two sides. The north side of the roadway consists of landscaped road shoulder with canopy trees in the foreground and middle ground. The south side is characterized by a large, tall warehouse with no trees lining between the building and the road. The large mass of the building and the lack of green buffer contrasts, in form and texture, with the adjacent areas. This large building blocks part of Site 2 and is the prominent element of the view.  *KOP 10: Existing street view from Paul Hamilton Avenue looking southeast.*

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	Description of Existing Views Toward Site 2
11	The foreground view from KOP 11 is primarily the wide, flat roadway surface of Russel Avenue. A fence and Building 159 are seen in the foreground and middle ground. In the middle ground to background, the roadway is bordered by mature monkeypod trees on both sides. The dark green pattern contrasts with the white/gray surroundings and redirects part of the visual focus from the warehouse to the line of trees.  *KOP 11: Existing view from Russel Avenue looking northwest with Building 159 in the background.*

Table 3.5-2 Views Toward Site 2 from Key Observation Points

KOP #	Description of Existing Views Toward Site 2
12	The view from KOP 12 from this angle includes primarily sky framed by green vegetation. In addition to the large monkeypod trees, other vertical elements (flagpole, street lights, and palm trees), part of a building, and the upper portion of a lava rock wall are seen from this KOP. Site 2 is not visible from this KOP.  *KOP 12: Existing street view from Nimitz Gate looking northwest.*

Table 3.5-3 Views Toward Site 5 from Key Observation Points

KOP #	***Description of Existing Views Toward Site 5***
13	The foreground view from KOP 13 is characterized by a park-like setting with sloped green manicured lawns. The flat, gray, paved parking lot and the tall, white, solid, vertical wall bring contrast in form and color. However, parts of the parking lot boundary lines are irregular and curved, creating a more organic connection with the natural characteristics of its surroundings. In the middle and background, the gray band of Salt Lake Boulevard separates the view into two parts. Residential houses with various colored roofs and scattered canopy trees are seen on the mauka side of the road. On the makai side, the park setting continues with a green ball field and a few light-colored manmade structures at Site 5.  *KOP 13: Existing view looking south from the playground at Connie Chun Aliamanu Neighborhood Park. The orange dashed lines indicate the approximate Site 5 boundary visible from this location. The orange arrow points to Site 5.*

Table 3.5-3 Views Toward Site 5 from Key Observation Points

KOP #	***Description of Existing Views Toward Site 5***
14	The foreground view from KOP 14 is characterized by the wide, gray-colored Salt Lake Boulevard. The silver, curved Quonset hut and street lights are the prominent elements in the foreground, blocking part of the view of Site 5. In the middle ground, some vacant green fields and a few small, light-colored buildings within and behind Site 5 are visible. Pearl City and the silhouette of Waianae Mountain are somewhat visible in the background.  *KOP 14: Existing street view looking northwest toward Site 5 from the sidewalk at the intersection of Salt Lake Boulevard and Maluna Street. The orange dashed lines indicate the approximate Site 5 boundary visible from this location. The orange arrow points to Site 5.*

Table 3.5-3 Views Toward Site 5 from Key Observation Points

KOP #	*Description of Existing Views Toward Site 5*
15	Most of the foreground and middle ground views from KOP 15 are of the residential neighborhood mauka of Site 5, which are characterized by a paved road and sidewalk, utility poles and overhead lines along the road, houses, and vegetation of various types and heights. A small portion of Site 5, which includes a few white buildings and a dark brown dumpster on a vacant gravel lot, is visible from this KOP. Pearl Harbor and Waianae Mountain are visible but indistinct in the far background.  *KOP 15: Existing view looking west from the intersection of Maluna Street and Wanaka Street. The orange arrow points to the storage shed structures at Site 5.*

Key: KOP = Key Observation Point.

3.5.2 Environmental Consequences

The evaluation of visual resources in the context of environmental analysis typically addresses the contrast between visible landscape elements. Collectively, these elements comprise the aesthetic environment, or landscape character. The landscape character is compared to the Proposed Action's visual effects to determine the compatibility or contrast resulting from the buildout and demolition activities associated with the Proposed Action.

Methods to analyze potential impacts would follow the Bureau of Land Management (BLM) Manual H-8410-1 – Visual Resource Inventory (BLM, 1984) and BLM Manual 8431 – Visual Resource Contrast Rating for determining visual resource contrast ratings (BLM, 1986).

The Proposed Action at Site 2 involves constructing structures that are much taller than existing structures near several features of historic significance and within the PHNHL. Photosimulations were created to assist with the analysis of visual impacts to the historic significance of the viewshed. Site 5 lies outside the PHNHL and does not encompass any unique or irreplaceable viewsheds. Site photos from KOPs are used for Site 5 visual impact analysis.

The methodology followed for this analysis, using concepts from BLM, is as follows:

1. Establish representative KOPs that represent common public viewing areas as well as other viewpoints that allow a comprehensive understanding of the existing landscape.
2. Assess the existing landscape from the KOPs identified by evaluating form, line, color, and texture of both natural and human-made elements. Other factors considered when assessing the existing landscape include scale, dominance, and extent of view (enclosed versus panoramic).
3. Prepare photosimulations of the primary project elements of the Proposed Action (Site 2).
4. Perform a contrast rating from each KOP, informed by the photosimulations (Site 2) or site photos (Site 5). The contrast rating evaluates how the form, line, color, and texture of the project components would contrast against the existing landscape. When determining the anticipated level of visual contrast, the following factors are considered:
    a. Viewing distance
    b. Relative size of facilities and activities
5. Review potential actions associated with the Proposed Action for anticipated types of impacts to visual resources from each KOP. The following impact indicators are used to assess the visual impacts:
    a. Level of contrast introduced by project as visible from KOPs assessed through change to form, line, color, and/or texture
    b. Degree of scenic quality impacts, informed by the level of degradation of landscape character and damage/destruction of prominent visual/aesthetic resources because of introduced visual contrast

Short-term project activities that would only occur during construction are considered to have no impacts or minor impacts to visual resources. For permanent facility long-term project operations activities, the level of impact as viewed from each KOP was assessed. The analysis considers the affected area and degree of effects from the long-term components of the Proposed Action. Specifically, level of impact to views experienced from each KOP was determined by assessing the level of contrast (Table 3.5-4) and the degree to which those visual changes would degrade the existing character of the landscape (Table 3.5-5).

Table 3.5-4 Levels of Visual Contrast Defined

Levels of Visual Contrast	***Definition***
None	The element contrast is not visible or perceived.
Weak	The element contrast can be seen but does not attract attention.
Moderate	The element contrast begins to attract attention and begins to dominate the characteristic landscape.
Strong	The element contrast demands attention, will not be overlooked, and is dominant in the landscape.

Source: BLM (1986a).

Table 3.5-5 Degree of Visual Impact

Degree of Visual Impact	***Description***
None	No discernable or measurable visual contrast.
Negligible	Impacts that would not diminish the scenic quality of the landscape.
Minor	Impacts that diminish the scenic quality of the landscape to a minimal degree and are potentially noticeable when viewed from moderately sensitive viewpoints.
Moderate	Impacts that would diminish the scenic quality of the landscape and would be easily noticeable from sensitive viewpoints.
Significant	Impacts resulting from construction disturbances and the long-term presence of new facilities would substantially alter the scenic value of the landscape and would dominate views from sensitive viewpoints.

3.5.2.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and no change would occur to visual resources. Therefore, no impacts would occur with implementation of the No Action Alternative.

3.5.2.2 Proposed Action Alternative

The sites proposed for the Proposed Action include Sites 2 and 5, the corridor along the 46 kV electrical transmission backbone, and adjacent lands where these sites are visible, which define the study area for visual resources analyses.

The Proposed Action Alternative would lead to changes in landscape character mainly at and around Sites 2 and 5. During construction, both Sites 2 and 5 would be fenced around active construction areas. Prior to the construction of the new facilities, Site 2 would require demolition of two large warehouses (Warehouses YA and YB) and a small support facility (Warehouse 244), which are NHRP-listed as contributing resources to the PHNHL District. The current conceptual site plan for Site 2 includes several tall structures, such as:

- **Exhaust Stacks:** Approximately 110 feet tall
- **Engine Hall:** Approximately 50 feet tall
- **Storage Tanks:** Up to 40 feet tall
- **Cooling Radiator Field:** Approximately 25 feet tall
- **Lube Oil Storage Tank Area:** Up to 20 feet tall

Several palm trees along Paul Hamilton Avenue would be removed during construction but the large banyan tree, the canopy trees, and a historic rail line along Russell Avenue would remain undisturbed during proposed construction and operation at Site 2.

At Site 5, the site preparation would include surface vegetation clearing and grubbing, as well as necessary grading. Site 5 is approximately 15 acres in size, and most of this site would be constructed with more than 40 rows of solar PV modules.

The proposed underground 46 kV electrical transmission backbone as part of the IKC projects would be installed using a combination of trenching, horizontal directional drilling, and microtunneling. Once installed, the project components would be located below ground.

3.5.2.2.1 Construction Impacts

For both Sites 2 and 5, active construction activities would be contained within fenced construction areas. The fencing would include screen material to obstruct and minimize views of heavy equipment, stockpile areas, and other facility demolition and construction activities.

Visual contrast at Site 2 from the construction area would vary depending on the phase of construction and viewing locations. The level of visual contrast can range from "none" for viewers at locations where Site 2 is not visible, to "strong" when viewers are close to Site 2 during the phase when large construction equipment are used to construct the buildings and exhaust stacks. However, visual impacts associated with construction equipment and activities would be short-term, occurring only during construction periods. The visual changes from the removal of historic properties and presence of new facilities are discussed in Section 3.5.2.2.2.

The public view of construction activities at Site 5 would mostly be blocked by the fence at street view but may still be visible from localized public vantage points at the Connie Chun Aliamanu Neighborhood Park, along Salt Lake Boulevard, and along Maluna Street. The visual contrast from the ball field/storage yard to a construction site would be moderate to strong for vantage points along Salt Lake Boulevard, and moderate for vantage points at the neighborhood park and on Maluna Street. The construction activities at Site 5 would not obstruct significant mountain and harbor views designated by the Primary Urban Center Development Plan from public vantage points.

The work areas for installation of the underground 46 kV electrical transmission backbone would be in an 11-foot-wide utility trench that would be located in the middle of existing base roads and/or within existing paved or landscaped lots. No visually massive or tall construction equipment is anticipated at these work areas. Therefore, changes in visual quality from construction activities at these work areas would be minimal. The extent of any aesthetic impacts would be localized and temporary (i.e., limited to the duration of construction). No protected resources would be affected.

The other five proposed IKC projects (DLA Relocation; Replace Protective Relays; Replace Live Front Equipment, Hickam; Protective Relay Coordination Study; and Replace Electrical Handholes) would involve the replacement of equipment for existing infrastructure and a desk-based study. These projects would have no effect on visual resources.

3.5.2.2.2 Operational Impacts

Operational impacts would primarily be associated with a change in landscape character from the Proposed Action. Table 3.5-6 (Site 2) and Table 3.5-7 (Site 5) provide a detailed discussion of potential changes at each site, as well as BMPs and mitigation measures where appropriate. Changes to the historic viewsheds within the larger PHNHL District are also described in these tables.

For Site 2, the FRG Plant facilities are visible from KOPs 2, 5, 6, 7, 10, and 11. However, due to the long viewing distance and the presence of other vertical features, only the upper portion of the exhaust stack(s) would be visible from KOPs 6 and 7. Therefore, photosimulations were only analyzed for KOPs 2, 5, 10, and 11 (Photo 3.5-1 through Photo 3.5-6). For KOPs 6 and 7, dashed lines are used to indicate the outline of the FRG Plant facilities (Photo 3.5-3 and Photo 3.5-4). See Appendix D for details and photosimulations for all KOPs.

In general, the visual contrast from the new FRG Plant facilities and structures at Site 2 would not be strong because the new FRG Plant would have the same building massing and scale as the two existing buildings. In addition, keeping the historic rail line and mature shade trees would help maintain the historic landscape character in the area. The exhaust stacks would be painted an appropriate shade of blue to further reduce visual contrast between the exhaust stacks and the surrounding sky.

At Site 5, the solar farm elements contrast with the previous industrial/storage lot in colors, lines, and texture. The dark-colored, smooth, non-reflective solar panels would form linear rows across most of Site 5, replacing the irregularly placed, light-colored storage buildings and dark brown stockpiles. Depending on the viewing distance and angle, the texture of the solar farm may be uniform or angular when viewing from nearby areas due to details seen of the individual panels; or relatively smooth when viewing from a distance from higher elevations, where the rows of panels start to blend together. As discussed further in Table 3.5-7, the panels will be constructed from materials that reflect as little as two percent of incoming sunlight, about the same as water and less than soil or wood shingles (DOER, MassDEP, and MassCEC, 2015). Therefore, the solar panel installation is not expected to cause adverse impact from glare.

Photo 3.5-1. Current view (top) and photosimulation at KOP 2 (bottom), photosimulation showing potential view of Site 2 west corner from Russell Avenue.

Photo 3.5-2. Current view (top) and photosimulation at KOP 5 (bottom), photosimulation showing potential view of Site 2 east corner from Paul Hamilton Avenue.

Photo 3.5-3. Current view (top) and photosimulation at KOP 6 (bottom), USS Missouri Museum. The outline of the power plant facility is shown in dashed lines. The top of one exhaust stack is visible from this KOP.

Photo 3.5-4. Current view (top) and photosimulation at KOP 7 (bottom), USS Arizona Memorial. The outline of the power plant facility is shown in dashed lines. Tops of the exhaust stacks are visible from this KOP.

Photo 3.5-5. Current view (top) and photosimulation at KOP 10 (bottom), photosimulation showing potential view of Site 2 north corner from Paul Hamilton Avenue near Club Road.

Photo 3.5-6. Current view (top) and photosimulation at KOP 11 (bottom), photosimulation showing potential view of Site 2 south corner from Russell Avenue near Safeguard Street.

Table 3.5-6 Impacts to Views Toward Site 2 from KOPs

KOP	*Level of Visual Contrast*	*Visible Degradation of Landscape Character*	*Visible Damage or Destruction of Prominent Visual Resources*
1	None	Site 2 features are not visible from KOP 1. There would be no discernible degradation to landscape character.	The permanent removal of historic facilities would not be a prominent visual change from this KOP. There would be no visible damage or destruction of prominent visual resources.
2	Weak	The visual contrast would be weak because the historic treescape would be kept in place, which maintains some of the historic characters and screens the visibility of the new Site 2 features, including most of the exhaust stacks (Photo 3.5-1). The overall landscape character of Site 2 would remain light industrial, so the scenic quality of the viewshed would not be altered. However, the historic value of the viewshed would be altered. The absence of historic facilities and the construction of new facilities would be visible and noticeable from this KOP because of the short viewing distance. Therefore, the degree of visual impact would be moderate.	The historic value of the viewshed within the larger PHNHL District would be altered as the result of the demolition of historic properties and the construction of new facilities.
3	None	Site 2 features are not visible from KOP 3. There would be no discernible degradation to landscape character.	The permanent removal of historic facilities would not be a prominent visual change from this KOP. There would be no visible damage or destruction of prominent visual resources.
4	None	Site 2 features are not visible from KOP 4. There would be no discernible degradation to landscape character.	The permanent removal of historic facilities would not be a prominent visual change from this KOP. There would be no visible damage or destruction of prominent visual resources.

Table 3.5-6 Impacts to Views Toward Site 2 from KOPs

KOP	*Level of Visual Contrast*	*Visible Degradation of Landscape Character*	*Visible Damage or Destruction of Prominent Visual Resources*
5	Moderate	Comparing to the demolished warehouses, the portion of the new facility that is visible from this KOP has a larger mass, including the tall exhaust stacks in the foreground. These changes would begin to attract attention, leading to a moderate level of visual contrast. The overall landscape character of Site 2 would remain light industrial, so the scenic quality of the viewshed would not be altered. However, the historic value of the viewshed would be altered. The monkeypod trees framing the view from the KOP redirects part of the visual focus from the new facilities but the absence of historic facilities and the construction of the new facilities would be visible and noticeable from this KOP because of the short viewing distance (Photo 3.5-2). Therefore, the degree of visual impact would be moderate.	The historic value of the viewshed within the larger PHNHL District would be altered as the result of the demolition of historic properties and the construction of new facilities.
6	None	From this KOP, only the very top of one stack would be visible. However, more prominent vertical features are present in the view, such as the 161-foot-tall Port Ops Signal Tower located approximately 1,500 feet southeast, the exhaust stack at the shipyard power plant located 2,000 feet southeast, and the portal cranes located more than 3,000 feet southeast along the shipyard shoreline. Because of the long viewing distance and the presence of other prominent vertical features, the visual contrast from Site 2 facilities would be indetectable (Photo 3.5-3). There would be no discernible degradation to landscape character.	The permanent removal of historic facilities would not be a prominent visual change from this KOP. There would be no visible damage or destruction of prominent visual resources.
7	None	Similar to KOP 6, only the very top of the exhaust stacks are visible from KOP 7. Because of the long viewing distance and the presence of many more prominent vertical features in the view, the visual contrast would be indetectable (Photo 3.5-4). There would be no discernible degradation to landscape character.	The permanent removal of historic facilities would not be a prominent visual change from this KOP. There would be no visible damage or destruction of prominent visual resources.
8	None	Site 2 features are not visible from KOP 8. There would be no discernible degradation to landscape character.	The permanent removal of historic facilities would not be a prominent visual change from this KOP. There would be no visible damage or destruction of prominent visual resources.

Table 3.5-6 Impacts to Views Toward Site 2 from KOPs

KOP	*Level of Visual Contrast*	*Visible Degradation of Landscape Character*	*Visible Damage or Destruction of Prominent Visual Resources*
9	None	Site 2 features are not visible from KOP 9. There would be no discernible degradation to landscape character.	The permanent removal of historic facilities would not be a prominent visual change from this KOP. There would be no visible damage or destruction of prominent visual resources.
10	Weak	One exhaust stack would be visible from this KOP in the middle ground, introducing a light-colored, tall, rectangular form to the landscape. Other parts of Site 2 features are visually screened by the parameter fencing and the historic treescape along Paul Hamilton Avenue. Building 39 in the foreground would remain as the prominent visual feature in the view because the new exhaust stack would appear relatively small in mass and scale. Therefore, the visual contrast would be weak (Photo 3.5-5). The landscape character of Site 2 would remain light industrial, so the scenic quality of the viewshed would not be altered. However, the historic value of the viewshed would be altered. The absence of historic facilities and the construction of the new facilities would be visible and noticeable from this KOP because of the short viewing distance. Therefore, the degree of visual impact would be moderate.	The historic value of the viewshed within the larger PHNHL District would be altered as the result of the demolition of historic properties and the construction of new facilities.
11	Moderate	The new Site 2 facility would introduce a large, light-colored structure with tall exhaust stacks protruding into the sky (Photo 3.5-6). Because of its height and large mass, the new facility would begin to attract attention, even though the monkeypod trees would redirect some of the visual focus away from the new facility. The visual contrast from the new facilities would be moderate. The overall landscape character of Site 2 would remain light industrial, so the scenic quality of the viewshed would not be altered. However, the historic value of the viewshed would be altered. The absence of historic facilities and the construction of the new facilities would be visible and noticeable from this KOP because of the short viewing distance. Therefore, the degree of visual impact would be moderate.	The historic value of the viewshed within the larger PHNHL District would be altered as the result of the demolition of historic properties and the construction of new facilities.
12	None	Site 2 features are not visible from KOP 12. There would be no discernible degradation to landscape character.	The permanent removal of historic facilities would not be a prominent visual change from this KOP. There would be no visible damage or destruction of prominent visual resources.

Table 3.5-7 Impacts to Views Toward Site 5 from KOPs

KOP	***Level of Visual Contrast***	***Visible Degradation of Landscape Character***	***Visible Damage or Destruction of Prominent Visual Resources***
13	Moderate	The solar farm would introduce rows of smooth, dark-colored, and uniformly sized and placed PV panels. From this KOP, these panels form a dark blue/gray, linear or grid pattern, contrasting in color and texture with the green, natural, park-like surroundings. The dark patches of solar panels would be noticeable for the community park users. However, because of the viewing distance and angle, a large portion of Site 5 would be obstructed by trees in the foreground. Therefore, the visual contrast and potential impacts would be moderate.	There are no significant mountain and harbor views designated by PUCDP from this KOP. One common concern about solar panel installation is glare from the modules. However, solar panels are designed to absorb solar energy rather than reflect it. Modern solar panels constructed of dark-colored materials and covered with anti-reflective coatings would be used (see BMP VISUAL-1 in Table 2.7-1). These materials reflect as little as two percent of incoming sunlight, about the same as water and less than soil or wood shingles (DOER, MassDEP, and MassCEC, 2015). Therefore, the installation of the solar panels is not expected to cause adverse impact from glare.
14	Moderate	The site would change from an industrial lot with storage buildings and open, graveled areas to a solar farm. Viewers (bicyclists, joggers, and pedestrians along Salt Lake Boulevard) would experience the visual changes in color, form, and texture when in close proximity to the site. As a result, these changes would attract the viewers' attention. However, given the current character of the site when compared with the site following construction of the Proposed Action, the solar farm would not dominate the entire landscape characters for viewers. Therefore, the visual contrast is expected to be moderate from this KOP. The current industrial nature of the site (with large high voltage poles and lines) would not change substantively with the addition of the non-glare solar panels and BESS. The mountain views would not be obstructed by the solar farm. The visual elements change from storage buildings and structures to solar panels would be easily noticeable. Therefore, the potential visual impacts would be moderate.	The solar farm would not obstruct any significant mountain and harbor views designated by PUCDP. The installation of the solar panels is not expected to cause adverse impact from glare.

KOP	Level of Visual Contrast	Visible Degradation of Landscape Character	Visible Damage or Destruction of Prominent Visual Resources
15	Weak	A few rows of PV panels would be visible from this KOP, adding uniform, narrow strips of smooth, solid surfaces to the Site 5 view. The landscape characters of this part of Site 5 would change from a few storage buildings on a semi-vacant lot to a PV solar farm. Due to the long viewing distance and the small portion of Site 5 that is visible from this KOP, the visual contrast is expected to be weak. The solar farm would not obstruct any significant mountain and harbor views. The potential visual impacts would be considered minor from this KOP.	The viewshed of the Waianae Mountain and Pearl Harbor would not be obstructed by the solar farm. The installation of the solar panels is not expected to cause adverse impact from glare.

Key: KOP = Key Observation Point; PHNHL = Pearl Harbor National Historic Landmark; PUCDP = Primary Urban Center Development Plan; PV = photovoltaic.

Facility lighting for worker activity and security would add to existing lighting at Sites 2 and 5. The increased lighting at Site 2 is expected to include sources at the top of tall structures. This lighting would be visible from public locations. This change would not substantially alter views or view quality due to the broad distribution of light sources within JBPHH. Lighting at Site 5 would be more limited and lower in profile than lighting at Site 2. Views from public locations (Salt Lake Boulevard and nearby residential housing along Namur Road) would not be obstructed or substantially degraded by existing light sources within JBPHH. The project would follow the Dark Skies Instruction and follow best practices in coordination with USFWS (see Section 3.4 for a related discussion).

The electrical transmission backbone would be underground during the operational phase and, therefore, have no visual impacts.

In summary, with the implementation of BMPs and mitigation measures identified in Tables 2.7-1 and Table 3.8-2, the Proposed Action Alternative would result in less than significant impacts to visual resources during the construction and operation phases.

3.5.2.2.3 Impacts of Climate Change on Visual Resources

Trends associated with climate change identified in Table 3.2-7 could alter the visual character of JBPHH. Visual changes caused by increased frequency and/or intensity of extreme weather events and rising sea levels could occur that may alter the historic landscape. The Proposed Action is not expected to interact with these new trends in a manner that would produce additional adverse effects.

3.6 Noise

This discussion of noise includes the types or sources of noise and the associated sensitive receptors in the human environment. Noise in relation to biological resources and wildlife species is discussed in Section 3.4. A description of the regulatory setting for noise is included in Appendix H.

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water, and are sensed by the human ear. Sound is all around us. The perception and evaluation of sound involves three basic physical characteristics:

- **Intensity:** The acoustic energy, which is expressed in terms of sound pressure, in decibels (dB)
- **Frequency:** The number of cycles per second the air vibrates, in hertz (Hz)
- **Duration:** The length of time the sound can be detected

Noise is defined as unwanted or annoying sound that interferes with or disrupts normal human activities. Although continuous and extended exposure to high noise levels (e.g., through occupational exposure) can cause hearing loss, the principal human response to noise is annoyance. The response of different individuals to similar noise events is diverse and is influenced by the type of noise, perceived importance of the noise, its appropriateness in the setting, time of day, and type of activity during which the noise occurs, and sensitivity of the individual.

3.6.1 Basics of Sound and A-Weighted Sound Level

The loudest sounds that can be comfortably heard by the human ear have intensities a trillion times higher than those of sounds barely heard. Because of this vast range, it is unwieldy to use a linear scale to represent the intensity of sound. As a result, a logarithmic unit known as dB is used to represent the intensity of a sound, also referred to as the sound level. A sound level of 0 dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels between 130 and 140 dB are felt as pain (Berglund and Lindvall, 1995).

All sounds have a spectral content, which means their magnitude or level changes with frequency, where frequency is measured in cycles per second or Hz. To mimic the human ear's non-linear sensitivity and perception of different frequencies of sound, the spectral content is weighted. For example, environmental noise measurements are usually on an A-weighted scale, which places less weight on very low and very high frequencies to replicate human hearing sensitivity. The general range of human hearing is from 20 to 20,000 Hz; humans hear best in the range of 1,000 to 4,000 Hz. A-weighting is a frequency-dependent adjustment of sound level used to approximate the natural range and sensitivity of the human auditory system. Table 3.6-1 (Cowan, 1994) provides a comparison of how the human ear perceives changes in loudness on the logarithmic scale.

Table 3.6-1 Subjective Responses to Changes in A-Weighted Decibels

Change	***Change in Perceived Loudness in Sound Intensity***
3 dB	Barely perceptible
5 dB	Quite noticeable
10 dB	Twice or half as loud
20 dB	Fourfold change in loudness

Key: dB = decibel.
Source: Cowan (1994).

Figure 3.6-1 (Cowan, 1994) provides a chart of A-weighted sound levels from typical noise sources. Some noise sources (e.g., air conditioner, vacuum cleaner) are continuous sounds that maintain a constant sound level for some period of time. Other sources (e.g., automobile, heavy truck) are the maximum sound produced during an event like a vehicle pass-by. Other sounds (e.g., urban daytime, urban nighttime) are averages taken over extended periods of time. A variety of noise metrics have been developed to describe noise over different time periods, discussed as follows.

3.6.2 Noise Metrics and Modeling

A metric is a system for measuring or quantifying a particular characteristic of a subject. Because noise is a complex physical phenomenon, different noise metrics help to quantify the noise levels and environment so they can be compared in a standardized way.

The noise metrics used in this EA are described in detail in Appendix B. While the day-night average sound level noise metric is the most commonly used for aircraft noise and is the focus of other Navy installation projects, this EA focuses on the equivalent sound level metric that is typically used to assess operational noise from stationary sources, such as the facilities outlined in the Proposed Action.

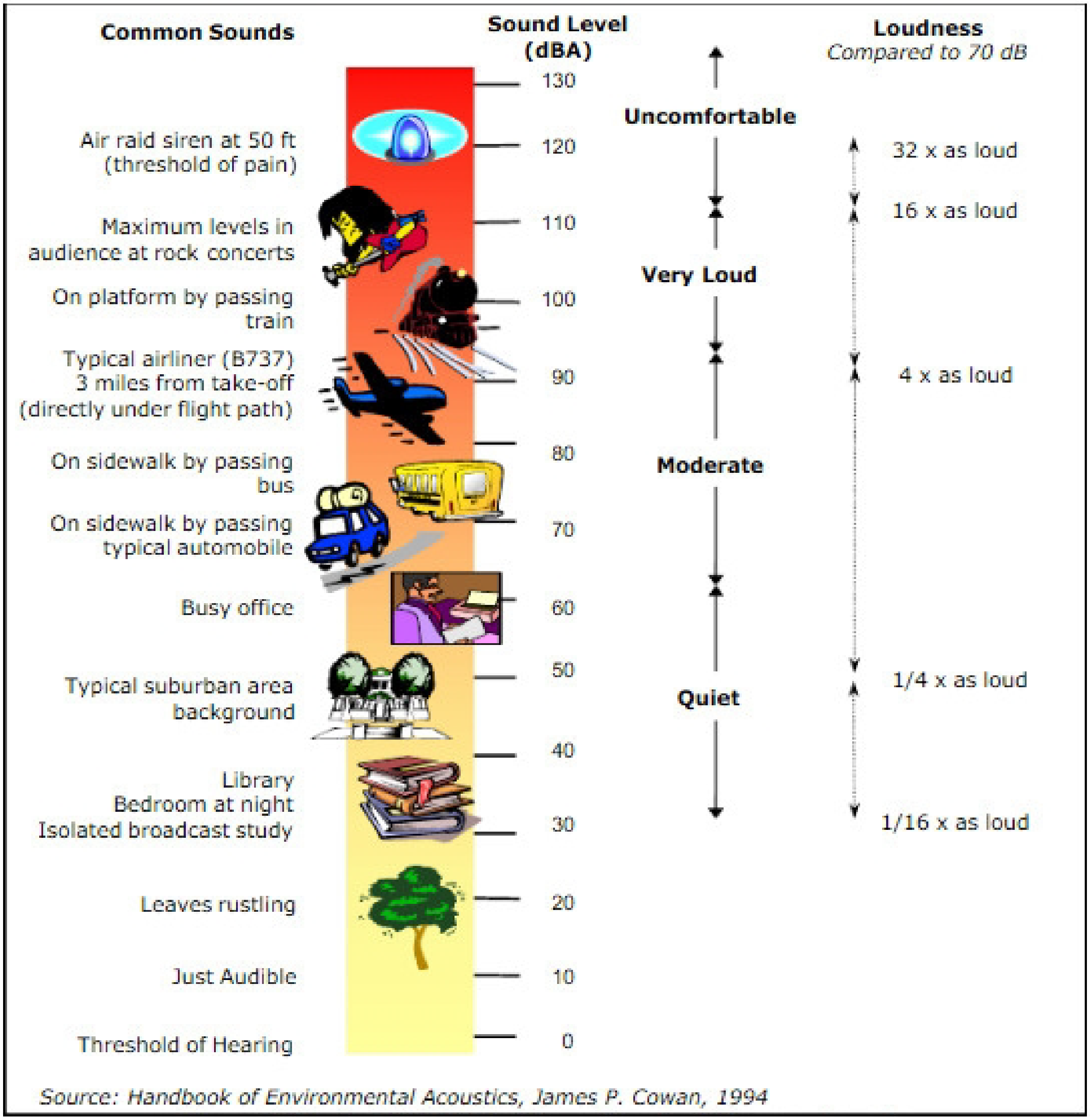

Figure 3.6-1 A-Weighted Sound Levels from Typical Sources

3.6.3 Affected Environment

Existing noise levels in the vicinity of the project area are typical of those normally associated with nearby land uses and activities and the overall level of development in the area. The primary noise sources in the area are road vehicle traffic, aircraft, and ship operations at JBPHH, aircraft operations at Daniel K. Inouye International Airport, maintenance equipment, and construction equipment.

The nearest sensitive receptors at the western side of the project area that encompasses the proposed FRG Plant facility (Site 2) are military housing along Russell Avenue and Hale Alii Avenue, as well as residential housing at Hickam Housing located along Porter Avenue. These receptors are located between 180 feet and 500 feet from the FRG Plant site boundary. The ambient noise levels monitored in this area north of the site during November 3–9, 2022, are relatively low with average hourly equivalent sound levels of 54 decibels (A-weighted scale) (dBA) during daytime hours (7 a.m.–10 p.m.) and 45 dBA during nighttime hours (10 p.m.–7 a.m.). The nearest sensitive receptors, housing areas, at the eastern side of the project area that encompasses the PV system and the BESS facility (Site 5) are located along Salt Lake Boulevard and Namur Road between 60 and 160 feet from the BESS site boundary. The closest receptors to the site consist of military housing along Namur Road. The ambient noise levels monitored in this area between October 27 and November 3, 2022, along Salt Lake Boulevard show average hourly equivalent sound levels of 56 dBA during daytime hours and 52 dBA during nighttime hours.

3.6.4 Environmental Consequences

The analysis of potential noise impacts includes estimating likely noise levels from the Proposed Action and determining potential effects to sensitive receptor sites.

3.6.4.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and no change would occur to baseline noise levels. Therefore, no impacts would occur under the No Action Alternative.

3.6.4.2 Proposed Action Alternative

A noise impact study was conducted at both Sites 2 and 5 to assess potential effects on residential receptors located adjacent to each site (Appendix B).

3.6.4.2.1 Construction Impacts

The construction activities associated with Site 2 of the Proposed Action Alternative would last slightly less than three years, while the construction of Site 5 would last approximately 9 months. Construction of the electrical transmission backbone would occur over two years as construction moves along the transmission line with short-duration noise exposure to adjacent receptors. The electrical transmission backbone and Defense Logistics Agency Relocation IKC projects would have varying construction durations. The other four proposed IKC projects (Replace Protective Relays; Replace Live Front Equipment, Hickam; Protective Relay Coordination Study; and Replace Electrical Handholes) would involve replacement of equipment for existing infrastructure and a desk-based study. These projects would have negligible noise impacts.

Construction activity and associated noise levels would vary at each location as the work progresses. Construction would result in short-term, intermittent noise impacts from the operation of heavy equipment, power and hand tools, and construction vehicles throughout the project area. Heavy equipment operation would occur sporadically throughout daytime hours. No construction is proposed at night. Noise would also be generated by trucks delivering materials to the construction site and by construction worker vehicles. The temporary construction equipment noise levels at the closest residential housing are anticipated to be in a range of 56 to 77 dBA around Site 2 and 65 to 86 dBA around Site 5. The loudest noise would be generated during pile driving activities. Construction noise level increases over the existing ambient noise environment, as analyzed and detailed in Appendix B, range from 2–33 dBA depending on the equipment source type and distance to the construction location. The loud and intrusive construction noise would occur similarly to typical construction projects in the neighborhood and to existing industrial noise sources in the area.

Construction noise at Site 2 is not likely to be audible to residents outside of JBPHH because of the distances between the construction noise sources and receptors and because of relatively high background noise levels where off-site (public) receptors exist. Construction noise at Site 5 would be temporary and shorter in duration, only occurring during the 9-month duration of construction at the site.

Short-term, temporary adverse noise impacts are anticipated during construction. Mufflers would be used on construction equipment and vehicles to minimize noise impacts during these activities. When pile driving occurs with loud, impulsive noise, using a vibratory or hydraulic driver with shrouds would be considered to mitigate the pile driving noise. Mitigation includes preparation of a noise mitigation and management plan by the construction contractor to address noise to communities adjacent to each site and to commit to these mitigation strategies (see MM NOISE-1 in Table 3.8-2). With the implementation of this plan, the effects of construction noise on surrounding sensitive receptors would be less than significant.

3.6.4.2.2 Operational Impacts

For long-term facility operations at Sites 2 and 5, the HAR 11-46 criteria for Class A zoning districts (i.e., residential, public, and open space) of 55 dBA during the daytime and 45 dBA during the nighttime have been used as the design criteria for the Proposed Action Alternative. Noise modeling predictions indicate potential noise exceedances that range from 3 to 16 dBA above the design criteria at Site 2 and 1 to 14 dBA at Site 5, for the receptors immediately adjacent to each site. At Site 2, noise sources would include the cooling radiator field for the FRG Plant facility and components associated with the BESS storage units. At Site 5, the only significant noise source would be the BESS unit. The preliminary predicted noise levels from facility operations at each representative receptor as compared to the daytime and nighttime criteria are detailed in Appendix B. Appendix B also includes detailed information related to representative receptor distances, source noise levels, modeling methodology, ambient noise monitoring results, and discussion of potential measures to mitigate operational noise to help meet the noise criteria.

The HDOH regulates excessive noise sources, including equipment related to operational noise and construction activities under Chapter 342F, Hawaii Revised Statutes (Noise Pollution) and HAR 11-46 (Community Noise Control). As a federal agency, the Navy considers HDOH noise provisions as local best practices and would exert best efforts to comply with applicable state noise regulations. The commercial developer has committed to meeting the HAR 11-46 criteria in the design for each facility under the Proposed Action. Proposed mitigation measures to reduce operational noise include noise barriers for the BESS units, low-noise fans, and other manufacturer-provided mitigation solutions (see MM NOISE-2 in Table 3.8-2 and Appendix B for more detail). With these measures in place, the effects of operational noise on the surrounding sensitive receptors would be less than significant.

3.6.4.2.3 Impacts of Climate Change on Noise

Trends associated with climate change identified in Table 3.2-7 would have no causal relationship to noise. The Proposed Action is not expected to interact with these trends in a manner that would produce additional adverse effects.

3.7 Transportation

This section addresses the existing transportation facilities and conditions in the project area including those associated with vehicles, pedestrians, bicycles, and transit within and serving relevant portions of JBPHH, and identifies potential construction and operational phase impacts of the No Action and Proposed Action Alternative. A description of the regulatory setting for transportation is included in Appendix H.

3.7.1 Affected Environment

3.7.1.1 Roadways

The local roadway network is presented in Figure 2.5-1 and Figure 2.5-3.

Site 2 is situated on JBPHH and is bounded by Russell Avenue, Paul Hamilton Avenue, Cimarron Street, and Safeguard Street/Central Avenue. These roadways are located within JBPHH and are potential paths to the shipyard and dry dock area on the base.

Site 5 is located off the JBPHH and is bounded by Salt Lake Boulevard and Namur Road. Salt Lake Boulevard is an arterial roadway and generally runs north-south, paralleling Interstate Highway H-1 (H-1).

Salt Lake Boulevard is a 4-lane, median-divided roadway with curb and gutter, a bicycle lane, and on-street parking on the north portion of the road. The south side has a parking restriction and is signed as a bike route. The posted speed limit in the direct vicinity of proposed Site 5 is 25 miles per hour (mph). The estimated average annual daily traffic along Salt Lake Boulevard is 23,400 based on HDOT 2019 traffic count station data (HDOT, 2019).

Namur Road is a collector road that generally runs east-west and intersects with Salt Lake Boulevard. Near Site 5, it is a 2-lane, undivided roadway with curb and gutters along both sides of the road. A detached sidewalk is present on the south side of the road. The posted speed limit is 25 mph. The intersection with Salt Lake Boulevard and Namur Road/Maluna Street is a four-legged, signalized intersection.

Other roads in the project area include North Road, Russell Avenue, Central Avenue, Safeguard Street, Porter Avenue, South Avenue, 18th Street, Fox Boulevard, and Vickers Avenue.

In general, the intersections around the area of greatest impact are stop-controlled (unsignalized). The Nimitz Highway and North Road/South Avenue intersection serves the Nimitz Gate, which is the main gate for JBPHH. Photo 3.7-1 presents the regional and local roadway network. Key features of the affected roadways are summarized in Table 3.7-1.

Table 3.7-1 Internal Roadway Description

Roadway	Description
Russell Avenue	4-lane, undivided roadway between South and Central Avenues, 2-lane, undivided beyond; sidewalks on portions of the road along with paved shoulders and parking stalls.
Paul Hamilton Avenue	2-lane, undivided roadway; sidewalks on portions of the road with paved shoulders and parking stalls.
Cimarron Street	2-lane, undivided roadway; paved shoulders appear to be present along both sides of the road. Connects Russell Avenue and Paul Hamilton Avenue.
Pearl Harbor Boulevard/Club Road	4-lane, undivided roadway as Pearl Harbor Boulevard that transitions to a 3-lane roadway, with 1 lane in the westbound direction and 2 lanes in the eastbound direction; sidewalks along both sides of Pearl Harbor Boulevard and a sidewalk along the south side of Club Road, with intermittent sidewalk along the north side of Club Road; several midblock crosswalks along Pearl Harbor Boulevard.
Safeguard Street	2-lane, undivided roadway; sidewalks scattered on both sides of the road; mid-block crosswalks signed with rectangular rapid-flashing beacons (RRFBs).
Central Avenue	4-lane, undivided roadway; sidewalks and paved asphalt shoulders along both sides; crosswalks are present at intersections along with mid-block crosswalks with RRFBs and pedestrian warning signs.
North Road	4-lane, undivided roadway; sidewalks are generally provided on both sides of the road, but sections have paved asphalt shoulders or a combination of the two. Crosswalks are supported with RRFBs. See Figure 2.5-2.
Porter Avenue	2-lane, undivided roadway; sidewalk along the south side of the road with sections of sidewalk on the north side.
South Avenue	4-lane, undivided roadway; to Russell Avenue, 2-lane, undivided beyond. During the morning peak period, South Avenue is contra-flowed between Paul Hamilton Avenue and Nimitz Gate to provide additional lanes toward the shipyard. Sidewalks are generally present on both sides of the road and a multi-purpose path is present on the east side of the road. Pedestrian crosswalks are supported by RRFBs.
18th Street	2-lane, undivided roadway in a residential area of the base; sidewalks or a paved area for pedestrian use appear to be present along both sides of the road.
Fox Boulevard	2-lane, undivided roadway from 19th Way to 18th Street; 4-lane, divided from 18th Street to Mills Boulevard; sidewalk on both sides of road; crosswalks at several intersections.
Vickers Avenue	2-lane, generally undivided roadway; appears to have sidewalks along both sides of the road. Crosswalks located at the intersections.

Note: Observations of existing conditions are from site visits in 2020.
Key: RRFB = rectangular rapid-flashing beacon.

The Nimitz Highway and North Road/South Avenue intersection is located immediately north and west of the Nimitz Gate (Photo 3.7-1). The Nimitz Gate has four entry lanes, which transition beyond the Entry Control Facility to two channelized right-turn lanes, and two left turn lanes. North Road has a through lane and a left-turn lane. South Avenue has a two–-lane approach, which becomes a through-right lane and a right-turn lane. The right-turn lanes open into three right-turn lanes, which are channelized, that vehicles use to exit JBPHH. A striped crosswalk crossing Nimitz Highway is present just inside the JBPHH fence line.

Photo 3.7-1. RRFBs along North Road.

Restrictions are in place during the morning peak period to allow for more efficient entry onto JBPHH. Traffic on North Road is routed to Ticonderoga Street to bypass the intersection. Due to the reroute of traffic during the morning peak, vehicles on North Road cannot exit at the Nimitz Gate. South Avenue is contra-flowed such that three lanes are inbound toward the shipyard and one lane is outbound from the shipyard area. South Avenue through traffic cannot cross the intersection and must exit JBPHH. This configuration allows vehicles entering through the Nimitz Gate a free-flow movement to enter the roadway network of the base with limited friction from conflicting movements. This configuration is not used during the p.m. peak period.

Traffic volume data was collected during the PHNSY dry dock study, as part of a Shipyard Infrastructure Optimization Program project, which included the intersection with Nimitz Highway and North Road/South Avenue (DON, 2022d). The a.m. and p.m. peak hour data from this study were used to determine the existing operations for the year 2023 and then developed further for the year 2026 to determine the impacts of the additional workers during construction to the transportation network.

Using the HDOT traffic station volume data from 2012 and 2019 (HDOT, 2012; 2019), a growth rate of 2.5 percent was calculated from the average annual daily traffic. This growth rate was used to grow the traffic data from the existing year 2020 data to the year 2023, and then again from the year 2023 to year 2026 to compare the results of the analysis. The traffic count station is located south of the Nimitz Gate and near Center Drive. Figure 3.7-1 depicts a sketch based on HDOT's traffic count data that shows the location of the count station.

As previously described, Nimitz Highway and the North Road/South Avenue intersection are located just beyond the Nimitz Gate. Due to the intersection's location directly adjacent to an Entry Control Facility (ECF), the lane restrictions during the a.m. peak period essentially allow a free-flow movement for entering traffic and, due to the lane configuration of the intersection, the unsignalized intersection capacity methods do not allow a typical analysis of the intersection. The intersection was instead analyzed as a signalized intersection to best replicate field conditions and to account for the previously described restrictions. A short cycle length was used to attempt to replicate arrivals onto JBPHH once clear of the ECF. The timings were adjusted to calibrate the model to replicate queues measured in the field from previous site visits.

The intersection of Nimitz Highway at North Road/South Avenue was analyzed using the analytical methods described in the *Highway Capacity Manual, 6th Edition* and implemented through the Synchro/Sim Traffic software (TRB, 2016).

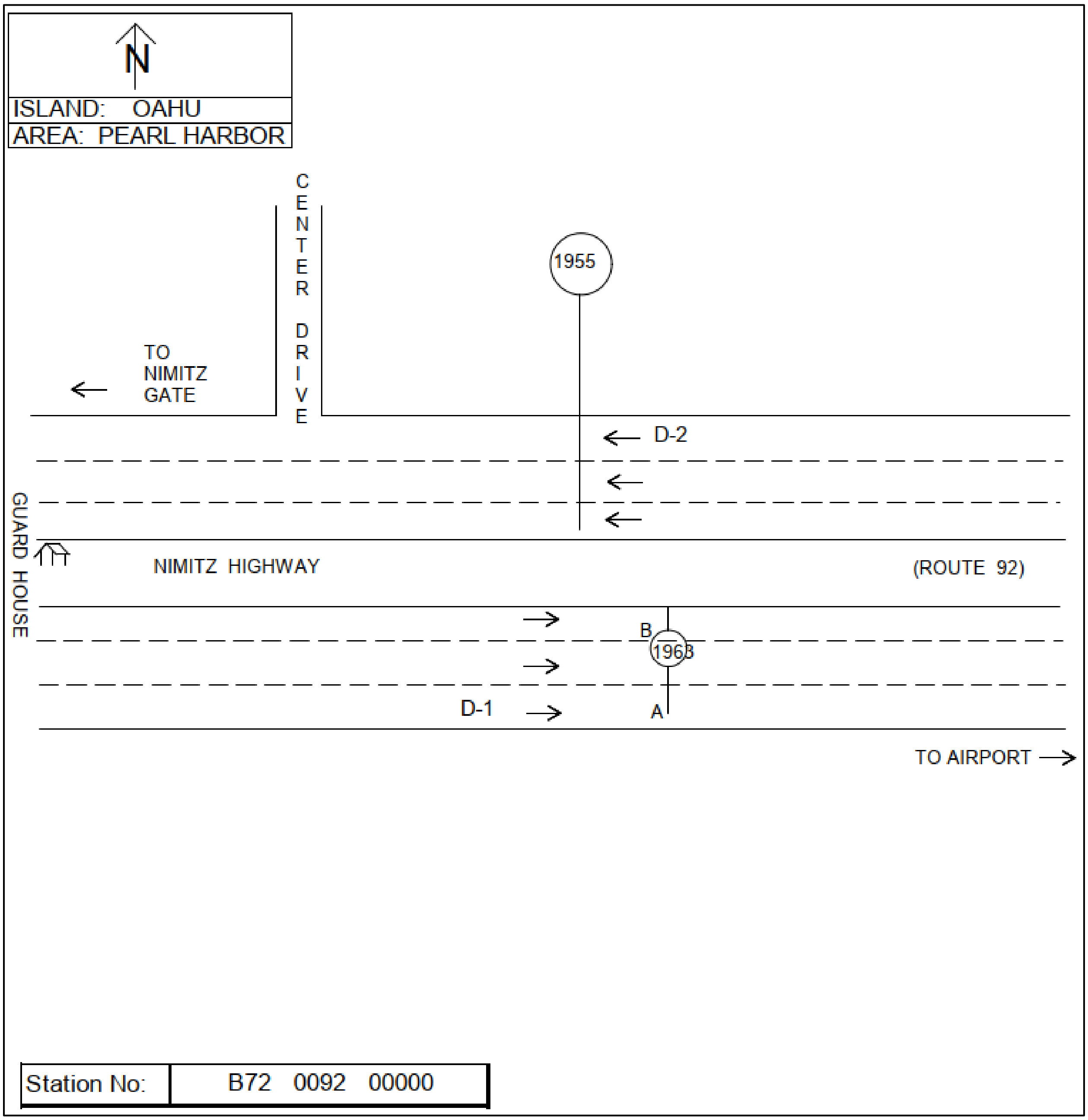

Figure 3.7-1 DOT Traffic Count Station Location

Source: HDOT Highways Traffic Station Maps 2015.

3.7.1.2 Pedestrian Facilities

In general, the roadways internal to JBPHH have sidewalks or paved shoulders and crosswalks that pedestrians can use while traveling the area.

A review of Google Earth satellite imagery shows that around the perimeter of Site 2, the intersections of Russell Avenue and Safeguard Street/Central Avenue and Paul Hamilton Avenue and Safeguard Street appear to have marked crosswalks across all four approaches of the intersection. The Russell Avenue at Cimarron Street and Paul Hamilton Avenue at Cimarron Street intersections appear to have a marked crosswalk to the west of Cimarron Street. Between Safeguard Street and Cimarron Street, Paul Hamilton Avenue has several mid-block crosswalks.

Salt Lake Boulevard has a concrete sidewalk along both sides of the road, though obstructions (light posts, fire hydrants, a traffic signal cabinet, mast arm and signal pedestal poles, and mailboxes) infringe upon the sidewalk in the vicinity of Site 5.

Namur Road has a sidewalk along the south side of the road. The Salt Lake Boulevard and Namur Road/Maluna Street intersection has marked crosswalks across the Namur Road, Maluna Street, and the southbound Salt Lake Boulevard approaches. Namur Road has a few crosswalks at the unsignalized intersections between Salt Lake Boulevard and Radford Drive.

3.7.1.3 Bicycle Facilities

Bicyclists traveling in JBPHH generally share the road with automobiles and other vehicles for most of the roadways. Many of these roads have a posted speed limit of 25 mph, which makes it more conducive for bicycles to share the road with automobiles.

Bicyclists traveling along Salt Lake Boulevard can use the existing bicycle lane on the north side of the road. The *Oahu Bike Plan 2019 Update* designates this section as an existing climbing bicycle lane, which provides separation between bicycles and other vehicles for the uphill section of the roadway while bicycles share the road for the downhill section (CCH, 2019). Currently, no bicycle-specific facility exists along Namur Road. Bicyclists share the road or sidewalk facilities with others.

3.7.1.4 Transit Options

TheBus is the public transportation bus service in Oahu. TheBus routes that service the areas include Route 9 (Kaimuki – Pearl Harbor), which provides service between the Kaimuki area to the JBPHH Nimitz Gate. Several variations of the Route 9 service are allowed to enter JBPHH and provide service to specific areas. These routes operate primarily during the morning and afternoon commuter periods from approximately 6:00 a.m. to 9:00 a.m. and 3:30 p.m. to 7:30 p.m., respectively.

The primary public transit options within the base include the municipal bus service (TheBus) and the Navy Exchange (NEX) shuttle.

Various Pearl Harbor (PH) express routes to JBPHH (Routes PH1, PH2, PH3, PH4, PH6, and PH7) travel to the installation from various areas on Oahu during the morning and afternoon peak periods. All routes enter the base from the Halawa Gate and exit at the O'Malley Gate.

Table 3.7-2 details the transit service for TheBus routes that service JBPHH.

Table 3.7-2 Bus Routes that Service JBPHH

Route	*Frequency*	*Span*
PH1 (Waianae Coast to Pearl Harbor Express)	2 buses per day	1 bus in a.m. peak 1 bus in p.m. peak
PH2 (Mililani Town – Pearl Harbor Express)	2 buses per day	1 bus in a.m. peak 1 bus in p.m. peak
PH3 (Wahiawa Heights – Pearl Harbor Express)	2 buses per day	1 bus in a.m. peak 1 bus in p.m. peak
PH4 (Kailua – Kahaluu – Pearl Harbor Express)	2 buses per day	1 bus in a.m. peak 1 bus in p.m. peak
PH6 (Hawaii Kai- Pearl Harbor Express)	2 buses per day	1 bus in a.m. peak 1 bus in p.m. peak
PH7 (Ewa Beach – Pearl Harbor Express)	2 buses per day	1 bus in a.m. peak 1 bus in p.m. peak
Route 9 (Kaimuki – Pearl Harbor) (Only buses that provide service into JBPHH discussed; others stop at Nimitz Gate)	1 bus per 30 minutes	3 buses to Shipyard in a.m. peak 3 buses to Shipyard in p.m. peak

Key: JBPHH = Joint Base Pearl Harbor-Hickam.

All express routes that travel to JBPHH generally operate between 4:30 a.m. to 6:00 a.m. during the morning peak period and between 3:00 p.m. to 5:00 p.m. during the afternoon peak period.

The NEX shuttle provides service between the JBPHH and the NEX, which is located on Radford Drive. It starts at the NEX Mall at Pearl Harbor, enters the base through the Kuntz Gate, circulates the base, and exits through Makalapa Gate before arriving back to the NEX. Its route takes approximately an hour to complete and runs from 10:00 a.m. to 9:00 p.m. daily.

TheBus Route 32 travels in the vicinity of this area but does not travel into JBPHH. Route 32 (Foster Village – Pearlridge) services the area between Aiea and Kalihi. It runs from approximately 5:00 a.m. to 10:00 p.m. daily.

3.7.2 Environmental Consequences

The following discussion addresses construction impacts and long-term operational impacts:

- Construction impacts would be caused by the installation of the electrical transmission backbone, transport of materials to and from the work site, and construction employee-generated travel. The construction impacts would be temporary, and BMPs identified in Table 2.7-1 (BMP TRANS MGMT-1) can be implemented to reduce impacts.
- Long-term operational impacts would be caused by increased employee-related travel demand and potential truck traffic to and from Sites 2 and 5. For this project, it is assumed that travel to and from both sites after construction is completed would be negligible and would not affect the operations of the roadway network. Operational impacts are discussed qualitatively.

3.7.2.1 No Action Alternative

3.7.2.1.1 Construction Impacts

Under the No Action Alternative, construction of the FRG Plant at Site 2, the PV system and the BESS at Site 5, and the electrical transmission backbone would not be constructed. Under this alternative, no impacts would occur to the transportation network.

3.7.2.1.2 Operational Impacts

No operational impacts would be generated by the No Action Alternative.

3.7.2.2 Proposed Action Alternative

3.7.2.2.1 Construction Impacts

The primary construction phase transportation impacts are anticipated to occur within JBPHH, including where construction traffic would enter and exit JBPHH. Short-term construction effects to the transportation system may occur. These effects may include increasing user delay and travel times at both internal and external intersections when construction traffic travels to and from the site. The addition of vehicles and increase in user delay could create short-term, localized congestion. Additionally, congestion is anticipated where lanes would need to be closed due to construction adjacent to the roadway.

The potential impacts stem from additional traffic from construction workers and the work that would occur in and near roadways during the installation of the electrical transmission backbone. The impact analysis is focused on where construction vehicles would need to enter and exit JBPHH, and on traffic disruption that may occur if lane closures and detours are needed during the installation of the electrical transmission backbone.

The estimated labor and time frame for construction for Site 2, Site 5, and the electrical transmission backbone work are based on labor curves provided by the developer. These labor curves are shown in Figure 3.7-2 (electrical transmission backbone), Figure 3.7-3 (Site 5), and Figure 3.7-4 (Site 2) with construction occurring December 2024 through mid-to-late 2027.

Construction workers and vehicles would be traveling to Sites 2 and 5, and to the locations where the electrical transmission backbone would be installed. This traffic would add to existing traffic volumes along key roadways.

The construction sequence of the Proposed Action would begin December 2024:

- Electrical transmission backbone work would be completed by February 2027.
- Site 5 work would be completed in October 2026 and would increase at a slower pace than the electrical transmission backbone work, with a peak in June 2025.
- Site 2 work would be completed in October 2027, with peak labor in December 2026.

From these labor curves, it is estimated that highest volume of workers needed for the construction is 135 workers at Site 2. For the purposes of this analysis, it is assumed that all the workers would arrive individually and enter and exit through Nimitz Gate, the main gate of JBPHH.

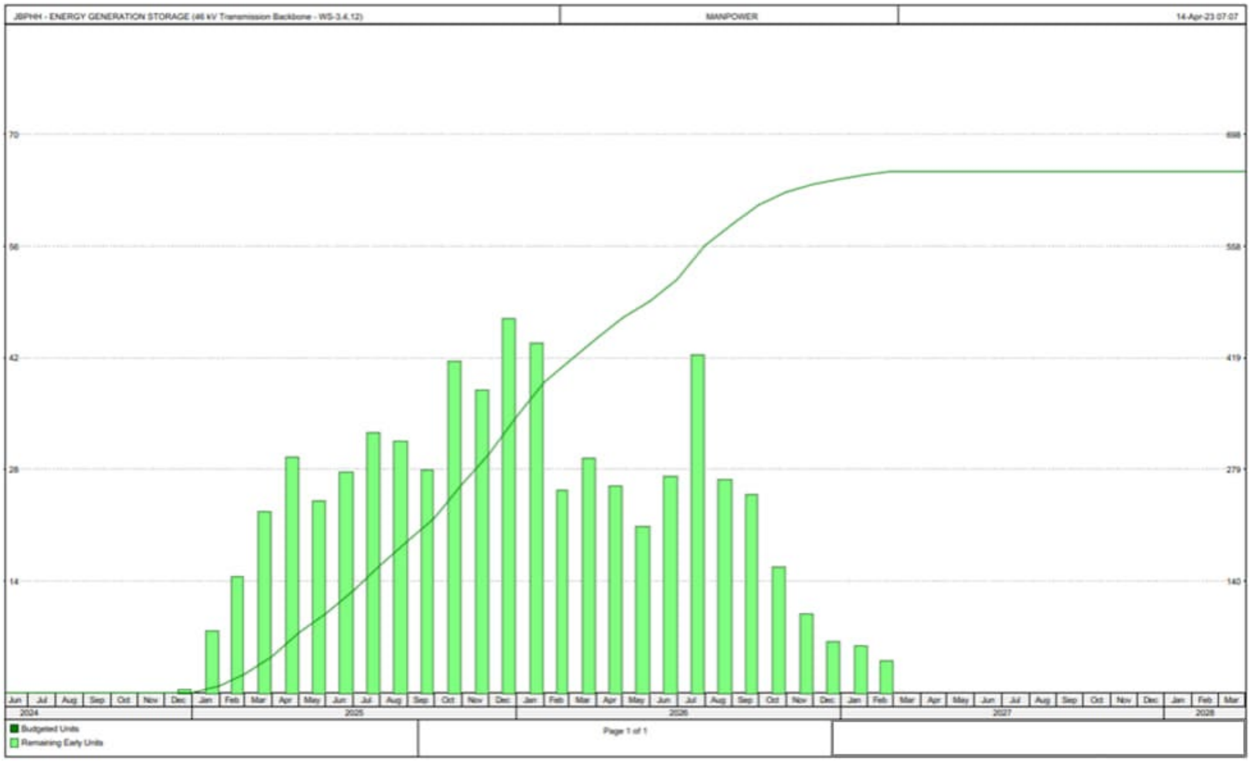

Figure 3.7-2 Electrical Transmission Backbone Estimated Labor/Labor Hour Curve

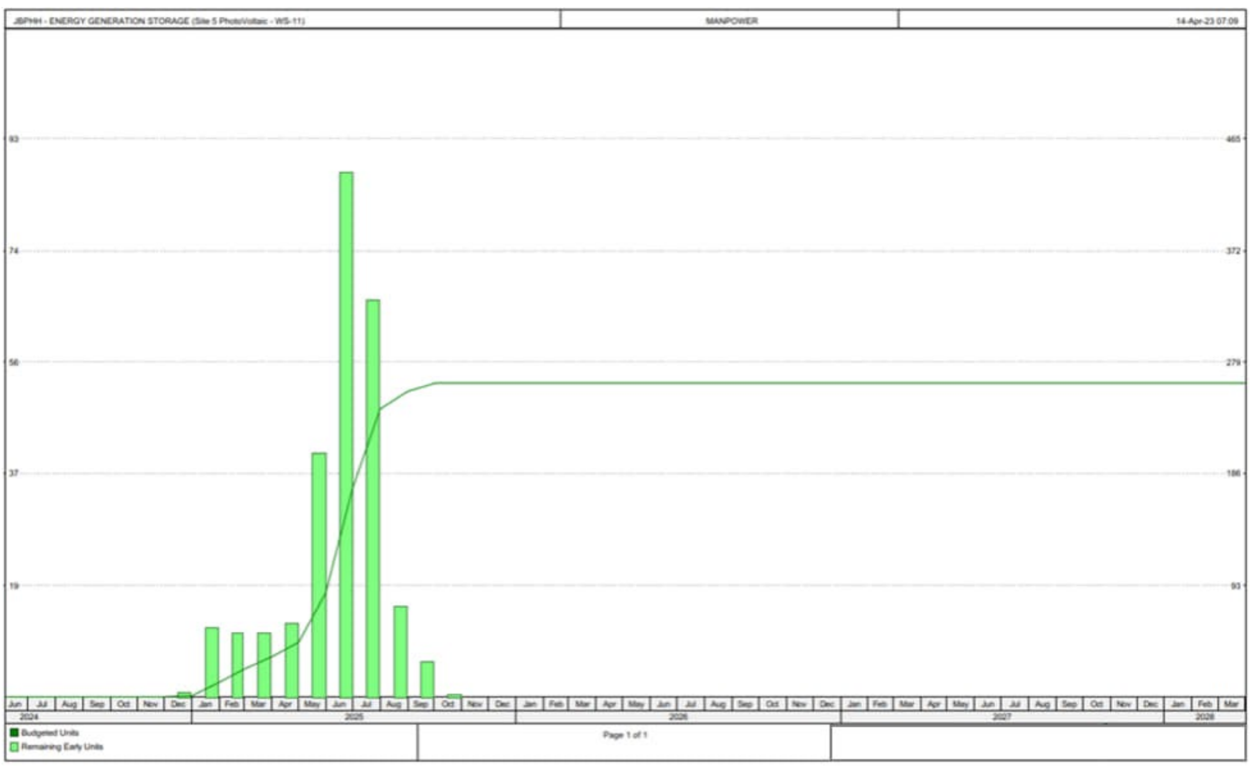

Figure 3.7-3 Site 5 Estimated Labor/Labor Hour Curve

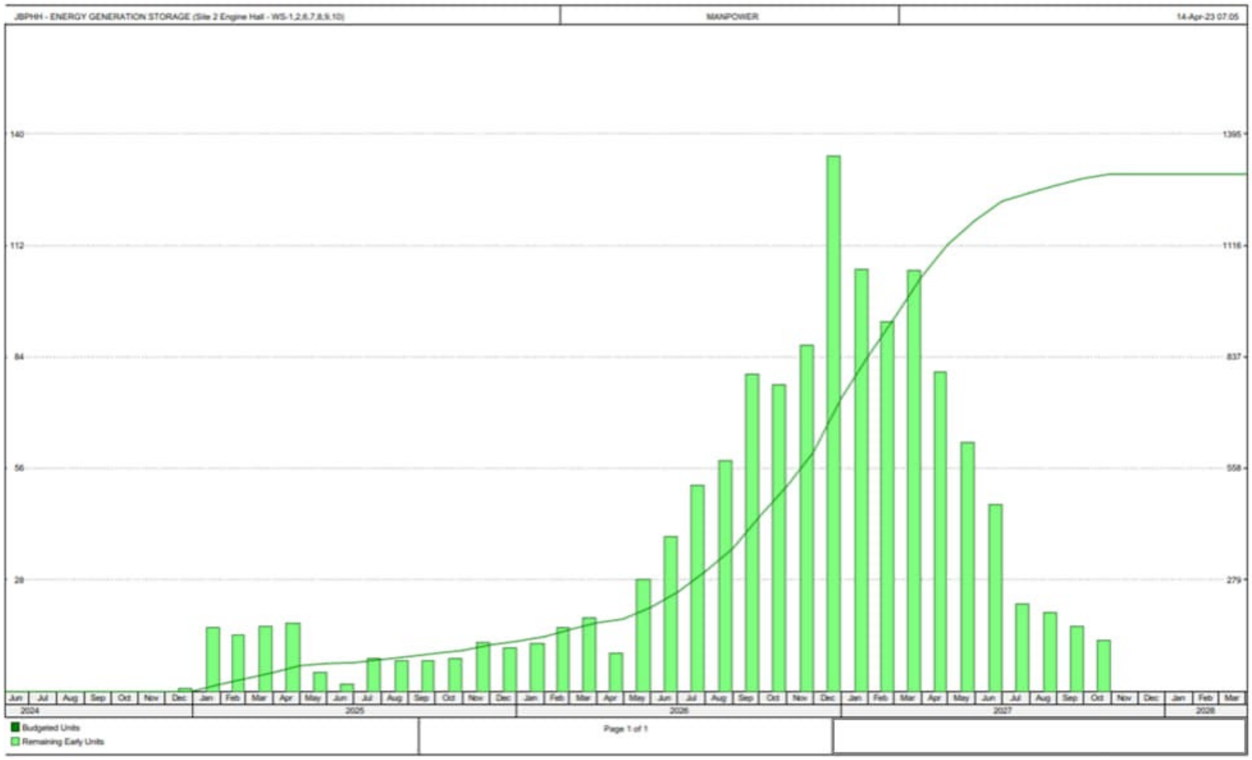

Figure 3.7-4 Site 2 Estimated Labor/Labor Hour Curve

Based on the known operations of the Nimitz Highway and North Road/South Avenue intersection, the largest concern is the impact on the ECF in the a.m. peak, as the additional traffic (construction workers) would have to be processed to access JBPHH. During the p.m. peak, the construction workers can exit the main gate as they would not need to be processed.

The analysis methodology was used to evaluate conditions in the a.m. and p.m. peaks for Existing (2023), No Action (2026), and Proposed Action (2026) scenarios. Once the model was calibrated for current conditions, no modifications were made to the model settings. The analysis results are expressed as vehicular delay (in seconds per vehicle) and level of service. The level of service for signalized/unsignalized intersections is a qualitative index that references a performance measure, such as intersection delay, to assess the relative quality of the traffic operations.

Table 3.7-3 details the comparison of the intersection operations between the years 2023 and 2026, including the No Action and the Proposed Action Alternative scenarios. The Proposed Action Alternative analysis assumes a worst-case scenario, with all workers needing to access JBPHH and all traffic entering/exiting from the same gate.

Table 3.7-3 Intersection Operations

Turning Movement	Existing		No Action		Proposed Action Alternative	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Nimitz Highway (Hwy) at North Road (Rd)/South Avenue (Ave) a.m. Peak Hour (5:30 a.m.–6:30 a.m.)						
Nimitz Hwy RT	19.4	B	21.5	C	21.5	C
Nimitz Hwy LT	53.5	F	83.5	F	129.6	F
North Rd LT	*Movement Prohibited*					
North Rd TH						
South Ave TH						
Nimitz Hwy at North Rd/South Ave p.m. Peak Hour (2:30 p.m.–3:30 p.m.)						
Nimitz Hwy RT	9.6	A	11.9	B	11.9	B
Nimitz Hwy LT	11.2	B	11.2	B	11.2	B
North Rd LT	35.9	D	51.0	D	51.0	D
North Rd TH	9.0	A	9.1	A	9.1	A
South Ave TH	9.6	A	9.7	A	9.7	A

Key: Ave = Avenue; Hwy = Highway; LOS = level of service; RT = Right Turn, LT = Left Turn, Rd = Road; sec/veh = seconds per vehicle; TH = Through.

As shown in Table 3.7-3, despite the influx of workers, the change in conditions between the No Action and the Proposed Action Alternative scenarios is negligible. During the a.m. peak hour, the analysis shows that between the No Action and the Proposed Action Alternative scenarios, the 95th percentile queue length increases from approximately 417 feet to 471 feet, which is approximately three vehicles. During the p.m. peak hour, construction worker vehicles exiting the site largely would not affect the operations at this intersection. Any potential queueing issues associated with the construction workers exiting would be localized on the base. No significant impacts would occur.

Work that would occur outside of JBPHH area includes the construction of the PV system and BESS at Site 5. Construction at Site 5 is anticipated to span less than a year, with the peak construction traffic occurring in the middle of 2025 before being virtually complete two months later. The primary effects that are expected to occur are the arrival of construction workers and trucks to and from the site. The added volumes may increase user delay and travel times along Salt Lake Boulevard and the roadways around the site for a few months during the construction period but are not expected to substantially worsen the level of service on the roads. Similar to the work completed within JBPHH, workers can be scheduled to arrive and depart outside of the commuter peak periods to reduce impacts (BMP TRANS MGMT-1 in Table 2.7-1). Navy housing is located south of Namur Road and one of the access points to Site 5 is along this roadway. However, the construction vehicular traffic is not anticipated to impede access to the housing. No significant impacts are expected for the reasons mentioned above.

The construction of the electrical transmission backbone may also increase traffic levels. Construction of the electrical transmission backbone would take approximately two years, with a peak of construction workers for a three-month period. Vehicles would need to travel to and from the construction sites from the location of the staging areas. The proposed laydown area is located at the southern end of Vickers Avenue on the Hickam side of the base near the Hickam Fishing Pier. It is assumed that construction workers and trucks would travel to and from that location to the current work area with the necessary materials. While the project would minimally increase traffic during these projects, the increase would be short-term and the overall construction period would last approximately two years.

The remaining IKC projects (Defense Logistics Agency Relocation; Replace Protective Relays; Replace Live Front Equipment, Hickam; Protective Relay Coordination Study; Replace Electrical Handholes) would include the construction of two concrete pads within a previously disturbed area, replacement of equipment for existing infrastructure, and a desktop study. While these projects would minimally increase traffic during these projects, the increase would be short-term and the overall construction period would last three years.

Parking for construction worker vehicles and other construction vehicles at Site 2 would occur primarily within Site 2 with an option for overflow parking routed toward Parking Lot D pending coordination with the Navy. Construction parking would be provided within the boundaries of Site 5 at the laydown/construction staging area that would be located at the existing ballfield parking lot. Utilization of on-street parking is not anticipated. Parking for construction workers involved with the electrical transmission backbone work would be provided in nearby lots defined through further coordination with the Navy. To minimize potential impacts during construction, the contractors would establish a construction traffic management plan (CTMP) to identify the appropriate work zone management strategies (BMP TRANS MGMT-1). The CTMP would complement the traffic control plans with mitigating impacts that may arise during construction. The CTMP would be reviewed by the Navy and HDOT to ensure that the appropriate measures are implemented and acceptable to both parties. With the CTMP and the traffic control plans, no parking impacts are anticipated within JBPHH. No parking issues are anticipated outside of JBPHH.

To minimize the impacts from construction, a CTMP would be developed to direct traffic during construction (BMP TRANS MGMT-1 in Table 2.7-1). As part of this traffic plan, the construction manager would review and use the construction schedule to manage the construction workers' arrival and departure times, reducing impacts to peak hour traffic. All of the work would be performed within JBPHH and would not affect the roadway network outside of the installation, aside from the arrival and departure of construction workers. The implementation of the CTMP is anticipated to further minimize traffic impacts; therefore, no significant impacts are expected.

3.7.2.2.2 Operational Impacts

The operation of the facilities is not anticipated to create long-term impacts to the transportation network. The operation of the facilities involves vehicle travel for approximately 12 workers (six to eight personnel during a normal shift and approximately two to four personnel overnight) and up to 15 trucks that would travel to and from Site 2 on a daily basis to deliver biofuel. It is assumed that the trucks would be distributed throughout the day rather than arriving and departing during the peak hour periods. The operations at Site 5 are not expected to require workers on a daily basis, so no regular daily employee or truck trips are anticipated.

The addition of six to eight vehicles during the peak hour periods for the worker trips to and from the site and an additional 15 trucks per day for biofuel delivery is expected to add minimal additional traffic volume on the roadways and at the key intersections. When the electrical infrastructure within the base is operational, traffic associated with it is anticipated to be minimal, aside from potential maintenance that may be needed. The long-term operational impacts would be similar to those of the No Action Alternative. Therefore, no significant impacts would occur.

3.7.2.2.3 Impacts of Climate Change on Transportation

Predictable environmental trends associated with climate change and the potential impacts are identified in Table 3.2-7. A rise in sea level resulting from climate change could impact the Pearl Harbor Bikeway and could impact the roadway subgrade of major arterial routes such as Kamehameha Highway by raising the level of underground streams in the Kalauao and Manana districts. Because the additional vehicle load associated the operation phase of the project is minimal, the Proposed Action is not expected to interact with climate change-related trends in a manner that would produce additional adverse effects.

3.8 Summary of Potential Impacts to Resources and Mitigation Measures

A summary of the potential impacts associated with the Proposed Action Alternative and the No Action Alternative is presented in Table 3.8-1. Table 3.8-2 provides a list of all mitigation requirements associated with the Proposed Action to reach a finding of no significant impact.

Table 3.8-1 Summary of Potential Impacts

Resource Area	*No Action Alternative*	*Proposed Action Alternative*
Air Quality and GHGs	No Impacts	Construction phase air pollutant emission sources include fuel-burning equipment, vehicles, and land disturbance. Elevated particulate matter concentrations are expected immediately downwind of earthwork activity, but because BMPs and SOPs would be applied during the construction process, visible fugitive dust plumes are unlikely to occur outside of the activity area. Potential exposure to elevated pollutant concentrations would be most intense and occur at a higher probability in years 2 and 3 of construction at Site 2, year 1 of construction at Site 5, and years 1 and 2 of construction of the electrical transmission backbone. Base residential housing immediately to the south of Site 2, base residential housing immediately adjacent to and to the south of Site 5, and off-base residential housing to the east of Site 5 could be impacted. Construction phase emissions of criteria pollutants and HAPs would not cause significant impacts on air quality because they are temporary with a low magnitude of emissions, and would not change the area's attainment status or appreciably increase human health risks in areas where sensitive receptors and/or public presence are anticipated. Emissions during the operations phase of the project would primarily be generated by energy production at Site 2. FRG Plant equipment, including emissions controls, would be operated and maintained according to manufacturer specifications. Equipment subject to air permitting requirements would be covered under a new Title V permit issued to the lessee as a separate source from JBPHH. The PV system and BESS at Site 5 would have minimal operational emissions. Operational emissions of criteria pollutants from the proposed power plant would be in compliance with the NAAQS/SAAQS. Ambient air concentrations of any hazardous air pollutant are anticipated to comply with limits established by HAR 11-60.1-179. Operational emissions from on-road traffic would be insignificant compared to current daily traffic counts at the nearby air monitors, based on an assumed number of delivery trucks and employee vehicles per day associated with the proposed new FRG Plant at Site 2. A qualitative impact assessment indicated that HAPs emitted during the operations phase would not appreciably increase human health risks in areas where sensitive receptors and/or public presence are anticipated. Estimated GHG emissions would increase over the 35 months of construction, and the annual operation of the power plant would not interfere with Hawaii's statewide goal to be carbon net-negative by 2045. In summary, implementation of the Proposed Action Alternative would have less than significant impacts to air quality and GHGs.
Cultural Resources	No Impacts	The Proposed Action Alternative would alter the PHNHL through the construction of new facilities, demolition of three historic properties, and reuse of six historic properties, all of which contribute to the PHNHL District. Viewsheds within the larger PHNHL District also would be altered as a result of new construction. The Proposed Action Alternative would result in minor, permanent, and irreversible impacts to historic architectural resources. Section 106 consultation is happening concurrently with this EA. The EA findings therefore will be updated in the Final EA with information pertaining to the results of Section 106 consultation, including mitigation requirements for adverse effects on historic properties.

Table 3.8-1 Summary of Potential Impacts

Resource Area	*No Action Alternative*	*Proposed Action Alternative*
		The Proposed Action Alternative does not include any activities that would alter resources of importance to Native Hawaiians because no areas with identified culturally important resources exist within the Proposed Action areas. Therefore, no impacts to cultural resources important to these groups would occur. Through consultation and implementation of mitigation pursuant to Section 106, the Navy would resolve effects to historic properties (see Table 3.8-2 and Appendix D for more detail). Therefore, the Proposed Action Alternative would result in a less than significant impact on cultural resources.
Biological Resources	No Impacts	Site 2 is currently developed with two warehouses and is in an urban setting with minimal vegetation. Site 5 has been previously disturbed and contains a baseball field, parking lot, and other impervious surfaces and a few small buildings, including a Quonset hut. The vegetation at Site 5 mostly consists of grasses with scattered non-native trees and shrubs. Some of these trees and shrubs would be removed from Site 5 for the PV system. Any minimally occurring wildlife on the sites would relocate to regions nearby with similar conditions. No federally- or SOH-listed vegetative species are known to occur at Sites 2 and 5 or along the proposed electrical transmission backbone. No special-status animal species are expected to be affected by the construction and operation of the Proposed Action Alternative as these sites are disturbed and do not support habitat. No permanent loss of significant or critical terrestrial habitat would occur under the Proposed Action Alternative. As a BMP, pre-construction surveys for nesting birds would be undertaken at both sites to avoid impacts on breeding birds (Table 2.7-1). Therefore, the Proposed Action Alternative would not negatively affect habitat use by any threatened or endangered species. The mitigation measures described in Table 3.8-2 would further minimize potential impacts, so construction would have no adverse effects to habitat. Therefore, construction of the Proposed Action Alternative would have less than significant impacts to threatened or endangered species. Construction, demolition, and site clearance would generate temporary noise and other disturbances; however, avian and terrestrial species on JBPHH are already habituated to high levels of noise associated with vehicle traffic, aircraft noise, light, and port activities. Increases in noise levels from construction activities to the ambient noise environment would be negligible, short-term, and temporary. The increases in noise levels may create an acoustic disturbance to Hawaiian hoary bats, but this disturbance would be minimized through BMPs (Table 2.7-1). BMPs to prevent ponding would be implemented to reduce attraction of waterbirds and shorebirds to the project areas, protecting them from risk of physical disturbance or strike. In addition, BMPs and SOPs would be implemented to prevent water quality degradation (Tables 2.7-1 and 2.7-2). As a result, construction would have no adverse effects and impacts to biological resources would be less than significant. No impacts to avian and terrestrial species are expected to occur during the operational phase of the Proposed Action Alternative as Site 2 is in an urban section of JBPHH and Site 5 mostly consists of grass that would be developed with a PV system. The FRG plant at Site 2 would generate minimal noise during operations; noise impacts from the BESS at Site 5 would be mitigated (Table 3.8-2). The proposed operational activities at Site 5 would not result in substantial

Table 3.8-1 Summary of Potential Impacts

Resource Area	***No Action Alternative***	***Proposed Action Alternative***
		increased noise levels or loss of significant vegetation that supports avian and terrestrial animals and would utilize anti-glare technology to avoid creating additional light or glare that would attract or disorient avian species. Therefore, operational impacts would have no adverse effects and impacts would be less than significant. No marine activities would take place as a result of the Proposed Action. Therefore, no adverse effects on federally- or SOH-listed marine species, critical marine habitat, or Essential Fish Habitat are anticipated as a result of the Proposed Action, and impacts would be less than significant.
Visual Resources	No Impacts	The Proposed Action Alternative would lead to changes in the visual landscape during construction at and around Sites 2 and 5. For both sites, active construction activities would be contained within the fenced construction site. The fencing would include screening material to obstruct and minimize views of heavy equipment, stockpile areas, and other facility demolition and construction activities. The visual effects of Site 2 would be permanent due to the exhaust stacks. In general, the visual contrast level from the new FRG Plant facilities and structures at Site 2 would not be strong because the new FRG Plant would have the same building massing and scale as the two existing buildings. In addition, keeping the historic rail line and mature shade trees would help maintain the historic landscape character in the area. The exhaust stacks would be painted an appropriate shade of blue to further reduce visual contrast between the exhaust stacks and the surrounding sky. Further consideration of potential impacts on the historic character of the area is provided under Cultural Resources and will be addressed through Section 106 consultation. The installation of the ground-mounted PV panels at Site 5 would result in the loss of approximately 5 acres of the baseball field and the removal of shade canopy trees, thereby altering the visual landscape at this site. The PV system would not obstruct any significant mountain and harbor views from public vantage points. From public vantage points along Salt Lake Boulevard, viewers would experience a high intensity of visual contrast from the landscape character alteration. Vegetation (e.g., hedges, trees) would be planted along Site 5 fence line, reducing the visual contrast for viewers along Salt Lake Boulevard to a medium level of intensity. From vantage points at the neighborhood park and along Maluna Street, the intensity of visual contrast would be low to medium due to distance as well as structures and trees that obstruct the view of Site 5. Lighting for worker activity and security during construction and operation of the facilities would add to existing lighting at Sites 2 and 5. The increased lighting at Site 5 is expected to include sources on the top of the PV mount structures. This lighting would be visible from public locations. This change would not substantially alter views or view quality due to the broad distribution of light sources within JBPHH. Lighting at Site 2 would be more limited and lower in profile than lighting at Site 5. Views from public locations (Salt Lake Boulevard) and nearby residential housing would not be obstructed or substantially degraded to existing light sources within JBPHH. The project would follow the Dark Skies Instruction and follow best practices in coordination with USFWS (see Section 3.3 for a related discussion).

Table 3.8-1 Summary of Potential Impacts

Resource Area	***No Action Alternative***	***Proposed Action Alternative***
		The modern solar panels are constructed of dark-colored materials, are covered with anti-reflective coatings and are not expected to cause adverse impact from glare. In summary, with the implementation of BMPs and mitigation measures identified in Tables 2.7-1 and Table 3.8 2, respectively, the Proposed Action Alternative would result in less than significant impacts to visual resources during the construction and operation phases.
Noise	No Impacts	Construction activity and associated noise levels would vary at each location as the work progresses. Construction would result in short-term, intermittent noise effects from the operation of heavy equipment, power and hand tools, and construction vehicles throughout the project area. Although short-term (less than three years), temporary adverse noise impacts are anticipated during construction, mufflers and vibratory or hydraulic drivers with shrouds would be used on construction equipment and vehicles to minimize noise impacts during these activities. A Construction Noise Permit is not required from the HDOH (HAR 11-46) because all construction would occur within JBPHH boundaries. Construction noise would not likely be audible to residents outside of JBPHH because of the distances between the construction noise sources and receptors and the relatively high background noise levels where off-site (public) receptors exist. A construction noise mitigation and management plan would be implemented in association with BMPs to reduce construction noise to less than significant impacts. For long-term facility operations at Sites 2 and 5, noise predictions indicate potential noise impacts that exceed the HAR 11-46 criteria for Class A zoning districts (i.e., residential, public, and open space) of 55 dBA during the daytime and 45 dBA during the nighttime, which was used as the design criteria for the Proposed Action Alternative. At Site 2, operational noise sources would include the cooling radiator field for the FRG Plant facility and components associated with the BESS storage units. At Site 5, the only significant noise source would be the BESS unit. For noise receptors immediately adjacent to each site, preliminary modeling results indicate potential noise exceedances ranging from 3 to 16 dBA above the design criteria at Site 2 and 1 to 14 dBA at Site 5. The commercial developer has committed to meeting the HAR 11-46 criteria in the design for each facility under the Proposed Action Alternative. Proposed mitigation measures to reduce operational noise include noise barriers for the BESS units, low-noise fans, and other mechanical and operational mitigation solutions (see Table 3.8-2 and Appendix B for more detail). With these measures in place, the effects of operational noise on the surrounding sensitive receptors would be less than significant.
Transportation	No Impacts	The JBPHH roadway network in the vicinity of each site would be affected by the construction traffic related to the installation of the FRG Plant and PV panels at Sites 2 and 5, respectively, duct banks, transport of materials to and from the work site, and construction employee-generated travel. Short-term construction effects to the transportation system may occur. These effects may include increasing user delay and travel times at both internal and external intersections when construction traffic travels to and from the site. The addition of vehicles and increase in user delay could create short-term, localized congestion. Additionally, congestion is anticipated where lanes would need to be closed due to construction adjacent to the roadway.

Table 3.8-1 Summary of Potential Impacts

Resource Area	*No Action Alternative*	*Proposed Action Alternative*
		To minimize any potential impacts during construction, the contractor would establish a CTMP that would include a list of lane/street closures and times as well as traffic control measures such as speed limit reduction, pavement markings, and flaggers to identify the appropriate work zone management strategies (BMP TRANS MGMT-1 Table 2.7-1). The CTMP would complement the traffic control plan to mitigate impacts that may arise during construction. Standard practices to protect construction workers, pedestrians, and motorists near roadways would address safe travel for vehicles near construction sites. With a Construction Traffic Plan and CTMP in place, no significant impacts on transportation are anticipated during the construction phase. Parking for construction worker vehicles would be accommodated within site boundaries with an option for overflow parking in Parking Lot D, pending coordination with the Navy. Utilization of on-street parking is not anticipated. The operation of the facilities is not anticipated to create long-term impacts to the transportation network. The addition of six to eight vehicles during the peak hour periods for the worker trips to and from Site 2 and an additional 15 trucks per day for fuel delivery are expected to add minimal additional traffic volume on the roadways and at key intersections. The long-term operational impacts would be similar to those of the No Action Alternative. Therefore, no significant impacts would occur.
Water Resources, Geology and Topography Resources, Soils, Land Use, Airspace, Infrastructure and Utilities, Public Health and Safety, Hazardous Materials and Wastes, Socioeconomics, Recreation, and Environmental Justice	No Impacts	No or negligible impacts.

Key: BESS = battery energy storage system; BMP = best management practice; CZMA = Coastal Zone Management Act; FRG = Firm Renewable Generation; GHG = greenhouse gas; HAP = hazardous air pollutant; HAR = Hawaii Administrative Rules; HDOH = State of Hawaii Department of Health; JBPHH = Joint Base Pearl Harbor-Hickam; kV = kilovolt; NAAQS = National Ambient Air Quality Standards; NHPA = National Historic Preservation Act; PHNHL = Pearl Harbor National Historic Landmark; PV = photovoltaic; SAAQS = State Ambient Air Quality Standards; SOP = standard operating procedure; CTMP = Construction Traffic Management Plan; USFWS = United States Fish and Wildlife Service.

Table 3.8-2 Mitigation Measures

Measure	*Anticipated Benefit/Evaluating Effectiveness*	*Implementing and Monitoring*	*Responsibility*	*Estimated Completion Date*
CULT MGMT-1 State Historic Preservation Division (SHPD): Consultation and coordination to address building demolition and visual effects on the PHNHL.	Customized approach to prepare appropriate records for the existing buildings/effective to reduce the level of impact on the historic context.	Consultation and coordination are ongoing during the NEPA EA process. Mitigation measures will result from Section 106 consultation. Resolution will be described in the EA when the details are available.	Navy	June 2023–April 2024
CULT MGMT-2 Implementation of Navy vibration protocols.	Effective to reduce the level of impacts to historic buildings.	Pile driving causes vibrations that may affect historic buildings. Any construction activity that may exceed the Navy threshold of 0.2 PPV would require mitigation including monitoring of historic buildings. If damages are caused to historic buildings, additional mitigation as determined through the Section 106 consultation process will be implemented.	Navy	June 2023–April 2024
VISUAL-1 Planting of tall shrubs along the side of Site 5 near Salt Lake Boulevard to provide a landscape screen between motorists and the planned facilities.	Visual screening to reduce visual contrast and enhance the visual quality of the site after removal of the ball field.	The revegetation plan would follow the Installation Appearance Plan for selection of appropriate plant species. The final design phase task would include plans and specifications for the installation and an interdisciplinary plan review focused on environmental compliance.	Contractor	2024–2026
VISUAL-2 Selection of appropriate paint color for the FRG Plant smokestacks.	Reduce visual contrast with surrounding environment.	Final design phase specification including interdisciplinary plan review focused on environmental compliance.	Final design lead	2024–2025

Table 3.8-2 Mitigation Measures

Measure	***Anticipated Benefit/Evaluating Effectiveness***	***Implementing and Monitoring***	***Responsibility***	***Estimated Completion Date***
NOISE-1 Preparation of a noise mitigation and management plan.	Reduced overall and maximum noise levels at public receptor sites	The construction contractor would provide a noise mitigation and management plan for construction and operation during the design phase. The plan would detail: • Specific equipment and mitigation measures for the construction phase to reduce the magnitude of noise at each facility (e.g., from pile drivers and other construction equipment noise sources). • Noise reduction methodologies for the energy generation and storage facilities, including measures to reduce source levels and limit noise pathways associated with off-site noise impacts to levels below the HAR 11-46 maximum noise limits. This includes mechanical and operational approaches.	Construction contractor	2024–2027
NOISE-2 Noise reduction methodologies for energy generation facilities and other equipment, including mitigation measures to reduce source levels and limit noise pathways associated with off-site noise impacts. This includes mechanical and operational approaches.	Reduced noise at offsite locations/Effective to achieve compliance	Mitigation measures to reduce operational noise include constructing an acoustical building with acoustical panels or concrete and solid sound walls around the BESS, insulation in the engine hall walls, doors, and roof, acoustical attenuation for air intake and exhaust, low-noise fans, engineer exhaust mufflers, ultra-low noise radiators, and manufacturer-provided mitigation solutions at the FRG Plant facility. Final design phase details and specifications and post-construction validation under actual operating conditions.	Final design lead and facility operators	2024–2027

Key: BESS = battery energy storage system; EA = Environmental Assessment; FRG = Firm Renewable Generation; HAR = Hawaii Administrative Rules; NEPA = National Environmental Policy Act; PHNHL = Pearl Harbor National Historic Landmark; PPV = peak particle velocity.

4 Cumulative Impacts

This section (1) defines cumulative impacts, (2) describes past, present, and reasonably foreseeable future actions relevant to cumulative impacts, (3) analyzes the incremental interaction the Proposed Action may have with other actions, and (4) evaluates cumulative impacts potentially resulting from these interactions.

4.1 Definition of Cumulative Impacts

The approach taken in the analysis of cumulative impacts follows the objectives of the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations, and CEQ guidance. Cumulative impacts are defined in 40 Code of Federal Regulations 1508.7 as “the impact on the environment that results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time” (40 CFR § 1508.7).

To determine the scope of environmental impact analyses, agencies shall consider cumulative actions, which when viewed with other Proposed Actions have cumulatively significant impacts and should therefore be discussed in the same impact analysis document.

In addition, CEQ and the United States (U.S.) Environmental Protection Agency have published guidance addressing implementation of cumulative impact analyses—*Guidance on the Consideration of Past Actions in Cumulative Effects Analysis* (CEQ, 2005) and *Consideration of Cumulative Impacts in EPA Review of NEPA Documents* (EPA, 1999). CEQ guidance titled *Considering Cumulative Impacts Under NEPA* states that cumulative impact analyses should:

> Determine the magnitude and significance of the environmental consequences of the Proposed Action in the context of the cumulative impacts of other past, present, and future actions…identify significant cumulative impacts…[and]…focus on truly meaningful impacts. (CEQ, 1997)

Cumulative impacts are most likely to arise when a relationship or synergism exists between a proposed action and other actions expected to occur in a similar location or during a similar time period. Actions overlapping with or in close proximity to the Proposed Action would be expected to have more potential for a relationship than those more geographically separated. Similarly, relatively concurrent actions would tend to offer a higher potential for cumulative impacts. To identify cumulative impacts, the analysis needs to address the following three fundamental questions.

- Does a relationship exist such that affected resource areas of the Proposed Action might interact with the affected resource areas of past, present, or reasonably foreseeable actions?
- If one or more of the affected resource areas of the Proposed Action and another action could be expected to interact, would the Proposed Action affect or be affected by impacts of the other action?
- If such a relationship exists, then does an assessment reveal any potentially significant impacts not identified when the Proposed Action is considered alone?

4.2 Scope of Cumulative Impacts Analysis

The scope of the cumulative impacts analysis involves both the geographic extent of the effects and the time frame in which the effects could be expected to occur. For this Environmental Assessment (EA), the study area delimits the geographic extent of the cumulative impacts analysis. In general, the study area includes those areas previously identified in Chapter 3 for the respective resource areas. The time frame for cumulative impacts centers on the timing of the Proposed Action.

Another factor influencing the scope of cumulative impacts analysis involves identifying other actions to consider. Beyond determining that the geographic scope and time frame for the actions interrelate to the Proposed Action, the analysis employs the measure of “reasonably foreseeable” to include or exclude other actions. For the purposes of this analysis, public documents prepared by federal, state, and local government agencies form the primary sources of information regarding reasonably foreseeable actions. Documents used to identify other actions include notices of intent for environmental impact statements (EISs) and EAs, management plans, land use plans, and other planning related studies.

4.3 Description of Geographic Study Area

The geographic study area for a cumulative effects analysis is the overall area where past, present, and reasonably foreseeable projects cause the same or similar effects as those caused by a project alternative. The cumulative effects boundaries for this analysis relate to where project impacts on air quality, greenhouse gases (GHGs), cultural resources, biological resources, visual resources, noise, and transportation occur. With each of these considerations, the geographic emphasis is local rather than regional, statewide, national, or global. Consequently, the local boundary is defined by off-site community receptors linked to potential air quality, GHG, noise, and visual impacts, cultural resource and biological impacts that would occur within Joint Base Pearl Harbor-Hickam (JBPHH) and its port operations, and the local roadway network within and immediately adjacent to JBPHH. Cumulative effects beyond this local boundary may occur, but the contributions made by the project to those effects would be extremely low, broadly distributed, and inconsequential. One example of such an effect would be related to impacts on marine species associated with shipping routes across the Pacific Ocean.

4.4 Past, Present, and Reasonably Foreseeable Actions

This section focuses on past, present, and reasonably foreseeable future projects at and near the Proposed Action locale. In determining which projects to include in the cumulative impacts analysis, a preliminary determination was made regarding the past, present, or reasonably foreseeable action. Specifically, using the first fundamental question included in Section 4.1, it was determined if a relationship exists such that the affected resource areas of the Proposed Action (included in this EA) might interact with the affected resource area of a past, present, or reasonably foreseeable action. If no such potential relationship exists, the project was not carried forward into the cumulative impacts analysis. In accordance with CEQ guidance (CEQ, 2005), these actions considered but excluded from further cumulative effects analysis are not catalogued here as the intent is to focus the analysis on the meaningful actions relevant to informed decision-making.

Projects included in this cumulative impacts analysis are listed in Table 4.4-1, shown in Figure 4.4-1, and described in the following subsections.

Table 4.4-1 Cumulative Actions for Evaluation

Action	*Level of NEPA Analysis Completed and Anticipated Project Timeline*	*Resources with Geographic Overlap (Overlapping Region of Influence)*	*Temporal Overlap with Proposed Action*
Past Actions			
HDOT Interstate Highway H-1, eastbound improvements	Construction in 2022 (past).	>2 miles from both sites. Transportation.	Operation phase only.
Present and Reasonably Foreseeable Future Actions			
Honolulu Authority for Rapid Transportation Skyline Rail System	ROD issued on January 18, 2011. Segment one of construction is complete. The second segment of construction began in September 2023 and is ongoing.	Closest segment of rail line is <0.5 mile to Site 5. Air Quality, GHGs, Biological Resources, Transportation.	Phase II of construction will likely overlap temporally with construction of the Proposed Action. No cumulative impacts are expected during the operation phase.
Aloha Stadium Site Redevelopment	Final EIS (April 2022). Construction anticipated to begin in 2025.	>1 mile from both sites. Air Quality, GHGs, Transportation.	Construction will overlap temporally with construction of Sites 2 and 5 and the backbone. No cumulative impacts are expected during the operation phase.
PHNSY Dry Dock and WPF	ROD (December 2022). Construction of the dry dock is anticipated to occur in 2023–2027. Construction of the WPF is anticipated to occur in 2029–2033.	<0.25 mile from Site 2. Air Quality, GHGs, Cultural Resources, Visual, Biological Resources, Transportation.	Construction of the dry dock will overlap temporally with construction of Site 2 and the backbone. Construction of the WPF will not overlap temporally. No cumulative impacts are expected during the operation phase.
JBPHH Ambulatory Care Clinic	Final EA (February 2022). Construction anticipated to begin in 2025 and the clinic is anticipated to be fully operational by 2030.	>1 mile from both sites. Air Quality, GHGs, Transportation.	Construction will overlap temporally with construction of the Proposed Action. No cumulative impacts are expected during the operation phase.
Little Makalapa and NAVFAC Hawaii Compound Redevelopment	NEPA RCE is in preparation with a target completion date of June 2024, and Section 106 consultation has begun.	Geographic overlap with Site 5. Air Quality, GHGs, Visual, Biological Resources, Noise, Transportation.	Construction may overlap temporally with construction of Site 5. Operational temporal overlap with the Proposed Action.

Table 4.4-1 Cumulative Actions for Evaluation

Action	*Level of NEPA Analysis Completed and Anticipated Project Timeline*	*Resources with Geographic Overlap (Overlapping Region of Influence)*	*Temporal Overlap with Proposed Action*
Shipyard Infrastructure Optimization Program (SIOP) Area Development Plan	No NEPA documentation for the program as a whole. Planning phase completed. Construction timeline split in multiple phases over several decades (2023–2043).	<0.25 mile from Site 2. Air Quality, GHGs, Cultural Resources, Visual, Biological Resources, Noise, Transportation.	Construction of SIOP projects phased in the next 0–5 years will overlap temporally with construction of Site 2 and the backbone. No cumulative impacts are expected during the operation phase.

Key: GHG = greenhouse gas; H-1 = Interstate Highway H-1; HDOT = State of Hawaii Department of Transportation; JBPHH = Joint Base Pearl Harbor-Hickam; NAVFAC = Naval Facilities Engineering Systems Command; Navy = Department of the Navy, United States; PHNSY Dry Dock and WPF = Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility Dry Dock and Waterfront Production Facility; NEPA = National Environmental Policy Act; RCE = Request for Categorical Exclusion; ROD = record of decision; SIOP = Shipyard Infrastructure Optimization Program.

4.4.1 Past Actions

State of Hawaii Department of Transportation Interstate Highway H-1 (H-1) Eastbound Improvements: Eastbound improvements to the H-1 would include adding an additional lane and improving existing ramps and shoulders between mileposts 8.68 and 13.03. Improvements to existing guardrails as well as reconstruction and paving on shoulders were completed along Moanalua Freeway (formerly Route 78) and Interstate Highway H-2 in 2022.

4.4.2 Present and Reasonably Foreseeable Actions

Honolulu Authority for Rapid Transportation Rail System: The City and County of Honolulu is currently constructing the Honolulu Authority for Rapid Transportation (HART) Skyline rail system, a 20-mile elevated urban rail transit system along the south shore of Oahu between East Kapolei and Ala Moana Center. The first segment of the system, from East Kapolei to Aloha Stadium, is operational and open to the public as of late June 2023 (HART, 2023). Construction of the second segment of the HART Skyline rail guideway began in September 2023 and is ongoing (HART, 2023). The Pearl Harbor Naval Base Rail Station is part of the second segment and is approximately 0.35 mile west of Site 5. The closest point between Site 5 and the rail construction (along Kamehameha and Nimitz Highways) is 0.35–0.45 mile.

Aloha Stadium Site Redevelopment: The State of Hawaii (SOH) Department of Accounting and General Services is proposing the construction of a new stadium facility in addition to related ancillary development that would serve to create a New Aloha Stadium Entertainment District on the grounds of the existing Aloha Stadium site in Halawa. The construction of a new stadium is expected to start in 2025, with phased mixed-use precinct built out over time. The construction of the Aloha Stadium HART Skyline Rail Station near Site 5 is complete. The 98-acre Aloha Stadium site is bound by Kamehameha Highway on the west and Salt Lake Boulevard on the south. H-1 is located on the east and Moanalua Freeway on the north. Site 2 is approximately 2 miles southwest of the Aloha Stadium site and Site 5 is approximately 1.2 miles south of the Aloha Stadium site.

Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility Dry Dock and Waterfront Production Facility: As part of the Navy's Shipyard Infrastructure Optimization Program (SIOP), a new Dry Dock and associated production facility are being constructed for Pearl Harbor Naval Shipyard

(PHNSY) and Intermediate Maintenance Facility (herein referred to as PHNSY Dry Dock and WPF). The new PHNSY Dry Dock and WPF are needed to accommodate new classes of vessels. The production facility is needed to increase efficiency through reducing the time and motion of the shipyard workforce by locating industrial spaces closer to a dry dock. Naval Facilities Engineering Systems Command (NAVFAC), Pacific awarded the task order for the project in March 2023 and the project was underway as of May 2023 (DON, 2022d).

JBPHH Ambulatory Care Clinic: The project will construct and operate a new consolidated health clinic located within JBPHH along the Par 3 Golf Course in the Hickam portion of JBPHH. The new ambulatory care clinic is a consolidated joint service facility replacing several existing facilities separately operated by the Navy, U.S. Air Force, and U.S. Army. The ambulatory care clinic will be sustained and administered by the Defense Health Agency, a tenant at JBPHH. The construction of the project will be implemented over approximately two years with construction beginning as early as fiscal year 2025, with operations anticipated to begin by 2030 (DON, 2022b).

Little Makalapa and Naval Facilities Engineering Systems Command, Hawaii Compound Redevelopment: The Little Makalapa and NAVFAC Hawaii Compound Redevelopment Project would support planned consolidation of PHNSY and Intermediate Maintenance Facility (IMF) industrial operations and future SIOP projects, increasing personnel at JBPHH. The redevelopment proposes demolition of all remaining houses at Little Makalapa and replacement with updated, consolidated facilities. The NEPA Request for Categorical Exclusion is in preparation and a formal Section 106 consultation is underway (NAVFAC Hawaii, personal communication, February 2024). This project would be located in the immediate vicinity of Site 5.

SIOP Area Development Plan Projects: Planning studies for PHNSY and IMF examined existing conditions and constraints at PHNSY. The SIOP Area Development Plan (ADP) developed Courses of Action that include proposed projects and sequencing for the ADP of PHNSY. Goals of the ADP include to enhance mission readiness, optimize real property assets, provide a safe and secure environment, practice exemplary resource stewardship, and enhance quality of life. The planning phase is complete, and the construction timeline includes multiple phases sequenced over two decades (2023–2043). The ADP projects anticipated to be constructed in the next 0–5 years include the PHNSY Dry Dock and WPF (discussed above) and three new parking structures/lots. There is no NEPA documentation for the overall ADP and, aside from the PHNSY Dry Dock and WPF EIS, relatively little information is publicly available.

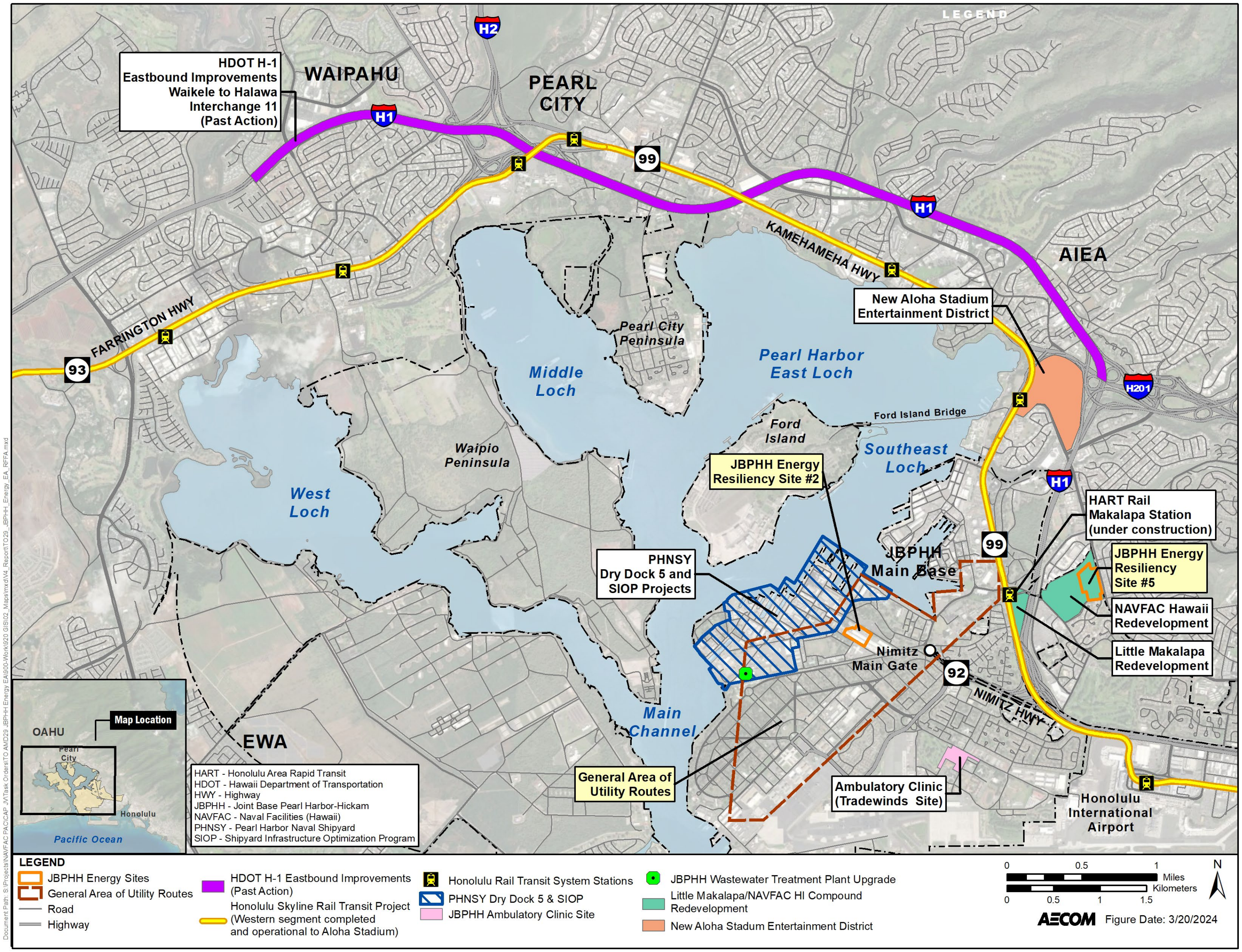

Figure 4.4-1 Proposed and Reasonably Foreseeable Future Actions

4.5 Cumulative Impact Analysis

Where feasible, the cumulative impacts were assessed using quantifiable data. For many of the resources included for analysis, quantifiable data were not available and a qualitative analysis was undertaken. In addition, where an analysis of potential environmental effects for future actions has not been completed, assumptions were made regarding cumulative impacts related to this EA where possible. The analytical methodology presented in Chapter 3, which was used to determine potential impacts to the various resources analyzed in this document, was also used to determine cumulative impacts.

4.5.1 Air Quality and Greenhouse Gases Cumulative Impact Analysis

Present and future actions in the region of influence (ROI) include the use of construction equipment that would result in a temporary increase in air pollutant emissions within the ROI. The timing of some future projects identified in Table 4.4-1, including the HART Skyline rail system, Aloha Stadium Site Redevelopment, JBPHH Ambulatory Care Clinic, Little Makalapa and NAVFAC Hawaii Compound Redevelopment, SIOP ADP projects, and the PHNSY Dry Dock action, may overlap with the construction period of the Proposed Action Alternative. While construction activities will generate temporary emissions within the ROI, the duration of emission increases will be relatively short and variable in location, and the magnitude of emissions will be relatively low with best management practices in place for all projects. Given the prevailing northeast wind condition, and close proximity of the PHNSY Dry Dock action and the Proposed Action Alternative, adverse cumulative air quality impacts at downwind sensitive receptors with potential exposure to elevated pollutant concentrations from overlapping construction emissions from these two projects are anticipated. However, these overlapping ground-level emissions would be temporary and quickly dispersed with no appreciable human health risks. Overall, temporary increases in emissions associated with construction of present and future actions are not expected to contribute significant adverse effects to air quality in the regional airshed or appreciably increase human health risks in areas where sensitive receptors and/or public presence are anticipated.

During the operational period, increased emissions from the Proposed Action Alternative would primarily be from the proposed new Firm Renewable Generation (FRG) Plant as well as minor emissions from on-road vehicles traveling to Sites 2 and 5. For those actions identified in Table 4.4-1, the PHNSY Dry Dock action, the SIOP ADP projects, and the Proposed Action Alternative at Site 2 would have the greatest potential for cumulative air quality impacts to the neighborhood given their close proximity. However, because the PHNSY Dry Dock action would not result in operational emissions and the SIOP ADP projects at PHNSY are related to the shipyard infrastructure optimization program that would likely result in an overall air emissions reduction, no adverse cumulative operational impacts are anticipated. For the other actions that are relatively far from both Site 2 and Site 5, ground-level emissions, if any, would be quickly dispersed under the prevailing wind and therefore unlikely to result in cumulative air quality impacts. Therefore, cumulative emissions from past, present, and reasonably foreseeable future projects would not generate emissions at a level that would change the attainment status or appreciably increase human health risks in areas where sensitive receptors and/or public presence are anticipated.

Impacts from GHG emissions are cumulative in nature, as individual emission sources are not large enough to have appreciable impact on global climate change. The other past, present, and reasonably foreseeable future projects would have an incremental contribution of GHG emissions to global climate change from the use of heavy equipment, gas- or diesel-powered vehicles, ships, or aircraft. Some projects, such as the HART rail system, would help to reduce GHG emissions over the long-term by increasing energy efficiencies and/or reducing vehicle-miles traveled. As discussed in Section 3.2.2.2.4, statewide GHG projections indicate that Hawaii met its statewide GHG emissions limit in 2020 and will continue to meet the limit in 2025 and 2030 (HDOH, 2023). Based on these projections, the estimated GHG increases over the 35 months of construction and the annual operation of the FRG Plant, in combination with other present and reasonably foreseeable actions, would not interfere with Hawaii's statewide goal to be carbon net-negative by 2045.

4.5.2 Cultural Resources Cumulative Impact Analysis

The ROI for cultural resources includes the Pearl Harbor National Historic Landmark (PHNHL) District and the area encompassed by Site 5. Within this ROI, other present and reasonably foreseeable future actions have or would likely affect cultural resources through adverse effects to the PHNHL.

Of the past, present, and future actions listed in Table 4.4-1, the PHNSY Dry Dock and WPF and SIOP ADP overlap with the ROI for cultural resources. These projects are located in the PHNHL near Site 2 and include demolition of and alterations to contributing resources within the PHNHL. The Little Makalapa and NAVFAC Hawaii Compound Redevelopment Project overlaps with Site 5 of the Proposed Action, but there are no known cultural resources within Site 5. The other past, present, and future actions listed in Table 4.4-1 do not overlap with the ROI for cultural resources.

Permanent adverse impacts to cultural resources are anticipated as a result of the construction of PHNSY Dry Dock and WPF. Five NRHP-eligible and/or PHNHL-contributing facilities would be demolished for the construction of the dry dock, and three additional facilities would be demolished for the construction of the WPF. Demolition of these facilities and construction of the new dry dock and WPF, which would be visible from public points of interest, would alter the PHNHL and cause adverse effects to historic properties pursuant to Sections 106 and 110 of the National Historic Preservation Act. Implementation of the SIOP ADP would also occur within the PHNHL and may cause additional alteration and/or demolition of historic properties. All Department of Defense projects and other actions on installation land are required to be implemented using the standard operating procedures detailed in the Integrated Cultural Resources Management Plan and to undergo consultation pursuant to National Historic Preservation Act Section 106 and Hawaii Revised Statutes Chapter 6E.

The Proposed Action would also impact cultural resources through adverse effects to the PHNHL, but at a lesser magnitude than those for the PHNSY Dry Dock and WPF and the SIOP ADP due to the Proposed Action's smaller geographic area, localized impacts at Site 2, and demolition of three PHNHL-contributing resources (Figure 4.4-1). All three projects would occur in the PHNHL, but the Proposed Action's direct construction activities would not overlap with those of reasonably foreseeable and future actions; thus, each would incrementally impact the PHNHL. When considered collectively with the reasonably foreseeable future actions, the Proposed Action demonstrates a pattern of actions with cumulative impacts on the PHNHL. Adverse effects to historic properties caused by the Proposed Action, PHNSY Dry Dock and WPF, and SIOP ADP would be resolved through consultation and implementation of mitigation pursuant to Section 106. Thus, the incremental mitigation of adverse effects to the PHNHL would result in a less than significant cumulative impact on cultural resources.

4.5.3 Biological Resources Cumulative Impact Analysis

Of the past, present, and future actions listed in Table 4.4-1, projects within 1 mile or less of the Proposed Action Alternative with overlapping construction periods include a small section of the HART

Skyline rail system, PHNSY Dry Dock action, the Little Makalapa and NAVFAC Hawaii Compound Redevelopment, and the SIOP ADP projects. When overlapping temporally, construction of these projects would result in collective construction disturbance (e.g., noise and light pollution) that could affect wildlife species. Given the intermittent nature of noise and lighting impacts during construction, cumulative effects would likely be intermittent and short-term in nature. All of the present and future actions are located in highly developed areas with minimal habitat value to wildlife. As the minimally occurring wildlife species within the ROI are already accustomed to disturbance from construction and traffic noise and are able to relocate to nearby areas with similar conditions, cumulative impacts from construction activities would not be significant. The Proposed Action would not result in any additional loss of habitat and, in combination with other present and future actions, would have little or no cumulative impact on native vegetation or habitat for wildlife, including special status species.

All of the projects listed in Table 4.4-1 are located within previously developed and disturbed areas that have limited populations of wildlife. During operation, the present and future actions within the ROI would implement impact avoidance and minimization measures to reduce impacts on biological resources. Information on impacts, avoidance, and minimization measures is not publicly available for some of the future projects in the immediate vicinity of the Proposed Action (e.g., SIOP ADP projects, Little Makalapa and NAVFAC Hawaii Compound Redevelopment); however, all Department of Defense projects and other actions on JBPHH properties will be required to operate according to the Integrated Natural Resources Management Plan (DON, 2019a). With implementation of best management practices and standard operating procedures, operation of the Proposed Action Alternative and other past, present, and reasonably foreseeable projects would not contribute significantly to increased noise or light beyond what is typically experienced by the species that inhabit the ROI.

Cumulative impacts of the Proposed Action, together with these past, present, and reasonably foreseeable future actions, would not result in significant impacts to biological resources, including special status species, in the region.

4.5.4 Visual Resources Cumulative Impact Analysis

Construction activities for the Proposed Action Alternative would not have cumulative impacts to visual resources in combination with most of the present and future actions in Table 4.4-1 as they would not be visible from the same vantage points, with the exception of the Little Makalapa and NAVFAC Hawaii Compound Redevelopment, which would overlap in geographic extent with construction activities at Site 5. The NEPA analysis is not yet available for the Little Makalapa project; however, it is reasonable to assume that fencing and temporary screening options similar to those employed by the Proposed Action would be in place during construction. With these measures in place, minor, temporary cumulative impacts on visual resources are anticipated during construction for members of the public in neighborhoods adjacent to Site 5.

Once operational, the Proposed Action as well as the Little Makalapa and NAVFAC Hawaii Compound Redevelopment would add new facilities to the viewshed that would be in keeping with the residential and light industrial nature of the site (Site 5), which would not cumulatively degrade the scenic quality of the area. Therefore, implementation of the Proposed Action combined with the past, present, and reasonably foreseeable future projects would not result in significant cumulative impacts on visual resources.

4.5.5 Noise Cumulative Impact Analysis

Construction of the assessed past, present, and future actions would include the use of construction equipment, vehicles, and increased personnel that would result in a temporary increase of ambient noise levels within the ROI. The timing of some future projects as identified in Table 4.4-1, particularly the PHNSY Dry Dock and WPF action and the Little Makalapa and NAVFAC Hawaii Compound Redevelopment, may overlap temporally and geographically with the construction period of the Proposed Action. However, noise level increases associated with construction of the Proposed Action would be temporary and typical of standard construction activities as identified in the noise resource section. While individual construction activities would temporarily increase noise levels in the construction area, the varied scale, location, and timing of future construction, and the relatively short duration of noise effects would result in less than significant cumulative impacts.

The projects identified in Table 4.4-1 would have minimal operational noise impacts. Long-term operational impacts of the Proposed Action would not overlap geographically with operation of other future projects, with the exception of the Little Makalapa and NAVFAC Hawaii Compound Redevelopment Project. NEPA documentation for that project is not yet publicly available; however, based on the description of the project (replacement of existing housing and other facilities with updated and consolidated facilities), it would result in little to no change in noise levels once constructed. Both the FRG facility (Site 2) and the battery energy storage system facilities (Sites 2 and 5) would be designed to meet the Hawaii Administrative Rules noise zoning code. As such, in the absence of any new, permanent operational noise sources from other future projects, implementation of the Proposed Action would not result in significant cumulative noise impacts within the ROI.

4.5.6 Transportation Cumulative Impact Analysis

Cumulative transportation impacts from past, present, and future actions within the ROI that would occur with implementation of the Proposed Action would include additional user delay and parking congestion on JBPHH due to the introduction of construction workers to the transportation network for the SIOP ADP, PHNSY Dry Dock and WPF, JBPHH Ambulatory Care Clinic, and Little Makalapa and NAVFAC Hawaii Compound Redevelopment. These impacts are anticipated because the projects would all be constructed during the same time period and within JBPHH. Additional regional traffic may occur as a result of the HART Skyline rail system and Aloha Stadium Redevelopment construction. Construction parking for the Proposed Action is expected to be accommodated on-site; therefore, no cumulative impacts are anticipated on availability of parking. The remaining projects listed in Table 4.4-1 are not anticipated to have cumulative transportation impacts with the Proposed Action.

Cumulative transportation impacts during construction of the Proposed Action and the projects identified above would be less than significant because: (1) the arrival and departure patterns of these workers would not coincide with regional traffic peaks, (2) network impacts would be mostly on or at the JBPHH gates, which are isolated and only used by those accessing the base, and (3) localized traffic-related impacts would be minimized to the extent practicable with implementation of mitigation measures and best management practices, including traffic management plans, for all present and future actions. The traffic management plans would take cumulative impacts into account where appropriate.

The Proposed Action is not expected to increase demand for parking during the operation phase, but may eliminate some existing parking spots at Site 5. The SIOP ADP projects beginning in the next 0–5 years include the construction of the PHNSY Dry Dock and WPF and the addition of three parking structures/lots at JBPHH. The addition of these parking structures/lots would help to alleviate potential cumulative parking congestion during the operation phase of the Proposed Action and the other assessed future projects. The operation of the Proposed Action is not anticipated to create long-term impacts to the transportation network. While incremental cumulative impacts to transportation resources from the operation of all present and future actions in the ROI can be reasonably anticipated, minimization measures and traffic management plans will take cumulative effects into account and minimize cumulative impacts to the extent feasible. Therefore, implementation of the Proposed Action combined with the past, present, and reasonably foreseeable future projects would not result in significant cumulative impacts on transportation within the ROI.

5 Other Considerations Required by NEPA

5.1 Consistency with Other Federal, State, and Local Laws, Plans, Policies, and Regulations

In accordance with 40 Code of Federal Regulations 1502.16(c), analysis of environmental consequences shall include discussion of possible conflicts between the Proposed Action and the objectives of federal, regional, state and local land use plans, policies, and controls. Table 5.1-1 identifies the principal federal and state laws and regulations that are applicable to the Proposed Action and describes briefly how compliance with these laws and regulations would be accomplished.

Table 5.1-1 Principal Federal, State, and Local Laws and Regulations Applicable to the Proposed Action

Federal, State, and Local Laws and Regulations	*Status of Compliance*
National Environmental Policy Act; Council on Environmental Quality National Environmental Policy Act implementing regulations; Navy procedures for Implementing National Environmental Policy Act	In Compliance
Clean Air Act	In Compliance
Clean Water Act	In Compliance
Rivers and Harbors Act	In Compliance
Coastal Zone Management Act	In Compliance
National Historic Preservation Act	In Compliance
Endangered Species Act	In Compliance
Magnuson-Stevens Fishery Conservation and Management Reauthorization Act	In Compliance
Marine Mammal Protection Act	In Compliance
Migratory Bird Treaty Act	In Compliance
Bald and Golden Eagle Protection Act	N/A
Comprehensive Environmental Response, Compensation, and Liability Act	In Compliance
Emergency Planning and Community Right-to-Know Act	In Compliance
Federal Insecticide, Fungicide, and Rodenticide Act	In Compliance
Resource Conservation and Recovery Act	In Compliance
Toxic Substances Control Act	In Compliance
Farmland Protection Policy Act	In Compliance
Executive Order 11988, Floodplain Management	In Compliance
Executive Order 12088, Federal Compliance with Pollution Control Standards	In Compliance
Executive Order 12114, Environmental Effects Abroad of Major Federal Actions (Department of Navy implementing regulation 32 CFR 287)	In Compliance
Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations	In Compliance
Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks	In Compliance
Executive Order 13089, Coral Reef Protection	In Compliance
Executive Order 13175, Consultation and Coordination with Indian Tribal Governments	In Compliance
Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management	In Compliance
Executive Order 13807, Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects	In Compliance

Table 5.1-1 Principal Federal, State, and Local Laws and Regulations Applicable to the Proposed Action

Federal, State, and Local Laws and Regulations	*Status of Compliance*
Executive Order 13927, Accelerating the Nation's Economic Recovery from COVID-19 Emergency by Expediting Infrastructure Investments and Other Activities	In Compliance
Hawaii Revised Statutes (Hawaii Administrative Rules)	In Compliance
Hawaii Coastal Zone Management Program	In Compliance

Note: Compliance with the Bald and Golden Eagle Protection Act is not applicable because no bald or golden eagles are known to occur in the State of Hawaii.
Key: CFR = Code of Federal Regulations; COVID-19 = Coronavirus Disease 2019.

5.2 Irreversible or Irretrievable Commitments of Resources

Resources that are irreversibly or irretrievably committed to a project are those that are used on a long-term or permanent basis. This includes the use of non-renewable resources such as metal and fuel, and natural or cultural resources. These resources are irretrievable in that they would be used for this project when they could have been used for other purposes. Human labor is also considered an irretrievable resource. Another impact that falls under this category is the unavoidable destruction of natural resources that could limit the range of potential uses of those resources.

The No Action Alternative would not generate irreversible or irretrievable commitments of resources.

The Proposed Action requires the use of fuel, oil, lubricants, and a variety of building materials during the construction process that would be consumed on a long-term/permanent basis. Operation of the energy generation facility would consume renewable biofuels which would not be considered a long-term/permanent use of the feedstock or this type of energy source. The proposed solar panels would offset the use of non-renewable fuels needed for an equivalent amount of energy by generating that energy from a renewable source. Construction and operation of the proposed facilities would also require human labor, which would be irreversible and irretrievable. The loss of trees and other vegetation at Sites 2 and 5 would not be considered a significant irreversible or irretrievable commitment of resources because this is minor relative to natural habitat values in the vicinity and because it could be offset over time by project landscaping proposals.

5.3 Unavoidable Adverse Impacts

Unavoidable adverse impacts reflect the potential for effect after implementation of standard operating procedures, best management practices, and implementation of additional measures to avoid, minimize, and mitigate potential effects.

The No Action Alternative would generate no unavoidable adverse effects. The benefits of energy generation from renewable resources would not occur.

The Proposed Action Alternative would not result in any significant unavoidable impacts. The primary unavoidable effects of the Proposed Action Alternative include:

- Emissions from energy generation and the resulting incremental effects on local air quality and climate.
- Noise from energy generation near Site 2, which includes Navy housing and industrial facilities.

- Cultural resource effects related to the local context of areas near designated historical sites due to the demolition and alterations to the setting of historic properties.
- Incremental effects that when added to similar effects from past, present, and reasonably foreseeable projects generate cumulative effects. The primary incremental effects include stormwater generation and runoff from an increased amount of impervious surface and new development, traffic generation, changes to the visual character of the area through more intense uses of developed parcels, and generation of solid and hazardous waste.

5.4 Relationship between Short-Term Use of the Environment and Long-Term Productivity

The following discussion addresses the relationship between a project's short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment as required by the National Environmental Policy Act. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This refers to the possibility that choosing one development site reduces future flexibility in pursuing other options, or that using a parcel of land or other resources often eliminates the possibility of other uses at that site.

The No Action Alternative presents no short-term effects or effects that would relate to long term productivity but would not support energy generation from non-renewable energy sources.

The Proposed Action Alternative would create short-term uses of environmental resources and cause related effects during construction and operations but would generate long-term beneficial effects from the use of biofuels. Air quality, noise and other resources and conditions would be impacted in the short term and long term. The Proposed Action Alternative would not result in any impacts that would significantly reduce environmental productivity or permanently narrow the range of beneficial uses of the environment.

5.5 Coastal Zone Management Act Consistency

The Proposed Action, while located near the Pearl Harbor Estuary, does not significantly impact coastal and marine resources. All project activities would be conducted on land within the JBPHH installation federal property, and would not impact access to recreational, historic, scenic, or coastal resources. Additionally, the location of the project on federal land excludes it from municipal or state land use policies or zoning regulations and coastal zone requirements. Effects to air quality and noise would occur under the Proposed Action; however, these impacts would be mitigated through best management practices, standard operating procedures, mitigation measures, and regulatory requirements.

The Navy/Marine Corps and the State of Hawaii Department of Business, Economic Development and Tourism, Office of Planning and Sustainable Development have come to an agreement that certain activities listed on the "Navy/Marine Corps De Minimis Activities under CZMA" (De Minimis Activity List) were not subject to further review by the Hawaii Coastal Zone Management (CZM) Program when such an activity was conducted in compliance with the corresponding "Project Mitigation/General Conditions" (DBEDT, July 9, 2009). The Proposed Action is listed among the De Minimis Activities (items 1, 2, and 11) as not requiring further review by the State CZM Program. The project would follow the relevant Project Mitigation/General Conditions as follows:

- (1) All activities will occur on Department of Defense property.
- (6) No project-related materials will be stockpiled in the water.

- (9) Fueling of project-related vehicles and equipment will take place away from the water. A contingency plan will be established to control accidental petroleum releases during project construction.
- (10) All fill material will be protected from erosion as soon as practicable.
- (11) All exposed soil will be protected from erosion and stabilized as soon as practicable.
- (12) Consultation pursuant to Section 106 of the National Historic Preservation Act will be completed.
- (13) No species or habitats protected under the Endangered Species Act will be affected by the Proposed Action.
- (14) National Environmental Policy Act environmental assessment (EA) process will be completed.
- (16) State CZM office notified on use of De Minimis List for an EA.

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Key: CZMA = Coastal Zone Management Act; GIS = geographic information system.	

8 Distribution List

(will be provided in the Final EA)

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Appendix A
Air Quality – Emission Calculations and Dispersion Modeling

Lease of Land for Energy Generation and Storage, Resiliency, Reliability, and Security

at

Joint Base Pearl Harbor-Hickam, Hawaii

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Construction Emission Calculations
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1 Construction Emissions

A qualitative assessment involves an examination of expected locations of pollutant plumes and sensitive receptors to determine whether they overlap to inform on exposure potential and how the exposure compares to ambient air quality limits and threshold values. Directional changes in concentration and how they would affect compliance with applicable limits or levels with respect to threshold values could be concluded; however, no concentration values would be available for comparison or determination of exposure severity. A qualitative assessment could consider the construction duration and how pollutant concentrations would affect design concentrations that are used to determine compliance with ambient air quality standards. For example, the 1-hour nitrogen dioxide National Ambient Air Quality Standards value is based on a 3-year average, but if Proposed Action activities do not occur for the entire duration of the 3-year period, then the period of no activity would lower the 3-year average. Therefore, the duration and intensity of pollutant exposure within the adjacent neighborhood of each localized activity area were considered in evaluating air quality impacts from the proposed temporary construction activities. The qualitative impact assessment methodology assumes the following:

- Construction of the project would comply with HAR Section 11-60.1-33 such that visible fugitive dust plumes would not likely occur outside of the activity area.
- Elevated pollutant concentrations are expected immediately downwind of pollutant release; therefore, the analysis focuses on the area influenced by local wind patterns.
- Potential impacts from exposure to additional on-road traffic associated with the action alternatives are based on historical 24-hour traffic volumes and the anticipated addition of expected traffic volume contributed by the action alternatives to estimate the total anticipated 24-hour traffic volumes.

Increased direct and indirect emissions are the result of the following potential construction activities at Site 2, Site 5, and the connection to the Hawaiian Electric Company (HECO) electric infrastructure ("46KV Transmission Backbone"):

- Use of construction equipment
- Movement of trucks containing construction and removal materials
- Commute of construction workers
- Earth disturbance dust emissions from equipment and truck operations

Estimates of the emissions from construction equipment were developed based on the estimated hours of nonroad equipment and on-road vehicle use and horsepower rating provided by Ameresco (Albertini, April 7, 2023), load factor and the emission factors for each type of equipment and vehicle using USEPA estimation tool.

Emission factors for all criteria pollutants and hazardous air pollutants from both construction equipment (nonroad engines including cranes, excavators, loaders, generators, and other construction equipment) and motor vehicles were derived from MOVES3, which is the USEPA's MOtor Vehicle Emission Simulator (MOVES). MOVES3 is an emission modeling system that estimates emissions for mobile sources at the national, county, and project levels for criteria air pollutants, greenhouse gases (GHGs), and air toxics. MOVES3 was the current model at the time of writing this EA. A newer version, MOVES4 replaced MOVES3 in August 2023, but no substantive increases in emissions are expected if the analysis were updated with MOVES4.

To calculate emission factors for each alternative, model runs were conducted for a conservatively assumed construction start year of 2025 and project-level emission rate mode. Nonroad emission factors from MOVES3 (version 3.1) are provided in units of grams per horsepower-hour (g/hp-hr), so emissions were estimated by multiplying the emission factor by the nonroad engine's assumed horsepower (hp) rating and the anticipated total operating hours, and the load factor for each different type of equipment as applied in MOVES model. Emission factors of hazardous air pollutants and GHGs, in terms of carbon dioxide (CO_2) and methane (CH_4), were also predicted using MOVES3. Emissions for nitrous oxide, N_2O, were estimated using a conversion factor. This was due to the limitations of MOVES3 where N_2O emission factors are not provided for nonroad equipment. Table B-8 of EPA's Direct Emissions from Mobile Combustion Sources was used and a conversion factor was calculated by dividing N_2O emission factor by CH_4 for diesel construction equipment.[1]

The calculation methodology for nonroad engines using the MOVES emission factors is as follows, per unit:

$$E = EF \times PR \times HR \times LF \times 1.10231E(-6)$$

Where:

E = nonroad emissions per unit (tons)

EF = nonroad emission factor per unit type (g/hp-hr)

PR = power rating (hp)

HR = total operating hours (hr)

LF = load factor

1.10231E(-6) = mass conversion factor (ton/g)

For N_2O emissions, the following equation is applied:

$$E = \mathrm{CH4}\ EF \times \frac{\mathrm{N2O}}{\mathrm{CH4}} conversion\ factor\ x\ PR \times HR \times LF \times 1.10231E(-6)$$

Where:

E = nonroad emissions per unit (tons)

EF = nonroad emission factor per unit type (g/hp-hr)

N_2O/CH_4 conversion factor = 0.26/0.57 = 0.45614

PR = power rating (hp)

HR = total operating hours (hr)

LF = load factor

1.10231E(-6) = mass conversion factor (ton/g)

[1] EPA, 2020. Direct Emissions from Mobile Combustion Sources. Climate Leaders Greenhouse Gas Inventory Guidance. Table B-8. December 2020.

Typical load factors for various equipment types were based on Appendix A of EPA's "Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling".[2]

On-road emission factors from MOVES3 are provided in grams per vehicle mile traveled (g/VMT) for running operations, g/hour for idling and g/start for vehicle starts. Total emissions from on-road vehicles during construction were estimated based on running, idling, and starting operational modes.

The equation for emissions during running operations is the following:

$$E = EF \times VMT \times 1.10231E(-6)$$

Where:

E	=	on-road emissions per unit (tons)
EF	=	on-road emission factor per vehicle type (g/VMT)
VMT	=	vehicle miles traveled per year (VMT/yr)
1.10231E(-6)	=	mass conversion factor (ton/g)

Idling emissions were calculated by taking the MOVES3-produced emission factor and multiplying by the number of hours (represented as a fraction) spent in idle mode. Idling time, 10 minutes per day, was estimated based on engineering judgement.

The equation for emissions during idle operations is the following:

$$E = EF \times HR \times 1.10231E(-6)$$

Where:

E	=	on-road emissions per unit (tons)
EF	=	on-road emission factor per idle time (g/hr)
HR	=	total idling hours (hr)
1.10231E(-6)	=	mass conversion factor (ton/g)

Emissions from starts were calculated by taking the MOVES3 emission factor and multiplying by the number of starts, where two starts were assumed per day of use.

The equation for emissions during starts is the following:

$$E = EF \times ST \times 1.10231E(-6)$$

Where:

E	=	on-road emissions per unit (tons)
EF	=	on-road emission factor per starts (g/start)
ST	=	total number of starts
1.10231E(-6)	=	mass conversion factor (ton/g)

[2] EPA, 2010. Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling. NR-005d. Assessment and Standards Division. Office of Transportation and Air Quality – U.S. Environmental Protection Agency. EPA-420-R-10-016. July 2010.

In addition to engine emissions, fugitive dust emissions resulting from earth disturbance (e.g., excavation and transferring of excavated materials into dump trucks) were estimated with particulate emission factors from the "WRAP Fugitive Dust Handbook."[3] The PM_{10} emission factor is the following:

$$PM_{10}\ emission\ factor\ (tons/acre - month) = 0.11$$

Where:

$PM_{2.5}$ = PM_{10} emission factor × ratio [0.1 for construction and demolition activity]

Emissions were calculated using the following equation:

$$E = EF \times acres\ x\ months\ of\ activity$$

Where:

E = fugitive dust emissions (tons)

EF = emission factor (ton/acre-month)

Assumed acreage disturbed was based on total area for Site 2 and Site 5. For the 46KV line, some temporary ground disturbance would occur as the shafts are dug for the microtunneling and the open trench. Acreage disturbed based on area impacted when digging the shafts and the trenching.

The monthly labor distribution curves applicable for each site over the combined three construction years provided by Ameresco (Albertini, April 14, 2023) were used to prorate total construction emissions over three years. To determine emissions for each month, total emissions at each construction location were multiplied by the ratio of labor hours for that month over total labor hours for the entire activity (i.e., percent labor hours).

2 Operational Emissions

2.1 On-Road Emissions

As with on-road vehicles during construction, MOVES3 emission factors were utilized, with emission factors provided in g/VMT, g/hour and g/start to estimate emissions from on-road vehicles during operations. Operational on-road emissions are provided for Site 2 because the frequency and count of vehicular traffic at Site 5 is minimal (one truck once per month) and, thus, assumed to be insignificant.

Operational emissions from on-road traffic would be minimal and based on an assumed number of delivery trucks and employee vehicles per day associated with the proposed energy generating facility at Site 2 using the 2027 on-road vehicle emission factors estimated via MOVES3. Emissions associated with idling, driving and starts were accounted for at Site 2.

2.2 FRG Plant – Operational Emissions

Details on emissions associated with the proposed energy generating facility and associated air dispersion modeling is included in the attached permit application to the State of Hawaii Department of Health, Clean Air Branch.

[3] WRAP Fugitive Dust Handbook. Prepared by Countess Environmental. Prepared for Western Governors' Association. September 7, 2006.

In accordance with H.A.R. §11-60.1-179, HAP emissions were modeled to compare resultant concentrations to significant ambient air concentrations as defined in H.A.R. §11-60.1-179 (c). For acute and chronic impacts, for those HAPs with a published Threshold Limit Value-Time Weighted Average (TLV-TWA), the 8-hour and annual HAP concentrations associated with full and minimum load operations using RNG-only and biodiesel-only scenarios were compared to these thresholds to determine significance. For acute and chronic impacts for HAPs without TLV-TWAs, in accordance with H.A.R. §11-60.1-179 (c)(2), the 1-hour, 8-hour and annual reference exposure levels (RELs) established by the California Office of Environmental Health Hazard Assessment (OEHHA) were used as criteria to determine whether the modeled ambient concentrations are significant. Cancer risks were determined using the carcinogenic unit risk estimates from EPA's Prioritized Chronic Dose-Response Values for inhalation. Because the EPA guidance document does not provide a quantitative estimate of carcinogenic risk from inhalation exposure of ethylbenzene or naphthalene, the carcinogenic unit risk values from OEHHA's "Hot Spots Unit Risk and Cancer Potency Values" were used to characterize cancer risk from those substances. Table 2.2-1 details the HAPS Assessment, Comparison of Model Concentrations with HDOH Significance Thresholds. Table 2.2-2 details HAPs Assessment, Comparison of Modeled Concentrations with OEHHA RELs for HAPs without TWA-TLVs. Table 2.2-3 details HAPs Assessment, Assessment of Cancer Risk.

Table 2.2-1 HAPs Assessment, Comparison of Modeled Concentrations with HDOH Significance Thresholds

Pollutant	***Averaging Period***	***Impact (µg/m^3)***	***TWA-TLV(1) (8-hour Basis) (µg/m^3)***	***1/100 x TWA-TLV***	***1/420 x TWA-TLV***	***ACUTE 8-hour Impact > 1/100 x TWA-TLV?***	***CHRONIC Annual Impact > 1/420 x TWA-TLV?***
RNG Only – Full Load Operations							
Acetaldehyde	8-Hour	0.14	N/A	N/A	N/A	N/A	N/A
	Annual	0.024					
Acrolein	8-Hour	0.02	N/A	N/A	N/A	N/A	N/A
	Annual	0.003					
Benzene	8-Hour	0.06	1,597	16	4	No	No
	Annual	0.010					
1,3-Butadiene	8-Hour	0.10	4,425	44	11	No	No
	Annual	0.016					
Ethylbenzene	8-Hour	0.02	86,869	869	207	No	No
	Annual	0.003					
Formaldehyde	8-Hour	0.84	123	1.23	0.29	No	No
	Annual	0.137					
Naphthalene	8-Hour	0.01	52,429	524	125	No	No
	Annual	0.001					
PAHs (as B(a)P)	8-Hour	4.70E-06	2,064	21	5	No	No
	Annual	7.681E-07					
Toluene	8-Hour	0.07	75,362	754	179	No	No
	Annual	0.011					
Xylene	8-Hour	0.18	434,192	4,342	1,034	No	No
	Annual	0.029					

Table 2.2-1 HAPs Assessment, Comparison of Modeled Concentrations with HDOH Significance Thresholds

Pollutant	*Averaging Period*	*Impact (µg/m³)*	*TWA-TLV[(1)] (8-hour Basis) (µg/m³)*	*1/100 x TWA-TLV*	*1/420 x TWA-TLV*	*ACUTE 8-hour Impact > 1/100 x TWA-TLV?*	*CHRONIC Annual Impact > 1/420 x TWA-TLV?*
RNG Only – Minimum Load Operations							
Acetaldehyde	8-Hour	0.09	N/A	N/A	N/A	N/A	N/A
	Annual	0.035					
Acrolein	8-Hour	0.01	N/A	N/A	N/A	N/A	N/A
	Annual	3.90E-03					
Benzene	8-Hour	0.04	1,597	16	4	No	No
	Annual	0.014					
1,3-Butadiene	8-Hour	0.06	4,425	44	11	No	No
	Annual	0.024					
Ethylbenzene	8-Hour	0.01	86,869	869	207	No	No
	Annual	4.70E-03					
Formaldehyde	8-Hour	0.88	123	1.23	0.29	No	No
	Annual	0.202					
Naphthalene	8-Hour	0.00	52,429	524	125	No	No
	Annual	1.66E-03					
PAHs (as B(a)P)	8-Hour	0.00	2,064	21	5	No	No
	Annual	1.13E-06					
Toluene	8-Hour	0.04	75,362	754	179	No	No
	Annual	0.016					
Xylene	8-Hour	0.11	434,192	4,342	1,034	No	No
	Annual	0.043					
Biodiesel Only – Full Load Operations							
Acetaldehyde	8-Hour	7.52E-03	N/A	N/A	N/A	N/A	N/A
	Annual	4.32E-04					
Acrolein	8-Hour	2.32E-03	N/A	N/A	N/A	N/A	N/A
	Annual	1.33E-04					
Benzene	8-Hour	2.19E-01	1,597	16	4	No	No
	Annual	1.26E-02					
Ethylbenzene	8-Hour	1.46E-02	86,869	869	207	No	No
	Annual	8.42E-04					
Formaldehyde	8-Hour	0.74	123	1.23	0.29	No	No
	Annual	4.27E-02					
Hexane	8-Hour	3.01E-03	176,234	1,762.34	420	No	No
	Annual	1.74E-04					
Naphthalene	8-Hour	3.53E-02	52,429	524	125	No	No
	Annual	2.03E-03					
PAHs (as B(a)P)	8-Hour	1.35E-04	2,064	21	5	No	No
	Annual	7.74E-06					
Toluene	8-Hour	0.08	75,362	754	179	No	No
	Annual	4.66E-03					
Xylene	8-Hour	0.06	434,192	4,342	1,034	No	No
	Annual	3.34E-03					

Table 2.2-1 HAPs Assessment, Comparison of Modeled Concentrations with HDOH Significance Thresholds

Pollutant	*Averaging Period*	*Impact (μg/m³)*	*TWA-TLV(1) (8-hour Basis) (μg/m³)*	*1/100 x TWA-TLV*	*1/420 x TWA-TLV*	*ACUTE 8-hour Impact > 1/100 x TWA-TLV?*	*CHRONIC Annual Impact > 1/420 x TWA-TLV?*
Biodiesel Only – Minimum Load Operations							
Acetaldehyde	8-Hour	5.82E-03	N/A	N/A	N/A	N/A	N/A
	Annual	9.10E-04					
Acrolein	8-Hour	1.79E-03	N/A	N/A	N/A	N/A	N/A
	Annual	2.81E-04					
Benzene	8-Hour	0.17	1,597	16	4	No	No
	Annual	2.65E-02					
Ethylbenzene	8-Hour	1.13E-02	86,869	869	207	No	No
	Annual	1.77E-03					
Formaldehyde	8-Hour	0.57	123	1.23	0.29	No	No
	Annual	8.98E-02					
Hexane	8-Hour	2.33E-03	176,234	1,762.34	420	No	No
	Annual	3.65E-04					
Naphthalene	8-Hour	2.73E-02	52,429	524	125	No	No
	Annual	4.27E-03					
PAHs (as B(a)P)	8-Hour	1.04E-04	2,064	21	5	No	No
	Annual	1.63E-05					
Toluene	8-Hour	6.27E-02	75,362	754	179	No	No
	Annual	9.81E-03					
Xylene	8-Hour	4.49E-02	434,192	4,342	1,034	No	No
	Annual	7.03E-03					

(1) TWA-TLVs from ACGIH, "2019 TLVs and BEIs" except PAHs from https://www.atsdr.cdc.gov/csem/polycyclic-aromatic-hydrocarbons/standards_and_regulations_for_exposure.html.

Table 2.2-2 HAPs Assessment, Comparison of Modeled Concentrations with OEHHA RELs for HAPs without TWA-TLVs

Pollutant	*Averaging Period*	*Impact (µg/m³)*	*1-hour REL(1) (µg/m³)*	*8-hour REL(1) (µg/m³)*	*Annual REL(1) (µg/m³)*	*ACUTE 1-hour Impact > REL?*	*ACUTE 8-hour Impact > REL?*	*CHRONIC Annual Impact > REL?*
RNG Only – Full Load Operations								
Acetaldehyde	1-Hour	0.40	470	300	140	No	No	No
	8-Hour	0.14						
	Annual	0.024						
Acrolein	1-Hour	4.49E-02	2.5	0.7	0.35	No	No	No
	8-Hour	0.02						
	Annual	0.003						
RNG Only – Minimum Load Operations								
Acetaldehyde	1-Hour	0.29	470	300	140	No	No	No
	8-Hour	0.09						
	Annual	0.035						
Acrolein	1-Hour	0.03	2.5	0.7	0.35	No	No	No
	8-Hour	0.01						
	Annual	0.004						
Biodiesel Only – Full Load Operations								
Acetaldehyde	1-Hour	2.21E-02	470	300	140	No	No	No
	8-Hour	7.52E-03						
	Annual	4.32E-04						
Acrolein	1-Hour	6.81E-03	2.5	0.7	0.35	No	No	No
	8-Hour	2.32E-03						
	Annual	1.33E-04						
Biodiesel Only – Minimum Load Operations								
Acetaldehyde	1-Hour	1.56E-02	470	300	140	No	No	No
	8-Hour	5.82E-03						
	Annual	9.10E-04						
Acrolein	1-Hour	4.80E-03	2.5	0.7	0.35	No	No	No
	8-Hour	1.79E-03						
	Annual	2.81E-04						

(1) RELs from https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary

Table 2.2-3 HAPs Assessment, Assessment of Cancer Risk

Pollutant	*Annual Impact ($\mu g/m^3$)*	*Cancer Risk[(1)] Unit Risk (per $\mu g/m^3$)*	*Cancer Risk X 10E-6*
RNG Only – Full Load Operations			
Acetaldehyde	0.024	2.20E-06	0.05
Benzene	0.010	7.80E-05	0.08
1,3-Butadiene	0.016	3.50E-05	0.58
Ethylbenzene	0.003	2.60E-06	0.01
Formaldehyde	0.137	1.30E-05	1.78
Naphthalene	0.001	3.40E-05	0.04
PAHs (as B(a)P)	7.681E-07	6.40E-04	4.92E-04
		Total Cancer Risk	2.5 in one million
RNG Only – Minimum Load Operations			
Acetaldehyde	0.035	2.20E-06	0.08
Benzene	0.014	7.80E-05	0.11
1,3-Butadiene	0.024	3.50E-05	0.85
Ethylbenzene	4.70E-03	2.60E-06	1.22E-02
Formaldehyde	0.202	1.30E-05	2.63
Naphthalene	1.66E-03	3.40E-05	0.06
PAHs (as B(a)P)	1.13E-06	6.40E-04	7.25E-04
		Total Cancer Risk	3.7 in one million
Biodiesel Only – Full Load Operations			
Acetaldehyde	4.32E-04	2.20E-06	9.51E-04
Benzene	1.26E-02	7.80E-05	9.82E-02
Ethylbenzene	8.42E-04	2.60E-06	2.19E-03
Formaldehyde	4.27E-02	1.30E-05	0.55
Naphthalene	2.03E-03	3.40E-05	6.90E-02
PAHs (as B(a)P)	7.74E-06	6.40E-04	4.95E-03
		Total Cancer Risk	0.73 in one million
Biodiesel Only – Minimum Load Operations			
Acetaldehyde	9.10E-04	2.20E-06	2.00E-03
Benzene	2.65E-02	7.80E-05	0.21
Ethylbenzene	1.77E-03	2.60E-06	4.61E-03
Formaldehyde	8.98E-02	1.30E-05	1.17
Naphthalene	4.27E-03	3.40E-05	0.15
PAHs (as B(a)P)	1.63E-05	6.40E-04	0.01
		Total Cancer Risk	1.54 in one million

(1) Cancer risks from EPA's "Prioritized Chronic Dose-Response Values for inhalation" and OEHHA "Hot Spots Unit Risk and Cancer Potency Values."

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CONSTRUCTION EMISSION CALCULATIONS

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Construction: Schedule and Equipment

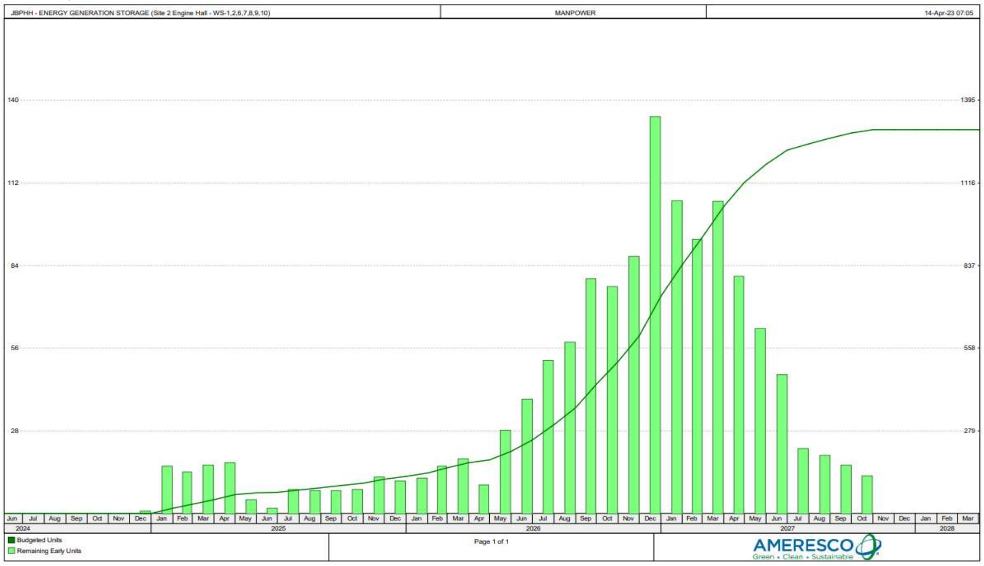
SITE 2 ENGINE HALL AND SITE 5 PHOTOVOLTAIC (PV) AND BESS

ITEM	DESCRIPTION	MANUFACTURE	MODEL	Power Rating (HP)	WS 1 - COVERED STORAGE	WS 2 - SITE PRECON	WS 3 - MICROTUNNELING	WS 4 - OPEN CUT DISTRIBUTION	WS 6 - BATTERY ENERGY STORAGE SYSTEMS (BESS)	WS 7 - SITE SUBSTATION	WS 8 - ENGINE	WS 9 - STORAGE TANKS & DISTRIBUTION	WS 10 - FUEL TERMINAL	WS 11 - PHOTOVOLTAI C (PV)	WS 12 - ELECTRICAL DISTRIBUTION	EQUIP. DAYS	USE FACTOR	TOTAL USE DAYS (8hrs)
					DURATION (DAYS)													
1	CONCRETE PUMP	PUTMEISTER	38Z-5	350	0	0	0	0	2	0	30	8	0	0	0	40	80	32
2	HELICAL PILE DRIVER	CATERPILLAR	308CR	69.5	0	0	0	0	0	0	0	0	0	50	0	50	35	18
3	SHEET PILE DRIVER	ABI	TM 13/16	420	0	0	300	0	0	0	0	0	0	0	0	300	70	210
4	CRANE (100 TON)	LINK-BELT	HTT-86100	480	0	0	0	0	0	0	16	0	0	0	0	16	45	7
5	CRANE (80 TON)	Grove RT 880E	RTC-8065	275	10	0	855	0	15	12	130	152	0	4	0	1178	45	530
6	DOZER	CATERPILLAR	D5	170	0	175	0	0	20	40	82	75	35	35	0	462	75	347
7	WHEEL LOADER	CATERPILLAR	950	168	0	175	810	82	0	0	30	45	20	50	0	1212	65	788
8	BACKHOE LOADER	CATERPILLAR	430F2	108	0	205	445	0	35	105	410	205	200	215	0	1820	60	1092
9	GRADER	CATERPILLAR	140GC	196	0	100	0	0	20	0	61	55	35	35	0	306	50	153
10	EXCAVATOR	CATERPILLAR	336	260	30	165	710	82	0	60	175	60	60	30	0	1372	40	549
11	EXCAVATOR	CATERPILLAR	320	172	0	0	445	82	0	0	0	0	0	0	0	527	65	343
12	EXCAVATOR (MINI)	CATERPILLAR	306CR	55.9	0	120	0	0	40	165	175	80	60	175	0	815	60	489
13	SKID STEER	CATERPILLAR	289D3	74.3	125	205	1165	82	60	200	420	240	185	300	0	2982	50	1491
14	TELEHANDLER	CATERPILLAR	TL1255D	111	40	150	720	82	50	260	371	350	90	295	155	2563	35	897
15	COMPACTOR (SOIL)	CATERPILLAR	CP56B	157	0	55	0	0	25	15	115	80	35	35	0	360	65	234
16	COMPACTOR (ROLLER)	CATERPILLAR	CB10	120	0	0	0	0	0	0	10	0	20	0	0	30	80	24
17	COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	24.7	5	0	0	0	0	0	10	0	20	0	0	35	80	28
18	COMPACTOR (TRENCH)	WACKER NEUSO	RTxSC3	23.7	0	90	415	48	0	75	155	60	60	0	0	903	40	361
19	COMPACTOR (RAMMER)	WACKER NEUSO	BS60-4	3.6	10	90	415	48	15	165	140	60	60	100	0	1103	30	331
20	COMPACTOR (PLATE)	WACKER NEUSO	WP1540A	9.9	10	0	0	0	15	60	130	65	95	60	0	435	30	131
21	PAVER	CATERPILLAR	AP555F	142	5	0	0	0	0	0	10	0	20	0	0	35	85	30
22	SLIPFORM PAVER	WIRTGEN	SP15i	127	0	0	0	0	0	0	15	0	0	0	0	15	70	11
23	TRUCK - DELIVERY	MACK	GRANITE	375	21	45	40	12	30	65	231	190	10	68	55	767	25	192
24	TRUCK - MIXER	MACK	GRANITE	375	15	0	0	0	25	22	80	40	30	22	0	234	25	59
25	TRUCK - DUMP	MACK	GRANITE	375	20	485	1155	82	45	75	257	115	145	223	0	2602	25	651
26	TRUCK - FUEL/MECH	MACK	GRANITE	375	16	205	1155	82	65	73	501	365	150	98	79	2789	30	837
26	TRUCK - LINEMAN BUCK	MACK	GRANITE	375	0	10	0	0	0	0	0	0	0	10	0	20	90	18
27	TRUCK - FLAT BED	FORD	F-750	330	15	75	410	0	5	0	0	0	0	123	0	628	10	63
28	TRUCK - WATER	FORD	F-650	300	0	0	0	82	0	0	0	0	0	10	0	92	10	9
29	TRUCK - PICKUP	FORD	F-250	430	180	280	1165	0	0	0	0	0	200	430	0	2255	10	226
30	TRUCK - PICKUP	FORD	F-150	290	180	280	1165	82	70	240	940	560	200	430	225	4372	10	437
31	TRUCK - (COMMUTER)	FORD	F-150	290	900	1680	9320	492	560	1920	7520	3360	1200	2630	1350	30932	10	3093
32	GENERATOR (MOBILE)	CATERPILLAR	XQ570	680	0	0	410	0	0	0	0	0	0	0	0	410	95	390
33	GENERATOR (MOBILE)	WACKER NEUSO	G50	70	55	0	1155	82	15	0	40	0	0	430	0	1777	95	1688
34	COMPRESSOR (MOBILE)	Sullair	185	49	0	0	410	82	0	0	0	0	0	0	0	492	95	467
35	PUMP (WELLPOINT)	MWI	DD PUMP	9	0	90	0	0	0	60	130	60	60	0	0	400	95	380
36	PUMPS (TRASH)	HONDA	WT30XK4A	8.4	20	205	1155	82	15	60	365	225	190	190	0	2507	95	2382
37	TOWER LIGHTS	WACKER NEUSO	LTV6L	12.2	0	0	1155	82	0	0	0	0	0	0	0	1237	95	1175

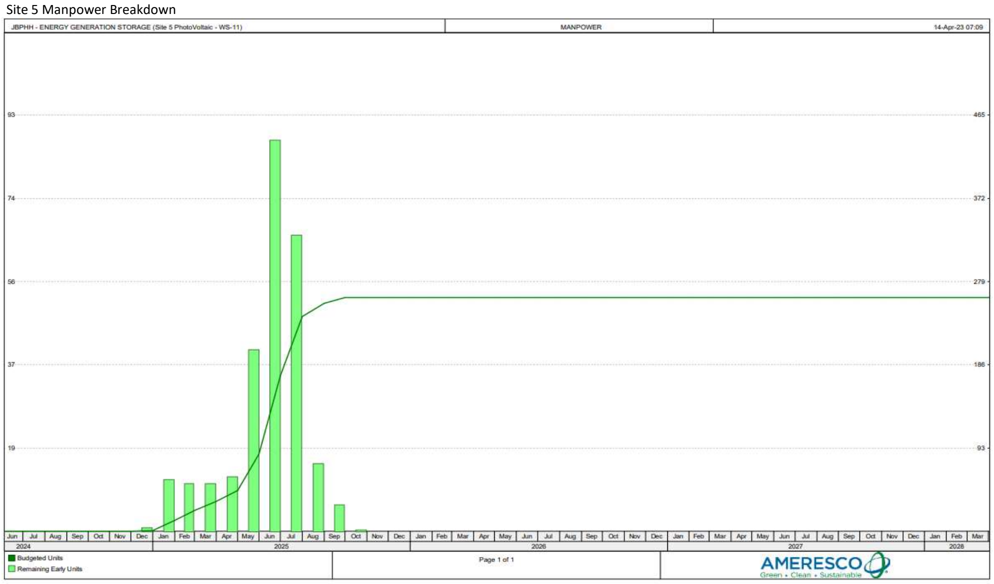
Legend	
(white)	SITE LOCATION 2 - ENGINE HALL, BATTERY STORAGE, FUEL STORAGE, FACILITIES
(light grey)	SITE LOCATION 5 - PHOTOVOLTAIC (PV) AND BESS
(dark grey)	46KV TRANSMISSION BACKBONE

Note:
1. All data shown is from Ameresco and developed per their project experience. Based on their file "JBPHH - EMISSIONS, SITE 2 ENGINE HALL- BESS & SITE 5 PV (3-30-23).xlsx"

Site 2 Manpower Breakdown



Site 5 Manpower Breakdown



Backbone Manpower Breakdown

Note:

1. Charts were provided by applicant. "JBPHH - Site 2 Engine Hall - Manpower WS1,2,6,7,8,9,10 April 14, 2023", "JBPHH - Site 5 Photovoltaic - Manpower WS-11 April 14, 2023" and "JBPHH - Transmission Backbone - Manpower WS-3,4,12 April 14, 2023"
2. Line graph represents budgeted units.
3. Bar graph represents remaining early units.

Construction: Manpower Tables

Site 2	Date																					
	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25	Jan-26	Feb-26	Mar-26
Manpower	0	0	0	0	0	0	1	16	14	16	17	5	2	8	8	8	8	12	11	12	16	19
Percentage	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%	1.23%	1.07%	1.23%	1.30%	0.38%	0.15%	0.61%	0.61%	0.61%	0.61%	0.92%	0.84%	0.92%	1.23%	1.45%

Site 2	Date																							
	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27	Jan-28	Feb-28	Mar-28
Manpower	10	28	39	52	58	80	77	87	135	106	93	106	81	63	47	22	20	16	13	0	0	0	0	0
Percentage	0.77%	2.14%	2.99%	3.98%	4.44%	6.13%	5.90%	6.66%	10.34%	8.12%	7.12%	8.12%	6.20%	4.82%	3.60%	1.68%	1.53%	1.23%	1.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Site 5	Date																					
	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25	Jan-26	Feb-26	Mar-26
Manpower	0	0	0	0	0	0	1	12	11	11	13	42	87	67	15	6	1	0	0	0	0	0
Percentage	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.38%	4.51%	4.14%	4.14%	4.89%	15.79%	32.71%	25.19%	5.64%	2.26%	0.38%	0.00%	0.00%	0.00%	0.00%	0.00%

Site 5	Date																							
	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27	Jan-28	Feb-28	Mar-28
Manpower	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Percentage	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Backbone	Date																					
	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25	Jan-26	Feb-26	Mar-26
Manpower	0	0	0	0	0	0	1	8	15	23	30	24	28	33	32	28	42	38	47	44	26	30
Percentage	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.15%	1.21%	2.27%	3.48%	4.55%	3.64%	4.24%	5.00%	4.85%	4.24%	6.36%	5.76%	7.12%	6.67%	3.94%	4.55%

Backbone	Date																							
	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27	Jan-28	Feb-28	Mar-28
Manpower	26	21	27	43	27	25	16	10	6	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Percentage	3.94%	3.18%	4.09%	6.52%	4.09%	3.79%	2.42%	1.52%	0.91%	0.91%	0.61%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Construction: Nonroad Emissions - Notes and References

Shift Details	
8	Hours / Day
6	Days / Week
4.3	Weeks / Month
25.8	Days / Month
206.4	Hours / Month

Conversions	
0.0005	lbs to tons
453.592	grams to lbs
0.45614	N_2O / CH_4 [4.]
0.1	PM2.5/PM10 (Fugitive Dust)[5.]
0.11	PM10 tons / acre month (Fugitive Dust)[5.]

Notes:

1. Pollution lookup and fuel lookup are based on EPA MOVES software decoding
2. Schedule is provided by Ameresco based on sheet "JBPHH - EMISSIONS, SITE 2 ENGINE HALL- BESS & SITE 5 PV (3-30-23)"

3. Calculations were built around this equation given by the EPA's Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100058Z.TXT

$$Emissions = (Pop)\ (Power)\ (LF)\ (A)\ (EF)$$

$$\begin{aligned} \text{where } Pop &= \text{Engine Population} \\ Power &= \text{Average Power (hp)} \\ LF &= \text{Load Factor (fraction of available power)} \\ A &= \text{Activity (hrs/yr)} \\ EF &= \text{Emission Factor (g/hp-hr)} \end{aligned}$$

4. N_2O is calculated using a conversion factor as expressd in D4. This was due to the limitations of offroad MOVES3.1 Table B-8 of EPA's Direct Emissions from Mobile Combustion Sources was used and a conversion was made by dividing N_2O (0.26) emission factor by CH_4 (0.57) for diesel construction equipment. https://www.epa.gov/sites/default/files/2016-03/documents/mobileemissions_3_2016.pdf#page=26

5. Fugitive Dust emission constants were taken from "Wrap Fugitive Dust Handbook" pages 38 and 43. The PM10 emission factor of 0.11 tons/acre-month already accounts for routine watering. http://waterfrontballparkdistrict.com.s3.amazonaws.com/10.%20Remainder/AR%200025064-%20AR%200025307.pdf

Table 3-2. Recommended PM10 Emission Factors for Construction Operations[1]

Basis for emission factor	Recommended PM10 emission factor
Level 1 Only area and duration known	0.11 ton/acre-month (average conditions) 0.42 ton/acre-month (worst-case conditions)[a]
Level 2 Amount of earth moving known, in addition to total project area and duration	0.011 ton/acre-month for general construction (for each month of construction activity) plus 0.059 ton/1,000 cubic yards for on-site cut/fill[b] 0.22 ton/1,000 cubic yards for off-site cut/fill[b]
Level 3 More detailed information available on duration of earth moving and other material movement	0.13 lb/acre-work hr for general construction plus 49 lb/scraper-hr for on-site haulage[c] 94 lb/hr for off-site haulage[d]
Level 4 Detailed information on number of units and travel distances available	0.13 lb/acre-work hr for general construction plus 0.21 lb/ton-mile for on-site haulage 0.62 lb/ton-mile for off-site haulage[c]

[a] Worst-case refers to construction sites with active large-scale earth moving operations

3.3.1 Emission Estimation Methodology

Emission Factor. The PM10 emission factor used for estimating geologic dust emissions from building construction activities is based on work performed by MRI[3] under contract to the PM10 Best Available Control Measure (BACM) working group. For most parts of the state, the emission factor used is 0.11 tons PM10/acre-month of activity. This emission factor is based on MRI's observation of the types, quantity, and duration of operations at eight construction sites (three in Las Vegas and five in California). The bulk of the operations observed were site preparation-related activities. The observed activity data were then combined with operation-specific emission factors provided in AP-42[2] to produce site emissions estimates. These site estimates were then combined to produce the overall average emission factor of 0.11 tons PM10/acre-month. The PM2.5/PM10 ratio for fugitive dust from construction and demolition activities is 0.1 based on the analysis conducted by MRI on behalf of WRAP.[7]

Table B-8: CH_4 and N_2O Emission Factors for Non-Road Vehicles

Vehicle Type/Fuel Type	Emission Factor (g CH_4/gal fuel)	Emission Factor (g N_2O/gal fuel)
Ships and Boats		
Residual Fuel Oil	0.11	0.57
Gasoline	0.64	0.22
Diesel	0.06	0.45
Rail		
Diesel	0.80	0.26
Agricultural Equipment		
Gasoline	1.26	0.22
Diesel	1.44	0.26

r Corporate Climate Leadership – GHG Inventory Guidance

rom Mobile Sources   *Appendix B: Default CH_4 and N_2C*

Vehicle Type/Fuel Type	Emission Factor (g CH_4/gal fuel)	Emission Factor (g N_2O/gal fuel)
Construction/Mining Equipment		
Gasoline	0.50	0.22
Diesel	0.57	0.26
Aircraft		
Jet Fuel	0.00	0.30
Aviation Gasoline	7.06	0.11
Other Non-Road		
Gasoline	0.50	0.22
Diesel	0.57	0.26
LPG	0.50	0.22
Biodiesel	0.57	0.26

MOVES Specs:	
Scale	Nonroad Default Inventory
Time Spans	2025 January and July Weekdays All
Geographic Bounds	Hawaii Honolulu County
Nonroad Equipment	Commercial Construction Industrial
Road Type	Nonroad
Pollutants and Processes	All
Units	Grams Million BTU Miles
Output Emissions Detail	Fuel Type Emission Process SCC HP Class

Construction: Summary Nonroad Emissions

Nonroad

Site 2

Activity	Pollutant (tons)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
Workstream 1	0.10957	0.00896	0.00869	0.05928	0.01256	0.00010	0.00066	33.54010	0.00030	0.00045	0.00000	0.00312	0.00111	0.00024	0.00002	0.00006	0.00002	0.00034	0.00020	0.00005
Workstream 2	0.35512	0.02695	0.02615	0.16039	0.04131	0.00064	0.00278	232.53654	0.00127	0.00175	0.00000	0.01080	0.00388	0.00077	0.00007	0.00020	0.00004	0.00130	0.00065	0.00017
Workstream 6	0.08799	0.00600	0.00582	0.03682	0.00844	0.00012	0.00052	43.77318	0.00024	0.00033	0.00000	0.00214	0.00077	0.00016	0.00002	0.00004	0.00001	0.00025	0.00014	0.00003
Workstream 7	0.24758	0.01695	0.01644	0.11099	0.02729	0.00027	0.00178	94.60173	0.00081	0.00111	0.00000	0.00709	0.00253	0.00052	0.00005	0.00013	0.00003	0.00082	0.00042	0.00011
Workstream 8	0.66048	0.04747	0.04605	0.30105	0.07454	0.00090	0.00482	317.50805	0.00220	0.00309	0.00000	0.01940	0.00695	0.00142	0.00014	0.00037	0.00007	0.00228	0.00117	0.00030
Workstream 9	0.35194	0.02758	0.02676	0.16942	0.04323	0.00054	0.00276	192.45460	0.00126	0.00179	0.00000	0.01123	0.00402	0.00082	0.00008	0.00022	0.00004	0.00132	0.00068	0.00017
Workstream 10	0.22876	0.01801	0.01747	0.11662	0.02926	0.00031	0.00197	111.42520	0.00090	0.00126	0.00000	0.00774	0.00277	0.00055	0.00005	0.00014	0.00003	0.00092	0.00044	0.00012
Fugitive Dust	-	41.30088	4.13009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total:	2.04	41.45	4.28	0.95	0.24	0.00	0.02	1025.84	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00

Site 5

Activity	Pollutant (tons)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
Workstream 11	0.76406	0.05090	0.04937	0.31975	0.07334	0.00057	0.00432	194.13680	0.00197	0.00279	0.00000	0.01865	0.00664	0.00143	0.00014	0.00037	0.00009	0.00208	0.00114	0.00028
Fugitive Dust	-	21.05799	2.10580	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total:	0.76	21.11	2.16	0.32	0.07	0.00	0.00	194.14	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Backbone

Activity	Pollutant (tons)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
Workstream 3	6.27807	0.33672	0.32662	2.17714	0.50493	0.00557	0.03003	1861.38458	0.01370	0.02007	0.00000	0.12940	0.04632	0.01025	0.00092	0.00276	0.00053	0.01462	0.00814	0.00199
Workstream 4	0.23960	0.01616	0.01568	0.09974	0.02438	0.00028	0.00154	99.72920	0.00070	0.00099	0.00000	0.00630	0.00225	0.00047	0.00004	0.00012	0.00003	0.00073	0.00038	0.00010
Workstream 12	0.02540	0.00251	0.00244	0.01306	0.00399	0.00002	0.00021	6.97550	0.00009	0.00015	0.00000	0.00102	0.00036	0.00008	0.00001	0.00002	0.00000	0.00011	0.00006	0.00002
Fugitive Dust	-	5.45441	0.54544	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total:	6.54	5.81	0.89	2.29	0.53	0.01	0.03	1968.09	0.01	0.02	0.00	0.14	0.05	0.01	0.00	0.00	0.00	0.02	0.01	0.00

Note

Workstream 1 - COVERED STORAGE
Workstream 2 - SITE PRECON
Workstream 3 - MICROTUNNELING
Workstream 4 - OPEN CUT DISTRIBUTION
Workstream 6 - BATTERY ENERGY STORAGE SYSTEMS (BESS)
Workstream 7 - SITE SUBSTATION
Workstream 8 - ENGINE HALL
Workstream 9 - STORAGE TANKS & DISTRIBUTION
Workstream 10 - FUEL TERMINAL
Workstream 11 - PHOTOVOLTAIC (PV)
Workstream 12 - ELECTRICAL DISTRIBUTION

Construction: Annual Summary Nonroad Emissions

Site 2	Emissions (tons) per year		
	2025 [1.]	2026	2027
NOX	0.196954392	0.9581987	0.8862948
PM10	3.999274735	19.456789	17.996736
PM2.5	0.412679399	2.007718	1.8570573
CO	0.092094784	0.4480484	0.4144265
VOC	0.022828966	0.1110647	0.1027303
SO2	0.000277937	0.0013522	0.0012507
CH4	0.001475553	0.0071787	0.00664
CO2	98.97072341	481.50042	445.36826
N2O	0.000673059	0.0032745	0.0030288
Benzene	0.000943128	0.0045884	0.0042441
Ethanol	0.000000	0.000000	0.000000
Formaldehyde	0.005935644	0.0288774	0.0267104
Acetaldehyde	0.002124623	0.0103365	0.0095608
Acrolein	0.000431906	0.0021013	0.0019436
1,3-Butadiene	4.14744E-05	0.0002018	0.0001866
Ethyl Benzene	0.000113049	0.00055	0.0005087
Hexane	2.22432E-05	0.0001082	0.0001001
Toluene	0.000698453	0.003398	0.003143
Xylene	0.000356402	0.0017339	0.0016038
Naphthalene gas	9.07086E-05	0.0004413	0.0004082

Site 5	Emissions (tons) per year		
	2025 [1.]	2026	2027
NOX	0.764056226	0	0
PM10	21.10889038	0	0
PM2.5	2.155169711	0	0
CO	0.319749384	0	0
VOC	0.073338846	0	0
SO2	0.000572536	0	0
CH4	0.00431961	0	0
CO2	194.1368021	0	0
N2O	0.001970347	0	0
Benzene	0.002785464	0	0
Ethanol	0	0	0
Formaldehyde	0.018654882	0	0
Acetaldehyde	0.006640575	0	0
Acrolein	0.001433786	0	0
1,3-Butadiene	0.000135042	0	0
Ethyl Benzene	0.000372916	0	0
Hexane	9.4465E-05	0	0
Toluene	0.002080202	0	0
Xylene	0.001139158	0	0
Naphthalene gas	0.000282087	0	0

Backbone	Emissions (tons) per year		
	2025 [1.]	2026	2027
NOX	3.459892586	2.9840334	0.0991373
PM10	3.07214882	2.6496183	0.0880272
PM2.5	0.470710115	0.4059706	0.0134874
CO	1.2108947	1.0443533	0.0346961
VOC	0.282007129	0.243221	0.0080804
SO2	0.003107823	0.0026804	8.905E-05
CH4	0.016802784	0.0144918	0.0004815
CO2	1040.701753	897.56799	29.819534
N2O	0.007664422	0.0066103	0.0002196
Benzene	0.011217112	0.0096744	0.0003214
Ethanol	0	0	0
Formaldehyde	0.072295825	0.0623526	0.0020715
Acetaldehyde	0.025879665	0.0223203	0.0007415
Acrolein	0.005713377	0.0049276	0.0001637
1,3-Butadiene	0.000514921	0.0004441	1.475E-05
Ethyl Benzene	0.001534664	0.0013236	4.397E-05
Hexane	0.000297024	0.0002562	8.511E-06
Toluene	0.008174823	0.0070505	0.0002342
Xylene	0.004539148	0.0039149	0.0001301
Naphthalene gas	0.001110145	0.0009575	3.181E-05

Note:
1. Due to 2024 only having one month of emissions it has been grouped with 2025 emissions.

Site 2 acres: 10.7275

PM10 (Tons) / Month	PM2.5 (Tons) / Month
1.18	0.12
PM10 (Tons)	**PM2.5 (Tons)**
41.30	4.13

Site 5 acres: 17.4033

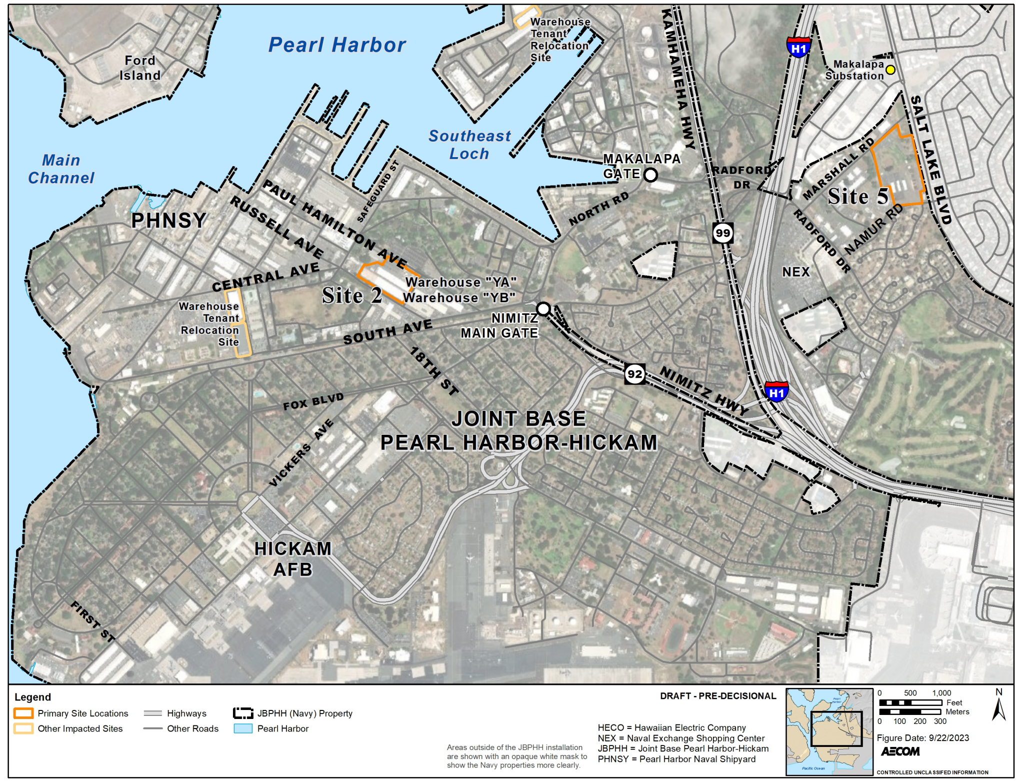
PM10 (Tons) / Month	PM2.5 (Tons) / Month
1.91	0.19
PM10 (Tons)	**PM2.5 (Tons)**
21.06	2.11

Backbone acres: 1.8365

PM10 (Tons) / Month	PM2.5 (Tons) / Month
0.20	0.02
PM10 (Tons)	**PM2.5 (Tons)**
5.45	0.55

Note:
1. Acerage estimated from image received from applicant
2. Backbone location not shown on figure.

Construction: Fugitive Dust from Earth Disturbance



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Workstream 1 (Covered Storage): Equipment Emissions

Equipment[1]	Manufacture[1]	Model[1]	Equipment Description	HP[1]	HP BIN	Load Factor[2]	Usage Factor[1]	Days Of Use[1]
CONCRETE PUMP	PUTZMEISTER	38Z-5	Pumps	350	300 < hp <= 600	0.43	80%	0
HELICAL PILE DRIVER	CATERPILLAR	308CR	Bore/Drill Rigs	69.5	50 < hp <= 75	0.43	35%	0
SHEET PILE DRIVER	ABI	TM 13/16	Bore/Drill Rigs	420	300 < hp <= 600	0.43	70%	0
CRANE (100 TON)	LINK-BELT	HTT-86100	Cranes	480	300 < hp <= 600	0.43	45%	0
CRANE (80 TON)	Grove RT 880E	RTC-8065	Cranes	275	175 < hp <= 300	0.43	45%	10
DOZER	CATERPILLAR	D5	Crawler Tractor/Dozers	170	100 < hp <= 175	0.59	75%	0
WHEEL LOADER	CATERPILLAR	950	Tractors/Loaders/Backhoes	168	100 < hp <= 175	0.21	65%	0
BACKHOE LOADER	CATERPILLAR	430F2	Tractors/Loaders/Backhoes	108	100 < hp <= 175	0.21	60%	0
GRADER	CATERPILLAR	140GC	Graders	196	175 < hp <= 300	0.59	50%	0
EXCAVATOR	CATERPILLAR	336	Excavators	260	175 < hp <= 300	0.59	40%	30
EXCAVATOR	CATERPILLAR	320	Excavators	172	100 < hp <= 175	0.59	65%	0
EXCAVATOR (MINI)	CATERPILLAR	306CR	Excavators	55.9	50 < hp <= 75	0.59	60%	0
SKID STEER	CATERPILLAR	289D3	Skid Steer Loaders	74.3	50 < hp <= 75	0.21	50%	125
TELEHANDLER	CATERPILLAR	TL1255D	Aerial Lifts	111	100 < hp <= 175	0.21	35%	40
COMPACTOR (SOIL)	CATERPILLAR	CP56B	Rollers	157	100 < hp <= 175	0.43	65%	0
COMPACTOR (ROLLER)	CATERPILLAR	CB10	Rollers	120	100 < hp <= 175	0.59	80%	0
COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	Rollers	24.7	16 < hp <= 25	0.59	80%	5
COMPACTOR (TRENCH)	WACKER NEUSON	RTxSC3	Rollers	23.7	16 < hp <= 25	0.43	40%	0
COMPACTOR (RAMMER)	WACKER NEUSON	BS60-4	Rollers	3.6	3 < hp <= 6	0.43	30%	10
COMPACTOR (PLATE)	WACKER NEUSON	WP1540A	Rollers	9.9	6 < hp <= 11	0.59	30%	10
PAVER	CATERPILLAR	AP555F	Pavers	142	100 < hp <= 175	0.59	85%	5
SLIPFORM PAVER	WIRTGEN	SP15i	Pavers	127	100 < hp <= 175	0.59	70%	0
TRUCK - DELIVERY	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	25%	21
TRUCK - MIXER	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	25%	15
TRUCK - DUMP	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	25%	20
TRUCK - FUEL/MECH	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	30%	16
TRUCK - LINEMAN BUCKET	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	90%	0
TRUCK - FLAT BED	FORD	F-750	Included in On-road emissions[3]	330	300 < hp <= 600	0.59	10%	15
TRUCK - WATER	FORD	F-650	Off-Highway Trucks	300	175 < hp <= 300	0.59	10%	0
TRUCK - PICKUP	FORD	F-250	Included in On-road emissions[3]	430	300 < hp <= 600	0.59	10%	180
TRUCK - PICKUP	FORD	F-150	Included in On-road emissions[3]	290	175 < hp <= 300	0.59	10%	180
TRUCK - (COMMUTER)	FORD	F-150	Included in On-road emissions[3]	290	175 < hp <= 300	0.59	10%	900
GENERATOR (MOBILE)[4]	CATERPILLAR	XQ570	Generator Sets	800	300 < hp <= 600	0.43	95%	0
GENERATOR (MOBILE)	WACKER NEUSON	G50	Generator Sets	70	50 < hp <= 75	0.43	95%	55
COMPRESSOR (MOBILE)	Sullair	185	Generator Sets	49	40 < hp <= 50	0.43	95%	0
PUMP (WELLPOINT)	MWI	DD PUMP	Pumps	9	6 < hp <= 11	0.43	95%	0
PUMPS (TRASH)	HONDA	WT30XK4A	Pumps	8.4	6 < hp <= 11	0.43	95%	20
TOWER LIGHTS	WACKER NEUSON	LTV6L	Generator Sets	12.2	11 < hp <= 16	0.43	95%	0

Emission Factor (g/hp-hr)

Equipment	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	2.22	0.10	0.09	0.63	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HELICAL PILE DRIVER	3.95	0.24	0.23	1.42	0.29	0.00	0.02	589.52	0.01	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
SHEET PILE DRIVER	2.53	0.09	0.09	0.61	0.13	0.00	0.01	530.67	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (100 TON)	0.77	0.03	0.03	0.18	0.04	0.00	0.00	530.92	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (80 TON)	0.33	0.02	0.02	0.08	0.02	0.00	0.00	530.97	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOZER	0.33	0.02	0.02	0.09	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHEEL LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BACKHOE LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
GRADER	0.20	0.01	0.01	0.05	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.24	0.02	0.02	0.07	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR (MINI)	2.57	0.02	0.02	0.24	0.06	0.00	0.01	595.99	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SKID STEER	4.33	0.52	0.50	3.67	0.70	0.00	0.03	693.98	0.01	0.02	0.00	0.17	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00
TELEHANDLER	2.28	0.23	0.22	1.17	0.36	0.00	0.02	625.52	0.01	0.01	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00
COMPACTOR (SOIL)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (TRENCH)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (RAMMER)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
COMPACTOR (PLATE)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SLIPFORM PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.11	0.01	0.01	0.02	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4]	2.22	0.09	0.09	0.62	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GENERATOR (MOBILE)	3.89	0.23	0.22	1.43	0.30	0.00	0.02	589.49	0.01	0.01	0.00	0.08	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPRESSOR (MOBILE)	3.09	0.12	0.12	0.71	0.20	0.00	0.02	589.79	0.01	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PUMP (WELLPOINT)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PUMPS (TRASH)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
TOWER LIGHTS	3.97	0.21	0.20	1.69	0.42	0.00	0.03	589.18	0.01	0.02	0.00	0.12	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00

Emission (lbs)

Equipment	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HELICAL PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHEET PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (100 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (80 TON)	3.1	0.2	0.2	0.8	0.2	0.0	0.0	4983.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DOZER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WHEEL LOADER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BACKHOE LOADER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRADER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	5.1	0.3	0.3	1.2	0.4	0.0	0.0	17427.7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR (MINI)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SKID STEER	74.5	8.9	8.6	63.1	12.0	0.0	0.5	11936.1	0.2	0.4	0.0	3.0	1.0	0.2	0.0	0.1	0.0	0.3	0.2	0.0
TELEHANDLER	13.1	1.3	1.3	6.7	2.1	0.0	0.1	3600.3	0.0	0.1	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
COMPACTOR (SOIL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	3.9	0.2	0.2	1.5	0.4	0.0	0.0	611.9	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (TRENCH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (RAMMER)	0.3	0.0	0.0	0.2	0.1	0.0	0.0	48.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (PLATE)	1.3	0.1	0.1	0.8	0.3	0.0	0.0	183.5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVER	2.6	0.2	0.2	0.8	0.1	0.0	0.0	3370.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLIPFORM PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TRUCK - MIXER	2.3	0.1	0.1	0.6	0.2	0.0	0.0	7855.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TRUCK - LINEMAN BUCKET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TRUCK - WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GENERATOR (MOBILE)[4]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GENERATOR (MOBILE)	107.8	6.4	6.2	39.7	8.4	0.1	0.5	16351.4	0.2	0.3	0.0	2.1	0.7	0.2	0.0	0.0	0.0	0.2	0.1	0.0
COMPRESSOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMP (WELLPOINT)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMPS (TRASH)	5.2	0.3	0.3	3.2	1.0	0.0	0.1	711.7	0.0	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOWER LIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total:	219.1	17.9	17.4	118.6	25.1	0.2	1.3	67080.2	0.6	0.9	0.0	6.2	2.2	0.5	0.0	0.1	0.0	0.7	0.4	0.09

Notes:

1. Based on sheet Schedule tab
2. Based on data gathered from "Median Life, Annual Activity, and LoadFactor Values for Nonroad EngineEmissions Modeling" by the EPA
3. Truck - Delivery, Dump, Fuel/Mech, Flat Bed, Pickup and Commuter are included in On-road emissions
4. The highest horsepower MOVES provides for Generators is up to 600. For generator Caterpillar XQ570 the horsepower bin is 300 < hp <= 600 due to this limit.

Formula:

Emissions = Emission factor * HP * Load Factor * Usage Factor * Days of Use * 8 (Hours per Day)*grams to lbs conversion

Workstream 2 (Site Precon): Equipment Emissions

Equipment[1]	Manufacture[1]	Model[1]	Equipment Description	HP[1]	HP BIN	Load Factor[2]	Usage Factor[1]	Days Of Use[1]
CONCRETE PUMP	PUTZMEISTER	38Z-5	Pumps	350	300 < hp <= 600	0.43	80%	0
HELICAL PILE DRIVER	CATERPILLAR	308CR	Bore/Drill Rigs	69.5	50 < hp <= 75	0.43	35%	0
SHEET PILE DRIVER	ABI	TM 13/16	Bore/Drill Rigs	420	300 < hp <= 600	0.43	70%	0
CRANE (100 TON)	LINK-BELT	HTT-86100	Cranes	480	300 < hp <= 600	0.43	45%	0
CRANE (80 TON)	Grove RT 880E	RTC-8065	Cranes	275	175 < hp <= 300	0.43	45%	0
DOZER	CATERPILLAR	D5	Crawler Tractor/Dozers	170	100 < hp <= 175	0.59	75%	175
WHEEL LOADER	CATERPILLAR	950	Tractors/Loaders/Backhoes	168	100 < hp <= 175	0.21	65%	175
BACKHOE LOADER	CATERPILLAR	430F2	Tractors/Loaders/Backhoes	108	100 < hp <= 175	0.21	60%	205
GRADER	CATERPILLAR	140GC	Graders	196	175 < hp <= 300	0.59	50%	100
EXCAVATOR	CATERPILLAR	336	Excavators	260	175 < hp <= 300	0.59	40%	165
EXCAVATOR	CATERPILLAR	320	Excavators	172	100 < hp <= 175	0.59	65%	0
EXCAVATOR (MINI)	CATERPILLAR	306CR	Excavators	55.9	50 < hp <= 75	0.59	60%	120
SKID STEER	CATERPILLAR	289D3	Skid Steer Loaders	74.3	50 < hp <= 75	0.21	50%	205
TELEHANDLER	CATERPILLAR	TL1255D	Aerial Lifts	111	100 < hp <= 175	0.21	35%	150
COMPACTOR (SOIL)	CATERPILLAR	CP56B	Rollers	157	100 < hp <= 175	0.43	65%	55
COMPACTOR (ROLLER)	CATERPILLAR	CB10	Rollers	120	100 < hp <= 175	0.59	80%	0
COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	Rollers	24.7	16 < hp <= 25	0.59	80%	0
COMPACTOR (TRENCH)	WACKER NEUSON	RTxSC3	Rollers	23.7	16 < hp <= 25	0.43	40%	90
COMPACTOR (RAMMER)	WACKER NEUSON	BS60-4	Rollers	3.6	3 < hp <= 6	0.43	30%	90
COMPACTOR (PLATE)	WACKER NEUSON	WP1540A	Rollers	9.9	6 < hp <= 11	0.59	30%	0
PAVER	CATERPILLAR	AP555F	Pavers	142	100 < hp <= 175	0.59	85%	0
SLIPFORM PAVER	WIRTGEN	SP15i	Pavers	127	100 < hp <= 175	0.59	70%	0
TRUCK - DELIVERY	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	25%	45
TRUCK - MIXER	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	25%	0
TRUCK - DUMP	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	25%	485
TRUCK - FUEL/MECH	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	30%	205
TRUCK - LINEMAN BUCKET	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	90%	10
TRUCK - FLAT BED	FORD	F-750	Included in On-road emissions[3]	330	300 < hp <= 600	0.59	10%	75
TRUCK - WATER	FORD	F-650	Off-Highway Trucks	300	175 < hp <= 300	0.59	10%	0
TRUCK - PICKUP	FORD	F-250	Included in On-road emissions[3]	430	300 < hp <= 600	0.59	10%	280
TRUCK - PICKUP	FORD	F-150	Included in On-road emissions[3]	290	175 < hp <= 300	0.59	10%	280
TRUCK - (COMMUTER)	FORD	F-150	Included in On-road emissions[3]	290	175 < hp <= 300	0.59	10%	1680
GENERATOR (MOBILE)[4]	CATERPILLAR	XQ570	Generator Sets	800	300 < hp <= 600	0.43	95%	0
GENERATOR (MOBILE)	WACKER NEUSON	G50	Generator Sets	70	50 < hp <= 75	0.43	95%	0
COMPRESSOR (MOBILE)	Sullair	185	Generator Sets	49	40 < hp <= 50	0.43	95%	0
PUMP (WELLPOINT)	MWI	DD PUMP	Pumps	9	6 < hp <= 11	0.43	95%	90
PUMPS (TRASH)	HONDA	WT30XK4A	Pumps	8.4	6 < hp <= 11	0.43	95%	205
TOWER LIGHTS	WACKER NEUSON	LTV6L	Generator Sets	12.2	11 < hp <= 16	0.43	95%	0

Equipment	Emission Factor (g/hp-hr)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	2.22	0.10	0.09	0.63	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HELICAL PILE DRIVER	3.95	0.24	0.23	1.42	0.29	0.00	0.02	589.52	0.01	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
SHEET PILE DRIVER	2.53	0.09	0.09	0.61	0.13	0.00	0.01	530.67	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (100 TON)	0.77	0.03	0.03	0.18	0.04	0.00	0.00	530.92	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (80 TON)	0.33	0.02	0.02	0.08	0.02	0.00	0.00	530.97	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOZER	0.33	0.02	0.02	0.09	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHEEL LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BACKHOE LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
GRADER	0.20	0.01	0.01	0.05	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.24	0.02	0.02	0.07	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR (MINI)	2.57	0.02	0.02	0.24	0.06	0.00	0.01	595.99	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SKID STEER	4.33	0.52	0.50	3.67	0.70	0.00	0.03	693.98	0.01	0.02	0.00	0.17	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00
TELEHANDLER	2.28	0.23	0.22	1.17	0.36	0.00	0.02	625.52	0.01	0.01	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00
COMPACTOR (SOIL)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (TRENCH)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (RAMMER)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
COMPACTOR (PLATE)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SLIPFORM PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.11	0.01	0.01	0.02	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4]	2.22	0.09	0.09	0.62	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GENERATOR (MOBILE)	3.89	0.23	0.22	1.43	0.30	0.00	0.02	589.49	0.01	0.01	0.00	0.08	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPRESSOR (MOBILE)	3.09	0.12	0.12	0.71	0.20	0.00	0.02	589.79	0.01	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PUMP (WELLPOINT)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PUMPS (TRASH)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
TOWER LIGHTS	3.97	0.21	0.20	1.69	0.42	0.00	0.03	589.18	0.01	0.02	0.00	0.12	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00

Equipment	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HELICAL PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHEET PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (100 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (80 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DOZER	75.7	5.0	4.8	20.5	3.2	0.3	0.3	124632.1	0.1	0.1	0.0	0.8	0.3	0.1	0.0	0.0	0.0	0.1	0.1	0.0
WHEEL LOADER	103.7	10.3	10.0	48.7	15.7	0.1	1.0	44301.6	0.5	0.7	0.0	4.2	1.5	0.3	0.0	0.1	0.0	0.5	0.2	0.1
BACKHOE LOADER	72.1	7.2	6.9	33.9	10.9	0.1	0.7	30795.5	0.3	0.5	0.0	2.9	1.0	0.2	0.0	0.1	0.0	0.3	0.2	0.0
GRADER	20.5	1.3	1.2	5.4	1.5	0.1	0.1	54739.9	0.0	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0
EXCAVATOR	28.0	1.7	1.6	6.5	2.1	0.3	0.1	95852.1	0.1	0.1	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.0
EXCAVATOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR (MINI)	107.5	0.9	0.9	9.9	2.3	0.1	0.4	24960.7	0.2	0.1	0.0	0.7	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
SKID STEER	122.2	14.5	14.1	103.6	19.8	0.1	0.9	19575.1	0.4	0.7	0.0	4.8	1.7	0.4	0.0	0.1	0.0	0.5	0.3	0.1
TELEHANDLER	49.2	4.9	4.7	25.3	7.7	0.0	0.4	13501.0	0.2	0.3	0.0	2.0	0.7	0.2	0.0	0.0	0.0	0.2	0.1	0.0
COMPACTOR (SOIL)	20.6	1.7	1.6	6.6	1.0	0.1	0.1	22848.0	0.0	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (TRENCH)	24.3	1.1	1.1	9.7	2.3	0.0	0.2	3851.0	0.1	0.1	0.0	0.7	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
COMPACTOR (RAMMER)	3.1	0.2	0.2	1.8	0.6	0.0	0.1	437.7	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (PLATE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLIPFORM PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	5.5	0.3	0.3	1.3	0.4	0.0	0.0	18852.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GENERATOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPRESSOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMP (WELLPOINT)	24.9	1.6	1.5	15.2	4.8	0.0	0.4	3431.4	0.2	0.3	0.0	1.4	0.5	0.1	0.0	0.0	0.0	0.2	0.1	0.0
PUMPS (TRASH)	52.9	3.4	3.3	32.4	10.3	0.0	0.9	7294.9	0.4	0.5	0.0	3.0	1.1	0.2	0.0	0.0	0.0	0.4	0.1	0.0
TOWER LIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total:	710.2	53.9	52.3	320.8	82.6	1.3	5.6	465073.1	2.5	3.5	0.0	21.6	7.8	1.5	0.1	0.4	0.1	2.6	1.3	0.33

Notes:

1. Based on sheet Schedule tab
2. Based on data gathered from "Median Life, Annual Activity, and LoadFactor Values for Nonroad EngineEmissions Modeling" by the EPA
3. Truck - Delivery, Dump, Fuel/Mech, Flat Bed, Pickup and Commuter are included in On-road emissions
4. The highest horsepower MOVES provides for Generators is up to 600. For generator Caterpillar XQ570 the horsepower bin is 300 < hp <= 600 due to this limit.

Formula:

Emissions = Emission factor * HP * Load Factor * Usage Factor * Days of Use * 8 (Hours per Day)*grams to lbs conversion

Workstream 3 (Microtunneling): Equipment Emissions

Equipment[1.]	Manufacture[1.]	Model[1.]	Equipment Description	HP[1.]	HP BIN	Load Factor[2.]	Usage Factor[1.]	Days Of Use[1.]
CONCRETE PUMP	PUTZMEISTER	38Z-5	Pumps	350	300 < hp <= 600	0.43	80%	0
HELICAL PILE DRIVER	CATERPILLAR	308CR	Bore/Drill Rigs	69.5	50 < hp <= 75	0.43	35%	0
SHEET PILE DRIVER	ABI	TM 13/16	Bore/Drill Rigs	420	300 < hp <= 600	0.43	70%	300
CRANE (100 TON)	LINK-BELT	HTT-86100	Cranes	480	300 < hp <= 600	0.43	45%	0
CRANE (80 TON)	Grove RT 880E	RTC-8065	Cranes	275	175 < hp <= 300	0.43	45%	855
DOZER	CATERPILLAR	D5	Crawler Tractor/Dozers	170	100 < hp <= 175	0.59	75%	0
WHEEL LOADER	CATERPILLAR	950	Tractors/Loaders/Backhoes	168	100 < hp <= 175	0.21	65%	810
BACKHOE LOADER	CATERPILLAR	430F2	Tractors/Loaders/Backhoes	108	100 < hp <= 175	0.21	60%	445
GRADER	CATERPILLAR	140GC	Graders	196	175 < hp <= 300	0.59	50%	0
EXCAVATOR	CATERPILLAR	336	Excavators	260	175 < hp <= 300	0.59	40%	710
EXCAVATOR	CATERPILLAR	320	Excavators	172	100 < hp <= 175	0.59	65%	445
EXCAVATOR (MINI)	CATERPILLAR	306CR	Excavators	55.9	50 < hp <= 75	0.59	60%	0
SKID STEER	CATERPILLAR	289D3	Skid Steer Loaders	74.3	50 < hp <= 75	0.21	50%	1165
TELEHANDLER	CATERPILLAR	TL1255D	Aerial Lifts	111	100 < hp <= 175	0.21	35%	720
COMPACTOR (SOIL)	CATERPILLAR	CP56B	Rollers	157	100 < hp <= 175	0.43	65%	0
COMPACTOR (ROLLER)	CATERPILLAR	CB10	Rollers	120	100 < hp <= 175	0.59	80%	0
COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	Rollers	24.7	16 < hp <= 25	0.59	80%	0
COMPACTOR (TRENCH)	WACKER NEUSON	RTxSC3	Rollers	23.7	16 < hp <= 25	0.43	40%	415
COMPACTOR (RAMMER)	WACKER NEUSON	BS60-4	Rollers	3.6	3 < hp <= 6	0.43	30%	415
COMPACTOR (PLATE)	WACKER NEUSON	WP1540A	Rollers	9.9	6 < hp <= 11	0.59	30%	0
PAVER	CATERPILLAR	AP555F	Pavers	142	100 < hp <= 175	0.59	85%	0
SLIPFORM PAVER	WIRTGEN	SP15i	Pavers	127	100 < hp <= 175	0.59	70%	0
TRUCK - DELIVERY	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	40
TRUCK - MIXER	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	25%	0
TRUCK - DUMP	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	1155
TRUCK - FUEL/MECH	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	30%	1155
TRUCK - LINEMAN BUCKET	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	90%	0
TRUCK - FLAT BED	FORD	F-750	Included in On-road emissions[3.]	330	300 < hp <= 600	0.59	10%	410
TRUCK - WATER	FORD	F-650	Off-Highway Trucks	300	175 < hp <= 300	0.59	10%	0
TRUCK - PICKUP	FORD	F-250	Included in On-road emissions[3.]	430	300 < hp <= 600	0.59	10%	1165
TRUCK - PICKUP	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	1165
TRUCK - (COMMUTER)	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	9320
GENERATOR (MOBILE)[4.]	CATERPILLAR	XQ570	Generator Sets	800	300 < hp <= 600	0.43	95%	410
GENERATOR (MOBILE)	WACKER NEUSON	G50	Generator Sets	70	50 < hp <= 75	0.43	95%	1155
COMPRESSOR (MOBILE)	Sullair	185	Generator Sets	49	40 < hp <= 50	0.43	95%	410
PUMP (WELLPOINT)	MWI	DD PUMP	Pumps	9	6 < hp <= 11	0.43	95%	0
PUMPS (TRASH)	HONDA	WT30XK4A	Pumps	8.4	6 < hp <= 11	0.43	95%	1155
TOWER LIGHTS	WACKER NEUSON	LTV6L	Generator Sets	12.2	11 < hp <= 16	0.43	95%	1155

Emission Factor (g/hp-hr)

Equipment	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	2.22	0.10	0.09	0.63	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HELICAL PILE DRIVER	3.95	0.24	0.23	1.42	0.29	0.00	0.02	589.52	0.01	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
SHEET PILE DRIVER	2.53	0.09	0.09	0.61	0.13	0.00	0.01	530.67	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (100 TON)	0.77	0.03	0.03	0.18	0.04	0.00	0.00	530.92	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (80 TON)	0.33	0.02	0.02	0.08	0.02	0.00	0.00	530.97	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOZER	0.33	0.02	0.02	0.09	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHEEL LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BACKHOE LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
GRADER	0.20	0.01	0.01	0.05	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.24	0.02	0.02	0.07	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR (MINI)	2.57	0.02	0.02	0.24	0.06	0.00	0.01	595.99	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SKID STEER	4.33	0.52	0.50	3.67	0.70	0.00	0.03	693.98	0.01	0.02	0.00	0.17	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00
TELEHANDLER	2.28	0.23	0.22	1.17	0.36	0.00	0.02	625.52	0.01	0.01	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00
COMPACTOR (SOIL)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (TRENCH)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (RAMMER)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
COMPACTOR (PLATE)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SLIPFORM PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.11	0.01	0.01	0.02	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4.]	2.22	0.09	0.09	0.62	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GENERATOR (MOBILE)	3.89	0.23	0.22	1.43	0.30	0.00	0.02	589.49	0.01	0.01	0.00	0.08	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPRESSOR (MOBILE)	3.09	0.12	0.12	0.71	0.20	0.00	0.02	589.79	0.01	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PUMP (WELLPOINT)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PUMPS (TRASH)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
TOWER LIGHTS	3.97	0.21	0.20	1.69	0.42	0.00	0.03	589.18	0.01	0.02	0.00	0.12	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00

Emission (lbs)

Equipment	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HELICAL PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHEET PILE DRIVER	1690.6	60.2	58.4	407.0	88.1	1.1	5.6	354963.6	2.6	3.8	0.0	23.2	8.3	1.8	0.2	0.5	0.1	2.7	1.4	0.4
CRANE (100 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (80 TON)	261.8	13.8	13.4	64.2	19.4	1.2	1.5	426065.5	0.7	0.8	0.0	4.6	1.8	0.3	0.0	0.1	0.0	0.7	0.5	0.1
DOZER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WHEEL LOADER	480.1	47.6	46.2	225.6	72.6	0.6	4.7	205053.1	2.2	3.2	0.0	19.4	6.9	1.4	0.1	0.3	0.1	2.3	1.0	0.3
BACKHOE LOADER	156.5	15.5	15.1	73.6	23.7	0.2	1.5	66848.8	0.7	1.0	0.0	6.3	2.3	0.4	0.0	0.1	0.0	0.8	0.3	0.1
GRADER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	120.7	7.3	7.0	27.9	9.2	1.1	0.5	412454.7	0.2	0.3	0.0	1.6	0.7	0.1	0.0	0.1	0.0	0.3	0.4	0.0
EXCAVATOR	126.7	8.5	8.2	35.9	5.7	0.7	0.4	277901.0	0.2	0.3	0.0	1.4	0.5	0.1	0.0	0.0	0.0	0.2	0.1	0.0
EXCAVATOR (MINI)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SKID STEER	694.7	82.6	80.1	588.5	112.3	0.4	5.1	111244.1	2.3	3.7	0.0	27.5	9.7	2.1	0.2	0.5	0.2	2.9	1.8	0.4
TELEHANDLER	236.0	23.3	22.6	121.3	37.1	0.2	1.9	64804.6	0.9	1.4	0.0	9.4	3.4	0.8	0.1	0.2	0.0	1.0	0.6	0.1
COMPACTOR (SOIL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (TRENCH)	112.3	5.1	5.0	44.5	10.5	0.1	0.9	17757.2	0.4	0.6	0.0	3.1	1.1	0.2	0.0	0.0	0.0	0.4	0.1	0.0
COMPACTOR (RAMMER)	14.2	0.8	0.8	8.4	2.8	0.0	0.3	2018.2	0.1	0.2	0.0	0.8	0.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0
COMPACTOR (PLATE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLIPFORM PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4.]	5250.1	218.0	211.4	1466.0	323.1	3.9	17.4	1253996.4	7.9	12.3	0.0	81.1	29.1	7.2	0.6	2.0	0.4	8.7	5.6	1.3
GENERATOR (MOBILE)	2264.0	133.7	129.6	834.7	176.7	1.1	9.6	343379.3	4.4	6.3	0.0	44.1	15.7	3.6	0.3	0.9	0.3	4.7	2.8	0.7
COMPRESSOR (MOBILE)	447.3	17.3	16.8	102.6	28.7	0.2	2.4	85367.9	1.1	1.3	0.0	7.8	2.8	0.6	0.1	0.2	0.0	0.9	0.4	0.1
PUMP (WELLPOINT)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMPS (TRASH)	298.2	18.9	18.3	182.3	57.9	0.2	4.9	41100.6	2.2	3.0	0.0	16.7	5.9	1.1	0.1	0.3	0.0	2.1	0.7	0.3
TOWER LIGHTS	402.9	20.9	20.2	171.7	42.1	0.2	3.2	59814.1	1.5	2.1	0.0	11.8	4.2	0.8	0.1	0.2	0.0	1.4	0.5	0.2
Total:	12556.1	673.4	653.2	4354.3	1009.9	11.1	60.1	3722769.2	27.4	40.1	0.0	258.8	92.6	20.5	1.8	5.5	1.1	29.2	16.3	3.98

Notes:

1. Based on sheet Schedule tab
2. Based on data gathered from "Median Life, Annual Activity, and LoadFactor Values for Nonroad EngineEmissions Modeling" by the EPA
3. Truck - Delivery, dump, Fuel/Mech, Flat Bed, Pickup and Commuter are included in On-road emissions
4. The highest horsepower MOVES provides for Generators is up to 600. For generator Caterpillar XQ570 the horsepower bin is 300 < hp <= 600 due to this limit.

Formula:

Emissions = Emission factor * HP * Load Factor * Usage Factor * Days of Use * 8 (Hours per Day)*grams to lbs conversion

Workstream 4 (Open Cuts Distribution): Equipment Emissions

									Emission Factor (g/hp-hr)																				Emission (lbs)																			
Equipment[1.]	Manufacture[1.]	Model[1.]	Equipment Description	HP[1.]	HP BIN	Load Factor[2.]	Usage Factor[1.]	Days Of Use[1.]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	PUTZMEISTER	38Z-5	Pumps	350	300 < hp <= 600	0.43	80%	0	2.22	0.10	0.09	0.63	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HELICAL PILE DRIVER	CATERPILLAR	308CR	Bore/Drill Rigs	69.5	50 < hp <= 75	0.43	35%	0	3.95	0.24	0.23	1.42	0.29	0.00	0.02	589.52	0.01	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHEET PILE DRIVER	ABI	TM 13/16	Bore/Drill Rigs	420	300 < hp <= 600	0.43	70%	0	2.53	0.09	0.09	0.61	0.13	0.00	0.01	530.67	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (100 TON)	LINK-BELT	HTT-86100	Cranes	480	300 < hp <= 600	0.43	45%	0	0.77	0.03	0.03	0.18	0.04	0.00	0.00	530.92	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (80 TON)	Grove RT 880E	RTC-8065	Cranes	275	175 < hp <= 300	0.43	45%	0	0.33	0.02	0.02	0.08	0.02	0.00	0.00	530.97	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DOZER	CATERPILLAR	D5	Crawler Tractor/Dozers	170	100 < hp <= 175	0.59	75%	0	0.33	0.02	0.02	0.09	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WHEEL LOADER	CATERPILLAR	950	Tractors/Loaders/Backhoes	168	100 < hp <= 175	0.21	65%	82	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00	48.6	4.8	4.7	22.8	7.3	0.1	0.5	20758.5	0.2	0.3	0.0	2.0	0.7	0.1	0.0	0.0	0.0	0.2	0.1	0.0
BACKHOE LOADER	CATERPILLAR	430F2	Tractors/Loaders/Backhoes	108	100 < hp <= 175	0.21	60%	0	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRADER	CATERPILLAR	140GC	Graders	196	175 < hp <= 300	0.59	50%	0	0.20	0.01	0.01	0.05	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	CATERPILLAR	336	Excavators	260	175 < hp <= 300	0.59	40%	82	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.9	0.8	0.8	3.2	1.1	0.1	0.1	47635.6	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	CATERPILLAR	320	Excavators	172	100 < hp <= 175	0.59	65%	82	0.24	0.02	0.02	0.07	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.3	1.6	1.5	6.6	1.1	0.1	0.1	51208.7	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR (MINI)	CATERPILLAR	306CR	Excavators	55.9	50 < hp <= 75	0.59	60%	0	2.57	0.02	0.02	0.24	0.06	0.00	0.01	595.99	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SKID STEER	CATERPILLAR	289D3	Skid Steer Loaders	74.3	50 < hp <= 75	0.21	50%	82	4.33	0.52	0.50	3.67	0.70	0.00	0.03	693.98	0.01	0.02	0.00	0.17	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00	48.9	5.8	5.6	41.4	7.9	0.0	0.4	7830.1	0.2	0.3	0.0	1.9	0.7	0.1	0.0	0.0	0.0	0.2	0.1	0.0
TELEHANDLER	CATERPILLAR	TL1255D	Aerial Lifts	111	100 < hp <= 175	0.21	35%	82	2.28	0.23	0.22	1.17	0.36	0.00	0.02	625.52	0.01	0.01	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00	26.9	2.7	2.6	13.8	4.2	0.0	0.2	7380.5	0.1	0.2	0.0	1.1	0.4	0.1	0.0	0.0	0.0	0.1	0.1	0.0
COMPACTOR (SOIL)	CATERPILLAR	CP56B	Rollers	157	100 < hp <= 175	0.43	65%	0	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	CATERPILLAR	CB10	Rollers	120	100 < hp <= 175	0.59	80%	0	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	Rollers	24.7	16 < hp <= 25	0.59	80%	0	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (TRENCH)	WACKER NEUSON	RTxSC3	Rollers	23.7	16 < hp <= 25	0.43	40%	48	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00	13.0	0.6	0.6	5.2	1.2	0.0	0.1	2053.8	0.0	0.1	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (RAMMER)	WACKER NEUSON	BS60-4	Rollers	3.6	3 < hp <= 6	0.43	30%	48	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00	1.6	0.1	0.1	1.0	0.3	0.0	0.0	233.4	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (PLATE)	WACKER NEUSON	WP1540A	Rollers	9.9	6 < hp <= 11	0.59	30%	0	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVER	CATERPILLAR	AP555F	Pavers	142	100 < hp <= 175	0.59	85%	0	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLIPFORM PAVER	WIRTGEN	SP15i	Pavers	127	100 < hp <= 175	0.59	70%	0	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DELIVERY	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	25%	0	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DUMP	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	30%	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	90%	0	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - FLAT BED	FORD	F-750	Included in On-road emissions[3.]	330	300 < hp <= 600	0.59	10%	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	FORD	F-650	Off-Highway Trucks	300	175 < hp <= 300	0.59	10%	82	0.11	0.01	0.01	0.02	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.9	0.2	0.2	0.5	0.2	0.0	0.0	13741.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - PICKUP	FORD	F-250	Included in On-road emissions[3.]	430	300 < hp <= 600	0.59	10%	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	492	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4.]	CATERPILLAR	XQ570	Generator Sets	800	300 < hp <= 600	0.43	95%	0	2.22	0.09	0.09	0.62	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GENERATOR (MOBILE)	WACKER NEUSON	G50	Generator Sets	70	50 < hp <= 75	0.43	95%	82	3.89	0.23	0.22	1.43	0.30	0.00	0.02	589.49	0.01	0.01	0.00	0.08	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00	160.7	9.5	9.2	59.3	12.5	0.1	0.7	24378.4	0.3	0.4	0.0	3.1	1.1	0.3	0.0	0.1	0.0	0.3	0.2	0.0
COMPRESSOR (MOBILE)	Sullair	185	Generator Sets	49	40 < hp <= 50	0.43	95%	82	3.09	0.12	0.12	0.71	0.20	0.00	0.02	589.79	0.01	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00	89.5	3.5	3.4	20.5	5.7	0.0	0.5	17073.6	0.2	0.3	0.0	1.6	0.6	0.1	0.0	0.0	0.0	0.2	0.1	0.0
PUMP (WELLPOINT)	MWI	DD PUMP	Pumps	9	6 < hp <= 11	0.43	95%	0	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMPS (TRASH)	HONDA	WT30XK4A	Pumps	8.4	6 < hp <= 11	0.43	95%	82	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00	21.2	1.3	1.3	12.9	4.1	0.0	0.3	2918.0	0.2	0.2	0.0	1.2	0.4	0.1	0.0	0.0	0.0	0.2	0.0	0.0
TOWER LIGHTS	WACKER NEUSON	LTV6L	Generator Sets	12.2	11 < hp <= 16	0.43	95%	82	3.97	0.21	0.20	1.69	0.42	0.00	0.03	589.18	0.01	0.02	0.00	0.12	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00	28.6	1.5	1.4	12.2	3.0	0.0	0.2	4246.5	0.1	0.1	0.0	0.8	0.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0
																												Total:	479.2	32.3	31.4	199.5	48.8	0.6	3.1	199458.4	1.4	2.0	0.0	12.6	4.5	0.9	0.1	0.2	0.1	1.5	0.8	0.19

Notes:
1. Based on sheet Schedule tab
2. Based on data gathered from "Median Life, Annual Activity, and LoadFactor Values for Nonroad EngineEmissions Modeling" by the EPA
3. Truck - Delivery, dump, Fuel/Mech, Flat Bed, Pickup and Commuter are included in On-road emissions
4. The highest horsepower MOVES provides for Generators is up to 600. For generator Caterpillar XQ570 the horsepower bin is 300 < hp <= 600 due to this limit.

Formula:

Emissions = Emission factor * HP * Load Factor * Usage Factor * Days of Use * 8 (Hours per Day)*grams to lbs conversion

Workstream 6 (Battery Energy Storage Systems (BESS)): Equipment Emissions

Equipment[1.]	Manufacture[1.]	Model[1.]	Equipment Description	HP[1.]	HP BIN	Load Factor[2.]	Usage Factor[1.]	Days Of Use[1.]
CONCRETE PUMP	PUTZMEISTER	38Z-5	Pumps	350	300 < hp <= 600	0.43	80%	2
HELICAL PILE DRIVER	CATERPILLAR	308CR	Bore/Drill Rigs	69.5	50 < hp <= 75	0.43	35%	0
SHEET PILE DRIVER	ABI	TM 13/16	Bore/Drill Rigs	420	300 < hp <= 600	0.43	70%	0
CRANE (100 TON)	LINK-BELT	HTT-86100	Cranes	480	300 < hp <= 600	0.43	45%	0
CRANE (80 TON)	Grove RT 880E	RTC-8065	Cranes	275	175 < hp <= 300	0.43	45%	15
DOZER	CATERPILLAR	D5	Crawler Tractor/Dozers	170	100 < hp <= 175	0.59	75%	20
WHEEL LOADER	CATERPILLAR	950	Tractors/Loaders/Backhoes	168	100 < hp <= 175	0.21	65%	0
BACKHOE LOADER	CATERPILLAR	430F2	Tractors/Loaders/Backhoes	108	100 < hp <= 175	0.21	60%	35
GRADER	CATERPILLAR	140GC	Graders	196	175 < hp <= 300	0.59	50%	20
EXCAVATOR	CATERPILLAR	336	Excavators	260	175 < hp <= 300	0.59	40%	0
EXCAVATOR	CATERPILLAR	320	Excavators	172	100 < hp <= 175	0.59	65%	0
EXCAVATOR (MINI)	CATERPILLAR	306CR	Excavators	55.9	50 < hp <= 75	0.59	60%	40
SKID STEER	CATERPILLAR	289D3	Skid Steer Loaders	74.3	50 < hp <= 75	0.21	50%	60
TELEHANDLER	CATERPILLAR	TL1255D	Aerial Lifts	111	100 < hp <= 175	0.21	35%	50
COMPACTOR (SOIL)	CATERPILLAR	CP56B	Rollers	157	100 < hp <= 175	0.43	65%	25
COMPACTOR (ROLLER)	CATERPILLAR	CB10	Rollers	120	100 < hp <= 175	0.59	80%	0
COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	Rollers	24.7	16 < hp <= 25	0.59	80%	0
COMPACTOR (TRENCH)	WACKER NEUSON	RTxSC3	Rollers	23.7	16 < hp <= 25	0.43	40%	0
COMPACTOR (RAMMER)	WACKER NEUSON	BS60-4	Rollers	3.6	3 < hp <= 6	0.43	30%	15
COMPACTOR (PLATE)	WACKER NEUSON	WP1540A	Rollers	9.9	6 < hp <= 11	0.59	30%	15
PAVER	CATERPILLAR	AP555F	Pavers	142	100 < hp <= 175	0.59	85%	0
SLIPFORM PAVER	WIRTGEN	SP15i	Pavers	127	100 < hp <= 175	0.59	70%	0
TRUCK - DELIVERY	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	30
TRUCK - MIXER	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	25%	25
TRUCK - DUMP	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	45
TRUCK - FUEL/MECH	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	30%	65
TRUCK - LINEMAN BUCKET	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	90%	0
TRUCK - FLAT BED	FORD	F-750	Included in On-road emissions[3.]	330	300 < hp <= 600	0.59	10%	5
TRUCK - WATER	FORD	F-650	Off-Highway Trucks	300	175 < hp <= 300	0.59	10%	0
TRUCK - PICKUP	FORD	F-250	Included in On-road emissions[3.]	430	300 < hp <= 600	0.59	10%	0
TRUCK - PICKUP	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	70
TRUCK - (COMMUTER)	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	560
GENERATOR (MOBILE)[4.]	CATERPILLAR	XQ570	Generator Sets	800	300 < hp <= 600	0.43	95%	0
GENERATOR (MOBILE)	WACKER NEUSON	G50	Generator Sets	70	50 < hp <= 75	0.43	95%	15
COMPRESSOR (MOBILE)	Sullair	185	Generator Sets	49	40 < hp <= 50	0.43	95%	0
PUMP (WELLPOINT)	MWI	DD PUMP	Pumps	9	6 < hp <= 11	0.43	95%	0
PUMPS (TRASH)	HONDA	WT30XK4A	Pumps	8.4	6 < hp <= 11	0.43	95%	15
TOWER LIGHTS	WACKER NEUSON	LTV6L	Generator Sets	12.2	11 < hp <= 16	0.43	95%	0

Emission Factor (g/hp-hr)

Equipment	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	2.22	0.10	0.09	0.63	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HELICAL PILE DRIVER	3.95	0.24	0.23	1.42	0.29	0.00	0.02	589.52	0.01	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
SHEET PILE DRIVER	2.53	0.09	0.09	0.61	0.13	0.00	0.01	530.67	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (100 TON)	0.77	0.03	0.03	0.18	0.04	0.00	0.00	530.92	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (80 TON)	0.33	0.02	0.02	0.08	0.02	0.00	0.00	530.97	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOZER	0.33	0.02	0.02	0.09	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHEEL LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BACKHOE LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
GRADER	0.20	0.01	0.01	0.05	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.24	0.02	0.02	0.07	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR (MINI)	2.57	0.02	0.02	0.24	0.06	0.00	0.01	595.99	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SKID STEER	4.33	0.52	0.50	3.67	0.70	0.00	0.03	693.98	0.01	0.02	0.00	0.17	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00
TELEHANDLER	2.28	0.23	0.22	1.17	0.36	0.00	0.02	625.52	0.01	0.01	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00
COMPACTOR (SOIL)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (TRENCH)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (RAMMER)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
COMPACTOR (PLATE)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SLIPFORM PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.11	0.01	0.01	0.02	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4.]	2.22	0.09	0.09	0.62	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GENERATOR (MOBILE)	3.89	0.23	0.22	1.43	0.30	0.00	0.02	589.49	0.01	0.01	0.00	0.08	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPRESSOR (MOBILE)	3.09	0.12	0.12	0.71	0.20	0.00	0.02	589.79	0.01	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PUMP (WELLPOINT)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PUMPS (TRASH)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
TOWER LIGHTS	3.97	0.21	0.20	1.69	0.42	0.00	0.03	589.18	0.01	0.02	0.00	0.12	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00

Emission (lbs)

Equipment	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	9.4	0.4	0.4	2.7	0.6	0.0	0.0	2253.7	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HELICAL PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHEET PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (100 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (80 TON)	4.6	0.2	0.2	1.1	0.3	0.0	0.0	7474.8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DOZER	8.6	0.6	0.5	2.3	0.4	0.0	0.0	14243.7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WHEEL LOADER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BACKHOE LOADER	12.3	1.2	1.2	5.8	1.9	0.0	0.1	5257.8	0.1	0.1	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
GRADER	4.1	0.3	0.2	1.1	0.3	0.0	0.0	10948.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR (MINI)	35.8	0.3	0.3	3.3	0.8	0.0	0.1	8320.2	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SKID STEER	35.8	4.3	4.1	30.3	5.8	0.0	0.3	5729.3	0.1	0.2	0.0	1.4	0.5	0.1	0.0	0.0	0.0	0.2	0.1	0.0
TELEHANDLER	16.4	1.6	1.6	8.4	2.6	0.0	0.1	4500.3	0.1	0.1	0.0	0.7	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.0
COMPACTOR (SOIL)	9.3	0.8	0.7	3.0	0.5	0.0	0.0	10385.5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (TRENCH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (RAMMER)	0.5	0.0	0.0	0.3	0.1	0.0	0.0	72.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (PLATE)	1.9	0.1	0.1	1.1	0.4	0.0	0.0	275.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLIPFORM PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	3.8	0.2	0.2	0.9	0.3	0.0	0.0	13091.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4.]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GENERATOR (MOBILE)	29.4	1.7	1.7	10.8	2.3	0.0	0.1	4459.5	0.1	0.1	0.0	0.6	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
COMPRESSOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMP (WELLPOINT)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMPS (TRASH)	3.9	0.2	0.2	2.4	0.8	0.0	0.1	533.8	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOWER LIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total:	176.0	12.0	11.6	73.6	16.9	0.2	1.0	87546.4	0.5	0.7	0.0	4.3	1.5	0.3	0.0	0.1	0.0	0.5	0.3	0.07

Notes:
1. Based on sheet Schedule tab
2. Based on data gathered from "Median Life, Annual Activity, and LoadFactor Values for Nonroad EngineEmissions Modeling" by the EPA
3. Truck - Delivery, dump, Fuel/Mech, Flat Bed, Pickup and Commuter are included in On-road emissions
4. The highest horsepower MOVES provides for Generators is up to 600. For generator Caterpillar XQ570 the horsepower bin is 300 < hp <= 600 due to this limit.

Formula:
Emissions = Emission factor * HP * Load Factor * Usage Factor * Days of Use * 8 (Hours per Day)*grams to lbs conversion

Workstream 7 (Site Substation): Equipment Emissions

Equipment[1.]	Manufacture[1.]	Model[1.]	Equipment Description	HP[1.]	HP BIN	Load Factor[2.]	Usage Factor[1.]	Days Of Use[1.]
CONCRETE PUMP	PUTZMEISTER	38Z-5	Pumps	350	300 < hp <= 600	0.43	80%	0
HELICAL PILE DRIVER	CATERPILLAR	308CR	Bore/Drill Rigs	69.5	50 < hp <= 75	0.43	35%	0
SHEET PILE DRIVER	ABI	TM 13/16	Bore/Drill Rigs	420	300 < hp <= 600	0.43	70%	0
CRANE (100 TON)	LINK-BELT	HTT-86100	Cranes	480	300 < hp <= 600	0.43	45%	0
CRANE (80 TON)	Grove RT 880E	RTC-8065	Cranes	275	175 < hp <= 300	0.43	45%	12
DOZER	CATERPILLAR	D5	Crawler Tractor/Dozers	170	100 < hp <= 175	0.59	75%	40
WHEEL LOADER	CATERPILLAR	950	Tractors/Loaders/Backhoes	168	100 < hp <= 175	0.21	65%	0
BACKHOE LOADER	CATERPILLAR	430F2	Tractors/Loaders/Backhoes	108	100 < hp <= 175	0.21	60%	105
GRADER	CATERPILLAR	140GC	Graders	196	175 < hp <= 300	0.59	50%	0
EXCAVATOR	CATERPILLAR	336	Excavators	260	175 < hp <= 300	0.59	40%	60
EXCAVATOR	CATERPILLAR	320	Excavators	172	100 < hp <= 175	0.59	65%	0
EXCAVATOR (MINI)	CATERPILLAR	306CR	Excavators	55.9	50 < hp <= 75	0.59	60%	165
SKID STEER	CATERPILLAR	289D3	Skid Steer Loaders	74.3	50 < hp <= 75	0.21	50%	200
TELEHANDLER	CATERPILLAR	TL1255D	Aerial Lifts	111	100 < hp <= 175	0.21	35%	260
COMPACTOR (SOIL)	CATERPILLAR	CP56B	Rollers	157	100 < hp <= 175	0.43	65%	15
COMPACTOR (ROLLER)	CATERPILLAR	CB10	Rollers	120	100 < hp <= 175	0.59	80%	0
COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	Rollers	24.7	16 < hp <= 25	0.59	80%	0
COMPACTOR (TRENCH)	WACKER NEUSON	RTxSC3	Rollers	23.7	16 < hp <= 25	0.43	40%	75
COMPACTOR (RAMMER)	WACKER NEUSON	BS60-4	Rollers	3.6	3 < hp <= 6	0.43	30%	165
COMPACTOR (PLATE)	WACKER NEUSON	WP1540A	Rollers	9.9	6 < hp <= 11	0.59	30%	60
PAVER	CATERPILLAR	AP555F	Pavers	142	100 < hp <= 175	0.59	85%	0
SLIPFORM PAVER	WIRTGEN	SP15i	Pavers	127	100 < hp <= 175	0.59	70%	0
TRUCK - DELIVERY	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	65
TRUCK - MIXER	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	25%	22
TRUCK - DUMP	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	75
TRUCK - FUEL/MECH	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	30%	73
TRUCK - LINEMAN BUCKET	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	90%	0
TRUCK - FLAT BED	FORD	F-750	Included in On-road emissions[3.]	330	300 < hp <= 600	0.59	10%	0
TRUCK - WATER	FORD	F-650	Off-Highway Trucks	300	175 < hp <= 300	0.59	10%	0
TRUCK - PICKUP	FORD	F-250	Included in On-road emissions[3.]	430	300 < hp <= 600	0.59	10%	0
TRUCK - PICKUP	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	240
TRUCK - (COMMUTER)	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	1920
GENERATOR (MOBILE)[4.]	CATERPILLAR	XQ570	Generator Sets	800	300 < hp <= 600	0.43	95%	0
GENERATOR (MOBILE)	WACKER NEUSON	G50	Generator Sets	70	50 < hp <= 75	0.43	95%	0
COMPRESSOR (MOBILE)	Sullair	185	Generator Sets	49	40 < hp <= 50	0.43	95%	0
PUMP (WELLPOINT)	MWI	DD PUMP	Pumps	9	6 < hp <= 11	0.43	95%	60
PUMPS (TRASH)	HONDA	WT30XK4A	Pumps	8.4	6 < hp <= 11	0.43	95%	60
TOWER LIGHTS	WACKER NEUSON	LTV6L	Generator Sets	12.2	11 < hp <= 16	0.43	95%	0

Equipment	Emission Factor (g/hp-hr)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	2.22	0.10	0.09	0.63	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HELICAL PILE DRIVER	3.95	0.24	0.23	1.42	0.29	0.00	0.02	589.52	0.01	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
SHEET PILE DRIVER	2.53	0.09	0.09	0.61	0.13	0.00	0.01	530.67	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (100 TON)	0.77	0.03	0.03	0.18	0.04	0.00	0.00	530.92	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (80 TON)	0.33	0.02	0.02	0.08	0.02	0.00	0.00	530.97	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOZER	0.33	0.02	0.02	0.09	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHEEL LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BACKHOE LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
GRADER	0.20	0.01	0.01	0.05	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.24	0.02	0.02	0.07	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR (MINI)	2.57	0.02	0.02	0.24	0.06	0.00	0.01	595.99	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SKID STEER	4.33	0.52	0.50	3.67	0.70	0.00	0.03	693.98	0.01	0.02	0.00	0.17	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00
TELEHANDLER	2.28	0.23	0.22	1.17	0.36	0.00	0.02	625.52	0.01	0.01	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00
COMPACTOR (SOIL)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (TRENCH)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (RAMMER)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
COMPACTOR (PLATE)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SLIPFORM PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.11	0.01	0.01	0.02	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4.]	2.22	0.09	0.09	0.62	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GENERATOR (MOBILE)	3.89	0.23	0.22	1.43	0.30	0.00	0.02	589.49	0.01	0.01	0.00	0.08	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPRESSOR (MOBILE)	3.09	0.12	0.12	0.71	0.20	0.00	0.02	589.79	0.01	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PUMP (WELLPOINT)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PUMPS (TRASH)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
TOWER LIGHTS	3.97	0.21	0.20	1.69	0.42	0.00	0.03	589.18	0.01	0.02	0.00	0.12	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00

Equipment	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HELICAL PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHEET PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (100 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (80 TON)	3.7	0.2	0.2	0.9	0.3	0.0	0.0	5979.9	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DOZER	17.3	1.1	1.1	4.7	0.7	0.1	0.1	28487.3	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WHEEL LOADER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BACKHOE LOADER	36.9	3.7	3.6	17.4	5.6	0.0	0.4	15773.3	0.2	0.2	0.0	1.5	0.5	0.1	0.0	0.0	0.0	0.2	0.1	0.0
GRADER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	10.2	0.6	0.6	2.4	0.8	0.1	0.0	34855.3	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR (MINI)	147.8	1.3	1.3	13.6	3.2	0.1	0.5	34321.0	0.2	0.2	0.0	0.9	0.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0
SKID STEER	119.3	14.2	13.7	101.0	19.3	0.1	0.9	19097.7	0.4	0.6	0.0	4.7	1.7	0.4	0.0	0.1	0.0	0.5	0.3	0.1
TELEHANDLER	85.2	8.4	8.2	43.8	13.4	0.1	0.7	23401.7	0.3	0.5	0.0	3.4	1.2	0.3	0.0	0.1	0.0	0.4	0.2	0.1
COMPACTOR (SOIL)	5.6	0.5	0.4	1.8	0.3	0.0	0.0	6231.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (TRENCH)	20.3	0.9	0.9	8.0	1.9	0.0	0.2	3209.1	0.1	0.1	0.0	0.6	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
COMPACTOR (RAMMER)	5.7	0.3	0.3	3.3	1.1	0.0	0.1	802.4	0.0	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (PLATE)	7.8	0.4	0.4	4.6	1.6	0.0	0.1	1101.0	0.1	0.1	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLIPFORM PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	3.4	0.2	0.2	0.8	0.3	0.0	0.0	11520.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4.]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GENERATOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPRESSOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMP (WELLPOINT)	16.6	1.1	1.0	10.1	3.2	0.0	0.3	2287.6	0.1	0.2	0.0	0.9	0.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0
PUMPS (TRASH)	15.5	1.0	1.0	9.5	3.0	0.0	0.3	2135.1	0.1	0.2	0.0	0.9	0.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0
TOWER LIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total:	495.2	33.9	32.9	222.0	54.6	0.5	3.6	189203.5	1.6	2.2	0.0	14.2	5.1	1.0	0.1	0.3	0.1	1.6	0.8	0.22

Notes:
1. Based on sheet Schedule tab
2. Based on data gathered from "Median Life, Annual Activity and LoadFactor Values for Nonroad EngineEmissions Modeling" by the EPA
3. Truck - Delivery, dump, Fuel/Mech, Flat Bed, Pickup and Commuter are included in On-road emissions
4. The highest horsepower MOVES provides for Generators is up to 600. For generator Caterpillar XQ570 the horsepower bin is 300 < hp <= 600 due to this limit.

Formula:
Emissions = Emission factor * HP * Load Factor * Usage Factor * Days of Use * 8 (Hours per Day)*grams to lbs conversion

Workstream 8 (Engine Hall): Equipment Emissions

Equipment[1]	Manufacture[1]	Model[1]	Equipment Description	HP[1]	HP BIN	Load Factor[2]	Usage Factor[1]	Days Of Use[1]
CONCRETE PUMP	PUTZMEISTER	38Z-5	Pumps	350	300 < hp <= 600	0.43	80%	30
HELICAL PILE DRIVER	CATERPILLAR	308CR	Bore/Drill Rigs	69.5	50 < hp <= 75	0.43	35%	0
SHEET PILE DRIVER	ABI	TM 13/16	Bore/Drill Rigs	420	300 < hp <= 600	0.43	70%	0
CRANE (100 TON)	LINK-BELT	HTT-86100	Cranes	480	300 < hp <= 600	0.43	45%	16
CRANE (80 TON)	Grove RT 880E	RTC-8065	Cranes	275	175 < hp <= 300	0.43	45%	130
DOZER	CATERPILLAR	D5	Crawler Tractor/Dozers	170	100 < hp <= 175	0.59	75%	82
WHEEL LOADER	CATERPILLAR	950	Tractors/Loaders/Backhoes	168	100 < hp <= 175	0.21	65%	30
BACKHOE LOADER	CATERPILLAR	430F2	Tractors/Loaders/Backhoes	108	100 < hp <= 175	0.21	60%	410
GRADER	CATERPILLAR	140GC	Graders	196	175 < hp <= 300	0.59	50%	61
EXCAVATOR	CATERPILLAR	336	Excavators	260	175 < hp <= 300	0.59	40%	175
EXCAVATOR	CATERPILLAR	320	Excavators	172	100 < hp <= 175	0.59	65%	0
EXCAVATOR (MINI)	CATERPILLAR	306CR	Excavators	55.9	50 < hp <= 75	0.59	60%	175
SKID STEER	CATERPILLAR	289D3	Skid Steer Loaders	74.3	50 < hp <= 75	0.21	50%	420
TELEHANDLER	CATERPILLAR	TL1255D	Aerial Lifts	111	100 < hp <= 175	0.21	35%	371
COMPACTOR (SOIL)	CATERPILLAR	CP56B	Rollers	157	100 < hp <= 175	0.43	65%	115
COMPACTOR (ROLLER)	CATERPILLAR	CB10	Rollers	120	100 < hp <= 175	0.59	80%	10
COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	Rollers	24.7	16 < hp <= 25	0.59	80%	10
COMPACTOR (TRENCH)	WACKER NEUSON	RTxSC3	Rollers	23.7	16 < hp <= 25	0.43	40%	155
COMPACTOR (RAMMER)	WACKER NEUSON	BS60-4	Rollers	3.6	3 < hp <= 6	0.43	30%	140
COMPACTOR (PLATE)	WACKER NEUSON	WP1540A	Rollers	9.9	6 < hp <= 11	0.59	30%	130
PAVER	CATERPILLAR	AP555F	Pavers	142	100 < hp <= 175	0.59	85%	10
SLIPFORM PAVER	WIRTGEN	SP15i	Pavers	127	100 < hp <= 175	0.59	70%	15
TRUCK - DELIVERY	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	25%	231
TRUCK - MIXER	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	25%	80
TRUCK - DUMP	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	25%	257
TRUCK - FUEL/MECH	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	30%	501
TRUCK - LINEMAN BUCKET	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	90%	0
TRUCK - FLAT BED	FORD	F-750	Included in On-road emissions[3]	330	300 < hp <= 600	0.59	10%	0
TRUCK - WATER	FORD	F-650	Off-Highway Trucks	300	175 < hp <= 300	0.59	10%	0
TRUCK - PICKUP	FORD	F-250	Included in On-road emissions[3]	430	300 < hp <= 600	0.59	10%	0
TRUCK - PICKUP	FORD	F-150	Included in On-road emissions[3]	290	175 < hp <= 300	0.59	10%	940
TRUCK - (COMMUTER)	FORD	F-150	Included in On-road emissions[3]	290	175 < hp <= 300	0.59	10%	7520
GENERATOR (MOBILE)[4]	CATERPILLAR	XQ570	Generator Sets	800	300 < hp <= 600	0.43	95%	0
GENERATOR (MOBILE)	WACKER NEUSON	G50	Generator Sets	70	50 < hp <= 75	0.43	95%	40
COMPRESSOR (MOBILE)	Sullair	185	Generator Sets	49	40 < hp <= 50	0.43	95%	0
PUMP (WELLPOINT)	MWI	DD PUMP	Pumps	9	6 < hp <= 11	0.43	95%	130
PUMPS (TRASH)	HONDA	WT30XK4A	Pumps	8.4	6 < hp <= 11	0.43	95%	365
TOWER LIGHTS	WACKER NEUSON	LTV6L	Generator Sets	12.2	11 < hp <= 16	0.43	95%	0

Equipment	Emission Factor (g/hp-hr)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	2.22	0.10	0.09	0.63	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HELICAL PILE DRIVER	3.95	0.24	0.23	1.42	0.29	0.00	0.02	589.52	0.01	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
SHEET PILE DRIVER	2.53	0.09	0.09	0.61	0.13	0.00	0.01	530.67	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (100 TON)	0.77	0.03	0.03	0.18	0.04	0.00	0.00	530.92	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (80 TON)	0.33	0.02	0.02	0.08	0.02	0.00	0.00	530.97	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOZER	0.33	0.02	0.02	0.09	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHEEL LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BACKHOE LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
GRADER	0.20	0.01	0.01	0.05	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.24	0.02	0.02	0.07	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR (MINI)	2.57	0.02	0.02	0.24	0.06	0.00	0.01	595.99	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SKID STEER	4.33	0.52	0.50	3.67	0.70	0.00	0.03	693.98	0.01	0.02	0.00	0.17	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00
TELEHANDLER	2.28	0.23	0.22	1.17	0.36	0.00	0.02	625.52	0.01	0.01	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00
COMPACTOR (SOIL)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (TRENCH)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (RAMMER)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
COMPACTOR (PLATE)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SLIPFORM PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.11	0.01	0.01	0.02	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4]	2.22	0.09	0.09	0.62	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GENERATOR (MOBILE)	3.89	0.23	0.22	1.43	0.30	0.00	0.02	589.49	0.01	0.01	0.00	0.08	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPRESSOR (MOBILE)	3.09	0.12	0.12	0.71	0.20	0.00	0.02	589.79	0.01	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PUMP (WELLPOINT)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PUMPS (TRASH)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
TOWER LIGHTS	3.97	0.21	0.20	1.69	0.42	0.00	0.03	589.18	0.01	0.02	0.00	0.12	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00

Equipment	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	141.7	6.1	6.0	40.0	8.7	0.1	0.5	33804.8	0.2	0.3	0.0	2.2	0.8	0.2	0.0	0.1	0.0	0.2	0.2	0.0
HELICAL PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHEET PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (100 TON)	20.2	0.8	0.7	4.7	1.1	0.0	0.1	13915.5	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (80 TON)	39.8	2.1	2.0	9.8	3.0	0.2	0.2	64781.9	0.1	0.1	0.0	0.7	0.3	0.0	0.0	0.0	0.0	0.1	0.1	0.0
DOZER	35.5	2.3	2.3	9.6	1.5	0.2	0.1	58399.0	0.1	0.1	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
WHEEL LOADER	17.8	1.8	1.7	8.4	2.7	0.0	0.2	7594.6	0.1	0.1	0.0	0.7	0.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0
BACKHOE LOADER	144.2	14.3	13.9	67.8	21.8	0.2	1.4	61591.0	0.7	0.9	0.0	5.8	2.1	0.4	0.0	0.1	0.0	0.7	0.3	0.1
GRADER	12.5	0.8	0.7	3.3	0.9	0.1	0.1	33391.3	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	29.7	1.8	1.7	6.9	2.3	0.3	0.1	101661.4	0.1	0.1	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.0
EXCAVATOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR (MINI)	156.8	1.4	1.3	14.4	3.4	0.1	0.6	36401.1	0.3	0.2	0.0	1.0	0.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0
SKID STEER	250.4	29.8	28.9	212.2	40.5	0.1	1.8	40105.2	0.8	1.3	0.0	9.9	3.5	0.8	0.1	0.2	0.1	1.1	0.6	0.1
TELEHANDLER	121.6	12.0	11.7	62.5	19.1	0.1	1.0	33392.4	0.5	0.7	0.0	4.9	1.7	0.4	0.0	0.1	0.0	0.5	0.3	0.1
COMPACTOR (SOIL)	43.0	3.5	3.4	13.9	2.2	0.1	0.2	47773.2	0.1	0.1	0.0	0.6	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
COMPACTOR (ROLLER)	4.8	0.4	0.4	1.6	0.2	0.0	0.0	5362.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	7.7	0.4	0.3	3.1	0.7	0.0	0.1	1223.7	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (TRENCH)	41.9	1.9	1.9	16.6	3.9	0.0	0.3	6632.2	0.2	0.2	0.0	1.1	0.4	0.1	0.0	0.0	0.0	0.1	0.0	0.0
COMPACTOR (RAMMER)	4.8	0.3	0.3	2.8	1.0	0.0	0.1	680.8	0.0	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (PLATE)	16.8	1.0	0.9	9.9	3.4	0.0	0.3	2385.5	0.1	0.2	0.0	1.0	0.4	0.1	0.0	0.0	0.0	0.1	0.0	0.0
PAVER	5.1	0.4	0.4	1.5	0.2	0.0	0.0	6741.8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLIPFORM PAVER	5.7	0.4	0.4	1.7	0.3	0.0	0.0	7448.4	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	12.2	0.7	0.7	3.0	0.9	0.1	0.1	41893.3	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GENERATOR (MOBILE)	78.4	4.6	4.5	28.9	6.1	0.0	0.3	11891.9	0.2	0.2	0.0	1.5	0.5	0.1	0.0	0.0	0.0	0.2	0.1	0.0
COMPRESSOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMP (WELLPOINT)	36.0	2.3	2.2	22.0	7.0	0.0	0.6	4956.5	0.3	0.4	0.0	2.0	0.7	0.1	0.0	0.0	0.0	0.3	0.1	0.0
PUMPS (TRASH)	94.2	6.0	5.8	57.6	18.3	0.0	1.6	12988.5	0.7	1.0	0.0	5.3	1.9	0.3	0.0	0.1	0.0	0.7	0.2	0.1
TOWER LIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total:	1321.0	94.9	92.1	602.1	149.1	1.8	9.6	635016.1	4.4	6.2	0.0	38.8	13.9	2.8	0.3	0.7	0.1	4.6	2.3	0.59

Notes:
1. Based on sheet Schedule tab
2. Based on data gathered from "Median Life, Annual Activity, and LoadFactor Values for Nonroad EngineEmissions Modeling" by the EPA
3. Truck - Delivery, dump, Fuel/Mech, Flat Bed, Pickup and Commuter are included in On-road emissions
4. The highest horsepower MOVES provides for Generators is up to 600. For generator Caterpillar XQ570 the horsepower bin is 300 < hp <= 600 due to this limit.

Formula:
Emissions = Emission factor * HP * Load Factor * Usage Factor * Days of Use * 8 (Hours per Day)*grams to lbs conversion

Workstream 9 (Storage Tanks & Distribution): Equipment Emissions

Equipment[1]	Manufacture[1]	Model[1]	Equipment Description	HP[1]	HP BIN	Load Factor[2]	Usage Factor[1]	Days Of Use[1]	Emission Factor (g/hp-hr) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	PUTZMEISTER	38Z-5	Pumps	350	300 < hp <= 600	0.43	80%	8	2.22	0.10	0.09	0.63	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HELICAL PILE DRIVER	CATERPILLAR	308CR	Bore/Drill Rigs	69.5	50 < hp <= 75	0.43	35%	0	3.95	0.24	0.23	1.42	0.29	0.00	0.02	589.52	0.01	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
SHEET PILE DRIVER	ABI	TM 13/16	Bore/Drill Rigs	420	300 < hp <= 600	0.43	70%	0	2.53	0.09	0.09	0.61	0.13	0.00	0.01	530.67	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (100 TON)	LINK-BELT	HTT-86100	Cranes	480	300 < hp <= 600	0.43	45%	0	0.77	0.03	0.03	0.18	0.04	0.00	0.00	530.92	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (80 TON)	Grove RT 880E	RTC-8065	Cranes	275	175 < hp <= 300	0.43	45%	152	0.33	0.02	0.02	0.08	0.02	0.00	0.00	530.97	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOZER	CATERPILLAR	D5	Crawler Tractor/Dozers	170	100 < hp <= 175	0.59	75%	75	0.33	0.02	0.02	0.09	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHEEL LOADER	CATERPILLAR	950	Tractors/Loaders/Backhoes	168	100 < hp <= 175	0.21	65%	45	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BACKHOE LOADER	CATERPILLAR	430F2	Tractors/Loaders/Backhoes	108	100 < hp <= 175	0.21	60%	205	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
GRADER	CATERPILLAR	140GC	Graders	196	175 < hp <= 300	0.59	50%	55	0.20	0.01	0.01	0.05	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	CATERPILLAR	336	Excavators	260	175 < hp <= 300	0.59	40%	60	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	CATERPILLAR	320	Excavators	172	100 < hp <= 175	0.59	65%	0	0.24	0.02	0.02	0.07	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR (MINI)	CATERPILLAR	306CR	Excavators	55.9	50 < hp <= 75	0.59	60%	80	2.57	0.02	0.02	0.24	0.06	0.00	0.01	595.99	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SKID STEER	CATERPILLAR	289D3	Skid Steer Loaders	74.3	50 < hp <= 75	0.21	50%	240	4.33	0.52	0.50	3.67	0.70	0.00	0.03	693.98	0.01	0.02	0.00	0.17	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00
TELEHANDLER	CATERPILLAR	TL1255D	Aerial Lifts	111	100 < hp <= 175	0.21	35%	350	2.28	0.23	0.22	1.17	0.36	0.00	0.02	625.52	0.01	0.01	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00
COMPACTOR (SOIL)	CATERPILLAR	CP56B	Rollers	157	100 < hp <= 175	0.43	65%	80	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	CATERPILLAR	CB10	Rollers	120	100 < hp <= 175	0.59	80%	0	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	Rollers	24.7	16 < hp <= 25	0.59	80%	0	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (TRENCH)	WACKER NEUSON	RTxSC3	Rollers	23.7	16 < hp <= 25	0.43	40%	60	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (RAMMER)	WACKER NEUSON	BS60-4	Rollers	3.6	3 < hp <= 6	0.43	30%	60	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
COMPACTOR (PLATE)	WACKER NEUSON	WP1540A	Rollers	9.9	6 < hp <= 11	0.59	30%	65	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PAVER	CATERPILLAR	AP555F	Pavers	142	100 < hp <= 175	0.59	85%	0	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SLIPFORM PAVER	WIRTGEN	SP15i	Pavers	127	100 < hp <= 175	0.59	70%	0	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DELIVERY	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	25%	190	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	25%	40	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	25%	115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	30%	365	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	90%	0	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Included in On-road emissions[3]	330	300 < hp <= 600	0.59	10%	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	FORD	F-650	Off-Highway Trucks	300	175 < hp <= 300	0.59	10%	0	0.11	0.01	0.01	0.02	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Included in On-road emissions[3]	430	300 < hp <= 600	0.59	10%	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	FORD	F-150	Included in On-road emissions[3]	290	175 < hp <= 300	0.59	10%	560	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	FORD	F-150	Included in On-road emissions[3]	290	175 < hp <= 300	0.59	10%	3360	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4]	CATERPILLAR	XQ570	Generator Sets	800	300 < hp <= 600	0.43	95%	0	2.22	0.09	0.09	0.62	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GENERATOR (MOBILE)	WACKER NEUSON	G50	Generator Sets	70	50 < hp <= 75	0.43	95%	0	3.89	0.23	0.22	1.43	0.30	0.00	0.02	589.49	0.01	0.01	0.00	0.08	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPRESSOR (MOBILE)	Sullair	185	Generator Sets	49	40 < hp <= 50	0.43	95%	0	3.09	0.12	0.12	0.71	0.20	0.00	0.02	589.79	0.01	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PUMP (WELLPOINT)	MWI	DD PUMP	Pumps	9	6 < hp <= 11	0.43	95%	60	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PUMPS (TRASH)	HONDA	WT30XK4A	Pumps	8.4	6 < hp <= 11	0.43	95%	225	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
TOWER LIGHTS	WACKER NEUSON	LTV6L	Generator Sets	12.2	11 < hp <= 16	0.43	95%	0	3.97	0.21	0.20	1.69	0.42	0.00	0.03	589.18	0.01	0.02	0.00	0.12	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00

Equipment[1]	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	37.8	1.6	1.6	10.7	2.3	0.0	0.1	9014.6	0.1	0.1	0.0	0.6	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.0
HELICAL PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHEET PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (100 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (80 TON)	46.5	2.4	2.4	11.4	3.5	0.2	0.3	75745.0	0.1	0.1	0.0	0.8	0.3	0.1	0.0	0.0	0.0	0.1	0.1	0.0
DOZER	32.4	2.1	2.1	8.8	1.4	0.1	0.1	53413.7	0.1	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WHEEL LOADER	26.7	2.6	2.6	12.5	4.0	0.0	0.3	11391.8	0.1	0.2	0.0	1.1	0.4	0.1	0.0	0.0	0.0	0.1	0.1	0.0
BACKHOE LOADER	72.1	7.2	6.9	33.9	10.9	0.1	0.7	30795.5	0.3	0.5	0.0	2.9	1.0	0.2	0.0	0.1	0.0	0.3	0.2	0.0
GRADER	11.3	0.7	0.7	3.0	0.8	0.1	0.1	30106.9	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	10.2	0.6	0.6	2.4	0.8	0.1	0.0	34855.3	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR (MINI)	71.7	0.6	0.6	6.6	1.6	0.0	0.3	16640.5	0.1	0.1	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
SKID STEER	143.1	17.0	16.5	121.2	23.1	0.1	1.0	22917.2	0.5	0.8	0.0	5.7	2.0	0.4	0.0	0.1	0.0	0.6	0.4	0.1
TELEHANDLER	114.7	11.3	11.0	59.0	18.0	0.1	0.9	31502.3	0.4	0.7	0.0	4.6	1.6	0.4	0.0	0.1	0.0	0.5	0.3	0.1
COMPACTOR (SOIL)	29.9	2.4	2.4	9.6	1.5	0.1	0.1	33233.5	0.1	0.1	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (TRENCH)	16.2	0.7	0.7	6.4	1.5	0.0	0.1	2567.3	0.1	0.1	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
COMPACTOR (RAMMER)	2.1	0.1	0.1	1.2	0.4	0.0	0.0	291.8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (PLATE)	8.4	0.5	0.5	5.0	1.7	0.0	0.1	1192.8	0.1	0.1	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLIPFORM PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	6.1	0.4	0.4	1.5	0.5	0.1	0.0	20946.7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GENERATOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPRESSOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMP (WELLPOINT)	16.6	1.1	1.0	10.1	3.2	0.0	0.3	2287.6	0.1	0.2	0.0	0.9	0.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0
PUMPS (TRASH)	58.1	3.7	3.6	35.5	11.3	0.0	1.0	8006.6	0.4	0.6	0.0	3.3	1.2	0.2	0.0	0.1	0.0	0.4	0.1	0.1
TOWER LIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total:	703.9	55.2	53.5	338.8	86.5	1.1	5.5	384909.2	2.5	3.6	0.0	22.5	8.0	1.6	0.2	0.4	0.1	2.6	1.4	0.34

Notes:
1. Based on sheet Schedule tab
2. Based on data gathered from "Median Life, Annual Activity, and LoadFactor Values for Nonroad EngineEmissions Modeling" by the EPA
3. Truck - Delivery, Dump, Fuel/Mech, Flat Bed, Pickup and Commuter are included in On-road emissions
4. The highest horsepower MOVES provides for Generators is up to 600. For generator Caterpillar XQ570 the horsepower bin is 300 < hp <= 600 due to this limit.

Formula:
Emissions = Emission factor * HP * Load Factor * Usage Factor * Days of Use * 8 (Hours per Day)*grams to lbs conversion

Workstream 10 (Fuel Terminal): Equipment Emissions

Equipment[1.]	Manufacture[1.]	Model[1.]	Equipment Description	HP[1.]	HP BIN	Load Factor[2.]	Usage Factor[1.]	Days Of Use[1.]	Emission Factor (g/hp-hr)																			
									NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	PUTZMEISTER	38Z-5	Pumps	350	300 < hp <= 600	0.43	80%	0	2.22	0.10	0.09	0.63	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HELICAL PILE DRIVER	CATERPILLAR	308CR	Bore/Drill Rigs	69.5	50 < hp <= 75	0.43	35%	0	3.95	0.24	0.23	1.42	0.29	0.00	0.02	589.52	0.01	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
SHEET PILE DRIVER	ABI	TM 13/16	Bore/Drill Rigs	420	300 < hp <= 600	0.43	70%	0	2.53	0.09	0.09	0.61	0.13	0.00	0.01	530.67	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (100 TON)	LINK-BELT	HTT-86100	Cranes	480	300 < hp <= 600	0.43	45%	0	0.77	0.03	0.03	0.18	0.04	0.00	0.00	530.92	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (80 TON)	Grove RT 880E	RTC-8065	Cranes	275	175 < hp <= 300	0.43	45%	0	0.33	0.02	0.02	0.08	0.02	0.00	0.00	530.97	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOZER	CATERPILLAR	D5	Crawler Tractor/Dozers	170	100 < hp <= 175	0.59	75%	35	0.33	0.02	0.02	0.09	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHEEL LOADER	CATERPILLAR	950	Tractors/Loaders/Backhoes	168	100 < hp <= 175	0.21	65%	20	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BACKHOE LOADER	CATERPILLAR	430F2	Tractors/Loaders/Backhoes	108	100 < hp <= 175	0.21	60%	200	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
GRADER	CATERPILLAR	140GC	Graders	196	175 < hp <= 300	0.59	50%	35	0.20	0.01	0.01	0.05	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	CATERPILLAR	336	Excavators	260	175 < hp <= 300	0.59	40%	60	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	CATERPILLAR	320	Excavators	172	100 < hp <= 175	0.59	65%	0	0.24	0.02	0.02	0.07	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR (MINI)	CATERPILLAR	306CR	Excavators	55.9	50 < hp <= 75	0.59	60%	60	2.57	0.02	0.02	0.24	0.06	0.00	0.01	595.99	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SKID STEER	CATERPILLAR	289D3	Skid Steer Loaders	74.3	50 < hp <= 75	0.21	50%	185	4.33	0.52	0.50	3.67	0.70	0.00	0.03	693.98	0.01	0.02	0.00	0.17	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00
TELEHANDLER	CATERPILLAR	TL1255D	Aerial Lifts	111	100 < hp <= 175	0.21	35%	90	2.28	0.23	0.22	1.17	0.36	0.00	0.02	625.52	0.01	0.01	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00
COMPACTOR (SOIL)	CATERPILLAR	CP56B	Rollers	157	100 < hp <= 175	0.43	65%	35	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	CATERPILLAR	CB10	Rollers	120	100 < hp <= 175	0.59	80%	20	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	Rollers	24.7	16 < hp <= 25	0.59	80%	20	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (TRENCH)	WACKER NEUSON	RTxSC3	Rollers	23.7	16 < hp <= 25	0.43	40%	60	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (RAMMER)	WACKER NEUSON	BS60-4	Rollers	3.6	3 < hp <= 6	0.43	30%	60	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
COMPACTOR (PLATE)	WACKER NEUSON	WP1540A	Rollers	9.9	6 < hp <= 11	0.59	30%	95	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PAVER	CATERPILLAR	AP555F	Pavers	142	100 < hp <= 175	0.59	85%	20	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SLIPFORM PAVER	WIRTGEN	SP15i	Pavers	127	100 < hp <= 175	0.59	70%	0	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DELIVERY	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	25%	30	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	145	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	30%	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	90%	0	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Included in On-road emissions[3.]	330	300 < hp <= 600	0.59	10%	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	FORD	F-650	Off-Highway Trucks	300	175 < hp <= 300	0.59	10%	0	0.11	0.01	0.01	0.02	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Included in On-road emissions[3.]	430	300 < hp <= 600	0.59	10%	200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	1200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4.]	CATERPILLAR	XQ570	Generator Sets	800	300 < hp <= 600	0.43	95%	0	2.22	0.09	0.09	0.62	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GENERATOR (MOBILE)	WACKER NEUSON	G50	Generator Sets	70	50 < hp <= 75	0.43	95%	0	3.89	0.23	0.22	1.43	0.30	0.00	0.02	589.49	0.01	0.01	0.00	0.08	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPRESSOR (MOBILE)	Sullair	185	Generator Sets	49	40 < hp <= 50	0.43	95%	0	3.09	0.12	0.12	0.71	0.20	0.00	0.02	589.79	0.01	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PUMP (WELLPOINT)	MWI	DD PUMP	Pumps	9	6 < hp <= 11	0.43	95%	60	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PUMPS (TRASH)	HONDA	WT30XK4A	Pumps	8.4	6 < hp <= 11	0.43	95%	190	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
TOWER LIGHTS	WACKER NEUSON	LTV6L	Generator Sets	12.2	11 < hp <= 16	0.43	95%	0	3.97	0.21	0.20	1.69	0.42	0.00	0.03	589.18	0.01	0.02	0.00	0.12	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00

Equipment[1.]	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HELICAL PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHEET PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (100 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (80 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DOZER	15.1	1.0	1.0	4.1	0.6	0.1	0.1	24926.4	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WHEEL LOADER	11.9	1.2	1.1	5.6	1.8	0.0	0.1	5063.0	0.1	0.1	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
BACKHOE LOADER	70.3	7.0	6.8	33.1	10.6	0.1	0.7	30044.4	0.3	0.5	0.0	2.8	1.0	0.2	0.0	0.1	0.0	0.3	0.1	0.0
GRADER	7.2	0.4	0.4	1.9	0.5	0.1	0.0	19159.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	10.2	0.6	0.6	2.4	0.8	0.1	0.0	34855.3	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR (MINI)	53.8	0.5	0.5	5.0	1.2	0.0	0.2	12480.4	0.1	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SKID STEER	110.3	13.1	12.7	93.5	17.8	0.1	0.8	17665.4	0.4	0.6	0.0	4.4	1.5	0.3	0.0	0.1	0.0	0.5	0.3	0.1
TELEHANDLER	29.5	2.9	2.8	15.2	4.6	0.0	0.2	8100.6	0.1	0.2	0.0	1.2	0.4	0.1	0.0	0.0	0.0	0.1	0.1	0.0
COMPACTOR (SOIL)	13.1	1.1	1.0	4.2	0.7	0.0	0.1	14539.7	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	9.6	0.8	0.8	3.1	0.5	0.0	0.0	10724.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	15.5	0.7	0.7	6.1	1.4	0.0	0.1	2447.5	0.1	0.1	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
COMPACTOR (TRENCH)	16.2	0.7	0.7	6.4	1.5	0.0	0.1	2567.3	0.1	0.1	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
COMPACTOR (RAMMER)	2.1	0.1	0.1	1.2	0.4	0.0	0.0	291.8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (PLATE)	12.3	0.7	0.7	7.2	2.5	0.0	0.2	1743.3	0.1	0.1	0.0	0.7	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0
PAVER	10.2	0.8	0.7	3.1	0.5	0.0	0.0	13483.7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLIPFORM PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	4.6	0.3	0.3	1.1	0.3	0.0	0.0	15710.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4.]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GENERATOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPRESSOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMP (WELLPOINT)	16.6	1.1	1.0	10.1	3.2	0.0	0.3	2287.6	0.1	0.2	0.0	0.9	0.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0
PUMPS (TRASH)	49.1	3.1	3.0	30.0	9.5	0.0	0.8	6761.1	0.4	0.5	0.0	2.7	1.0	0.2	0.0	0.0	0.0	0.4	0.1	0.0
TOWER LIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total:	457.5	36.0	34.9	233.2	58.5	0.6	3.9	222850.4	1.8	2.5	0.0	15.5	5.5	1.1	0.1	0.3	0.1	1.8	0.9	0.24

Notes:
1. Based on sheet Schedule tab
2. Based on data gathered from "Median Life, Annual Activity, and LoadFactor Values for Nonroad EngineEmissions Modeling" by the EPA
3. Truck - Delivery, dump, Fuel/Mech, Flat Bed, Pickup and Commuter are included in On-road emissions
4. The highest horsepower MOVES provides for Generators is up to 600. For generator Caterpillar XQ570 the horsepower bin is 300 < hp <= 600 due to this limit.

Formula:

Emissions = Emission factor * HP * Load Factor * Usage Factor * Days of Use * 8 (Hours per Day)*grams to lbs conversion

Workstream 11 (Photovoltaic (PV)): Equipment Emissions

Equipment[1]	Manufacture[1]	Model[1]	Equipment Description	HP[1]	HP BIN	Load Factor[2]	Usage Factor[1]	Days Of Use[1]
CONCRETE PUMP	PUTZMEISTER	38Z-5	Pumps	350	300 < hp <= 600	0.43	80%	0
HELICAL PILE DRIVER	CATERPILLAR	308CR	Bore/Drill Rigs	69.5	50 < hp <= 75	0.43	35%	50
SHEET PILE DRIVER	ABI	TM 13/16	Bore/Drill Rigs	420	300 < hp <= 600	0.43	70%	0
CRANE (100 TON)	LINK-BELT	HTT-86100	Cranes	480	300 < hp <= 600	0.43	45%	0
CRANE (80 TON)	Grove RT 880E	RTC-8065	Cranes	275	175 < hp <= 300	0.43	45%	4
DOZER	CATERPILLAR	D5	Crawler Tractor/Dozers	170	100 < hp <= 175	0.59	75%	35
WHEEL LOADER	CATERPILLAR	950	Tractors/Loaders/Backhoes	168	100 < hp <= 175	0.21	65%	50
BACKHOE LOADER	CATERPILLAR	430F2	Tractors/Loaders/Backhoes	108	100 < hp <= 175	0.21	60%	215
GRADER	CATERPILLAR	140GC	Graders	196	175 < hp <= 300	0.59	50%	35
EXCAVATOR	CATERPILLAR	336	Excavators	260	175 < hp <= 300	0.59	40%	30
EXCAVATOR	CATERPILLAR	320	Excavators	172	100 < hp <= 175	0.59	65%	0
EXCAVATOR (MINI)	CATERPILLAR	306CR	Excavators	55.9	50 < hp <= 75	0.59	60%	175
SKID STEER	CATERPILLAR	289D3	Skid Steer Loaders	74.3	50 < hp <= 75	0.21	50%	300
TELEHANDLER	CATERPILLAR	TL1255D	Aerial Lifts	111	100 < hp <= 175	0.21	35%	295
COMPACTOR (SOIL)	CATERPILLAR	CP56B	Rollers	157	100 < hp <= 175	0.43	65%	35
COMPACTOR (ROLLER)	CATERPILLAR	CB10	Rollers	120	100 < hp <= 175	0.59	80%	0
COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	Rollers	24.7	16 < hp <= 25	0.59	80%	0
COMPACTOR (TRENCH)	WACKER NEUSON	RTxSC3	Rollers	23.7	16 < hp <= 25	0.43	40%	0
COMPACTOR (RAMMER)	WACKER NEUSON	BS60-4	Rollers	3.6	3 < hp <= 6	0.43	30%	100
COMPACTOR (PLATE)	WACKER NEUSON	WP1540A	Rollers	9.9	6 < hp <= 11	0.59	30%	60
PAVER	CATERPILLAR	AP555F	Pavers	142	100 < hp <= 175	0.59	85%	0
SLIPFORM PAVER	WIRTGEN	SP15i	Pavers	127	100 < hp <= 175	0.59	70%	0
TRUCK - DELIVERY	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	25%	68
TRUCK - MIXER	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	25%	22
TRUCK - DUMP	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	25%	223
TRUCK - FUEL/MECH	MACK	GRANITE	Included in On-road emissions[3]	375	300 < hp <= 600	0.59	30%	98
TRUCK - LINEMAN BUCKET	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	90%	10
TRUCK - FLAT BED	FORD	F-750	Included in On-road emissions[3]	330	300 < hp <= 600	0.59	10%	123
TRUCK - WATER	FORD	F-650	Off-Highway Trucks	300	175 < hp <= 300	0.59	10%	10
TRUCK - PICKUP	FORD	F-250	Included in On-road emissions[3]	430	300 < hp <= 600	0.59	10%	430
TRUCK - PICKUP	FORD	F-150	Included in On-road emissions[3]	290	175 < hp <= 300	0.59	10%	430
TRUCK - (COMMUTER)	FORD	F-150	Included in On-road emissions[3]	290	175 < hp <= 300	0.59	10%	2630
GENERATOR (MOBILE)[4]	CATERPILLAR	XQ570	Generator Sets	800	300 < hp <= 600	0.43	95%	0
GENERATOR (MOBILE)	WACKER NEUSON	G50	Generator Sets	70	50 < hp <= 75	0.43	95%	430
COMPRESSOR (MOBILE)	Sullair	185	Generator Sets	49	40 < hp <= 50	0.43	95%	0
PUMP (WELLPOINT)	MWI	DD PUMP	Pumps	9	6 < hp <= 11	0.43	95%	0
PUMPS (TRASH)	HONDA	WT30XK4A	Pumps	8.4	6 < hp <= 11	0.43	95%	190
TOWER LIGHTS	WACKER NEUSON	LTV6L	Generator Sets	12.2	11 < hp <= 16	0.43	95%	0

Equipment	Emission Factor (g/hp-hr)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	2.22	0.10	0.09	0.63	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HELICAL PILE DRIVER	3.95	0.24	0.23	1.42	0.29	0.00	0.02	589.52	0.01	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
SHEET PILE DRIVER	2.53	0.09	0.09	0.61	0.13	0.00	0.01	530.67	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (100 TON)	0.77	0.03	0.03	0.18	0.04	0.00	0.00	530.92	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (80 TON)	0.33	0.02	0.02	0.08	0.02	0.00	0.00	530.97	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOZER	0.33	0.02	0.02	0.09	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHEEL LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BACKHOE LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
GRADER	0.20	0.01	0.01	0.05	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.24	0.02	0.02	0.07	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR (MINI)	2.57	0.02	0.02	0.24	0.06	0.00	0.01	595.99	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SKID STEER	4.33	0.52	0.50	3.67	0.70	0.00	0.03	693.98	0.01	0.02	0.00	0.17	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00
TELEHANDLER	2.28	0.23	0.22	1.17	0.36	0.00	0.02	625.52	0.01	0.01	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00
COMPACTOR (SOIL)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (TRENCH)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (RAMMER)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
COMPACTOR (PLATE)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SLIPFORM PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.11	0.01	0.01	0.02	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4]	2.22	0.09	0.09	0.62	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GENERATOR (MOBILE)	3.89	0.23	0.22	1.43	0.30	0.00	0.02	589.49	0.01	0.01	0.00	0.08	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPRESSOR (MOBILE)	3.09	0.12	0.12	0.71	0.20	0.00	0.02	589.79	0.01	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PUMP (WELLPOINT)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PUMPS (TRASH)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
TOWER LIGHTS	3.97	0.21	0.20	1.69	0.42	0.00	0.03	589.18	0.01	0.02	0.00	0.12	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00

Equipment	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HELICAL PILE DRIVER	36.4	2.2	2.2	13.1	2.7	0.0	0.1	5437.7	0.1	0.1	0.0	0.7	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
SHEET PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (100 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (80 TON)	1.2	0.1	0.1	0.3	0.1	0.0	0.0	1993.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DOZER	15.1	1.0	1.0	4.1	0.6	0.1	0.1	24926.4	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WHEEL LOADER	29.6	2.9	2.9	13.9	4.5	0.0	0.3	12657.6	0.1	0.2	0.0	1.2	0.4	0.1	0.0	0.0	0.0	0.1	0.1	0.0
BACKHOE LOADER	75.6	7.5	7.3	35.5	11.4	0.1	0.7	32297.7	0.3	0.5	0.0	3.1	1.1	0.2	0.0	0.1	0.0	0.4	0.2	0.0
GRADER	7.2	0.4	0.4	1.9	0.5	0.1	0.0	19159.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	5.1	0.3	0.3	1.2	0.4	0.0	0.0	17427.7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR (MINI)	156.8	1.4	1.3	14.4	3.4	0.1	0.6	36401.1	0.3	0.2	0.0	1.0	0.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0
SKID STEER	178.9	21.3	20.6	151.6	28.9	0.1	1.3	28646.5	0.6	1.0	0.0	7.1	2.5	0.5	0.1	0.1	0.1	0.8	0.5	0.1
TELEHANDLER	96.7	9.6	9.3	49.7	15.2	0.1	0.8	26551.9	0.4	0.6	0.0	3.9	1.4	0.3	0.0	0.1	0.0	0.4	0.2	0.1
COMPACTOR (SOIL)	13.1	1.1	1.0	4.2	0.7	0.0	0.1	14539.7	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (TRENCH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (RAMMER)	3.4	0.2	0.2	2.0	0.7	0.0	0.1	486.3	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (PLATE)	7.8	0.4	0.4	4.6	1.6	0.0	0.1	1101.0	0.1	0.1	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLIPFORM PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	3.4	0.2	0.2	0.8	0.3	0.0	0.0	11520.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	5.5	0.3	0.3	1.3	0.4	0.0	0.0	18852.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.4	0.0	0.0	0.1	0.0	0.0	0.0	1675.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GENERATOR (MOBILE)	842.9	49.8	48.3	310.8	65.8	0.4	3.6	127838.2	1.6	2.3	0.0	16.4	5.8	1.3	0.1	0.3	0.1	1.7	1.0	0.2
COMPRESSOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMP (WELLPOINT)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMPS (TRASH)	49.1	3.1	3.0	30.0	9.5	0.0	0.8	6761.1	0.4	0.5	0.0	2.7	1.0	0.2	0.0	0.0	0.0	0.4	0.1	0.0
TOWER LIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total:	1528.1	101.8	98.7	639.5	146.7	1.1	8.6	388273.6	3.9	5.6	0.0	37.3	13.3	2.9	0.3	0.7	0.2	4.2	2.3	0.56

Notes:
1. Based on sheet Schedule tab
2. Based on data gathered from "Median Life, Annual Activity, and LoadFactor Values for Nonroad EngineEmissions Modeling" by the EPA
3. Truck - Delivery, dump, Fuel/Mech, Flat Bed, Pickup and Commuter are included in On-road emissions
4. The highest horsepower MOVES provides for Generators is up to 600. For generator Caterpillar XQ570 the horsepower bin is 300 < hp <= 600 due to this limit.

Formula:
Emissions = Emission factor * HP * Load Factor * Usage Factor * Days of Use * 8 (Hours per Day)*grams to lbs conversion

Workstream 12 (Electrical Distribution): Equipment Emissions

Equipment[1.]	Manufacture[1.]	Model[1.]	Equipment Description	HP[1.]	HP BIN	Load Factor[2.]	Usage Factor[1.]	Days Of Use[1.]
CONCRETE PUMP	PUTZMEISTER	38Z-5	Pumps	350	300 < hp <= 600	0.43	80%	0
HELICAL PILE DRIVER	CATERPILLAR	308CR	Bore/Drill Rigs	69.5	50 < hp <= 75	0.43	35%	0
SHEET PILE DRIVER	ABI	TM 13/16	Bore/Drill Rigs	420	300 < hp <= 600	0.43	70%	0
CRANE (100 TON)	LINK-BELT	HTT-86100	Cranes	480	300 < hp <= 600	0.43	45%	0
CRANE (80 TON)	Grove RT 880E	RTC-8065	Cranes	275	175 < hp <= 300	0.43	45%	0
DOZER	CATERPILLAR	D5	Crawler Tractor/Dozers	170	100 < hp <= 175	0.59	75%	0
WHEEL LOADER	CATERPILLAR	950	Tractors/Loaders/Backhoes	168	100 < hp <= 175	0.21	65%	0
BACKHOE LOADER	CATERPILLAR	430F2	Tractors/Loaders/Backhoes	108	100 < hp <= 175	0.21	60%	0
GRADER	CATERPILLAR	140GC	Graders	196	175 < hp <= 300	0.59	50%	0
EXCAVATOR	CATERPILLAR	336	Excavators	260	175 < hp <= 300	0.59	40%	0
EXCAVATOR	CATERPILLAR	320	Excavators	172	100 < hp <= 175	0.59	65%	0
EXCAVATOR (MINI)	CATERPILLAR	306CR	Excavators	55.9	50 < hp <= 75	0.59	60%	0
SKID STEER	CATERPILLAR	289D3	Skid Steer Loaders	74.3	50 < hp <= 75	0.21	50%	0
TELEHANDLER	CATERPILLAR	TL1255D	Aerial Lifts	111	100 < hp <= 175	0.21	35%	155
COMPACTOR (SOIL)	CATERPILLAR	CP56B	Rollers	157	100 < hp <= 175	0.43	65%	0
COMPACTOR (ROLLER)	CATERPILLAR	CB10	Rollers	120	100 < hp <= 175	0.59	80%	0
COMPACTOR (ROLLER)	CATERPILLAR	CB1.7	Rollers	24.7	16 < hp <= 25	0.59	80%	0
COMPACTOR (TRENCH)	WACKER NEUSON	RTxSC3	Rollers	23.7	16 < hp <= 25	0.43	40%	0
COMPACTOR (RAMMER)	WACKER NEUSON	BS60-4	Rollers	3.6	3 < hp <= 6	0.43	30%	0
COMPACTOR (PLATE)	WACKER NEUSON	WP1540A	Rollers	9.9	6 < hp <= 11	0.59	30%	0
PAVER	CATERPILLAR	AP555F	Pavers	142	100 < hp <= 175	0.59	85%	0
SLIPFORM PAVER	WIRTGEN	SP15i	Pavers	127	100 < hp <= 175	0.59	70%	0
TRUCK - DELIVERY	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	55
TRUCK - MIXER	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	25%	0
TRUCK - DUMP	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	25%	0
TRUCK - FUEL/MECH	MACK	GRANITE	Included in On-road emissions[3.]	375	300 < hp <= 600	0.59	30%	79
TRUCK - LINEMAN BUCKET	MACK	GRANITE	Off-Highway Trucks	375	300 < hp <= 600	0.59	90%	0
TRUCK - FLAT BED	FORD	F-750	Included in On-road emissions[3.]	330	300 < hp <= 600	0.59	10%	0
TRUCK - WATER	FORD	F-650	Off-Highway Trucks	300	175 < hp <= 300	0.59	10%	0
TRUCK - PICKUP	FORD	F-250	Included in On-road emissions[3.]	430	300 < hp <= 600	0.59	10%	0
TRUCK - PICKUP	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	225
TRUCK - (COMMUTER)	FORD	F-150	Included in On-road emissions[3.]	290	175 < hp <= 300	0.59	10%	1350
GENERATOR (MOBILE)[4.]	CATERPILLAR	XQ570	Generator Sets	800	300 < hp <= 600	0.43	95%	0
GENERATOR (MOBILE)	WACKER NEUSON	G50	Generator Sets	70	50 < hp <= 75	0.43	95%	0
COMPRESSOR (MOBILE)	Sullair	185	Generator Sets	49	40 < hp <= 50	0.43	95%	0
PUMP (WELLPOINT)	MWI	DD PUMP	Pumps	9	6 < hp <= 11	0.43	95%	0
PUMPS (TRASH)	HONDA	WT30XK4A	Pumps	8.4	6 < hp <= 11	0.43	95%	0
TOWER LIGHTS	WACKER NEUSON	LTV6L	Generator Sets	12.2	11 < hp <= 16	0.43	95%	0

Equipment[1.]	Emission Factor (g/hp-hr)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	2.22	0.10	0.09	0.63	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HELICAL PILE DRIVER	3.95	0.24	0.23	1.42	0.29	0.00	0.02	589.52	0.01	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
SHEET PILE DRIVER	2.53	0.09	0.09	0.61	0.13	0.00	0.01	530.67	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (100 TON)	0.77	0.03	0.03	0.18	0.04	0.00	0.00	530.92	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE (80 TON)	0.33	0.02	0.02	0.08	0.02	0.00	0.00	530.97	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOZER	0.33	0.02	0.02	0.09	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHEEL LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BACKHOE LOADER	1.47	0.15	0.14	0.69	0.22	0.00	0.01	625.91	0.01	0.01	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
GRADER	0.20	0.01	0.01	0.05	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR	0.24	0.02	0.02	0.07	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXCAVATOR (MINI)	2.57	0.02	0.02	0.24	0.06	0.00	0.01	595.99	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SKID STEER	4.33	0.52	0.50	3.67	0.70	0.00	0.03	693.98	0.01	0.02	0.00	0.17	0.06	0.01	0.00	0.00	0.00	0.02	0.01	0.00
TELEHANDLER	2.28	0.23	0.22	1.17	0.36	0.00	0.02	625.52	0.01	0.01	0.00	0.09	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00
COMPACTOR (SOIL)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	0.48	0.04	0.04	0.16	0.02	0.00	0.00	536.76	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPACTOR (ROLLER)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (TRENCH)	3.76	0.17	0.17	1.49	0.35	0.00	0.03	595.15	0.01	0.02	0.00	0.10	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPACTOR (RAMMER)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
COMPACTOR (PLATE)	4.18	0.24	0.23	2.47	0.84	0.00	0.07	593.75	0.03	0.05	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SLIPFORM PAVER	0.41	0.03	0.03	0.12	0.02	0.00	0.00	536.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.16	0.01	0.01	0.04	0.01	0.00	0.00	536.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.11	0.01	0.01	0.02	0.01	0.00	0.00	536.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4.]	2.22	0.09	0.09	0.62	0.14	0.00	0.01	530.65	0.00	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GENERATOR (MOBILE)	3.89	0.23	0.22	1.43	0.30	0.00	0.02	589.49	0.01	0.01	0.00	0.08	0.03	0.01	0.00	0.00	0.00	0.01	0.00	0.00
COMPRESSOR (MOBILE)	3.09	0.12	0.12	0.71	0.20	0.00	0.02	589.79	0.01	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00
PUMP (WELLPOINT)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
PUMPS (TRASH)	4.27	0.27	0.26	2.61	0.83	0.00	0.07	587.99	0.03	0.04	0.00	0.24	0.09	0.02	0.00	0.00	0.00	0.03	0.01	0.00
TOWER LIGHTS	3.97	0.21	0.20	1.69	0.42	0.00	0.03	589.18	0.01	0.02	0.00	0.12	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00

Equipment[1.]	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
CONCRETE PUMP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HELICAL PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHEET PILE DRIVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (100 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRANE (80 TON)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DOZER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WHEEL LOADER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BACKHOE LOADER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRADER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EXCAVATOR (MINI)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SKID STEER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TELEHANDLER	50.8	5.0	4.9	26.1	8.0	0.0	0.4	13951.0	0.2	0.3	0.0	2.0	0.7	0.2	0.0	0.0	0.0	0.2	0.1	0.0
COMPACTOR (SOIL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (ROLLER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (TRENCH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (RAMMER)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPACTOR (PLATE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SLIPFORM PAVER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DELIVERY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - MIXER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - DUMP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - FUEL/MECH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - LINEMAN BUCKET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - FLAT BED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - PICKUP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUCK - (COMMUTER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GENERATOR (MOBILE)[4.]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GENERATOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMPRESSOR (MOBILE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMP (WELLPOINT)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUMPS (TRASH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOWER LIGHTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total:	50.8	5.0	4.9	26.1	8.0	0.0	0.4	13951.0	0.2	0.3	0.0	2.0	0.7	0.2	0.0	0.0	0.0	0.2	0.1	0.03

Notes:

1. Based on sheet Schedule tab
2. Based on data gathered from "Median Life, Annual Activity, and LoadFactor Values for Nonroad EngineEmissions Modeling" by the EPA
3. Truck - Delivery, Dump, Fuel/Mech, Flat Bed, Pickup and Commuter are included in On-road emissions
4. The highest horsepower MOVES provides for Generators is up to 600. For generator Caterpillar XQ570 the horsepower bin is 300 < hp <= 600 due to this limit.

Formula:

Emissions = Emission factor * HP * Load Factor * Usage Factor * Days of Use * 8 (Hours per Day)*grams to lbs conversion

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Construction: Onroad Emissions - Notes and References

Shift Details	
8	Hours / Day
6	Days / Week
4.3	Weeks / Month
25.8	Days / Month
206.4	Hours / Month

Conversions	
0.0005	lbs to short tons
453.592	grams to lbs
60	Minutes in hour

Notes:

1. Pollution lookup and fuel lookup are based on EPA MOVES software decoding
2. Schedule is provided by Ameresco based on sheet "JBPHH - EMISSIONS, SITE 2 ENGINE HALL- BESS & SITE 5 PV (3-30-23)"
3. Highlighted Vehicles within the schedule are being summarized here.
4. Time and distance traveled were assumptions made and confirmed by applicant (04/13/23)
5. Calculations were built around this equation below.

$AE\ i = VMT \times EF\ i \times 0.002205$

Where,

AE_i = Annual emissions of chemical *i* (*lb i/yr*)

VMT = number of vehicle miles traveled per year (*miles/yr*)

EF_i = Chemical *i* emission factor (*g i/mile*)

0.002205 = Factor to convert grams to pounds (*lb i/g i*)

MOVES Specs:	
Scale	Onroad Project Inventory
Time Spans	2025 January and July Weekdays 8am-6pm
Geographic Bounds	Hawaii Honolulu County
Onroad Equipment	Passenger Truck Single Unit Short Haul Truck Light Commercial Truck Combination Short Haul Truck
Road Type	All
Pollutants and Processes	All
Units	Grams Million BTU Miles
Output Emissions Detail	Fuel Type Emission Process SCC

Construction: Summary Onroad Emissions

Onroad

Site 2

Activity	Pollutant (tons)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
Workstream 1	0.01877	0.00249	0.00080	0.21434	0.00521	0.00012	0.00100	19.23112	0.00025	0.00018	0.00012	0.00011	0.00008	0.00001	0.00003	0.00008	0.00010	0.00037	0.00031	0.00002
Workstream 2	0.10099	0.01040	0.00504	0.42058	0.01552	0.00029	0.00212	56.98859	0.00050	0.00036	0.00022	0.00068	0.00037	0.00006	0.00006	0.00017	0.00019	0.00070	0.00061	0.00008
Workstream 6	0.02019	0.00220	0.00098	0.11349	0.00361	0.00007	0.00055	13.25954	0.00013	0.00010	0.00006	0.00013	0.00008	0.00001	0.00002	0.00005	0.00005	0.00019	0.00016	0.00002
Workstream 7	0.04106	0.00506	0.00184	0.37264	0.00976	0.00022	0.00176	35.96210	0.00044	0.00031	0.00021	0.00025	0.00017	0.00002	0.00005	0.00015	0.00017	0.00065	0.00053	0.00003
Workstream 8	0.17615	0.02117	0.00805	1.46846	0.03963	0.00086	0.00698	146.02500	0.00173	0.00123	0.00083	0.00108	0.00071	0.00008	0.00019	0.00058	0.00068	0.00254	0.00210	0.00014
Workstream 9	0.10261	0.01166	0.00485	0.69270	0.02031	0.00042	0.00334	74.74038	0.00082	0.00058	0.00038	0.00065	0.00040	0.00005	0.00009	0.00028	0.00032	0.00119	0.00099	0.00008
Workstream 10	0.04501	0.00503	0.00215	0.28456	0.00858	0.00018	0.00138	31.56038	0.00034	0.00024	0.00016	0.00029	0.00017	0.00002	0.00004	0.00011	0.00013	0.00049	0.00041	0.00004
Total:	0.50	0.06	0.02	3.57	0.10	0.00	0.02	377.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

Site 5

Activity	Pollutant (tons)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
Workstream 11	0.08298	0.00964	0.00387	0.61181	0.01730	0.00037	0.00293	63.71673	0.00072	0.00051	0.00034	0.00052	0.00033	0.00004	0.00008	0.00024	0.00028	0.00105	0.00088	0.00007
Total:	0.08	0.01	0.00	0.61	0.02	0.00	0.00	63.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Backbone

Activity	Pollutant (tons)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
Workstream 3	0.38118	0.04137	0.01850	2.10321	0.06740	0.00135	0.01029	247.82560	0.00250	0.00179	0.00114	0.00249	0.00145	0.00020	0.00029	0.00085	0.00096	0.00357	0.00302	0.00031
Workstream 4	0.02275	0.00239	0.00112	0.10595	0.00369	0.00007	0.00053	13.54816	0.00013	0.00009	0.00006	0.00015	0.00009	0.00001	0.00002	0.00004	0.00005	0.00018	0.00015	0.00002
Workstream 12	0.02782	0.00350	0.00123	0.27048	0.00692	0.00015	0.00127	25.50987	0.00032	0.00023	0.00015	0.00016	0.00012	0.00001	0.00003	0.00011	0.00013	0.00047	0.00039	0.00002
Total:	0.43	0.05	0.02	2.48	0.08	0.00	0.01	286.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note

Workstream 1 - COVERED STORAGE
Workstream 2 - SITE PRECON
Workstream 3 - MICROTUNNELING
Workstream 4 - OPEN CUT DISTRIBUTION
Workstream 6 - BATTERY ENERGY STORAGE SYSTEMS (BESS)
Workstream 7 - SITE SUBSTATION
Workstream 8 - ENGINE HALL
Workstream 9 - STORAGE TANKS & DISTRIBUTION
Workstream 10 - FUEL TERMINAL
Workstream 11 - PHOTOVOLTAIC (PV)
Workstream 12 - ELECTRICAL DISTRIBUTION

Construction: Annual Summary Onroad Emissions

Site 2	Emissions (tons) per year		
	2025 [1.]	2026	2027
NOX	0.0486998	0.2369286	0.2191493
PM10	0.005597	0.0272298	0.0251864
PM2.5	0.002287	0.0111265	0.0102916
CO	0.3441142	1.6741427	1.5485137
VOC	0.0099	0.0481642	0.0445499
SO2	0.0002086	0.0010148	0.0009387
CH4	0.0016522	0.0080379	0.0074347
CO2	36.446137	177.31335	164.00762
N2O	0.0004059	0.0019749	0.0018267
Benzene	0.0002892	0.001407	0.0013014
Ethanol	0.000191	0.000930	0.000860
Formaldehyde	0.0003074	0.0014953	0.0013831
Acetaldehyde	0.0001918	0.0009334	0.0008633
Acrolein	2.44E-05	0.0001187	0.0001098
1,3-Butadiene	4.51E-05	0.0002194	0.0002029
Ethyl Benzene	0.0001373	0.0006682	0.000618
Hexane	0.000159	0.0007735	0.0007155
Toluene	0.0005906	0.0028731	0.0026575
Xylene	0.0004935	0.0024008	0.0022206
Naphthalene gas	3.936E-05	0.0001915	0.0001771

Site 5	Emissions (tons) per year		
	2025 [1.]	2026	2027
NOX	0.0829792	0	0
PM10	0.0096418	0	0
PM2.5	0.003871	0	0
CO	0.6118127	0	0
VOC	0.017304	0	0
SO2	0.0003677	0	0
CH4	0.002929	0	0
CO2	63.716726	0	0
N2O	0.000721	0	0
Benzene	0.0005134	0	0
Ethanol	0.000341	0	0
Formaldehyde	0.0005199	0	0
Acetaldehyde	0.000329	0	0
Acrolein	4.118E-05	0	0
1,3-Butadiene	7.951E-05	0	0
Ethyl Benzene	0.0002439	0	0
Hexane	0.000283	0	0
Toluene	0.0010518	0	0
Xylene	0.0008772	0	0
Naphthalene gas	6.707E-05	0	0

Backbone	Emissions (tons) per year		
	2025 [1.]	2026	2027
NOX	0.2283078	0.1969073	0.0065418
PM10	0.024993	0.0215556	0.0007161
PM2.5	0.0110274	0.0095107	0.000316
CO	1.3112005	1.1308635	0.0375702
VOC	0.041249	0.0355758	0.0011819
SO2	0.0008317	0.0007173	2.383E-05
CH4	0.0063954	0.0055158	0.0001832
CO2	151.70058	130.83632	4.3467216
N2O	0.0015557	0.0013418	4.458E-05
Benzene	0.0011114	0.0009585	3.185E-05
Ethanol	0.000713	0.000615	2.043E-05
Formaldehyde	0.0014864	0.001282	4.259E-05
Acetaldehyde	0.0008745	0.0007542	2.506E-05
Acrolein	0.0001192	0.0001028	3.415E-06
1,3-Butadiene	0.0001798	0.0001551	5.153E-06
Ethyl Benzene	0.0005265	0.0004541	1.509E-05
Hexane	0.0006018	0.0005191	1.724E-05
Toluene	0.0022287	0.0019222	6.386E-05
Xylene	0.0018825	0.0016236	5.394E-05
Naphthalene gas	0.0001845	0.0001591	5.286E-06

Note:
1. Due to 2024 only having one month of emissions it has been grouped with 2025 emissions.

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Workstream 1 (Covered Storage): Vehicle (Onroad) Emissions

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	0mph Emission Factor (g/hour)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	21	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	20	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	16	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	15	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	10	180	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	180	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	900	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

DESCRIPTION	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.046	0.003	0.003	0.031	0.007	0.000	0.000	8.307	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	0.044	0.003	0.003	0.029	0.007	0.000	0.000	7.911	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FUEL/MECH	0.035	0.003	0.002	0.023	0.005	0.000	0.000	6.329	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FLAT BED	0.033	0.002	0.002	0.022	0.005	0.000	0.000	5.934	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.010	0.000	0.000	0.097	0.005	0.000	0.001	58.804	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.010	0.000	0.000	0.097	0.005	0.000	0.001	58.804	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - (COMMUTER)	0.048	0.001	0.001	0.486	0.026	0.002	0.007	294.018	0.007	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.000

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	25mph Emission Factor (g/mile)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	21	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	20	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	16	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	15	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	30	180	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	180	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	900	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

DESCRIPTION	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	2.207	0.236	0.127	1.242	0.202	0.002	0.011	657.420	0.002	0.001	0.000	0.016	0.007	0.001	0.001	0.001	0.000	0.001	0.002	0.002
TRUCK - DUMP	2.102	0.225	0.121	1.183	0.192	0.002	0.011	626.114	0.002	0.001	0.000	0.015	0.007	0.001	0.001	0.001	0.000	0.001	0.002	0.002
TRUCK - FUEL/MECH	1.681	0.180	0.097	0.947	0.154	0.002	0.009	500.891	0.001	0.001	0.000	0.012	0.006	0.001	0.000	0.001	0.000	0.001	0.002	0.001
TRUCK - FLAT BED	1.576	0.169	0.091	0.887	0.144	0.002	0.008	469.585	0.001	0.001	0.000	0.011	0.005	0.001	0.000	0.000	0.000	0.001	0.001	0.001
TRUCK - PICKUP	1.211	0.373	0.065	27.279	0.433	0.015	0.114	2190.196	0.018	0.015	0.008	0.006	0.004	0.000	0.002	0.008	0.008	0.036	0.029	0.001
TRUCK - PICKUP	1.211	0.373	0.065	27.279	0.433	0.015	0.114	2190.196	0.018	0.015	0.008	0.006	0.004	0.000	0.002	0.008	0.008	0.036	0.029	0.001
TRUCK - (COMMUTER)	6.057	1.864	0.326	136.396	2.165	0.073	0.572	10950.980	0.090	0.077	0.042	0.029	0.022	0.001	0.008	0.040	0.042	0.180	0.146	0.004

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	55mph Emission Factor (g/mile)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	21	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	20	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	16	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	15	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Restricted	20	180	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	180	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	900	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DESCRIPTION	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	1.770	0.127	0.092	1.015	0.172	0.002	0.007	729.512	0.001	0.001	0.000	0.014	0.006	0.001	0.000	0.001	0.000	0.001	0.001	0.002
TRUCK - DUMP	1.686	0.121	0.088	0.967	0.164	0.002	0.007	694.774	0.001	0.001	0.000	0.013	0.006	0.001	0.000	0.001	0.000	0.001	0.001	0.001
TRUCK - FUEL/MECH	1.349	0.097	0.070	0.773	0.131	0.002	0.005	555.819	0.001	0.001	0.000	0.010	0.005	0.001	0.000	0.000	0.000	0.001	0.001	0.001
TRUCK - FLAT BED	1.265	0.091	0.066	0.725	0.123	0.002	0.005	521.080	0.001	0.001	0.000	0.010	0.005	0.001	0.000	0.000	0.000	0.001	0.001	0.001
TRUCK - PICKUP	1.625	0.139	0.035	27.348	0.322	0.016	0.090	2483.501	0.012	0.013	0.006	0.004	0.003	0.000	0.001	0.006	0.006	0.027	0.022	0.001
TRUCK - PICKUP	1.625	0.139	0.035	27.348	0.322	0.016	0.090	2483.501	0.012	0.013	0.006	0.004	0.003	0.000	0.001	0.006	0.006	0.027	0.022	0.001
TRUCK - (COMMUTER)	8.126	0.693	0.175	136.740	1.608	0.082	0.448	12417.505	0.060	0.063	0.031	0.022	0.016	0.001	0.006	0.030	0.032	0.134	0.109	0.003

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	Starts Emission Factor (g/start)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	21	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	20	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	16	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Off Network	N/A	15	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Off Network	N/A	180	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	180	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	900	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00

DESCRIPTION	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.141	0.001	0.001	0.147	0.004	0.000	0.002	8.862	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	0.134	0.001	0.001	0.140	0.004	0.000	0.002	8.440	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FUEL/MECH	0.107	0.001	0.000	0.112	0.003	0.000	0.001	6.752	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FLAT BED	0.101	0.000	0.000	0.105	0.003	0.000	0.001	6.330	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.477	0.021	0.019	5.324	0.541	0.000	0.071	74.383	0.038	0.021	0.020	0.005	0.008	0.001	0.004	0.009	0.013	0.042	0.035	0.001
TRUCK - PICKUP	0.477	0.021	0.019	5.324	0.541	0.000	0.071	74.383	0.038	0.021	0.020	0.005	0.008	0.001	0.004	0.009	0.013	0.042	0.035	0.001
TRUCK - (COMMUTER)	2.385	0.106	0.093	26.620	2.704	0.002	0.353	371.914	0.192	0.106	0.102	0.026	0.042	0.003	0.020	0.047	0.067	0.212	0.173	0.006
Total:	37.540	4.989	1.597	428.685	10.425	0.240	2.004	38462.244	0.501	0.355	0.246	0.212	0.161	0.016	0.052	0.169	0.200	0.747	0.614	0.030

Rural Unrestricted
1. Based on MOVES data.
2. Based on Schedule tab

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use / grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance * Days of Use / grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) / grams to pound conversion (453.592)
Distance = Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)

Workstream 2 (Site Precon): Vehicle (Onroad) Emissions

								0mph Emission Factor (g/hour)																				Emission (lbs)																			
DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	45	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.099	0.007	0.007	0.065	0.015	0.000	0.001	17.801	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	485	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	1.066	0.079	0.073	0.705	0.160	0.001	0.009	191.852	0.003	0.001	0.000	0.012	0.006	0.001	0.000	0.001	0.000	0.001	0.002	0.001
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	205	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.451	0.033	0.031	0.298	0.068	0.000	0.004	81.092	0.001	0.001	0.000	0.005	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.001
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	75	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.165	0.012	0.011	0.109	0.025	0.000	0.001	29.668	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	10	280	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.015	0.000	0.000	0.151	0.008	0.001	0.002	91.472	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	280	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.015	0.000	0.000	0.151	0.008	0.001	0.002	91.472	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	1680	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.090	0.002	0.002	0.907	0.048	0.004	0.013	548.833	0.013	0.002	0.001	0.001	0.000	0.000	0.000	0.001	0.001	0.004	0.003	0.000

								25mph Emission Factor (g/mile)																				Emission (lbs)																			
DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	45	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.729	0.506	0.272	2.662	0.433	0.005	0.025	1408.756	0.004	0.003	0.000	0.034	0.016	0.003	0.001	0.001	0.001	0.003	0.004	0.004
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	485	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.968	5.455	2.932	28.693	4.663	0.052	0.264	15183.260	0.044	0.035	0.000	0.365	0.172	0.030	0.012	0.016	0.009	0.028	0.048	0.040
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	205	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.543	2.306	1.239	12.128	1.971	0.022	0.112	6417.667	0.019	0.015	0.000	0.154	0.073	0.013	0.005	0.007	0.004	0.012	0.020	0.017
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	75	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.882	0.844	0.453	4.437	0.721	0.008	0.041	2347.927	0.007	0.005	0.000	0.056	0.027	0.005	0.002	0.002	0.001	0.004	0.007	0.006
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	30	280	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	1.884	0.580	0.101	42.434	0.674	0.023	0.178	3406.971	0.028	0.024	0.013	0.009	0.007	0.000	0.002	0.013	0.013	0.056	0.046	0.001
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	280	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	1.884	0.580	0.101	42.434	0.674	0.023	0.178	3406.971	0.028	0.024	0.013	0.009	0.007	0.000	0.002	0.013	0.013	0.056	0.046	0.001
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	1680	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	11.306	3.480	0.608	254.606	4.042	0.136	1.068	20441.829	0.167	0.143	0.079	0.055	0.041	0.003	0.015	0.075	0.079	0.336	0.273	0.008

								55mph Emission Factor (g/mile)																				Emission (lbs)																			
DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	45	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.794	0.272	0.197	2.175	0.369	0.005	0.015	1563.241	0.003	0.003	0.000	0.029	0.014	0.002	0.001	0.001	0.001	0.002	0.003	0.003
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	485	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.886	2.931	2.127	23.439	3.975	0.057	0.163	16848.263	0.029	0.030	0.000	0.318	0.146	0.026	0.011	0.012	0.008	0.022	0.031	0.035
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	205	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.282	1.239	0.899	9.907	1.680	0.024	0.069	7121.431	0.012	0.013	0.000	0.134	0.062	0.011	0.005	0.005	0.003	0.009	0.013	0.015
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	75	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.323	0.453	0.329	3.625	0.615	0.009	0.025	2605.401	0.005	0.005	0.000	0.049	0.023	0.004	0.002	0.002	0.001	0.003	0.005	0.005
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Restricted	20	280	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.528	0.216	0.054	42.541	0.500	0.026	0.139	3863.224	0.019	0.020	0.010	0.007	0.005	0.000	0.002	0.009	0.010	0.042	0.034	0.001
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	280	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.528	0.216	0.054	42.541	0.500	0.026	0.139	3863.224	0.019	0.020	0.010	0.007	0.005	0.000	0.002	0.009	0.010	0.042	0.034	0.001
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	1680	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.169	1.294	0.327	255.248	3.002	0.154	0.837	23179.343	0.111	0.118	0.058	0.041	0.030	0.002	0.011	0.056	0.059	0.249	0.203	0.006

								Starts Emission Factor (g/start)																				Emission (lbs)																			
DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	45	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.302	0.001	0.001	0.314	0.009	0.000	0.004	18.991	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	485	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.251	0.016	0.015	3.387	0.097	0.001	0.040	204.679	0.008	0.000	0.000	0.006	0.004	0.001	0.000	0.001	0.000	0.001	0.005	0.000
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	205	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.374	0.007	0.006	1.432	0.041	0.000	0.017	86.514	0.003	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.001	0.002	0.000
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Off Network	N/A	75	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.503	0.002	0.002	0.524	0.015	0.000	0.006	31.651	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Off Network	N/A	280	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	0.742	0.033	0.029	8.282	0.841	0.001	0.110	115.706	0.060	0.033	0.032	0.008	0.013	0.001	0.006	0.015	0.021	0.066	0.054	0.002
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	280	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	0.742	0.033	0.029	8.282	0.841	0.001	0.110	115.706	0.060	0.033	0.032	0.008	0.013	0.001	0.006	0.015	0.021	0.066	0.054	0.002
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	1680	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	4.452	0.197	0.174	49.690	5.047	0.005	0.660	694.239	0.359	0.197	0.191	0.048	0.079	0.005	0.038	0.088	0.124	0.396	0.322	0.010
																											Total:	201.971	20.795	10.078	841.169	31.042	0.581	4.233	113977.185	1.010	0.725	0.438	1.363	0.747	0.111	0.126	0.342	0.381	1.402	1.210	0.163

Rural Unrestricted
1. Based on MOVES data.
2. Based on Schedule tab

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use / grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance * Days of Use / grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) / grams to pound conversion (453.592)
Distance = Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)

Workstream 3 (Microtunneling): Vehicle (Onroad) Emissions

0mph Emission Factor (g/hour)

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	40	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	1155	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	1155	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	410	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	10	1165	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	1165	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	9320	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

Emission (lbs)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.088	0.007	0.006	0.058	0.013	0.000	0.001	15.823	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	2.539	0.188	0.173	1.679	0.382	0.002	0.022	456.886	0.007	0.003	0.000	0.030	0.014	0.002	0.001	0.001	0.001	0.002	0.004	0.003
TRUCK - FUEL/MECH	2.539	0.188	0.173	1.679	0.382	0.002	0.022	456.886	0.007	0.003	0.000	0.030	0.014	0.002	0.001	0.001	0.001	0.002	0.004	0.003
TRUCK - FLAT BED	0.901	0.067	0.062	0.596	0.136	0.001	0.008	162.185	0.002	0.001	0.000	0.011	0.005	0.001	0.000	0.000	0.000	0.001	0.001	0.001
TRUCK - PICKUP	0.062	0.002	0.001	0.629	0.034	0.003	0.009	380.590	0.009	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.002	0.000
TRUCK - PICKUP	0.062	0.002	0.001	0.629	0.034	0.003	0.009	380.590	0.009	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.002	0.000
TRUCK - (COMMUTER)	0.500	0.012	0.011	5.034	0.269	0.020	0.073	3044.716	0.074	0.011	0.005	0.004	0.003	0.000	0.001	0.005	0.005	0.022	0.018	0.001

25mph Emission Factor (g/mile)

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	40	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	1155	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	1155	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	410	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	30	1165	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	1165	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	9320	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

Emission (lbs)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	4.204	0.450	0.242	2.366	0.385	0.004	0.022	1252.228	0.004	0.003	0.000	0.030	0.014	0.003	0.001	0.001	0.001	0.002	0.004	0.003
TRUCK - DUMP	121.376	12.991	6.983	68.331	11.105	0.123	0.629	36158.073	0.105	0.082	0.000	0.869	0.409	0.072	0.030	0.037	0.022	0.066	0.114	0.096
TRUCK - FUEL/MECH	121.376	12.991	6.983	68.331	11.105	0.123	0.629	36158.073	0.105	0.082	0.000	0.869	0.409	0.072	0.030	0.037	0.022	0.066	0.114	0.096
TRUCK - FLAT BED	43.086	4.612	2.479	24.256	3.942	0.044	0.223	12835.333	0.037	0.029	0.000	0.309	0.145	0.026	0.010	0.013	0.008	0.023	0.040	0.034
TRUCK - PICKUP	7.840	2.413	0.422	176.557	2.803	0.094	0.741	14175.435	0.116	0.099	0.055	0.038	0.028	0.002	0.010	0.052	0.055	0.233	0.190	0.006
TRUCK - PICKUP	7.840	2.413	0.422	176.557	2.803	0.094	0.741	14175.435	0.116	0.099	0.055	0.038	0.028	0.002	0.010	0.052	0.055	0.233	0.190	0.006
TRUCK - (COMMUTER)	62.724	19.304	3.373	1412.460	22.423	0.753	5.926	113403.478	0.927	0.794	0.436	0.304	0.226	0.015	0.083	0.417	0.438	1.867	1.516	0.046

55mph Emission Factor (g/mile)

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	40	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	1155	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	1155	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	410	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Restricted	20	1165	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	1165	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	9320	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Emission (lbs)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	3.372	0.242	0.175	1.933	0.328	0.005	0.013	1389.547	0.002	0.003	0.000	0.026	0.012	0.002	0.001	0.001	0.001	0.002	0.003	0.003
TRUCK - DUMP	97.369	6.979	5.066	55.818	9.467	0.136	0.388	40123.183	0.070	0.073	0.000	0.756	0.347	0.062	0.026	0.029	0.019	0.052	0.073	0.084
TRUCK - FUEL/MECH	97.369	6.979	5.066	55.818	9.467	0.136	0.388	40123.183	0.070	0.073	0.000	0.756	0.347	0.062	0.026	0.029	0.019	0.052	0.073	0.084
TRUCK - FLAT BED	34.564	2.477	1.798	19.814	3.361	0.048	0.138	14242.861	0.025	0.026	0.000	0.268	0.123	0.022	0.009	0.010	0.007	0.019	0.026	0.030
TRUCK - PICKUP	10.519	0.897	0.227	177.002	2.082	0.107	0.580	16073.771	0.077	0.082	0.040	0.028	0.021	0.001	0.008	0.039	0.041	0.173	0.140	0.004
TRUCK - PICKUP	10.519	0.897	0.227	177.002	2.082	0.107	0.580	16073.771	0.077	0.082	0.040	0.028	0.021	0.001	0.008	0.039	0.041	0.173	0.140	0.004
TRUCK - (COMMUTER)	84.150	7.178	1.813	1416.017	16.655	0.854	4.643	128590.165	0.618	0.655	0.322	0.226	0.167	0.011	0.061	0.309	0.328	1.383	1.124	0.034

Starts Emission Factor (g/start)

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	40	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	1155	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	1155	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Off Network	N/A	410	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Off Network	N/A	1165	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	1165	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	9320	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00

Emission (lbs)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.268	0.001	0.001	0.279	0.008	0.000	0.003	16.881	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	7.741	0.038	0.035	8.067	0.230	0.002	0.094	487.432	0.020	0.001	0.000	0.014	0.009	0.001	0.000	0.002	0.000	0.003	0.011	0.001
TRUCK - FUEL/MECH	7.741	0.038	0.035	8.067	0.230	0.002	0.094	487.432	0.020	0.001	0.000	0.014	0.009	0.001	0.000	0.002	0.000	0.003	0.011	0.001
TRUCK - FLAT BED	2.748	0.014	0.013	2.864	0.082	0.001	0.033	173.028	0.007	0.000	0.000	0.005	0.003	0.000	0.000	0.001	0.000	0.001	0.004	0.000
TRUCK - PICKUP	3.087	0.137	0.121	34.458	3.500	0.003	0.457	481.421	0.249	0.137	0.132	0.033	0.055	0.004	0.027	0.061	0.086	0.275	0.223	0.007
TRUCK - PICKUP	3.087	0.137	0.121	34.458	3.500	0.003	0.457	481.421	0.249	0.137	0.132	0.033	0.055	0.004	0.027	0.061	0.086	0.275	0.223	0.007
TRUCK - (COMMUTER)	24.697	1.093	0.967	275.660	27.997	0.026	3.659	3851.371	1.993	1.095	1.058	0.267	0.438	0.030	0.212	0.491	0.690	2.198	1.786	0.058
Total:	762.368	82.747	36.997	4206.420	134.800	2.694	20.587	495651.196	4.997	3.572	2.277	4.989	2.906	0.401	0.583	1.691	1.928	7.135	6.041	0.616

Rural Unrestricted
1. Based on MOVES data.
2. Based on Schedule tab

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use / grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance * Days of Use / grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) / grams to pound conversion (453.592)
Distance = Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)

Workstream 4 (Open Cut Distribution): Vehicle (Onroad) Emissions

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	0mph Emission Factor (g/hour) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	12	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	82	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	82	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	0	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	10	0	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	82	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	492	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.026	0.002	0.002	0.017	0.004	0.000	0.000	4.747	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	0.180	0.013	0.012	0.119	0.027	0.000	0.002	32.437	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FUEL/MECH	0.180	0.013	0.012	0.119	0.027	0.000	0.002	32.437	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.004	0.000	0.000	0.044	0.002	0.000	0.001	26.788	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - (COMMUTER)	0.026	0.001	0.001	0.266	0.014	0.001	0.004	160.730	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	25mph Emission Factor (g/mile) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	12	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	82	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	82	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	0	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	30	0	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	82	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	492	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	1.261	0.135	0.073	0.710	0.115	0.001	0.007	375.668	0.001	0.001	0.000	0.009	0.004	0.001	0.000	0.000	0.000	0.001	0.001	0.001
TRUCK - DUMP	8.617	0.922	0.496	4.851	0.788	0.009	0.045	2567.067	0.007	0.006	0.000	0.062	0.029	0.005	0.002	0.003	0.002	0.005	0.008	0.007
TRUCK - FUEL/MECH	8.617	0.922	0.496	4.851	0.788	0.009	0.045	2567.067	0.007	0.006	0.000	0.062	0.029	0.005	0.002	0.003	0.002	0.005	0.008	0.007
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.552	0.170	0.030	12.427	0.197	0.007	0.052	997.756	0.008	0.007	0.004	0.003	0.002	0.000	0.001	0.004	0.004	0.016	0.013	0.000
TRUCK - (COMMUTER)	3.311	1.019	0.178	74.563	1.184	0.040	0.313	5986.536	0.049	0.042	0.023	0.016	0.012	0.001	0.004	0.022	0.023	0.099	0.080	0.002

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	55mph Emission Factor (g/mile) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	12	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	82	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	82	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	0	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Restricted	20	0	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	82	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	492	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	1.012	0.073	0.053	0.580	0.098	0.001	0.004	416.864	0.001	0.001	0.000	0.008	0.004	0.001	0.000	0.000	0.000	0.001	0.001	0.001
TRUCK - DUMP	6.913	0.495	0.360	3.963	0.672	0.010	0.028	2848.572	0.005	0.005	0.000	0.054	0.025	0.004	0.002	0.002	0.001	0.004	0.005	0.006
TRUCK - FUEL/MECH	6.913	0.495	0.360	3.963	0.672	0.010	0.028	2848.572	0.005	0.005	0.000	0.054	0.025	0.004	0.002	0.002	0.001	0.004	0.005	0.006
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.740	0.063	0.016	12.459	0.147	0.008	0.041	1131.373	0.005	0.006	0.003	0.002	0.001	0.000	0.001	0.003	0.003	0.012	0.010	0.000
TRUCK - (COMMUTER)	4.442	0.379	0.096	74.751	0.879	0.045	0.245	6788.236	0.033	0.035	0.017	0.012	0.009	0.001	0.003	0.016	0.017	0.073	0.059	0.002

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	Starts Emission Factor (g/start) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	12	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	82	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	82	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Off Network	N/A	0	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Off Network	N/A	0	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	82	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	492	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.080	0.000	0.000	0.084	0.002	0.000	0.001	5.064	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	0.550	0.003	0.003	0.573	0.016	0.000	0.007	34.606	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FUEL/MECH	0.550	0.003	0.003	0.573	0.016	0.000	0.007	34.606	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.217	0.010	0.009	2.425	0.246	0.000	0.032	33.885	0.018	0.010	0.009	0.002	0.004	0.000	0.002	0.004	0.006	0.019	0.016	0.001
TRUCK - (COMMUTER)	1.304	0.058	0.051	14.552	1.478	0.001	0.193	203.313	0.105	0.058	0.056	0.014	0.023	0.002	0.011	0.026	0.036	0.116	0.094	0.003
Total:	45.497	4.777	2.248	211.891	7.376	0.142	1.054	27096.323	0.253	0.181	0.112	0.304	0.170	0.025	0.031	0.086	0.096	0.356	0.305	0.037

Rural Unrestricted
1. Based on MOVES data.
2. Based on Schedule tab

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use / grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance * Days of Use / grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) / grams to pound conversion (453.592)
Distance = Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)

Workstream 6 (Battery Energy Storage Systems): Vehicle (Onroad) Emissions

								0mph Emission Factor (g/hour)																				Emission (lbs)																			
DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	30	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.066	0.005	0.005	0.044	0.010	0.000	0.001	11.867	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	45	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.099	0.007	0.007	0.065	0.015	0.000	0.001	17.801	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	65	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.143	0.011	0.010	0.095	0.021	0.000	0.001	25.712	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	5	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.011	0.001	0.001	0.007	0.002	0.000	0.000	1.978	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	10	0	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	70	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.004	0.000	0.000	0.038	0.002	0.000	0.001	22.868	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	560	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.030	0.001	0.001	0.302	0.016	0.001	0.004	182.944	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000

								25mph Emission Factor (g/mile)																				Emission (lbs)																			
DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	30	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.153	0.337	0.181	1.775	0.288	0.003	0.016	939.171	0.003	0.002	0.000	0.023	0.011	0.002	0.001	0.001	0.001	0.002	0.003	0.002
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	45	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.729	0.506	0.272	2.662	0.433	0.005	0.025	1408.756	0.004	0.003	0.000	0.034	0.016	0.003	0.001	0.001	0.001	0.003	0.004	0.004
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	65	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.831	0.731	0.393	3.845	0.625	0.007	0.035	2034.870	0.006	0.005	0.000	0.049	0.023	0.004	0.002	0.002	0.001	0.004	0.006	0.005
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	5	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.525	0.056	0.030	0.296	0.048	0.001	0.003	156.528	0.000	0.000	0.000	0.004	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	30	0	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	70	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.471	0.145	0.025	10.609	0.168	0.006	0.045	851.743	0.007	0.006	0.003	0.002	0.002	0.000	0.001	0.003	0.003	0.014	0.011	0.000
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	560	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	3.769	1.160	0.203	84.869	1.347	0.045	0.356	6813.943	0.056	0.048	0.026	0.018	0.014	0.001	0.005	0.025	0.026	0.112	0.091	0.003

								55mph Emission Factor (g/mile)																				Emission (lbs)																			
DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	30	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.529	0.181	0.132	1.450	0.246	0.004	0.010	1042.161	0.002	0.002	0.000	0.020	0.009	0.002	0.001	0.001	0.000	0.001	0.002	0.002
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	45	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.794	0.272	0.197	2.175	0.369	0.005	0.015	1563.241	0.003	0.003	0.000	0.029	0.014	0.002	0.001	0.001	0.001	0.002	0.003	0.003
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	65	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.480	0.393	0.285	3.141	0.533	0.008	0.022	2258.015	0.004	0.004	0.000	0.043	0.020	0.004	0.001	0.002	0.001	0.003	0.004	0.005
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	5	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.422	0.030	0.022	0.242	0.041	0.001	0.002	173.693	0.000	0.000	0.000	0.003	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Restricted	20	0	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	70	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.632	0.054	0.014	10.635	0.125	0.006	0.035	965.806	0.005	0.005	0.002	0.002	0.001	0.000	0.000	0.002	0.002	0.010	0.008	0.000
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	560	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.056	0.431	0.109	85.083	1.001	0.051	0.279	7726.448	0.037	0.039	0.019	0.014	0.010	0.001	0.004	0.019	0.020	0.083	0.068	0.002

								Starts Emission Factor (g/start)																				Emission (lbs)																			
DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	30	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.201	0.001	0.001	0.210	0.006	0.000	0.002	12.661	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	45	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.302	0.001	0.001	0.314	0.009	0.000	0.004	18.991	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	65	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.436	0.002	0.002	0.454	0.013	0.000	0.005	27.431	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Off Network	N/A	5	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.034	0.000	0.000	0.035	0.001	0.000	0.000	2.110	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Off Network	N/A	0	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	70	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	0.185	0.008	0.007	2.070	0.210	0.000	0.027	28.927	0.015	0.008	0.008	0.002	0.003	0.000	0.002	0.004	0.005	0.017	0.013	0.000
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	560	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	1.484	0.066	0.058	16.563	1.682	0.002	0.220	231.413	0.120	0.066	0.064	0.016	0.026	0.002	0.013	0.029	0.041	0.132	0.107	0.003
																											Total:	40.383	4.400	1.956	226.979	7.212	0.145	1.109	26519.077	0.269	0.193	0.123	0.264	0.154	0.021	0.031	0.091	0.104	0.385	0.326	0.033

Rural Unrestricted
1. Based on MOVES data.
2. Based on Schedule tab

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use / grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance * Days of Use / grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) / grams to pound conversion (453.592)
Distance = Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)

Workstream 7 (Site Substation): Vehicle (Onroad) Emissions

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	65
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	75
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	73
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	0
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	10	0
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	240
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	1920

0mph Emission Factor (g/hour)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - DUMP	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FUEL/MECH	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FLAT BED	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - PICKUP	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

Emission (lbs)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.143	0.011	0.010	0.095	0.021	0.000	0.001	25.712	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	0.165	0.012	0.011	0.109	0.025	0.000	0.001	29.668	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FUEL/MECH	0.160	0.012	0.011	0.106	0.024	0.000	0.001	28.877	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.013	0.000	0.000	0.130	0.007	0.001	0.002	78.405	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
TRUCK - (COMMUTER)	0.103	0.003	0.002	1.037	0.055	0.004	0.015	627.238	0.015	0.002	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.005	0.004	0.000

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	65
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	75
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	73
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	0
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	30	0
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	240
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	1920

25mph Emission Factor (g/mile)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

Emission (lbs)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	6.831	0.731	0.393	3.845	0.625	0.007	0.035	2034.870	0.006	0.005	0.000	0.049	0.023	0.004	0.002	0.002	0.001	0.004	0.006	0.005
TRUCK - DUMP	7.882	0.844	0.453	4.437	0.721	0.008	0.041	2347.927	0.007	0.005	0.000	0.056	0.027	0.005	0.002	0.002	0.001	0.004	0.007	0.006
TRUCK - FUEL/MECH	7.671	0.821	0.441	4.319	0.702	0.008	0.040	2285.315	0.007	0.005	0.000	0.055	0.026	0.005	0.002	0.002	0.001	0.004	0.007	0.006
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	1.615	0.497	0.087	36.372	0.577	0.019	0.153	2920.261	0.024	0.020	0.011	0.008	0.006	0.000	0.002	0.011	0.011	0.048	0.039	0.001
TRUCK - (COMMUTER)	12.922	3.977	0.695	290.979	4.619	0.155	1.221	23362.090	0.191	0.163	0.090	0.063	0.047	0.003	0.017	0.086	0.090	0.385	0.312	0.010

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	65
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	75
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	73
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	0
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Restricted	20	0
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	240
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	1920

55mph Emission Factor (g/mile)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - (COMMUTER)	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Emission (lbs)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	5.480	0.393	0.285	3.141	0.533	0.008	0.022	2258.015	0.004	0.004	0.000	0.043	0.020	0.004	0.001	0.002	0.001	0.003	0.004	0.005
TRUCK - DUMP	6.323	0.453	0.329	3.625	0.615	0.009	0.025	2605.401	0.005	0.005	0.000	0.049	0.023	0.004	0.002	0.002	0.001	0.003	0.005	0.005
TRUCK - FUEL/MECH	6.154	0.441	0.320	3.528	0.598	0.009	0.025	2535.924	0.004	0.005	0.000	0.048	0.022	0.004	0.002	0.002	0.001	0.003	0.005	0.005
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	2.167	0.185	0.047	36.464	0.429	0.022	0.120	3311.335	0.016	0.017	0.008	0.006	0.004	0.000	0.002	0.008	0.008	0.036	0.029	0.001
TRUCK - (COMMUTER)	17.336	1.479	0.374	291.712	3.431	0.176	0.956	26490.678	0.127	0.135	0.066	0.047	0.034	0.002	0.013	0.064	0.068	0.285	0.232	0.007

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1.]	Fuel Type[1.]	Road Type[1.]	Time Driven (minutes)	Days of Use[2.]
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	65
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	75
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	73
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Off Network	N/A	0
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Off Network	N/A	0
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	240
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	1920

Starts Emission Factor (g/start)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - PICKUP	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - (COMMUTER)	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00

Emission (lbs)

DESCRIPTION	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.436	0.002	0.002	0.454	0.013	0.000	0.005	27.431	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - DUMP	0.503	0.002	0.002	0.524	0.015	0.000	0.006	31.651	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FUEL/MECH	0.489	0.002	0.002	0.510	0.015	0.000	0.006	30.807	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.636	0.028	0.025	7.099	0.721	0.001	0.094	99.177	0.051	0.028	0.027	0.007	0.011	0.001	0.005	0.013	0.018	0.057	0.046	0.001
TRUCK - (COMMUTER)	5.088	0.225	0.199	56.788	5.768	0.005	0.754	793.415	0.411	0.226	0.218	0.055	0.090	0.006	0.044	0.101	0.142	0.453	0.368	0.012
Total:	82.115	10.118	3.689	745.273	19.514	0.432	3.524	71924.198	0.874	0.621	0.422	0.493	0.337	0.039	0.093	0.296	0.347	1.291	1.068	0.066

Rural Unrestricted
1. Based on MOVES data.
2. Based on Schedule tab

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use / grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance * Days of Use / grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) / grams to pound conversion (453.592)
Distance = Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)

Workstream 8 (Engine Hall): Vehicle (Onroad) Emissions

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	0mph Emission Factor (g/hour)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	231	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	257	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	501	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	0	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	10	0	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	940	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	7520	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

DESCRIPTION	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.508	0.038	0.035	0.336	0.076	0.000	0.004	91.377	0.001	0.001	0.000	0.006	0.003	0.000	0.000	0.000	0.000	0.000	0.001	0.001
TRUCK - DUMP	0.565	0.042	0.039	0.374	0.085	0.000	0.005	101.662	0.001	0.001	0.000	0.007	0.003	0.001	0.000	0.000	0.000	0.001	0.001	0.001
TRUCK - FUEL/MECH	1.101	0.082	0.075	0.728	0.166	0.001	0.010	198.182	0.003	0.001	0.000	0.013	0.006	0.001	0.000	0.001	0.000	0.001	0.002	0.001
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.050	0.001	0.001	0.508	0.027	0.002	0.007	307.085	0.007	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.000
TRUCK - (COMMUTER)	0.403	0.010	0.009	4.062	0.217	0.016	0.059	2456.681	0.059	0.009	0.004	0.003	0.002	0.000	0.001	0.004	0.004	0.018	0.015	0.000

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	25mph Emission Factor (g/mile)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	231	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	257	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	501	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	0	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	30	0	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	940	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	7520	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

DESCRIPTION	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	24.275	2.598	1.397	13.666	2.221	0.025	0.126	7231.615	0.021	0.016	0.000	0.174	0.082	0.014	0.006	0.007	0.004	0.013	0.023	0.019
TRUCK - DUMP	27.008	2.891	1.554	15.204	2.471	0.027	0.140	8045.562	0.023	0.018	0.000	0.193	0.091	0.016	0.007	0.008	0.005	0.015	0.025	0.021
TRUCK - FUEL/MECH	52.649	5.635	3.029	29.640	4.817	0.053	0.273	15684.151	0.046	0.036	0.000	0.377	0.178	0.031	0.013	0.016	0.010	0.029	0.049	0.042
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	6.326	1.947	0.340	142.458	2.262	0.076	0.598	11437.690	0.093	0.080	0.044	0.031	0.023	0.002	0.008	0.042	0.044	0.188	0.153	0.005
TRUCK - (COMMUTER)	50.610	15.576	2.722	1139.667	18.092	0.608	4.782	91501.519	0.748	0.640	0.352	0.245	0.182	0.012	0.067	0.336	0.353	1.506	1.224	0.037

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	55mph Emission Factor (g/mile)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	231	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	257	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	501	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	0	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Restricted	20	0	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	940	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	7520	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DESCRIPTION	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	19.474	1.396	1.013	11.164	1.893	0.027	0.078	8024.637	0.014	0.015	0.000	0.151	0.069	0.012	0.005	0.006	0.004	0.010	0.015	0.017
TRUCK - DUMP	21.666	1.553	1.127	12.420	2.107	0.030	0.086	8927.842	0.016	0.016	0.000	0.168	0.077	0.014	0.006	0.006	0.004	0.012	0.016	0.019
TRUCK - FUEL/MECH	42.235	3.027	2.198	24.212	4.107	0.059	0.169	17404.082	0.030	0.031	0.000	0.328	0.151	0.027	0.011	0.013	0.008	0.023	0.032	0.037
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	8.487	0.724	0.183	142.817	1.680	0.086	0.468	12969.394	0.062	0.066	0.033	0.023	0.017	0.001	0.006	0.031	0.033	0.140	0.113	0.003
TRUCK - (COMMUTER)	67.898	5.792	1.463	1142.537	13.438	0.689	3.746	103755.155	0.499	0.528	0.260	0.183	0.135	0.009	0.049	0.249	0.265	1.116	0.907	0.028

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	Starts Emission Factor (g/start)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	231	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	257	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	501	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Off Network	N/A	0	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Off Network	N/A	0	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	940	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	7520	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00

DESCRIPTION	Emission (lbs)																			
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	1.548	0.008	0.007	1.613	0.046	0.000	0.019	97.486	0.004	0.000	0.000	0.003	0.002	0.000	0.000	0.000	0.000	0.001	0.002	0.000
TRUCK - DUMP	1.722	0.009	0.008	1.795	0.051	0.000	0.021	108.459	0.004	0.000	0.000	0.003	0.002	0.000	0.000	0.000	0.000	0.001	0.003	0.000
TRUCK - FUEL/MECH	3.358	0.017	0.015	3.499	0.100	0.001	0.041	211.432	0.009	0.000	0.000	0.006	0.004	0.001	0.000	0.001	0.000	0.001	0.005	0.000
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	2.491	0.110	0.097	27.803	2.824	0.003	0.369	388.443	0.201	0.110	0.107	0.027	0.044	0.003	0.021	0.049	0.070	0.222	0.180	0.006
TRUCK - (COMMUTER)	19.927	0.882	0.780	222.421	22.590	0.021	2.952	3107.544	1.608	0.884	0.854	0.215	0.354	0.024	0.171	0.396	0.557	1.774	1.441	0.047
Total:	352.301	42.336	16.092	2936.924	79.268	1.726	13.953	292049.998	3.451	2.454	1.653	2.156	1.425	0.169	0.373	1.167	1.363	5.072	4.208	0.285

Rural Unrestricted
1. Based on MOVES data.
2. Based on Schedule tab

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use / grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance * Days of Use / grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) / grams to pound conversion (453.592)
Distance = Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)

Workstream 9 (Storage Tanks & Distribution): Vehicle (Onroad) Emissions

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	0mph Emission Factor (g/hour)																				Emission (lbs)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	190	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.418	0.031	0.029	0.276	0.063	0.000	0.004	75.159	0.001	0.000	0.000	0.005	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.001
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	115	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.253	0.019	0.017	0.167	0.038	0.000	0.002	45.491	0.001	0.000	0.000	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	365	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.802	0.060	0.055	0.531	0.121	0.000	0.007	144.384	0.002	0.001	0.000	0.009	0.004	0.001	0.000	0.000	0.000	0.001	0.001	0.001
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	0	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	10	0	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	560	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.030	0.001	0.001	0.302	0.016	0.001	0.004	182.944	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	3360	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.180	0.004	0.004	1.815	0.097	0.007	0.026	1097.666	0.027	0.004	0.002	0.001	0.001	0.000	0.000	0.002	0.002	0.008	0.007	0.000

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	25mph Emission Factor (g/mile)																				Emission (lbs)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	190	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.967	2.137	1.149	11.241	1.827	0.020	0.104	5948.081	0.017	0.014	0.000	0.143	0.067	0.012	0.005	0.006	0.004	0.011	0.019	0.016
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	115	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.085	1.294	0.695	6.804	1.106	0.012	0.063	3600.154	0.010	0.008	0.000	0.087	0.041	0.007	0.003	0.004	0.002	0.007	0.011	0.010
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	365	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.357	4.106	2.207	21.594	3.509	0.039	0.199	11426.577	0.033	0.026	0.000	0.275	0.129	0.023	0.009	0.012	0.007	0.021	0.036	0.030
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	0	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	30	0	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	560	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	3.769	1.160	0.203	84.869	1.347	0.045	0.356	6813.943	0.056	0.048	0.026	0.018	0.014	0.001	0.005	0.025	0.026	0.112	0.091	0.003
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	3360	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	22.613	6.959	1.216	509.213	8.084	0.272	2.137	40883.657	0.334	0.286	0.157	0.110	0.081	0.005	0.030	0.150	0.158	0.673	0.547	0.017

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	55mph Emission Factor (g/mile)																				Emission (lbs)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	190	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.017	1.148	0.833	9.182	1.557	0.022	0.064	6600.350	0.012	0.012	0.000	0.124	0.057	0.010	0.004	0.005	0.003	0.009	0.012	0.014
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	115	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.695	0.695	0.504	5.558	0.943	0.014	0.039	3994.949	0.007	0.007	0.000	0.075	0.035	0.006	0.003	0.003	0.002	0.005	0.007	0.008
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	365	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.770	2.206	1.601	17.639	2.992	0.043	0.123	12679.621	0.022	0.023	0.000	0.239	0.110	0.020	0.008	0.009	0.006	0.017	0.023	0.027
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	0	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Restricted	20	0	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	560	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.056	0.431	0.109	85.083	1.001	0.051	0.279	7726.448	0.037	0.039	0.019	0.014	0.010	0.001	0.004	0.019	0.020	0.083	0.068	0.002
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	3360	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.337	2.588	0.654	510.495	6.004	0.308	1.674	46358.686	0.223	0.236	0.116	0.082	0.060	0.004	0.022	0.111	0.118	0.499	0.405	0.012

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	Starts Emission Factor (g/start)																				Emission (lbs)																			
								NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	190	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.273	0.006	0.006	1.327	0.038	0.000	0.015	80.184	0.003	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.001	0.002	0.000
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	115	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.771	0.004	0.004	0.803	0.023	0.000	0.009	48.532	0.002	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	365	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.446	0.012	0.011	2.549	0.073	0.001	0.030	154.037	0.006	0.000	0.000	0.004	0.003	0.000	0.000	0.001	0.000	0.001	0.004	0.000
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Off Network	N/A	0	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Off Network	N/A	0	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	560	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	1.484	0.066	0.058	16.563	1.682	0.002	0.220	231.413	0.120	0.066	0.064	0.016	0.026	0.002	0.013	0.029	0.041	0.132	0.107	0.003
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	3360	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	8.904	0.394	0.348	99.380	10.093	0.009	1.319	1388.477	0.719	0.395	0.381	0.096	0.158	0.011	0.076	0.177	0.249	0.793	0.644	0.021
																											Total:	205.227	23.319	9.703	1385.391	40.613	0.848	6.673	149480.753	1.636	1.166	0.766	1.305	0.803	0.104	0.183	0.554	0.639	2.373	1.987	0.166

Rural Unrestricted
1. Based on MOVES data.
2. Based on Schedule tab

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use / grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance * Days of Use / grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) / grams to pound conversion (453.592)
Distance = Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)

Workstream 10 (Fuel Terminal): Vehicle (Onroad) Emissions

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	0mph Emission Factor (g/hour) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	10	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	145	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	150	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	0	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	10	200	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	200	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	1200	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.022	0.002	0.002	0.015	0.003	0.000	0.000	3.956	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	0.319	0.024	0.022	0.211	0.048	0.000	0.003	57.358	0.001	0.000	0.000	0.004	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FUEL/MECH	0.330	0.024	0.023	0.218	0.050	0.000	0.003	59.336	0.001	0.000	0.000	0.004	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.011	0.000	0.000	0.108	0.006	0.000	0.002	65.337	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.011	0.000	0.000	0.108	0.006	0.000	0.002	65.337	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - (COMMUTER)	0.064	0.002	0.001	0.648	0.035	0.003	0.009	392.024	0.009	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.002	0.000

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	25mph Emission Factor (g/mile) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	10	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	145	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	150	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	0	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	30	200	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	200	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	1200	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	1.051	0.112	0.060	0.592	0.096	0.001	0.005	313.057	0.001	0.001	0.000	0.008	0.004	0.001	0.000	0.000	0.000	0.001	0.001	0.001
TRUCK - DUMP	15.238	1.631	0.877	8.578	1.394	0.015	0.079	4539.325	0.013	0.010	0.000	0.109	0.051	0.009	0.004	0.005	0.003	0.008	0.014	0.012
TRUCK - FUEL/MECH	15.763	1.687	0.907	8.874	1.442	0.016	0.082	4695.854	0.014	0.011	0.000	0.113	0.053	0.009	0.004	0.005	0.003	0.009	0.015	0.012
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	1.346	0.414	0.072	30.310	0.481	0.016	0.127	2433.551	0.020	0.017	0.009	0.007	0.005	0.000	0.002	0.009	0.009	0.040	0.033	0.001
TRUCK - PICKUP	1.346	0.414	0.072	30.310	0.481	0.016	0.127	2433.551	0.020	0.017	0.009	0.007	0.005	0.000	0.002	0.009	0.009	0.040	0.033	0.001
TRUCK - (COMMUTER)	8.076	2.485	0.434	181.862	2.887	0.097	0.763	14601.306	0.119	0.102	0.056	0.039	0.029	0.002	0.011	0.054	0.056	0.240	0.195	0.006

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	55mph Emission Factor (g/mile) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	10	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	145	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	150	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	0	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Restricted	20	200	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	200	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	1200	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.843	0.060	0.044	0.483	0.082	0.001	0.003	347.387	0.001	0.001	0.000	0.007	0.003	0.001	0.000	0.000	0.000	0.000	0.001	0.001
TRUCK - DUMP	12.224	0.876	0.636	7.007	1.189	0.017	0.049	5037.110	0.009	0.009	0.000	0.095	0.044	0.008	0.003	0.004	0.002	0.007	0.009	0.011
TRUCK - FUEL/MECH	12.645	0.906	0.658	7.249	1.230	0.018	0.050	5210.803	0.009	0.009	0.000	0.098	0.045	0.008	0.003	0.004	0.002	0.007	0.010	0.011
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	1.806	0.154	0.039	30.387	0.357	0.018	0.100	2759.446	0.013	0.014	0.007	0.005	0.004	0.000	0.001	0.007	0.007	0.030	0.024	0.001
TRUCK - PICKUP	1.806	0.154	0.039	30.387	0.357	0.018	0.100	2759.446	0.013	0.014	0.007	0.005	0.004	0.000	0.001	0.007	0.007	0.030	0.024	0.001
TRUCK - (COMMUTER)	10.835	0.924	0.233	182.320	2.144	0.110	0.598	16556.674	0.080	0.084	0.041	0.029	0.021	0.001	0.008	0.040	0.042	0.178	0.145	0.004

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	Starts Emission Factor (g/start) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	10	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	145	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	150	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Off Network	N/A	0	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Off Network	N/A	200	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	200	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	1200	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.067	0.000	0.000	0.070	0.002	0.000	0.001	4.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	0.972	0.005	0.004	1.013	0.029	0.000	0.012	61.193	0.002	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FUEL/MECH	1.005	0.005	0.005	1.048	0.030	0.000	0.012	63.303	0.003	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.530	0.023	0.021	5.915	0.601	0.001	0.079	82.647	0.043	0.023	0.023	0.006	0.009	0.001	0.005	0.011	0.015	0.047	0.038	0.001
TRUCK - PICKUP	0.530	0.023	0.021	5.915	0.601	0.001	0.079	82.647	0.043	0.023	0.023	0.006	0.009	0.001	0.005	0.011	0.015	0.047	0.038	0.001
TRUCK - (COMMUTER)	3.180	0.141	0.124	35.493	3.605	0.003	0.471	495.885	0.257	0.141	0.136	0.034	0.056	0.004	0.027	0.063	0.089	0.283	0.230	0.007
Total:	90.018	10.069	4.295	569.121	17.155	0.353	2.755	63120.751	0.673	0.480	0.313	0.578	0.349	0.046	0.076	0.228	0.262	0.972	0.817	0.073

Rural Unrestricted
1. Based on MOVES data.
2. Based on Schedule tab

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use / grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance * Days of Use / grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) / grams to pound conversion (453.592)
Distance = Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)

Workstream 11 (Photovoltaic (PV)): Vehicle (Onroad) Emissions

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	0mph Emission Factor (g/hour)																				Emission (lbs)																			
								NO_x	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_x	PM_{10}	$PM_{2.5}$	CO	VOC	SO_x	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	68	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.150	0.011	0.010	0.099	0.022	0.000	0.001	26.899	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	223	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.490	0.036	0.033	0.324	0.074	0.000	0.004	88.213	0.001	0.001	0.000	0.006	0.003	0.000	0.000	0.000	0.000	0.000	0.001	0.001
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	98	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.215	0.016	0.015	0.142	0.032	0.000	0.002	38.766	0.001	0.000	0.000	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	123	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.270	0.020	0.018	0.179	0.041	0.000	0.002	48.655	0.001	0.000	0.000	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	10	430	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.023	0.001	0.001	0.232	0.012	0.001	0.003	140.475	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	430	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.023	0.001	0.001	0.232	0.012	0.001	0.003	140.475	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	2630	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.141	0.003	0.003	1.421	0.076	0.006	0.021	859.185	0.021	0.003	0.001	0.001	0.001	0.000	0.000	0.001	0.002	0.006	0.005	0.000

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	25mph Emission Factor (g/mile)																				Emission (lbs)																			
								NO_x	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_x	PM_{10}	$PM_{2.5}$	CO	VOC	SO_x	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	68	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.146	0.765	0.411	4.023	0.654	0.007	0.037	2128.787	0.006	0.005	0.000	0.051	0.024	0.004	0.002	0.002	0.001	0.004	0.007	0.006
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	223	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.435	2.508	1.348	13.193	2.144	0.024	0.122	6981.169	0.020	0.016	0.000	0.168	0.079	0.014	0.006	0.007	0.004	0.013	0.022	0.019
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	98	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.299	1.102	0.592	5.798	0.942	0.010	0.053	3067.958	0.009	0.007	0.000	0.074	0.035	0.006	0.003	0.003	0.002	0.006	0.010	0.008
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	123	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.926	1.384	0.744	7.277	1.183	0.013	0.067	3850.600	0.011	0.009	0.000	0.093	0.044	0.008	0.003	0.004	0.002	0.007	0.012	0.010
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	30	430	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	2.894	0.891	0.156	65.167	1.035	0.035	0.273	5232.135	0.043	0.037	0.020	0.014	0.010	0.001	0.004	0.019	0.020	0.086	0.070	0.002
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	430	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	2.894	0.891	0.156	65.167	1.035	0.035	0.273	5232.135	0.043	0.037	0.020	0.014	0.010	0.001	0.004	0.019	0.020	0.086	0.070	0.002
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	2630	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	17.700	5.447	0.952	398.580	6.327	0.213	1.672	32001.196	0.262	0.224	0.123	0.086	0.064	0.004	0.023	0.118	0.124	0.527	0.428	0.013

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	55mph Emission Factor (g/mile)																				Emission (lbs)																			
								NO_x	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_x	PM_{10}	$PM_{2.5}$	CO	VOC	SO_x	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	68	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.733	0.411	0.298	3.286	0.557	0.008	0.023	2362.231	0.004	0.004	0.000	0.045	0.020	0.004	0.002	0.002	0.001	0.003	0.004	0.005
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	223	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.799	1.347	0.978	10.777	1.828	0.026	0.075	7746.727	0.014	0.014	0.000	0.146	0.067	0.012	0.005	0.006	0.004	0.010	0.014	0.016
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	98	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.262	0.592	0.430	4.736	0.803	0.012	0.033	3404.391	0.006	0.006	0.000	0.064	0.029	0.005	0.002	0.002	0.002	0.004	0.006	0.007
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	123	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.369	0.743	0.540	5.944	1.008	0.015	0.041	4272.858	0.007	0.008	0.000	0.081	0.037	0.007	0.003	0.003	0.002	0.006	0.008	0.009
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Restricted	20	430	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.882	0.331	0.084	65.331	0.768	0.039	0.214	5932.808	0.029	0.030	0.015	0.010	0.008	0.001	0.003	0.014	0.015	0.064	0.052	0.002
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	430	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.882	0.331	0.084	65.331	0.768	0.039	0.214	5932.808	0.029	0.030	0.015	0.010	0.008	0.001	0.003	0.014	0.015	0.064	0.052	0.002
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	2630	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.746	2.025	0.512	399.584	4.700	0.241	1.310	36286.710	0.174	0.185	0.091	0.064	0.047	0.003	0.017	0.087	0.093	0.390	0.317	0.010

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	Starts Emission Factor (g/start)																				Emission (lbs)																			
								NO_x	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas	NO_x	PM_{10}	$PM_{2.5}$	CO	VOC	SO_x	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	68	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.456	0.002	0.002	0.475	0.014	0.000	0.006	28.697	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	223	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.495	0.007	0.007	1.557	0.044	0.000	0.018	94.110	0.004	0.000	0.000	0.003	0.002	0.000	0.000	0.000	0.000	0.001	0.002	0.000
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	98	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.657	0.003	0.003	0.684	0.020	0.000	0.008	41.358	0.002	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Off Network	N/A	123	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.824	0.004	0.004	0.859	0.025	0.000	0.010	51.908	0.002	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Off Network	N/A	430	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	1.139	0.050	0.045	12.718	1.292	0.001	0.169	177.692	0.092	0.051	0.049	0.012	0.020	0.001	0.010	0.023	0.032	0.101	0.082	0.003
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	430	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	1.139	0.050	0.045	12.718	1.292	0.001	0.169	177.692	0.092	0.051	0.049	0.012	0.020	0.001	0.010	0.023	0.032	0.101	0.082	0.003
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	2630	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00	6.969	0.308	0.273	77.788	7.900	0.007	1.032	1086.814	0.563	0.309	0.299	0.075	0.124	0.008	0.060	0.138	0.195	0.620	0.504	0.016
																											Total:	165.958	19.284	7.742	1223.625	34.608	0.735	5.858	127433.452	1.442	1.027	0.682	1.040	0.658	0.082	0.159	0.488	0.566	2.104	1.754	0.134

Rural Unrestricted
1. Based on MOVES data.
2. Based on Schedule tab

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use / grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance * Days of Use / grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) / grams to pound conversion (453.592)
Distance = Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)

Workstream 12 (Electrical Distribution): Vehicle (Onroad) Emissions

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	0mph Emission Factor (g/hour) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	55	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	0	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	79	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	0	5.98	0.44	0.41	3.96	0.90	0.00	0.05	1076.57	0.02	0.01	0.00	0.07	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	10	0	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	225	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	1350	0.15	0.00	0.00	1.47	0.08	0.01	0.02	889.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.121	0.009	0.008	0.080	0.018	0.000	0.001	21.756	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - DUMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FUEL/MECH	0.174	0.013	0.012	0.115	0.026	0.000	0.002	31.250	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.012	0.000	0.000	0.122	0.006	0.000	0.002	73.504	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
TRUCK - (COMMUTER)	0.072	0.002	0.002	0.729	0.039	0.003	0.011	441.027	0.011	0.002	0.001	0.001	0.000	0.000	0.000	0.001	0.001	0.003	0.003	0.000

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	25mph Emission Factor (g/mile) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	55	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	0	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	79	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	30	0	3.81	0.41	0.22	2.15	0.35	0.00	0.02	1136.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Unrestricted	30	0	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	225	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	30	1350	0.24	0.08	0.01	5.50	0.09	0.00	0.02	441.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	5.780	0.619	0.333	3.254	0.529	0.006	0.030	1721.813	0.005	0.004	0.000	0.041	0.019	0.003	0.001	0.002	0.001	0.003	0.005	0.005
TRUCK - DUMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FUEL/MECH	8.302	0.889	0.478	4.674	0.760	0.008	0.043	2473.150	0.007	0.006	0.000	0.059	0.028	0.005	0.002	0.003	0.002	0.005	0.008	0.007
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	1.514	0.466	0.081	34.099	0.541	0.018	0.143	2737.745	0.022	0.019	0.011	0.007	0.005	0.000	0.002	0.010	0.011	0.045	0.037	0.001
TRUCK - (COMMUTER)	9.086	2.796	0.489	204.594	3.248	0.109	0.858	16426.470	0.134	0.115	0.063	0.044	0.033	0.002	0.012	0.060	0.063	0.270	0.220	0.007

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	55mph Emission Factor (g/mile) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	55	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	0	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	79	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Urban Restricted	20	0	2.09	0.15	0.11	1.20	0.20	0.00	0.01	859.48	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Urban Restricted	20	0	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	225	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	20	1350	0.22	0.02	0.00	3.76	0.04	0.00	0.01	341.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	4.637	0.332	0.241	2.658	0.451	0.006	0.018	1910.628	0.003	0.003	0.000	0.036	0.017	0.003	0.001	0.001	0.001	0.002	0.003	0.004
TRUCK - DUMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FUEL/MECH	6.660	0.477	0.347	3.818	0.648	0.009	0.027	2744.356	0.005	0.005	0.000	0.052	0.024	0.004	0.002	0.002	0.001	0.004	0.005	0.006
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	2.032	0.173	0.044	34.185	0.402	0.021	0.112	3104.376	0.015	0.016	0.008	0.005	0.004	0.000	0.001	0.007	0.008	0.033	0.027	0.001
TRUCK - (COMMUTER)	12.189	1.040	0.263	205.110	2.412	0.124	0.673	18626.258	0.090	0.095	0.047	0.033	0.024	0.002	0.009	0.045	0.048	0.200	0.163	0.005

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Days of Use[2]	Starts Emission Factor (g/start) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	55	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - DUMP	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	0	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FUEL/MECH	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	79	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - FLAT BED	FORD	F-750	Single Unit Short Haul Truck	Diesel	Off Network	N/A	0	1.52	0.01	0.01	1.58	0.05	0.00	0.02	95.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - PICKUP	FORD	F-250	Passenger Truck	Gasoline	Off Network	N/A	0	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - PICKUP	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	225	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	1350	0.60	0.03	0.02	6.71	0.68	0.00	0.09	93.72	0.05	0.03	0.03	0.01	0.01	0.00	0.01	0.01	0.02	0.05	0.04	0.00

DESCRIPTION	Emission (lbs) NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.369	0.002	0.002	0.384	0.011	0.000	0.004	23.211	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - DUMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - FUEL/MECH	0.529	0.003	0.002	0.552	0.016	0.000	0.006	33.340	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
TRUCK - FLAT BED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - PICKUP	0.596	0.026	0.023	6.655	0.676	0.001	0.088	92.978	0.048	0.026	0.026	0.006	0.011	0.001	0.005	0.012	0.017	0.053	0.043	0.001
TRUCK - (COMMUTER)	3.577	0.158	0.140	39.929	4.055	0.004	0.530	557.870	0.289	0.159	0.153	0.039	0.064	0.004	0.031	0.071	0.100	0.318	0.259	0.008
Total:	55.649	7.005	2.464	540.957	13.838	0.310	2.548	51019.732	0.634	0.450	0.308	0.329	0.231	0.026	0.067	0.214	0.252	0.939	0.775	0.045

Rural Unrestricted
1. Based on MOVES data.
2. Based on Schedule tab

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use / grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance * Days of Use / grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) / grams to pound conversion (453.592)
Distance = Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)

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Total Construction Emissions

Location of Activity by Year	*Emissions (tpy)*										
	VOCs	*CO*	*NO_x*	*SO_x*	*PM_{10}*	*$PM_{2.5}$*	*CO_2*	*CH_4*	*N_2O*	*CO_2e*	*HAPs*
2025											
Site 2	0.03	0.44	0.25	4.87E-04	4.0	0.41	135.4	3.13E-03	1.08E-03	135.8	0.01
Site 5	0.09	0.93	0.85	9.40E-04	21.1	2.2	257.9	0.01	2.69E-03	258.8	0.04
Transmission Backbone	0.32	2.5	3.7	3.94E-03	3.10	0.48	1192	0.02	0.01	1196	0.14
Total	**0.45**	**3.9**	**4.8**	**0.01**	**28.2**	**3.1**	**1586**	**0.03**	**0.01**	1590	**0.19**
2026											
Site 2	0.16	2.1	1.2	2.37E-03	19.5	2.0	658.8	0.02	0.01	660.8	0.06
Site 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transmission Backbone	0.28	2.2	3.2	3.40E-03	2.67	0.42	1028.4	0.02	0.01	1031.3	0.12
Total	**0.44**	**4.3**	**4.4**	**0.01**	**22.2**	**2.4**	**1687**	**0.04**	**0.01**	1692	**0.19**
2027											
Site 2	0.15	2.0	1.1	2.19E-03	18.0	1.9	609.4	0.01	4.86E-03	611.2	0.06
Site 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transmission Backbone	0.01	0.07	0.11	1.13E-04	0.09	0.01	34.2	6.65E-04	2.64E-04	34.3	4.05E-03
Total	**0.16**	**2.0**	**1.2**	**2.30E-03**	**18.1**	**1.9**	**643.5**	**0.01**	**0.01**	645.4	**0.06**

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OPERATIONAL ON-ROAD EMISSION TABLES

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Operations: Onroad Emissions - Notes and References

Shift Details	
8	Hours / Day
6	Days / Week
4.3	Weeks / Month
25.8	Days / Month
206.4	Hours / Month

Conversions	
0.0005	lbs to short tons
453.592	grams to lbs
60	Minutes in hour

Notes:

1. Pollution lookup and fuel lookup are based on EPA MOVES software decoding

2. Schedule is provided by Ameresco based on sheet "JBPHH - Daily Vehicle Traffic - Operations Phase (003).xlsx)"

3. Calculations were built around this equation below

AE i = VMT ´ EF i ´ 0.002205

Where,

AE_i = Annual emissions of chemical *i* (*lb i/yr*)

VMT = number of vehicle miles traveled per year (*miles/yr*)

EF_i = Chemical *i* emission factor (*g i/mile*)

0.002205 = Factor to convert grams to pounds (*lb i/g i*)

MOVES Specs:	
Scale	Onroad Project Inventory
Time Spans	2027 January and July Weekdays 8am and 2pm
Geographic Bounds	Hawaii Honolulu County
Onroad Equipment	Passenger Truck Single Unit Short Haul Truck Light Commercial Truck Combination Short Haul Truck
Road Type	All
Pollutants and Processes	All
Units	Grams Million BTU Miles
Output Emissions Detail	Fuel Type Emission Process SCC

Operations: Onroad Schedule

VEHICLE TYPES	FRG (SITE 2)		SOLAR/BESS (SITE 5)	
	Number of Trips	Estimated Ave. Distance	Number of Trips	Estimated Ave. Distance
Trucks (Delivery of fuel, reagent, and other routine services)	15	20	0	0
Employees (Delivery Truck Drivers)	15		0	0
Trucks (Plant Employees)	8	20		
Employees	8			
Total Trips & Total Miles/Day	23	40		

Note:
1. Information is based on Ameresco provided data. "JBPHH - Daily Vehicle Traffic - Operations Phase (003).xlsx"

Operations: Summary Onroad Emissions

Operations
Site 2

Activity	Pollutant (tons)																				
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	CO_2e	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
Operations	5.93E-04	5.08E-05	2.85E-05	8.98E-04	6.21E-05	1.01E-06	5.89E-06	2.54E-01	1.65E-06	2.54E-01	9.13E-07	4.64E-07	3.88E-06	1.97E-06	3.24E-07	2.15E-07	4.14E-07	4.45E-07	1.41E-06	1.45E-06	4.39E-07
Total:	5.93E-04	5.08E-05	2.85E-05	8.98E-04	6.21E-05	1.01E-06	5.89E-06	2.54E-01	1.65E-06	2.54E-01	9.13E-07	4.64E-07	3.88E-06	1.97E-06	3.24E-07	2.15E-07	4.14E-07	4.45E-07	1.41E-06	1.45E-06	4.39E-07

Note:
1. Site 5 would not generate meaningful vehicular trips other than a few during occasional maintenance period. Therefore vehicle emissions are negligible

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Operations: Vehicles (Onroad) Emissions

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Time Driven (minutes)	Number of Trips[3]
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	15
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	8

DESCRIPTION	0mph Emission Factor (g/hour)																				
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	CO_2e	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	5.51	0.36	0.33	3.66	0.75	0.00	0.05	1048.50	0.02	1054.49	0.01	0.00	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.01
TRUCK - (COMMUTER)	0.08	0.00	0.00	1.37	0.03	0.01	0.01	851.13	0.02	856.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DESCRIPTION	Emission (lbs)																				
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	CO_2e	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.030	0.002	0.002	0.020	0.004	0.000	0.000	5.779	0.000	5.812	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - (COMMUTER)	0.000	0.000	0.000	0.004	0.000	0.000	0.000	2.502	0.000	2.519	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Estimated Ave. Distance (miles)[3]	Number of Trips[3]
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Unrestricted	10	15
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Unrestricted	10	8

DESCRIPTION	25mph Emission Factor (g/mile)																				
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	CO_2e	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	3.35	0.37	0.18	1.97	0.28	0.00	0.02	1099.28	0.00	1100.73	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - (COMMUTER)	0.15	0.07	0.01	4.76	0.05	0.00	0.02	424.13	0.00	425.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DESCRIPTION	Emission (lbs)																				
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	CO_2e	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.462	0.051	0.025	0.272	0.039	0.001	0.003	151.468	0.000	151.668	0.000	0.000	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - (COMMUTER)	0.011	0.005	0.001	0.349	0.004	0.000	0.001	31.168	0.000	31.265	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Estimated Ave. Distance (miles)[3]	Number of Trips[3]
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Urban Restricted	10	15
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Urban Restricted	10	8

DESCRIPTION	55mph Emission Factor (g/mile)																				
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	CO_2e	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	1.76	0.13	0.09	1.09	0.16	0.00	0.01	836.06	0.00	836.69	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - (COMMUTER)	0.15	0.02	0.00	3.33	0.03	0.00	0.01	328.29	0.00	328.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DESCRIPTION	Emission (lbs)																				
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	CO_2e	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.534	0.039	0.027	0.331	0.050	0.001	0.002	253.440	0.000	253.631	0.000	0.000	0.004	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - (COMMUTER)	0.025	0.003	0.001	0.538	0.004	0.000	0.001	53.076	0.000	53.179	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

DESCRIPTION	MANUFACTURE	MODEL	Vehicle Type[1]	Fuel Type[1]	Road Type[1]	Estimated Ave. Distance (miles)[3]	Number of Trips[3]
TRUCK - DELIVERY	MACK	GRANITE	Single Unit Short Haul Truck	Diesel	Off Network	N/A	15
TRUCK - (COMMUTER)	FORD	F-150	Passenger Truck	Gasoline	Off Network	N/A	8

DESCRIPTION	Start Emission Factor (g/start)																				
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_2	CH_4	CO_2	N_2O	CO_2e	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	1.59	0.01	0.01	1.42	0.04	0.00	0.02	95.38	0.00	97.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCK - (COMMUTER)	0.50	0.03	0.02	5.28	0.58	0.00	0.07	92.47	0.04	107.20	0.02	0.02	0.01	0.01	0.00	0.00	0.01	0.01	0.04	0.04	0.00

DESCRIPTION	Emission (lbs)																				
	NO_X	PM_{10}	$PM_{2.5}$	CO	VOC	SO_X	CH_4	CO_2	N_2O	CO_2e	Benzene	Ethanol	Formaldehyde	Acetaldehyde	Acrolein	1,3-Butadiene	Ethyl Benzene	Hexane	Toluene	Xylene	Naphthalene gas
TRUCK - DELIVERY	0.105	0.000	0.000	0.094	0.003	0.000	0.001	6.308	0.000	6.417	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK - (COMMUTER)	0.017	0.001	0.001	0.186	0.020	0.000	0.003	3.262	0.002	3.781	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.001	0.000
Total:	1.185	0.102	0.057	1.796	0.124	0.002	0.012	507.003	0.003	508.272	0.002	0.001	0.008	0.004	0.001	0.000	0.001	0.001	0.003	0.003	0.001

1. Based on MOVES data.
2. Based on Schedule tab
3. Provided by Ameresco

Formula:
0mph Emissions = Emission factor (g/hour) * Minutes Driven / Minutes in Hour (60) * Days of Use * grams to pound conversion (453.592)
25 and 55 mph Emissions = Emission factor (g/mile) * Distance(Minutes Driven / Minutes in Hour (60) * Speed Driven(mph)) * Days of Use * grams to pound conversion (453.592)
Start Emissions = Emission factor (g/start) * Days of use * Starts per Day (2) * grams to pound conversion (453.592)

Foulweather Consulting

Application to the Hawaii Department of Health Clean Air Branch for a Covered Source Permit For a New Generating Project at Joint Base Pearl Harbor-Hickam

prepared for:

Pu`uloa Energy LLC

March 2023

prepared by:

Foulweather Consulting
Foulweather Bluff, Hansville, WA

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APPLICATION TO THE HAWAII DEPARTMENT OF HEALTH CLEAN AIR BRANCH FOR A COVERED SOURCE PERMIT FOR A NEW GENERATING PROJECT AT JOINT BASE PEARL HARBOR-HICKAM

Prepared for:

Pu`uloa Energy LLC

Submitted to:

Hawaii Department of Health Clean Air Branch

March 2023

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1. Introduction

The U.S. Navy, Naval Facilities Engineering Command (Navy), owns and operates Joint Base Pearl Harbor-Hickam (JBPHH) on the island of Oahu. The new power plant project is being developed in response to a Request for Proposals from Hawaiian Electric Company (HECO) and will reside on land leased from the U.S. Department of the Navy, providing JBPHH with enhanced energy security. During normal operations, the project will operate in grid tied mode to provide capacity and energy to Hawaiian Electric Company (HECO) via a Power Purchase Agreement. During a grid outage, the plant will provide power to JBPHH, enhancing its energy security and resiliency, and more importantly, supporting national security. The nominal 103.1 megawatts (MW) of new generating facilities would consist of eleven Wärtsilä 20V34DF biofuel-fired reciprocating internal combustion engine generators and up to 40 MW (80 MW-hours) of battery energy storage (BESS), for a total of 143.1 MW (gross) of generating capacity.

2. Proposed Generating Facility

The Wärtsilä engine portion of the project[1] will consist of eleven Wärtsilä 20V34DF generating units. The eleven Wärtsilä 20V34DF generating units and auxiliary equipment are the subject of this application.

The Wärtsilä generators are dual-fuel compression ignition engine generators, each rated at 9.4 MW (gross, nominal). The generators are designed to be fuel-flexible; the primary fuels for the engine generators will be renewable natural gas and biodiesel. Each dual-fueled generator will be equipped with an emission control system consisting of Selective Catalyst Reduction (SCR) for oxides of nitrogen (NOx) emissions control and oxidation catalysts to control carbon monoxide (CO), volatile organic compound (VOC) and hazardous air pollutant (HAP) emissions; continuous emissions monitoring system (CEMS); and associated support equipment.

Other equipment and facilities to be constructed include water treatment facilities, fire protection and emergency services, a new 46 kilovolt (kV) air-insulated switchgear switchyard, other electrical switchgear and transformers, and an operations and maintenance building.

Following completion of the Hawaii Department of Health's (HDOH) permitting activities, Ameresco intends to commence demolition of the existing warehouse structures on the plant site in late 2024. Construction of the Wärtsilä generators is expected to start in early to mid-2025, with a projected on-line date in late 2027.

The HDOH application forms for the project are enclosed as Appendix A.

2.1. Environmental Assessment

The draft Environmental Assessment is expected to be released for public review by U.S. Department of Navy (DON) in mid-2023.

[1] In this document, the term "project" refers to the Wärtsilä engine portion of the JBPHH energy resilience project.

3. Existing Site Conditions

3.1. Geography and Topography

Joint Base Pearl Harbor Hickam is located eight miles west of Honolulu, approximately two miles west of the Daniel K. Inouye International Airport. The project power generation equipment will be constructed on the southeastern portion of the 9.5-acre site leased from JBPHH. The property, which is bounded by Russell Avenue to the southwest, Avenue D to the northeast, Central Avenue to the northwest and Cimarron Street to the southeast, is currently occupied by Navy-owned storage facilities that will be demolished to make space for the proposed project. The approximate latitude and longitude coordinates of the generation project are 21°20'52" N and 157°57'1" W.

3.2. Climate and Meteorology

The Hawaiian Island chain is situated south of the large Eastern Pacific semipermanent high-pressure cell, the dominant atmospheric feature affecting air circulation in the region. Over the Hawaiian Islands, this high-pressure cell produces very persistent winds called the northeast trades, which blow from the northeast. During the winter months, cold fronts sweep across the north central Pacific Ocean, bringing rain to the Hawaiian Islands and intermittently modifying the trade wind regime. Thunderstorms also contribute to annual precipitation.

Due to the tempering influence of the Pacific Ocean and the low-latitude location, the Hawaiian Islands experience extremely small diurnal and seasonal variations in ambient temperature. Average temperatures range from about 74-75ºF in March to 79-80ºF in July. These temperature variations are quite modest compared to those experienced at inland continental locations.

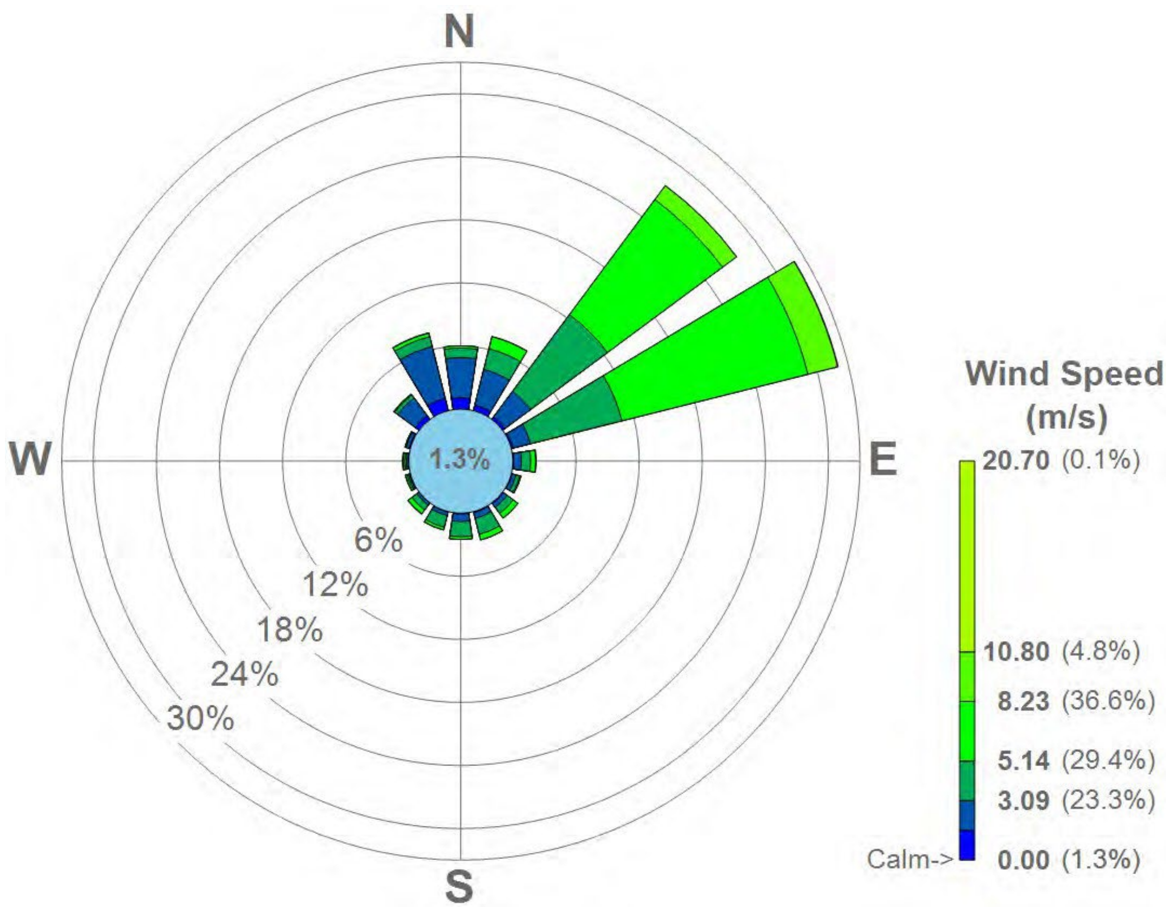
Surface wind patterns on Oahu result from a combination of synoptic (large-scale), mesoscale (regional), and small-scale circulations. The Hawaiian Islands lie at a tropical latitude where northeasterly trade winds prevail. This circulation is extremely persistent. Occasional hurricanes disrupt wind and rain patterns in the Hawaiian Islands.

Superimposed on the large-scale flow in and around Honolulu are so-called "mountain and valley" circulations. Mountain and valley winds result from differential heating or cooling between the slope and adjacent free air. Upslope, or up-valley, flow occurs during the day as air is warmed. Downslope, or down-valley, flow occurs at night due to radiational cooling.

The nearest full-time meteorological monitoring station to the proposed project site is maintained at the Honolulu International Airport, approximately 2.5 miles southeast of the project site. Wind patterns for the project site are presented in Figure 1, which is a wind rose for the Honolulu International Airport meteorological station. The wind rose shows that at this site, the majority of winds come from the northeast and east-northeast. Calm conditions prevail only about 1% of the time.

The average high temperature at the project site is 84 degrees Fahrenheit (°F); the average annual temperature is 77°F. Temperatures of 60°F or below and of 100°F or above rarely occur at this location.

Figure 1. Honolulu International Airport Wind Rose (Example Year)



3.3. Overview of Air Quality Standards

The U.S. Environmental Protection Agency (EPA) has established national ambient air quality standards (NAAQS) for the following seven pollutants, termed criteria pollutants: ozone, nitrogen dioxide (NO_2), CO, sulfur dioxide (SO_2), particulate matter with aerodynamic diameter less than or equal to 10 microns (PM_{10}), particulate matter with aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), and airborne lead. The federal Clean Air Act (CAA) requires EPA to designate areas (counties) as attainment or non-attainment with respect to each criteria pollutant, depending on whether the areas meet the NAAQS. An area that is designated non-attainment means the area is not meeting the NAAQS and is subject to planning requirements to attain the standard.

In addition to the seven pollutants listed above, the Hawaii Department of Health (HDOH) has established state standards for CO, PM_{10}, ozone, SO_2, hydrogen sulfide and lead. The state standards were designed to protect the most sensitive members of the population, such as children, the elderly, and people who suffer from lung or heart diseases.

Both state and federal air quality standards are based on two variables: maximum concentration and an averaging time over which the concentration would be measured. Maximum concentrations are based on levels that may have an adverse effect on human health. The averaging times are based on whether the damage caused by the pollutant would occur during exposures to a high concentration for a short time (for example, 1 hour), or to a relatively lower average concentration over a longer period (8 hours, 24 hours, or 1 month). For some pollutants, there is more than one air quality standard, reflecting both short-term and long-term effects. Table 1 presents the NAAQS and HAAQS.

3.1. Existing Air Quality

The project site is an urban area that is in attainment for all state and federal standards. The impacts of existing sources will be represented by the existing ambient air quality data collected at nearby monitoring stations. The monitoring stations that will be used to provide background data for the proposed project are listed in Table 2.

Ambient air quality monitoring data for ozone, PM_{10}, $PM_{2.5}$, CO, NO_2 and SO_2 from the representative monitoring station for the years 2018 through 2020 are summarized in Table 3. The locations of the monitoring stations relative to the project site is shown in Figure 2.

The ambient air quality data are based on data published by HDOH (HDOH Web site) and EPA (AIRS Web site). The maximum ambient background concentrations will be combined with the modeled concentrations and used for comparison to the AAQS.

Table 1. Ambient Air Quality Standards			
Pollutant	Averaging Time	Hawaii	National
Ozone	1-hour 8 hour	-- 0.08 ppm	— 0.070 ppm
CO	1-hour 8-hour	9 ppm (10 mg/m³) 4.4 ppm	35 ppm (40 mg/m³) 9 ppm (10 mg/m³)
NO_2	1-hour Annual arithmetic mean	-- 0.04 ppm	100 ppb (188 µg/m³) [a] 53 ppb (100 µg/m³)
SO_2 [b]	1-hour 3-hour (secondary standard) 24-hour	-- 0.5 ppm 0.14 ppm 0.03 ppm	75 ppb (196 µg/m³) 0.5 ppm (1,300 µg/m³) -- —
Respirable Particulate Matter (PM_{10})	24-hour Annual arithmetic mean	150 µg/m³ 50 µg/m³	150 µg/m3 —
Fine Particulate Matter ($PM_{2.5}$)	24-hour Annual arithmetic mean	— --	35 µg/m³ [c] 12 µg/m³ [d]
Lead	Calendar quarter Rolling 3-month average	-- 1.5 µg/m³	1.5 µg/m³ 0.15 µg/m³
Hydrogen sulfide (H_2S)	1- hour	0.025 ppm	—

Note:

a. To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb.

b. On June 2, 2010, EPA established a new 1-hour SO2 standard, effective August 23, 2010, which is based on the 3-year average of the annual 99th percentile of 1-hour daily maximum concentrations. The EPA also revoked both the 24-hour SO2 standard of 0.14 ppm and the annual primary SO2 standard of 0.030 ppm, effective August 23, 2010. The secondary SO2 standard was not revised at that time; however, the secondary standard is undergoing a separate review by EPA.

c. The 24-hour standard is attained when 98 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard.

d. 3-year average of the weighted annual mean concentrations.

µg/m³ = microgram(s) per cubic meter
ppm = parts per million
Source: HDOH, 2020

Table 2. Monitoring Station Locations

Pollutant	**Monitoring Station**
NO_2	Kapolei
SO_2	Downtown Honolulu
O_3	Sand Island
CO	Downtown Honolulu
PM_{10}	Pearl City
$PM_{2.5}$	Pearl City

Figure 2. Locations of Monitoring Stations and Project Site

Table 3. Background Concentrations from Representative Monitoring Stations in the Project Area					
Pollutant	Averaging Period	Monitored Background Concentration			Maximum Concentration
		2018	2019	2020	
NO_2	1-hour[a] – federal std Annual – state std	100 ppb 40 ppb	30 ppb 4 ppb	29 ppb 4 ppb	27 ppb 3 ppb
SO_2	1-hour[b] – federal std 3-hour – state std 24-hour – state std Annual – state std	75 ppb 500 ppb 140 ppb 30 ppb	5 ppb 9 ppb 2 ppb 1 ppb	4 ppb 1 ppb 1 ppb <1 ppb	3 ppb 1 ppb 1 ppb <1 ppb
CO	1-hour – state std 8-hours – state std	9 ppm 4.4 ppm	1.0 ppm 0.8 ppm	1.4 ppm 0.8 ppm	0.9 ppm 0.6 ppm
PM_{10}	24-hour – state std Annual[c] – state std	150 µg/m³ 50 µg/m³	34 µg/m³ 14.4 µg/m³	36 µg/m³ --[f]	28 µg/m³ 11.7 µg/m³
$PM_{2.5}$	24-hour[d] – federal std Annual[e] – federal std	35 µg/m³ 12 µg/m³	12 µg/m³ 3.3 µg/m³	9.8 µg/m³ 3.6 µg/m³	7.2 µg/m³ 3.2 µg/m³

Source: PM_{10} and $PM_{2.5}$ from Pearl City; SO_2 and CO from Downtown Honolulu; NO_2 from Kapolei. 2018, 2019, and 2020 data from State of Hawaii Annual Summaries of Air Quality Data (https://health.hawaii.gov/cab/hawaii-air-quality-data-books).

Notes:

a. 3-year average 98th percentile design values are listed.

b. 3-year average 99th percentile design values are listed.

c. Three-year maximum annual average.

d. 3-year average 98th percentile design values are listed.

e. 3-year average design values are listed.

f. Reporting error.

3.2. Greenhouse Gases

HDOH and the state of Hawaii have promulgated several regulations to address the potential effects of increasing atmospheric concentrations of carbon dioxide and other greenhouse gases.

Greenhouse gases include the following pollutants:

- Carbon dioxide (CO_2) is a naturally occurring gas, as well as a by-product of burning fossil fuels and biomass, land-use changes, and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance.
- Methane (CH_4) is a greenhouse gas with a global warming potential (GWP) most recently estimated at 25 times that of CO_2. GWP is a measure of how much a given mass of greenhouse gas is estimated to contribute to global warming and is a relative scale that compares the mass of a greenhouse gas to that same mass of carbon dioxide. CH_4 is produced through anaerobic (without oxygen [O_2]) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion.

- Nitrous oxide (N_2O) is a greenhouse gas with a GWP of 298 times that of CO_2. Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

The project impact assessment includes the impacts from emissions of CO_2, CH_4, and N_2O.

4. Environmental Analysis

The following sections describe the emission sources that have been evaluated, the results of the ambient impact analyses, and the evaluation of project compliance with the applicable air quality regulations. These analyses are designed to confirm that the proposed project's design features lead to less-than–significant impacts even with the following conservative analysis assumptions and procedures: maximum allowable emission rates, project operating schedules that lead to maximum emissions, worst-case meteorological conditions, and the worst-observed existing air quality added to the highest potential ground-level impact from modeling—even when all of these situations could not physically occur at the same time.

4.1. Process Description

As discussed above, the proposed project includes the installation of eleven new Wärtsilä 20V34DF reciprocating IC engines. Each new engine generator will be equipped with an inlet air filter and an intercooling system. Table 4 lists the technical specifications for the new engines. Note the specifications are for a single engine.

Table 4. Wärtsilä 20V34DF Nominal Specifications

Parameter	Specifications	
Manufacturer	Wärtsilä	
Model	20V34DF	
Fuel Types	Renewable natural gas (RNG)	Biodiesel
Fuel Higher Heating Value	1024 Btu/scf	19,280 Btu/lb
Heat Input (HHV) (peak load)[a]	77.9 MMBtu/hr	78.7 MMBtu/hr
Fuel Consumption	68.6 Mscf/hr	4,028 lb/hr
Exhaust Flow (peak load)	52,823 dscfm	60,091 dscfm
Exhaust Temperature (peak load)	708.8 ºF	608.0 ºF
Engine Generator Output	9,370 kW (nominal – gross)	

Note:
a. Represents the maximum fuel consumption of the engine, based on rated heat input and fuel heat content.

Manufacturer's literature is provided in Appendix E.

These compression ignition engines use a pilot fuel injection system to ignite the air-gas mixture in the cylinder when operating the engine in gaseous fuel mode.[2] The engine operates in a binary mode of either biodiesel pilot fuel/renewable natural gas or 100% biodiesel fuel. The engines are designed to operate on a wide range of liquid and gaseous fuels. References to RNG in this application are intended to represent gaseous fuels and references to biodiesel are intended to represent liquid fuels. The emission rates presented in this application represent worst case emissions for each fuel type (liquid or gaseous).

The Wärtsilä dual-fuel engine operates on the lean burn principle: the mixture of air and gas in the cylinder contains more air than is needed for complete combustion. Lean combustion reduces peak temperatures and therefore NO_X emissions. Emissions will be further minimized through the use of post-combustion air pollution controls, which will consist of SCR for NO_X control and oxidation catalysts for carbon monoxide (CO) control. Any or all of the reciprocating engines may be operated up to 24 hours per day, 7 days per week, with annual operation limited by fuel use and emissions limitations.

4.2. Air Pollution Control (APC) Systems

Each engine generator will utilize an SCR catalyst with ammonia or urea injection for control of NOx emissions. As a result, the NOx emissions at full load will be limited to 6 ppmv, 3-hour average, dry basis at 15% O_2 (ppmc), on RNG and 35 ppmc on biodiesel. The oxidation catalyst is expected to achieve CO emissions at full load of 15 ppmc, 3-hour average, on RNG and 20 ppm on biodiesel. VOC emissions at full load will be limited to 26 ppmc on RNG and 40 ppmc on biodiesel (as methane). SOx and PM_{10} emissions will be minimized through the use of ultra-low sulfur fuels. Ammonia slip from the SCR system will be limited to 10 ppmc, 3-hour average basis.

The exhaust from each engine will be discharged from a 95-foot tall, 4-foot diameter exhaust stack. Individual Continuous Emission Monitoring System (CEMS) sampling probes will be located in the horizontal ducting prior to the silencer for each engine for continuous measurement and recording of NOx and CO emissions.

4.3. Emergency Diesel Generator and Fire Pump Engine

The emergency diesel generator and emergency fire pump engine will be constructed adjacent to the reciprocating engines. Specifications for the emergency generators and emergency fire pump engine are shown in Table 5 and Table 6, respectively. Because these units are used solely in emergencies, they are insignificant sources and are exempt from permitting under 11-60.1-82(d)(8).

Manufacturers' literature for the emergency engines is provided in Appendix E.

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[2] The amount of pilot fuel varies with engine load and under most operating conditions comprises less than 1% of full-load fuel consumption. The amount of pilot fuel is optimized for efficient combustion by the engine control and monitoring system. The volume/mass of pilot fuel stays more or less constant throughout the load range, so the effective percentage rises as load decreases.

Table 5. Emergency Diesel Engine Generator Specifications	
Parameter	**Value**
Manufacturer	Caterpillar or equivalent
Model	C27 ATAAC or equivalent
EPA Emissions Certification	Tier 2 (Stationary Emergency)
Fuel	ULSD
Engine Output, kw (each)	750
Engine Output, bhp	1141
Heat Input, MMBtu/hr (HHV)	7.4
Heat Input, gal/hr	53.6
Operating hours per year[a]	500
Note: a. Operating hours per year used to determine annual emissions.	

Table 6. Emergency Diesel Fire Pump Engine Specifications	
Parameter	**Value**
Manufacturer	Cummins or equivalent
Model	CFP9E-F65 or equivalent
EPA Emissions Certification	Tier 3
Fuel	ULSD
Engine Output, bhp	380
Heat Input, MMBtu/hr (HHV)	3.0
Heat Input, gal/hr	21.8
Operating hours per year[a]	500
Note: a. Operating hours per year used to determine annual emissions.	

4.4. Criteria Pollutant Emissions from the New Generating Units

The highest hourly heat input and emission rates for the Wärtsilä 20V34DG engine generators during normal operation occur at peak load. The primary fuel for the engines will initially be biodiesel, with other fuels (including natural gas and ultralow sulfur diesel) as backups. The engines may be operated under a wide variety of load conditions and may start up and/or operate on either RNG or biodiesel. The worst-case hourly emissions assume all eleven engines will undergo startups on biodiesel during the same hour. Worst-case hourly emissions for RNG reflect the maximum emissions on any gaseous fuel; worst-case hourly emissions for biodiesel reflect the maximum emissions on any liquid fuel. Maximum daily emissions are calculated assuming that each engine will undergo one startup/shutdown per day and will operate at full load for the remaining hours of the day. Maximum annual emissions are calculated for three operating scenarios that describe maximum potential emissions for the various combinations of fuel use: 100% RNG operation, 100% biodiesel operation, and biodiesel operation with RNG startups. However, the engines may operate in any one or a combination of these modes, depending upon operational demands and fuel availability. Details of the emissions calculations are provided in the following sections.

4.4.1. Commissioning Period

Engine commissioning consists of no-load, partial-load and full-load testing performed immediately after construction for the purpose of optimizing engine operations, followed by installation of the emission control systems and optimizing and testing of the SCR systems. Several parameters—such as engine load, engine tuning, and degree of SCR control—may be varied simultaneously during testing at the discretion of the applicant and in accordance with the commissioning program laid out by the engine and control equipment manufacturers.

Emissions during the commissioning period may be higher than those during normal operations for some pollutants due to the fact that the engines may not be optimally tuned and the SCR systems may be only partially operational or not operational at all. However, operations during commissioning are episodic and short-term, and not all engines are operated simultaneously so emissions during these activities will be minimized.

The CEMS will be installed and calibrated on each engine prior to the first start of each engine, and NOx and CO emissions will be continuously monitored during the commissioning phase.

4.4.2. Emissions Calculations

Criteria pollutant emission rates were calculated for various operating modes of the project: engine startup and engine operation. These operating modes are described in Table 7. Detailed emission calculations are in Appendix B.

Table 7. Operating Modes of the Engine Generators	
Mode	**Description**
Start-up	There will be up to eleven total startups per day; the equivalent of one startup for each engine. Startup emissions are elevated due to the fact that the control equipment has not reached optimal temperature to begin the chemical reactions needed to convert NOx to elemental nitrogen and water. Most startups are expected to occur using RNG, but startup emissions using biodiesel fuel are also evaluated as a worst case.
Normal Operation	Normal operation occurs after the engines and the control equipment are working optimally, as designed. Emissions may vary due to fluctuations in engine load, but mass emissions at part load are not higher than mass emissions at full load. Most operations are expected to use RNG, but operating emissions on biodiesel fuel are also evaluated as a worst case.

4.4.3. Start-Up Emissions

The applicant expects that there will be an average of the equivalent of 365 startups per year for each engine during normal plant operations. During a startup, there are up to 30 minutes with elevated emissions (emissions higher than during normal operation) as the emission control devices reach full effectiveness. Shutdowns occur quickly enough that they are not expected to result in emissions above normal levels.

The startup emission calculations are shown in Appendix B. The applicant expects that there will be an average of one startup per day per engine; however, this is not proposed as an operational limit as daily operations will vary. During start-up operations, each engine is assumed to operate at elevated NOx and CO emission rates due to the phased-in effectiveness of the SCR systems and oxidation catalysts. Compliance with emission limits during startup will be monitored by the CEMS.

4.4.4. Normal Operations

The emissions during normal operations are assumed to be fully controlled to Best Available Control Technology (BACT) levels and exclude emissions due to commissioning and startup periods. Hourly and annual averages are calculated and shown in Appendix B.

Table 8 and Table 9 show hourly and annual emissions for the eleven engines for three typical operating scenarios. Each operating scenario includes startup and normal (fully control) operation. Details of the hourly and annual emissions calculations for each scenario are shown in Appendix B. The engines are expected to operate in any one or a combination of these operating scenarios.

4.4.5. Hourly and Annual Emissions Limits

The maximum hourly and annual emissions for all eleven engines, shown as the maximum of any scenario, are proposed as permit limits to ensure that the project is operated in a manner consistent with the operating assumptions used to evaluate project impacts. NOx and CO emissions will be continuously monitored during at all times. No other operational limitations are proposed for the project.

4.5. Criteria Pollutant Emissions from the New Emergency Diesel Generator

The new emergency diesel engine generator will provide black start capability for the Wärtsilä engine generators in the event of complete loss of power from the grid. The emergency engine will operate to provide electric power only during an emergency situation—that is, when electric power from the local utility is interrupted. As such, it is expected to operate infrequently, with non-emergency operation (maintenance and testing) limited to 100 hours per year. In accordance with H.A.R. 11-60.1-82(f)(5), the emergency generator is an insignificant source. However, its annual emissions have been evaluated to ensure compliance with H.A.R. 11-60.1-82(e). Annual emissions are calculated based on 500 hours of operation per year, based on EPA policy for emergency engines, and are included in the total project emissions shown in Table 10.

Table 8. Maximum Mass Emission Rates, lb/hr						
	NOx	CO	VOC	SOx	$PM_{10}/PM_{2.5}$	NH_3
100% RNG Operation						
Each Individual Engine						
Normal Operating Hour	1.65	2.51	2.50	0.062	2.01	1.02
Startup Hour[a]	14.83	11.76	3.25	0.062	3.01	0.51
Maximum Hour	14.83	11.76	3.25	0.062	3.01	1.02
Total, Eleven Engines						
Normal Operating Hour	18.2	27.6	27.5	0.69	22.1	11.2
Startup Hour[a]	163.1	129.3	35.8	0.69	33.1	5.6
Maximum Hour	163.1	129.3	35.8	0.69	33.1	11.2
RNG Startups, Biodiesel Operation						
Each Individual Engine						
Normal Operating Hour	10.86	3.78	4.33	0.121	4.53	1.15
Startup Hour[a]	19.43	12.39	4.17	0.092	4.27	0.58
Maximum Hour	19.43	12.39	4.33	0.121	4.53	1.15
Total, Eleven Engines						
Normal Operating Hour	119.5	41.6	47.6	1.33	49.8	12.6
Startup Hour[a]	213.7	136.3	45.8	1.0	46.9	6.3
Maximum Hour	213.7	136.3	47.6	1.33	49.8	12.6
100% Biodiesel Operation						
Each Individual Engine						
Normal Operating Hour	10.86	3.78	4.33	0.121	4.53	1.15
Startup Hour[a]	50.43	7.89	4.67	0.121	7.27	0.58
Maximum Hour	50.43	7.89	4.67	0.121	7.27	1.15
Total, Eleven Engines						
Normal Operating Hour	119.5	41.6	47.6	1.33	49.8	12.6
Startup Hour[a]	554.7	86.8	51.3	1.33	79.9	6.3
Maximum Hour	554.7	86.8	51.3	1.33	79.9	12.6
Maximum, Any Scenario	554.7	86.8	51.3	1.33	79.9	12.6

Note:

a. Pounds per hour emission rates for startup hour include 30 minutes of cold startup and 30 minutes of full-load operation.

Table 9. Maximum Mass Emission Rates, tons/year						
	NOx	CO	VOC	SOx	$PM_{10}/PM_{2.5}$	NH_3
100% RNG Operation						
Each Individual Engine						
Normal Operations	6.6	10.1	10.0	0.25	8.1	4.1
Startups[a]	2.3	1.9	0.6	0.01	0.6	0.09
Total[b]	8.9	12.0	10.6	0.26	8.6	4.2
Total, Eleven Engines						
Normal Operations	72.9	110.9	110.4	2.8	88.8	45.0
Startups[a]	25.5	20.7	6.0	0.11	6.0	1.0
Total[b]	98.3	131.5	116.4	2.9	94.8	46.1
RNG Startups, Biodiesel Operation						
Each Individual Engine						
Normal Operations	18.6	6.5	7.4	0.21	7.8	2.0
Startups[a]	3.2	2.0	0.7	0.02	0.8	0.10
Total[b]	21.8	8.5	8.1	0.22	8.6	2.1
Total, Eleven Engines						
Normal Operations	204.9	71.3	81.7	2.3	85.5	21.7
Startups[a]	34.7	21.9	7.8	0.2	8.6	1.1
Total[b]	239.6	93.3	89.6	2.5	94.0	22.9
100% Biodiesel Operation						
Each Individual Engine						
Normal Operations	13.9	4.8	5.5	0.15	5.8	1.5
Startups[a]	7.8	1.3	0.8	0.02	1.3	0.10
Total[b]	21.7	6.1	6.3	0.18	7.1	1.6
Total, Eleven Engines						
Normal Operations	152.6	53.1	60.8	1.7	63.7	16.2
Startups[a]	85.7	14.3	8.8	0.2	14.6	1.2
Total[b]	238.4	67.4	69.6	1.9	78.2	17.3
Maximum, Any Scenario	239.6	131.5	116.4	2.9	94.8	46.1

Note:
a. Startup emissions reflect 30 minutes of cold startup and 30 minutes of full-load operation for each hour of startup during the year.
b. Numbers may not add directly due to rounding.

Table 10. Maximum Annual Project Emissions, tons/year					
	NOx	CO	VOC	SOx	$PM_{10}/PM_{2.5}$
11 20V34DF Engines, Maximum, Any Scenario	239.6	131.5	116.4	2.9	94.8
Emergency Generator	3.3	0.2	0.02	0.003	0.01
Emergency Fire Pump Engine	0.5	0.3	0.03	0.001	0.02
Total Project Emissions	243.4	132.0	116.5	2.9	94.8
Note: a. Startup emissions reflect 30 minutes of cold startup and 30 minutes of full-load operation for each hour of startup during the year.					

4.6. Criteria Pollutant Emissions from the New Emergency Diesel Fire Pump Engine

The new emergency diesel fire pump engine will power the emergency fire water pump. As such, it is expected to operate infrequently and non-emergency operation (that is, operation for maintenance and testing) is restricted to 100 hours per year by regulation. In accordance with H.A.R. 11-60.1-82(f)(5), the emergency fire pump engine is an insignificant source. However, its annual emissions have been evaluated to ensure compliance with H.A.R. 11-60.1-82(e). Annual emissions are calculated based on 500 hours of operation per year, based on EPA policy for emergency engines, and are included in the total project emissions shown in Table 10.

4.7. Non-Criteria Pollutant Emissions from the New Generating Units

Noncriteria pollutant emissions were estimated for the new engines. These emissions are summarized in Table 11. The detailed noncriteria pollutant emissions calculations and the associated screening-level health risk assessment are included in Appendix C. Because the emissions of any single HAP are below 10 tons per year and maximum total HAP emissions are below 25 tons per year, the facility will be an area source of HAPs.

Table 11. Non-Criteria Pollutant Emissions for the New Equipment			
	100% RNG Operation	RNG Startups/ Biodiesel Operation	100% Biodiesel Operation
Compound	**Emissions (tons/yr, each engine)**		
Ammonia (not a HAP)	46.1	22.9	17.3
Propylene (not a HAP)	10.23	2.8	2.12
Acetaldehyde	1.01	0.05	0.02
Acrolein	0.11	9.73E-03	0.01
Benzene	0.41	0.70	0.56
1,3-Butadiene	0.70	0.02	0.04
Ethylbenzene	0.14	0.05	1.88
Formaldehyde	9.23	2.53	0.01
Naphthalene	0.05	9.47E-03	0.09
PAHs (other)	0.00	0.11	0.00
Toluene	0.45	4.24E-04	0.21
Xylene	1.23	0.26	0.15
Total, All HAPs	**Emissions (tons/yr, 11 engines)**		
Total HAPs	13.33	3.95	2.95
See detailed calculations in Appendix B, Appendix Tables B-16, B-17 and B-18.			

4.8. Greenhouse Gas Emission Estimates

Combustion of fossil fuels in the reciprocating engine generators would result in emissions of CO_2, CH_4, and N_2O. GHG emissions for normal facility operations under each of the three operating scenarios were calculated based on the maximum fuel use predicted for each scenario and emission factors contained in the EPA GHG Reporting Regulation.[3] Emissions of CO_2, N_2O, and CH_4 resulting from operation of the generators are presented in Table 12.

[3] 40 CFR 98 (as revised on 12/09/2016).

Table 12. Greenhouse Gas Emissions from the New Generators					
	CO_2, metric tons/year	CH_4, metric tons/year	N_2O, metric tons/year	CO_2eq, metric tons/yr[a]	CO_2, pounds per MWh
100% RNG Operation					
Each Engine	34,705.7	19.5	16.4		
Total, 11 Engines	381,763.0	214.4	179.9	382,157.3	977.2
RNG Startups/ Biodiesel Operation					
Each Engine	21,824.5	51.3	21.8		
Total, 11 Engines	240,069.5	565.0	238.9	240,872.7	1,368.2
100% Biodiesel Operation					
Each Engine	17,026.2	41.2	17.3		
Total, 11 Engines	187,288.6	452.8	189.9	187,931.3	1,391.1

Note:
a. Includes CH_4 and N_2O.

Detailed GHG emission calculations for the new engines are included in Appendix B.

4.9. Consistency with Laws, Ordinances, Regulations, and Standards

This section demonstrates consistency separately for federal and state requirements.

4.9.1. Consistency with Federal Requirements

PSD Program

EPA has promulgated PSD regulations for areas that are in compliance with national ambient air quality standards (40 CFR 52.21). The PSD program allows new sources of air pollution to be constructed, or existing sources to be modified, while preserving the existing ambient air quality levels, protecting public health and welfare, and protecting Class I areas (e.g., specific national parks and wilderness areas). There are five principal areas of the PSD program: (1) Applicability; (2) Best Available Control Technology; (3) Pre-Construction Monitoring; (4) Increments Analysis; and (5) Air Quality Impact Analysis.

Applicability. The federal PSD requirements apply on a pollutant-specific basis to any project that is a new major stationary source or a major modification to an existing stationary source. (These terms are defined in federal regulations.) (40 CFR 52.21). Since the proposed project will be a new major source, the determination of PSD applicability to the proposed project is based on evaluating the emissions increases associated with the proposed project. In Table 13, the emissions from the proposed project, based on the maximum emissions from any of the proposed operating scenarios, are compared to the regulatory significance thresholds. As shown in this table, the emissions associated with the proposed project are below these PSD applicability thresholds for all pollutants, and thus the proposed project is not subject to PSD review.

Table 13. Project Emissions and PSD Applicability			
Pollutant	Maximum Annual Emissions from New Equipment (tpy)[a]	PSD Applicability Thresholds (tpy)	Emissions Exceed Threshold?
NOx	243.4	250	No
SOx	2.9	250	No
CO	132.0	250	No
VOC	116.5	250	No
PM_{10}	94.8	250	No
$PM_{2.5}$	94.8	250	No
GHG	421,682	75,000[b]	No

Note:
a. Includes emissions from the emergency generator and fire pump engine. See Table 10.
b. GHG significance threshold is applicable only if potential to emit for one or more attainment pollutants exceed the applicable threshold. Since PTEs for all other pollutants are below the applicability thresholds, the GHG threshold does not apply.

New Source Performance Standards: Wärtsilä Reciprocating Engines

When fired on RNG, the proposed Wärtsilä 20V34DF units will be subject to the NSPS Subpart JJJJ requirements for non-emergency engines manufactured on or after July 1, 2010, for engines with a maximum engine power greater than or equal to 500 horsepower (hp). Although these engines utilize pilot biodiesel and not sparking devices to ignite the compressed fuel in the cylinder, they meet the definition of spark ignition in NSPS Subpart JJJJ, as follows:

> *Spark ignition means relating to either: a gasoline-fueled engine; or any type of engine with a spark plug (or other sparking device) and with operating characteristics significantly similar to the theoretical Otto combustion cycle. Spark ignition engines usually use a throttle to regulate intake air flow to control power during normal operation. Dual-fuel engines in which a liquid fuel (typically diesel fuel) is used for compression ignition and gaseous fuel (typically natural gas) is used as the primary fuel at an annual average ratio of less than 2 parts diesel fuel to 100 parts total fuel on an energy equivalent basis are spark ignition engines.*

As discussed in Section 1.3, the Wärtsilä 20V34DF engines use a biodiesel pilot fuel injection system to ignite the air-gas mixture in the cylinder when the engine operates in gas mode. The Wärtsilä units are normally started in biodiesel mode. Gas admission is activated when combustion is stable in all cylinders (usually within 1-2 minutes). When the engine operates in gas mode, the biodiesel pilot fuel amounts to less than 1.5% of full-load fuel consumption, and the engine's operating characteristics are substantially similar to the theoretical Otto combustion cycle. Therefore, the proposed Wärtsilä 20V34DF units will be regulated as spark ignition engines under NSPS Subpart JJJJ when fueled with RNG.

40 CFR Part 60 Subpart JJJJ, Standards of Performance for Stationary Spark Ignition Internal Combustion Engines (NSPS JJJJ) applies to owners and operators of stationary spark ignition internal combustion engines (SI ICE) that commence construction after June 12, 2006. The NSPS Subpart JJJJ requirements are dependent on the following factors:

- The maximum engine power,
- When the SI ICE was manufactured, and
- The purpose of the stationary SI ICE.

Per 40 CFR §60.4233(e), the applicable NSPS Subpart JJJJ NO_X, CO, and VOC emission standards are those for non-emergency SI ICE with a maximum engine power greater than or equal to 500 bhp fired on natural gas and manufactured on or after July 1, 2010. The proposed permit limits are well below the applicable NSPS standards, as shown in Table 14.

Table 14. Compliance with SI NSPS Limits

Pollutant	Proposed Permit Limits[a]	Subpart JJJJ Limits
NO_X	6 ppmvd at 15% O_2	1.0 g/hp-hr OR 82 ppmvd at 15% O_2
CO	15 ppmvd at 15% O_2	2.0 g/hp-hr OR 270 ppmvd at 15% O_2
VOC (excluding formaldehyde)	26 ppmvd at 15% O_2	0.7 g/hp-hr OR 60 ppmvd at 15% O_2

Note:
a. Exhaust concentrations vary by load; highest (full load) limits shown. See Appendix B, Table B-1.

40 CFR Part 60 Subpart IIII, Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (NSPS Subpart IIII) applies to owners and operators of stationary compression ignition internal combustion engines (CI) ICE that commence construction after July 11, 2005 where the stationary CI ICE is manufactured after April 1, 2006. The NSPS Subpart IIII requirements are dependent on the following factors:

- When the stationary CI ICE will be installed,
- The size (cylinder displacement) of the stationary CI ICE;
- The engine speed; and
- The purpose of the stationary CI ICE.

When the proposed Wärtsilä 20V34DF units are fired primarily or solely on biodiesel, they will be subject to the NSPS Subpart IIII requirements for non-emergency compression ignition engines with a displacement of greater than or equal to 30 liters per cylinder. The NSPS Subpart IIII NO_X limits for CI ICE with a displacement of greater than or equal to 30 liters per cylinder were revised on June 28, 2011, to match the International Maritime Organization's Annex VI NO_X limits. Based on these revised limits, the use of post-combustion controls (such as SCR) to meet the applicable NSPS NO_X limit was not expected to be required until 2016. This change was made to allow additional time to transfer control technologies, such as SCR, to large displacement CI ICE. Per 40 CFR §60.4204(c)(3), the applicable NSPS Subpart IIII NO_X limit for non-emergency stationary CI ICE with a displacement of greater than or equal to 30 liters per cylinder installed on or after January 1, 2016, and an engine speed is between 130 and 2,000 rpm, is calculated as follows:

$$EE_{NNNNNNNN} = 9.0 * nn^{-0.20}$$

Where:

E_{NSPS} = Applicable NSPS NO_X limit (g/kW_m-hr)
n = Maximum Engine Speed (RPM)

Based on the Wärtsilä 20V34DF's maximum rated engine speed of 750 rpm, the applicable NSPS Subpart IIII NO_X limit is 2.4 g/kW_m-hr (1.8 g/hp-hr). The NSPS limit is based on the engine's mechanical output, not the generator's electrical output. The manufacturer's guaranteed NO_X emission rates are equivalent to 0.526 g/kW_m-hr at full load and 0.622 g/kW_m-hr at minimum (50%) load and are less than the applicable NSPS Subpart IIII NO_X limit.

NSPS Subpart IIII requires non-emergency stationary CI ICE with a displacement of greater than or equal to 30 liters per cylinder to limit PM emissions to 0.15 g/kW_m-hr (0.11 g/hp-hr) (40 CFR §60.4204(c)(4)). The manufacturer's guaranteed PM emission rates are equivalent to 0.004 g/kW_m-hr at full load and 0.005 g/kW_m-hr at minimum (50%) load, and are well below the applicable NSPS Subpart IIII PM limit.

Per 40 CFR §60.4215(b), stationary CI ICE with a displacement of greater than or equal to 30 liters per cylinder are required by 40 CFR §60.4207to use diesel fuel with a sulfur content that does not exceed 1,000 ppm. Nevertheless, the biodiesel fuel used in this application will have a sulfur content that does not exceed 15 ppm as BACT for SO_2 and PM_{10}/$PM_{2.5}$, as discussed previously.

New Source Performance Standards for the Emergency Engines

The proposed 750 kW emergency diesel engine generator and fire pump engine will be subject to the NSPS Subpart IIII requirements for emergency CI ICE with a displacement of less than 30 liters per cylinder. Stationary CI ICE with a displacement of less than 30 liters per cylinder are required to meet the applicable emission standards in §40 C.F.R. 60.4205 for their model year.

40 CFR §60.4205 requires the emergency engines to meet the applicable standards in Table 4 to Subpart IIII of Part 60. The applicant will comply with this requirement by installing a Tier 2 certified emergency generator and a Tier 3 certified fire pump engine.

National Emission Standards for Hazardous Air Pollutants

40 CFR Part 63 Subpart ZZZZ, National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE NESHAP)

applies to all stationary RICE. The specific applicable requirements are dependent on the following factors:

- The engine output and engine type (CI or SI),
- The engine installation date,
- Whether the source is a major or area source of HAPs, and
- The purpose of the stationary RICE.

The RICE NESHAP classifies the proposed Wärtsilä 20V34DF units as "new stationary engines >500 hp located at area source of HAP, spark ignition 4-stroke lean burn" while using RNG as they:

- Have a site rating of more than 500 brake horsepower (bhp),
- Will be constructed after June 12, 2006,
- Are four-stroke, lean burn spark ignition engines, and
- Will be located at an area source of HAP emissions (40 CFR §63.6590(a)(2)(iii)).

The RICE NESHAP classifies the proposed Wärtsilä 20V34DF units as "new stationary engines >500 hp located at area source of HAP, compression ignition" while using biodiesel fuel as they:

- Have a site rating of more than 500 brake horsepower (bhp),
- Will be constructed after June 12, 2006,
- Are compression ignition engines, and
- Will be located at an area source of HAP emissions (40 CFR §63.6590(a)(2)(iii)).

The NESHAP requires new stationary engines >500 hp located at area sources of HAP to comply with the requirements of NSPS Subparts IIII or JJJJ, as appropriate. There are no separate requirements for these engines under the NESHAP.

Compliance Assurance Monitoring (CAM)

The CAM regulation (40 CFR 64) applies to emission units at major stationary sources required to obtain a Title V permit, which use control equipment to achieve a specified emission limit. The rule is intended to provide "reasonable assurance" that the control systems are operating properly to maintain compliance with the emission limits. Since the project will be issued a Covered Source Permit requiring the installation and operation of continuous emissions monitoring systems, the project will qualify for this exemption from the requirements of the CAM rule. Therefore, CAM requirements do not apply to the proposed project.

Acid Rain Requirements

The federal Acid Rain program (40 CFR Part 72) applies to electric generating units rated at greater than 25 MW that are located within the 48 contiguous states. Because each of the Wärtsilä generating units is rated at 9.4 MW and the project will be located in Hawaii, these units are not subject to Acid Rain program requirements.

4.9.2. Consistency with State Requirements

The proposed project is subject to State of Hawaii Administrative Rules, Chapter 11-60.1, Air Pollution Control, Subchapters 1, 2, 5, 6, 8, and 11. Each of these rules requires, in various forms, descriptions and analyses of the project, its emissions, and its impact on air quality. The data and analyses in this application support document verify that the project will comply with all applicable state and federal air quality requirements.

As discussed in Part I of this application, the facility is considered to be a "covered source" for the purposes of Chapter 11-60.1. Section 11-60.1-101 requires that every application for a covered source permit include:

A description of the compliance status of the existing covered source or proposed source with respect to all the applicable requirements . . .

"Applicable requirements" are defined in §11-60.1-61 as:

[A] ll of the following as they apply to emissions units in a covered source:

> (1) Any NAAQS or state ambient air quality standard;
> (2) The application of best available control technology to control those pollutants subject to any NAAQS or state ambient air quality standard, but only as best available control technology would apply to new covered sources and modifications to covered sources that have the potential to emit or increase emissions above significant amounts considering any limitations, enforceable by the director, on the covered source to emit a pollutant; and
> (3) Any standard or other requirement provided for in chapter 342B, HRS; this chapter; or chapter 11-59.

Compliance with each of these requirements is discussed in the following sections.

1) Any NAAQS or state ambient air quality standard.

The source will comply with all national and state ambient air quality standards. The ambient air quality impact analysis is provided in Appendix C.

2) The application of best available control technology to control those pollutants subject to any NAAQS or state ambient air quality standard, but only as best available control technology would apply to new covered sources and modifications to covered sources that have the potential to emit or increase emissions above significant amounts considering any limitations, enforceable by the director, on the covered source to emit a pollutant.

The required BACT analyses are provided in Appendix D.

3) Any standard or other requirement provided for in chapter 342B, HRS; this chapter; or chapter 11-59.

Chapter 11-60.1 was developed to implement the requirements of chapter 342B as well as Title V of the Clean Air Act Amendments. Compliance with the requirements of chapter 11-60.1 will also ensure compliance with chapter 342B. Chapter 11-59 lists the state ambient air quality standards, which were discussed previously in this section.

The "General Requirements" of Chapter 11-60.1 Subchapter 1 that are applicable to the source are discussed below.

a. Subchapter 1, General Requirements

§ 1 Definitions. This section contains definitions that are applicable to various standards and requirements, but no actual standards or requirements. This section defines "covered source" to include any stationary source constructed, modified, or relocated after March 20, 1972, that is not a covered source. A "covered source" includes any "major source," or any source subject to NSPS, NESHAPS, or PSD. A "major source" includes all sources with a "potential to emit" in excess of 100 tons per year of any air pollutant. The proposed project is considered to be a "covered source" because it is a "major source."

§ 2 Prohibition of air pollution. This section requires any activity that causes air pollution to secure written approval from the director. The source will comply with this requirement by securing written approval from the director in the form of a permit prior to modifying the facility.

§ 3 General conditions for considering applications. This section requires that an applicant demonstrate to the satisfaction of the director that all of the applicable provisions of this chapter are complied with, including the following, before an application for covered or covered source permit can be approved: (1) NSPS, NESHAPS, and PSD requirements if applicable; and (2) the maintenance or attainment of any NAAQS or state air quality standard. This application document contains all the information necessary to make the required demonstration.

§ 4 Certification. This section requires that all information submitted in the permit application be certified by a responsible official as true, accurate, and complete. The required certification is included in this application.

§ 5 Permit Conditions. This section authorizes the director to impose permit conditions that may be more restrictive than otherwise required by regulations to protect public health, welfare, and safety. The project will to comply with all permit conditions.

§ 6 Holding of permit. This section requires the permit to be maintained at the stationary source site and made available for inspection upon request. The source will comply with this requirement by keeping the permit onsite.

§ 7 Transfer of permit. This section prohibits transfer of permits between equipment and locations and requires director approval for transfer from one person to another. The source will comply with this requirement if a permit transfer is ever needed.

§ 8 Reporting discontinuance. This section requires written notification to the director of any permanent discontinuance of construction or operation. The source will supply all necessary written notifications if operation is discontinued.

§ 11 Sampling, testing, and reporting methods. This section requires that all sampling and testing be in accordance with EPA reference methods, allows the department to conduct tests of emissions from any source, and allows the director to require a source to maintain records of all operating data necessary to determine compliance with applicable emissions limitations. The source will conduct all necessary testing according to EPA methods and will maintain all appropriate records.

§ 14 Public access to information. This section allows public access to all emissions information and permit applications submitted to the department, except for information that is requested and approved for "confidential treatment." The source will comply with this requirement by following appropriate procedures when confidential treatment of information is required.

§ 15 Reporting of equipment shutdown. This section requires reporting of any scheduled shutdowns of air pollution control equipment at least 24 hours prior to the shutdown and sets out specific items that must be contained in this report. The source will comply with all applicable reporting requirements during any scheduled shutdown of air pollution control equipment.

§ 16 Prompt reporting of deviations. This section requires immediate notification of failure or breakdown of emissions units or related equipment that causes a violation of this chapter or permit. The source will comply with all applicable notification requirements during failure or breakdown.

§ 17 Prevention of air pollution emergency episodes. This section allows the director to curtail source activities during periods of excessive buildup of air contaminants. The source will comply with any curtailment orders issued under this section.

§ 18 Variances. This section requires that all variances and variance applications comply with Hawaii Revised Statutes (HRS) ' 342B-14 and prohibits any variance from interfering with the maintenance or attainment of any NAAQS. Also, it allows no variances from federal regulations or federally enforceable permit conditions. The source will comply with any applicable variance procedures.

§ 19 Penalties and remedies. This section states that any person who violates any provision in chapter 11-60.1 is subject to the penalties and remedies provided in certain sections of the HRS. The source will abide by any applicable penalties and remedies properly imposed on the source.

b. Subchapter 2, General Prohibitions

§ 32 Visible emissions. This section limits the emission of visible air pollutants (not including uncombined water vapor) from sources modified or constructed after March 20, 1972, to 20% opacity, except when “building a new fire” or during “breakdown of equipment” when emissions may be 60% opacity for not more than 6 minutes in any 60 minute period. The source will comply with the visible emission criteria set forth in this section by utilizing clean gaseous and liquid fuels and good combustion practices.

§ 33 Fugitive dust. This section requires that “reasonable precautions” be taken to prevent visible fugitive dust from becoming airborne, and that “best practical operation or treatment” be implemented to prevent visible emissions of fugitive dust beyond the property line. Several examples of “reasonable precautions” are cited in this section, including water or chemical dust suppressants, paving of roads, and the installation of hoods and fabric filters. The source will take reasonable precautions and will implement best practical operation or treatment to minimize fugitive dust emissions.

§ 34 Motor vehicles. This section limits visible emissions and engine idling time for mobile sources used in the construction, maintenance, and operation of this source. The source will comply with all applicable mobile source emissions limitations by requiring proper maintenance and operation of mobile sources.

§ 38 Sulfur oxides from fuel combustion. This section sets a general limit on fuel sulfur content at 2% by weight. The fuel sulfur content for this source be well below this limit.

§ 39 Storage of volatile organic compounds. This section requires all "volatile organic compounds" stored in vessels larger than 250-gallon capacity to have a permanent submerged fill pipe or be stored in a pressure vessel or vented to a control device. Distillate oil and gasoline are "volatile organic compounds" as defined in § 11 60.1 1, and therefore the fuel storage tanks must have at least a submerged fill pipe. Further controls are required for storage of volatile organic compounds with true vapor pressures exceeding 1.5 psia and capacities exceeding 40,000 gallons. Biodiesel has a true vapor pressure much lower than 1.5 psia and therefore is not subject to these additional controls.

§ 41 Pump and compressor requirements. This section limits emissions from pumps and compressors handling volatile organic compounds with true vapor pressures exceeding 1.5 psia. Biodiesel has a true vapor pressure much less than 1.5 psia, so the pumps in liquid fuel service are not subject to this section.

c. Subchapter 5, Covered Sources

§ 82 Applicability. This section requires that a covered source permit be obtained from the director for all covered sources except exempt and insignificant sources. Subsections (d), (e), (f), and (g) list the exemptions applicable to this subchapter.

The emergency diesel generator and emergency fire pump engine are insignificant activities pursuant to § 11-60.1-82(f)(5):

> *Standby generators used exclusively to provide electricity, standby sewage pump drives, and other emergency equipment used to protect the health and welfare of personnel and the public, all of which are used only during power outages, emergency equipment maintenance and testing, and which:*
>
> *(A) Are fired exclusively by natural or synthetic gas; or liquified petroleum gas; or fuel oil No. 1 or No. 2; or diesel fuel oil No. 1D or No. 2D; and*
>
> *(B) Do not trigger a Prevention of Significant Deterioration (PSD) or covered source review, based on their potential to emit regulated or hazardous air pollutants*

The emergency engines will be fired exclusively on diesel fuel oil No. 2, and their emissions do not trigger a PSD review, as shown in Table 13.

§ 85 Compliance plan. This section requires submittal of a "compliance plan" with every application for a new covered source permit. The compliance plan must include a description of the compliance status of the existing covered source with respect to all applicable requirements. The source will comply with this requirement by identifying all applicable requirements and stating the compliance status of the source with respect to all of these requirements.

§ 86 Compliance certification. This section requires submittal of a "compliance certification" with every application for a new covered source permit. The required certification is being submitted as part of this application.

d. Subchapter 6, Fees for Covered Sources, Noncovered Sources, and Agricultural Burning

§ 11-60.1-111 through § 11-60.1-121 set out the fees required for a covered source permit application. The applicant will pay all applicable permit fees.

e. Subchapter 9. Hazardous Air Pollutants

§ 11-60.1-179 prohibits a facility owner/operator from emitting hazardous air pollutants (HAPs) "…in such quantities that result in, or contribute to, an ambient air concentration which endangers human health." Because the proposed project is not a new major source of HAPs, there is no reason to believe that the emissions of HAPs may result in an unacceptable ambient air concentration.

f. Subchapter 11. Greenhouse Gas (GHG) Emissions

§11-60.1-201 through § 11-60.1-206 outline the requirement to prepare and implement a greenhouse gas reduction plan. This requirement applies only to sources that had begun construction or operation by June 30, 2014, so is not applicable to the proposed new facility.

Best Available Control Technology

Section 81 of Chapter 60.1 identifies BACT as an applicable requirement for new covered sources. New covered sources must apply BACT for any pollutants whose emissions are "significant." Emissions from all sources at the facility were shown in Table 10. The new engines are subject to BACT for NOx, VOC, CO, $PM_{10}/PM_{2.5}$, and GHG.

HDOH regulations define BACT as the following:

> *…an emissions limitation…based on the maximum degree of reduction for each pollutant subject to regulation approved pursuant to the Act which would be emitted from any proposed stationary source or modification which the director, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through the application of production techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant.*

The following tasks were performed for the BACT analysis for NOx:

- Reviewed published BACT guidelines;
- Reviewed federal NSPS; and
- Reviewed EPA's RBLC database.

The detailed BACT analysis is included in Appendix D. As discussed in this analysis, the new engines will comply with BACT using the following measures. All proposed limits are expressed on a 3-hour average basis.

- BACT for NOx emissions will be the use of low-NOx emitting equipment and add-on controls. The proposed project will use combustion technology and SCR to reduce NOx emissions (as NO_2) to 6 ppmc while operating on RNG and 35 ppmc while operating on biodiesel.
- BACT for CO emissions will be achieved by using good combustion practices and an oxidation catalyst to achieve CO emissions of 15 ppmc while operating on RNG and 20 ppmc while operating on biodiesel.

- BACT for VOC emissions will be achieved by use of good combustion practices and an oxidation catalyst to achieve VOC emissions (as methane) of 26 ppmc while operating on RNG and 40 ppmc while operating on biodiesel.
- BACT for PM_{10} and $PM_{2.5}$ is best combustion practices and the use of clean, low-sulfur renewable fuels. The proposed engines will burn exclusively renewable natural gas with a maximum sulfur content of 5 parts per million by volume (0.32 grains per 100 scf (gr/100 scf) and biodiesel with a maximum sulfur content of 15 ppm.

Rule 1325 Federal NSR for $PM_{2.5}$

The purpose of this rule is to address emissions of $PM_{2.5}$ and its precursors, NOx and SOx. Applicability of the rule is determined on a pollutant-by-pollutant basis.

This rule applies to any new major polluting facility, major modifications to a major polluting facility, and any modification to an existing facility that would constitute a major polluting facility in and of itself; located in areas federally designated pursuant to Title 40 of the Code of Federal Regulations (40 CFR) 81.305 as nonattainment for $PM_{2.5}$. (Rule 1325(a)). Because the project will not be located in an area that is designated as nonattainment for $PM_{2.5}$, the rule is not applicable to the proposed project regardless of its emission rates.

Screening Health Risk Assessment

§ 11-60.1-179(c) requires that any new major source of hazardous air pollutants (HAPs) must demonstrate that the HAP emissions from the proposed new major source will not result in or contribute to any ambient air concentration which endangers human health. In addition, per HAR 11-60.1-83(a)(14) the director can request a risk assessment of the air quality related impacts caused by a proposed project.

Calculation of noncriteria pollutant emissions from the proposed project are provided in Appendix B and summarized in Table 11 above. The calculations demonstrate that the proposed project will not be a major source of HAP, so no risk assessment is required. However, a risk assessment will be provided upon request.

Appendix A

HDOH Application Forms

File/Application No.: NEW

S-1: Standard Air Pollution Control Permit Application Form

(Covered Source Permit and Noncovered Source Permit)

State of Hawaii
Department of Health
Environmental Management Division
Clean Air Branch
P.O. Box 3378 • Honolulu, HI 96801-3378 • Phone: (808) 586-4200

1. Company Name: Pu'ulou Energy LLC

2. Facility Name (if different from the Company): Pu'ulou Energy

3. Mailing Address: 1001 Bishop Street, ASB Building,Suite 950

   City: Honolulu State: HI Zip Code: 96813

   Phone Number: 708-710-5645

4. Name of Owner/Owner's Agent: Nicole Bulgarino

   Title: Executive Vice President Phone: 865-414-1341

   Mailing Address: 101 Constitution Avenue, N.W., Suite 525 East

   City: Washington State: DC Zip Code: 20001

5. Plant Site Manager/Other Contact: Bob Albertini

   Title: Senior Director Phone: 708-710-5645

   Mailing Address: 1001 Bishop Street, ASB Building, Suite 950

   City: Honolulu State: HI Zip Code: 96813

6. Permit Application Basis: (Check all applicable categories.)

   - [x] Initial Permit for a New Source
   - [ ] Initial Permit for an Existing Source
   - [ ] Renewal of Existing Permit
   - [ ] General Permit
   - [ ] Temporary Source
   - [ ] Transfer of Permit

☐ Modification to a Covered Source: ➔ Is Modification? ☐ Significant ☐ Minor ☐ Uncertain

☐ Modification to a Noncovered Source

7. If renewal or modification, include existing permit number: ______________________

8. Does the Proposed Source require a County Special Management Area Permit? ☐ Yes ☑ No

9. Type of Source (Check One): ☑ Covered Source ☐ Covered and PSD Source

   ☐ Noncovered Source ☐ Uncertain

10. Standard Industrial Classification Code (SICC), if known: 4911

11. Proposed Equipment/Plant Location (e.g. street address): 4535 Paul Hamilton Avenue

City: JBPHH State: HI Zip Code: _96_8_60_ _

UTM Coordinates (meters): East: _60_8_8_80_ _ North: 2369975

UTMZone: UTM Horizontal Datum: D Old Hawaiian 0 NAD-27 [ZI NAD-83

12. General Nature of Business: _E_le_ct_ri_c_ge_n_e_ra_ti_o_n_

13D.ate of Planned Commencement of Construction or Modification: ..;.ea._rl.:...:.y""t.;;.o.;.;.m.;.;..id""-2.;.;..0..;;;2;..;,.5_

14. Is ***any*** of the equipment to be leased to another individual or entity? D Yes 0 No

15. Type of Organization: 0 Corporation D Individual Owner D Partnership

D Government Agency (Government Facility Code: ______

0 Other: ______

Any applicant for a permit who fails to submit any relevant facts or who has submitted incorrect information in any permit application shall, upon becoming aware of such failure or incorrect submittal, promptly submit such supplementary facts or corrected information. In addition, an applicant shall provide additional information as necessary to address any requirements that become applicable to the source after the date it filed a complete application, but prior to the issuance of the noncovered source permit or release of a draft covered source permit. (HAR §11-60.1-64 & 11-60.1-84)

RESPONSIBLE OFFICIAL (as defined in HAR §11-60.1-1)

Name (Last): _B_ul_ga_r_in_o_ (First): _N_ic_o_le_ (MI): ______

Title: Executive Vice President Phone: 865-414-1341

Mailing Address: 101 Constitution Avenue. N.W.. Suite 525 East

City: Washington State: DC Zip Code: _2_00_0_1_ _

Certification by Responsible Official (pursuant to HAR §11-60.1-4)

I certify that I have knowledge of the facts herein set forth, that the same are true; accurate and complete to the best of my knowledge and belief, and that all information not identified by me as confidential in nature shall be treated by the Department of Health as public record. I further state that I will assume responsibility for the construction, modification, or operation of the source in accordance with the Hawaii Administrative Rules (HAR), Title 11, Chapter 60.1, Air Pollution Control, and any permit issued thereof.

NAME (Print/Type): Nicole Bulgarino

(Signature): Nicole Bulgarino Date: 1-20-20

FOR AGENCY USE ONLY:

File/Application No.: ____________________

Island: ________________________________

Date Received: ____________________ __

Submit the following documents as part of your application:

A. The ***Emissions Units Table***, filled in as completely as possible. Use separate sheets of paper as needed. General instructions include the following:

1. Identify each **emission point** with a unique number for this plant site, consistent with emission point identification used on the location drawing and previous permits; if known, provide the SICC number. Emission points shall be identified and described in sufficient detail to establish the basis for **fees** and applicability of requirement of HAR, Chapter 11-60.1. Examples of emission point names are: heater, vent, boiler, tank, baghouse, fugitive, etc. Abbreviations may be used.
   a. For each emission point use as many lines as necessary to list regulated and hazardous air pollutant data. For hazardous air pollutants, also list the Chemical Abstracts Service number (CAS#).
   b. Indicate the emission points that discharge together for any length of time.
   c. The **Equipment Date** is the date of equipment construction, reconstruction, or modification. Provide supporting documentation.

2. State the **maximum emission rates** in terms sufficient to establish compliance with the applicable requirements and standard reference test methods. Provide all supporting emission calculations and assumptions:
   a. Include all regulated and hazardous air pollutants and air pollutants for which the source is major, as defined in HAR §11-60.1-1. Examples of regulated pollutant names are: Carbon Monoxide (CO), Nitrogen Oxides (NO_X), Sulfur Dioxide (SO_2), Volatile Organic Compounds (VOC), particulate matter (PM), and particulate less than 10 microns (PM_{10}). Abbreviations may be used.
   b. Include fugitive emissions.
   c. **Pounds per hour (#/HR**) is the maximum potential emission rate expected by applicant.
   d. **Tons per year** is the annual maximum potential emissions expected by the applicant, taking into account the typical operating schedule.

3. Describe ***Stack Source Parameters***:
   a. **Stack Height** is the height above the ground.
   b. **Direction** refers to the exit direction of stack emissions: up, down or horizontal.
   c. **Flow Rate** is the actual, not the calculated, flow rate.

4. Provide any additional information, if applicable, as follows:
   a. If combinations of different fuels are used that cause any of the stack source parameters to differ, complete one row for each possible set of stack parameters and identify each fuel in the **Equipment Description**.
   b. For a rectangular stack, indicate the length and width.
   c. Provide any information on stack parameters or any stack height limitations developed pursuant to Section 123 of the Clean Air Act.

B. A **process flow diagram** identifying all equipment used in the process, including the following:
   1. Identify and describe each emission point.
   2. Identify the locations of safety valves, bypasses, and other such devices which when activated may release air pollutants to the atmosphere.

C. A **facility location map**, drawn to a reasonable scale and showing the following:
   1. The property involved and all structures on it. Identify property/fence lines plainly.
   2. Layout of the facility.
   3. Location and identification of the proposed emissions unit on the property.
   4. Location of the property and equipment with respect to streets and all adjacent property. Show the location of all structures within 100 meters of the applicant's emissions unit. Provide the building dimensions (height, length, and width) of all structures that have heights greater than 40% of the stack height of the emissions unit.

D. Provide a description of any proposed modifications or permit revisions. Include any justification or supporting information for the proposed modifications or permit revisions.

EMISSIONS UNITS

Review of applications and issuance of permits will be expedited by supplying all necessary information on this Table.

AIR POLLUTANT DATA: EMISSION POINTS			AIR POLLUTANT	AIR POLLUTANT EMISSION RATE		UTM COORDINATES OF EMISSION POINT			STACK SOURCE PARAMETERS					
STACK NO.	UNIT NO.	EQUIPMENT NAME/DESCRIPTION and SICC Code	REGULATED or HAZARDOUS AIR POLLUTANT NAME (CAS#)[3]	#/ HR.	TONS/ YEAR	ZONE	EAST (Mtrs)	NORTH (Mtrs)	HEIGHT ABOVE GROUND (mtrs)	DIRECT. (1)	DIA. (ft.)	VEL. (m/s)	FLOW RATE (m^3/s)	TEMP. (°C)
1	1	Wärtsilä 20V34DF RICE	NOx	50.4	21.7	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
1	1	Wärtsilä 20V34DF RICE	SO_2	0.12	0.18	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
1	1	Wärtsilä 20V34DF RICE	CO	7.9	6.1	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
1	1	Wärtsilä 20V34DF RICE	PM_{10}	7.3	7.1	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
1	1	Wärtsilä 20V34DF RICE	HC	4.7	6.3	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
2	2	Wärtsilä 20V34DF RICE	NOx	50.4	21.7	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
2	2	Wärtsilä 20V34DF RICE	SO_2	0.12	0.18	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
2	2	Wärtsilä 20V34DF RICE	CO	7.9	6.1	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
2	2	Wärtsilä 20V34DF RICE	TSP/PM_{10}/ $PM_{2.5}$	7.3	7.1	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
2	2	Wärtsilä 20V34DF RICE	HC	4.7	6.3	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
3	3	Wärtsilä 20V34DF RICE	NOx	50.4	21.7	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
3	3	Wärtsilä 20V34DF RICE	SO_2	0.12	0.18	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
3	3	Wärtsilä 20V34DF RICE	CO	7.9	6.1	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
3	3	Wärtsilä 20V34DF RICE	TSP/PM_{10}/ $PM_{2.5}$	7.3	7.1	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
3	3	Wärtsilä 20V34DF RICE	HC	4.7	6.3	4	608866.0	2361014.5	29.96	up	6.0	varies[2]	varies[2]	varies[2]
4	4	Wärtsilä 20V34DF RICE	NOx	50.4	21.7	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
4	4	Wärtsilä 20V34DF RICE	SO_2	0.12	0.18	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
4	4	Wärtsilä 20V34DF RICE	CO	7.9	6.1	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
4	4	Wärtsilä 20V34DF RICE	PM_{10}	7.3	7.1	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
4	4	Wärtsilä 20V34DF RICE	HC	4.7	6.3	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
5	5	Wärtsilä 20V34DF RICE	NOx	50.4	21.7	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
5	5	Wärtsilä 20V34DF RICE	SO_2	0.12	0.18	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
5	5	Wärtsilä 20V34DF RICE	CO	7.9	6.1	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
5	5	Wärtsilä 20V34DF RICE	TSP/PM_{10}/ $PM_{2.5}$	7.3	7.1	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
5	5	Wärtsilä 20V34DF RICE	HC	4.7	6.3	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
6	6	Wärtsilä 20V34DF RICE	NOx	50.4	21.7	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
6	6	Wärtsilä 20V34DF RICE	SO_2	0.12	0.18	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
6	6	Wärtsilä 20V34DF RICE	CO	7.9	6.1	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
6	6	Wärtsilä 20V34DF RICE	TSP/PM_{10}/ $PM_{2.5}$	7.3	7.1	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]

AIR POLLUTANT DATA: EMISSION POINTS			AIR POLLUTANT	AIR POLLUTANT EMISSION RATE		UTM COORDINATES OF EMISSION POINT			STACK SOURCE PARAMETERS					
STACK NO.	UNIT NO.	EQUIPMENT NAME/DESCRIPTION and SICC Code	REGULATED or HAZARDOUS AIR POLLUTANT NAME (CAS#)[3]	#/ HR.	TONS/ YEAR	ZONE	EAST (Mtrs)	NORTH (Mtrs)	HEIGHT ABOVE GROUND (mtrs)	DIRECT. (1)	DIA. (ft.)	VEL. (m/s)	FLOW RATE (m^3/s)	TEMP. (°C)
6	6	Wärtsilä 20V34DF RICE	HC	4.7	6.3	4	608864.4	2361011.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
7	7	Wärtsilä 20V34DF RICE	NOx	50.4	21.7	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
7	7	Wärtsilä 20V34DF RICE	SO_2	0.12	0.18	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
7	7	Wärtsilä 20V34DF RICE	CO	7.9	6.1	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
7	7	Wärtsilä 20V34DF RICE	PM_{10}	7.3	7.1	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
7	7	Wärtsilä 20V34DF RICE	HC	4.7	6.3	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
8	8	Wärtsilä 20V34DF RICE	NOx	50.4	21.7	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
8	8	Wärtsilä 20V34DF RICE	SO_2	0.12	0.18	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
8	8	Wärtsilä 20V34DF RICE	CO	7.9	6.1	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
8	8	Wärtsilä 20V34DF RICE	TSP/PM_{10}/ $PM_{2.5}$	7.3	7.1	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
8	8	Wärtsilä 20V34DF RICE	HC	4.7	6.3	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
9	9	Wärtsilä 20V34DF RICE	NOx	50.4	21.7	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
9	9	Wärtsilä 20V34DF RICE	SO_2	0.12	0.18	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
9	9	Wärtsilä 20V34DF RICE	CO	7.9	6.1	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
9	9	Wärtsilä 20V34DF RICE	TSP/PM_{10}/ $PM_{2.5}$	7.3	7.1	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
9	9	Wärtsilä 20V34DF RICE	HC	4.7	6.3	4	608819.8	2361042.7	29.96	up	6.0	varies[2]	varies[2]	varies[2]
10	10	Wärtsilä 20V34DF RICE	NOx	50.4	21.7	4	608818.2	2361039.9	29.96	up	6.0	varies[2]	varies[2]	varies[2]
10	10	Wärtsilä 20V34DF RICE	SO_2	0.12	0.18	4	608818.2	2361039.9	29.96	up	6.0	varies[2]	varies[2]	varies[2]
10	10	Wärtsilä 20V34DF RICE	CO	7.9	6.1	4	608818.2	2361039.9	29.96	up	6.0	varies[2]	varies[2]	varies[2]
10	10	Wärtsilä 20V34DF RICE	PM_{10}	7.3	7.1	4	608818.2	2361039.9	29.96	up	6.0	varies[2]	varies[2]	varies[2]
10	10	Wärtsilä 20V34DF RICE	HC	4.7	6.3	4	608818.2	2361039.9	29.96	up	6.0	varies[2]	varies[2]	varies[2]
11	11	Wärtsilä 20V34DF RICE	NOx	50.4	21.7	4	608818.2	2361039.9	29.96	up	6.0	varies[2]	varies[2]	varies[2]
11	11	Wärtsilä 20V34DF RICE	SO_2	0.12	0.18	4	608818.2	2361039.9	29.96	up	6.0	varies[2]	varies[2]	varies[2]
11	11	Wärtsilä 20V34DF RICE	CO	7.9	6.1	4	608818.2	2361039.9	29.96	up	6.0	varies[2]	varies[2]	varies[2]
11	11	Wärtsilä 20V34DF RICE	TSP/PM_{10}/ $PM_{2.5}$	7.3	7.1	4	608818.2	2361039.9	29.96	up	6.0	varies[2]	varies[2]	varies[2]
11	11	Wärtsilä 20V34DF RICE	HC	4.7	6.3	4	608818.2	2361039.9	29.96	up	6.0	varies[2]	varies[2]	varies[2]

Notes:
1. Exit direction of stack emissions: up, down, or horizontal.
2. Exhaust gas flow rate, velocity and temperature vary with fuel type and load. See Appendix C, Table 2-2.
3. Hazardous air pollutant emission rates shown in Appendix B, Tables B-10, B-11 and B-12.

File No.: NEW

S-2: Application for an Initial Covered Source Permit

In providing the required information, reference the corresponding letters and numbers listed below.
Provide a minimum of two (2) sets (1 original and 1 copy) of all application materials to the Hawaii Department of Health. Also, mail one (1) set directly to EPA at the following address:

Chief (Attention: AIR-3) Permits Office, Air Division
U.S. Environmental Protection Agency Region 9
75 Hawthorne Street
San Francisco, CA 94105

I. In accordance with Hawaii Administrative Rules (HAR) §11-60.1-83, the following information is required:

A. Equipment Specifications:
1. Maximum design capacity.
2. Fuel type.
3. Fuel use.
4. Production capacity.
5. Production rates.
6. Raw materials.
7. Provide any manufacturer's literature.

Please see Section 4.1, Table 4, and Appendix E of the application support document.

B. Provide detailed descriptions of all processes and products defined by Standard Industrial Classification Code (SICC). Also, provide any reasonably anticipated alternative operating scenarios, associated processes, and products, by SICC.
1. Identify and describe in detail all air pollution control equipment and compliance monitoring devices or activities planned by the owner or operator, and to the extent of available information, an estimate of emissions before and after controls. Provide all calculations and assumptions.
2. List all ***insignificant*** activities in accordance with HAR §11-60.1-82.

Please see Section 4 of the application support document.

C. Maximum Operating Schedule (to the extent needed to determine or regulate emissions):
   1. Total hours per day, per week, and/or per month.
   2. Total hours per year.
   3. If operation is seasonal or irregular, describe.

   Please see Section 4.4 of the application support document.

D. Cite and describe all ***applicable requirements*** as defined in HAR §11-60.1-81, including the following:
   1. Description of or reference to any applicable test methods for determining compliance with each applicable requirement.
   2. Explanation of all proposed exemptions from any applicable requirements.

   Please see Section 4.9 of the application support document.

E. Identify and describe current operational limitations or work practices, or for covered sources that have not yet begun operation, such limitations or practices which the owner or operator of the source plans to implement that affect emissions of any regulated or hazardous air pollutant. Provide all calculations and assumptions.

   Please see Section 4 of the application support document.

F. Provide a detailed schedule for construction or modification of the proposed source, including any major milestones, if applicable.

   Please see Section 2 of the application support document.

G. For ***new*** covered sources and ***significant*** modifications which increase the emissions of any air pollutant or result in the emission of any air pollutant not previously emitted, an assessment of the ambient air quality impact of the covered source or significant modification, with the inclusion of any available background air quality data. The assessment shall include all supporting data, calculations and assumptions, and a comparison with the NAAQS and SAAQS.

   Please see Section 4.9 and Appendix C of the application support document.

H. For ***new*** covered sources and ***significant*** modifications subject to the requirements of subchapter 7 of HAR Chapter 11-60.1, all analyses, assessments, monitoring, and other application requirements of subchapter 7.

   Not applicable.

I. Provide detailed information to define permit terms and conditions for any proposed ***emissions trading*** within the facility in accordance with HAR §11-60.1-96.

   Not applicable.

J. Provide the following for compliance purposes:
   1. A Compliance Plan, Form C-1.
   2. A Compliance Certification, Form C-2.

   Please see Appendix A to the application support document.

II. Submit an application fee according to the Application Fee Schedule in the Instructions for Applying for an Air Pollution Control Permit.

The required application fee is included with this application.

III. Provide other information as follows:

A. As required by any applicable requirement or as requested and deemed necessary by the Director of Health (hereafter, Director) to make a decision on the application.

B. As may be necessary to implement and enforce other applicable requirements of the Clean Air Act or of HAR Chapter 11-60.1 or to determine the applicability of such requirements.

Additional necessary information will be provided as requested.

IV. The Director reserves the right to request the following information:

A. An assessment of the ambient air quality impact of the source or modification. The assessment shall include all supporting data, calculations and assumptions, and a comparison with the National Ambient Air Quality Standards and State Ambient Air Quality Standards.

B. A risk assessment of the air quality related impacts caused by the covered source or significant modification to the surrounding environment.

C. Results of source emissions testing, ambient air quality monitoring, or both.

D. Information on other available control technologies.

Additional necessary information will be provided as requested.

V. An application shall be determined to be complete only when all of the following have been complied with:

A. All information required or requested in numbers **I, III, and IV** has been submitted.

B. All documents requiring certification have been certified pursuant to HAR §11-60.1-4.

C. All applicable fees have been submitted.

D. The Director has certified that the application is complete.

VI. The Director shall not continue to act upon or consider an incomplete application.

A. The applicant shall be notified in writing whether the application is complete:
   1. For the requirements of subchapter 7, thirty days after receipt of the application.
   2. For the requirements of HAR subchapter 5, sixty days after receipt of the application. For purposes of this paragraph, the date of receipt of an application for a new covered source or significant modification subject to the requirements of subchapter 7 shall be the date the application is determined to be complete for the requirements of subchapter 7.
   3. Unless the Director requests additional information or notifies the applicant of incompleteness within sixty days after receipt of an application pursuant to VI.A.2 above, the application shall be deemed complete for the requirements of subchapter 5.

B. During the processing of an application that has been determined or deemed complete, if additional information is necessary to evaluate or take final action on the application, the Director may request such information in writing and set a reasonable deadline for a response.

VII. After receipt of a complete application, the Director, in writing, shall approve, conditionally approve, or deny an application within eighteen months, except as provided in HAR §11-60.1-88 and (A) and (B) below.

A. Upon program approval, within nine months for an application containing an early reduction demonstration pursuant to section 112(i)(5) of the Clean Air Act.

B. Within twelve months for a new covered source or significant modification subject to the requirements of subchapter 7.

VIII. A Covered Source Permit application for a new covered source or a significant modification shall be approved only if the Director determines that the construction or operation of the new covered source or significant modification will be in compliance with all applicable requirements.

IX. The Director shall provide for public notice, including the method by which a public hearing can be requested, and an opportunity for public comment on the draft Covered Source Permit in accordance with HAR §11-60.1-99.

X. The Director shall provide a statement that sets forth the legal and factual bases for the draft permit conditions (including references to the applicable statutory or regulatory provisions) to EPA and any other person requesting it.

XI. Each application and proposed Covered Source Permit shall be subject to EPA oversight in accordance with HAR §11-60.1-95.

File No.: __NEW__

C-1: Compliance Plan

The Responsible Official shall submit a Compliance Plan as indicated in the Instructions for Applying for an Air Pollution Control Permit and at such other times as requested by the Director of Health (hereafter, Director).

Use separate sheets of paper if necessary.

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1. Compliance status with respect to all Applicable Requirements:

   Will your facility be in compliance, or is your facility in compliance, with all applicable requirements in effect at the time of your permit application submittal?

   ☑ YES {If YES, complete items a and c below}

   ☐ NO {If NO, complete items a, b, and c below}

   a. Identify all applicable requirement(s) for which compliance is achieved.

      Please see attached list.

      Provide a statement that the source is in compliance and will continue to comply with all such requirements.

      The source will be in compliance and will continue to comply with all applicable requirements.

   b. Identify all applicable requirement(s) for which compliance is NOT achieved.

      None known.

      Provide a detailed Schedule of Compliance Schedule and a description of how the source will achieve compliance with all such applicable requirements.

Description of Remedial Action	Expected Date of Completion

c. Identify any other applicable requirement(s) with a future compliance date that your source is subject to. These applicable requirements may take effect AFTER permit issuance:

Applicable Requirement	Effective Date	Currently in Compliance?
None known.		

If the source is not currently in compliance, provide a Schedule of Compliance and a description of how the source will achieve compliance with all such applicable requirements:

Description of Proposed Action/Steps to Achieve Compliance	Expected Date of Achieving Compliance

Provide a statement that the source on a timely basis will meet all these applicable requirements:

____

____

____

____

____

If the expected date of achieving compliance will NOT meet the applicable requirement's effective date, provide a more detailed description of each remedial action and the expected date of completion:

Description of Remedial Action and Explanation	Expected Date of Completion

2. Compliance Progress Reports:

a. If a compliance plan is being submitted to remedy a violation, complete the following information:

Frequency of Submittal: ______________________ Beginning Date: ________________
(less than or equal to 6 months)

b. Date(s) that the Action described in (1)(b) was achieved:

Remedial Action	Date Achieved

c. Narrative description of why any date(s) in (1)(b) was not met, and any preventive or corrective measures taken in the interim:

____

____

____

RESPONSIBLE OFFICIAL (as defined in HAR §11-60.1-1)

Name (Last): _s_ulg_ar_in_o__________ (First): _N_ic_o_le__________ (MI): _______

Title: Executive Vice President Phone: 865-414-1341

Mailing Address: 101 Constitution Avenue. N.W.. Suite 525 East

City: Washington State: -o_c__________ Zip Code: _2_0_00_1__________

Certification by Responsible Official (pursuant to HAR §11-60.1-4)

I certify that I have knowledge of the facts herein set forth, that the same are true, accurate and complete to the best of my knowledge and belief, and that all information not identified by me as confidential in nature shall be treated by the Department of Health as public record. I further state that I will assume responsibility for the construction, modification, or operation of the source in accordance with the Hawaii Administrative Rules, Title 11, Chapter 60.1, Air Pollution Control, and any permit issued thereof.

Name (Print/Type): Nicole Bulgarino

(Signature): ______________ Date: 3-20-23

Facility Name: _P_u_'u_lo_u_E_ne_rg;.;.y______________

Location: 4535 Paul Hamilton Ave. JBPHH. HI

Permit Number: ______________________

FOR AGENCY USE ONLY

File/Application No.: __________

Island: __________

Date Received: __________

File No.: NEW

C-2: Compliance Certification

The Responsible Official shall submit a Compliance Certification as indicated in the Instructions for Applying for an Air Pollution Control Permit and at such other times as requested by the Director of Health (hereafter, Director).

Complete as many copies of this form as needed. Use separate sheets of paper if necessary.

RESPONSIBLE OFFICIAL (as defined in HAR §11-60.1-1)

Name (Last): _B_u_lg""a_r_in_o___ (First): _N_ic_o_le___ (MI): ______

Title: Executive Vice President   Phone: 865-414-1341

Mailing Address: 101 Constitution Avenue N.W. Suite 525 East

City: WashinQton   State: DC______   Zip Code: ""2.0..0._0_1 _

Certification by Responsible Official (pursuant to HAR §11-60.1-4)

I certify that I have knowledge of the facts herein set forth, that the same are true, accurate and complete to the best of my knowledge and belief, and that all information not identified by me as confidential in nature shall be treated by the Department of Health as public record. I further state that I will assume responsibility for the construction, modification, or operation of the source in accordance with the Hawaii Administrative Rules, Title 11, Chapter 60.1, Air Pollution Control, and any permit issued thereof.

Name (Print/Type): Nicole Bulgarino

(Signature): [signature]   Date: 3-20-23

Facility Name: P u 'u lo u E n e .r.9..Y...

Location: 4535 Paul Hamilton Ave, JBPHH, HI

Permit Number: ______

FOR AGENCY USE ONLY

File/Application No.: ______________

Island: ________________________

Date Received: _________________

Complete the following information for ***each*** applicable requirement that applies to ***each*** emissions unit at the source. Also include any additional information as required by the Director. The compliance certification may reference information contained in a previous compliance certification submittal to the Director, provided such referenced information is certified as being current and still applicable.

1. Schedule for submission of Compliance Certifications during the term of the permit:

   Frequency of Submittal: annually   Beginning Date: tbd

2. Emissions Unit No./Description: Eleven (11) Wartsila 20V34DF reciprocating IC engine generators

3. Identify the applicable requirement(s) that is/are the basis of this certification:

   Please see attached list.

4. Compliance status:

   a. Will the emissions unit be in compliance with the identified applicable requirement(s)?

      ☑ YES   ☐ NO

   b. If YES, will compliance be continuous or intermittent?

      ☑ Continuous   ☐ Intermittent

   c. If NO, explain:

5. Describe the methods to be used in determining compliance of the emissions unit with the applicable requirement(s), including any monitoring, recordkeeping, reporting requirements, and/or test methods:

Please see attached list.

Provide a detailed description of the methods used to determine compliance (e.g. monitoring device type and location, test method description, or parameter being recorded, frequency of recordkeeping, etc.):

Please see attached list.

6. Statement of Compliance with Enhanced Monitoring and Compliance Certification Requirements.

a. Will the emissions unit identified in this application be in compliance with applicable enhanced monitoring and compliance certification requirements?

☑ YES ☐ NO

b. If YES, identify the requirements and the provisions being taken to achieve compliance:

Please see attached list.

c. If NO, describe below which requirements will not be met:

Attachment to Forms C-1 and C-2
Applicable Requirements and Determination of Compliance

Applicable Requirement	Method(s) to be Used in Determining Compliance	Description of Method(s) to be Used
40 CFR 60 Subparts IIII and JJJJ	Monitoring, recordkeeping, reporting, periodic testing	CEMS for NOx and CO; periodic emissions testing for VOC and PM; fuel sulfur sampling

Table B-1
Typical Project Operating Scenarios and Emissions Summaries

Operations Summary						
	Case 1: RNG only		**Case 2: startup on RNG, switch to biodiesel**		**Case 3: biodiesel only**	
No. of units on Biodiesel (baseload)	0		11		11	
No. of units on RNG (baseload)	11		0		0	
No. of units	11		11		11	
MW gross	103.1		103.1		103.1	
MWh gross	862,138		388,119		297,829	
Operating hours per startup	22.0		9.4		7.0	
Total op. hrs (including starts)/year	8395		3796		2920	
RNG req'd for startups, MMft3/yr	137.8		137.8		0.0	
Annual Capacity Factor	95%		43%		33%	
Annual Fuel Consumption, MMBtu (HHV)	0	biodiesel	3,133,716	biodiesel	2,532,296	biodiesel
	7,194,930	RNG	156,412	RNG	0	RNG

Operating Scenarios									
	Case 1: RNG only			**Case 2: startup on RNG, switch to biodiesel**			**Case 3: biodiesel only**		
	Base Load			Base Load			Base Load		
Equipment	max. hour	hrs/day	hrs/yr	max. hour	hrs/day	hrs/yr	max. hour	hrs/day	hrs/yr
Total baseload hours per engine			8030			3431			2555
Total startup hours per engine			365			365			365
Biodiesel, baseload hours per engine	0	0	0	0	23	3431	0	23	2555
Biodiesel, cold startups per engine	0	0	0	0	0	0	1	0	52
Biodiesel, warm startups per engine	0	0	0	0	0	0	0	1	313
Biodiesel, hot startups per engine	0	0	0	0	0	0	0	0	0
RNG, baseload hours per engine	0	23	8030	0	0	0	0	0	0
RNG, cold startups per engine	1	0	52	0	0	0	0	0	0
RNG, warm startups per engine	0	1	313	0	0	0	0	0	0
RNG, hot startups per engine	0	0	0	0	0	0	0	0	0
RNG, cold startup/switch to biodiesel	0	0	0	1	0	52	0	0	0
RNG, warm startup/switch to biodiesel	0	0	0	0	1	313	0	0	0

Table B-1
Typical Project Operating Scenarios and Emissions Summaries

Emissions Summaries						
Case 1: RNG only						
	Emissions, tpy					
	NOx	SO2	CO	VOC	PM10	CO2e
Emissions Total, 11 Engines	98.3	2.9	131.5	116.4	94.8	421,256
Black Start Generator	3.3	0.003	0.2	0.02	0.01	303
Fire Pump Engine	0.5	0.001	0.3	0.03	0.02	123
Project Total	102.1	2.9	132.0	116.5	94.8	421,682
PSD Threshold	250	250	250	250	250	n/a

Case 2: startup on RNG, switch to biodiesel						
	Emissions, tpy					
	NOx	SO2	CO	VOC	PM10	CO2e
Emissions Total, 11 Engines	239.6	2.5	93.3	89.6	94.0	265,517
Black Start Generator	3.3	0.003	0.2	0.02	0.01	302.6
Fire Pump Engine	0.5	0.001	0.3	0.03	0.02	123.1
Project Total	243.4	2.5	93.7	89.6	94.1	265,942
PSD Threshold	250	250	250	250	250	n/a

Case 3: biodiesel only						
	Emissions, tpy					
	NOx	SO2	CO	VOC	PM10	CO2e
Emissions Total, 11 Engines	238.4	1.9	67.4	69.6	78.2	207,159
Black Start Generator	3.3	0.003	0.2	0.02	0.01	302.6
Fire Pump Engine	0.5	0.001	0.3	0.03	0.02	123.1
Project Total	242.1	1.9	67.9	69.7	78.3	207,584
PSD Threshold	250	250	250	250	250	n/a

Table B-2
Example Operating Scenarios

Example Operating Scenarios									
Scenario	**No. of Units**	**Starts per year per unit**	**Fuel for Startups**	**Total Baseload Hrs/Yr/Unit**	**Fuel for Baseload Operation**	**Annual NOx (tons/year)**	**Annual Capacity Factor**	**Annual Fuel Consumption, MMBtu**	**Description**
Case 1	11	0	Biodiesel	0	Diesel	102.1	95%	0	Operating hours on RNG only
	11	365	RNG	8030	NG			7,194,930	
Case 2	11	0	Biodiesel	3431	Diesel	243.4	43%	3,133,716	Startup on RNG, operation on biodiesel
	11	365	RNG	0	NG			156,412	
Case 3	11	365	Biodiesel	2555	Diesel	242.1	33%	2,532,296	Operating hours on biodiesel only
	11	0	RNG	0	NG			0	

Notes:

1. Emissions and fuel consumption for startups calculated on a 1-hour basis: 30 minutes for the startup plus 30 minutes at baseload.
2. Capacity factor calculated based on the assumption that a startup hour includes the equivalent of 55 minutes of baseload operation.
3. Case 1: 100% operation on gaseous fuel with pilot injection; 365 30-minute startups on gaseous fuel for each engine, with the remaining operations at 100% load on gaseous fuel. Assume one start per day, seven days per week (one cold and 6 warm starts per week).
4. Case 2: 365 30-minute startups on gaseous fuel for each engine, with the remaining operations at 100% load on liquid fuel. Assume one start per day, seven days per week (one cold and 6 warm starts per week).
5. Case 3: 100% operation on liquid fuel; 365 30-minute startups on liquid fuel for each engine, with the remaining operations at 100% load on liquid fuel. Assume one start per day, seven days per week (one cold and 6 warm starts per week)

Table B-3
Emissions Data Provided by Wartsila

Flue gas emissions on liquid fuel operation after emission control system

Stable load as 1 hour average values (Using TYPICAL values)

Pollutant		Engine Load		Units
		100%	50%	
NO_x	as NO_2	35	40	ppm-v, 15 vol-% O_2, dry
CO		20	20	ppm-v, 15 vol-% O_2, dry
VOC (NMNEHC)	as CH_4	40	40	ppm-v, 15 vol-% O_2, dry
$PM_{10}/PM_{2.5}$ (total)		30	40	mg/Nm^{3*}, 15 vol-% O_2
NH_3		10	10	ppm-v, 15 vol-% O_2, dry

Engine performance on liquid fuels

Parameter	Engine Load		Units
	100%	50%	
Engine output	9,370	4685	kWe, gross
Plant output	103,066	51,533	kWe, gross
Heat rate, gross	7893	8228	Btu/kWh, LHV
Fuel consumption	4028	2099	lb/hr
	78.84	41.09	MMBtu/hr, HHV (calculated)
Fuel heat content	18,362	18,362	Btu/lb, LHV
Fuel sulfur content	15	15	ppm-w
	11	11	Number of Units

Table B-3
Emissions Data Provided by Wartsila

Flue gas emissions on gaseous fuel operation after emission control system

Stable load as 1 hour average values (Using TYPICAL values)

Pollutant		Engine Load 100%	Engine Load 50%	Units
NO_x	as NO_2	6	9	ppm-v, 15 vol-% O_2, dry
CO		15	15	ppm-v, 15 vol-% O_2, dry
VOC (NMNEHC)	as CH_4	26	37	ppm-v, 15 vol-% O_2, dry
$PM_{10}/PM_{2.5}$ (total)		15	20	mg/Nm3*, 15 vol-% O_2
NH_3		10	10	ppm-v, 15 vol-% O_2, dry

Engine performance on gaseous fuels

Parameter	Engine Load 100%	Engine Load 50%	Units
Engine output	9,370	4685	kWe, gross
Plant output	103,066	51,533	kWe, gross
Heat rate, gross	7502	8668	Btu/kWh, LHV
Fuel consumption	68,646.2	39,657.8	ft3/hr
	77.91	45.01	MMBtu/hr, HHV (calculated)
	70.29	40.61	MMBtu/hr, LHV (Wärtsilä spec)
Fuel heat content	1,024	1,024	Btu/ft3, LHV (Wärtsilä specification)
Fuel sulfur content	5	5	ppm-w
	11	11	Number of Units

Wärtsilä Exhibit B1 Performance Figures PQ2020-01888A3R - 11 x 20V34DF
Dated 9/21/2021

* Nm3 is defined at 32°F and 101.325 kPa (abs.)

Table B-4

Emission Rate Calculations - Biodiesel

Parameter	Variable	Units	Wärtsilä 20V34DF		Data Source
			100% Load Value	50% Load Value	
Performance Data					
Mechanical Output	MO	kW_m	9,370	4,685	
	--	HP	12,556	6,278	Converted from KW_m
Generation	G	kW_e	103,066	51,533	
Heat Rate (LHV)	HR_{LHV}	Btu/kW_e-hr	7,893	8,228	
Heat Input (LHV)	HI_{LHV}	MMBtu/hr	813.5	424.0	HR_{LHV}*G/10^6
Heat Input (HHV)	HI_{HHV}	MMBtu/hr	78.8	40.5	LHV*$FF_{lb/hr}$*1.05/10^6
Fuel Heat Content (LHV)	LHV	Btu/lb	18,362	18,362	
Fuel Flow	$FF_{lb/hr}$	lb/hr	4,028	2,099	
Exhaust Data					
Exhaust Temp	--	°F	608.0	608.0	Converted from °C
	T_{stack}	°R	1,068.0	1,068.0	Converted from °F
	--	°C	320	320	Wärtsilä specs
	$T_{stack\text{-}K}$	K	593.15	593.15	Converted from °C
Universal Gas Constant	R	psia-ft^3/lbmol-R	10.73	10.73	http://en.wikipedia.org/wiki/Gas_constant
Standard Pressure	P_{std}	psia	14.696	14.696	40 CFR Part 60, Appendix A, Method 5
Standard Temperature	T_{std}	K	293.2	293.2	40 CFR Part 60, Appendix A, Method 5
Exhaust Volumetric Flow (actual)	Q_{m3s}	m^3/s	30.2	16.3	Converted from Nm3/min
	--	acfh	3,839,711	2,078,584	Converted from m^3/s
	Q_{acfm}	acfm	63,995	34,643	Converted from acfm
Exhaust H_2O Content	$\%H_2O$	% by Vol	6.1%	5.7%	Wärtsilä specs
Exhaust O_2 Content	$\%O_2$	% by Vol	11.55%	11.98%	Calculatedfrom O2 dry and %H2O
Exhaust CO_2 Content	$\%CO_2$	% by Vol	5.78%	5.3%	Wärtsilä specs
Dry Exhaust Volumetric Flow	Q_{dry}	dcf/min	60,091	32,668	Q_{acfm}*(1-%H_2O)
$\%O_2$ Dry Basis	$\%O_{2\text{-}Dry}$	%	12.3%	12.7%	Wärtsilä spec
$\%CO_2$ Dry Basis	$\%CO_{2\text{-}Dry}$	%	6.16%	5.64%	%CO_2/(1-%H_2O)
Dry Exhaust Volumetric Flow (Std)	$Q_{dry\text{-}std}$	dscf/min	29,704	16,148	Q_{dry}*(T_{std}/$T_{stack\text{-}K}$)
Dry Exhaust Volumetric Flow (32 °F)	$Q_{dry\text{-}32F}$	Nm^3/min	13.06	7.10	Q_{dry}*(273.15/$T_{stack\text{-}K}$)*$.3048^3$
Emission Rates					
Max Sulfur	FS_{ppm}	ppm	15	15	
SO_2 Emission Rates	--	g/s	1.521E-02	7.930E-03	Converted from lb/hr
	M_{SO2}	lb/hr	0.121	0.063	$FF_{lb/hr}$*(FS_{ppm}/10^6)*(MW_{SO2}/MW) (Mass Balance - 100% conversion of fuel S)
SO_2 Emission Factors	--	lb/MMBtu	0.00153	0.00155	M_{SO2}/HI_{HHV}
SO_2 Molecular Weight	MW_{SO2}	lb/lbmol	64.1	64.1	http://www.webelements.com/
S Molecular Weight	MW_S	lb/lbmol	32.1	32.1	http://www.webelements.com/
	Q_{SO2}	ft^3/min	0.0245	0.0128	Calculated using Ideal Gas Law [((M_{SO2}/MW_{SO2})*R*T_{stack})/(P_{std}*60)]
	$C_{d\text{-}SO2}$	ppmvd	0.41	0.39	(Q_{SO2}/Q_{dry})*10^6
	--	ppmvd @ 15% O_2	0.28	0.28	$C_{d\text{-}SO2}$*((20.9-15)/(20.9-%$O_{2\text{-}Dry}$*100))
PM_{10}/$PM_{2.5}$ Stack Conc.	$C_{d15\text{-}PM10}$	mg/Nm^3 @ 15% O_2	30	40	Supplied by Wärtsilä
	$C_{d\text{-}PM10}$	mg/Nm^3	43.7	55.6	$C_{d15\text{-}PM10}$*((20.9-%$O_{2\text{-}dry}$*100)/(20.9-15))
PM_{10}/$PM_{2.5}$ Emission Rates	$M_{PM\text{-}g/s}$	g/s	9.500E-03	6.600E-03	$C_{d\text{-}PM10}$/1000*$Q_{dry\text{-}32F}$/60
	$M_{PM10\text{-}lb/hr}$	lb/hr	4.53	3.13	Supplied by Wärtsilä
PM_{10}/$PM_{2.5}$ Emission Factors	--	lb/MMBtu	0.0575	0.0773	$M_{PM10\text{-}lb/hr}$/HI_{HHV}
	--	g/kW_m-hr	0.004	0.005	$M_{pm10\text{-}g/s}$ * 3600/MO
	--	g/kW_e-hr	0	0	$M_{pm10\text{-}g/s}$ * 3600/G
NO_X as NO_2 Stack Conc.	$C_{d15\text{-}NOX}$	ppmvd @ 15% O_2	35	40	Supplied by Wärtsilä
	$C_{d\text{-}NOX}$	ppmvd	51.0	55.6	$C_{d15\text{-}NOX}$*((20.9-%$O_{2\text{-}dry}$*100)/(20.9-15))
NO_2 Molecular Weight	MW_{NO2}	lb/lbmol	46.0	46.0	http://www.webelements.com/
NO_X as NO_2 Emission Rates	$M_{NOX\text{-}lb/hr}$	lb/hr	10.86	6.43	Supplied by Wärtsilä
	$M_{NOX\text{-}g/s}$	g/s	1.368	0.810	Calculated from lb/hr
NO_X as NO_2 Emission Factors	--	lb/MMBtu	0.138	0.159	$M_{NOX\text{-}lb/hr}$/HI_{HHV}
	--	g/kW_m-hr	0.526	0.622	$M_{NOX\text{-}g/s}$ * 3600/MO
	--	g/kW_e-hr	0.048	0.057	$M_{NOX\text{-}g/s}$ * 3600/G
Emission Rates (Continued)					
CO Stack Conc.	$C_{d15\text{-}CO}$	ppmvd @ 15% O_2	20	20	Supplied by Wärtsilä
	$C_{d\text{-}CO}$	ppmvd	29.2	27.8	$C_{d15\text{-}CO}$*((20.9-%$O_{2\text{-}dry}$*100)/(20.9-15))
CO Molecular Weight	MW_{CO}	lb/lbmol	28.0	28.0	http://www.webelements.com/
CO Emission Rates	$M_{CO\text{-}lb/hr}$	lb/hr	3.78	1.96	Supplied by Wärtsilä
	$M_{CO\text{-}g/s}$	g/s	4.763E-01	2.470E-01	Calculated from lb/hr
CO Emission Factors	--	lb/MMBtu	0.0479	0.0484	$M_{CO\text{-}lb/hr}$/HI_{HHV}
	--	g/kW_m-hr	0.183	0.19	$M_{CO\text{-}g/s}$ * 3600/MO
	--	g/kW_e-hr	0.017	0.017	$M_{CO\text{-}g/s}$ * 3600/G
VOC (as CH_4) Stack Conc.	$C_{d15\text{-}VOC}$	ppmvd @ 15% O_2	40	40	Supplied by Wärtsilä
	$C_{d\text{-}VOC}$	ppmvd	58.3	55.6	$C_{d15\text{-}VOC}$*((20.9-%$O_{2\text{-}dry}$*100)/(20.9-15))
VOC (as CH_4) Molecular Weight	MW_{CH4}	lb/lbmol	16.0	16.0	http://www.webelements.com/
VOC (as CH_4) Emission Rates	$M_{VOC\text{-}lb/hr}$	lb/hr	4.33	2.24	Supplied by Wärtsilä
	$M_{VOC\text{-}g/s}$	g/s	5.456E-01	2.822E-01	Calculated from lb/hr
VOC (as CH_4) Emission Factors	--	lb/MMBtu	0.0549	0.0553	$M_{VOC\text{-}lb/hr}$/HI_{HHV}
	--	g/kW_m-hr	0.21	0.217	$M_{VOC\text{-}g/s}$ * 3600/MO
	--	g/kW_e-hr	0.019	0.02	$M_{VOC\text{-}g/s}$ * 3600/G
NH_3 Slip	$C_{d15\text{-}NH3}$	ppmvd @ 15% O_2	10	10	Supplied by Wärtsilä
	$C_{d\text{-}NH3}$	ppmvd	14.6	13.9	$C_{d15\text{-}NH3}$*((20.9-%$O_{2\text{-}Dry}$*100)/(20.9-15))
NH_3 Molecular Weight	MW_{NH3}	lb/lbmol	17.0	17.0	http://www.webelements.com/
NH_3 Emission Rate	$M_{NH3\text{-}lb/hr}$	lb/hr	1.15	0.60	Supplied by Wärtsilä
	$M_{NH3\text{-}g/s}$	g/s	1.449E-01	7.560E-02	Converted from lb/hr
Formaldehyde	$C_{d15\text{-}HCOH}$	ppbvd @ 15% O_2	580	580	RICE NESHAP limit for major source
	$C_{d\text{-}HCOH}$	ppmvd	0.845	0.806	$C_{d15\text{-}HCOH}$*((20.9-%$O_{2\text{-}Dry}$*100)/(20.9-15))
	MW_{HCOH}	lb/lbmol	30.03	30.03	http://www.webelements.com/
	$M_{HCOH\text{-}lb/hr}$	lb/hr	0.117	0.06	(($C_{d\text{-}HCOH}$*(1-%H_2O))*Q_{acfm}/10^6)*P_{std}*MW_{HCOH} /(R*T_{stack})*60
	$M_{HCOH\text{-}g/s}$	g/s	1.480E-02	7.600E-03	Converted from lb/hr
	EF_{HCOH}	lb/MMBtu	0.001489	0.0015	$M_{HCOH\text{-}lb/hr}$/HI_{HHV}

All emissions data from "Indicative emissions US projects 20V34DF-B/C2; Doc.ID: DBAD556770"

Dated 12/18/2020; rec'd 08/05/2021; updated 02/04/2022

Table B-5
Emission Rate Calculations: RNG*

Parameter	Variable	Units	Wärtsilä 20V34DF 100% Load Value	Wärtsilä 20V34DF 50% Load Value	Data Source
Performance Data					
Mechanical Output	MO	kW_m	9,370	4,685	Wärtsilä data
	--	HP	12,556	6,278	Converted from KW_m
Generation	G	kW_e	103,066	51,533	
Heat Rate (LHV)	HR_{LHV}	Btu/kW_e-hr	7,502	8,668	Wärtsilä data
Heat Input (LHV)	HI_{LHV}	MMBtu/hr	70.3	40.6	LHV=HHV/1.1084
Heat Input (HHV)	HI_{HHV}	MMBtu/hr	77.9	45.0	Wärtsilä data
Fuel Heat Content (LHV)	LHV	Btu/ft3	1,024	1,024	Wärtsilä data
Fuel Flow	$FF_{lb/hr}$	ft3/hr	68,646	39,658	Calculated
Fuel Density	$F_{density}$	lb/ft^3	0.0447	0.0447	Density of CH_4 at 0 °C and 1 atm
Exhaust Data					
Exhaust Temp	--	°F	708.8	753.8	Converted from °C
	T_{stack}	°R	1,168.8	1,213.8	Converted from °F
	--	°C	376	401	Wärtsilä data
	$T_{stack-K}$	K	649.15	674.15	Converted from °C
Universal Gas Constant	R	psia-ft^3/lbmol-R	10.73	10.73	http://en.wikipedia.org/wiki/Gas_constant
Standard Pressure	P_{std}	psia	14.696	14.696	40 CFR Part 60, Appendix A, Method 5
Standard Temperature	T_{std}	K	293.2	293.2	40 CFR Part 60, Appendix A, Method 5
Exhaust Volumetric Flow (actual)	Q_{m3s}	m^3/s	27.9	19.8	Calculated from Qdry-32F, Tstack and %H2O
	--	acfh	3,545,189	2,512,930	Converted from m^3/s
	Q_{acfm}	acfm	59,086	41,882	Converted from acfm
Exhaust H_2O Content	$\%H_2O$	% by Vol	10.6%	9.1%	Wärtsilä specs
Exhaust O_2 Content	$\%O_2$	% by Vol			
Exhaust CO_2 Content	$\%CO_2$	% by Vol	5.0%	4.2%	Wärtsilä specs
Dry Exhaust Volumetric Flow	Q_{dry}	dcf/min	52,823	38,071	$Q_{acfm}*(1-\%H_2O)$
$\%O_2$ Dry Basis	$\%O_{2-Dry}$	%	11.4%	13.1%	Wärtsilä spec
$\%CO_2$ Dry Basis	$\%CO_{2-Dry}$	%	5.59%	4.62%	$\%CO_2/(1-\%H_2O)$
Dry Exhaust Volumetric Flow (Std)	$Q_{dry-std}$	dscf/min	23,859	16,558	$Q_{dry}*(T_{std}/T_{stack-K})$
Dry Exhaust Volumetric Flow (32 °F)	$Q_{dry-32F}$	Nm^3/min	10.49	7.28	$Q_{dry}*(273.15/T_{stack-K})*.3048^3$
Emission Rates					
Max Sulfur	FS_{ppm}	ppm	5	5	Wärtsilä max. fuel sulfur content spec
	FS	gr/100 SCF	0.318	0.318	converted from ppmv
SO_2 Emission Rates	--	g/s	7.860E-03	4.540E-03	Converted from lb/hr
	M_{SO2}	lb/hr	0.062	0.036	Calculated using mass balance (100% conversion of fuel S)
SO_2 Emission Factors	--	lb/MMBtu	0.00080	0.00080	M_{SO2}/HI_{HHV}
SO_2 Molecular Weight	MW_{SO2}	lb/lbmol	64.1	64.1	http://www.webelements.com/
S Molecular Weight	MW_S	lb/lbmol	32.1	32.1	http://www.webelements.com/
	Q_{SO2}	ft^3/min	0.0139	0.0083	Calculated using Ideal Gas Law $[((M_{SO2}/MW_{SO2})*R*T_{stack})/(P_{std}*60)]$
	C_{d-SO2}	ppmvd	0.26	0.22	$(Q_{SO2}/Q_{dry})*10^6$
	--	ppmvd @ 15% O_2	0.16	0.17	$C_{d-SO2}*((20.9-15)/(20.9-\%O_{2-Dry}*100))$
$PM_{10}/PM_{2.5}$ Stack Conc.	$C_{d15-PM10}$	mg/Nm^3 @ 15% O_2	15	20	Supplied by Wärtsilä
	C_{d-PM10}	mg/Nm^3	24.2	26.4	$C_{d15-PM10}*((20.9-\%O_{2-dry}*100)/(20.9-15))$
$PM_{10}/PM_{2.5}$ Emission Rates	$M_{PM-g/s}$	g/s	4.200E-03	3.200E-03	$C_{d-PM10}/1000*Q_{dry-32F}/60$
	$M_{PM10-lb/hr}$	lb/hr	2.01	1.53	Supplied by Wärtsilä
$PM_{10}/PM_{2.5}$ Emission Factors	--	lb/MMBtu	0.0258	0.0340	$M_{PM10-lb/hr}/HI_{HHV}$
	--	g/kW_m-hr	0.002	0.002	$M_{pm10-g/s}$ * 3600/MO
	--	g/kW_e-hr	0	0	$M_{pm10-g/s}$ * 3600/G
NO_X as NO_2 Stack Conc.	$C_{d15-NOX}$	ppmvd @ 15% O_2	6	9	Supplied by Wärtsilä
	C_{d-NOX}	ppmvd	9.7	11.9	$C_{d15-NOX}*((20.9-\%O_{2-dry}*100)/(20.9-15))$
NO_2 Molecular Weight	MW_{NO2}	lb/lbmol	46.0	46.0	http://www.webelements.com/
NO_X as NO_2 Emission Rates	$M_{NOX-lb/hr}$	lb/hr	1.65	1.41	Supplied by Wärtsilä
	$M_{NOX-g/s}$	g/s	0.208	0.178	Calculated from lb/hr
NO_X as NO_2 Emission Factors	--	lb/MMBtu	0.021	0.031	$M_{NOX-lb/hr}/HI_{HHV}$
	--	g/kW_m-hr	0.080	0.137	$M_{NOX-g/s}$ * 3600/MO
	--	g/kW_e-hr	0.007	0.012	$M_{NOX-g/s}$ * 3600/G
Emission Rates (Continued)					
CO Stack Conc.	C_{d15-CO}	ppmvd @ 15% O_2	15	15	Supplied by Wärtsilä
	C_{d-CO}	ppmvd	24.2	19.8	$C_{d15-CO}*((20.9-\%O_{2-dry}*100)/(20.9-15))$
CO Molecular Weight	MW_{CO}	lb/lbmol	28.0	28.0	http://www.webelements.com/
CO Emission Rates	$M_{CO-lb/hr}$	lb/hr	2.51	1.43	Supplied by Wärtsilä
	$M_{CO-g/s}$	g/s	3.163E-01	1.802E-01	Calculated from lb/hr
CO Emission Factors	--	lb/MMBtu	0.0322	0.0318	$M_{CO-lb/hr}/HI_{HHV}$
	--	g/kW_m-hr	0.122	0.138	$M_{CO-g/s}$ * 3600/MO
	--	g/kW_e-hr	0.011	0.013	$M_{CO-g/s}$ * 3600/G
VOC (as CH_4) Stack Conc.	$C_{d15-VOC}$	ppmvd @ 15% O_2	26	37	Supplied by Wärtsilä
	C_{d-VOC}	ppmvd	41.9	48.9	$C_{d15-VOC}*((20.9-\%O_{2-dry}*100)/(20.9-15))$
VOC (as CH_4) Molecular Weight	MW_{CH4}	lb/lbmol	16.0	16.0	http://www.webelements.com/
VOC (as CH_4) Emission Rates	$M_{VOC-lb/hr}$	lb/hr	2.50	2.02	Supplied by Wärtsilä
	$M_{VOC-g/s}$	g/s	3.150E-01	2.545E-01	Calculated from lb/hr
VOC (as CH_4) Emission Factors	--	lb/MMBtu	0.0321	0.0449	$M_{VOC-lb/hr}/HI_{HHV}$
	--	g/kW_m-hr	0.121	0.196	$M_{VOC-g/s}$ * 3600/MO
	--	g/kW_e-hr	0.011	0.018	$M_{VOC-g/s}$ * 3600/G
NH_3 Slip	$C_{d15-NH3}$	ppmvd @ 15% O_2	10	10	Supplied by Wärtsilä
	C_{d-NH3}	ppmvd	16.1	13.2	$C_{d15-NH3}*((20.9-\%O_{2-Dry}*100)/(20.9-15))$
NH_3 Molecular Weight	MW_{NH3}	lb/lbmol	17.0	17.0	http://www.webelements.com/
NH_3 Emission Rate	$M_{NH3-lb/hr}$	lb/hr	1.02	0.58	Supplied by Wärtsilä
	$M_{NH3-g/s}$	g/s	1.285E-01	7.310E-02	Converted from lb/hr
Formaldehyde	$C_{d15-HCOH}$	ppbvd @ 15% O_2	1100.0	1700	Supplied by Wärtsilä
	C_{d-HCOH}	ppmvd	1.771	2.248	$C_{d15-HCOH}*((20.9-\%O_{2-Dry}*100)/(20.9-15))$
	MW_{HCOH}	lb/lbmol	30.03	30.03	http://www.webelements.com/
	$M_{HCOH-lb/hr}$	lb/hr	0.20	0.17	Supplied by Wärtsilä
	$M_{HCOH-g/s}$	g/s	2.520E-02	2.140E-02	Converted from lb/hr
	EF_{HCOH}	lb/MMBtu	0.002567	0.0038	$M_{HCOH-lb/hr}/HI_{HHV}$

All emissions data from "Indicative emissions US projects 20V34DF-B/C2; Doc.ID: DBAD556770"
Dated 12/18/2020; rec'd 08/05/2021; updated 02/04/2022

Note:
* Includes pilot fuel

Table B-6
Startup Emission Rates - Biodiesel

Cold Start[1]

Time (min.)	Operating Mode	NO_X	SO_2	CO	VOC	$PM_{10}/PM_{2.5}$	NH3
1 - 30	Startup	45.0	0.0604	6.0	2.5	5.0	0
31 - 60	Normal (Full load)	5.43	0.0604	1.89	2.17	2.27	0.575
Total	**(lbs/hr)**	**50.4**	**0.1207**	**7.89**	**4.67**	**7.27**	**0.58**

[1] A cold catalyst start is when the temperature of the catalyst is close to the ambient temperature.

Warm Start[2]

Time (min.)	Operating Mode	NO_X	SO_2	CO	VOC	$PM_{10}/PM_{2.5}$	NH3
1 - 30	Startup	36.0	0.0604	5.1	2.15	5.0	0
31 - 60	Normal (Full load)	5.43	0.0604	1.89	2.17	2.27	0.575
Total	**(lbs/hr)**	**41.4**	**0.1207**	**6.99**	**4.32**	**7.27**	**0.58**

[2] A warm catalyst start is when the unit is started between 6 and 12 hours after shutdown.

Hot Start[3]

Time (min.)	Operating Mode	NO_X	SO_2	CO	VOC	$PM_{10}/PM_{2.5}$	NH3
1 - 30	Startup	32.0	0.0604	5.0	1.8	5.0	0
31 - 60	Normal (Full load)	5.43	0.0604	1.89	2.17	2.27	0.575
Total	**(lbs/hr)**	**37.4**	**0.1207**	**6.89**	**3.97**	**7.27**	**0.58**

[3] A hot catalyst start is when the unit is started within 6 hours of shutdown and the catalyst temperature is above 100°F.

Source Data
Wärtsilä Doc. ID DETA00003584, "expected start up and unloading emissions 20V34DF," 18 Dec 2020; rec'd 08/08/2021

Table B-7
Startup Emission Rates - RNG

Cold Start [1]

Time (min.)	Operating Mode	NO_X	SO_2	CO	VOC	$PM_{10}/PM_{2.5}$	NH3
1 - 30	Startup	14.0	0.0312	10.5	2.0	2.0	0
31 - 60	Normal (Full load)	0.83	0.0312	1.26	1.25	1.01	0.51
Total	**(lbs/hr)**	**14.8**	**0.0624**	**11.76**	**3.25**	**3.01**	**0.51**

[1] A cold catalyst start is when the temperature of the catalyst is close to the ambient temperature.

Warm Start [2]

Time (min.)	Operating Mode	NO_X	SO_2	CO	VOC	$PM_{10}/PM_{2.5}$	NH3
1 - 30	Startup	11.5	0.0312	8.8	1.7	2.0	0
31 - 60	Normal (Full load)	0.83	0.0312	1.26	1.25	1.01	0.51
Total	**(lbs/hr)**	**12.3**	**0.0624**	**10.06**	**2.95**	**3.01**	**0.51**

[2] A warm catalyst start is when the unit is started between 6 and 12 hours after shutdown.

Hot Start [3]

Time (min.)	Operating Mode	NO_X	SO_2	CO	VOC	$PM_{10}/PM_{2.5}$	NH3
1 - 30	Startup	9.0	0.0312	7.5	1.5	2.0	0
31 - 60	Normal (Full load)	0.83	0.0312	1.26	1.25	1.01	0.51
Total	**(lbs/hr)**	**9.8**	**0.0624**	**8.76**	**2.75**	**3.01**	**0.51**

[3] A hot catalyst start is when the unit is started within 6 hours of shutdown and the catalyst temperature is above 100°F.

Source Data
Wärtsilä Doc. ID DETA00003584, "Expected start up and unloading emissions 20V34DF," 18 Dec 2020; rec'd 08/05/2021

Table B-8
Emergency Generator Performance Data

Parameter	Units	Full Load Value	Data Source
Performance Data			
Generation	kW	750	Caterpillar C27 specification sheet*
Engine Power	bhp	1141	Caterpillar C27 specification sheet
Fuel Flow	gal/hr	53.6	Caterpillar C27 specification sheet
	lb/hr	377.9	Calculated from fuel flow and fuel density.
Fuel Heat Content (HHV)	Btu/gal	138,000	Table C-1 to Subpart C of CFR 40 Part 98
Fuel Density	lb/gal	7.05	AP-42, Appendix A
Heat Input (HHV)	MMBtu/hr	7.3968	Calculated from fuel flow and fuel heat content.
Operating Hours	hr/day	4	Expected
	hr/yr	500	EPA default for emissions calculations**
Exhaust Data			
Exhaust Temperature	°F	948.7	Caterpillar C27 specification sheet
	K	782.4	Converted from °F
Exhaust Volumetric Flow (actual)	acfm	5,612	Caterpillar C27 specification sheet
	m^3/s	2.648	converted from acfm
Emission Rates			
Fuel Sulfur Content	ppm	15	Requested permit limit
SO_2 Emissions	lb/hr	0.0113	Mass Balance - 100% conversion of fuel S
	g/s	1.428E-03	Converted from lb/hr
	tpy	0.0028	Calculated from lb/hr and annual operating hours
PM	g/bhp-hr	0.02	Caterpillar C27 specification sheet
(Filterable PM)	lb/hr	0.05	Calculated from g/hp-hr limit and bhp
	g/s	6.339E-03	Converted from lb/hr
	tpy	0.0126	Calculated from lb/hr and annual operating hours
$PM_{10}/PM_{2.5}$	g/bhp-hr	0.02	Assume 100% of PM is PM2.5
(Filterable plus Condensable PM)	lb/hr	0.05	Calculated from g/hp-hr limit and bhp
	g/s	6.339E-03	Converted from lb/hr
	tpy	0.0126	Calculated from lb/hr and annual operating hours
NO_X	g/bhp-hr	5.25	Caterpillar C27 specification sheet
	lb/hr	13.206	Calculated from g/hp-hr limit and bhp
	g/s	1.6640	Converted from lb/hr
	tpy	3.3016	Calculated from lb/hr and annual operating hours
CO	g/bhp-hr	0.25	Caterpillar C27 specification sheet
	lb/hr	0.629	Calculated from g/hp-hr limit and bhp
	g/s	0.0792	Converted from lb/hr
	tpy	0.1572	Calculated from lb/hr and annual operating hours
VOC	g/bhp-hr	0.03	Caterpillar C27 specification sheet
	lb/hr	0.075	Calculated from g/hp-hr limit and bhp
	g/s	0.0095	Converted from lb/hr
	tpy	0.02	Calculated from lb/hr and annual operating hours
Lead	lb/MMBtu	1.40E-05	AP-42, Section 3.1, Table 3.1-5
	lb/hr	1.04E-04	Calculated from lb/MMBtu and heat input
	g/s	1.30E-05	Converted from lb/hr
	tpy	2.59E-05	Calculated from lb/hr and annual operating hours

Table B-8
Emergency Generator Performance Data

Parameter	Units	Full Load Value	Data Source
Fluorides	lb/MMBtu	2.49E-04	AP-42, Section 1.3, Table 1.3-11 for No. 6 Fuel Oil
	lb/hr	1.84E-03	Calculated from lb/MMBtu and heat input
	g/s	2.32E-04	Converted from lb/hr
	tpy	4.60E-04	Calculated from lb/hr and annual operating hours
CO2	kg/MMBtu	73.96	40 CFR Part 98
	tpy	301.5	Calculated from kg/MMBtu and heat input
CH4	g/MMBtu	3.0	40 CFR Part 98
	tpy	0.01	Calculated from kg/MMBtu and heat input
N2O	g/MMBtu	0.6	40 CFR Part 98
	tpy	0.002	Calculated from kg/MMBtu and heat input
CO2e	tpy	302.6	Sum of GHGs weighted by GWP

Notes:
* Engine/generator specs provided by Vanderweil 4/22/22
** Seitz 1995 memo at www.epa.doc/files/documents/emgen

Table B-9
Fire Pump Engine Emissions Calculations

Parameter	Units	Full Load Value	Data Source
Performance Data			
Engine Power	bhp	380	CFP9E-F65 Specification Sheet*
Fuel Flow	gal/hr	21.8	CFP9E-F65 Specification Sheet
	lb/hr	153.69	Calculated from fuel flow and fuel density.
Fuel Heat Content (HHV)	Btu/gal	138,000	Table C-1 to Subpart C of CFR 40 Part 98
Fuel Density	lb/gal	7.05	AP-42, Appendix A
Heat Input (HHV)	MMBtu/hr	3.0084	Calculated from fuel flow and fuel heat content.
Operating Hours	hr/day	4	Expected maximum
	hr/yr	500	EPA guidance for emergency engines**
Exhaust Data			
Exhaust Temperature	°F	977	CFP9E-F65 Specification Sheet
	K	798.2	Converted from °F
Exhaust Volumetric Flow (actual)	acfm	2,170	CFP9E-F65 Specification Sheet
	m^3/s	1.024	converted from acfm
Emission Rates			
Fuel Sulfur Content	ppm	15	Requested permit limit
SO_2 Emissions	lb/hr	0.0046	Mass Balance - 100% conversion of fuel S
	g/s	5.809E-04	Converted from lb/hr
	tpy	0.0012	Calculated from lb/hr and annual operating hours
PM	g/bhp-hr	0.118	CFP9E-F65 Specification Sheet
	lb/hr	0.099	Calculated from g/hp-hr limit and bhp
	g/s	1.246E-02	Converted from lb/hr
	tpy	0.0247	Calculated from lb/hr and annual operating hours
$PM_{10}/PM_{2.5}$	g/bhp-hr	0.118	Assume all PM is PM2.5
	lb/hr	0.099	Calculated from g/hp-hr limit and bhp
	g/s	0.0125	Converted from lb/hr
	tpy	0.0247	Calculated from lb/hr and annual operating hours
NO_X	g/bhp-hr	2.166	CFP9E-F65 Specification Sheet
	lb/hr	1.815	Calculated from g/hp-hr limit and bhp
	g/s	0.2286	Converted from lb/hr
	tpy	0.4536	Calculated from lb/hr and annual operating hours
CO	g/bhp-hr	1.417	CFP9E-F65 Specification Sheet
	lb/hr	1.187	Calculated from g/hp-hr limit and bhp
	g/s	0.1496	Converted from lb/hr
	tpy	0.2968	Calculated from lb/hr and annual operating hours
VOC	g/bhp-hr	0.154	CFP9E-F65 Specification Sheet
	lb/hr	0.129	Calculated from g/hp-hr limit and bhp
	g/s	0.0163	Converted from lb/hr
	tpy	0.0323	Calculated from lb/hr and annual operating hours
Lead	lb/MMBtu	1.40E-05	AP-42, Section 3.1, Table 3.1-5
	lb/hr	4.21E-05	Calculated from lb/MMBtu and heat input
	g/s	5.31E-06	Converted from lb/hr
	tpy	1.05E-05	Calculated from lb/hr and annual operating hours

Table B-9
Fire Pump Engine Emissions Calculations

Parameter	Units	Full Load Value	Data Source
Fluorides	lb/MMBtu	2.49E-04	AP-42, Section 1.3, Table 1.3-11 for No. 6 Fuel Oil
	lb/hr	7.48E-04	Calculated from lb/MMBtu and heat input
	g/s	9.43E-05	Converted from lb/hr
	tpy	1.87E-04	Calculated from lb/hr and annual operating hours
CO2	kg/MMBtu	73.96	40 CFR Part 98
	tpy	122.6	Calculated from kg/MMBtu and heat input
CH4	g/MMBtu	3.0	40 CFR Part 98
	tpy	0.005	Calculated from kg/MMBtu and heat input
N2O	g/MMBtu	0.6	40 CFR Part 98
	tpy	0.001	Calculated from kg/MMBtu and heat input
CO2e	tpy	123.1	Sum of GHGs weighted by GWP

Notes:
* Spec sheet provided by B. Albertini 4/14/22
** Seitz 1995 memo at www.epa.doc/files/documents/emgen

Table B-10
Operating and Emissions Assumptions
Case 1: RNG Only

Equipment	NOx lb/hr	SOx (1) lb/hr	CO lb/hr	VOC lb/hr	PM10 lb/hr	NH3 lb/hr
Biodiesel, baseload hour	10.86	0.121	3.78	4.33	4.53	1.15
Biodiesel, cold startup hour	50.43	0.121	7.89	4.67	7.27	1.15
Biodiesel, warm startup hour	41.43	0.121	6.99	4.32	7.27	1.15
Biodiesel, hot startup hour	37.43	0.121	6.89	3.97	7.27	1.15
RNG, baseload hour	1.65	0.062	2.51	2.50	2.01	1.02
RNG, cold startup hour	14.83	0.062	11.76	3.25	3.01	1.02
RNG, warm startup hour	12.33	0.062	10.06	2.95	3.01	1.02
RNG, hot startup hour	9.83	0.062	8.76	2.75	3.01	1.02
RNG, cold startup/switch to biodiesel	19.43	0.092	12.39	4.17	4.27	0.58
RNG, warm startup/switch to biodiesel	16.93	0.092	10.69	3.87	4.27	0.58

	NOx Emissions			NH3 Emissions	
Equipment	Max lb/hr	Max lb/day	Total tons/yr	Max lb/hr	Max tons/yr
Biodiesel, baseload hour	0.00	0.00	0.0	0.0	0.00
Biodiesel, cold startup hour	0.0	0.0	0.0	0.0	0.00
Biodiesel, warm startup hour	0.0	0.0	0.0	0.0	0.00
Biodiesel, hot startup hour	0.0	0.0	0.0	0.0	0.00
RNG, baseload hour	0.00	38.0	6.6	0.0	4.10
RNG, cold startup hour	14.8	0.0	0.4	1.0	0.03
RNG, warm startup hour	0.0	12.3	1.9	0.0	0.16
RNG, hot startup hour	0.0	0.0	0.0	0.0	0.00
RNG, cold startup/switch to biodiesel	0.0	0.0	0.0	0.0	0.00
RNG, warm startup/switch to biodiesel	0.0	0.0	0.0	0.0	0.00
ICE Total, 11 engines	163.1 lb/hr	553.0 lb/day	98.3 tons/yr	11.2 lb/hr	47.1 tons/yr

	SOx Emissions		
Equipment	Max lb/hr	Max lb/day	Total tons/yr
Biodiesel, baseload hour	0.00	0.00	0.00
Biodiesel, cold startup hour	0.00	0.00	0.00
Biodiesel, warm startup hour	0.00	0.00	0.00
Biodiesel, hot startup hour	0.00	0.00	0.00
RNG, baseload hour	0.00	1.44	0.25
RNG, cold startup hour	0.06	0.00	0.00
RNG, warm startup hour	0.00	0.06	0.01
RNG, hot startup hour	0.00	0.00	0.00
RNG, cold startup/switch to biodiesel	0.00	0.00	0.00
RNG, warm startup/switch to biodiesel	0.00	0.00	0.00
ICE Total, all engines	0.7 lb/hr	16.5 lb/day	2.9 tons/yr

Table B-10
Operating and Emissions Assumptions
Case 1: RNG Only

Equipment	CO Emissions Max lb/hr	CO Emissions Max lb/day	CO Emissions Total tons/yr
Biodiesel, baseload hour	0.0	0.0	0.0
Biodiesel, cold startup hour	0.0	0.0	0.0
Biodiesel, warm startup hour	0.0	0.0	0.0
Biodiesel, hot startup hour	0.0	0.0	0.0
RNG, baseload hour	0.0	57.7	10.1
RNG, cold startup hour	11.8	0.0	0.3
RNG, warm startup hour	0.0	10.1	1.6
RNG, hot startup hour	0.0	0.0	0.0
RNG, cold startup/switch to biodiesel	0.0	0.0	0.0
RNG, warm startup/switch to biodiesel	0.0	0.0	0.0
ICE Total, all engines	129.3 lb/hr	745.6 lb/day	131.5 tons/yr

Equipment	VOC Emissions Max lb/hr	VOC Emissions Max lb/day	VOC Emissions Total tons/yr
Biodiesel, baseload hour	0.0	0.0	0.0
Biodiesel, cold startup hour	0.0	0.0	0.0
Biodiesel, warm startup hour	0.0	0.0	0.0
Biodiesel, hot startup hour	0.0	0.0	0.0
RNG, baseload hour	0.0	57.5	10.0
RNG, cold startup hour	3.3	0.0	0.1
RNG, warm startup hour	0.0	3.0	0.5
RNG, hot startup hour	0.0	0.0	0.0
RNG, cold startup/switch to biodiesel	0.0	0.0	0.0
RNG, warm startup/switch to biodiesel	0.0	0.0	0.0
ICE Total, all engines	35.8 lb/hr	665.0 lb/day	116.4 tons/yr

Equipment	PM10 Emissions Max lb/hr	PM10 Emissions Max lb/day	PM10 Emissions Total tons/yr
Biodiesel, baseload hour	0.0	0.0	0.0
Biodiesel, cold startup hour	0.0	0.0	0.0
Biodiesel, warm startup hour	0.0	0.0	0.0
Biodiesel, hot startup hour	0.0	0.0	0.0
RNG, baseload hour	0.0	46.2	8.1
RNG, cold startup hour	3.0	0.0	0.1
RNG, warm startup hour	0.0	3.0	0.5
RNG, hot startup hour	0.0	0.0	0.0
RNG, cold startup/switch to biodiesel	0.0	0.0	0.0
RNG, warm startup/switch to biodiesel	0.0	0.0	0.0
ICE Total, all engines	33.1 lb/hr	541.6 lb/day	94.8 tons/yr

Table B-11
Operating and Emissions Assumptions
Case 2: Startup on RNG, Switch to Biodiesel

Equipment	NOx lb/hr	SOx (1) lb/hr	CO lb/hr	VOC lb/hr	PM10 lb/hr	NH3 lb/hr
Biodiesel, baseload hour	10.86	0.121	3.78	4.33	4.53	1.15
Biodiesel, cold startup hour	50.43	0.121	7.89	4.67	7.27	1.15
Biodiesel, warm startup hour	41.43	0.121	6.99	4.32	7.27	1.15
Biodiesel, hot startup hour	37.43	0.121	6.89	3.97	7.27	1.15
RNG, baseload hour	1.65	0.062	2.51	2.50	2.01	1.02
RNG, cold startup hour	14.83	0.062	11.76	3.25	3.01	1.02
RNG, warm startup hour	12.33	0.062	10.06	2.95	3.01	1.02
RNG, hot startup hour	9.83	0.062	8.76	2.75	3.01	1.02
RNG, cold startup/switch to biodiesel	19.43	0.092	12.39	4.17	4.27	0.58
RNG, warm startup/switch to biodiesel	16.93	0.092	10.69	3.87	4.27	0.58

Equipment	NOx Emissions Max lb/hr	NOx Emissions Max lb/day	NOx Emissions Total tons/yr	NH3 Emissions Max lb/hr	NH3 Emissions Max tons/yr
Biodiesel, baseload hour	0.00	249.78	18.6	0.0	1.97
Biodiesel, cold startup hour	0.0	0.0	0.0	0.0	0.00
Biodiesel, warm startup hour	0.0	0.0	0.0	0.0	0.00
Biodiesel, hot startup hour	0.0	0.0	0.0	0.0	0.00
RNG, baseload hour	0.00	0.00	0.0	0.0	0.00
RNG, cold startup hour	0.0	0.0	0.0	0.0	0.00
RNG, warm startup hour	0.0	0.0	0.0	0.0	0.00
RNG, hot startup hour	0.0	0.0	0.0	0.0	0.00
RNG, cold startup/switch to biodiesel	19.4	0.0	0.5	0.6	0.01
RNG, warm startup/switch to biodiesel	0.0	16.9	2.6	0.0	0.09
ICE Total, 11 engines	213.7 lb/hr	2,933.8 lb/day	239.6 tons/yr	6.3 lb/hr	22.9 tons/yr

Equipment	SOx Emissions Max lb/hr	SOx Emissions Max lb/day	SOx Emissions Total tons/yr
Biodiesel, baseload hour	0.0	2.8	0.2
Biodiesel, cold startup hour	0.0	0.0	0.0
Biodiesel, warm startup hour	0.0	0.0	0.0
Biodiesel, hot startup hour	0.0	0.0	0.0
RNG, baseload hour	0.0	0.0	0.0
RNG, cold startup hour	0.0	0.0	0.0
RNG, warm startup hour	0.0	0.0	0.0
RNG, hot startup hour	0.0	0.0	0.0
RNG, cold startup/switch to biodiesel	0.1	0.0	0.0
RNG, warm startup/switch to biodiesel	0.0	0.1	0.0
ICE Total, all engines	1.0 lb/hr	31.5 lb/day	2.5 tons/yr

Table B-11
Operating and Emissions Assumptions
Case 2: Startup on RNG, Switch to Biodiesel

Equipment	CO Emissions Max lb/hr	CO Emissions Max lb/day	CO Emissions Total tons/yr
Biodiesel, baseload hour	0.0	86.9	6.5
Biodiesel, cold startup hour	0.0	0.0	0.0
Biodiesel, warm startup hour	0.0	0.0	0.0
Biodiesel, hot startup hour	0.0	0.0	0.0
RNG, baseload hour	0.0	0.0	0.0
RNG, cold startup hour	0.0	0.0	0.0
RNG, warm startup hour	0.0	0.0	0.0
RNG, hot startup hour	0.0	0.0	0.0
RNG, cold startup/switch to biodiesel	12.4	0.0	0.3
RNG, warm startup/switch to biodiesel	0.0	10.7	1.7
ICE Total, all engines	136.3 lb/hr	1,073.9 lb/day	93.3 tons/yr

Equipment	VOC Emissions Max lb/hr	VOC Emissions Max lb/day	VOC Emissions Total tons/yr
Biodiesel, baseload hour	0.0	99.6	7.4
Biodiesel, cold startup hour	0.0	0.0	0.0
Biodiesel, warm startup hour	0.0	0.0	0.0
Biodiesel, hot startup hour	0.0	0.0	0.0
RNG, baseload hour	0.0	0.0	0.0
RNG, cold startup hour	0.0	0.0	0.0
RNG, warm startup hour	0.0	0.0	0.0
RNG, hot startup hour	0.0	0.0	0.0
RNG, cold startup/switch to biodiesel	4.2	0.0	0.1
RNG, warm startup/switch to biodiesel	0.0	3.9	0.6
ICE Total, all engines	45.8 lb/hr	1,138.0 lb/day	89.6 tons/yr

Equipment	PM10 Emissions Max lb/hr	PM10 Emissions Max lb/day	PM10 Emissions Total tons/yr
Biodiesel, baseload hour	0.0	104.2	7.8
Biodiesel, cold startup hour	0.0	0.0	0.0
Biodiesel, warm startup hour	0.0	0.0	0.0
Biodiesel, hot startup hour	0.0	0.0	0.0
RNG, baseload hour	0.0	0.0	0.0
RNG, cold startup hour	0.0	0.0	0.0
RNG, warm startup hour	0.0	0.0	0.0
RNG, hot startup hour	0.0	0.0	0.0
RNG, cold startup/switch to biodiesel	4.3	0.0	0.1
RNG, warm startup/switch to biodiesel	0.0	4.3	0.7
ICE Total, all engines	46.9 lb/hr	1,193.0 lb/day	94.0 tons/yr

Table B-12
Operating and Emissions Assumptions
Case 3: Biodiesel Only

Equipment	NOx lb/hr	SOx (1) lb/hr	CO lb/hr	VOC lb/hr	PM10 lb/hr	NH3 lb/hr
Biodiesel, baseload hour	10.86	0.121	3.78	4.33	4.53	1.15
Biodiesel, cold startup hour	50.43	0.121	7.89	4.67	7.27	1.15
Biodiesel, warm startup hour	41.43	0.121	6.99	4.32	7.27	1.15
Biodiesel, hot startup hour	37.43	0.121	6.89	3.97	7.27	1.15
RNG, baseload hour	1.65	0.062	2.51	2.50	2.01	1.02
RNG, cold startup hour	14.83	0.062	11.76	3.25	3.01	1.02
RNG, warm startup hour	12.33	0.062	10.06	2.95	3.01	1.02
RNG, hot startup hour	9.83	0.062	8.76	2.75	3.01	1.02
RNG, cold startup/switch to biodiesel	19.43	0.092	12.39	4.17	4.27	0.58
RNG, warm startup/switch to biodiesel	16.93	0.092	10.69	3.87	4.27	0.58

Equipment	NOx Emissions			NH3 Emissions	
	Max lb/hr	Max lb/day	Total tons/yr	Max lb/hr	Max tons/yr
Biodiesel, baseload hour	0.00	249.78	13.9	0.00	1.47
Biodiesel, cold startup hour	50.4	0.0	1.3	1.15	0.03
Biodiesel, warm startup hour	0.0	41.4	6.5	0.0	0.2
Biodiesel, hot startup hour	0.0	0.0	0.0	0.0	0.00
RNG, baseload hour	0.00	0.00	0.0	0.00	0.00
RNG, cold startup hour	0.0	0.0	0.0	0.00	0.00
RNG, warm startup hour	0.0	0.0	0.0	0.0	0.0
RNG, hot startup hour	0.0	0.0	0.0	0.0	0.00
RNG, cold startup/switch to biodiesel	0.0	0.0	0.0	0.00	0.00
RNG, warm startup/switch to biodiesel	0.0	0.0	0.0	0.00	0.00
ICE Total, 11 engines	554.7 lb/hr	3,203.3 lb/day	238.4 tons/yr	12.7 lb/hr	18.5 tons/yr

Equipment	SOx Emissions		
	Max lb/hr	Max lb/day	Total tons/yr
Biodiesel, baseload hour	0.0	2.8	0.2
Biodiesel, cold startup hour	0.1	0.0	0.0
Biodiesel, warm startup hour	0.0	0.1	0.0
Biodiesel, hot startup hour	0.0	0.0	0.0
RNG, baseload hour	0.0	0.0	0.0
RNG, cold startup hour	0.0	0.0	0.0
RNG, warm startup hour	0.0	0.0	0.0
RNG, hot startup hour	0.0	0.0	0.0
RNG, cold startup/switch to biodiesel	0.0	0.0	0.0
RNG, warm startup/switch to biodiesel	0.0	0.0	0.0
ICE Total, all engines	1.3 lb/hr	31.9 lb/day	1.9 tons/yr

Table B-12
Operating and Emissions Assumptions
Case 3: Biodiesel Only

Equipment	CO Emissions Max lb/hr	CO Emissions Max lb/day	CO Emissions Total tons/yr
Biodiesel, baseload hour	0.0	86.9	4.8
Biodiesel, cold startup hour	7.9	0.0	0.2
Biodiesel, warm startup hour	0.0	7.0	1.1
Biodiesel, hot startup hour	0.0	0.0	0.0
RNG, baseload hour	0.0	0.0	0.0
RNG, cold startup hour	0.0	0.0	0.0
RNG, warm startup hour	0.0	0.0	0.0
RNG, hot startup hour	0.0	0.0	0.0
RNG, cold startup/switch to biodiesel	0.0	0.0	0.0
RNG, warm startup/switch to biodiesel	0.0	0.0	0.0
ICE Total, all engines	86.8 lb/hr	1,033.2 lb/day	67.4 tons/yr

Equipment	VOC Emissions Max lb/hr	VOC Emissions Max lb/day	VOC Emissions Total tons/yr
Biodiesel, baseload hour	0.0	99.6	5.5
Biodiesel, cold startup hour	4.7	0.0	0.1
Biodiesel, warm startup hour	0.0	4.3	0.7
Biodiesel, hot startup hour	0.0	0.0	0.0
RNG, baseload hour	0.0	0.0	0.0
RNG, cold startup hour	0.0	0.0	0.0
RNG, warm startup hour	0.0	0.0	0.0
RNG, hot startup hour	0.0	0.0	0.0
RNG, cold startup/switch to biodiesel	0.0	0.0	0.0
RNG, warm startup/switch to biodiesel	0.0	0.0	0.0
ICE Total, all engines	51.3 lb/hr	1,143.0 lb/day	69.6 tons/yr

Equipment	PM10 Emissions Max lb/hr	PM10 Emissions Max lb/day	PM10 Emissions Total tons/yr
Biodiesel, baseload hour	0.0	104.2	5.8
Biodiesel, cold startup hour	7.3	0.0	0.2
Biodiesel, warm startup hour	0.0	7.3	1.1
Biodiesel, hot startup hour	0.0	0.0	0.0
RNG, baseload hour	0.0	0.0	0.0
RNG, cold startup hour	0.0	0.0	0.0
RNG, warm startup hour	0.0	0.0	0.0
RNG, hot startup hour	0.0	0.0	0.0
RNG, cold startup/switch to biodiesel	0.0	0.0	0.0
RNG, warm startup/switch to biodiesel	0.0	0.0	0.0
ICE Total, all engines	79.9 lb/hr	1,226.0 lb/day	78.2 tons/yr

Table B-13
GHG Emissions
Case 1: RNG Only

Unit	Heat Input (MMBtu/hr)	Operating Output (gross MW)	Operating Hours (hrs/yr)	Annual Heat Input per Unit (MMBtu/yr)	Number of Units	Total Annual Heat Input (MMBtu/yr)	Total Annual Output MWh/yr	GHG Pollutant[1]	Emission Factor[2] (kg/MMBtu)	Max. Hourly Emissions (kg/hr)	Annual Emissions (metric tpy)	Global Warming Potential[3]	Per Unit Total GHG Emissions CO_2e (lb/hr)	Per Unit Total GHG Emissions CO_2e (metric tpy)	Per Unit Total GHG Emissions CO_2e (tpy)	Total GHG Emissions CO_2e (lb/hr)	Total GHG Emissions CO_2e (metric tpy)	Total GHG Emissions CO_2e (tpy)	Total GHG Emissions CO_2e lb/MWh	Total GHG Emissions CO_2e g/kWh	Total GHG Emissions CO_2e lb/MMBtu
GHG Emissions when Firing Biodiesel, Full Load																					
Wärtsilä 20V34DF Engines	78.8	103.1	0	0	11	0	0	CO_2	73.96	5,831	0	1	0.0	0.0	0.0	0.0	0.0	0.0	0		
								N_2O	6.0E-04	4.73E-02	0.000	298	0.0	0.0	0.0	0.0	0.0	0.0	0		
								CH_4	3.0E-03	2.37E-01	0.00	25	0.0	0.0	0.0	0.0	0.0	0.0	0		
GHG Emissions when Firing RNG, Full Load																					
Wärtsilä 20V34DF Engines	77.9	103.1	8,395	654,085	11	7,194,930	862,138	CO_2	53.06	4,134	34,706	1	9,114.1	34,705.7	38,256.5	100,255.3	381,763.0	420,821.6	976		
								N_2O	1.0E-04	7.79E-03	0.065	298	0.0	19.5	21.5	0.0	214.4	236.3	1		
								CH_4	1.0E-03	7.79E-02	0.65	25	0.0	16.4	18.0	0.0	179.9	198.3	0		
												Total CO_2e =	**9,114.1**	**34,741.6**	**38,296.0**	**100,255.3**	**382,157.3**	**421,256.3**	**977.2**	**443.3**	**117.1**
												Biogenic[4] CO_2 =	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**			
												non-Biogenic CO_2e =	**9,114.1**	**34,741.6**	**38,296.0**	**100,255.3**	**382,157.3**	**421,256.3**			

Unit	Heat Input (MMBtu/hr)	Operating Output (gross MW)	Operating Hours (hrs/yr)	Annual Heat Input per Unit (MMBtu/yr)	Number of Units	Total Annual Heat Input (MMBtu/yr)	Total Annual Output MWh/yr	GHG Pollutant[1]	Emission Factor[2] (kg/MMBtu)	Max. Hourly Emissions (kg/hr)	Annual Emissions (metric tpy)	Global Warming Potential[3]	Per Unit Total GHG Emissions CO_2e (lb/hr)	Per Unit Total GHG Emissions CO_2e (metric tpy)	Per Unit Total GHG Emissions CO_2e (tpy)	Total GHG Emissions CO_2e (lb/hr)	Total GHG Emissions CO_2e (metric tpy)	Total GHG Emissions CO_2e (tpy)	Total GHG Emissions CO_2e lb/MWh	Total GHG Emissions CO_2e g/kWh	Total GHG Emissions CO_2e lb/MMBtu
GHG Emissions when Firing Biodiesel, Minimum Load																					
Wärtsilä 20V34DF Engines	41.1	51.5	0	0	11	0	0	CO_2	73.96	3,039	0	1	0.0	0.0	0.0	0.0	0.0	0.0	0		
								N_2O	6.0E-04	2.47E-02	0.000	298	0.0	0.0	0.0	0.0	0.0	0.0	0		
								CH_4	3.0E-03	1.23E-01	0.00	25	0.0	0.0	0.0	0.0	0.0	0.0	0		
GHG Emissions when Firing RNG, Minimum Load																					
Wärtsilä 20V34DF Engines	45.0	51.5	8,395	377,873	11	4,156,602	432,620	CO_2	53.06	2,388	20,050	1	5,265.3	20,049.9	22,101.3	57,918.8	220,549.3	243,114.0	1124		
								N_2O	1.0E-04	4.50E-03	0.038	298	0.0	11.3	12.4	0.0	123.9	136.5	1		
								CH_4	1.0E-03	4.50E-02	0.38	25	0.0	9.4	10.4	0.0	103.9	114.5	1		
												Total CO_2e =	**5,265.3**	**20,070.6**	**22,124.1**	**57,918.8**	**220,777.1**	**243,365.1**	**1,125.1**	**510.3**	**117.1**
												Biogenic[4] CO_2 =	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**			
												non-Biogenic CO_2e =	**5,265.3**	**20,070.6**	**22,124.1**	**57,918.8**	**220,777.1**	**243,365.1**			

[1] Greenhouse Gas (GHG) pollutants from the Mandatory Greenhouse Gas Reporting rule (40 CFR §98.32).

[2] Emission factors from the Mandatory Greenhouse Gas Reporting rule (40 CFR Part 98 Subpart C, Tables C-1 and C-2).

[3] Global Warming Potentials from the Mandatory Greenhouse Gas Reporting rule (40 CFR Part 98 Subpart A, Table A-1).

[4] Per 40 CFR §98.6, biogenic CO_2 means carbon dioxide emissions generated as the result of biomass combustion.

Table B-14
GHG Emissions
Case 2: Startup on RNG, Switch to Biodiesel

Unit	Heat Input (MMBtu/hr)	Operating Output (gross MW)	Operating Hours (hrs/yr)	Annual Heat Input per Unit (MMBtu/yr)	Number of Units	Total Annual Heat Input (MMBtu/yr)	Total Annual Output MWh/yr	GHG Pollutant[1]	Emission Factor[2] (kg/MMBtu)	Max. Hourly Emissions (kg/hr)	Annual Emissions (metric tpy)	Global Warming Potential[3]	Per Unit Total GHG Emissions CO_2e (lb/hr)	Per Unit Total GHG Emissions CO_2e (metric tpy)	Per Unit Total GHG Emissions CO_2e (tpy)	Total GHG Emissions CO_2e (lb/hr)	Total GHG Emissions CO_2e (metric tpy)	Total GHG Emissions CO_2e (tpy)	Total GHG Emissions CO_2e lb/MWh	Total GHG Emissions CO_2e g/kWh	Total GHG Emissions CO_2e lb/MMBtu
GHG Emissions when Firing Biodiesel																					
Wärtsilä								CO_2	73.96	5,831	21,070	1	12,854.9	21,070.0	23,225.7	141,404.3	231,769.6	255,482.3	1445		
20V34DF	78.8	103.1	3,614	284,883	11	3,133,716	353,633	N_2O	6.0E-04	4.73E-02	0.171	298	31.1	50.9	56.1	341.8	560.3	617.6	3		
Engines								CH_4	3.0E-03	2.37E-01	0.85	25	13.0	21.4	23.6	143.4	235.0	259.1	1		
GHG Emissions when Firing RNG																					
Wärtsilä								CO_2	53.06	4,134	754	1	9,114.1	754.5	831.7	100,255.3	8,299.2	9,148.3	531		
20V34DF	77.9	103.1	183	14,219	11	156,412	34,486	N_2O	1.0E-04	7.79E-03	0.001	298	0.0	0.4	0.5	0.0	4.7	5.1	0		
Engines								CH_4	1.0E-03	7.79E-02	0.01	25	0.0	0.4	0.4	0.0	3.9	4.3	0		
												Total CO_2e =	**12,899.1**	**21,897.5**	**24,137.9**	**141,889.6**	**240,872.7**	**265,516.7**	**1,368.2**	**620.6**	**161.4**
												Biogenic[4] CO_2 =	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**			
												non-Biogenic CO_2e =	**12,899.1**	**21,897.5**	**24,137.9**	**141,889.6**	**240,872.7**	**265,516.7**			

[1] Greenhouse Gas (GHG) pollutants from the Mandatory Greenhouse Gas Reporting rule (40 CFR §98.32).
[2] Emission factors from the Mandatory Greenhouse Gas Reporting rule (40 CFR Part 98 Subpart C, Tables C-1 and C-2).
[3] Global Warming Potentials from the Mandatory Greenhouse Gas Reporting rule (40 CFR Part 98 Subpart A, Table A-1).
[4] Per 40 CFR §98.6, biogenic CO_2 means carbon dioxide emissions generated as the result of biomass combustion.

Table B-15
GHG Emissions
Case 3: Biodiesel Only

Unit	Heat Input (MMBtu/hr)	Operating: Output (gross MW)	Operating: Hours (hrs/yr)	Annual Heat Input per Unit (MMBtu/yr)	Number of Units	Total Annual Heat Input (MMBtu/yr)	Total Annual Output MWh/yr	GHG Pollutant[1]	Emission Factor[2] (kg/MMBtu)	Max. Hourly Emissions (kg/hr)	Annual Emissions (metric tpy)	Global Warming Potential[3]	Per Unit Total GHG Emissions CO_2e (lb/hr)	Per Unit Total GHG Emissions CO_2e (metric tpy)	Per Unit Total GHG Emissions CO_2e (tpy)	Total GHG Emissions CO_2e (lb/hr)	Total GHG Emissions CO_2e (metric tpy)	Total GHG Emissions CO_2e (tpy)	Total GHG Emissions CO_2e lb/MWh	Total GHG Emissions CO_2e g/kWh	Total GHG Emissions CO_2e lb/MMBtu
GHG Emissions when Firing Biodiesel, Full Load																					
Wärtsilä 20V34DF Engines	78.8	103.1	2,920	230,209	11	2,532,296	297,829	CO_2	73.96	5,831	17,026	1	12,854.9	17,026.2	18,768.2	141,404.3	187,288.6	206,450.3	1386		
								N_2O	6.0E-04	4.73E-02	0.138	298	31.1	41.2	45.4	341.8	452.8	499.1	3		
								CH_4	3.0E-03	2.37E-01	0.69	25	13.0	17.3	19.0	143.4	189.9	209.4	1		
GHG Emissions when Firing RNG, Full Load																					
Wärtsilä 20V34DF Engines	77.9	103.1	0	0	11	0	0	CO_2	53.06	4,134	0	1	0.0	0.0	0.0	0.0	0.0	0.0	0		
								N_2O	1.0E-04	7.79E-03	0.000	298	0.0	0.0	0.0	0.0	0.0	0.0	0		
								CH_4	1.0E-03	7.79E-02	0.00	25	0.0	0.0	0.0	0.0	0.0	0.0	0		
												Total CO_2e =	**12,899.1**	**17,084.7**	**18,832.6**	**141,889.6**	**187,931.3**	**207,158.8**	**1,391.1**	**631.0**	**163.6**
												Biogenic[4] CO_2 =	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**			
												non-Biogenic CO_2e =	**12,899.1**	**17,084.7**	**18,832.6**	**141,889.6**	**187,931.3**	**207,158.8**			

Unit	Heat Input (MMBtu/hr)	Operating: Output (gross MW)	Operating: Hours (hrs/yr)	Annual Heat Input per Unit (MMBtu/yr)	Number of Units	Total Annual Heat Input (MMBtu/yr)	Total Annual Output MWh/yr	GHG Pollutant[1]	Emission Factor[2] (kg/MMBtu)	Max. Hourly Emissions (kg/hr)	Annual Emissions (metric tpy)	Global Warming Potential[3]	Per Unit Total GHG Emissions CO_2e (lb/hr)	Per Unit Total GHG Emissions CO_2e (metric tpy)	Per Unit Total GHG Emissions CO_2e (tpy)	Total GHG Emissions CO_2e (lb/hr)	Total GHG Emissions CO_2e (metric tpy)	Total GHG Emissions CO_2e (tpy)	Total GHG Emissions CO_2e lb/MWh	Total GHG Emissions CO_2e g/kWh	Total GHG Emissions CO_2e lb/MMBtu
GHG Emissions when Firing Biodiesel, Minimum																					
Wärtsilä 20V34DF Engines	41.1	51.5	2,920	119,990	11	1,319,887	150,476	CO_2	73.96	3,039	8,874	1	6,700.3	8,874.4	9,782.4	73,703.0	97,618.8	107,606.3	1430		
								N_2O	6.0E-04	2.47E-02	0.072	298	16.2	21.5	23.6	178.2	236.0	260.1	3		
								CH_4	3.0E-03	1.23E-01	0.36	25	6.8	9.0	9.9	74.7	99.0	109.1	1		
GHG Emissions when Firing RNG, Minimum Load																					
Wärtsilä 20V34DF Engines	45.0	51.5	0	0	11	0	0	CO_2	53.06	2,388	0	1	0.0	0.0	0.0	0.0	0.0	0.0	0		
								N_2O	1.0E-04	4.50E-03	0.000	298	0.0	0.0	0.0	0.0	0.0	0.0	0		
								CH_4	1.0E-03	4.50E-02	0.00	25	0.0	0.0	0.0	0.0	0.0	0.0	0		
												Total CO_2e =	**6,723.3**	**8,904.9**	**9,816.0**	**73,955.9**	**97,953.8**	**107,975.6**	**1,435.1**	**651.0**	**163.6**
												Biogenic[4] CO_2 =	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**			
												non-Biogenic CO_2e =	**6,723.3**	**8,904.9**	**9,816.0**	**73,955.9**	**97,953.8**	**107,975.6**			

[1] Greenhouse Gas (GHG) pollutants from the Mandatory Greenhouse Gas Reporting rule (40 CFR §98.32).
[2] Emission factors from the Mandatory Greenhouse Gas Reporting rule (40 CFR Part 98 Subpart C, Tables C-1 and C-2).
[3] Global Warming Potentials from the Mandatory Greenhouse Gas Reporting rule (40 CFR Part 98 Subpart A, Table A-1).
[4] Per 40 CFR §98.6, biogenic CO_2 means carbon dioxide emissions generated as the result of biomass combustion.

Table B-16
Annual and Maximum Hourly HAP Emissions
Case 1: RNG Only

Pollutant	RNG Emission Factor (1) lb/MMcf	Controlled RNG Em Factor (2) lb/MMcf	Hourly Emissions per Engine, Case 2 (4) lb/hr	Total Annual Emissions, all Engines Case2 (5) tpy
Ammonia	(3)	n/a	1.15	47.1
Propylene	5.38E+00	3.23E+00	0.22	10.23
Hazardous Air Pollutants				
Acetaldehyde	5.29E-01	3.17E-01	0.02	1.01
Acrolein	5.90E-02	3.54E-02	2.43E-03	0.11
Benzene	2.18E-01	1.31E-01	0.01	0.41
1,3-Butadiene	3.67E-01	2.20E-01	0.02	0.70
Ethylbenzene	7.11E-02	4.27E-02	2.93E-03	0.14
Formaldehyde	n/a	2.91E+00	0.20	9.23
Naphthalene	2.51E-02	1.51E-02	1.03E-03	0.05
PAHs (as B(a)P) (6)	1.71E-05	1.03E-05	7.06E-07	0.00
Toluene	2.39E-01	1.43E-01	9.84E-03	0.45
Xylene	6.46E-01	3.88E-01	0.03	1.23
Total HAPs				13.33

Notes:

(1) All factors except formaldehyde are from CATEF mean emission factors for a natural gas 4S/Lean/>650Hp engine.
https://www.arb.ca.gov/app/emsinv/catef_form.html
Formaldehyde based on RICE NESHAP limit for SI engines (1.1 ppm).

(2) 40% control efficiency for oxidation catalyst applied for all TACs except formaldehyde. Source: BAAQMD PDOC for Eastshore Energy Center, April 30, 2007. Formaldehyde emission factor provided by vendor reflects ox cat control.

(3) Based on 10 ppm ammonia slip from SCR system.

(4) Based on maximum ICE firing rate of MMft3/hr for RNG
0.07 MMscf per engine

(5) Based on maximum ICE firing rate (from (4)) for RNG.
576 MMscf per engine

(6) Emission factors for individual PAHs weighted by cancer risk relative to B(a)P and summed to obtain overall B(a)P equivalent emission rate for HRA.

	Mean EF NG (lb/MMscf)	PEF Equiv.	Weighted EF NG (lb/MMscf)
PAHs (as B(a)P)			
Benzo(a)anthracene	5.88E-05	0.1	5.88E-06
Benzo(a)pyrene	2.70E-06	1	2.70E-06
Benzo(b)fluoranthene	4.09E-05	0.1	4.09E-06
Benzo(k)fluoranthene	7.83E-06	0.1	7.83E-07
Chrysene	1.43E-05	0.01	1.43E-07
Dibenz(a,h)anthracene	2.70E-06	1.05	2.84E-06
Indeno(1,2,3-cd)pyrene	7.17E-06	0.1	7.17E-07

Table B-17
Annual and Maximum Hourly HAP Emissions
Case 2: Startup on RNG, Switch to Biodiesel

Pollutant	Biodiesel Emission Factor (1) lb/Mgal	Controlled Biodiesel Em Factor (2) lb/Mgal	Hourly Emissions per Engine, Biodiesel Firing (4) lb/hr	Total Annual Emissions, all Engines Biodiesel Firing (5) tpy	RNG Emission Factor (1) lb/MMcf	Controlled RNG Em Factor (2) lb/MMcf	Hourly Emissions per Engine, RNG Firing (4) lb/hr	Total Annual Emissions, all Engines RNG Firing (5) tpy	Maximum Hourly Emissions per Engine lb/hr	Total Annual Emissions, all Engines tpy
Ammonia	(3)	n/a	1.15	n/a	(3)	n/a	1.02	n/a	1.2	22.9
Propylene	3.85E-01	2.31E-01	0.13	2.62	5.38E+00	3.23E+00	0.22	0.22	0.2	2.8
Hazardous Air Pollutants										
Acetaldehyde	3.47E-03	2.08E-03	1.19E-03	0.02	5.29E-01	3.17E-01	2.18E-02	0.02	2.18E-02	0.05
Acrolein	1.07E-03	6.42E-04	3.67E-04	0.01	5.90E-02	3.54E-02	2.43E-03	2.44E-03	2.43E-03	9.73E-03
Benzene	1.01E-01	6.06E-02	3.46E-02	0.69	2.18E-01	1.31E-01	8.98E-03	0.01	0.03	0.70
1,3-Butadiene	n/a	0	0	0.00	3.67E-01	2.20E-01	1.51E-02	0.02	1.51E-02	0.02
Ethylbenzene	6.76E-03	4.06E-03	2.32E-03	0.05	7.11E-02	4.27E-02	2.93E-03	2.94E-03	2.93E-03	0.05
Formaldehyde	n/a	2.05E-01	1.17E-01	2.33	n/a	2.91E+00	2.00E-01	0.20	2.00E-01	2.53
Hexane	1.39E-03	8.34E-04	4.76E-04	0.01	n/a	0	0	0	4.76E-04	9.47E-03
Naphthalene	1.63E-02	9.78E-03	5.59E-03	0.11	2.51E-02	1.51E-02	1.03E-03	1.04E-03	5.59E-03	0.11
PAHs (as B(a)P) (6)	6.21E-05	3.73E-05	2.13E-05	0.00	1.71E-05	1.03E-05	7.06E-07	7.09E-07	2.13E-05	4.24E-04
Toluene	3.74E-02	2.24E-02	1.28E-02	0.25	2.39E-01	1.43E-01	9.84E-03	9.88E-03	1.28E-02	0.26
Xylene	2.68E-02	1.61E-02	9.19E-03	0.18	6.46E-01	3.88E-01	2.66E-02	2.67E-02	2.66E-02	0.21
Total HAPs				3.66				0.29		3.95

Notes:

(1) All factors except formaldehyde are CATEF mean values for large Diesel engines (SCC 20200102 or 20300101) or a natural gas 4S/Lean/>650Hp engine.
https://www.arb.ca.gov/app/emsinv/catef_form.html
Formaldehyde based on RICE NESHAP limit for CI engines (580 ppb).

(2) 40% control efficiency for oxidation catalyst applied for all TACs except formaldehyde. Source: BAAQMD PDOC for Eastshore Energy Center, April 30, 2007. Formaldehyde emission factor is RICE NESHAP limit for diesel engines.

(3) Based on 10 ppm ammonia slip from SCR system.

(4) Based on maximum ICE firing rate of 78.8 MMBtu/hr and default fuel HHV of 138,000 Btu/gal for biodiesel fuel
0.57 Mgal/hr per engine

(5) Based on maximum ICE firing rate (from (4)) for 100% biodiesel fuel.
2,064 Mgal/yr per engine

(6) Based on maximum ICE firing rate of MMft3/hr for RNG
0.07 MMscf per engine

(7) Based on maximum ICE firing rate (from (4)) for 100% RNG.
13 MMscf per engine

(8) Emission factors for individual PAHs weighted by cancer risk relative to B(a)P and summed to obtain overall B(a)P equivalent emission rate for HRA.

	Mean EF Diesel (lb/Mgal)	PEF Equiv.	Weighted EF Diesel (lb/Mgal)	Mean EF NG (lb/MMscf)	PEF Equiv.	Weighted EF NG (lb/MMscf)
PAHs (as B(a)P)						
Benzo(a)anthracene	5.03E-05	0.1	5.03E-06	5.88E-05	0.1	5.88E-06
Benzo(a)pyrene	1.81E-05	1	1.81E-05	2.70E-06	1	2.70E-06
Benzo(b)fluoranthene	7.96E-05	0.1	7.96E-06	4.09E-05	0.1	4.09E-06
Benzo(k)fluoranthene	1.56E-05	0.1	1.56E-06	7.83E-06	0.1	7.83E-07
Chrysene	1.06E-04	0.01	1.06E-06	1.43E-05	0.01	1.43E-07
Dibenz(a,h)anthracene	2.43E-05	1.05	2.55E-05	2.70E-06	1.05	2.84E-06
Indeno(1,2,3-cd)pyrene	2.89E-05	0.1	2.89E-06	7.17E-06	0.1	7.17E-07

Table B-18
Annual and Maximum Hourly HAP Emissions
Case 3: Biodiesel Only

Pollutant	**Biodiesel Emission Factor (1) lb/Mgal**	**Controlled Biodiesel Em Factor (2) lb/Mgal**	**Hourly Emissions per Engine, Biodiesel Firing lb/hr**	**Total Annual Emissions, all Engines Biodiesel Firing (5) tpy**
Ammonia	(3)	n/a	1.15	18.5
Propylene	3.85E-01	2.31E-01	0.13	2.12
Hazardous Air Pollutants				
Acetaldehyde	3.47E-03	2.08E-03	1.19E-03	0.02
Acrolein	1.07E-03	6.42E-04	3.67E-04	0.01
Benzene	1.01E-01	6.06E-02	3.46E-02	0.56
Ethylbenzene	6.76E-03	4.06E-03	2.32E-03	0.04
Formaldehyde	n/a	2.05E-01	1.17E-01	1.88
Hexane	1.39E-03	8.34E-04	4.76E-04	0.01
Naphthalene	1.63E-02	9.78E-03	5.59E-03	0.09
PAHs (as B(a)P) (6)	6.21E-05	3.73E-05	2.13E-05	0.00
Toluene	3.74E-02	2.24E-02	1.28E-02	0.21
Xylene	2.68E-02	1.61E-02	9.19E-03	0.15
Total HAPs				2.95

Notes:
(1) All factors except formaldehyde are CATEF mean values for large Diesel engines (SCC 20200102 or 20300101).
https://www.arb.ca.gov/app/emsinv/catef_form.html
Formaldehyde based on RICE NESHAP limit for CI engines (580 ppb).
(2) 40% control efficiency for oxidation catalyst applied for all TACs except formaldehyde. Source: BAAQMD PDOC for Eastshore Energy Center, April 30, 2007. Formaldehyde emission factor is RICE NESHAP limit for diesel engines.
(3) Based on 10 ppm ammonia slip from SCR system.
(4) Based on maximum ICE firing rate of 78.8 MMBtu/hr and default fuel HHV of 138,000 Btu/gal for biodiesel fuel
0.57 Mgal/hr per engine
(5) Based on maximum ICE firing rate (from (4)) for 100% biodiesel fuel.
1,668 Mgal/yr per engine
(6) Emission factors for individual PAHs weighted by cancer risk relative to B(a)P and summed to obtain overall B(a)P equivalent emission rate for HRA.

PAHs (as B(a)P)	Mean EF Diesel	PEF Equiv.	Weighted EF Diesel
Benzo(a)anthracene	5.03E-05	0.1	5.03E-06
Benzo(a)pyrene	1.81E-05	1	1.81E-05
Benzo(b)fluoranthene	7.96E-05	0.1	7.96E-06
Benzo(k)fluoranthene	1.56E-05	0.1	1.56E-06
Chrysene	1.06E-04	0.01	1.06E-06
Dibenz(a,h)anthracene	2.43E-05	1.05	2.55E-05
Indeno(1,2,3-cd)pyrene	2.89E-05	0.1	2.89E-06

Appendix C

Air Dispersion Modeling Report

AIR QUALITY IMPACT ANALYSIS

Joint Base Pearl Harbor-Hickam / Power Plant Project

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September 2022

Project 224401.0016

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1. INTRODUCTION

This air quality impact analysis (AQIA) is submitted to the State of Hawaii Department of Health (HDOH) for the initial application for a Covered Source Permit (CSP) for a new power plant project to be constructed and operated in Honolulu. The proposed project will be located near the northern end of Joint Base Pearl Harbor-Hickam (JBPHH), north of South Avenue. The generating project is being developed in response to a Request for Proposals from the U.S. Department of the Navy and is intended to provide JBPHH with energy security. The project will also enable the sale of surplus capacity and energy to Hawaiian Electric Company (HECO).

The project developer is proposing to remove several existing warehouse structures located between Russell Avenue and Avenue D and to construct and operate a new electric generating facility in that location. The proposed generating facility will consist of eleven Wärtsilä 20V34 DF dual fuel reciprocating internal combustion engine generators, for a total of 103.1 MW (gross) of new generation.

The Wärtsilä generators are four-stroke compression ignition engines, each rated at 9.4 MW (gross). The engine generators will be permitted to operate with a range of liquid and gaseous fuels, but principally biodiesel, renewable natural gas (biomethane) or a combination of these biofuels. Each generator will be equipped with an emission control system consisting of a Selective Catalytic Reduction system (SCR) for oxides of nitrogen (NO_X) emissions control and oxidation catalysts to control carbon monoxide (CO), volatile organic compound (VOC), and hazardous air pollutant (HAP) emissions; continuous emissions monitoring system (CEMS); and associated support equipment.

Other equipment and facilities to be constructed include water treatment facilities, fire protection and emergency services, a new 69 kilovolt (kV) gas-insulated switchgear (GIS) switchyard, other electrical switchgear and transformers, and an operations and maintenance building.

As required by HDOH rules, the AQIA demonstrates that the project will not cause or contribute to a violation of a State Ambient Air Quality Standard (SAAQS) or National Ambient Air Quality Standard (NAAQS).

2. MODELING METHODOLOGY

Dispersion modeling was used to determine the ambient air quality impacts of the proposed project. All modeling is consistent with HDOH and EPA guidelines, including "40 CFR Part 51, Appendix W - Guideline on Air Quality Models" (*Guideline*).

2.1 Model Selection

EPA's recommended dispersion model, AERMOD (version 22112), was used in the modeling analysis. AERMOD is a steady-state plume model capable of modeling simple, intermediate, and complex terrain receptors. In the stable boundary layer (nighttime), it assumes the concentration distribution to be Gaussian in both the vertical and horizontal. In the convective boundary layer (daytime) the probability density function describing the horizontal distribution is assumed to be Gaussian, while the vertical distribution is assumed to be bi-Gaussian. AERMOD also contains the PRIME algorithm, which incorporates the two fundamental features associated with building downwash: (1) enhanced plume dispersion coefficients due to the turbulent wake, and (2) reduced plume rise caused by a combination of the descending streamlines in the lee of the building and the increased entrainment in the wake. The Building Profile Input Program for PRIME (BPIPPRM version 04274) was used to account for building downwash effects.

The modeling was conducted using AERMOD's regulatory default options. These options include the following:

- The rural dispersion option;
- A uniform Cartesian receptor grid with spacing of 100 meters or less within one kilometer of the source and finer resolution as required to identify maximum impacts; and
- Terrain data developed through AERMAP.

The NO_2 modeling followed the three tier NO_2 modeling approach for the conversion of nitric oxide (NO) to NO_2 described in EPA's *Guideline* Section 4.2.3.4. The three tiers are:

- Tier 1 – Assume total conversion of NO to NO_2.
- Tier 2 – Use the Ambient Ratio Method 2 (ARM2), which multiplies the modeled NO_X impacts by estimates of representative NO_2/NO_X equilibrium ratios based on ambient levels of NO_2 and NO_X. The national default for ARM2 includes a minimum ambient NO_2/NO_X ratio of 0.5 and a maximum ambient ratio of 0.9.
- Tier 3 – Perform a detailed screening analysis on a case-by-case basis. EPA has implemented two Tier 3 options, Ozone Limiting Method (OLM) and Plume Volume Molar Ratio Method (PVMRM), into AERMOD as regulatory options. Both OLM and PVMRM require representative source specific in-stack NO_2/NO_X ratios and background O_3 concentrations. The source specific in-stack NO_2/NO_X ratios are discussed in Section 2.2. The required representative background O_3 concentrations are discussed in Section 2.5. OLM was used for the 1-hour NO_2 project impact and full impact analyses.

AERMOD (starting with version 11059) is capable of calculating the distribution of daily maximum 1-hour values. The daily maximum 1-hour values are calculated when the pollutant ID is either "SO2" or "NO2" and the only short-term averaging period specified is "1-hour." When modeling with 5 years of NWS meteorological data, the receptor-by-receptor 5-year average serves as an unbiased estimate of the 3-year average for comparison to the 1-hour SO_2, 1-hour NO_2, and 24-hour $PM_{2.5}$ NAAQS. Controlling modeled concentrations for the percentile based 1-hour SO_2, 1-hour NO_2, and 24-hour $PM_{2.5}$ NAAQS are as follows:

- The 1-hour SO_2 NAAQS controlling modeled concentration is the 99th percentile (4th high averaged over 5-years) daily maximum 1-hour average SO_2 concentration.
- The 1-hour NO_2 NAAQS controlling modeled concentration is the 98th percentile (8th high averaged over 5-years) daily maximum 1-hour average NO_2 concentration.
- The 24-hour $PM_{2.5}$ NAAQS controlling modeled concentration is the 98th percentile (8th high averaged over 5-years) daily $PM_{2.5}$ concentration.

For comparison to the NAAQS, the background concentrations described in Section 2.5 were added to the controlling modeled concentrations.

2.2 Modeled Project Emissions

The project is comprised of eleven Wärtsilä 20V34DF generating units. The *Guideline* (Section 8.2.2.d) requires changes in operating conditions that affect the physical emission parameters (e.g., release height, initial plume volume, and exit velocity) of the project sources be considered to ensure that maximum project impacts are determined. Therefore, stack parameters and emissions were developed for full load, minimum load, and startup, for both biodiesel and renewable natural gas (RNG) operating scenarios. On an annual basis, the generating units may operate on 100% biodiesel, 100% RNG, or a combination of the two.[1] Table 2-1 lists the modeled UTM coordinates of the proposed units. Table 2-2 lists the modeled emission rates and stack parameters for the proposed units. Figure 2-1 show the proposed site layout.

The stacks will be spaced closely enough for the exhaust plumes to merge, enhancing plume rise. AERMOD does not explicitly account for this enhanced plume rise. However, the use of a pseudo stack diameter in AERMOD based on the total volume flow rate of the adjacent stacks account for the enhanced plume rise. EPA has allowed this technique on a case-by-case basis.[2] The judgement as to whether combining flows is appropriate includes:

- Stack locations – Only stacks located with within 1 diameter of each other are treated as a merged source.
- Stack height and diameter – All of the stacks treated as a merged source have the same stack height and diameter.
- Stack emission parameters (temperature, momentum or volume flow, emission rates, etc.) - All of the stacks treated as a merged source have the same emission parameters.

The proposed stack arrangement meets these criteria, and the EPA-accepted merged plume technique was used in the modeling analysis. The PSD regulations (40 CFR 51.118(a) and 40 CFR 52.21(h)) contain limits on the use of other dispersion techniques. Dispersion techniques are defined in 40 CFR 51.100(hh)(1) as "any technique which attempts to affect the concentration of a pollutant

[1] A third operating scenario evaluated in the application support document reflects starting up the units on RNG to minimize startup emissions, and then switching to biodiesel when RNG supplies are not adequate to support 100% RNG operation. Because the switchover to biodiesel occurs within a few minutes of startup, stack parameters for this mode of operation are the same as stack parameters for 100% biodiesel operation.

[2] Model Clearinghouse Information Storage and Retrieval System Record Details - OH GM Defiance Bubble (97-V-02)

in the ambient air by…increasing final exhaust gas plume rise by… selective handling of exhaust gas streams so as to increase the exhaust gas plume rise." However, 40 CFR 51.100(hh)(2) exempts the merging of exhaust gas streams when the facility is originally designed and constructed with merged gas streams.

Table 2-1. Modeled Stack Locations

Model ID	Description	NAD 83 - Zone 4 UTM Coordinates Easting (m)	Northing (m)	Base Elevation [A] (ft)	(m)
1_3_100	Units 1, 2, & 3	608866.0	2361014.5	19.69	6.0
4_6_100	Units 4, 5, & 6	608864.4	2361011.7	19.69	6.0
7_9_100	Units 7, 8, & 9	608819.8	2361042.7	19.69	6.0
10_11_100	Units 10 & 11	608818.2	2361039.9	19.69	6.0

[A] Base elevations from AERMAP.

Table 2-2. Modeled Stack Parameters and Emissions

Load/ Scenario	Stack Parameters [A]							Per Unit Modeled Emissions (g/s) [A]								NO_2/NO_X In-Stack Ratio [E]
	Diameter		Height		Flow	Velocity	Temp.	SO_2 [B]		NO_X		CO [B]		$PM_{10}/PM_{2.5}$		
	(ft)	(m)	(ft)	(m)	(m^3/s)	(m/s)	(K)	Short-Term	Annual [C]	Short-Term	Annual [C]	1-Hour	8-Hour	Short-Term	Annual [C]	
Wärtsilä 20V34DF - Biodiesel - Individual Stacks																
Startup [D]	4.00	1.219	95.00	28.96	30.20	25.879	593.15	0.0152	0.0051	6.3542	0.6639	0.9941	0.9941	0.5852	0.2046	15%
Full (100%)	4.00	1.219	95.00	28.96	30.20	25.879	593.15	0.0152	0.0044	1.3684	0.3991	0.4763	0.4763	0.5708	0.1665	15%
Min. (50%)	4.00	1.219	95.00	28.96	16.35	14.009	593.15	0.0079	0.0044	0.8102	0.3991	0.2470	0.2470	0.3944	0.1665	15%
Wärtsilä 20V34DF - Renewable Natural Gas - Individual Stacks																
Startup [D]	4.00	1.219	95.00	28.96	27.89	23.894	649.15	0.0079	0.0075	1.8680	0.2685	1.4811	1.4811	0.2585	0.2480	15%
Full (100%)	4.00	1.219	95.00	28.96	27.89	23.894	649.15	0.0079	0.0072	0.2080	0.1907	0.3163	0.3163	0.2533	0.2322	15%
Min. (50%)	4.00	1.219	95.00	28.96	19.77	16.937	674.15	0.0045	0.0072	0.1780	0.1907	0.1802	0.1802	0.1928	0.2322	15%
Wärtsilä 20V34DF - Biodiesel - 3 Merged Stacks																
Startup [D]	6.93	2.111	95.00	28.96	90.61	25.879	593.15	0.0456	0.0152	19.0625	1.9916	2.9824	2.9824	1.7555	0.6139	15%
Full (100%)	6.93	2.111	95.00	28.96	90.61	25.879	593.15	0.0456	0.0133	4.1052	1.1974	1.4289	1.4289	1.7124	0.4995	15%
Min. (50%)	6.93	2.111	95.00	28.96	49.05	14.009	593.15	0.0238	0.0133	2.4306	1.1974	0.7410	0.7410	1.1832	0.4995	15%
Wärtsilä 20V34DF - Bioiesel - 2 Merged Stacks																
Startup [D]	5.66	1.724	95.00	28.96	60.40	25.879	593.15	0.0304	0.0101	12.7084	1.3277	1.9883	1.9883	1.1703	0.4092	15%
Full (100%)	5.66	1.724	95.00	28.96	60.40	25.879	593.15	0.0304	0.0089	2.7368	0.7982	0.9526	0.9526	1.1416	0.3330	15%
Min. (50%)	5.66	1.724	95.00	28.96	32.70	14.009	593.15	0.0159	0.0089	1.6204	0.7982	0.4940	0.4940	0.7888	0.3330	15%
Wärtsilä 20V34DF - Renewable Natural Gas - 3 Merged Stacks																
Startup [D]	6.93	2.111	95.00	28.96	83.66	23.894	649.15	0.0236	0.0226	5.6039	0.8055	4.4434	4.4434	0.7756	0.7439	15%
Full (100%)	6.93	2.111	95.00	28.96	83.66	23.894	649.15	0.0236	0.0216	0.6240	0.5720	0.9489	0.9489	0.7599	0.6966	15%
Min. (50%)	6.93	2.111	95.00	28.96	59.30	16.937	674.15	0.0136	0.0216	0.5340	0.5720	0.5406	0.5406	0.5784	0.6966	15%
Wärtsilä 20V34DF - Renewable Natural Gas - 2 Merged Stacks																
Startup [D]	5.66	1.724	95.00	28.96	55.77	23.894	649.15	0.0157	0.0151	3.7359	0.5370	2.9623	2.9623	0.5170	0.4959	15%
Full (100%)	5.66	1.724	95.00	28.96	55.77	23.894	649.15	0.0157	0.0144	0.4160	0.3813	0.6326	0.6326	0.5066	0.4644	15%
Min. (50%)	5.66	1.724	95.00	28.96	39.53	16.937	674.15	0.0091	0.0144	0.3560	0.3813	0.3604	0.3604	0.3856	0.4644	15%

[A] Stack parameters and emissions based on manufacturer data. The listed modeled emissions for the merged stacks are the total emissions from the multiple units.

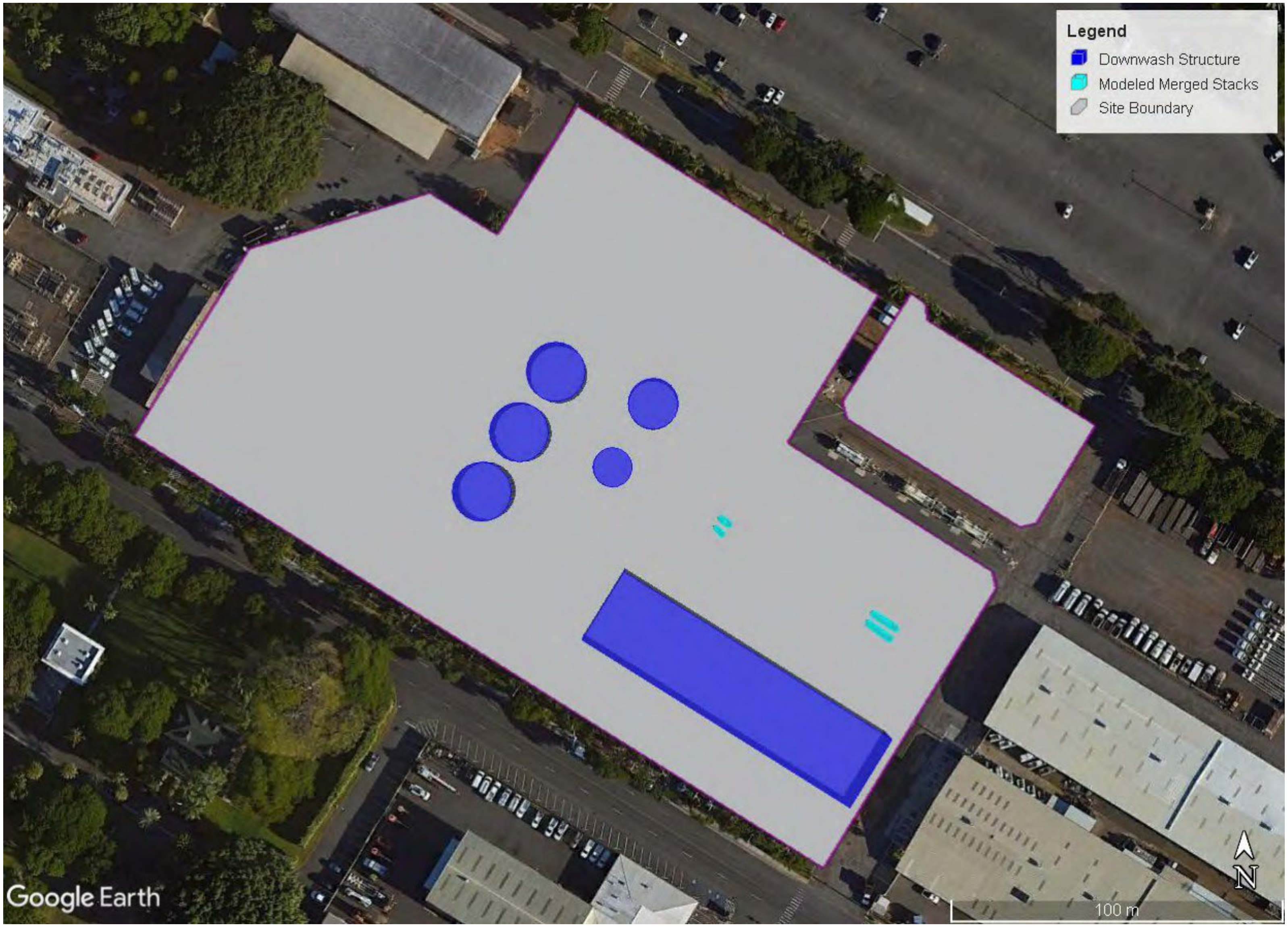
[B] The maximum hourly SO_2 and CO emission rates were modeled for all short-term averaging periods.

[C] The modeled annual emission rates for the startup scenario are based on the proposed PTE. The modeled annual emission rates for the full and min. load scenarios are based on the proposed annual operating hour limit and the maximum hourly emission rate during normal operations.

[D] During startup, the units reach the 100% load within 5 minutes of the initial firing. Therefore, the stack parameters are based on the 100% load. The modeled short-term (24-hour) $PM_{10}/PM_{2.5}$ emissions rate is based on 1 startup hour and 23 hours of 100% load operation.

[E] The NO_2/NO_X in-stack ratios are used in NO_2 modeling.

Figure 2-1. Site Layout



During startup, the engines reach full load within 5 to 10 minutes of the initial firing. The SCR and oxidation catalyst systems become fully functional once the respective catalyst reaches the operating temperature, within 30 minutes following initiation of fuel flow. The time for each catalyst to reach the operating temperature is dependent on how long the unit was shut down. The oxidation catalysts reach their operating temperature before the SCR catalysts. Startup emissions were evaluated for the following scenarios:

- Cold Startup – when the catalyst temperature is close to ambient temperature. Cold starts are expected after overhaul periods or when the engine has not been operated during the last 24 hours.
- Warm Startup – when the catalyst temperature is above ambient but less than 100 °C. Warm starts are expected after the engine has been shut down for more than 12 hours but less than 24 hours.
- Hot Startup – when the catalyst temperature is greater than 100 °C. Hot starts are expected after the engine has been operated within the previous 12 hours.

The short-term startup emissions are based on the worst-case startup scenario (cold catalysts). The long-term startup emissions are based on worst-case expected operation of the proposed units. Unit shutdowns occur very quickly and emissions greater than normal levels during shutdowns are not expected.

Tier 3 NO_2 modeling using OLM requires a source specific NO_2/NO_X in-stack ratio. Based on the review of data for similar units from EPA's NO_2/NO_X In-Stack Ratio (ISR) Database a source specific NO_2/NO_X in-stack ratio of 15% is used for the proposed units. The supporting data for the selected NO_2/NO_X in-stack ratios of 15% for diesel engines with a displacement of greater than 30 liters per cylinder is summarizes below:

- Dutch Harbor Power Plant tested a Wärtsilä Model 12V32C DEG. EPA's ISR Database lists a NO_2/NO_X in-stack ratio of 5.52% for the 50% load.
- Dutch Harbor Power Plant tested a Caterpillar C-280 DEG. EPA's ISR Database lists a NO_2/NO_X in-stack ratio of 4.5% for the 100% load.
- Tor Viking II tested a MaK/6M32 (rated at 3,784 hp) main propulsion diesel engine equipped with SCR and diesel oxidation catalyst. EPA's Alpha ISR Database lists NO_2/NO_X in-stack ratios for 30%, 40%, 60%, and 80% loads ranging from 4.24% to 15.93%. Of the 7 tests listed, only one had an in-stack ratio greater than 15%.
- Tor Viking II tested a MaK/8M32 (rated at 5,046 hp) main propulsion diesel engine equipped with SCR and diesel oxidation catalyst. EPA's Alpha ISR Database lists NO_2/NO_X in-stack ratios for 30%, 40%, and 80% loads ranging from 4.71% to 9.27%.
- Vladimir Ignatuk tested a Stork/8TM410 (rated at 5,720 hp) main propulsion diesel engine. EPA's Alpha ISR Database lists NO2/NOX in-stack ratios for 40%, 60%, and 80% loads ranging from 8.16% to 14.79%.

The data from these units support the use of a 15% source specific NO_2/NO_X in-stack ratio for the proposed units.

2.3 AERMOD Meteorological Data

AERMOD uses several different boundary layer parameters to model how pollutants disperse in the atmosphere. Many of these parameters are not directly measured but are calculated from other variables that are more easily measured. AERMET, EPA's meteorological processor for AERMOD, uses observed near-surface wind and temperature and site-specific surface characteristics to estimate these boundary layer parameters. The following surface characteristics are input into AERMET during the processing:

- ► Surface roughness length (z_o) – the height above the ground at which horizontal wind velocity is typically zero,
- ► Noon-time albedo (r) – the fraction of radiation reflected by the surface, and
- ► Daytime Bowen ratio (B_o) – the ratio of the sensible heat flux (H) to the latent heat flux (λE).

In the AERMOD Implementation Guide, EPA recommends the following methodology to determine these surface characteristics:

1. The determination of the surface roughness length should be based on an inverse-distance weighted geometric mean for a default upwind distance of 1 km relative to the measurement site. Surface roughness length may be varied by sector to account for variations in land cover near the measurement site; however, the sector widths should be no smaller than 30 degrees.
2. The determination of the Bowen ratio should be based on a simple unweighted geometric mean (i.e., no direction or distance dependency) for a representative domain, with a default domain defined by a 10 km by 10 km region centered on the measurement site.
3. The determination of the albedo should be based on a simple unweighted arithmetic mean (i.e., no direction or distance dependency) for the same representative domain as defined for Bowen ratio, with a default domain defined by a 10 km by 10 km region centered on the measurement site.

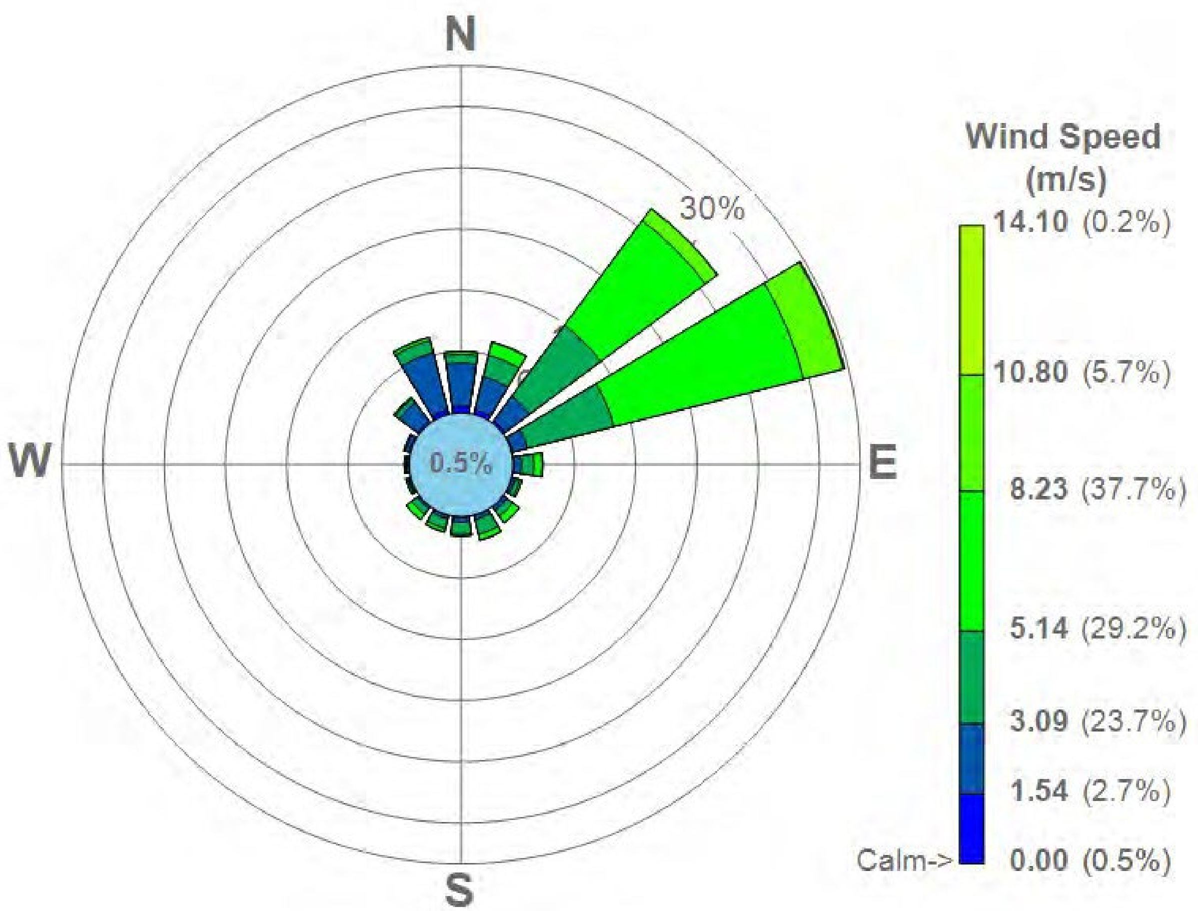
EPA developed AERSURFACE to calculate the surface characteristics based on this recommended methodology. AERSURFACE reads land cover, impervious surface, and tree canopy data from the United States Geological Survey (USGS) National Land Cover Dataset (NLCD). The AERSURFACE analysis used the newest dataset available for Hawaii and compatible with AERSURFACE. Meteorological surface data collected at the Honolulu International Airport (PHNL) meteorological monitoring station was used in the AQIA. Figure 2-2 shows the location of the PHNL meteorological monitoring station and the project site. Although there was previously a meteorological monitoring station for Hickam Air Force Base (PHIK, part of Joint Base Pearl Harbor-Hickam), data collection at PHIK was discontinued in 2016.

Figure 2-2. Project Site and Meteorological Monitoring Station Locations

EPA modeling guidance states that the determination of representativeness of meteorological data should include a comparison of factors such as surface characteristics of the measurement site and source locations, surrounding land use, wind roses and significant terrain features. The PHNL meteorological data monitoring site is located approximately 2.5 miles southeast of the project site. No major geographic features impacting the surface conditions or wind patterns exist between the two locations. The facility location with historical prevailing wind direction predominantly northeasterly winds is consistent with persistent trade winds and local terrain considerations. The land uses surrounding the meteorological monitoring site and the project site are similar.

In the *Guideline*, EPA states that five (5) years of NWS meteorological data are adequate to ensure that worst-case meteorological conditions are represented in the model results. A five-year dataset is also recommended by HDOH. The meteorological data was compiled using EPA's AERMOD processor and pre-processors AERMINUTE (version 15272), AERMET (version 22112) and AERSURFACE (version 20060) using the ADJ_U* option, and include the period of January 1, 2017, through December 31, 2021. Figure 2-3 shows the wind rose for meteorological data collected at the PHNL monitoring station.

Figure 2-3. PHNL Wind Rose (2017-2021)



2.4 AERMOD Receptor Data and Modeling Domain

The modeling grid consist of:

- 25-m spaced receptors along the fence line (i.e., that area to which public access is physically restricted),
- 50-m spaced receptors centered at the project property to 0.5 km,
- 100-m spaced receptors from 0.5 km to 2.5 km,
- 500-m spaced receptors from 2.5 km to 5.0 km, and
- 1,000-m spaced receptors from 5.0 km to 10 km.

The maximum impacts are located in simple terrain and within the 50-m spaced receptors. Therefore, additional receptors were not needed to identify the maximum impact.

EPA's AERMAP (version 18081) program determined the receptor elevations and height scales. AERMOD uses the receptor's height scale to determine if the plume is terrain following or terrain impacting. The AERMAP User's Guide states that the domain boundary must include all terrain features that exceed a 10% elevation slope from any given receptor. USGS National Elevation Dataset (NED) 1/3 arc-second data was used to identify all terrain features surrounding the project site.

2.5 Background Concentrations

The impacts of existing sources are represented by the existing ambient air quality data collected at nearby monitoring stations. In accordance with Section 8.3.1 of Appendix W to 40 CFR Part 51: Background concentrations are an essential part of the total air quality concentration to be considered in determining source impacts. Background air quality includes pollutant concentrations due to: (1) nearby sources, and (2) other sources, the portion of the background attributable to natural sources, other unidentified sources in the vicinity of the project, and regional transport contributions from more distant sources (domestic and international). Ambient air quality data was used to establish background concentrations in the vicinity of the project site. The monitoring stations used to provide background data for the proposed project are listed in Table 2-3.

Table 2-3. Monitoring Station Locations

Pollutant	Monitoring Station
NO_2	Kapolei
SO_2	Downtown Honolulu
O_3	Sand Island
CO	Downtown Honolulu
PM_{10}	Pearl City
$PM_{2.5}$	Pearl City

As outlined in 40 CFR 51, Appendix W, Section 8.2, the background data used to evaluate the potential air quality impacts need not be collected on a project site, as long as the data are representative of the air quality in the subject area. The following three criteria were used for determining whether the background data is representative: (1) location, (2) data quality, and (3) data currentness. These criteria are defined and apply to the project as follows:

- Location: The measured data must be representative of the areas where the maximum concentration occurs for the proposed stationary source, existing sources, and a combination of the proposed and existing sources. Each of the monitoring stations listed in Table 2-3 is the station nearest to the proposed project site, and each station has been sited to monitor population exposure and/or maximum concentration. Figure 2-4 shows the location of the project related to the monitoring stations.
- Data quality: Data must be collected and equipment must be operated in accordance with the requirements of 40 CFR Part 58, Appendices A and B, and PSD monitoring guidance. The HDOH and EPA ambient air quality data summaries have been used as the primary sources of data. Therefore, the data listed in Table 2-4 meet the data quality requirements of 40 CFR Part 58, Appendices A and B, and PSD monitoring guidance.
- Data currentness: The data are current if they have been collected within the preceding 3 years and are representative of existing conditions. The maximum ambient background concentrations from the period 2018 – 2020 are combined with the modeled concentrations and used for comparison to the ambient air quality standards. Therefore, the data listed in Table 2-4 represent the three most recent years of data available.

Figure 2-4. Locations of Background Monitoring Stations

Based on the criteria presented above, the maximum of the three most recent years of background NO_2, CO, SO_2, PM_{10} and $PM_{2.5}$ data from the listed monitoring stations are combined with the modeled concentrations and for comparison to the ambient air quality standards, as applicable. A summary of the background concentrations is presented in Table 2-4 below. Background values for state and federal standards are shown separately when necessary to reflect the form of the standard and the monitor sampling methods.

In accordance with USEPA guidelines, the highest second-highest modeled concentrations are used to demonstrate compliance with the short-term federal standards (except for the statistically based federal one-hour NO_2 and SO_2, and 24-hour $PM_{2.5}$ standards, discussed in Section 2.1 above) and the highest modeled concentration are used to demonstrate compliance with the federal annual standards and all state standards. If the predicted total ground-level concentration is below the state or federal ambient air quality standard for each pollutant and averaging period, no further analysis is required for that pollutant and averaging period.

Table 2-4. Background Concentrations from Representative Monitoring Stations in the Project Area

Pollutant	Averaging Period	Ambient Standard	Monitored Background Concentration			Maximum Concentration	
			2018	2019	2020		
NO_2	1-hour[a] – federal std Annual – state std	100 ppb 40 ppb	30 ppb 4 ppb	29 ppb 4 ppb	27 ppb 3 ppb	30 ppb 4 ppb	56.4 μg/m^3 7.5 μg/m^3
SO_2	1-hour[b] – federal std 3-hour – state std 24-hour – state std Annual – state std	75 ppb 500 ppb 140 ppb 30 ppb	5 ppb 9 ppb 2 ppb 1 ppb	4 ppb 1 ppb 1 ppb <1 ppb	3 ppb 1 ppb 1 ppb <1 ppb	5 ppb 9 ppb 2 ppb 1 ppb	13.1 μg/m^3 23.6 μg/m^3 5.2 μg/m^3 2.6 μg/m^3
CO	1-hour – state std 8-hours – state std	9 ppm 4.4 ppm	1.0 ppm 0.8 ppm	1.4 ppm 0.8 ppm	0.9 ppm 0.6 ppm	1.4 ppm 0.8 ppm	1,602 μg/m^3 915 μg/m^3
PM_{10}	24-hour – state std Annual[c] – state std	150 μg/m^3 50 μg/m^3	34 μg/m^3 14.4 μg/m^3	36 μg/m^3 --[f]	28 μg/m^3 11.7 μg/m^3	36 μg/m^3 14.4 μg/m^3	
$PM_{2.5}$	24-hour[d] – federal std Annual[e] – federal std	35 μg/m^3 12 μg/m^3	12 μg/m^3 3.3 μg/m^3	9.8 μg/m^3 3.6 μg/m^3	7.2 μg/m^3 3.2 μg/m^3	12 μg/m^3 3.6 μg/m^3	

Source: PM_{10} and $PM_{2.5}$ from Pearl City; SO_2 and CO from Downtown Honolulu; NO_2 from Kapolei. 2018, 2019, and 2020 data from State of Hawaii Annual Summaries of Air Quality Data (https://health.hawaii.gov/cab/hawaii-air-quality-data-books).

Notes:

a. 3-year average 98th percentile design values are listed.
b. 3-year average 99th percentile design values are listed.
c. Three-year maximum annual average.
d. 3-year average 98th percentile design values are listed.
e. 3-year average design values are listed.
f. Reporting error.

Tier 3 NO_2 OLM modeling requires concurrent hourly O_3 data. HDOH's Sand Island AQM station supplies the required O_3 data. HDOH's Sand Island AQM station is the state's SLAMS O_3 monitor and is located at the University of Hawai'i's Ānuenue Fisheries. This area is composed of light industrial, commercial, recreational, and harbor units and is approximately 1.5 km southwest (typically downwind) of downtown Honolulu. Hourly O_3 data were obtained from EPA's Air Quality System (AQS) Data Mart for the 5-year period of the NWS meteorological data. Missing observations were filled using the following three step approach:

1. When one or two consecutive hours are missing, interpolation was used to fill these missing values.
2. When three or more consecutive hours are missing, the missing values were filled with the maximum concentration from the same hour from the previous and following day.
3. When three or more consecutive hours are missing and both concentrations for the same hour from the previous and following day are missing, missing values were filled with the maximum concentration from the same hour from the entire calendar year.

Table 2-5 lists the number of times each method was used. The use of the maximum hourly concentrations for data gaps greater than two hours is not expected to result in an underestimation of the missing O_3 concentrations.

Table 2-5. Summary of Methods Used to Fill Missing Ozone Data

Missing Data Fill Method	2017	2018	2019	2020	2021	Total
Filled with interpolation	97	132	116	106	104	555
Filled with the maximum concentrations from the same hour from the previous or following day	233	198	55	56	177	719
Filled with the maximum concentrations from the same hour from the entire year	400	805	184	0	546	1,935
Total	**730**	**1,135**	**355**	**162**	**827**	**3,209**

Source: Hourly O_3 data from HDOH's Sand Island monitoring station was downloaded from EPA's AQS Data Mart.

2.6 GEP Stack Height and Building Downwash

For air quality modeling purposes, the proposed new units were evaluated in terms of their proximity to nearby structures to determine whether stack effluents may be affected by downwash in the turbulent wake of such structures. AERMOD uses the following building parameters to account for downwash:

- BUILDHGT, the building height,
- BUILDWID, the projected width of the building perpendicular to the flow,
- BUILDLEN, the projected length of the building along the flow,
- XBADJ, the along-flow distance from the stack to the center of the upwind face of the projected building, and
- YBADJ, the across-flow distance from the stack to the center of the upwind face of the projected building.

Building parameters were obtained using EPA's Building Profile Input Program designed for AERMOD (BPIPPRM – version 04274). BPIPPRM calculates the building parameters for 36 wind directions based on the physical dimensions of the structures surrounding a source. Trinity reviewed information from Google Earth and determined that off-site buildings do not need to be included in the modeling. The BPIPPRM input and output files are included with the modeling files.

The *Guideline* states the use of stack heights greater than the Good Engineering Practice (GEP) stack height in the modeling is prohibited (40 CFR §51.118 and 40 CFR §51.164). Per 40 CFR §51.100 the GEP stack height limit for this project is the greater of:

- 65 meters, measured from the ground-level elevation at the base of the stack, or
- The formula GEP stack height ($GEP_f = H + 1.5L$). Where, H is the structure height, and L is the lesser dimension of the structure (height or projected width).

The proposed stack heights of 28.96 meters (95 ft) are close to the formula GEP stack heights and less than the 65-meter limit; therefore, the stack heights are within acceptable limits.

3. AMBIENT IMPACT MODELING RESULTS

This section describes the modeling methodology used to demonstrate the proposed project does not cause or contribute to the violation of any NAAQS or SAAQS. The air quality dispersion modeling analyses is organized into two major sub-sections based on U.S. EPA modeling guidance: the Significance Analysis and the Full Impact Analysis. Per U.S. EPA guidance, the Significance Analysis considers the emissions associated only with the proposed project to determine whether they have a significant impact upon the surrounding area. The modeled ground-level concentrations of the Significance Analysis are compared to the corresponding significant impact levels (SILs) to determine whether any modeled ground-level concentrations are greater than the SIL at any receptor (defined as "significant" receptors). When the Significance Analysis reveals that modeled ground-level concentrations for a particular pollutant and averaging period exceeded the applicable SIL at any modeled receptor, a Full Impact Analysis is performed. Each analysis conducted is discussed in detail below. Appendix A contains listings of the modeling files.

3.1 Significance Analysis

The significant impact analysis determines the potential of the project to cause or contribute to a violation of any NAAQS/SAAQS. When screening or refined modeling indicates that the project will not cause or contribute to any potential violation of any applicable standard, then the significant impact analysis is generally sufficient for the required demonstration. Table 3-1 lists the modeling SILs that used to determine if the project has the potential to cause or contribute to a violation.

Table 3-1. Modeling Significant Impact Level

Pollutant	Averaging Period	Significant Impact Level (µg/m^3)
NO_2	1-hour Annual	7.5[a] 1[b]
SO_2	1-hour 3-hour 24-hour Annual	7.8[c] 25[b] 5[b] 1[b]
CO	1-hour 8-hour	2,000[b] 500[b]
PM_{10}	24-hour Annual	5[b] 1[b]
$PM_{2.5}$	24-hour Annual	1.2[d] 0.2[d]

Source:

a. EPA's Stephen D. Page memorandum, dated June 29, 2010, "Guidance Concerning the Implementing the 1-hr NO2 National Ambient Air Quality Standard in Prevention of Significant Deterioration Permits," recommends a 1-hr NO^2 SIL of 4 ppb (7.5 µg/m^3).
b. Table C-4 (page C.28) of the October 1990 Draft New Source Review Workshop Manual.
c. EPA's Stephen D. Page memorandum, dated August 23, 2010, "Guidance Concerning the Implementation of the 1-hour SO_2 NAAQS for the Prevention of Significant Deterioration Program," recommends a 1-hour SO_2 SIL of 3 ppb (7.8 µg/m^3).
d. EPA's Peter Tsirigotis memorandum, dated April 17, 2018, "Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program"

As previously discussed, the project impact analysis evaluated the units while operating under full load, minimum load, and startup conditions. The following steps were followed for the project impact analysis:

1. Determine the project's maximum impact for all receptors for all averaging periods for the three operating conditions (full load, minimum load, and startup) with all units operating simultaneously.
2. Compare the project's maximum impact identified in step 1 with the SILs listed in Table 3-1.
3. Compare the project's full load impacts with the SILs listed in Table 3-1.

Since the project consist of eleven identical units, the project impact modeling, except for the 1-hour NO_2 modeling using OLM, was conducted using unit impact modeling. During startup, the units are expected to reach full load within 5 to 10 minutes of the initial firing. Therefore, the modeled stack parameters and resulting normalized unit impact for the startup and full load scenarios are identical. Table 3-2 and Table 3-3 list the unit impacts for the startup/full load and minimum load scenarios for the Biodiesel and RNG operating scenarios, respectively. The project's secondary $PM_{2.5}$ impacts were included based on EPA's worst-case Modeled Emission Modeled Emission Rates for Precursors (MERPs)[3] for the West and Northwest climate zones. Table 3-4 shows the project's secondary $PM_{2.5}$ impact calculation. Table 3-5 and Table 3-6 shows the modeled project emission rates, unit impact multiplier and the resulting project impacts for the startup, full load, and minimum load scenarios for the Biodiesel and RNG operating scenarios, respectively. Table 3-5 and Table 3-6 also show the comparison of the project impacts to the respective SIL.

Table 3-2. Summary of Unit Impacts (Biodiesel only)

Scenario [A]	Source Group	Maximum Unit Impact (µg/m³ per g/s) - Across 5-Yrs [B]				
		1-hr	3-hr	8-hr	24-hr	Annual [C]
Startup/Full Load	FULL	6.47201	6.10130	5.20113	4.00648	0.46683
Min. Load	MIN	11.76079	9.49942	8.48794	7.59460	1.47324
Scenario	**Source Group**	**Maximum Annual Unit Impact (µg/m³ per g/s) [C]**				
		2017	**2018**	**2019**	**2020**	**2021**
Startup/Full Load	FULL	0.33611	0.37836	0.32017	0.43060	0.46683
Min. Load	MIN	0.99053	1.13528	0.96045	1.29621	1.47324
Scenario	**Source Group**	**Maximum Unit Impact (µg/m³) - 5-Yrs Average [D]**				
					24-Hr	**Annual**
Startup/Full Load	FULL				3.12363	0.38640
Min. Load	MIN				6.67425	1.17114

[A] The modeling was conducted using EPA's AERMOD dispersion model (version 21112).

[B] The listed values are the maximum unit impacts from the 5 years (2017-2021) of modeled meteorological data.

[C] The listed values are the maximum annual unit impacts from each of the 5 years (2017-2021) of modeled meteorological data.

[D] The listed values are the maximum 5-year (2017-2021) average impacts used for the $PM_{2.5}$ project impact modeling.

[3] EPA's Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (EPA-454/R-19-003), dated April 2019

Table 3-3. Summary of Unit Impacts (RNG only)

Scenario [A]	Source Group	Maximum Unit Impact (μg/m³ per g/s) - Across 5-Yrs [B]				
		1-hr	3-hr	8-hr	24-hr	Annual [C]
Startup/Full Load	FULL	6.82382	6.50560	5.51114	4.38823	0.49618
Min. Load	MIN	9.82579	7.97167	7.23932	6.40442	0.95906
Scenario	**Source Group**	**Maximum Annual Unit Impact (μg/m³ per g/s) [C]**				
		2017	**2018**	**2019**	**2020**	**2021**
Startup/Full Load	FULL	0.35709	0.39978	0.33799	0.45609	0.49618
Min. Load	MIN	0.64582	0.73245	0.62129	0.84269	0.95906
Scenario	**Source Group**	**Maximum Unit Impact (μg/m³) - 5-Yrs Average [D]**				
					24-Hr	**Annual**
Startup/Full Load	FULL				3.47765	0.40901
Min. Load	MIN				5.39645	0.76026

[A] The modeling was conducted using EPA's AERMOD dispersion model (version 21112).

[B] The listed values are the maximum unit impacts from the 5 years (2017-2021) of modeled meteorological data.

[C] The listed values are the maximum annual unit impacts from each of the 5 years (2017-2021) of modeled meteorological data.

[D] The listed values are the maximum 5-year (2017-2021) average impacts used for the $PM_{2.5}$ project impact modeling.

Table 3-4. MERP Based Estimated Secondary $PM_{2.5}$

Precursor	Precursor Emissions [A] (tpy)	MERP [B] Daily PM (tpy)	MERP [B] Annual PM (tpy)
NO_X	243.4	1,073	3,182
SO_2	2.9	188	2,331
MERP Critical Threshold (μg/m³)		1.2	0.2
Project % of MERP		24.2%	7.8%
MERP Secondary $PM_{2.5}$		0.2906	0.01555

[A] The listed precursor emissions are the worst-case project emissions.

[B] The listed MERPs are from EPA's *Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program* (EPA-454/R-19-003), dated April 2019. The lowest (worst-case) MERPs for the West and Northwest climates zones from Table 4-1 were selected.

Table 3-5. Project Impact Modeling Results (Biodiesel)

	Pollutant	Averaging Period	Total Emission Rate [A] (g/s)	Unit Impact [B] ($\mu g/m^3$ per g/s)	Total Impact [A] ($\mu g/m^3$)	Significant Impact Level ($\mu g/m^3$)	Notes
Startup	SO_2	1-hr	0.167	6.47201	1.083	7.8	Max (H1H)
		3-hr	0.167	6.10130	1.021	25	
		24-hr	0.167	4.00648	0.670	5	
		Annual	0.056	0.46683	0.026	1	
	PM_{10}	24-hr	6.437	4.00648	25.789	5	24-hr average emissions
		Annual	2.251	0.46683	1.051	1	
	$PM_{2.5}$ [C]	24-hr	6.437	3.12363	20.397	1.2	24-hr average emissions
		Annual	2.251	0.38640	0.885	0.2	
	NO_2 (OLM) [D]	1-hr			141.766	7.5	Max (H1H) - Continuous Startup [E]
	NO_X as NO_2	Annual	7.303	0.46683	3.409	1	
	CO	1-hr	10.936	6.47201	70.775	2,000	Continuous Startup [E]
		8-hr	10.936	5.20113	56.877	500	Continuous Startup [E]
100% Load	SO_2	1-hr	0.167	6.47201	1.083	7.8	Max (H1H)
		3-hr	0.167	6.10130	1.021	25	
		24-hr	0.167	4.00648	0.670	5	
		Annual	0.049	0.46683	0.023	1	
	PM_{10}	24-hr	6.279	4.00648	25.156	5	
		Annual	1.831	0.46683	0.855	1	
	$PM_{2.5}$ [C]	24-hr	6.279	3.12363	19.903	1.2	
		Annual	1.831	0.38640	0.723	0.2	
	NO_2 (OLM) [D]	1-hr			76.194	7.5	Max (H1H)
	NO_X as NO_2	Annual	4.390	0.46683	2.050	1	
	CO	1-hr	5.239	6.47201	33.909	2,000	
		8-hr	5.239	5.20113	27.250	500	
Min. Load	SO_2	1-hr	0.087	11.76079	1.026	7.8	Max (H1H)
		3-hr	0.087	9.49942	0.829	25	
		24-hr	0.087	7.59460	0.662	5	
		Annual	0.049	1.47324	0.072	1	
	PM_{10}	24-hr	4.338	7.59460	32.948	5	
		Annual	1.831	1.47324	2.698	1	
	$PM_{2.5}$ [C]	24-hr	4.338	6.67425	29.246	1.2	
		Annual	1.831	1.17114	2.160	0.2	
	NO_2 (OLM) [D]	1-hr			73.907	7.5	Max (H1H)
	NO_X as NO_2	Annual	4.390	1.47324	6.468	1	
	CO	1-hr	2.717	11.76079	31.954	2,000	
		8-hr	2.717	8.48794	23.062	500	

[A] The listed total emission rate and total impact reflect the total from all 11 units.

[B] The modeling was conducted using EPA's AERMOD dispersion model (version 21112).

[C] Includes secondary $PM_{2.5}$, based on EPA's worst-case MERPs for the West and Northwest climites zones.

[D] Maximum daily 1-hr concentration averaged over 5 years

[E] The startup scenario modeling is based on all 11 units starting in the same hour and an unlimited number of startups.

Below Significant Impact Level | Above Significant Impact Level

Table 3-6. Project Impact Modeling Results (RNG)

Scenario	Pollutant	Averaging Period	Total Emission Rate [A] (g/s)	Unit Impact [B] ($\mu g/m^3$ per g/s)	Total Impact [A] ($\mu g/m^3$)	Significant Impact Level ($\mu g/m^3$)	Notes
Startup	SO_2	1-hr	0.086	6.82382	0.590	7.8	Max (H1H)
		3-hr	0.086	6.50560	0.563	25	
		24-hr	0.086	4.38823	0.380	5	
		Annual	0.083	0.49618	0.041	1	
	PM_{10}	24-hr	2.844	4.38823	12.479	5	24-hr average emissions
		Annual	2.728	0.49618	1.353	1	
	$PM_{2.5}$ [C]	24-hr	2.844	3.47765	10.180	1.2	24-hr average emissions
		Annual	2.728	0.40901	1.131	0.2	
	NO_2 (OLM) [D]	1-hr			97.751	7.5	Max (H1H) - Continuous Startup [E]
	NO_x as NO_2	Annual	2.953	0.49618	1.465	1	
	CO	1-hr	16.292	6.82382	111.177	2,000	Continuous Startup [E]
		8-hr	16.292	5.51114	89.790	500	Continuous Startup [E]
100% Load	SO_2	1-hr	0.086	6.82382	0.590	7.8	Max (H1H)
		3-hr	0.086	6.50560	0.563	25	
		24-hr	0.086	4.38823	0.380	5	
		Annual	0.079	0.49618	0.039	1	
	PM_{10}	24-hr	2.786	4.38823	12.227	5	
		Annual	2.554	0.49618	1.267	1	
	$PM_{2.5}$ [C]	24-hr	2.786	3.47765	9.980	1.2	
		Annual	2.554	0.40901	1.060	0.2	
	NO_2 (OLM) [D]	1-hr			12.863	7.5	Max (H1H)
	NO_x as NO_2	Annual	2.097	0.49618	1.041	1	
	CO	1-hr	3.479	6.82382	23.742	2,000	
		8-hr	3.479	5.51114	19.175	500	
Min. Load	SO_2	1-hr	0.050	9.82579	0.490	7.8	Max (H1H)
		3-hr	0.050	7.97167	0.398	25	
		24-hr	0.050	6.40442	0.320	5	
		Annual	0.079	0.95906	0.076	1	
	PM_{10}	24-hr	2.121	6.40442	13.582	5	
		Annual	2.554	0.95906	2.450	1	
	$PM_{2.5}$ [C]	24-hr	2.121	5.39645	11.735	1.2	
		Annual	2.554	0.76026	1.957	0.2	
	NO_2 (OLM) [D]	1-hr			14.253	7.5	Max (H1H)
	NO_x as NO_2	Annual	2.097	0.95906	2.011	1	
	CO	1-hr	1.982	9.82579	19.477	2,000	
		8-hr	1.982	7.23932	14.350	500	

[A] The listed total emission rate and total impact reflect the total from all 11 units.

[B] The modeling was conducted using EPA's AERMOD dispersion model (version 21112).

[C] Includes secondary $PM_{2.5}$, based on EPA's worst-case MERPs for the West and Northwest climites zones.

[D] Maximum daily 1-hr concentration averaged over 5 years

[E] The startup scenario modeling is based on all 11 units starting in the same hour and an unlimited number of startups.

Below Significant Impact Level | Above Significant Impact Level

Based on the results of the significant impact analysis a full impact analysis is required for NO_2, $PM_{2.5}$, and PM_{10}. The results of the full impact analysis are presented in the following section.

3.2 Full Impact Analysis

A Full Impact Analysis was conducted for NO_2, $PM_{2.5}$, and PM_{10}. The NAAQS/SAAQS are maximum concentration limits measured in terms of the total concentration of a pollutant in the atmosphere. To ensure compliance with the NAAQS/SAAQS the significant project impacts are added to the representative background concentration. The representative background concentration includes the impact of other nearby and distant sources.

Table 3-7 and Table 3-8 compare the combined impact of the proposed project under worst-case operating conditions (from Table 3-5 and Table 3-6) and background to the respective NAAQS or SAAQS for the Biodiesel and RNG operating scenarios, respectively. Table 3-9 and Table 3-10 compare the combined impact of the proposed project under full load operating conditions and background to the respective NAAQS or SAAQS for the Biodiesel and RNG operating scenarios, respectively. These results show the project, in either operating scenario, does not cause or contribute to an exceedance for any NAAQS or SAAQS.

Table 3-7. NAAQS/SAAQS Analysis Results (Biodiesel – Worst-Case Scenario)

Pollutant[1]	Averaging Period[1]	Modeled Years	Controlling Scenario	Description	Modeled GLC_{max} ($\mu g/m^3$)	Secondary $PM_{2.5}$ Concentration[2] ($\mu g/m^3$)	Background Concentration[3] ($\mu g/m^3$)	Combined Maximum Impact[4] ($\mu g/m^3$)	SAAQS/ NAAQS ($\mu g/m^3$)	Below SAAQS/ NAAQS?
NO_2 [5]	1-hr	2017-2021	Startup	Project Only - OLM - (H8H averaged over 5-years)	120.6	--	56.4	177.0	188	Yes
NO_X as NO_2	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	6.47	--	7.5	14.0	100	Yes
$PM_{2.5}$	24-hr	2017-2021	Min Load	Project Only (H8H averaged over 5-years)	21.38	0.291	12.0	33.7	35	Yes
	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	2.14	0.016	3.6	5.8	12	Yes
PM_{10}	24-hr	2017-2021	Min Load	Project Only (H1H across 5-years)	32.95	--	36.0	68.9	150	Yes
	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	2.70	--	14.4	17.1	50	Yes

[1] A NAAQS analysis is only required for pollutants and averaging periods with project impacts greater than or equal to the corresponding SIL.
[2] Secondary $PM_{2.5}$ concentrations are estimated using EPA's Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (EPA-454/R-19-003), dated April 2019. The lowest (worst-case) MERPs for the West and Northwest climates zones from Table 4-1 were selected.
[3] The background concentrations are based on DOH monitoring data: NO_2 concentrations are from the Kapolei monitor, $PM_{2.5}$ and PM_{10} concentrations are from the Pearl City monitor.
[4] The combined maximum impact includes impacts from the project sources (including secondary $PM_{2.5}$, as appropriate) plus the background concentration.
[5] AERMOD's Ozone Limiting Method (OLM) Option is used to output NO_2 impacts from modeled NO_X emissions.

Table 3-8. NAAQS/SAAQS Analysis Results (RNG – Worst-Case Scenario)

Pollutant[1]	Averaging Period[1]	Modeled Years	Controlling Scenario	Description	Modeled GLC_{max} ($\mu g/m^3$)	Secondary $PM_{2.5}$ Concentration[2] ($\mu g/m^3$)	Background Concentration[3] ($\mu g/m^3$)	Combined Maximum Impact[4] ($\mu g/m^3$)	SAAQS/ NAAQS ($\mu g/m^3$)	Below SAAQS/ NAAQS?
NO_2 [5]	1-hr	2017-2021	Startup	OLM - Project Only (H8H averaged over 5-years)	80.5	--	56.4	136.9	188	Yes
NO_X as NO_2	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	2.01	--	7.5	9.5	100	Yes
$PM_{2.5}$	24-hr	2017-2021	Min Load	Project Only (H8H averaged over 5-years)	7.54	0.291	12.0	19.8	35	Yes
	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	1.94	0.016	3.6	5.6	12	Yes
PM_{10}	24-hr	2017-2021	Min Load	Project Only (H1H across 5-years)	13.58	--	36.0	49.6	150	Yes
	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	2.45	--	14.4	16.8	50	Yes

[1] A NAAQS analysis is only required for pollutants and averaging periods with project impacts greater than or equal to the corresponding SIL.
[2] Secondary $PM_{2.5}$ concentrations are estimated using EPA's Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (EPA-454/R-19-003), dated April 2019. The lowest (worst-case) MERPs for the West and Northwest climates zones from Table 4-1 were selected.
[3] The background concentrations are based on DOH monitoring data: NO_2 concentrations are from the Kapolei monitor, $PM_{2.5}$ and PM_{10} concentrations are from the Pearl City monitor.
[4] The combined maximum impact includes impacts from the project sources (including secondary $PM_{2.5}$, as appropriate) plus the background concentration.
[5] AERMOD's Ozone Limiting Method (OLM) Option is used to output NO_2 impacts from modeled NO_X emissions.

Table 3-9. NAAQS/SAAQS Analysis Results (Biodiesel – Full Load Scenario)

Pollutant[1]	Averaging Period[1]	Modeled Years	Scenario	Description	Modeled GLC_{max} ($\mu g/m^3$)	Secondary $PM_{2.5}$ Concentration[2] ($\mu g/m^3$)	Background Concentration[3] ($\mu g/m^3$)	Combined Maximum Impact[4] ($\mu g/m^3$)	SAAQS/ NAAQS ($\mu g/m^3$)	Below SAAQS/ NAAQS?
NO_2 [5]	1-hr	2017-2021	Full Load	Project Only - OLM - (H8H averaged over 5-years)	59.1	--	56.4	115.5	188	Yes
NO_X as NO_2	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	2.05	--	7.5	9.5	100	Yes
$PM_{2.5}$	24-hr	2017-2021	Full Load	Project Only (H8H averaged over 5-years)	10.99	0.291	12.0	23.3	35	Yes
	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	0.71	0.016	3.6	4.3	12	Yes
PM_{10}	24-hr	2017-2021	Full Load	Project Only (H1H across 5-years)	25.16	--	36.0	61.2	150	Yes
	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	0.85	--	14.4	15.3	50	Yes

[1] A NAAQS analysis is only required for pollutants and averaging periods with project impacts greater than or equal to the corresponding SIL.
[2] Secondary $PM_{2.5}$ concentrations are estimated using EPA's Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (EPA-454/R-19-003), dated April 2019. The lowest (worst-case) MERPs for the West and Northwest climates zones from Table 4-1 were selected.
[3] The background concentrations are based on DOH monitoring data: NO_2 concentrations are from the Kapolei monitor, $PM_{2.5}$ and PM_{10} concentrations are from the Pearl City monitor.
[4] The combined maximum impact includes impacts from the project sources (including secondary $PM_{2.5}$, as appropriate) plus the background concentration.
[5] AERMOD's Ozone Limiting Method (OLM) Option is used to output NO_2 impacts from modeled NO_X emissions.

Table 3-10. NAAQS/SAAQS Analysis Results (RNG – Full Load Scenario)

Pollutant[1]	Averaging Period[1]	Modeled Years	Controlling Scenario	Description	Modeled GLC_{max} ($\mu g/m^3$)	Secondary $PM_{2.5}$ Concentration[2] ($\mu g/m^3$)	Background Concentration[3] ($\mu g/m^3$)	Combined Maximum Impact[4] ($\mu g/m^3$)	SAAQS/ NAAQS ($\mu g/m^3$)	Below SAAQS/ NAAQS?
NO_2 [5]	1-hr	2017-2021	Full Load	OLM - Project Only (H8H averaged over 5-years)	10.2	--	56.4	66.6	188	Yes
NO_X as NO_2	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	1.04	--	7.5	8.5	100	Yes
$PM_{2.5}$	24-hr	2017-2021	Full Load	Project Only (H8H averaged over 5-years)	5.40	0.291	12.0	17.7	35	Yes
	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	1.04	0.016	3.6	4.7	12	Yes
PM_{10}	24-hr	2017-2021	Full Load	Project Only (H1H across 5-years)	12.23	--	36.0	48.2	150	Yes
	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	1.27	--	14.4	15.7	50	Yes

[1] A NAAQS analysis is only required for pollutants and averaging periods with project impacts greater than or equal to the corresponding SIL.
[2] Secondary $PM_{2.5}$ concentrations are estimated using EPA's Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (EPA-454/R-19-003), dated April 2019. The lowest (worst-case) MERPs for the West and Northwest climates zones from Table 4-1 were selected.
[3] The background concentrations are based on DOH monitoring data: NO_2 concentrations are from the Kapolei monitor, $PM_{2.5}$ and PM_{10} concentrations are from the Pearl City monitor.
[4] The combined maximum impact includes impacts from the project sources (including secondary $PM_{2.5}$, as appropriate) plus the background concentration.
[5] AERMOD's Ozone Limiting Method (OLM) Option is used to output NO_2 impacts from modeled NO_X emissions.

APPENDIX A. MODELING FILES

Appendix Table A-1. AERSURFACE Processing Files

Filename	File Type	Description
HNL_zorad_sfc.W.inp HNL_zorad_sfc.A.inp	Input	AERSURFACE Input Files* (W - Wet; A - Average)
NLCD_2001_Land_Cover_HI_20080930.tiff	Input	2001 National Land Cover Data Land Cover datafile
NLCD_2016_Tree_Canopy_HI_20191018.tiff	Input	2016 National Land Cover Data Tree Canopy datafile
NLCD_2001_Impervious_HI_20080930.tiff	Input	2001 National Land Cover Data Impervious Surface datafile
HNL_zorad_sfc.W.out HNL_zorad_sfc.A.out	Output	AERSURFACE Output File
HNL_zorad_sfc.W.log HNL_zorad_sfc.A.log	Output	AERSURFACE Log File
HNL_zorad_sfc.W.txt HNL_zorad_sfc.A.txt	Output	AERSURFACE calculated surface parameters

*Due to the tropical location of Honolulu, the surface parameters for the summer season are used.

Appendix Table A-2. AERMET Processing Files

Filename	File Type	Description
AERMET_XX.INP	Input	AERMET Input File
LIH1721.RAO	Input	Upper air observations from Lihue Airport (2017 - 2021)
HNLXX	Input	Honolulu Airport (PHNL) Surface Meteorological Data
HNL_1min_20XX_15272.dat	Input	Honolulu Airport (PHNL) 1-Min Wind Data
HNL_zorad_sfc.W.txt HNL_zorad_sfc.A.txt	Input	AERFURACE Calculated Surface Parameter (W - Wet; A - Average)
NHLLIH_XX.MSG	Output	Message File
NHLLIH_XX.RPT	Output	Summary Report
SFEXXX.DAT	Output	Extracted Surface Data
SFQAXX.DAT	Output	QAed Surface Data
UAEXOUTXX.DAT	Output	Extracted Upper Air Data
UAQAOUTXX.DAT	Output	QAed Upper Air Data
HNLLIHXX.SFC	Output	AERMOD input surface meteorological data
HNLLIHXX.PFL	Output	AERMOD input meteorological profile data
HNLLIH1721.SFC	Output	5-Year AERMOD input surface meteorological data
HNLLIH1721.PFL	Output	5-Year AERMOD input meteorological profile data

XX - The list 2-digits of the year (17 - 21)

Appendix Table A-3. AERMAP Processing Files

Filename	File Type	Description
Aermap input file	Input	AERMAP input file
USGS_n22w158.tif USGS_n22w159.tif	Input	USGS 1/3 Degree National Elevation Datasets covering Oahu
Aermap output file	Output	AERMAP output file
Aermap receptor file	Output	AERMAP Receptor Output File
Aermap source file	Output	AERMAP Source Output File
Aermap map detail file	Output	AERMAP map detail file output
Aermap domain detail file	Output	Aermap domain detail file output
Aermap map parameters file	Output	AERMAP map parameters file output

Appendix Table A-4. BPIP-PRIME Processing Files

Filename	File Type	Description
Bpip input file	Input	BPIP-PRIME input file
Bpip output file	Output	BPIP-PRIME output information
Bpip summary file	Output	BPIP-PRIME summary file

Appendix Table A-5. AERMOD Run Log

Filename	Pollutant	Averaging Periods	Modeled Year(s)	Description
UER1721HTED03D	UER	1-Hour, 3-Hour, 8-Hour, and 24-Hour	2017 - 2021	Project impact modeling - Biodiesel Maximum (H1H) impacts across 5-year
UER1721HD03D	UER	1-Hour and 24-Hour	2017 - 2021	Project impact modeling - Biodiesel Maximum (H1H) impacts 5-year average
UER17A03D UER18A03D UER18A03D UER20A03D UER21A03D	UER	Annual	2017 2018 2019 2020 2021	Project impact modeling - Biodiesel
UER1721HTED03G	UER	1-Hour, 3-Hour, 8-Hour, and 24-Hour	2017 - 2021	Project impact modeling - RNG Maximum (H1H) impacts across 5-year
UER1721HD03G	UER	1-Hour and 24-Hour	2017 - 2021	Project impact modeling - RNG Maximum (H1H) impacts 5-year average
UER17A03G UER18A03G UER18A03G UER20A03G UER21A03G	UER	Annual	2017 2018 2019 2020 2021	Project impact modeling - RNG
N1721H03D*	NO_2	1-Hour	2017 - 2021	Project impact/NAAQS modeling - Biodiesel Maximum (H1H and H8H) impacts 5-year average
N1721H03G*	NO_2	1-Hour	2017 - 2021	Project impact/NAAQS modeling - RNG Maximum (H1H and H8H) impacts 5-year average
P21721D05D	$PM_{2.5}$	24-Hour	2017 - 2021	Project impact/NAAQS modeling - Biodiesel Maximum (H1H and H8H) impacts 5-year average
P21721D05G	$PM_{2.5}$	24-Hour	2017 - 2021	Project impact/NAAQS modeling - RNG Maximum (H1H and H8H) impacts 5-year average

* Hourly ozone data file SI_17-21_Hrly_O3.dat (calculation spreadsheet Sand Island 17-21 Hrly Ozone.xlsx)

Appendix D

Best Available Control Technology Analysis

Best Available Control Technology (BACT) is defined in HDOH regulations as follows:

> *…an emissions limitation…based on the maximum degree of reduction for each pollutant …which the Administrator, on a case by case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable…through the application of production processes or available methods, systems, and techniques…*

In no event can the application of BACT result in emissions of any pollutant that would exceed the level allowed by an applicable NSPS or NESHAP.

The BACT analyses presented in this report are based on a "top down" approach consistent with the 1990 draft New Source Review Workshop Manual (EPA, 1990). In the top-down methodology, control technology alternatives are identified through knowledge of the industry and previous regulatory decisions for other identical or similar sources. These alternatives are then ranked by stringency into a control technology hierarchy. The hierarchy is evaluated starting with the "top," or most stringent alternative, to determine economic, environmental, and energy impacts. If the top control alternative is not applicable, technically infeasible, or is economically infeasible, it is rejected as BACT and the next most stringent alternative is then considered. This process continues until a control alternative is determined to be both technically and economically feasible, thereby defining the emission level corresponding to BACT for the pollutant. The BACT analysis for each pollutant is discussed in the following sections for the eleven proposed Wärtsilä 20V34DF units.[1]

Steps in a Top-Down BACT Analysis

<u>Step 1 – Identify All Possible Control Technologies</u>

The first step in a top-down analysis is to identify, for the emissions unit and pollutant in question, all available control options. Available control options are those air pollution control technologies or techniques, including alternate basic equipment or processes, with a practical potential for application to the emissions unit in question. The control alternatives should include not only existing controls for the source category in question, but also, through technology transfer, controls applied to similar source categories and gas streams.

BACT must be at least as stringent as what has been achieved in practice (AIP) for a category or class of source. Additionally, EPA guidelines require that a technology that is determined to be AIP for one category of source be considered for transfer to other source categories. There are two types of potentially transferable control technologies: (1) exhaust stream controls, and (2) process controls and modifications. For the first type,

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[1] Although not require by DOH regulations, the emergency generator and emergency fire pump engine are designed to meet BACT requirements as well.

technology transfer must be considered between source categories that produce similar exhaust streams; for the second type, technology transfer must be considered between source categories with similar processes.

Candidate control options that do not meet basic project requirements (i.e., alternative basic designs that "redefine the source") are eliminated at this step.

<u>Step 2 – Eliminate Technologically Infeasible Options</u>

To be considered, the candidate control option must be technologically feasible for the application being reviewed.

<u>Step 3 – Rank Remaining Control Options by Control Effectiveness</u>

All feasible options are ranked in the order of decreasing control effectiveness for the pollutant under consideration. In some cases, a given control technology may be listed more than once, representing different levels of control. Any control option less stringent than what has been already achieved in practice for the category of source under review must also be eliminated at this step.

<u>Step 4 – Evaluate Most Effective Control Technology Considering Environmental, Energy, and Cost Impacts</u>

To be required as BACT, the candidate control option must be cost effective, considering energy, environmental, economic, and other costs. The most stringent control technology for control of one pollutant may have other undesirable environmental or economic impacts. The purpose of Step 4 is to either validate the suitability of the top control option or provide a clear justification as to why that option should not be selected as BACT.

Once all of the candidate control technologies have been ranked, and other impacts have been evaluated, the most stringent candidate control technology is deemed to be BACT, unless the other impacts are unacceptable.

<u>Step 5 – Determine BACT/Present Conclusions</u>

BACT is determined to be the most effective control technology subject to evaluation, and not rejected as infeasible or having unacceptable energy, environmental, or cost impacts.

BACT Analysis for the Wärtsilä Engine Generators: Normal Operations

<u>NO_X</u>

BACT must be at least as stringent as the applicable NSPS. The applicable NSPS limits are discussed in Section 4.9.

Identify All Possible Control Technologies

Potential methods for controlling NO_X emissions from the proposed units, listed in order of most to least effective (i.e., the top-down approach) are summarized below.

Selective Catalytic Reduction (SCR) – SCR is a post-combustion NO_X control technology (i.e., it treats the exhaust gas downstream of the combustion source). SCR controls NO_X emissions by injecting ammonia (NH_3) into the exhaust gas upstream of a catalyst bed. On the catalyst surface, the NH_3 reacts with NO_X to form molecular nitrogen and water vapor. The general chemical reactions are as follows:

$$4NNNN + 4NNNN_3 + NN_2 \rightarrow 4NN_2 + 6NN_2NN$$

$$2NNNN_2 + 4NNNN_3 + NN_2 \rightarrow 3NN_2 + 6NN_2NN$$

$$NNNN + NNNN_2 + 2NNNN_3 \rightarrow 2NN_2 + 3NN_2NN$$

Selective Non-Catalytic Reduction (SNCR) – SNCR is a post-combustion control technology that involves injecting ammonia or urea into regions of the exhaust with temperatures greater than 1400–1500 degrees Fahrenheit. The nitrogen oxides in the exhaust are reduced to nitrogen and water vapor. Additional fuel is required to heat the engine exhaust to the correct operating temperature. Heat recovery from the engine exhaust can limit the additional fuel requirement and concurrent additional emissions from heating exhaust gases. Temperature is the operational parameter affecting the reaction, as well as degree of contaminant mixing with reagent and residence time.

Engine Design – Engine manufactures have developed various methods to minimize the formation of NO_X through the use of the following:

- Fuel injection timing retard (FITR),
- Turbocharging combined with intake air aftercooling, and
- Computerized fuel and combustion air management.

Alternative Basic Equipment:

- Gas turbines (simple cycle or combined cycle)
- Boilers
- Renewable Energy Source (e.g., solar, wind, etc.)

It should be noted that the use of any of these alternative generating technologies in lieu of the proposed reciprocating engines would "redefine the source."

Renewable energy facilities require significantly more land to construct and need to be located in areas with very specific characteristics. Wind and solar facilities have power generation profiles that cannot match demand; conventional power plants are needed in order to follow demand. The capital costs for wind or solar facilities are substantially higher than for a comparable conventional facility, making financing of such a project significantly different. Finally, one of the fundamental objectives of the proposed project is to provide baseload capacity when needed, making the use of renewable energy for the project fundamentally incompatible with the project objective. Nonetheless, these alternative generating technologies are carried forward to Step 2.

Eliminate Technologically Infeasible Options; Rank Remaining Control Technologies by Control Effectiveness; Evaluate the Most Effective Control Technology

Exhaust Stream Controls

SCR is the only method that can control emissions below the applicable NSPS NO_X limits. The proposed units will be equipped with SCR to control NO_X emissions. Since SCR is the most effective method, no additional steps in the top-down approach are required.

A search of the EPA RACT/BACT/LAER Clearinghouse (RBLC) in August 2022 starting with calendar year 2018 identified only two permits[2] for similar-sized, liquid-fueled compression ignition internal combustion engines (CI ICE) with a displacement of greater than or equal to 30 liters per cylinder and subject to NSPS Subpart IIII: one for the Dutch Harbor Power Plant and another for the Donlin Gold Project. In addition, although not in the RBLC, the Humboldt Bay Repowering Project (HBRP) in Eureka, CA, obtained a PSD permit in 2008. The Dutch Harbor Power Plant units were scheduled to be installed in the second phase of the project; however, the second phase of the project was revised and different units with displacement of less than 30 liters per cylinder were installed.[3] The Donlin Gold Project units are 12 Wärtsilä 18V50DF diesel/LNG fired ICE; HBRP consists of ten Wärtsilä 18V50DF engines fueled primarily on natural gas with diesel backup. The permitted BACT NOx limits for both projects are as follows:

Liquid fuel – 0.53 g/kW_e-hr, and

RNG – 0.08 g/kW_e-hr.

Appendix Table D-1 contains the results of the RBLC search listed in order of most to least stringent NO_X limits.

Alternative Basic Technology

Simple-Cycle and Combined-Cycle Gas Turbines

The use of simple-cycle gas turbines instead of the proposed reciprocating IC engines would be technically feasible but less efficient. Multiple smaller fast-starting engines are needed to effectively handle variable loads and perform multiple startups/shutdowns per day. While reciprocating engines have a relatively flat heat rate curve across their load range, gas turbines experience a degradation in efficiency at lower loads. Efficiency vs. load is illustrated in Figure D-1.[4]

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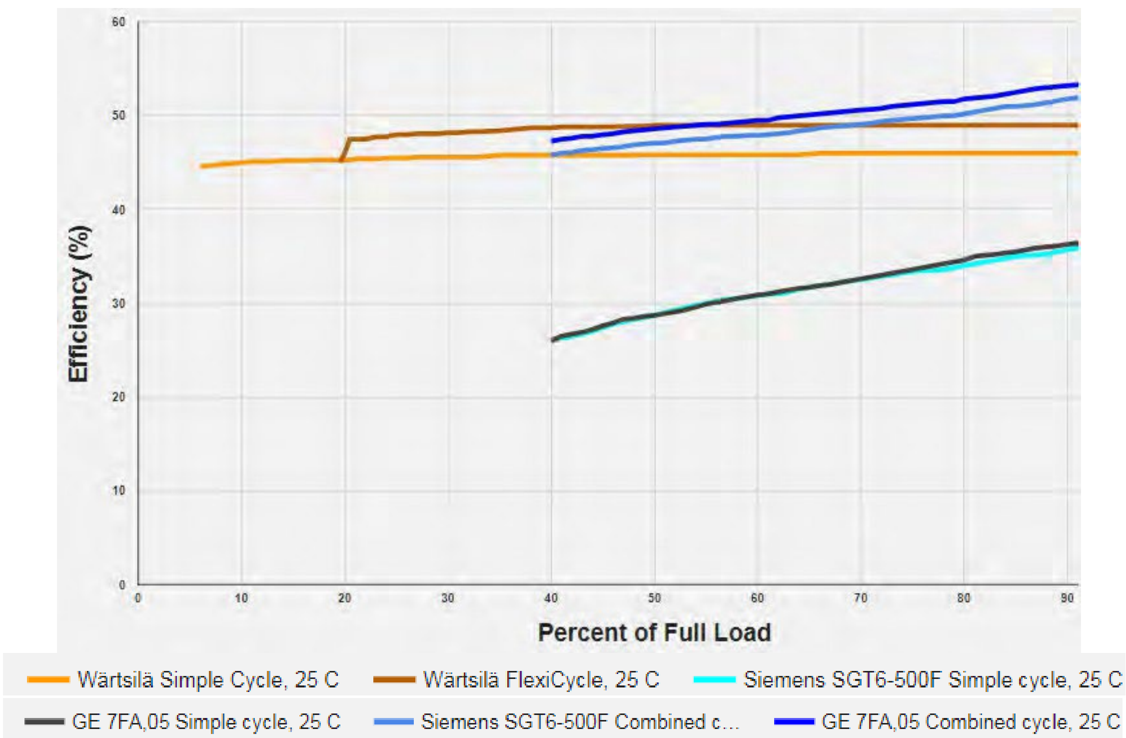
[2] Permit No. AQ0934CPT01 issued June 30, 2017 for the Donlin Gold Project, located 12 miles north of Crooked Creek, Alaska and Permit No. AQ0215CPT02 issued January 31, 2007 for the Dutch Harbor Power Plant, City of Unalaska, Alaska.

[3] Permit No. AQ0215MSS03 issued November 28, 2012 and Permit No. AQ0215MSS04 issued November 24, 2014 for the Dutch Harbor Power Plant, City of Unalaska, Alaska.

[4] Wärtsilä, Combustion Engine vs. Gas Turbine: Part Load Efficiency and Flexibility, available at https://www.wartsila.com/energy/learning-center/technical-comparisons/combustion-engine-vs-gas-

Combined-cycle turbines might be technically feasible for the project, but may not meet the project objectives. Multiple smaller fast-starting engines are needed to effectively handle variable loads and to more effectively allow the host utility to utilize more of the intermittent renewable energy from solar projects. While advanced combined-cycle turbines can start relatively quickly (within approximately 12 minutes to reach 100% rated capacity of the gas turbine generator), they may need as much as 2 hours to reach full combined-cycle output (combined output of gas turbine and steam turbine generators).[5] When operating in simple-cycle mode (while waiting for the steam system to warm up), fast-start combined-cycle units will have efficiencies that are no better than, and potentially worse than, those achieved with the Wärtsilä engines. In addition, advanced combined-cycle gas turbines require a large auxiliary steam source to achieve fast startup times. This steam must be provided by an auxiliary boiler, which is not currently part of the project and would be an additional source of emissions.

Figure D-1. Part Load Efficiency for Gas Turbines and Reciprocating Engines



Therefore, simple-cycle turbines are eliminated because they cannot operate through the load range without significant efficiency impacts. Combined-cycle turbines are eliminated for similar reasons.

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turbine-part-load-efficiency-and-flexibility. "25 C" refers to ambient temperature at which the comparison is made.

[5] El Segundo Energy Center LLC, 00-AFC-014C: Petition to Amend, 4/23/13, Section 2.2.7

Solar Thermal and Solar Photovoltaic (PV)

Solar thermal facilities collect solar radiation, then heat a working fluid (water or a hydrocarbon liquid) to create steam to power a steam turbine generator. Solar PV facilities use solar energy and arrays of photovoltaic panels to generate electricity directly. All solar thermal and utility-scale solar PV facilities require considerable land for the collection field and are best located in areas of high solar incident energy per unit area. In addition, power is generated only while the sun shines, so the units do not supply power at night or on cloudy days. The project parcel is not sufficiently large to be feasible for a commercial solar power plant. Furthermore, a solar power plant would not meet the project's objective of providing firm power that is available when needed and flexible generation capacity to support increased penetration of intermittent renewable generating resources. For these reasons, a solar thermal or solar PV power plant is rejected as BACT for this application.

Wind

Wind power facilities use a wind-driven rotor to turn a generator to generate electricity. Like solar thermal and utility-scale solar PV facilities, wind power facilities require considerable land area. Even in prime locations the wind does not blow continuously, so power is not always available. Due to limited available space on the project parcel, limited dependability, and relatively high cost, this technology is not feasible for this project. Furthermore, a wind power plant would not meet the project's objective of providing firm power that is available when needed and flexible generation capacity to support increased penetration of intermittent renewable generating resources. For these reasons, a wind power plant is rejected as BACT for this application.

Determine BACT/Present Conclusions

The proposed BACT NO_X limits shown below are based on the manufacturer's guaranteed NO_X emission rate at full load.

> Biodiesel – 35 ppmc (0.52 g/kW_e-hr) at full load
> RNG – 6 ppmc (0.08 g/kW_e-hr) at full load

These NO_X limits are below the applicable NSPS NO_X limits and are consistent with previous BACT NO_X limits for CI ICE identified. Therefore, these limits satisfy HDOH's definition of BACT.

$PM/PM_{10}/PM_{2.5}$

BACT must be at least as stringent as the applicable NSPS. The applicable PM NSPS limit is discussed in Section 4.10.1.

Identify All Possible Control Technologies

Potential methods for controlling $PM/PM_{10}/PM_{2.5}$ emissions from the proposed units listed in order of most to least effective (i.e., the top-down approach) are outlined below.

Electrostatic Precipitator (ESP) – An ESP is a post-combustion control technology (i.e., it treats the exhaust gas downstream of the combustion source) that reduces PM emissions.

Diesel Particulate Filter (DPF) – A DPF is a device that removes post-combustion PM emissions from the exhaust gas.

Diesel Oxidation Catalyst – Catalytic oxidation using a diesel oxidation catalyst reduces the organic fraction of particulate emissions.

Combustion Design and Practices – Good combustion design and combustion practices are employed to minimize the formation of $PM/PM_{10}/PM_{2.5}$ emissions.

Low Sulfur Liquid Fuels – The formation of secondary $PM_{2.5}$ from sulfates is directly related to the fuel sulfur content. Therefore, lowering the fuel sulfur content reduces secondary $PM_{2.5}$ emissions from sulfates.

Alternative basic equipment—including renewable energy sources, such as solar and wind—has also been identified as a potential option for the control of $PM/PM_{10}/PM_{2.5}$ emissions. Such alternative basic equipment was already discussed above (Steps 1 and 2 for NO_X BACT). For the same reasons discussed above for NO_X, solar, wind, and other renewable energy sources are rejected as $PM/PM_{10}/PM_{2.5}$ BACT for this application.

Eliminate Technologically Infeasible Options; Rank Remaining Control Technologies by Control Effectiveness; Evaluate the Most Effective Control Technology Considering Environmental, Energy, and Cost Impacts

In EPA's response to comments[6] on the initial PM NSPS Subpart IIII standards, EPA stated:

> *…EPA agrees in general with the comments regarding the proposed emission limitation for PM. The final rule has been written considering the comments received and requires 60 percent PM reduction or an emission limit of 0.15 g/kW-hr (0.11 g/ HP-hr). EPA believes the PM standard will be achievable through the use of lower sulfur fuel, on-engine controls, and aftertreatment EPA believes that the PM percent reduction requirement is feasible through application of ESP…*

However, a search of the RBLC in August 2022 starting with calendar year 2000 did not identify any application of an ESP on similar units. Appendix Table D-2 contains the results of the RBLC search listed in order of most to least stringent $PM/PM_{10}/PM_{2.5}$

[6] 71 FR 39167, July 11, 2006

limits. Supporting information[7] contained in EPA's initial NSPS Subpart IIII docket (EPA-HQ-OAR-2005-0029) did not identify any similar stationary sources located in the U.S. that use an ESP to control PM emissions. However, this information identified the following stationary sources outside the US:

Two facilities in Korea (five engines),
One facility in India (three engines), and
One facility in Barbados (two engines).

No additional information was provided on the size of these units or the fuel they burned. Outside of the U.S., it is not uncommon to operate similar large CI ICE on heavy fuel oil (e.g., fuel oil no. 5 and/or 6).

Additionally, this supporting information contained a cost evaluation of using an ESP to control PM. EPA's consultant calculated an average cost of $76,880 per ton of PM removed for similar units (i.e., Wärtsilä 12V32 and 12V46). Therefore, an ESP is not cost effective and is rejected as BACT based on cost.

The next most effective PM control is a DPF. As part of the development of NSPS Subpart IIII, EPA concluded that it is infeasible to install a DPF on CI ICE with a displacement of greater than or equal to 30 liters per cylinder.[8] A review of more recent vendor data shows that DPFs are limited to applications up to approximately 4 MW.[9] The proposed units have a displacement of greater than or equal to 30 liters per cylinder and are larger than 4 MW. Therefore, DPFs are infeasible and do not represent BACT for this project.

The next most effective PM control is catalytic oxidation. The Donlin Gold Project received a permit in 2017 for twelve 17-MW Wärtsilä 18V50DF diesel/LNG fired ICEs; HBRP permitted ten Wärtsilä 18V50DF diesel/natural gas fired ICE. The permitted PM BACT limits for both projects are as follows:

PM, PM_{10}, $PM_{2.5}$ – 0.29 g/kW_e-hr (full load, diesel fuel) and
PM, PM_{10}, $PM_{2.5}$ – 0.13 g/kW_e-hr (full load, natural gas).

Hawaiian Electric received a permit for the installation of six Wärtsilä 20V34DF CI ICE with a displacement of greater than or equal to 30 liters per cylinder and subject to NSPS Subpart IIII. The PM/PM_{10}/$PM_{2.5}$ BACT determination has not been added to the RBLC. The permitted PM and PM_{10}/$PM_{2.5}$ BACT limits when firing diesel/biodiesel are as follows:

PM_{10}/$PM_{2.5}$ – 0.27 g/kW_e-hr and 4.95 lb/hr (full load).

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[7] Memorandum from Bradley Nelson, Alpha-Gamma Technologies, Inc. to Jaime Pagan, EPA Energy Strategies Group, dated May 22, 2006. Re: Emission Standards for Engines with a Displacement of ≥30 Liters per Cylinder (EPA-HQ-OAR-2005-0029-0274)

[8] 70 FR 39884, July 11, 2005

[9] http://www.miratechcorp.com/fa-content/uploads/2014/09/MIRATECH_LTR_9-16-14.pdf

These emissions limits apply at all times. Hawaiian Electric is using the combination of catalytic oxidation, combustion design, good combustion practices, and the use of diesel, biodiesel, and diesel/biodiesel blends with a maximum sulfur content of 42 ppm to meet the BACT limits.

As discussed above, solar, wind and other renewable energy alternatives are not considered technologically feasible for this application.

Determine BACT/Present Conclusions

The project will use a combination of catalytic oxidation, combustion design, good combustion practices, and the use of liquid (renewable diesel) and RNG fuels with a maximum sulfur content of 15 ppm as BACT for $PM/PM_{10}/PM_{2.5}$. Therefore, no further control analysis is required. The proposed BACT PM limits are as follows:

> 4.53 lb/hr (0.22 g/kW_e-hr), at full load on liquid fuel, and
> 2.01 lb/hr (0.10 g/kW_e-hr), at full load on RNG.

These proposed limits are based on the manufacturer's guaranteed PM_{10} and $PM_{2.5}$ emission rate at full load. The proposed $PM_{10}/PM_{2.5}$ limits are lower than the previous BACT $PM_{10}/PM_{2.5}$ limits identified. Therefore, these proposed limits satisfy the CAA's definition of BACT.

<u>VOC and CO</u>

Identify All Possible Control Technologies

Potential methods for controlling VOC and CO emissions from the proposed units, listed in order of most to least effective (i.e., the top-down approach), are outlined below.

<u>Catalytic Oxidation</u> – Catalytic oxidation is a post-combustion control technology (i.e., it treats the exhaust gas downstream of the combustion source) that reduces VOC, CO, and PM emissions. CO emissions are oxidized to CO_2, and VOC emissions are oxidized to CO_2 and water vapor.

<u>Engine Design</u> – Engine manufactures have developed various methods to minimize the VOC emissions through the use of:

- FITR,
- Turbocharging combined with intake air aftercooling, and
- Computerized fuel and combustion air management.

Alternative basic equipment – The use of alternative basic equipment—including renewable energy sources, such as solar and wind—has also been identified as a potential option for the control of VOC and CO emissions. Such alternative basic equipment was already discussed above (Steps 1 and 2 for NO_X BACT). For the same reasons discussed above for NO_X, solar, wind and other renewable energy sources are rejected as VOC and CO BACT for this application.

Eliminate Technologically Infeasible Options; Rank Remaining Control Technologies by Control Effectiveness; Evaluate the Most Effective Control Technology Considering Environmental, Energy, and Cost Impacts

Appendix Table D-3 contains the results of the VOC and CO RBLC search conducted in August 2022, starting with calendar year 2000 and listed in order of most to least stringent VOC limits. The BACT VOC and CO limits for the 17 MW Wärtsilä 18V50DF engines at Donlin Gold Project when firing on diesel fuel are as follows:

VOC – 0.21 g/kW_e-hr at full load, and
CO – 0.18 g/kW_e-hr at full load.

Listed below are the BACT VOC and CO limits for the same engines when fired on LNG fuel.

VOC – 0.09 g/kW_e-hr at full load
CO – 0.12 g/kW_e-hr at full load

The Donlin Gold Project is using the combination of an oxidation catalyst and good combustion practices to meet the BACT limits.

As discussed above, solar, wind and other renewable energy alternatives are not considered technologically feasible for this application.

Determine BACT/Present Conclusions

The project will use a combination of combustion design, good combustion practices, and an oxidation catalyst as BACT for VOC and CO. Since catalytic oxidation is the most effective method, no additional steps are required and the proposed VOC and CO controls represent BACT.

The proposed BACT VOC limits of 4.33 lb/hr (liquid fuel; 0.21 g/kW_e-hr at full load) and 2.50 lb/hr (RNG; 0.12 g/kW_e-hr at full load) are based on the manufacturer's guaranteed VOC emission rates at full load. The proposed BACT CO limit of 3.78 lb/hr (liquid fuel; 0.18 g/kW_e-hr at full load) and 2.51 lb/hr (RNG; 0.12 g/kW_e-hr at full load) are based on the manufacturer's guaranteed CO emission rates at full load. These limits are consistent with previous BACT CO and VOC limits identified. Therefore, these limits satisfy the CAA's definition of BACT.

Greenhouse Gases (GHGs)

Identify All Possible Control Technologies

EPA's 2011 guidance document "PSD and Title V Permitting Guidance for Greenhouse Gases" (EPA, 2011b) specifies that the following types of controls must be considered in determining BACT for GHGs:

- Inherently lower-emitting processes/practices/designs,
- Add-on controls, and

- Combinations of inherently lower emitting processes/practices/designs and add-on controls.

EPA's guidance recognizes that inherently lower polluting processes that fundamentally redefine the nature of the source proposed by the permit applicant can be eliminated for the list of available controls. EPA's guidance states:

> *In assessing whether an option would fundamentally redefine a proposed source, EPA recommends that permitting authorities apply the analytical framework recently articulated by the Environmental Appeals Board. Under this framework, a permitting authority should look first at the administrative record to see how the applicant defined its goal, objectives, purpose, or basic design for the proposed facility in its application.* (EPA, 2011b).

Ameresco selected the Wärtsilä 20V34DF CI ICE as the best method to meet the following objectives of the needed generation:

- Quick starting,
- Extremely efficient IC engine technology,
- Firm power (available when needed),
- Fuel flexibility, and
- Flexible generation capacity to support increased penetration of intermittent renewable generating resources.

Table D-1 lists the potential GHG emissions control options and discusses their feasibility and compatibility with the objectives of the proposed project.

Alternative Basic Equipment:

- Gas turbines (simple cycle or combined cycle)
- Boilers
- Renewable Energy Source (e.g., solar, wind, etc.)

It should be noted that the use of any of these alternative generating technologies in lieu of the proposed reciprocating engines would "redefine the source."

Renewable energy facilities require significantly more land to construct and need to be located in areas with very specific characteristics. Wind and solar facilities have power generation profiles that cannot match demand; conventional power plants are needed in order to follow demand. The capital costs for wind or solar facilities are substantially higher than for a comparable conventional facility, making financing of such a project significantly different. Lastly, one of the fundamental objectives of the proposed project is to provide baseload capacity, making the use of renewable energy for the project fundamentally incompatible with the project objective. Nonetheless, these alternative generating technologies are carried forward to Step 2.

Table D-1. Evaluation of GHG Emissions Control Options

GHG Control Option	Heat Rate Range (HHV Basis)	Fundamentally Redefines the Nature of the Source Proposed by the Permit Applicant?
Nuclear Generation	Not Applicable	Yes – Nuclear generation is best suited for base loaded units, while the proposed project requires load following.
Renewable Energy Sources (Wind, Solar, Hydro)	Not Applicable	Yes – The project requires firm generation that can help to integrate intermittent renewable resources such as wind and solar. Hydroelectric power is not a viable alternative.
Low Carbon Fuels (Natural Gas)	Proposed	No – This is already a project feature. Project is designed to utilize RNG as much as possible.
Carbon Capture and Storage (CCS)	Not Applicable	No.
Combined-Cycle Gas Turbines	~7,000 to 8,000 Btu/kWh	No – Combined-cycle gas turbines do not offer the generation flexibility of 11 RICE engines.
RICE	~7,500 to 8,600 Btu/kWh	No – Currently proposed.
Simple-Cycle Gas Turbines	~8,700 to 10,000 Btu/kWh	No.
Boilers	>10,000 Btu/kWh	Yes – Cannot meet the quick start requirements of the project. Also, boilers are less efficient than the proposed engines, and thus would be rejected under Step 3.

Eliminate Technologically Infeasible Options; Rank Remaining Control Technologies by Control Effectiveness; Evaluate the Most Effective Control Technology Considering Environmental, Energy, and Cost Impacts

As shown in Table D-1, the only potential GHG emissions controls for the proposed generating units, other than the selected use of RICE generators, is switching exclusively to a lower carbon fuel (i.e., natural gas) or adding carbon capture and storage (CCS). Switching to 100% natural gas would reduce GHG emissions by approximately 27%; however, renewable natural gas is currently not available on Oahu in the quantity needed for the proposed project. For this reason, the project is designed to utilize RNG to the extent possible, with biodiesel as an alternate fuel. While alternative basic technology (simple- and combined-cycle gas turbines) would not fundamentally redefine the nature of the project, both simple-cycle and combined-cycle gas turbines are less efficient at lower loads, and combined-cycle gas turbines do not meet the basic project requirements related to quick start capability, as discussed above.

A search of the RBLC in August 2022 identified three permits for CI ICE in the proposed size range used for power generation. The BACT GHG emission limits for the Donlin Gold Project when firing on diesel fuel and on LNG are as follows:

- Diesel – 1,299,630 tpy CO_2e (equivalent to 657 g/kW_e-hr and 1448 lb/MW-hr), and
- LNG – 869,621 tpy CO_2e (equivalent to 440 g/kW_e-hr and 969 lb/MW-hr).[10]

The RBLC lists two additional projects consisting of multiple 18.8 MW Wärtsilä RICE, located at the Wisconsin Public Service Weston Plant[11] and the Arvah B. Hopkins Generating Station.[12] The BACT GHG limit for both projects is 1100 lb/MW-hr for 100% natural gas firing.

Table D-2 lists GHG BACT limits from similar RICE facilities located by additional research. Due to the abundant supply of natural gas on the mainland, none of these facilities are permitted to burn diesel. Therefore, the BACT limits were scaled using the diesel to natural gas CO_2 ratio. This ratio is based on EPA's Mandatory Greenhouse Gas Reporting Rule default emission factors (40 CFR Part 98, Table C-1). These GHG BACT limits for similar facilities are consistent with the calculated equivalent GHG BACT limits for these projects.

[10] Conversion based on 17,076 kW rated output and 8,760 hrs/yr of operation per engine, 12 engines.

[11] RBLC ID: WI-0314; permit issue date 03/10/2022.

[12] RBLC ID: FL-0370; permit issue date 04/03/2019.

Table D-2. GHG BACT Limits for Similar RICE Facilities

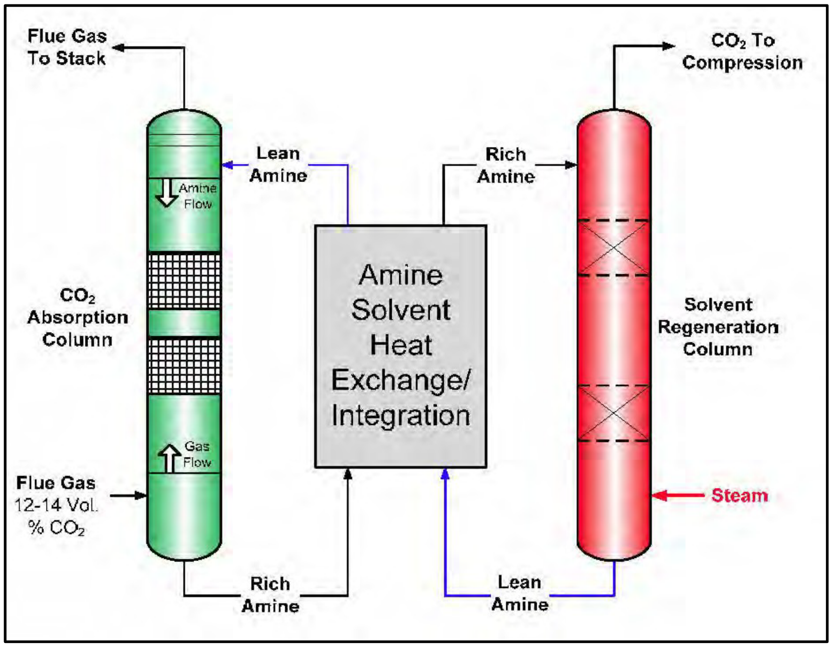
Facility	Generating Units	Permitted Fuel	Permitted Rolling 12-month CO_2 Emissions Limit [A] (lb/MW_e-hr)	Diesel to Natural Gas CO_2 Ratio [B]	Diesel Equivalent Rolling 12-month CO_2 Emissions Limit (lb/MW_e-hr)
Lacey Randall Generation Facility, LLC, Lacey Randall Station	Wärtsilä 20V34SG	Natural Gas	1,080	1.394	1,505
Mid-Kansas Electric Company, LLC, Rubart Station	Caterpillar G20CM34	Natural Gas	1,250	1.394	1,742
Wisconsin Public Service, Weston Plant and Arvah B. Hopkins Generating Station	Wärtsilä 18V50SG	Natural Gas	1,100	1.394	1,533
South Texas Electric Cooperative, Inc., Red Gate Power Plant	Wärtsilä 18V50SG	Natural Gas	1,145	1.394	1,596
		Average			1,594
		Average + Compliance Factor (Approx. 5%)			1,679

[A] The Lacey Randall Generation Facility, LLC and Mid-Kansas Electric Company, LLC CO_2 emissions limits exclude startup. The inclusion of startup emissions would result in a higher CO_2 emissions limit.

[B] The diesel to natural gas CO_2 ratio is based on EPA's Mandatory Greenhouse Gas Reporting Rule default emission factors (40 CFR Part 98 Subpart C, Table C-1).

CCS is composed of two major functions: CO_2 capture and CO_2 storage. A number of methods may potentially be used for separating the CO_2 from the exhaust gas stream, including adsorption, physical absorption, chemical absorption, cryogenic separation, and membrane separation (Wang et al., 2011). Many of these methods are either still in development or not suitable for treating power plant flue gas due to the characteristics of the exhaust stream (Wang, 2011; IPCC, 2005). Of the potentially applicable post-combustion CO_2 capture options, the use of an amine solvent such as monoethanolamine (MEA) it is the most mature and well-documented technology (Kvamsdal et al., 2011). Figure D-2 illustrates the amine-based post-combustion capture process.

Figure D-2. Schematic Diagram of Amine-based CO_2 Capture Process



Source: Interagency Task Force on Carbon Capture and Storage, 2010

EPA generally considers post-combustion CO_2 capture with an amine solvent to be technically feasible for natural gas fired combined-cycle combustion turbines and coal fired power plants. However, the technology cannot yet be considered "applicable." The Interagency Task Force on Carbon Capture and Storage (ITF) found that

> *…it is unclear how transferable the experience with natural gas processing is to separation of power plant flue gases, given the significant differences in the chemical make-up of the two gas steams. In addition, integration of these technologies with the power cycle at generating plants present significant cost and operating issues that will need to be addressed.* (ITF, 2010, p. 28)

CCS has not yet reached the licensing and commercial sales stage of development. It is an emerging technology that has had limited successful applications on an industrial scale, and there have been no successful applications on a comparably sized natural gas or dual-fuel power plant. There are no CCS systems commercially available for such power plants in the United States. The Department of Energy states that "investment in and deployment of [CCS] technology lags other clean energy technologies." (DOE, 2016) Because the proposed project must go online by 2024, CCS is not commercially available for this application. Nonetheless, the cost for implementing CO_2 capture with an amine solvent is estimated below.

The project's remote location imposes many additional challenges to implementing CO_2 storage that are not present for continental U.S. sources. Ameresco is not aware of any proven CO_2 geological storage sites on Oahu. Therefore, ocean storage—i.e., direct CO_2

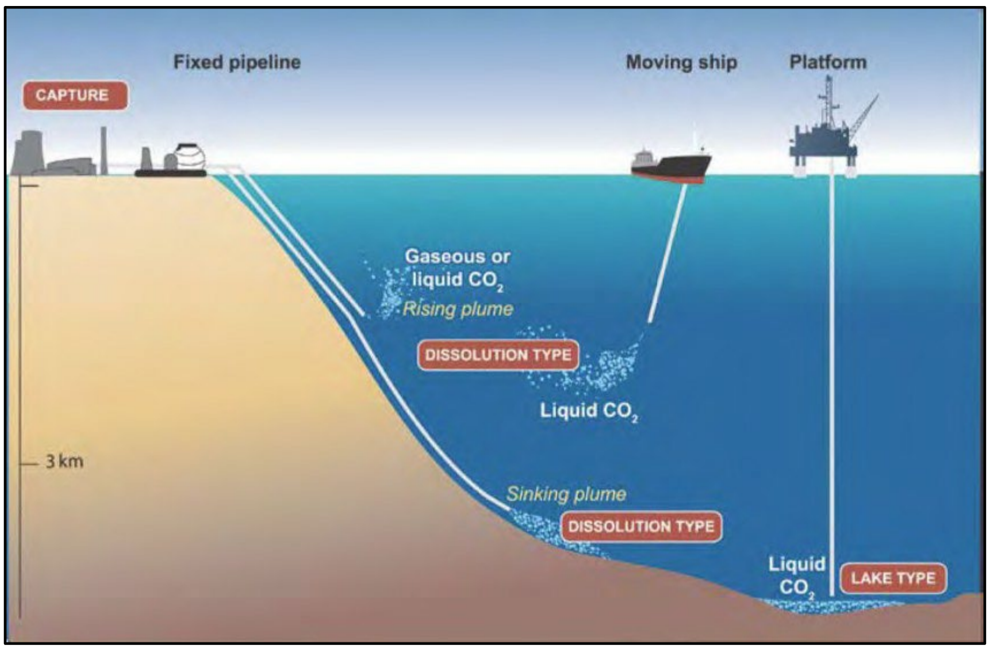
release into the ocean water column or onto the deep seafloor—appears to be the most readily available CO_2 storage option.

As shown in Figure D-3, CO_2 ocean storage potentially could be implemented in two ways:

- By injecting and dissolving CO_2 into the water column (typically below 1,000 meters) via a fixed pipeline or a moving ship, or
- By depositing CO_2 via a fixed pipeline or an offshore platform onto the sea floor at depths below 3,000 m, where CO_2 is denser than water and is expected to form a "lake" that would delay dissolution of CO_2 into the surrounding environment.

Ocean storage and its ecological impacts are still in the research phase, and the legal status of intentional ocean storage is unknown (Herzog, 2010; IPCC, 2005; Purdy, 2006).

Figure D-3. Overview of Ocean Storage Concepts



Source: IPCC, 2005

Table D-3 lists the estimated cost to add CCS to the proposed project based on expected operations. The estimate includes the amine absorber system cost, the onshore CO_2 storage cost, and the ocean injection cost. The annual estimated cost is $126 per ton of CO_2 removed, for a total annual cost of over $57 million based on permitted operations on RNG fuel and over $28 million based on permitted operations on liquid fuel. The listed estimated total ocean CO_2 storage cost of $151.37 per ton is well above the estimated total cost for geological storage ($87.30 per ton).[13]

[13] U.S. DOE, National Energy Technology Laboratory, Cost and Performance Baseline for Fossil Energy Plants, Volume 1a, Revision 3; July 6, 2015. Exhibit 4-32.

If geological storage were an option, switching to it would have little impact on the cost estimate.

Table D-3. Estimated CCS Cost ($/Ton) – Permitted Operations

Carbon Capture and Storage (CCS) Component	Cost ($/ton CO_2 Captured)	Units 1 – 11 Project CO_2 Emissions [A] (tpy)	% Captured [B]	CO_2 Emissions Captured (tpy)	Total Annual Cost
Liquid Fuel					
CO_2 Capture and Compression [C]	127.76				$23,819,958
Onshore CO_2 Storage [D]	3.42	207,159	90%	186,443	$637,635
Ship transport to injection ship [D]	8.23				$1,534,426
Injection ship, pipe and nozzle [D]	11.96				$2,229,858
Total Cost (Liquid fuel)	151.37				$28,221,877
RNG					
CO_2 Capture and Compression [C]	127.76				$48,437,777
Onshore CO_2 Storage [D]	3.42	421,256	90%	379,131	$1,296,628
Ship transport to injection ship [D]	8.23				$3,120,248
Injection ship, pipe and nozzle [D]	11.96				$4,534,407
Total Cost (RNG)	151.37				$57,389,060

[A] See Appendix Tables B-13 and B-15 for the emissions calculations.

[B] Typical value for amine absorber systems (Interagency Task Force on CCS, 2010; NETL, 2013).

[C] The CO_2 capture and compression cost is based on information presented in Figure III-1 of the Report of the Interagency Task Force on CCS, dated August 2010. The listed dollar per ton of CO_2 captured is the cost of applying post-combustion CCS to an existing natural gas fired combined cycle power plant. The listed cost ($103 per metric ton or $93.44 per ton in 2010 dollars) is based on permitted operation (i.e., maximum allowable operation per unit per year at full load for each fuel type), inflated to 2022 dollars (latest available CPI data at https://data.bls.gov/cgi-bin/cpicalc.pl).

[D] Costs are from Table 6.6 of the IPCC Special Report on Carbon Dioxide Capture and Storage, dated 2005, inflated to 2022 dollars (latest available CPI data at https://data.bls.gov/cgi-bin/cpicalc.pl).

Table D-4. Estimated CCS Cost ($/kWh) – Permitted Operations

Load	Total Generation (kW)	Fuel Type	Operating Hrs Per Unit (hrs/yr)	Total Annual Generation (kWh)	Total Annual Cost	CO_2 Removal Cost ($/kWh)
100% (Base)	103,100	Liquid fuel	2920	297,829,354	$ 28,221,877	$ 0.095
		RNG	8395	862,137,604	$ 57,389,060	$ 0.067

As shown in Table D-4, these costs equate to 9.5¢ per kWh for liquid fuel firing and 6.7¢ per kWh for RNG firing, based on permitted operations.

Because of the high cost and commercial unavailability of CCS, the proposed engines are the most effective option to reduce GHG emissions and represent BACT.

Determine BACT/Present Conclusions

Ameresco proposes the use of the proposed dual-fuel RICE generating units as BACT for GHG and proposes to limit CO_2e emissions to a lb/MWe-hr limit weighted by liquid and RNG fuel consumption during a rolling 12-month period. To account for the reduced engine efficiency at lower loads required to achieve the project objective of increasing the penetration of renewable energy on Oahu, the proposed limit on CO_2e is based on the GHG emission rates at 50% of rated load (see Tables B-13 and B-15). The proposed limit would be the sum of 1,435 lb CO_2e/MWe-hr times the MWe-hr produced using liquid fuel, and 1,125 lb CO_2e/MWe-hr times the MWe-hr produced using RNG, divided by the total MWe-hr produced, evaluated monthly on a rolling 12-month basis. These CO_2e limits are in the range of the previous BACT CO_2 and CO_2e limits identified in Table D-2. Therefore, these limits satisfy the CAA's definition of BACT.

BACT for the Wärtsilä Engine Generators: Startup/Shutdown

Startup and shutdown periods are a normal part of the operation of reciprocating engine generator power plants. BACT must also be applied during the startup and shutdown periods of IC engine operation. The BACT limits discussed in the previous section apply to steady-state operation, when the engines have reached stable operations and the emission control systems are fully operational.

Identify All Possible Control Technologies

The emission control technologies that will be effective during normal operation are discussed in the previous section. The following are additional technologies for control of emissions during startups and shutdowns:

- Fast-start technologies; and
- Operating practices to minimize the duration of startup and shutdown.

Eliminate Technologically Infeasible Options

The post-combustion controls that are used to achieve additional emissions reductions (SCR and oxidation catalyst) require that specific exhaust temperature ranges be reached to be fully effective. The use of SCR to control NO_X is not technically feasible during the initial stages of startup, when the temperature of the SCR catalyst is below the manufacturer's recommended operating range. Ammonia will not react completely with NO_X when catalyst temperatures are low, resulting in excess NO_X emissions or excess ammonia slip or both. The oxidation catalyst is not effective at controlling CO and VOC emissions when exhaust temperature is below the design temperature range. Therefore, exhaust gas controls used to achieve BACT for normal operations are not feasible control techniques during startups and shutdowns.

This "top-down" BACT analysis will consider the following emission limitations:

- Operating practices to minimize emissions during startup and shutdown; and
- Design features to minimize the duration of startup and shutdown.

Rank Remaining Control Technologies by Control Effectiveness

Operating Practices to Minimize Emissions during Startup and Shutdown

There are basic principles of operation, or Best Management Practices, that minimize emissions during startups and shutdowns. These Best Management Practices are outlined below.

- During a startup, bring the engine to the minimum load necessary to achieve compliance with the applicable NO_X, CO, and VOC emission limits as quickly as possible, consistent with the equipment manufacturers' recommendations and safe operating practices.
- During a startup, initiate reagent injection to the SCR system as soon as the SCR catalyst temperature and reagent vaporization system have reached their minimum operating temperatures.
- During a shutdown, once an engine reaches a load that is below the minimum load necessary to maintain compliance with the applicable NO_X, CO, and VOC emission limits, reduce the engine load to zero as quickly as possible, consistent with the equipment manufacturers' recommendations and safe operating practices.
- During a shutdown, maintain ammonia injection to the SCR system as long as the SCR catalyst temperature and reagent vaporization system remain above their minimum operating temperatures.

A key underlying consideration of these Best Management Practices is the overall safety of the plant staff by promoting operation within the limitations of the equipment and systems and allowing for operator judgment and response times to respond to alarms and trips during a startup or shutdown sequence.

Design Features to Minimize the Duration of Startup and Shutdown

An additional technique to reduce startup emissions is to minimize the amount of time the engine spends in startup. Startup times are generally driven by the rate at which engine load can increase, and the rate at which the SCR system and oxidation catalyst come up to operating temperature. Having the engines at full load will, in turn, minimize the time required for emission control systems to reach operating temperature, thus minimizing the length of time during which engine emissions exceed normal controlled levels.

Evaluate the Most Effective Control Technology Considering Environmental, Energy, and Cost Impacts

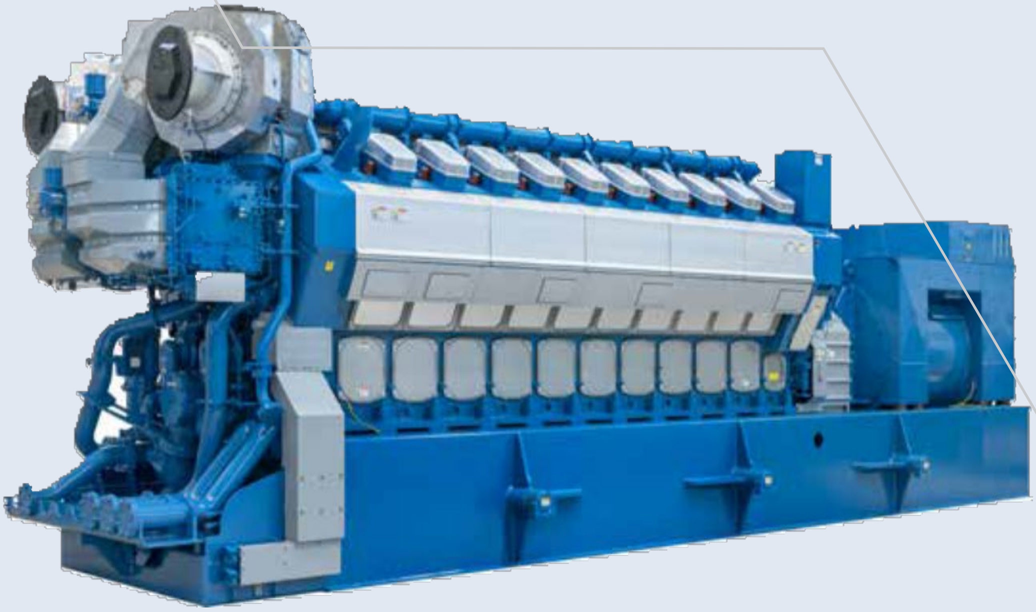
Utilizing best operating practices to minimize emissions during startups and shutdowns has no adverse environmental or energy impacts, nor does it require additional capital expenditure.

Determine BACT/Present Conclusions

BACT for NO_X, CO, VOC, and GHG during startups/shutdowns is the use of operating systems/practices that reduce the duration of startups and shutdowns to the greatest extent feasible and the use of operational techniques to initiate ammonia injection as soon as possible during a startup. Therefore, BACT is determined to be the use of reciprocating IC engine technology and the application of operating systems/practices that minimize startup and shutdown durations, in combination with the use of operational techniques to initiate ammonia injection as soon as possible during a startup.

Appendix E

Manufacturers' Literature



WÄRTSILÄ 34DF

MULTI-FUEL ENGINE GENERATING SET

The Wärtsilä 34DF is a four-stroke multi-fuel engine generating set. It allows instant switching to alternative fuels, should price instability or delivery challenges affect the use of the primary fuel. It operates on the lean burn principle, which reduces peak temperatures and lowers NO_x emissions considerably.

The Wärtsilä 34DF engine generating set is extremely reliable as it is based on the well-proven Wärtsilä 32 engine, that has a track record from the mid-1990s. The Wärtsilä 34DF features a wide power output range from 5.6 to 9.8 MW, as it is available in 12V, 16V and 20V cylinder configurations.

We help our customers in decarbonisation by developing market-leading technologies such as flexible power plants that can be delivered as engineering, procurement and construction (EPC). With our full lifecycle support we ensure guaranteed performance of the plant.

Main benefits

- Ensures energy security in operation through fuel flexibility and seamless switching between fuels
- Can operate on natural gas or any liquid fuel, including HFO
- Low emissions in gas mode and meets even the most stringent emission limits with exhaust gas after treatment
- Optimised performance and efficiency supported by Wärtsilä Lifecycle solutions

2

Minutes to full load

48.6

% Electrical efficiency

More than

1000

generating sets delivered

WÄRTSILÄ

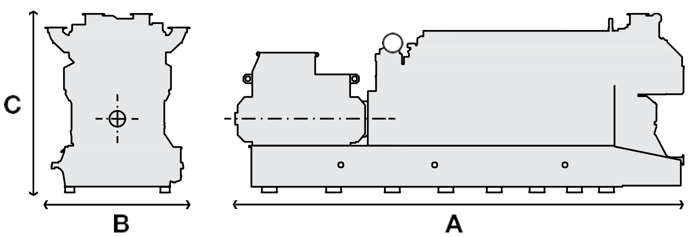
Main technical data

Engine generating set			
Cylinder configurations	12 V, 16 V, 20 V		
Cylinder bore	340 mm		
Piston stroke	400 mm		
Engine speed	750 rpm (50 Hz), 720 rpm (60 Hz)		
Performance [1]			
	20V34DF (50Hz / 60Hz)	**16V34DF (50Hz / 60Hz)**	**12V34DF (50Hz / 60Hz)**
Rated electrical power (kW)	9795 / 9388	7830 / 7491	5840 / 5580
Electrical efficiency (%)	GAS: 48.6 / 48.5 LFO: 45.6 / 45.8 HFO: 45.8 / 46	GAS: 48.6 / 48.4 LFO: 45.6 / 45.6 HFO: 45.8 / 45.8	GAS: 48.4 / 48.1 LFO: 45.3 / 45.4 HFO: 45.6 / 45.6
Heat rate at generator terminals (kJ/kWh)	GAS: 7404 / 7415 LFO: 7898 / 7868 HFO: 7856 / 7828	GAS: 7408 / 7438 LFO: 7903 / 7893 HFO: 7861 / 7852	GAS: 7445 / 7482 LFO: 7941 / 7938 HFO: 7899 / 7897
Loading and unloading			
	Connected to grid	**Full load**	
Regular start time (min:sec)	00:30	< 5	
Fast start time (min:sec)	00:30	< 2	
Stop time (min)	1		
Ramp rate (hot, load/min)	> 100%		
Minimum load			
Unit level	10%		
Plant level	1%		

Maximum transportation dimensions (mm) and weights (tonnes) [2]				
Genset type	**Length (A)**	**Length (B)**	**Height (C)**	**Dry weight**
12V34DF	10 454	3 350	4 374	99
16V34DF	11 606	3 420	4 374	130
20V34DF	12 971	3 418	4 429	141

1 Rated electrical power and electrical efficiencies are given at generator terminals at 100kPa ambient pressure, 25°C suction air temperature and 30% relative humidity, and without engine driven pumps. Power factor 1.0 (site). NOx emission level 90ppm @15% O2 dry. Electrical efficiency with 5% tolerance. Gas LHV >28MJ/Nm3. Gas methane number >80. Site conditions, fuel and applicable emission limits may have an impact on performance figures. Please contact Wärtsilä for project-specific performance data.

2 There are different dismantling options available to reduce weight and height for transporting. Please contact Wärtsilä for further information.



wartsila.com/energy

Image shown may not
reflect actual package.

STANDBY
750 ekW 938 kVA
60 Hz 1800 rpm 480 Volts

Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.

FEATURES

FUEL/EMISSIONS STRATEGY
· EPA Certified for Stationary Emergency Application (EPA Tier 2 emissions levels)

DESIGN CRITERIA
· The generator set accepts 100% rated load in one step per NFPA 110 and meets ISO 8528-5 transient response.

UL 2200 / CSA - Optional
· UL 2200 listed packages
· CSA Certified
Certain restrictions may apply.
Consult with your Cat® Dealer.

FULL RANGE OF ATTACHMENTS
· Wide range of bolt-on system expansion attachments, factory designed and tested
· Flexible packaging options for easy and cost effective installation

SINGLE-SOURCE SUPPLIER
· Fully prototype tested with certified torsional vibration analysis available

WORLDWIDE PRODUCT SUPPORT
· Cat dealers provide extensive post sale support including maintenance and repair agreements
· Cat dealers have over 1,800 dealer branch stores operating in 200 countries
· The Cat® S·O·S[SM] program cost effectively detects internal engine component condition, even the presence of unwanted fluids and combustion by-products

CAT® C27 ATAAC DIESEL ENGINE
· Utilizes ACERT™ Technology
· Reliable, rugged, durable design
· Four-cycle diesel engine combines consistent performance and excellent fuel economy with minimum weight
· Electronic engine control

CAT GENERATOR
· Designed to match the performance and output characteristics of Cat diesel engines
· Single point access to accessory connections
· UL 1446 recognized Class H insulation

CAT EMCP 4 CONTROL PANELS
· Simple user friendly interface and navigation
· Scalable system to meet a wide range of customer needs
· Integrated Control System and Communications Gateway

SEISMIC CERTIFICATION
· Seismic Certification available
· Anchoring details are site specific, and are dependent on many factors such as generator set size, weight, and concrete strength.
IBC Certification requires that the anchoring system used is reviewed and approved by a Professional Engineer
· Seismic Certification per Applicable Building Codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, CBC 2007
· Pre-approved by OSHPD and carries an OSP-0084-10 for use in healthcare projects in California

STANDBY 750 ekW 938 kVA
60 Hz 1800 rpm 480 Volts

FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT

System	Standard	Optional
Air Inlet	· Air cleaner	
Cooling	· Package mounted radiator	
Exhaust	· Exhaust flange outlet	~~[ ] Exhaust mufflers (except Tier 4)~~
Fuel	· Primary fuel filter with integral water separator · Secondary fuel filters · Fuel priming pump	
Generator	· Matched to the performance and output characteristics of Cat engines · Load adjustment module provides engine relief upon load impact and improves laod acceptance and recovery time · IP23 protection	~~[ ] Oversize and premium generators~~ [ ] Permanent magnet excitation (PMG) ~~[ ] Internal excited (IE)~~ [ ] Anti-condensation space heaters
Power Termination	· Bus bar	[ ] Circuit breakers, UL listed ~~[ ] Circuit breakers, IEC compliant~~
Control Panel	· EMCP 4 Genset Controller	[ ] EMCP 4.2 ~~[ ] EMCP 4.3~~ ~~[ ] EMCP 4.4~~ ~~[ ] Generator temperature monitoring and protection~~ ~~[ ] Load share module~~ [ ] Digital I/O module ~~[ ] Remote monitoring software~~
Mounting		Caterpillar Spring Isolators
Starting/Charging		[ ] Battery chargers ~~[ ] Oversize batteries~~ [ ] Jacket water heater ~~[ ] Heavy duty starting system~~ [ ] Charging alternator ~~[ ] Air starting motor with control and silencer (3500 & C175 models only)~~
General	· Paint - Caterpillar Yellow except rails and radiators gloss black	The following options are based on regional and product configuration: ~~[ ] Seismic Certification per Applicable Building Codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, CBC 2007~~ ~~[ ] EU Certificate of Conformance (CE)~~ [ ] UL 2200 package ~~[ ] CSA Certification~~ ~~[ ] EEC Declaration of Conformity~~ ~~[ ] E l - d tt t d, th p t ti~~ ~~[ ] Automatic transfer switches (ATS)~~ ~~[ ] Integral & sub-base fuel tanks~~ ~~[ ] Int g l & b-b UL list d d l all f el t k~~

SPECIFICATIONS

CAT GENERATOR

Please see Generator Data Sheet

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CAT DIESEL ENGINE

C27 TA, V-12, 4-Stroke Water-cooled Diesel
Bore...137.20 mm (5.4 in)
Stroke. ....152.40 mm (6.0 in)
Displacement. .... 27.03 L (1649.47 in³)
Compression Ratio. 16.5:1
Aspiration. .... TA
Fuel System...MEUI
Governor Type. ....ADEM™ A4

CAT EMCP 4 SERIES CONTROLS

EMCP 4 controls including:
- Run / Auto / Stop Control
- Speed and Voltage Adjust
- Engine Cycle Crank
- 24-volt DC operation
- Environmental sealed front face
- Text alarm/event descriptions

Digital indication for:
- RPM
- DC volts
- Operating hours
- Oil pressure (psi, kPa or bar)
- Coolant temperature
- Volts (L-L & L-N), frequency (Hz)
- Amps (per phase & average)
- ekW, kVA, kVAR, kW-hr, %kW, PF

Warning/shutdown with common LED indication of:
- Low oil pressure
- High coolant temperature
- Overspeed
- Emergency stop
- Failure to start (overcrank)
- Low coolant temperature
- Low coolant level

Programmable protective relaying functions:
- Generator phase sequence
- Over/Under voltage (27/59)
- Over/Under Frequency (81 o/u)
- Reverse Power (kW) (32)
- Reverse reactive power (kVAr) (32RV)
- Overcurrent (50/51)

Communications:
- Six digital inputs (4.2 only)
- Four relay outputs (Form A)
- Two relay outputs (Form C)
- Two digital outputs
- Customer data link (Modbus RTU)
- Accessory module data link
- Serial annunciator module data link
- Emergency stop pushbutton

Compatible with the following:
- Digital I/O module
- Local Annunciator
- Remote CAN annunciator
- Remote serial annunciator

TECHNICAL DATA

Open Generator Set - - 1800 rpm/60 Hz/480 Volts	DM9071	
EPA Certified for Stationary Emergency Application (EPA Tier 2 emissions levels)		
Generator Set Package Performance		
Genset Power rating @ 0.8 pf	937.5 kVA	
Genset Power rating with fan	750 ekW	
Fuel Consumption		
100% load with fan	202.9 L/hr	53.6 Gal/hr
75% load with fan	162.4 L/hr	42.9 Gal/hr
50% load with fan	116.2 L/hr	30.7 Gal/hr
Cooling System[1]		
Air flow restriction (system)	0.12 kPa	0.48 in. water
Engine coolant capacity	55.0 L	14.5 gal
Inlet Air		
Combustion air inlet flow rate	58.7 m³/min	2073.0 cfm
Exhaust System		
Exhaust stack gas temperature	509.3 ° C	948.7 ° F
Exhaust gas flow rate	158.9 m³/min	5611.5 cfm
Exhaust flange size (internal diameter)	203 mm	8 in
Exhaust system backpressure (maximum allowable)	10.0 kPa	40.2 in. water
Heat Rejection		
Heat rejection to coolant (total)	324 kW	18426 Btu/min
Heat rejection to exhaust (total)	742 kW	42197 Btu/min
Heat rejection to aftercooler	138 kW	7848 Btu/min
Heat rejection to atmosphere from engine	100 kW	5687 Btu/min
Heat rejection to atmosphere from generator	46.2 kW	2627.4 Btu/min
Alternator[2]		
Motor starting capability @ 30% voltage dip	2035 skVA	
Frame	596	
Temperature Rise	130 ° C	234 ° F
Lube System		
Sump refill with filter	68.0 L	18.0 gal
Emissions (Nominal)[3]		
NOx g/hp-hr	5.25 g/hp-hr	
CO g/hp-hr	.25 g/hp-hr	
HC g/hp-hr	.03 g/hp-hr	
PM g/hp-hr	.021 g/hp-hr	

[1] For ambient and altitude capabilities consult your Cat dealer. Air flow restriction (system) is added to existing restriction from factory.

[2] Generator temperature rise is based on a 40°C ambient per NEMA MG1-32. UL 2200 Listed packages may have oversized generators with a different temperature rise and motor starting characteristics.

[3] Emissions data measurement procedures are consistent with those described in EPA CFR 40 Part 89, Subpart D & E and ISO8178-1 for measuring HC, CO, PM, NOx. Data shown is based on steady state operating conditions of 77°F, 28.42 in HG and number 2 diesel fuel with 35° API and LHV of 18,390 btu/lb. The nominal emissions data shown is subject to instrumentation, measurement, facility and engine to engine variations. Emissions data is based on 100% load and thus cannot be used to compare to EPA regulations which use values based on a weighted cycle.

RATING DEFINITIONS AND CONDITIONS

Applicable Codes and Standards: AS1359, CSA C22.2 No 100-04, UL142, UL489, UL601, UL869, UL2200, NFPA 37, NFPA 70, NFPA 99, NFPA 110, IBC, IEC60034-1, ISO3046, ISO8528, NEMA MG 1-22, NEMA MG 1-33, 72/23/EEC, 98/37/EC, 2004/108/EC

Standby - Output available with varying load for the duration of the interruption of the normal source power. Average power output is 70% of the standby power rating. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year.

Ratings are based on SAE J1349 standard conditions. These ratings also apply at ISO3046 standard conditions.

Fuel Rates are based on fuel oil of 35° API (16° C or 60° F) gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.).

Additional Ratings may be available for specific customer requirements. Consult your Cat representative for details.

GENERATOR DATA

APRIL 29, 2015

For Help Desk Phone Numbers Click here

Selected Model

Engine: C27	**Generator Frame:** 1268	**Genset Rating (kW):** 750.0	**Line Voltage:** 480
Fuel: Diesel	**Generator Arrangement:** 3850626	**Genset Rating (kVA):** 937.0	**Phase Voltage:** 277
Frequency: 60	**Excitation Type:** Permanent Magnet	**Pwr. Factor:** 0.8	**Rated Current:** 1127.0
Duty: STANDBY	**Connection:** SERIES STAR	**Application:** EPG	**Status:** Current

Version: 41205 /41145 /41513 /10124

Spec Information

Generator Specification

Frame: 1268 **Type:** SR5	**No. of Bearings:** 1
Winding Type: RANDOM WOUND	**Flywheel:** 18.0
Connection: SERIES STAR	**Housing:** 0
Phases: 3	**No. of Leads:** 12
Poles: 4	**Wires per Lead:** 2
Sync Speed: 1800	**Generator Pitch:** 0.6667

Generator Efficiency

Per Unit Load	kW	Efficiency %
0.25	187.5	92.1
0.5	375.0	94.6
0.75	562.5	95.2
1.0	750.0	95.2

Reactances	Per Unit	Ohms
SUBTRANSIENT - DIRECT AXIS X''_d	0.1025	0.0252
SUBTRANSIENT - QUADRATURE AXIS X''_q	0.1115	0.0274
TRANSIENT - SATURATED X'_d	0.1270	0.0312
SYNCHRONOUS - DIRECT AXIS X_d	2.7002	0.6636
SYNCHRONOUS - QUADRATURE AXIS X_q	1.6211	0.3984
NEGATIVE SEQUENCE X_2	0.1070	0.0263
ZERO SEQUENCE X_0	0.0090	0.0022

Time Constants	Seconds
OPEN CIRCUIT TRANSIENT - DIRECT AXIS T'_{d0}	2.1110
SHORT CIRCUIT TRANSIENT - DIRECT AXIS T'_d	0.1000
OPEN CIRCUIT SUBSTRANSIENT - DIRECT AXIS T''_{d0}	0.0130
SHORT CIRCUIT SUBSTRANSIENT - DIRECT AXIS T''_d	0.0100
OPEN CIRCUIT SUBSTRANSIENT - QUADRATURE AXIS T''_{q0}	0.1450
SHORT CIRCUIT SUBSTRANSIENT - QUADRATURE AXIS T''_q	0.0100
EXCITER TIME CONSTANT T_e	0.0300
ARMATURE SHORT CIRCUIT T_a	0.0150

Short Circuit Ratio: 0.45 | Stator Resistance = 0.0046 Ohms | Field Resistance = 0.435 Ohms

Voltage Regulation

Voltage level adustment: +/-	5.0%
Voltage regulation, steady state: +/-	0.5%
Voltage regulation with 3% speed change: +/-	0.5%
Waveform deviation line - line, no load: less than	2.0%
Telephone influence factor: less than	50

Generator Excitation

	No Load	Full Load, (rated) pf Series	Full Load, (rated) pf Parallel
Excitation voltage:	11.16 Volts	43.03 Volts	Volts
Excitation current	0.93 Amps	2.95 Amps	Amps

Selected Model

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Duty: STANDBY	**Connection:** SERIES STAR	**Application:** EPG	**Status:** Current

Version: 41205 /41145 /41513 /10124

Generator Mechanical Information

Center of Gravity

Dimension X	-710.0 mm	-28.0 IN.
Dimension Y	0.0 mm	0.0 IN.
Dimension Z	0.0 mm	0.0 IN.

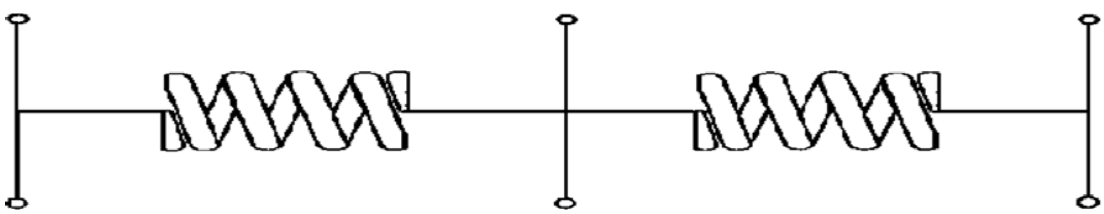
- "X" is measured from driven end of generator and parallel to rotor. Towards engine fan is positive. See General Information for details
- "Y" is measured vertically from rotor center line. Up is positive.
- "Z" is measured to left and right of rotor center line. To the right is positive.

Generator WT = 1865 kg	* Rotor WT = 703 kg	* Stator WT = 1162 kg
4,112 LB	1,550 LB	2,562 LB

Rotor Balance = 0.0508 mm deflection PTP

Overspeed Capacity = 125% of synchronous speed

Generator Torsional Data



J1 = Coupling and Fan **J2 = Rotor** **J3 = Exciter End**

TOTAL J = J1 + J2 + J3

K1 = Shaft Stiffness between J1 + J2 (Diameter 1) **K2 = Shaft Stiffness between J2 + J3 (Diameter 2)**

J1	K1	Min Shaft Dia 1	J2	K2	Min Shaft Dia 2	J3
9.9 LB IN. s^2	69.1 MLB IN./rad	5.7 IN.	93.4 LB IN. s^2	68.2 MLB IN./rad	5.5 IN.	3.3 LB IN. s^2
1.12 N m s^2	7.81 MN m/rad	145.0 mm	10.55 N m s^2	7.7 MN m/rad	140.0 mm	0.37 N m s^2

Total J

106.6 LB IN. s^2

12.04 N m s^2

Selected Model

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Version: 41205 /41145 /41513 /10124

Generator Cooling Requirements - Temperature - Insulation Data

Cooling Requirements:		**Temperature Data: (Ambient 40 ^{0}C)**	
Heat Dissipated:	37.8 kW	**Stator Rise:**	105.0 ^{0}C
Air Flow:	66.0 m^3/min	**Rotor Rise:**	105.0 ^{0}C

Insulation Class: H

Insulation Reg. as shipped: 100.0 MΩ minimum at 40 ^{0}C

Thermal Limits of Generator

Frequency:	60 Hz
Line to Line Voltage:	480 Volts
B BR 80/40	848.0 kVA
F BR -105/40	965.0 kVA
H BR - 125/40	1060.0 kVA
F PR - 130/40	1060.0 kVA
H PR - 150/40	1124.0 kVA
H PR27 - 163/27	1166.0 kVA

Selected Model

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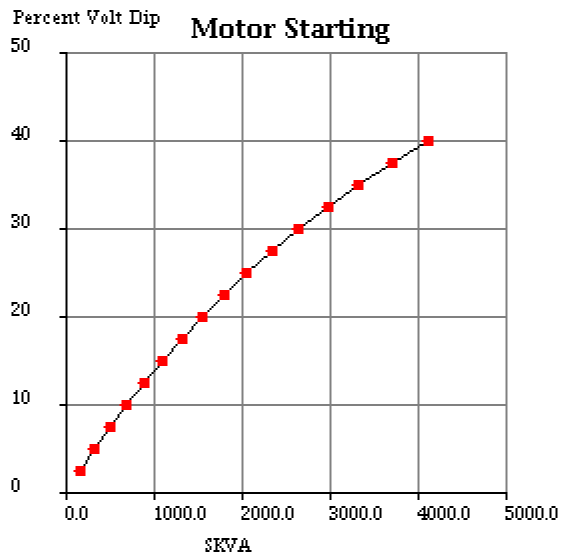
Version: 41205 /41145 /41513 /10124

Starting Capability & Current Decrement

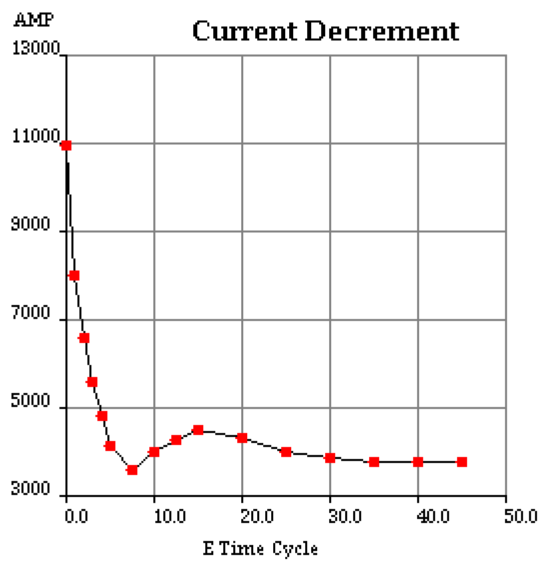
Motor Starting Capability (0.4 pf)

SKVA	Percent Volt Dip
158	2.5
324	5.0
500	7.5
685	10.0
880	12.5
1,088	15.0
1,307	17.5
1,541	20.0
1,789	22.5
2,054	25.0
2,338	27.5
2,641	30.0
2,968	32.5
3,319	35.0
3,698	37.5
4,109	40.0



Current Decrement Data

E Time Cycle	AMP
0.0	10,948
1.0	7,996
2.0	6,584
3.0	5,602
4.0	4,811
5.0	4,149
7.5	3,604
10.0	3,995
12.5	4,292
15.0	4,490
20.0	4,325
25.0	4,009
30.0	3,847
35.0	3,792
40.0	3,783
45.0	3,791



Instantaneous 3 Phase Fault Current: 10948 Amps **Instantaneous Line - Line Fault Current:** 9276 Amps
Instantaneous Line - Neutral Fault Current: 15420 Amps

Selected Model

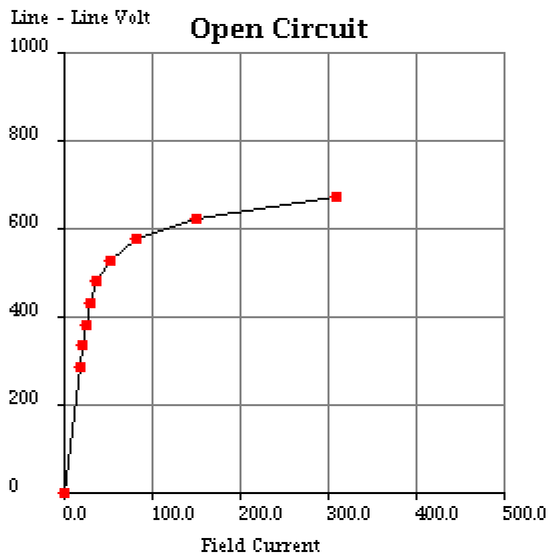
Engine: C27 **Generator Frame:** 1268 **Genset Rating (kW):** 750.0 **Line Voltage:** 480
Fuel: Diesel **Generator Arrangement:** 3850626 **Genset Rating (kVA):** 937.0 **Phase Voltage:** 277
Frequency: 60 **Excitation Type:** Permanent Magnet **Pwr. Factor:** 0.8 **Rated Current:** 1127.0
Duty: STANDBY **Connection:** SERIES STAR **Application:** EPG **Status:** Current

Version: 41205 /41145 /41513 /10124

Generator Output Characteristic Curves

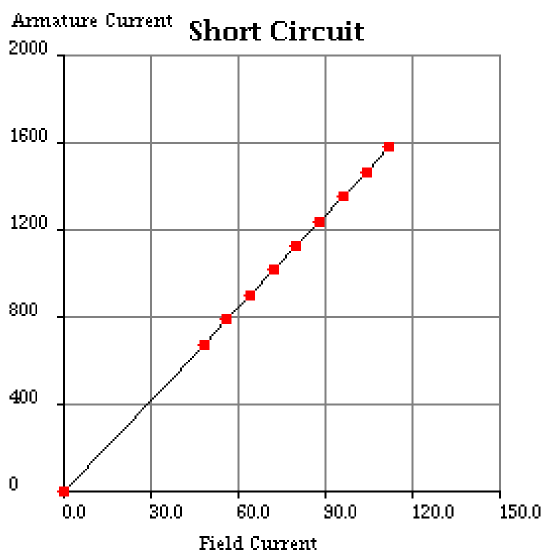
Open Circuit Curve

Field Current	Line - Line Volt
0.0	0
17.9	288
21.2	336
25.0	384
29.8	432
37.4	480
51.5	528
81.3	576
149.2	624
309.3	672



Short Circuit Curve

Field Current	Armature Current
0.0	0
48.1	677
56.1	789
64.1	902
72.1	1,015
80.1	1,128
88.1	1,240
96.1	1,353
104.1	1,466
112.1	1,579



Selected Model

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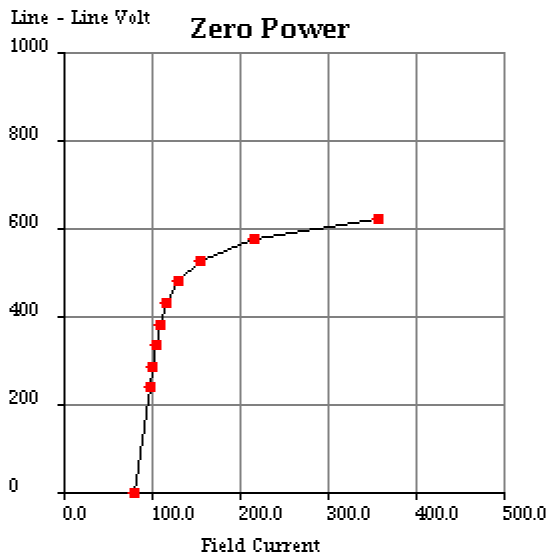
Fuel: Diesel **Generator Arrangement:** 3850626 **Genset Rating (kVA):** 937.0 **Phase Voltage:** 277
Frequency: 60 **Excitation Type:** Permanent Magnet **Pwr. Factor:** 0.8 **Rated Current:** 1127.0
Duty: STANDBY **Connection:** SERIES STAR **Application:** EPG **Status:** Current

Version: 41205 /41145 /41513 /10124

Generator Output Characteristic Curves

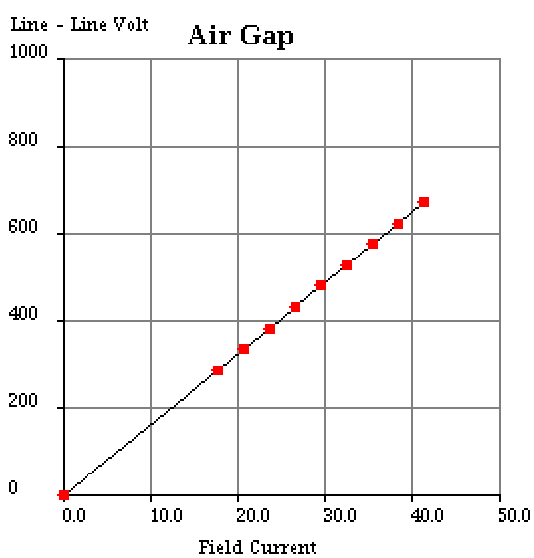
Zero Power Factor Curve

Field Current	Line - Line Volt
80.1	0
97.4	240
100.7	288
104.4	336
109.0	384
116.0	432
128.8	480
155.5	528
215.9	576
357.6	624



Air Gap Curve

Field Current	Line - Line Volt
0.0	0
17.7	288
20.7	336
23.6	384
26.6	432
29.5	480
32.5	528
35.4	576
38.4	624
41.3	672



Selected Model

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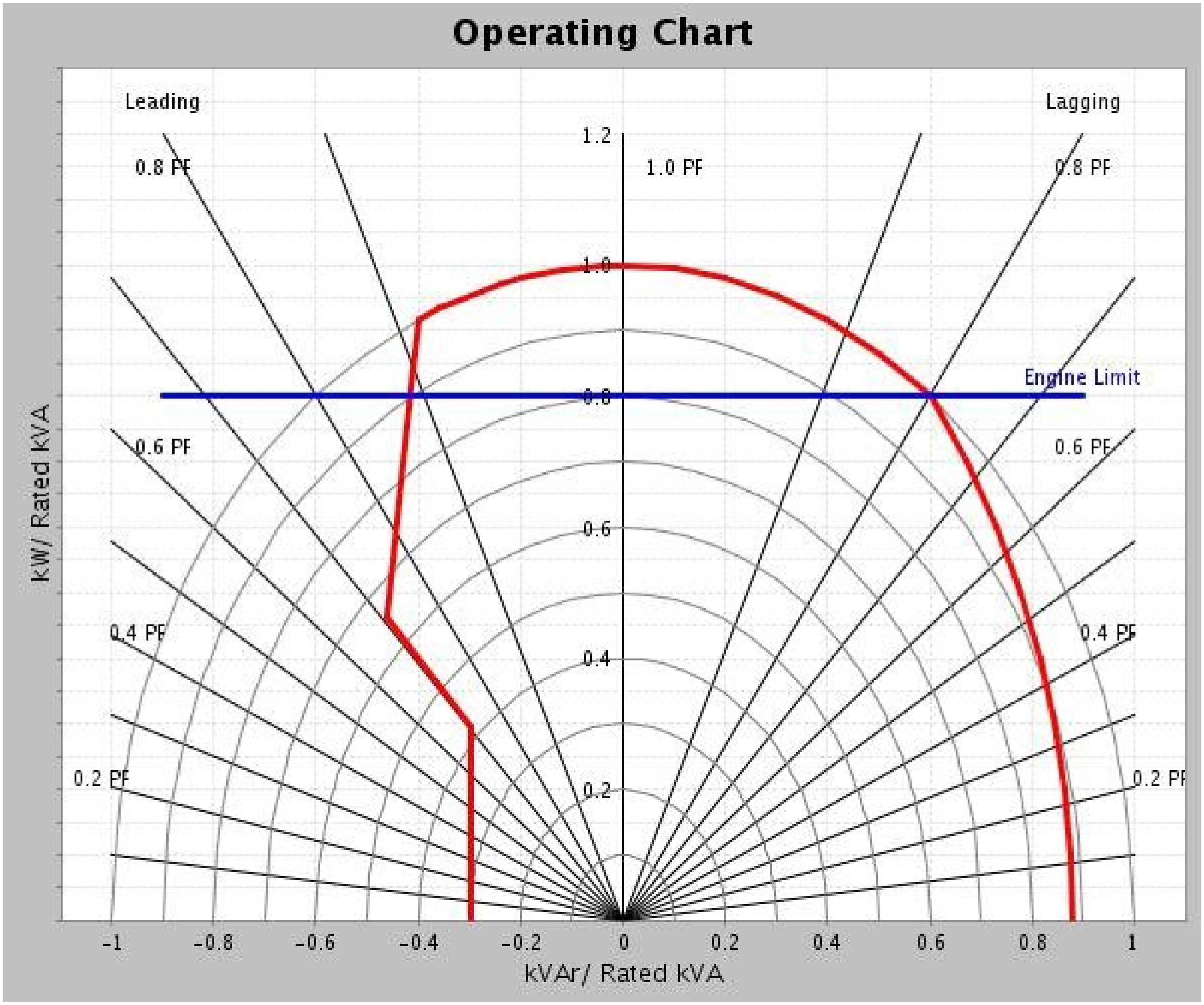
Fuel: Diesel **Generator Arrangement:** 3850626 **Genset Rating (kVA):** 937.0 **Phase Voltage:** 277
Frequency: 60 **Excitation Type:** Permanent Magnet **Pwr. Factor:** 0.8 **Rated Current:** 1127.0
Duty: STANDBY **Connection:** SERIES STAR **Application:** EPG **Status:** Current

Version: 41205 /41145 /41513 /10124

Reactive Capability Curve

Click to view Chart



Selected Model

Engine: C27	**Generator Frame:** 1268	**Genset Rating (kW):** 750.0	**Line Voltage:** 480
Fuel: Diesel	**Generator Arrangement:** 3850626	**Genset Rating (kVA):** 937.0	**Phase Voltage:** 277
Frequency: 60	**Excitation Type:** Permanent Magnet	**Pwr. Factor:** 0.8	**Rated Current:** 1127.0
Duty: STANDBY	**Connection:** SERIES STAR	**Application:** EPG	**Status:** Current

Version: 41205 /41145 /41513 /10124

General Information

DM7825 Caterpillar SR5 Generators (50 Hz, 60 Hz)
Data for 1400, 1600, 1700, 1800 and 1900 frames Caterpillar SR5 generators built by Leroy Somer - USA and Leroy Somer – France.

Refer to DM7821 for explanation of all generator data in Technical Marketing Information (TMI) except generator efficiency for which the explanation is given below.

GENERATOR EFFICIENCY
Generator efficiency is the percentage of engine flywheel (or other prime mover) power that is converted into electrical output. The generator efficiency shown is calculated by the summation of all losses method, and is determined in accordance with the IEC Standard 60034. The efficiency considers only the generator. There is no consideration of engine or parasitic losses here.

PERFORMANCE DATA:DM9 ;

Performance N m er: DM9 **C an e Le el: 2**

SALES MODEL:	C27	**COMBUSTION:**	DI
ENGINE POWER (BHP):	1,141	**ENGINE SPEED (RPM):**	1,800
GEN POWER WITH FAN (EKW):	750.0	**HERTZ:**	60
COMPRESSION RATIO:	16.5	**FAN POWER (HP):**	37.5
RATING LEVEL:	STAND	**ADDITIONAL PARASITICS (HP):**	52.7
PUMP QUANTITY:	1	**ASPIRATION:**	TA
FUEL TYPE:	DIESEL	**AFTERCOOLER TYPE:**	ATAAC
MANIFOLD TYPE:	DR	**AFTERCOOLER CIRCUIT TYPE:**	OC, ATAAC
GOVERNOR TYPE:	ADEM4	**INLET MANIFOLD AIR TEMP (F):**	120
ELECTRONICS TYPE:	ADEM4	**JACKET WATER TEMP (F):**	210.2
IGNITION TYPE:	CI	**TURBO CONFIGURATION:**	PARALLEL
INJECTOR TYPE:	EUI	**TURBO QUANTITY:**	2
REF EXH STACK DIAMETER (IN):	10	**TURBOCHARGER MODEL:**	GTA5008 S#56T#1.60
MAX OPERATING ALTITUDE (FT):	10,000	**CERTIFICATION YEAR:**	2006
		PISTON SPD @ RATED ENG SPD (FT/MIN):	1,800.0

INDUSTRY	SUBINDUSTRY	APPLICATION
ELECTRIC PO ER	STANDARD	PACKAGED GENSET
OIL AND GAS	LAND PRODUCTION	PACKAGED GENSET

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EK	%	&P	PSI	L ' &P#&R	GAL'&R	IN#&G	DEG (	DEG (	IN#&G	DEG (
750.0	100	1,141	305	0.329	53.6	52.6	120.7	1,210.7	36.7	948.7
675.0	90	1,036	276	0.333	49.3	48.2	117.3	1,184.5	33.3	935.9
600.0	80	931	248	0.339	45.0	43.6	114.3	1,157.5	30.1	920.5
562.5	75	878	234	0.342	42.9	41.2	112.8	1,143.4	28.5	911.5
525.0	70	826	220	0.344	40.6	38.3	110.7	1,127.0	26.5	902.0
450.0	60	722	193	0.346	35.7	31.9	105.8	1,084.0	22.3	877.6
375.0	50	618	165	0.348	30.7	25.3	100.8	1,028.5	18.0	845.1
300.0	40	516	138	0.350	25.8	19.1	97.6	957.6	14.1	798.9
225.0	30	413	110	0.356	21.0	13.6	95.6	866.3	10.9	731.9
187.5	25	361	96	0.361	18.7	11.0	94.8	813.1	9.5	691.2
150.0	20	309	82	0.368	16.3	8.6	94.0	754.4	8.2	645.3
75.0	10	201	54	0.403	11.6	4.9	92.4	617.0	6.1	532.3

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EK	%	&P	IN#&G	DEG (	C(M	C(M	L '&R	L '&R	(T3'MIN	(T3'MIN
750.0	100	1,141	55	340.2	2,073.6	5,610.2	8,929.7	9,304.9	1,958.6	1,773.7
675.0	90	1,036	51	321.4	1,972.9	5,269.2	8,478.1	8,823.2	1,856.4	1,685.5
600.0	80	931	46	304.2	1,874.4	4,932.9	8,053.0	8,368.4	1,757.3	1,600.2
562.5	75	878	43	295.1	1,825.8	4,766.3	7,827.5	8,127.9	1,709.1	1,558.8
525.0	70	826	40	282.3	1,763.3	4,540.6	7,544.0	7,828.2	1,639.5	1,497.3
450.0	60	722	34	253.9	1,610.3	4,039.0	6,871.8	7,121.9	1,485.0	1,359.5
375.0	50	618	27	225.6	1,444.6	3,541.1	6,147.8	6,362.8	1,334.4	1,225.1
300.0	40	516	21	197.9	1,288.0	3,054.4	5,467.1	5,647.9	1,193.2	1,099.5
225.0	30	413	15	170.0	1,143.5	2,567.6	4,844.7	4,992.1	1,059.4	981.2
187.5	25	361	12	155.9	1,073.8	2,322.4	4,546.8	4,677.5	992.1	921.8
150.0	20	309	10	141.7	1,005.3	2,074.6	4,256.4	4,370.3	923.1	860.8
75.0	10	201	6	120.2	905.7	1,659.5	3,831.9	3,913.1	822.6	775.2

Heat Rejection Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHUAST RECOVERY TO 3? F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
EK	%	&P	TU'MIN	TU'MIN	TU'MIN	TU'MIN	TU'MIN	TU'MIN	TU'MIN	TU'MIN	TU'MIN
750.0	100	1,141	18,420	5,664	42,192	23,831	6,126	7,849	48,396	115,016	122,520
675.0	90	1,036	17,400	5,193	39,249	22,066	5,635	6,930	43,919	105,788	112,691
600.0	80	931	16,092	4,896	36,354	20,327	5,147	6,123	39,470	96,630	102,935
562.5	75	878	15,154	5,120	34,836	19,404	4,904	5,715	37,253	92,070	98,078
525.0	70	826	14,494	5,043	33,095	18,346	4,642	5,184	35,034	87,162	92,850
450.0	60	722	13,468	4,399	29,123	15,903	4,084	4,077	30,613	76,677	81,680
375.0	50	618	11,700	4,303	24,895	13,283	3,509	3,072	26,205	65,876	70,174
300.0	40	516	10,463	3,778	20,710	10,638	2,951	2,194	21,876	55,406	59,021
225.0	30	413	9,817	2,772	16,546	7,940	2,405	1,443	17,528	45,159	48,105
187.5	25	361	9,420	2,280	14,506	6,617	2,133	1,114	15,330	40,038	42,651
150.0	20	309	8,879	1,864	12,505	5,323	1,858	813	13,103	34,888	37,164
75.0	10	201	6,965	1,736	8,856	2,900	1,326	427	8,541	24,901	26,525

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	?0.0	?B2.?	3 ?.0	18 .?	?.0
PERCENT LOAD		C	100	?	?0	2?	10
ENGINE POWER		BHP	1>1D1	8 8	B18	3B1	201
TOTAL NOX (AS NO2)		G/HR	7,181	4,159	2,639	1,824	1,310
TOTAL CO		G/HR	520	683	655	540	554
TOTAL HC		G/HR	55	82	96	88	101
PART MATTER		G/HR	47.2	59.4	150.5	116.9	78.8
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,190.9	2,326.7	2,078.5	2,424.5	2,904.0
TOTAL CO	(CORR 5% O2)	MG/NM3	231.7	383.5	519.6	772.5	1,347.1
TOTAL HC	(CORR 5% O2)	MG/NM3	21.1	40.7	65.9	111.3	214.7
PART MATTER	(CORR 5% O2)	MG/NM3	17.2	27.7	103.8	128.4	160.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,554	1,133	1,012	1,181	1,414
TOTAL CO	(CORR 5% O2)	PPM	185	307	416	618	1,078
TOTAL HC	(CORR 5% O2)	PPM	39	76	123	208	401
TOTAL NOX (AS NO2)		G/HP#HR	6.35	4.76	4.29	5.06	6.52
TOTAL CO		G/HP#HR	0.46	0.78	1.07	1.50	2.76
TOTAL HC		G/HP#HR	0.05	0.09	0.16	0.24	0.50
PART MATTER		G/HP#HR	0.04	0.07	0.24	0.32	0.39
TOTAL NOX (AS NO2)		L /HR	15.83	9.17	5.82	4.02	2.89
TOTAL CO		L /HR	1.15	1.51	1.45	1.19	1.22
TOTAL HC		L /HR	0.12	0.18	0.21	0.19	0.22
PART MATTER		L /HR	0.10	0.13	0.33	0.26	0.17

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	?0.0	?B2.?	3 ?.0	18 .?	?.0
PERCENT LOAD		C	100	?	?0	2?	10
ENGINE POWER		BHP	1>1D1	8 8	B18	3B1	201
TOTAL NOX (AS NO2)		G/HR	5,935	3,437	2,181	1,507	1,082
TOTAL CO		G/HR	278	365	351	289	296
TOTAL HC		G/HR	29	43	51	47	53
TOTAL CO2		KG/HR	525	419	298	180	112
PART MATTER		G/HR	24.2	30.5	77.2	59.9	40.4
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,637.1	1,922.9	1,717.8	2,003.7	2,400.0
TOTAL CO	(CORR 5% O2)	MG/NM3	123.9	205.1	277.9	413.1	720.4
TOTAL HC	(CORR 5% O2)	MG/NM3	11.2	21.5	34.9	58.9	113.6
PART MATTER	(CORR 5% O2)	MG/NM3	8.8	14.2	53.2	65.9	82.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,285	937	837	976	1,169
TOTAL CO	(CORR 5% O2)	PPM	99	164	222	330	576
TOTAL HC	(CORR 5% O2)	PPM	21	40	65	110	212
TOTAL NOX (AS NO2)		G/HP#HR	5.25	3.94	3.54	4.18	5.39
TOTAL CO		G/HP#HR	0.25	0.42	0.57	0.80	1.48
TOTAL HC		G/HP#HR	0.03	0.05	0.08	0.13	0.27
PART MATTER		G/HP#HR	0.02	0.03	0.13	0.17	0.20
TOTAL NOX (AS NO2)		L /HR	13.08	7.58	4.81	3.32	2.39
TOTAL CO		L /HR	0.61	0.81	0.77	0.64	0.65
TOTAL HC		L /HR	0.06	0.10	0.11	0.10	0.12
TOTAL CO2		L /HR	1,157	924	658	397	246
PART MATTER		L /HR	0.05	0.07	0.17	0.13	0.09
OX GEN IN EXH		%	8.9	10.1	11.2	13.2	15.4
DR SMOKE OPACIT		%	0.4	1.4	2.9	4.4	3.8
OSCH SMOKE NUM ER			0.18	0.48	1.07	1.51	1.40

Regulatory Information

EPA TIER 2		200B - 2010		
GASEOUS EMISSIONS DATA MEASUREMENTS PRO2IDED TO THE EPA ARE CONSISTENT ITH THOSE DESCRI ED IN EPA 40 C(R PART 89 SU PART D AND ISO 8178 (OR MEASURING HC, CO, PM, AND NOX. THE 3MAX LIMITS3 SHO N ELO ARE EIGHTED C CLE A2ERAGES AND ARE IN COMPLIANCE ITH THE NON#ROAD REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALI()	EPA	NON#ROAD	TIER 2	CO4 3.5 NO5 HC4 6.4 PM4 0.20

EPA EMERGENCY STATIONARY		2011 - ----		
GASEOUS EMISSIONS DATA MEASUREMENTS PRO2IDED TO THE EPA ARE CONSISTENT ITH THOSE DESCRI ED IN EPA 40 C(R PART 60 SU PART IIII AND ISO 8178 (OR MEASURING HC, CO, PM, AND NOX. THE 3MAX LIMITS3 SHO N ELO ARE EIGHTED C CLE A2ERAGES AND ARE IN COMPLIANCE ITH THE EMERGENC STATIONAR REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALI()	EPA	STATIONAR	EMERGENC STATIONAR	CO4 3.5 NO5 HC4 6.4 PM4 0.20

Print

Systems Data
Reference Number: DM9071

CATERPILLAR®

April 29, 2015
For Help Desk Phone Numbers
Click Here

AIR INTAKE SYSTEM		
THE INSTALLED SYSTEM MUST COMPLY WITH THE SYSTEM LIMITS BELOW FOR ALL EMISSIONS CERTIFIED ENGINES TO ASSURE REGULATORY COMPLIANCE.		
MAXIMUM ALLOWABLE INTAKE RESTRICTION WITH CLEAN ELEMENT	15	IN-H20
MAXIMUM ALLOWABLE INTAKE RESTRICTION WITH DIRTY ELEMENT	25	IN-H20
MAXIMUM PRESSURE DROP FROM COMPRESSOR OUTLET TO MANIFOLD INLET (OR MIXER INLET FOR EGR)	4.4	IN-HG
MAXIMUM TURBO INLET AIR TEMPERATURE	122	DEG F
MAXIMUM AIR FILTER INLET AIR TEMPERATURE	122	DEG F
CHARGE AIR FLOW AT RATED SPEED	153.2	LB/MIN
TURBO COMPRESSOR OUTLET PRESSURE AT RATED SPEED (ABSOLUTE)	84.8	IN-HG
COOLING SYSTEM		
ENGINE ONLY COOLANT CAPACITY	14.5	GAL
MAXIMUM ALLOWABLE JACKET WATER OUTLET TEMPERATURE	230	DEG F
REGULATOR LOCATION FOR JW CIRCUIT	OUTLET	
MAXIMUM UNINTERRUPTED FILL RATE	5.0	G/MIN
MINIMUM ALLOWABLE COOLANT LOSS (PERCENTAGE OF TOTAL)	12	PERCENT
COOLANT LOSS-MAXIMUM PERCENTAGE OF PUMP PRESSURE RISE LOSS	15	PERCENT
ENGINE SPEC SYSTEM		
CYLINDER ARRANGEMENT	VEE	
NUMBER OF CYLINDERS	12	
CYLINDER BORE DIAMETER	5.4	IN
PISTON STROKE	6.0	IN
TOTAL CYLINDER DISPLACEMENT	1649	CU IN
STANDARD CRANKSHAFT ROTATION FROM FLYWHEEL END	CCW	
STANDARD CYLINDER FIRING ORDER	1-10-9-6-5-12-11-4-3-8-7-2	
NUMBER 1 CYLINDER LOCATION	RIGHT FRONT	
STROKES/COMBUSTION CYCLE	4	
EXHAUST SYSTEM		
THE INSTALLED SYSTEM MUST COMPLY WITH THE SYSTEM LIMITS BELOW FOR ALL EMISSIONS CERTIFIED ENGINES TO ASSURE REGULATORY COMPLIANCE.		
MAXIMUM ALLOWABLE SYSTEM BACK PRESSURE	40	IN-H20
MANIFOLD TYPE	DRY	
MAXIMUM ALLOWABLE STATIC WEIGHT ON EXHAUST CONNECTION	110.2	LB
MAXIMUM ALLOWABLE STATIC BENDING MOMENT ON EXHAUST CONNECTION	0	LB-FT
FUEL SYSTEM		
MAXIMUM FUEL FLOW FROM TRANSFER PUMP TO ENGINE	227.2	G/HR
MAXIMUM ALLOWABLE FUEL SUPPLY LINE RESTRICTION	8.9	IN-HG
MAXIMUM ALLOWABLE FUEL TEMPERATURE AT TRANSFER PUMP INLET	149	DEG F
MAXIMUM FUEL FLOW TO RETURN LINE FROM ENGINE	198.1	G/HR
MAXIMUM ALLOWABLE FUEL RETURN LINE RESTRICTION	10.2	IN-HG
NORMAL FUEL PRESSURE IN A CLEAN SYSTEM	90.9	PSI
FUEL SYSTEM TYPE	DI	
MAXIMUM TRANSFER PUMP PRIMING LIFT WITHOUT PRIMING PUMP	12.1	FT
LUBE SYSTEM		
CRANKCASE VENTILATION TYPE	TO ATM	
MOUNTING SYSTEM		

CENTER OF GRAVITY LOCATION - X DIMENSION - FROM REAR FACE OF BLOCK - (REFERENCE TM7077)	23.0	IN
CENTER OF GRAVITY LOCATION - Y DIMENSION - FROM CENTERLINE OF CRANKSHAFT - (REFERENCE TM7077)	11.5	IN
CENTER OF GRAVITY LOCATION - Z DIMENSION - FROM CENTERLINE OF CRANKSHAFT - (REFERENCE TM7077)	0.0	IN
DRY WEIGHT - ENGINE ONLY (REFERENCE VALUE)	6462	LB
STARTING SYSTEM		
MINIMUM CRANKING SPEED REQUIRED FOR START-RPM	100	
LOWEST AMBIENT START TEMPERATURE WITHOUT AIDS	32	DEG F

ADEM™ A4 Engine Controller

The ADEM™ A4 is the main Electronic Control Module (ECM) used on select diesel engines. The ADEM A4 provides a higher degree of control over a large number of combustion variables. The ADEM A4 is designed to control/ interface Electronic Unit Injector (EUI) equipped engines. The ADEM A4 engine system is composed of the ADEM A4 ECM, control software, sensors, actuators, fuel injectors, and interface to the generator system. The prime benefit of an ADEM A4 engine system is to better control and maintain the particulate emissions, both steady state and transient, while improving engine performance

FEATURES

RELIABLE, DURABLE

All ADEM A4 controllers are designed to survive the harshest environments.

- Environmentally sealed, die-cast aluminum housing isolates and protects electronic components from moisture and dirt contamination.
- Rigorous vibration testing ensures product reliability and durability.
- Accuracy maintained from –40° C to 85° C
- Electrical noise immunity to 100 volts/meter
- Internal circuits are designed to withstand shorts to +battery and –battery.

SIMPLE SERVICING

Each ADEM A4 system works in combination with the Cat® ET service tool software to keep the engine operating at peak performance.

- Displays measured parameters
- Retrieves active and logged event code documenting abnormal system operation
- Performs calibrations and diagnostic tests
- Supports flash programming of new software into the ADEM A4 ECM

SELF DIAGNOSTICS

Each ADEM A4 ECM has a full compliment of diagnostics. The ECM can detect faults in the electrical system and report those faults to the service technician for quick repair.

- Self-diagnostic capability pinpoints operational problems in need of attention.

ADVANCED FEATURES

- Enhanced performance from fuel injection timing and limiting
- Adjustable monitoring of vital engine parameters
- Programmable speed acceleration ramp rate
- Data link interfaces

Specification sheet

Fire pump drive engine

CFP9E-F65

Description

Engine series - Cummins QSL9 Series
Exhaust emissions - EPA Tier 3

When performance matters, we take notice. Our engines are an assurance of safety specifically designed to fit your needs. The CFP9E high horsepower has advanced electronics, higher torque, and higher horsepower than the standard CFP9E while still offering shorter service times, longer maintenance intervals, increased fuel economy, and up to 50% less noise.

Features

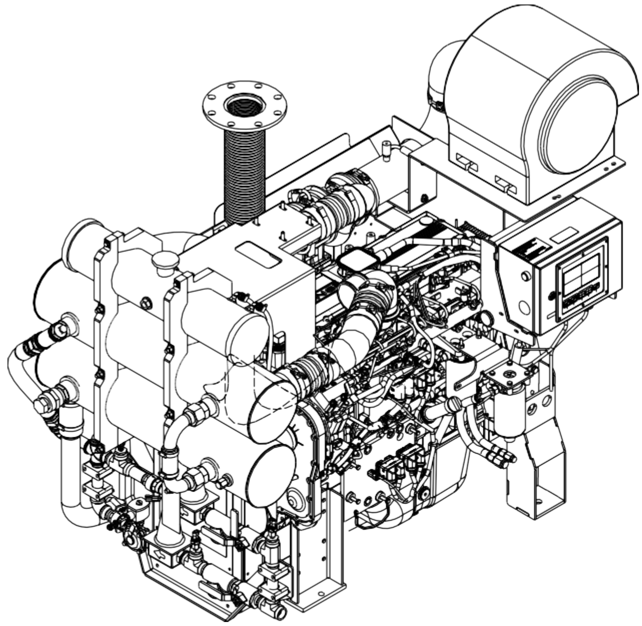
Certified power - The CFP9E-F65 complies with NFPA 20 and is UL 1247 Listed and FM 1333 Approved.

Control system - The industry-leading, state-of-the-art Fire Pump Digital Panel (FPDP) provides total fire pump drive engine system integration and intuitive operation, including:

- Color touchscreen;
- Dual microprocessors for critical signal redundancy;
- Standard J1939 parameter and Cummins fault code display;
- Engine idling;
- Electronic Control Module (ECM) self-diagnosis; and
- Optional Modbus field server remote messaging capability.

Warranty and service - Our models are backed by a comprehensive warranty and worldwide distributor network.

	Ratings in HP (kW)	
Operating speed (RPM)	**1760**	
CFP9E-F65 **NFPA, UL & FM**	380	(283)



General engine data	
Engine type	4 Cycle; In-Line, 6 Cylinder
Aspiration	Turbocharged and Charge-Air Cooled
Bore and stroke	4.49 x 5.69 in. (114 x 145 mm)
Displacement	543 in^3 (8.9 L)
Rotation	Counterclockwise from flywheel end
Compression ratio	16.1:1
Valves per cylinder	Intake - 2 Exhaust - 2
Fuel system	Bosch Electronic
Maximum allowable bending moment @ rear face of block	1000 lb.-ft. (1356 N-m)
Estimated wet weight*	TBD

* Weight includes engine, cooling loop, heat exchanger, dual Electronic Control Modules (ECMs), Fire Pump Digital Panel (FPDP), standard air cleaner, standard exhaust flex, and all fluids.

Equipment	Standard	Optional
Air cleaner	Disposable; treated for high humidity, indoor service	Heavy-duty, two-stage with replaceable elements
Alternator	12V-DC, 95 amps; includes belt guard	24V-DC, 45 amps with belt guard
Cooling loop (maximum pressure of 300 PSI)	1” diameter for fresh water; includes alarm sensors and FM-approval	Cu Ni construction available for sea water applications; approved loops up to 1 1/4”
Cooling system	Tube and shell type, 60 PSI with NPTF connections	Radiator[1]; sea water tube and shell
Engine heater	120V-AC, 2250 watts	240V-AC, 2250 watts
Exhaust protection	Metal guards on manifolds and turbocharger	N/A
Exhaust flex connection	Steel, flanged	Stainless steel flex, NPT
Flywheel power take-off	Flywheel	Driveshaft system, stub shaft
Fuel connections	Fire-resistant flexible supply and return lines	N/A
Fuel filter	Primary and secondary	N/A
Governor, speed	Constant speed	N/A
Fire pump digital panel (FPDP)	7” color touchscreen; enclosure rated as Type 2/Type 4X; Imperial and metric values	Optional 316SS construction; custom gauges with digital panel expansion module (DPEM)
Lube oil cooler	Engine-water-cooled, plate type	N/A
Lube oil filter	Full-flow with by-pass valve	N/A
Lube oil pump	Gear-driven	N/A
Manual start controls	On FPDP and/or contactors	N/A
Overspeed controls	Electronic with reset and test on FPDP	N/A
Starter	12V-DC	24V-DC/pneumatic[2]/hydraulic[2]

[1] Not UL Listed and not FM Approved.

[2] Only approved as a secondary starter.

Air induction system

Maximum temperature rise between ambient air and engine air inlet	30 °F (16.7 °C)
Maximum inlet restriction with dirty filter	18 in. H_2O (457 mm H_2O)
Recommended air cleaner element - (standard)	Cummins FIltration AH1101
Recommended air cleaner element - (heavy duty)	Optional: primary element AF4553M; secondary element AF4554M

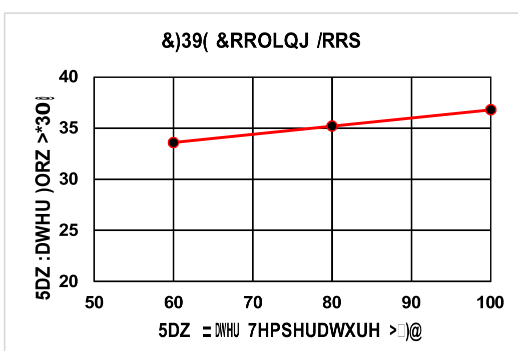
Lubrication system

Oil pressure range at rated	40-60 PSI (276-414 kPa)
Oil capacity of pan (high - low)	24-20 qt. (23-19 L)
Total system capacity	6.5 gal. (24.6 L)
Recommended lube oil filter	Cummins Filtration LF9009

Cooling system*

Raw water working pressure range at heat exchanger	60 PSI (413 kPa) MAX
Recommended minimum water supply pipe size to heat exchanger	1 in. (25.4 mm)
Recommended minimum water discharge pipe size from heat exchanger	1.25 in. (31.75 mm)
Coolant water capacity (engine only)	2.9 gal. (11 L)
Standard thermostat - type	Modulating
Standard thermostat - range	180-199 °F (82-93 °C)
Normal Operating Temperature	180-212 °F (82-100 °C)
Minimum raw water flow:	
- with water temperatures to 60 °F (16 °C)	33.6 GPM (2.12 L/sec)
- with water temperatures to 80 °F (27 °C)	35.2 GPM (2.22 L/sec)
- with water temperatures to 100 °F (38 °C)	36.8 GPM (2.32 L/sec)
Recommended cooling water filter	Cummins Filtration WF2072

* A jacket water heater is mandatory on this engine. The recommended heater wattage is 2250 down to 40 °F (4 °C)



Exhaust system

Maximum allowable back pressure by complete exhaust system	40.8 in. H_2O (10.2 kPa)
Exhaust pipe size normally acceptable	5 in. (127 mm)

Noise emissions - The noise emission values are estimated sound pressure levels at 3.3 ft. (1 m).

Top	119.5 dBa
Right side	119.5 dBa
Left side	119.5 dBa
Front	119.5 dBa
Exhaust	119.5 dBa

Fuel supply/drain system

Operating speed in RPM	1760	
Fuel rate - gal/hr (L/hr)	21.8	(82.6)

Fuel type	No. 2 diesel only
Minimum supply line size	0.5 in. (12.70 mm)
Minimum drain line size	0.375 in. (9.53 mm)
Maximum fuel height above C/L fuel pump	227 in. (5.7 m)
Recommended fuel filter - primary	Cummins Filtration FF5580
Recommended fuel filter - secondary	Cummins Filtration FS1212
Maximum restriction @ lift pump-inlet - with clean filter	6.0 in. Hg (152 mm Hg)
Maximum restriction @ lift pump-inlet - with dirty filter	10.0 in. Hg (254 mm Hg)
Maximum return line restriction - without check valves	10 in. Hg (254 mm Hg)
Minimum fuel tank vent capability	7.1 ft^3/hr (0.21 m^3/hr)
Maximum fuel temperature @ lift pump inlet	160 °F (71 °C)

Starting and electrical system

Minimum recommended battery capacity - cold soak at 0 °F (-18 °C) or above	12V	24V
Engine only - cold cranking amperes	1800 CCA*	750 CCA*
Engine only - reserve capacity	430 minutes*	430 minutes*
*Based on FM requirement for a minimum of 900 CCA and 430 reserve capacity minutes		

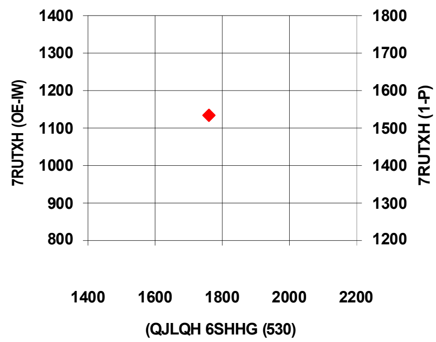
Battery cable size - minimum of 2/0 AWG and maximum cable length not to exceed 6 ft. (1.5 m)	12V	24V
Maximum resistance of starting circuit	0.001 Ohms	0.002 Ohms
Typical cranking speed	130 RPM	130 RPM
Alternator (standard), internally regulated	95 amps	45 amps

Operating conditions

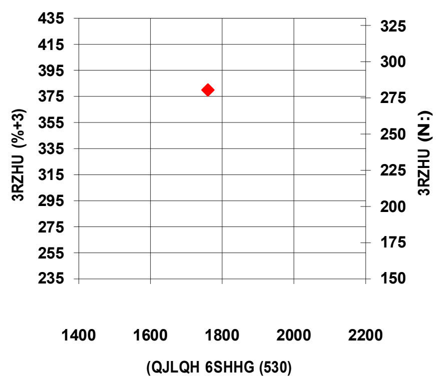
Operating speed in RPM	1760	
Output - BHP (kW)	380	(283)
Ventilation air required - CFM (litre/sec)	832	(393)
Exhaust gas flow - CFM (litre/sec)	2170	(1,024)
Exhaust gas temperature - °F (°C)	977	(525)
Heat rejection to coolant - BTU/min. (kW)	7657	(135)
Heat rejection to ambient - BTU/min. (kW)	1884	(33)

Engine performance for CFP9E-F65

7RUTXH 2XWSXW		
530	OE-IW	1-P
1760	1134	1537



+RUVHSRZHU 2XWSXW		
530	%+3	N:
1760	380	283



All data is based on the engine operating with a fuel system, water pump, lubricating oil pump, air cleaner, and alternator. The fan, optional equipment, and driven components are not included. Data is based on operation at SAE standard J1349 conditions of 300 ft. (91.4 m) altitude, 29.61 in. (752 mm) Hg dry barometer, and 77 °F (25 °C) intake air temperature, using No.2 diesel fuel only.

Altitude above which output should be limited*:	300 ft. (91.4 m)
Correction factor per 1000 ft. (305 m) above altitude limit:	3%
Temperature above which output should be limited:	77 °F (25 °C)
Correction factor per 10 °F (11 °C) above temperature limit:	1% (2%)

* Above 5,000 feet, contact Cummins for derate information.

US EPA NSPS Tier 3 Emissions Compliance

	D2 Cycle Exhaust Emissions*									
Fuel Percentage of Sulfur	Grams per BHP - HR					Grams per kW - HR				
	NMHC	**NO_x**	**NMHC + NO_x**	**CO**	**PM**	**NMHC**	**NO_x**	**NMHC + NO_x**	**CO**	**PM**
15 PPM Diesel Fuel	0.154	2.166	2.320	1.417	0.118	0.207	2.904	3.111	1.900	0.158
300-4000 PPM Diesel Fuel	0.186	2.349	2.535	1.417	0.134	0.25	3.150	3.400	1.900	0.180

*The emissions values above are based on CARB approved calculations for converting EPA (500 ppm) fuel to CARB (15 ppm) fuel.

Refer to the engine data tag for the EPA Standard Engine Family.

No special options are needed to meet current regulation emissions for all fifty states.

Tests conducted using alternate test methods, instrumentation, fuel, or reference conditions can yield different results.

Diesel Fuel Specifications:

- Cetane Number: 40-48
- Reference: ASTM D975 No. 2-D

Reference Conditions:

- Air Inlet Temperature: 25 °C (77 °F)
- Fuel Inlet Temperature: 40 °C (104 °F)
- Barometric Pressure: 100 kPa (29.53 in Hg)
- Humidity: 107 g H_2O/kg (75 grains H_2O/lb) of dry air; required for NO_x correction
- Intake Restriction set to a maximum allowable limit for clean filter
- Exhaust Back Pressure set to maximum allowable limit

Fire pump digital panel (FPDP)

The Cummins FPDP is an integrated microprocessor-based control system that provides full digital technology with enhanced accuracy and built-in redundancy.

Reliable design - Designed and tested with isolated mounting to minimize vibration for longer life and durability, the Cummins FPDP proves reliable in harsh environments.

Advanced control methodology - The Cummins FPDP allows for Input/Output (I/O) expansion and remote monitoring capabilities, as well as automatic Electronic Control Module (ECM) switching for electronic engines.

Certified quality - The Cummins FPDP is UL 1247 Listed and FM 1333 Approved.

Operator panel features

Operator/display panel

- 7” TFT LCD (thin-film-transistor liquid-crystal display) - color, 24-bit, 800x480 (WVGA).
- Auto, manual, start, stop, and fault reset.
- Assembly enclosure that meets NEMA Type 2 and Type 4X design requirements and is water, corrosion, fire, and impact-resistant.

Electronic engine communications - SAE J1939 protocol.

- Comprehensive full-authority engine (FAE) data: oil pressure and temperature; coolant temperature; and intake manifold pressure and temperature.
- Cummins fault code display.
- Sensor failure indication.
- Optional RS-485 serial - Modbus RTU/Modbus TCP/IP.

Other control features

- Digital Panel Expansion Module (DPEM) for additional analog/digital inputs and configurable dry relay contact output.
- Ability to idle at start-up for commissioning of electronic engines.
- Idle cool down for electronic engines.

Functional

- Configurable display units for temperature in degrees Fahrenheit or Celsius and pressure in PSI or kPa.
- Manual ECM selector switch on electronic engines.
- Ability to crank the fire pump drive engine from Battery A, Battery B, or both.
- Fixed engine speed adjustments in +/- 10 RPM increments.
- Overspeed shutdown.

Environmental

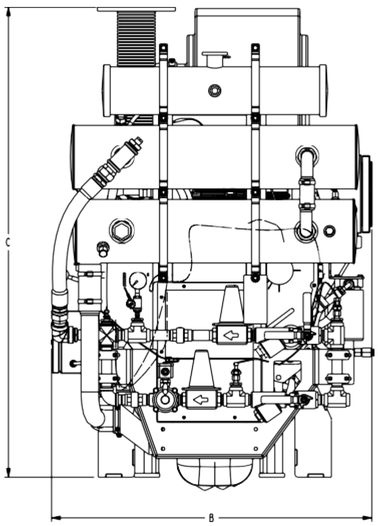
- Operating temperature: minus 4 to 140 °F (minus 20 to 60 °C).
- Storage temperature: minus 22 to 176 °F (minus 30 to 80 °C).
- Meets CISPR 11 Class B radiated emissions.

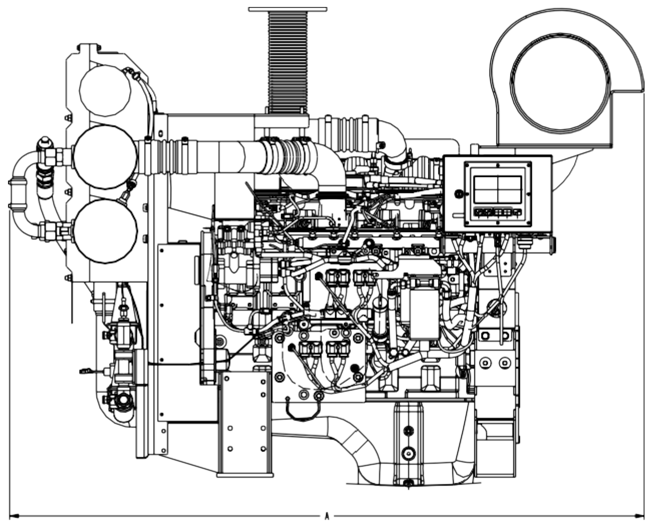
Electrical

- 8-30 VDC operating voltage.
- Reverse polarity protected.
- Spring cage terminal block interface.
- Built-in dual micro controllers for increased reliability.

Mechanical

- 1 3/8” pre-cut customer conduit knockout for easy field installation.
- Simplified internal design for efficiency and ease of customer connections.
- 16GA ASTM A366 material - 316 stainless steel optional.
- RAL3001 red powder coat finish.





This outline drawing is for reference only.
Do not use for installation design.

	Dim "A" in. (mm)	Dim "B" in. (mm)	Dim "C" in. (mm)
CFP9E F65-F85	81 (2067)	41 (1042)	60 (1530)

NOTE: Consult drawings or contact the factory for additional information.

NOTE: Specifications are subject to change without notice.
For more information, contact firepumpsales@cummins.com.

April 2021

This product has been manufactured under the controls estab- lished by a Bureau Veritas Certification approved management system that conforms with ISO 9001:2015.

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Foulweather Consulting
Foulweather Bluff
Hansville, WA
916.802.1375

October 13, 2023

Ms. Marianne Rossio, P.E.
Manager, Clean Air Branch
State of Hawaii Department of Health
2827 Waimano Home Road #130
Pearl City, HI 96782

Subject: Application for a Covered Source Permit No. 0894-01
Revised Ambient Air Quality Impact Assessment
Pu'uloa Energy LLC

Dear Ms. Rossio:

In March of this year, Pu'uloa Energy LLC submitted an application for a new covered source permit for a generation project at Joint Base Pearl Harbor-Hickam.[1] The application materials included an ambient air quality impact analysis that was carried out in accordance with the modeling protocol that was submitted to the Department in September 2022.

During a subsequent review of the application, it came to our attention that the modeling analysis submitted was not consistent with the final site design for the project. To address this inconsistency and allow the review process to move forward quickly, the applicant has prepared this revised ambient air quality impact assessment. This revised assessment includes an assessment of ambient air concentrations of hazardous air pollutants, in accordance with the requirements of H.A.R. § 11-60.1-179. Revised modeling files are also being provided.

We look forward to working with your staff to complete the review of the covered source permit application.

Sincerely,

Gary Rubenstein
Principal

Enclosures

cc: Kori Chun, HDOH CAB
Robert Albertini, Ameresco
Chief (Attention: AIR-3), Permits Office, Air Division, U.S. EPA Region 9

[1] The March submittal had a typographical error in the project name, and a corrected version of the application was submitted in June 2023. The correction was non-substantive.

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Revised Ambient Air Quality Impact Assessment for a New Generating Project at Joint Base Pearl Harbor-Hickam

October 2023

The application for a new Covered Source Permit that was submitted in March 2023 included an ambient air quality impact assessment that used a merged plume modeling technique.[1] This modeling technique has been accepted by several air permitting agencies, including U.S. EPA Region 9, for projects that utilized the same Wärtsilä reciprocating internal combustion engine technology as that proposed for the new project at Joint Base Pearl Harbor-Hickam (JBPHH). However, during a subsequent review of the modeling analysis, it was discovered that the assumptions in the modeling analysis were not consistent with the final site plan for the project. To address this inconsistency and allow the review process to move forward, the applicant prepared this revised ambient air quality impact assessment that does not utilize the merged plume modeling technique and reflects an increase in stack height. The revised assessment also includes an assessment of ambient air concentrations of hazardous air pollutants, in accordance with the requirements of H.A.R. § 11-60.1-179. This assessment demonstrates that the project will not cause or contribute to violations of any ambient air quality standards and will not emit hazardous air pollutants that may result in unacceptable concentrations in the ambient air.

Modeling Methodology

The modeling methodology used for this revised AQIA is identical to the modeling methodology described in Section 2 of Appendix C (Air Dispersion Modeling Report) to the March 2023[2] Application for a Covered Source Permit, with the exception of two elements:

- The stacks were modeled as individual stacks, not merged stacks; and
- The stack heights were increased from 95 feet to 110 feet.

These changes are reflected in the revised versions of Tables 2-1 and 2-2 and Figure 2-1 from the Appendix C Air Dispersion Modeling Report. These revised tables are presented in Attachment 1 as Tables 2-1R and 2-2R and Figure 2-1R.

Modeling Results

The results of the revised AQIA are presented in Attachment 1 as Tables 3-2R, 3-3R and 3-5R through 3-10R. These tables replace Tables 3-2, 3-3 and 3-5 through 3-10 in the Appendix C Air Dispersion Modeling Report. These results demonstrate that the project will not cause or contribute to violations of any ambient air quality standards, as required under H.A.R. § 11-60.1-83(a)(12).

[1] Please see Section 2.2 of the Appendix C Air Dispersion Modeling Report for a detailed description of the merged plume modeling technique.

[2] Following the submittal of the application in March, the applicant determined that the application materials contained a typographical error in the project name. This error was corrected in a June 2023 submittal that was not materially different from the March submittal.

Hazardous Air Pollutants

This assessment compares the modeled ambient concentrations of potential hazardous air pollutant (HAP) emissions from the project to significant ambient air concentrations as defined in H.A.R §11-60.1-179 (c). The modeled ambient concentration of each HAP was calculated using the unit impact modeling results for the 1-hour, 8-hour and annual averaging periods (see "Summary of Unit Impacts – Biodiesel" and "Summary of Unit Impacts – RNG," attached), in $\mu g/m^3$ per gram per second and the maximum hourly and annual emission rates from the engines (in grams per second) for the full-load and minimum load operating scenarios for Cases 1 and 3. [3] This calculation was performed for each HAP identified in Appendix B, Tables B-16 through B-18, of the March 2023 application support document.

Acute and Chronic Impacts for HAPs with TLV-TWAs

For HAPs with a published Threshold Limit Value-Time Weighted Average (TLV-TWA), [4] the 8-hour and annual average concentrations are compared with the §11-60.1-179 (c)(1) significance criteria in Attachment 2, Tables HAP-1 and HAP-2. Full-load and minimum load operating scenarios were evaluated for both 100% RNG and 100% biodiesel operations. The ambient concentrations of these HAPs are below the applicable significance thresholds under all operating scenarios.

Acute and Chronic Impacts for HAPs without TLV-TWAs

For HAPs without a published TLV-TWA, §11-60.1-179 (c)(2) defines a "significant ambient air concentration of any hazardous air pollutant" as:

> …any ambient air concentration greater than the concentration which the director determines to cause, to have the potential to cause, or to contribute to, the unreasonable endangerment of human health. The determination shall be made on a case-by-case basis, consider documented studies or information by recognized authorities on the specific health effects of such hazardous air pollutants, and include a reasonable margin of safety for the protection of the general public."

There are no published TLV-TWAs for acetaldehyde or acrolein. In accordance with §11-60.1-179 (c)(2), the 1-hour, 8-hour and annual reference exposure levels[5] (RELs) established by the California Office of Environmental Health Hazard Assessment were used as criteria to determine whether the modeled ambient concentrations of acetaldehyde and acrolein are significant. RELs are described by OEHHA as follows:

> Inhalation RELs are air concentrations or doses at or below which adverse noncancer health effects are not expected even in sensitive members of the general population under specified exposure scenarios…

---

[3] Case 2 operations (RNG startups and biodiesel operation) were not evaluated separately because the HAP emissions from that operating case are lower than the emissions from Case 1.

[4] TWA-TLVs from ACGIH, "2019 TLVs and BEIs."

[5] OEHHA, Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary. August 20, 2020.Available at https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary.

> OEHHA developed acute RELs for assessing potential noncancer health impacts for short-term, one-hour peak exposures to facility emissions (OEHHA, 2008; http://www.oehha.ca.gov/air/allrels.html). By definition, ***an acute REL is an exposure that is not likely to cause adverse health effects in a human population, including sensitive subgroups***, exposed to that concentration (in units of micrograms per cubic meter or $\mu g/m^3$) for the specified exposure duration on an intermittent basis…
>
> OEHHA has developed 8-hour RELs for assessing potential noncancer health impacts for exposures to the general public that occur on a recurrent basis, but only during a portion of each day (OEHHA, 2008; http://www.oehha.ca.gov/air/allrels.html). Eight-hour RELs are compared to air concentrations that represent an average (daily) 8-hour exposure. By definition, ***an 8-hour REL is an exposure that is not likely to cause adverse health effects in a human population, including sensitive subgroups***, exposed to that concentration (in units of micrograms per cubic meter or $\mu g/m^3$) for an 8-hour exposure duration on a regular (including daily) basis…
>
> OEHHA has developed chronic RELs for assessing noncancer health impacts from long-term exposure. (OEHHA, 2008; see also http://www.oehha.ca.gov/air/allrels.html) A chronic REL is a concentration level (expressed in units of micrograms per cubic meter ($\mu g/m^3$) for inhalation exposure…) ***at or below which no adverse health effects are anticipated following long-term exposure***. [emphasis added] [6]

These RELs meet the criteria in §11-60.1-179 (c)(2) in that they are "…documented studies or information by recognized authorities on the specific health effects of such hazardous air pollutants, and include a reasonable margin of safety for the protection of the general public." The modeled ambient concentrations of acetaldehyde and acrolein are compared with RELs in Attachment 2, Tables HAP-3 and HAP-4. Full-load and minimum load operating scenarios are evaluated for both 100% RNG and 100% biodiesel operations. The ambient concentrations of HAPs are below the applicable significance thresholds under all operating scenarios.

Cancer Risks

Finally, H.A.R. §11-60.1-179 (c)(3) requires:

> For any carcinogenic hazardous air pollutant, any ambient air concentration that may result in an excess individual lifetime cancer risk of more than ten in one million assuming continuous exposure for seventy years. The ambient air concentration of a carcinogenic hazardous air pollutant shall be determined by performing a risk assessment based on procedures consistent with EPA's risk assessment guidelines or other alternative risk assessment procedures approved by the director.

---

[6] OEHHA, Toxics Hot Spots Program: Risk Assessment Guidelines- Guidance Manual for Preparation of Health Risk Assessments, February 2015. P. 6-1. Available at https://oehha.ca.gov/media/downloads/crnr/2015guidancemanual.pdf.

Tables HAP-5 and HAP-6 in Attachment 2 summarize the assessment of cancer risks in accordance with EPA guidance,[7] using the carcinogenic unit risk estimates from EPA's Prioritized Chronic Dose-Response Values for inhalation.[8] Because the EPA guidance document does not provide a quantitative estimate of carcinogenic risk from inhalation exposure of ethylbenzene or naphthalene, the carcinogenic unit risk values from OEHHA's "Hot Spots Unit Risk and Cancer Potency Values"[9] were used to characterize cancer risk from those substances. Full-load and minimum load operating scenarios were evaluated for both 100% RNG and 100% biodiesel operations. The results of the assessment demonstrate that individual lifetime excess cancer risk from the project is well below ten in one million under all operating scenarios.

---

[7] U.S. EPA, "Dose-Response Assessment for Assessing Health Risks Associated With Exposure to Hazardous Air Pollutants: Risk Assessment for Carcinogenic Effects." Available at https://www.epa.gov/fera/risk-assessment-carcinogenic-effects

[8] U.S. EPA Table 1. Prioritized Chronic Dose-Response Values for Screening Risk Assessments. Available at https://www.epa.gov/system/files/documents/2021-09/chronicfinaloutput_9_29_2021-12-46-18-pm_0.pdf

[9] OEHHA, "Hot Spots Unit Risk and Cancer Potency Values," April 2023. Available at https://oehha.ca.gov/media/downloads/crnr/appendixa.pdf

Attachment 1

Revised Modeling Tables from Appendix C to the March 2023 Application

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Table 2-1R. Modeled Stack Locations

Model ID	Description	NAD 83 - Zone 4 UTM Coordinates Easting (m)	Northing (m)	Base Elevation [A] (ft)	(m)
1	Unit 1	608867.9	2361014.5	19.69	6.0
2	Unit 2	608866.3	2361012.1	19.69	6.0
3	Unit 3	608864.7	2361009.5	19.69	6.0
4	Unit 4	608862.2	2361011.0	19.69	6.0
5	Unit 5	608863.7	2361013.6	19.69	6.0
6	Unit 6	608865.4	2361016.1	19.69	6.0
7	Unit 7	608821.8	2361042.7	19.69	6.0
8	Unit 8	608820.4	2361040.1	19.69	6.0
9	Unit 9	608818.7	2361037.8	19.69	6.0
10	Unit 10	608816.1	2361039.2	19.69	6.0
11	Unit 11	608817.8	2361041.8	19.69	6.0

[A] Base elevations from AERMAP.

Table 2-2R. Modeled Stack Parameters and Emissions

Load/ Scenario	Stack Parameters [A] Diameter (ft)	Diameter (m)	Height (ft)	Height (m)	Flow (m^3/s)	Velocity (m/s)	Temp. (K)	Per Unit Modeled Emissions (g/s) [A] SO_2 [B] Short-Term	SO_2 [B] Annual [C]	NO_X Short-Term	NO_X Annual [C]	CO [B] 1-Hour	CO [B] 8-Hour	$PM_{10}/PM_{2.5}$ Short-Term	$PM_{10}/PM_{2.5}$ Annual [C]	NO_2/NO_X In-Stack Ratio [E]
Wärtsilä 20V34DF - Biodiesel - Individual Stacks																
Startup [D]	4.00	1.219	110.00	33.53	30.20	25.879	593.15	0.0152	0.0051	6.3542	0.6639	0.9941	0.9941	0.5852	0.2046	15%
Full (100%)	4.00	1.219	110.00	33.53	30.20	25.879	593.15	0.0152	0.0044	1.3684	0.3991	0.4763	0.4763	0.5708	0.1665	15%
Min. (50%)	4.00	1.219	110.00	33.53	16.35	14.009	593.15	0.0079	0.0044	0.8102	0.3991	0.2470	0.2470	0.3944	0.1665	15%
Wärtsilä 20V34DF - Renewable Natural Gas - Individual Stacks																
Startup [D]	4.00	1.219	110.00	33.53	27.89	23.894	649.15	0.0079	0.0075	1.8680	0.2685	1.4811	1.4811	0.2585	0.2480	15%
Full (100%)	4.00	1.219	110.00	33.53	27.89	23.894	649.15	0.0079	0.0072	0.2080	0.1907	0.3163	0.3163	0.2533	0.2322	15%
Min. (50%)	4.00	1.219	110.00	33.53	19.77	16.937	674.15	0.0045	0.0072	0.1780	0.1907	0.1802	0.1802	0.1928	0.2322	15%

[A] Stack parameters and emissions based on manufacturer data.

[B] The maximum hourly SO_2 and CO emission rates were modeled for all short-term averaging periods.

[C] The modeled annual emission rates for the startup scenario are based on the proposed PTE. The modeled annual emission rates for the full and min. load scenarios are based on the proposed annual operating hour limit and the maximum hourly emission rate during normal operations.

[D] During startup, the units reach the 100% load within 5 minutes of the initial firing. Therefore, the stack parameters are based on the 100% load. The modeled short-term (24-hour) $PM_{10}/PM_{2.5}$ emissions rate is based on 1 startup hour and 23 hours of 100% load operation.

[E] The NO_2/NO_X in-stack ratios are used in NO_2 modeling.

Figure 2-1R. Site Layout

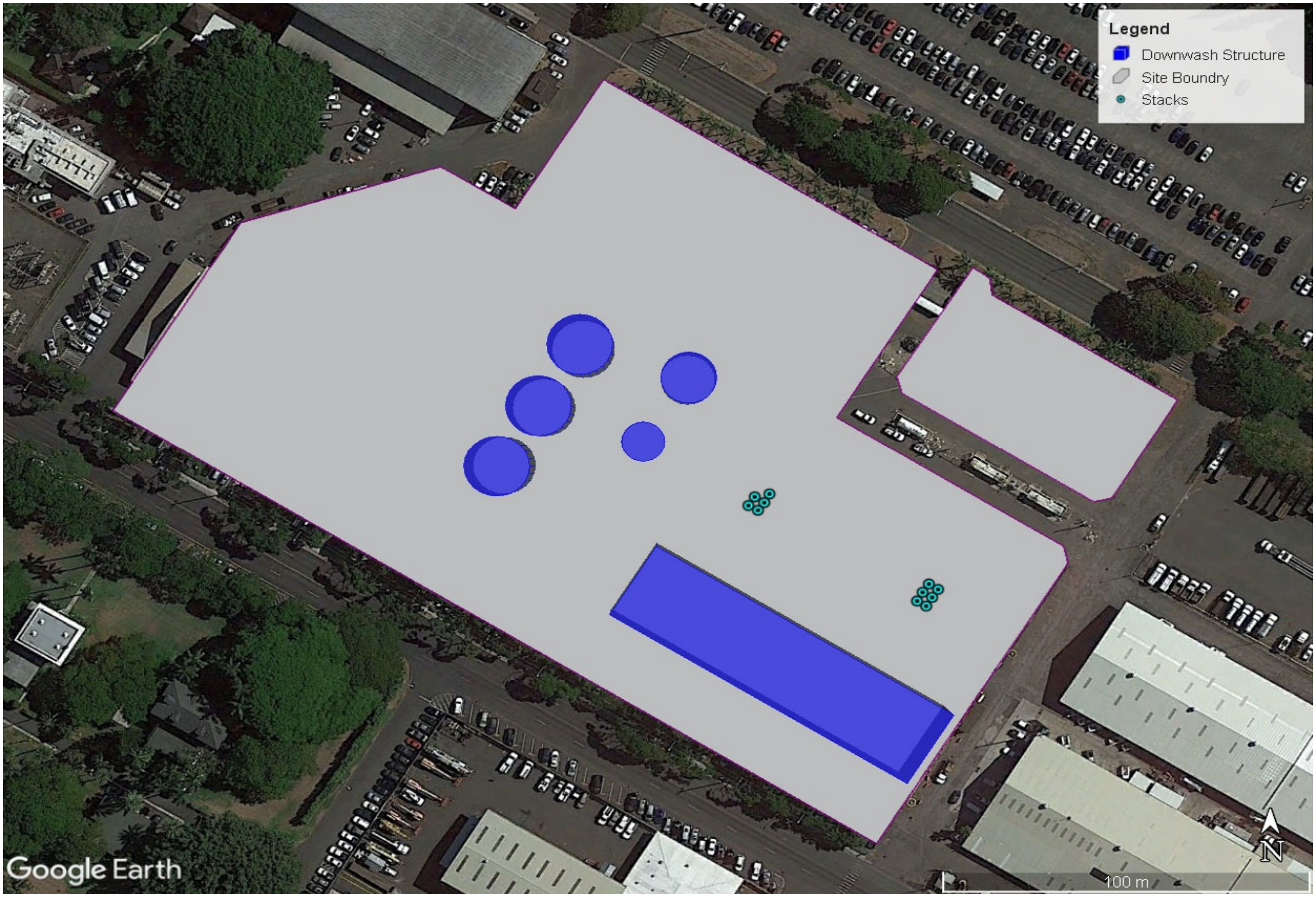

Table 3-2R. Summary of Unit Impacts (Biodiesel Only)

Scenario [A]	Source Group	Maximum Unit Impact ($\mu g/m^3$ per g/s) - Across 5-Yrs [B]				
		1-hr	3-hr	8-hr	24-hr	Annual [C]
Startup/Full Load	FULL	13.39097	4.91640	4.56147	3.68842	0.78674
Min. Load	MIN	18.37378	8.01781	6.87244	5.82358	1.65596
Scenario	**Source Group**	**Maximum Annual Unit Impact ($\mu g/m^3$ per g/s) [C]**				
		2017	**2018**	**2019**	**2020**	**2021**
Startup/Full Load	FULL	0.58052	0.64285	0.54379	0.72334	0.78674
Min. Load	MIN	1.20055	1.34652	1.13439	1.50578	1.65596
Scenario	**Source Group**	**Maximum Unit Impact ($\mu g/m^3$) - 5-Yrs Average [D]**				
					24-Hr	**Annual**
Startup/Full Load	FULL				3.19087	0.65393
Min. Load	MIN				5.68307	1.36864

[A] The modeling was conducted using EPA's AERMOD dispersion model (version 22112).

[B] The listed values are the maximum unit impacts from the 5 years (2017-2021) of modeled meteorological data.

[C] The listed values are the maximum annual unit impacts from each of the 5 years (2017-2021) of modeled meteorological data.

[D] The listed values are the maximum 5-year (2017-2021) average impacts used for the $PM_{2.5}$ project impact modeling.

Table 3-3R. Summary of Unit Impacts (RNG Only)

Scenario [A]	Source Group	Maximum Unit Impact ($\mu g/m^3$ per g/s) - Across 5-Yrs [B]				
		1-hr	3-hr	8-hr	24-hr	Annual [C]
Startup/Full Load	FULL	13.33682	5.22623	4.79730	3.87601	0.81871
Min. Load	MIN	16.53275	7.02488	5.99328	5.00488	1.20758
Scenario	**Source Group**	**Maximum Annual Unit Impact ($\mu g/m^3$ per g/s) [C]**				
		2017	**2018**	**2019**	**2020**	**2021**
Startup/Full Load	FULL	0.59992	0.66708	0.5635	0.74799	0.81871
Min. Load	MIN	0.87586	0.97863	0.8256	1.09551	1.20758
Scenario	**Source Group**	**Maximum Unit Impact ($\mu g/m^3$) - 5-Yrs Average [D]**				
					24-Hr	**Annual**
Startup/Full Load	FULL				3.37087	0.67925
Min. Load	MIN				4.69565	0.99664

[A] The modeling was conducted using EPA's AERMOD dispersion model (version 22112).

[B] The listed values are the maximum unit impacts from the 5 years (2017-2021) of modeled meteorological data.

[C] The listed values are the maximum annual unit impacts from each of the 5 years (2017-2021) of modeled meteorological data.

[D] The listed values are the maximum 5-year (2017-2021) average impacts used for the $PM_{2.5}$ project impact modeling.

Table 3-5R. Project Impact Modeling Results (Biodiesel)

Scenario	Pollutant	Averaging Period	Total Emission Rate [A] (g/s)	Unit Impact [B] (μg/m³ per g/s)	Total Impact [A] (μg/m³)	Significant Impact Level (μg/m³)	Notes
Startup	SO_2	1-hr	0.167	13.39097	2.240	7.8	Max (H1H)
		3-hr	0.167	4.91640	0.823	25	
		24-hr	0.167	3.68842	0.617	5	
		Annual	0.056	0.78674	0.044	1	
	PM_{10}	24-hr	6.437	3.68842	23.741	5	24-hr average emissions
		Annual	2.251	0.78674	1.771	1	
	$PM_{2.5}$ [C]	24-hr	6.437	3.19087	20.829	1.2	24-hr average emissions
		Annual	2.251	0.65393	1.487	0.2	
	NO_2 (OLM) [D]	1-hr			155.781	7.5	Max (H1H) - Continuous Startup [E]
	NO_X as NO_2	Annual	7.303	0.78674	5.745	1	
	CO	1-hr	10.936	13.39097	146.437	2,000	Continuous Startup [E]
		8-hr	10.936	4.56147	49.882	500	Continuous Startup [E]
100% Load	SO_2	1-hr	0.167	13.39097	2.240	7.8	Max (H1H)
		3-hr	0.167	4.91640	0.823	25	
		24-hr	0.167	3.68842	0.617	5	
		Annual	0.049	0.78674	0.038	1	
	PM_{10}	24-hr	6.279	3.68842	23.159	5	
		Annual	1.831	0.78674	1.441	1	
	$PM_{2.5}$ [C]	24-hr	6.279	3.19087	20.325	1.2	
		Annual	1.831	0.65393	1.213	0.2	
	NO_2 (OLM) [D]	1-hr			72.522	7.5	Max (H1H)
	NO_X as NO_2	Annual	4.390	0.78674	3.454	1	
	CO	1-hr	5.239	13.39097	70.159	2,000	
		8-hr	5.239	4.56147	23.899	500	
Min. Load	SO_2	1-hr	0.087	18.37378	1.603	7.8	Max (H1H)
		3-hr	0.087	8.01781	0.699	25	
		24-hr	0.087	5.82358	0.508	5	
		Annual	0.049	1.65596	0.081	1	
	PM_{10}	24-hr	4.338	5.82358	25.265	5	
		Annual	1.831	1.65596	3.033	1	
	$PM_{2.5}$ [C]	24-hr	4.338	5.68307	24.946	1.2	
		Annual	1.831	1.36864	2.522	0.2	
	NO_2 (OLM) [D]	1-hr			63.773	7.5	Max (H1H)
	NO_X as NO_2	Annual	4.390	1.65596	7.270	1	
	CO	1-hr	2.717	18.37378	49.922	2,000	
		8-hr	2.717	6.87244	18.672	500	

[A] The listed total emission rate and total impact reflect the total from all 11 units.

[B] The modeling was conducted using EPA's AERMOD dispersion model (version 22112).

[C] Includes secondary $PM_{2.5}$, based on EPA's worst-case MERPs for the West and Northwest climites zones.

[D] Maximum daily 1-hr concentration averaged over 5 years

[E] The startup scenario modeling is based on all 11 units starting in the same hour and an unlimited number of startups.

Below Significant Impact Level | Above Significant Impact Level

Table 3-6R. Project Impact Modeling Results (RNG)

	Pollutant	Averaging Period	Total Emission Rate [A] (g/s)	Unit Impact [B] ($\mu g/m^3$ per g/s)	Total Impact [A] ($\mu g/m^3$)	Significant Impact Level ($\mu g/m^3$)	Notes
Startup	SO_2	1-hr	0.086	13.33682	1.153	7.8	Max (H1H)
		3-hr	0.086	5.22623	0.452	25	
		24-hr	0.086	3.87601	0.335	5	
		Annual	0.083	0.81871	0.068	1	
	PM_{10}	24-hr	2.844	3.87601	11.022	5	24-hr average emissions
		Annual	2.728	0.81871	2.233	1	
	$PM_{2.5}$ [C]	24-hr	2.844	3.37087	9.876	1.2	24-hr average emissions
		Annual	2.728	0.67925	1.868	0.2	
	NO_2 (OLM) [D]	1-hr			92.312	7.5	Max (H1H) - Continuous Startup [E]
	NO_X as NO_2	Annual	2.953	0.81871	2.418	1	
	CO	1-hr	16.292	13.33682	217.289	2,000	Continuous Startup [E]
		8-hr	16.292	4.79730	78.160	500	Continuous Startup [E]
100% Load	SO_2	1-hr	0.086	13.33682	1.153	7.8	Max (H1H)
		3-hr	0.086	5.22623	0.452	25	
		24-hr	0.086	3.87601	0.335	5	
		Annual	0.079	0.81871	0.065	1	
	PM_{10}	24-hr	2.786	3.87601	10.800	5	
		Annual	2.554	0.81871	2.091	1	
	$PM_{2.5}$ [C]	24-hr	2.786	3.37087	9.683	1.2	
		Annual	2.554	0.67925	1.750	0.2	
	NO_2 (OLM) [D]	1-hr			16.242	7.5	Max (H1H)
	NO_X as NO_2	Annual	2.097	0.81871	1.717	1	
	CO	1-hr	3.479	13.33682	46.403	2,000	
		8-hr	3.479	4.79730	16.691	500	
Min. Load	SO_2	1-hr	0.050	16.53275	0.825	7.8	Max (H1H)
		3-hr	0.050	7.02488	0.351	25	
		24-hr	0.050	5.00488	0.250	5	
		Annual	0.079	1.20758	0.096	1	
	PM_{10}	24-hr	2.121	5.00488	10.614	5	
		Annual	2.554	1.20758	3.084	1	
	$PM_{2.5}$ [C]	24-hr	2.121	4.69565	10.249	1.2	
		Annual	2.554	0.99664	2.561	0.2	
	NO_2 (OLM) [D]	1-hr			15.720	7.5	Max (H1H)
	NO_X as NO_2	Annual	2.097	1.20758	2.533	1	
	CO	1-hr	1.982	16.53275	32.771	2,000	
		8-hr	1.982	5.99328	11.880	500	

[A] The listed total emission rate and total impact reflect the total from all 11 units.

[B] The modeling was conducted using EPA's AERMOD dispersion model (version 22112).

[C] Includes secondary $PM_{2.5}$, based on EPA's worst-case MERPs for the West and Northwest climites zones.

[D] Maximum daily 1-hr concentration averaged over 5 years

[E] The startup scenario modeling is based on all 11 units starting in the same hour and an unlimited number of startups.

Below Significant Impact Level | Above Significant Impact Level

Table 3-7R. NAAQS/SAAQS Analysis Results (Biodiesel - Worst-Case Scenario)

Pollutant[1]	Averaging Period[1]	Modeled Years	Controlling Scenario	Description	Modeled GLC_{max} (µg/m³)	Secondary $PM_{2.5}$ Concentration[2] (µg/m³)	Background Concentration[3] (µg/m³)	Combined Maximum Impact[4] (µg/m³)	SAAQS/ NAAQS (µg/m³)	Below SAAQS/ NAAQS?
NO_2 [5]	1-hr	2017-2021	Startup	Project Only - OLM - (H8H averaged over 5-years)	125.5	--	56.4	181.9	188	Yes
NO_X as NO_2	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	7.27	--	7.5	14.8	100	Yes
$PM_{2.5}$	24-hr	2017-2021	Min Load	Project Only (H8H averaged over 5-years)	20.05	0.291	12.0	32.3	35	Yes
	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	2.51	0.016	3.6	6.1	12	Yes
PM_{10}	24-hr	2017-2021	Min Load	Project Only (H1H across 5-years)	25.27	--	36.0	61.3	150	Yes
	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	3.03	--	14.4	17.4	50	Yes

[1] A NAAQS analysis is only required for pollutants and averaging periods with project impacts greater than or equal to the corresponding SIL.
[2] Secondary $PM_{2.5}$ concentrations are estimated using EPA's Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (EPA-454/R-19-003), dated April 2019. The lowest (worst-case) MERPs for the West and Northwest climates zones from Table 4-1 were selected.
[3] The background concentrations are based on DOH monitoring data: NO_2 concentrations are from the Kapolei monitor, $PM_{2.5}$ and PM_{10} concentrations are from the Pearl City monitor.
[4] The combined maximum impact includes impacts from the project sources (including secondary $PM_{2.5}$, as appropriate) plus the background concentration.
[5] AERMOD's Ozone Limiting Method (OLM) Option is used to output NO_2 impacts from modeled NO_X emissions.

Table 3-9R. NAAQS/SAAQS Analysis Results (Biodiesel - Full Load Scenario)

Pollutant[1]	Averaging Period[1]	Modeled Years	Scenario	Description	Modeled GLC_{max} (µg/m³)	Secondary $PM_{2.5}$ Concentration[2] (µg/m³)	Background Concentration[3] (µg/m³)	Combined Maximum Impact[4] (µg/m³)	SAAQS/ NAAQS (µg/m³)	Below SAAQS/ NAAQS?
NO_2 [5]	1-hr	2017-2021	Full Load	Project Only - OLM - (H8H averaged over 5-years)	57.1	--	56.4	113.5	188	Yes
NO_X as NO_2	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	3.45	--	7.5	11.0	100	Yes
$PM_{2.5}$	24-hr	2017-2021	Full Load	Project Only (H8H averaged over 5-years)	14.78	0.291	12.0	27.1	35	Yes
	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	1.20	0.016	3.6	4.8	12	Yes
PM_{10}	24-hr	2017-2021	Full Load	Project Only (H1H across 5-years)	23.16	--	36.0	59.2	150	Yes
	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	1.44	--	14.4	15.8	50	Yes

[1] A NAAQS analysis is only required for pollutants and averaging periods with project impacts greater than or equal to the corresponding SIL.
[2] Secondary $PM_{2.5}$ concentrations are estimated using EPA's Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (EPA-454/R-19-003), dated April 2019. The lowest (worst-case) MERPs for the West and Northwest climates zones from Table 4-1 were selected.
[3] The background concentrations are based on DOH monitoring data: NO_2 concentrations are from the Kapolei monitor, $PM_{2.5}$ and PM_{10} concentrations are from the Pearl City monitor.
[4] The combined maximum impact includes impacts from the project sources (including secondary $PM_{2.5}$, as appropriate) plus the background concentration.
[5] AERMOD's Ozone Limiting Method (OLM) Option is used to output NO_2 impacts from modeled NO_X emissions.

Table 3-8R. NAAQS/SAAQS Analysis Results (RNG - Worst-Case Scenario)

Pollutant[1]	Averaging Period[1]	Modeled Years	Controlling Scenario	Description	Modeled GLC_{max} (µg/m³)	Secondary $PM_{2.5}$ Concentration[2] (µg/m³)	Background Concentration[3] (µg/m³)	Combined Maximum Impact[4] (µg/m³)	SAAQS/ NAAQS (µg/m³)	Below SAAQS/ NAAQS?
NO_2 [5]	1-hr	2017-2021	Startup	OLM - Project Only (H8H averaged over 5-years)	78.6	--	56.4	135.0	188	Yes
NO_X as NO_2	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	2.53	--	7.5	10.0	100	Yes
$PM_{2.5}$	24-hr	2017-2021	Min Load	Project Only (H8H averaged over 5-years)	7.68	0.291	12.0	20.0	35	Yes
	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	2.55	0.016	3.6	6.2	12	Yes
PM_{10}	24-hr	2017-2021	Startup	Project Only (H1H across 5-years)	11.02	--	36.0	47.0	150	Yes
	Annual	2017-2021	Min Load	Project Only (maximum across 5-years)	3.08	--	14.4	17.5	50	Yes

[1] A NAAQS analysis is only required for pollutants and averaging periods with project impacts greater than or equal to the corresponding SIL.
[2] Secondary $PM_{2.5}$ concentrations are estimated using EPA's Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (EPA-454/R-19-003), dated April 2019. The lowest (worst-case) MERPs for the West and Northwest climates zones from Table 4-1 were selected.
[3] The background concentrations are based on DOH monitoring data: NO_2 concentrations are from the Kapolei monitor, $PM_{2.5}$ and PM_{10} concentrations are from the Pearl City monitor.
[4] The combined maximum impact includes impacts from the project sources (including secondary $PM_{2.5}$, as appropriate) plus the background concentration.
[5] AERMOD's Ozone Limiting Method (OLM) Option is used to output NO_2 impacts from modeled NO_X emissions.

Table 3-10R. NAAQS/SAAQS Analysis Results (RNG - Full Load Scenario)

Pollutant[1]	Averaging Period[1]	Modeled Years	Controlling Scenario	Description	Modeled GLC_{max} (µg/m³)	Secondary $PM_{2.5}$ Concentration[2] (µg/m³)	Background Concentration[3] (µg/m³)	Combined Maximum Impact[4] (µg/m³)	SAAQS/ NAAQS (µg/m³)	Below SAAQS/ NAAQS?
NO_2 [5]	1-hr	2017-2021	Full Load	OLM - Project Only (H8H averaged over 5-years)	9.4	--	56.4	65.8	188	Yes
NO_X as NO_2	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	1.72	--	7.5	9.2	100	Yes
$PM_{2.5}$	24-hr	2017-2021	Full Load	Project Only (H8H averaged over 5-years)	6.86	0.291	12.0	19.1	35	Yes
	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	1.73	0.016	3.6	5.4	12	Yes
PM_{10}	24-hr	2017-2021	Full Load	Project Only (H1H across 5-years)	10.80	--	36.0	46.8	150	Yes
	Annual	2017-2021	Full Load	Project Only (maximum across 5-years)	2.09	--	14.4	16.5	50	Yes

[1] A NAAQS analysis is only required for pollutants and averaging periods with project impacts greater than or equal to the corresponding SIL.
[2] Secondary $PM_{2.5}$ concentrations are estimated using EPA's Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program (EPA-454/R-19-003), dated April 2019. The lowest (worst-case) MERPs for the West and Northwest climates zones from Table 4-1 were selected.
[3] The background concentrations are based on DOH monitoring data: NO_2 concentrations are from the Kapolei monitor, $PM_{2.5}$ and PM_{10} concentrations are from the Pearl City monitor.
[4] The combined maximum impact includes impacts from the project sources (including secondary $PM_{2.5}$, as appropriate) plus the background concentration.
[5] AERMOD's Ozone Limiting Method (OLM) Option is used to output NO_2 impacts from modeled NO_X emissions.

Appendix Table A-5R. AERMOD Run Log

Filename	Pollutant	Averaging Periods	Modeled Year(s)	Description
UER1721HTED04D	UER	1-Hour, 3-Hour, 8-Hour, and 24-Hour	2017 - 2021	Project impact modeling - Biodiesel Maximum (H1H) impacts across 5-year
UER1721DA04D	UER	24-Hour and Annual	2017 - 2021	Project impact modeling - Biodiesel Maximum (H1H) impacts 5-year average
UER17A04D UER18A04D UER18A04D UER20A04D UER21A04D	UER	Annual	2017 2018 2019 2020 2021	Project impact modeling - Biodiesel
UER1721HTED04G	UER	1-Hour, 3-Hour, 8-Hour, and 24-Hour	2017 - 2021	Project impact modeling - RNG Maximum (H1H) impacts across 5-year
UER1721DA04G	UER	24-Hour and Annual	2017 - 2021	Project impact modeling - RNG Maximum (H1H) impacts 5-year average
UER17A04G UER18A04G UER18A04G UER20A04G UER21A04G	UER	Annual	2017 2018 2019 2020 2021	Project impact modeling - RNG
N1721H05D*	NO_2	1-Hour	2017 - 2021	Project impact/NAAQS modeling - Biodiesel Maximum (H1H and H8H) impacts 5-year average
N1721H05G*	NO_2	1-Hour	2017 - 2021	Project impact/NAAQS modeling - RNG Maximum (H1H and H8H) impacts 5-year average
P21721D08D	$PM_{2.5}$	24-Hour	2017 - 2021	NAAQS modeling - Biodiesel Maximum (H8H) impacts 5-year average
P21721D08G	$PM_{2.5}$	24-Hour	2017 - 2021	NAAQS modeling - RNG Maximum (H8H) impacts 5-year average

* Hourly ozone data file SI_17-21_Hrly_O3.dat (calculation spreadsheet Sand Island 17-21 Hrly Ozone.xlsx)

Attachment 2

HAPs Assessment

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Table HAP-1

HAPs Assessment, Comparison of Modeled Concentrations with HDOH Significance Thresholds, Case 1 (RNG Only)

Full-Load Operations

			Acute Impacts, 8-hr Avg							Chronic Impacts		
Pollutant	Full Load Hourly Emissions per Engine, Case 1, lb/hr	Total Annual Emissions, all Engines, Case 1, tpy	8-hour modeled impact, ug/m3	MW (g/mol)	TWA-TLV (8-hour basis) (2), ppm	TWA-TLV (8-hour basis), ug/m3	1/100 x TWA-TLV	8-hour impact> 1/100 x TWA/TLV?	Annual Emission Rate, g/s (all engines)	Annual impact, ug/m3	1/420 x TWA/TLV	Annual Impact > 1/420 x TWA/TLV?
Acetaldehyde	0.02	1.01	0.14	n/a	n/a	n/a	n/a	n/a	0.029	0.024	n/a	n/a
Acrolein	2.43E-03	0.11	0.02	n/a	n/a	n/a	n/a	n/a	0.003	0.003	n/a	n/a
Benzene	0.01	0.41	0.06	78.11	0.5	1,597	16	no	0.012	0.010	4	no
1,3-Butadiene	0.02	0.70	0.10	54.09	2	4,425	44	no	0.020	0.016	11	no
Ethylbenzene	2.93E-03	0.14	0.02	101.16	20	82,748	827	no	0.004	0.003	197	no
Formaldehyde	0.13	5.83	0.84	30.03	0.1	123	1.23	no	0.168	0.137	0	no
Naphthalene	1.03E-03	4.77E-02	0.01	128.19	10	52,429	524	no	0.001	0.001	125	no
PAHs (as B(a)P)	7.06E-07	3.26E-05	4.70E-06	252.31	0.2	2,064	21	no	9.381E-07	7.681E-07	5	no
Toluene	9.84E-03	0.45	0.07	92.13	20	75,362	754	no	0.013	0.011	179	no
Xylene	0.03	1.23	0.18	106.16	100	434,192	4342	no	0.035	0.029	1034	no

Minimum Load Operations

			Acute Impacts, 8-hr Avg							Chronic Impacts		
Pollutant	Total Annual Emissions, all Engines, Case 1, tpy	Min. Load Hourly Emissions per Engine, lb/hr	8-hour modeled impact, ug/m3	MW (g/mol)	TWA-TLV (8-hour basis) (2), ppm	TWA-TLV (8-hour basis), ug/m3	1/100 x TWA-TLV	8-hour impact> 1/100 x TWA-TLV?	Annual Emission Rate, g/s (all engines)	Annual impact, ug/m3	1/420 x TWA-TLV	Annual Impact > 1/420 x TWA-TLV?
Acetaldehyde	1.01	1.26E-02	0.09	n/a	n/a	n/a	n/a	n/a	0.029	0.035	n/a	n/a
Acrolein	0.11	1.40E-03	0.01	n/a	n/a	n/a	n/a	n/a	3.23E-03	3.90E-03	n/a	n/a
Benzene	0.41	5.19E-03	0.04	78.11	0.5	1,597	16	no	0.012	0.014	4	no
1,3-Butadiene	0.70	8.73E-03	0.06	54.09	2	4,425	44	no	0.020	0.024	11	no
Ethylbenzene	0.14	1.69E-03	0.01	101.16	20	82,748	827	no	3.89E-03	4.70E-03	197	no
Formaldehyde	5.83	0.13	0.88	30.03	0.1	123	1.23	no	0.168	0.202	0	no
Naphthalene	4.77E-02	5.97E-04	0.00	128.19	10	52,429	524	no	1.37E-03	1.66E-03	125	no
PAHs (as B(a)P)	3.26E-05	4.08E-07	0.00	252.31	0.2	2,064	21	no	9.38E-07	1.13E-06	5	no
Toluene	0.45	5.69E-03	0.04	92.13	20	75,362	754	no	0.013	0.016	179	no
Xylene	1.23	1.54E-02	0.11	106.16	100	434,192	4342	no	0.035	0.043	1034	no

TWA-TLVs from ACGIH, "2019 TLVs and BEIs" except PAHs from https://www.atsdr.cdc.gov/csem/polycyclic-aromatic-hydrocarbons/standards_and_regulations_for_exposure.html.

Table HAP-2

HAPs Assessment, Comparison of Modeled Concentrations with HDOH Significance Thresholds, Case 3 (Biodiesel Only)

Full-Load Operations

			Acute Impacts, 8-hr Avg								Chronic Impacts	
Pollutant	Full Load Hourly Emissions per Engine, Case 3, lb/hr	Total Annual Emissions, all Engines, Case 3, tpy	8-hour modeled impact, ug/m3	MW (g/mol)	TWA-TLV (8-hour basis) (2), ppm	TWA-TLV (8-hour basis), ug/m3	1/100 x TWA-TLV	8-hour impact> 1/100 x TWA-TLV?	Annual Emission Rate, g/s (all engines)	Annual impact, ug/m3	1/420 x TWA-TLV	Annual Impact > 1/420 x TWA-TLV?
Acetaldehyde	1.19E-03	1.91E-02	7.52E-03	n/a	n/a	n/a	n/a	n/a	5.50E-04	4.32E-04	n/a	n/a
Acrolein	3.67E-04	5.89E-03	2.32E-03	n/a	n/a	n/a	n/a	n/a	1.69E-04	1.33E-04	n/a	n/a
Benzene	3.46E-02	5.56E-01	2.19E-01	78.11	0.5	1,597	16	no	1.60E-02	1.26E-02	4	no
Ethylbenzene	2.32E-03	3.72E-02	1.46E-02	106.197	20	86,869	869	no	1.07E-03	8.42E-04	207	no
Formaldehyde	1.17E-01	1.88	0.74	30.03	0.1	123	1.23	no	5.42E-02	4.27E-02	0.29	no
Hexane	4.76E-04	7.65E-03	3.01E-03	86.17848	50	176,234	1762.34	no	2.20E-04	1.73E-04	420	no
Naphthalene	5.59E-03	8.97E-02	3.53E-02	128.19	10	52,429	524	no	2.58E-03	2.03E-03	125	no
PAHs (as B(a)P) (6)	2.13E-05	3.42E-04	1.35E-04	252.31	0.2	2,064	21	no	9.84E-06	7.74E-06	5	no
Toluene	1.28E-02	2.06E-01	0.08	92.13	20	75,362	754	no	5.92E-03	4.66E-03	179	no
Xylene	9.19E-03	1.48E-01	0.06	106.16	100	434,192	4342	no	4.24E-03	3.34E-03	1034	no

Minimum Load Operations

			Acute Impacts, 8-hr Avg							Chronic Impacts	
Pollutant	Total Annual Emissions, all Engines, Case 3, tpy	Min. Load Hourly Emissions per Engine, Case 3 lb/hr	8-hour modeled impact, ug/m3	MW (g/mol)	TWA-TLV (8-hour basis) (2), ppm	TWA-TLV (8-hour basis), ug/m3	1/100 x TWA-TLV	8-hour impact> 1/100 x TWA-TLV?	Annual impact, ug/m3	1/420 x TWA/TLV	Annual Impact > 1/420 x TWA/TLV?
Acetaldehyde	1.91E-02	6.11E-04	5.82E-03	n/a	n/a	n/a	n/a	n/a	9.10E-04	n/a	n/a
Acrolein	5.89E-03	1.88E-04	1.79E-03	n/a	n/a	n/a	n/a	n/a	2.81E-04	n/a	n/a
Benzene	5.56E-01	1.78E-02	0.17	78.11	0.5	1,597	16	no	2.65E-02	4	no
Ethylbenzene	3.72E-02	1.19E-03	1.13E-02	106.197	20	86,869	869	no	1.77E-03	207	no
Formaldehyde	1.88	6.00E-02	0.57	30.03	0.1	123	1.23	no	8.98E-02	0	no
Hexane	7.65E-03	2.45E-04	2.33E-03	86.17848	50	176,234	1762.34	no	3.65E-04	420	no
Naphthalene	8.97E-02	2.87E-03	2.73E-02	128.19	10	52,429	524	no	4.27E-03	125	no
PAHs (as B(a)P) (6)	3.42E-04	1.09E-05	1.04E-04	252.31	0.2	2,064	21	no	1.63E-05	5	no
Toluene	2.06E-01	6.58E-03	6.27E-02	92.13	20	75,362	754	no	9.81E-03	179	no
Xylene	1.48E-01	4.72E-03	4.49E-02	106.16	100	434,192	4342	no	7.03E-03	1034	no

TWA-TLVs from ACGIH, "2019 TLVs and BEIs" except PAHs from https://www.atsdr.cdc.gov/csem/polycyclic-aromatic-hydrocarbons/standards_and_regulations_for_exposure.html.

Table HAP-3

HAPs Assessment, Comparison of Modeled Concentrations with OEHHA RELs for HAPs without TWA-TLVs, Case 1 (RNG Only)

Full-Load Operations

			Acute Impacts, 1-hr Avg			Acute Impacts, 8-hr Avg				Chronic Impacts		
Pollutant	Full Load Hourly Emissions per Engine, Case 1, lb/hr	Total Annual Emissions, all Engines, Case 1, tpy	1-hour modeled impact, ug/m3	1-Hour REL, ug/m3 (1)	1-hour impact > REL?	8-hour modeled impact, ug/m3	8-hour REL, ug/m3 (1)	8-hour impact > REL?	Annual Emission Rate, g/s (all engines)	Annual impact, ug/m3	Annual REL, ug/m3 (1)	Annual Impact > REL?
Acetaldehyde	0.02	1.01	0.40	470	no	0.14	300	no	0.029	0.024	140	no
Acrolein	2.43E-03	0.11	4.49E-02	2.5	no	0.02	0.7	no	0.003	0.003	0.35	no

Minimum Load Operations

			Acute Impacts, 1-hr Avg			Acute Impacts, 8-hr Avg				Chronic Impacts		
Pollutant	Min. Load Hourly Emissions per Engine, lb/hr	Total Annual Emissions, all Engines, Case 1, tpy	1-hour modeled impact, ug/m3	1-Hour REL, ug/m3 (1)	1-hour impact > REL?	8-hour modeled impact, ug/m3	8-hour REL, ug/m3 (1)	8-hour impact > REL?	Annual Emission Rate, g/s (all engines)	Annual impact, ug/m3	Annual REL, ug/m3 (1)	Annual Impact > REL?
Acetaldehyde	1.26E-02	1.01	0.29	470	no	0.09	300	no	0.029	0.035	140	no
Acrolein	1.40E-03	0.11	0.03	2.5	no	0.01	0.7	no	0.003	0.004	0.35	no

RELs from https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary

Table HAP-4

HAPs Assessment, Comparison of Modeled Concentrations with OEHHA RELs for HAPs without TWA-TLVs, Case 3 (Biodiesel Only)

Full-Load Operations

			Acute Impacts, 1-hour Avg			Acute Impacts, 8-hr Avg					Chronic Impacts	
Pollutant	Full Load Hourly Emissions per Engine, Case 3, lb/hr	Total Annual Emissions, all Engines, Case 3, tpy	1-hour modeled impact, ug/m3	1-Hour REL, ug/m3 (1)	1-hour impact > REL?	8-hour modeled impact, ug/m3	8-hour REL, ug/m3 (1)	8-hour impact > REL?	Annual Emission Rate, g/s (all engines)	Annual impact, ug/m3	Annual REL, ug/m3 (1)	Annual Impact > REL?
Acetaldehyde	1.19E-03	1.91E-02	2.21E-02	470	no	7.52E-03	300	no	5.50E-04	4.32E-04	140	no
Acrolein	3.67E-04	5.89E-03	6.81E-03	2.5	no	2.32E-03	0.7	no	1.69E-04	1.33E-04	0.35	no

Minimum Load Operations

			Acute Impacts, 1-hour Avg			Acute Impacts, 8-hr Avg				Chronic Impacts	
Pollutant	Total Annual Emissions, all Engines, Case 3, tpy	Min. Load Hourly Emissions per Engine, Case 3 lb/hr	1-hour modeled impact, ug/m3	1-Hour REL, ug/m3 (1)	1-hour impact > REL?	8-hour modeled impact, ug/m3	8-hour REL, ug/m3 (1)	8-hour impact > REL?	Annual impact, ug/m3	Annual REL, ug/m3 (1)	Annual Impact > REL?
Acetaldehyde	0.02	6.11E-04	1.56E-02	470	no	5.82E-03	300	no	9.10E-04	140	no
Acrolein	0.01	1.88E-04	4.80E-03	2.5	no	1.79E-03	0.7	no	2.81E-04	0.35	no

RELs from https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary

Table HAP-5

HAPs Assessment, Assessment of Cancer Risk, Case 1 (RNG Only)

Full Load Operation

Pollutant	Total Annual Emissions, all Engines, Case 1, tpy	Annual Emission Rate, g/s (all engines)	Annual impact, ug/m3	Cancer Risk Unit Risk, per µg/m3 (3,4)	Cancer Risk Cancer Risk x10E-6
Acetaldehyde	1.01	0.029	0.024	2.20E-06	0.05
Benzene	0.41	0.012	0.010	7.80E-06	0.08
1,3-Butadiene	0.70	0.020	0.016	3.50E-05	0.58
Ethylbenzene	0.14	0.004	0.003	*2.60E-06*	0.01
Formaldehyde	5.83	0.168	0.137	1.30E-05	1.78
Naphthalene	4.77E-02	0.001	0.001	*3.40E-05*	0.04
PAHs (as B(a)P)	3.26E-05	9.381E-07	7.681E-07	6.40E-04	4.92E-04
Total Cancer Risk					2.5 in one million

Minimum Load Operation

Pollutant	Total Annual Emissions, all Engines, Case 1, tpy	Annual Emission Rate, g/s (all engines)	Annual impact, ug/m3	Cancer Risk Unit Risk, per µg/m3	Cancer Risk Cancer Risk x10E-6
Acetaldehyde	1.01	0.029	0.035	2.20E-06	0.08
Benzene	0.41	0.012	0.014	7.80E-06	0.11
1,3-Butadiene	0.70	0.020	0.024	3.50E-05	0.85
Ethylbenzene	0.14	3.89E-03	4.70E-03	*2.60E-06*	1.22E-02
Formaldehyde	5.83	0.168	0.202	1.30E-05	2.63
Naphthalene	4.77E-02	1.37E-03	1.66E-03	*3.40E-05*	0.06
PAHs (as B(a)P)	3.26E-05	9.38E-07	1.13E-06	6.40E-04	7.25E-04
Total Cancer Risk					3.7 in one million

Cancer risks from EPA's "Prioritized Chronic Dose-Response Values for inhalation" and OEHHA "Hot Spots Unit Risk and Cancer Potency Values ." See text.

Table HAP-6

HAPs Assessment, Assessment of Cancer Risk, Case 3 (Biodiesel Only)

Full Load Operation

				Cancer Risk	
Pollutant	**Total Annual Emissions, all Engines, Case 3, tpy**	**Annual Emission Rate, g/s (all engines)**	**Annual impact, ug/m3**	**Unit Risk, per µg/m3**	**Cancer Risk x10E-6**
Acetaldehyde	1.91E-02	5.50E-04	4.32E-04	2.20E-06	9.51E-04
Benzene	5.56E-01	1.60E-02	1.26E-02	7.80E-06	9.82E-02
Ethylbenzene	3.72E-02	1.07E-03	8.42E-04	*2.60E-06*	2.19E-03
Formaldehyde	1.88	5.42E-02	4.27E-02	1.30E-05	0.55
Naphthalene	8.97E-02	2.58E-03	2.03E-03	*3.40E-05*	6.90E-02
PAHs (as B(a)P) (6)	3.42E-04	9.84E-06	7.74E-06	6.40E-04	4.95E-03
Total Cancer Risk					0.73 in one million

Minimum Load Operation

				Cancer Risk	
Pollutant	**Total Annual Emissions, all Engines, Case 3, tpy**	**Annual Emission Rate, g/s (all engines)**	**Annual impact, ug/m3**	**Unit Risk, per µg/m3**	**Cancer Risk x10E-6**
Acetaldehyde	1.91E-02	5.50E-04	9.10E-04	2.20E-06	2.00E-03
Benzene	5.56E-01	1.60E-02	2.65E-02	7.80E-06	0.21
Ethylbenzene	3.72E-02	1.07E-03	1.77E-03	*2.60E-06*	4.61E-03
Formaldehyde	1.88	5.42E-02	8.98E-02	1.30E-05	1.17
Naphthalene	8.97E-02	2.58E-03	4.27E-03	*3.40E-05*	0.15
PAHs (as B(a)P) (6)	3.42E-04	9.84E-06	1.63E-05	6.40E-04	0.01
Total Cancer Risk					1.54 in one million

Cancer risks from EPA's "Prioritized Chronic Dose-Response Values for inhalation" and OEHHA "Hot Spots Unit Risk and Cancer Potency Values." See text.

MODELED CONCENTRATION ISOPLETHS

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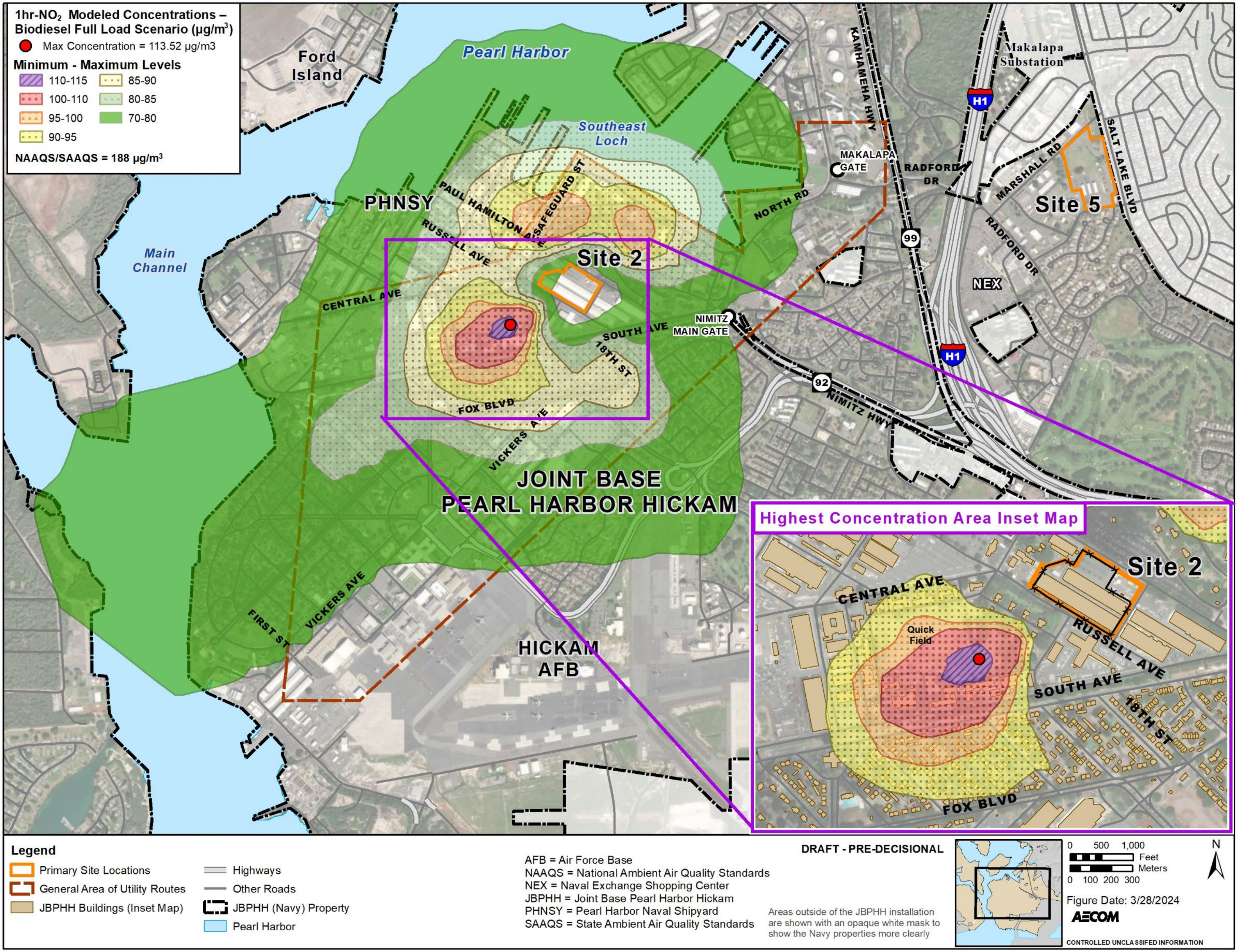
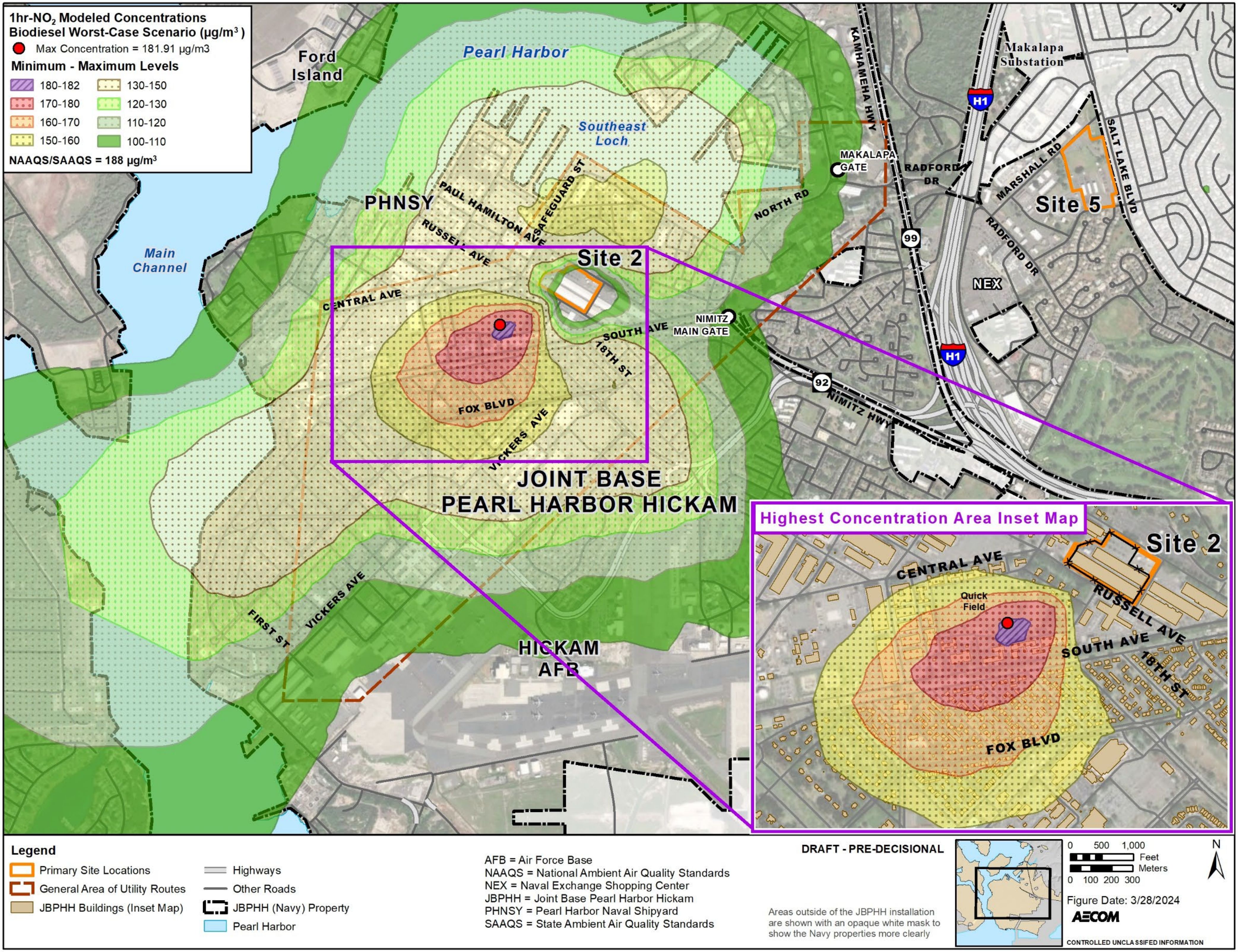
1-hr NO_2 – Biodiesel Full Load Scenario


1hr-NO2 Modeled Concentrations – Biodiesel Full Load Scenario (µg/m3)
Max Concentration = 113.52 µg/m3
Minimum - Maximum Levels
110-115
100-110
95-100
90-95
85-90
80-85
70-80
NAAQS/SAAQS = 188 µg/m3
Ford Island
Pearl Harbor
Southeast Loch
Main Channel
PHNSY
Makalapa Substation
MAKALAPA GATE
RADFORD DR
MARSHALL RD
SALT LAKE BLVD
Site 5
KAMEHAMEHA HWY
H1
99
92
NORTH RD
PAUL HAMILTON AVE
SAFEGUARD ST
RUSSELL AVE
Site 2
CENTRAL AVE
NIMITZ MAIN GATE
SOUTH AVE
18TH ST
NEX
NIMITZ HWY
FOX BLVD
VICKERS AVE
JOINT BASE PEARL HARBOR HICKAM
FIRST ST
HICKAM AFB
Highest Concentration Area Inset Map
Quick Field
Legend
Primary Site Locations
General Area of Utility Routes
JBPHH Buildings (Inset Map)
Highways
Other Roads
JBPHH (Navy) Property
Pearl Harbor
AFB = Air Force Base
NAAQS = National Ambient Air Quality Standards
NEX = Naval Exchange Shopping Center
JBPHH = Joint Base Pearl Harbor Hickam
PHNSY = Pearl Harbor Naval Shipyard
SAAQS = State Ambient Air Quality Standards
DRAFT - PRE-DECISIONAL
Areas outside of the JBPHH installation are shown with an opaque white mask to show the Navy properties more clearly
0 500 1,000 Feet
0 100 200 300 Meters
N
Figure Date: 3/28/2024
AECOM
CONTROLLED UNCLASSIFIED INFORMATION

1-hr NO_2 – Biodiesel Worst-Case Scenario



1hr-NO2 Modeled Concentrations
Biodiesel Worst-Case Scenario (µg/m3)
Max Concentration = 181.91 µg/m3
Minimum - Maximum Levels
180-182
170-180
160-170
150-160
130-150
120-130
110-120
100-110
NAAQS/SAAQS = 188 µg/m3
Ford Island
Pearl Harbor
Southeast Loch
Main Channel
PHNSY
PAUL HAMILTON AVE
RUSSELL AVE
SAFEGUARD ST
NORTH RD
CENTRAL AVE
SOUTH AVE
18TH ST
FOX BLVD
VICKERS AVE
FIRST ST
Site 2
Site 5
Makalapa Substation
KAMEHAMEHA HWY
MAKALAPA GATE
RADFORD DR
MARSHALL RD
SALT LAKE BLVD
NEX
NIMITZ MAIN GATE
NIMITZ HWY
H1
99
92
JOINT BASE PEARL HARBOR HICKAM
HICKAM AFB
Highest Concentration Area Inset Map
Quick Field
Legend
Primary Site Locations
General Area of Utility Routes
JBPHH Buildings (Inset Map)
Highways
Other Roads
JBPHH (Navy) Property
Pearl Harbor
AFB = Air Force Base
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DRAFT - PRE-DECISIONAL
Areas outside of the JBPHH installation are shown with an opaque white mask to show the Navy properties more clearly
0 500 1,000 Feet
0 100 200 300 Meters
N
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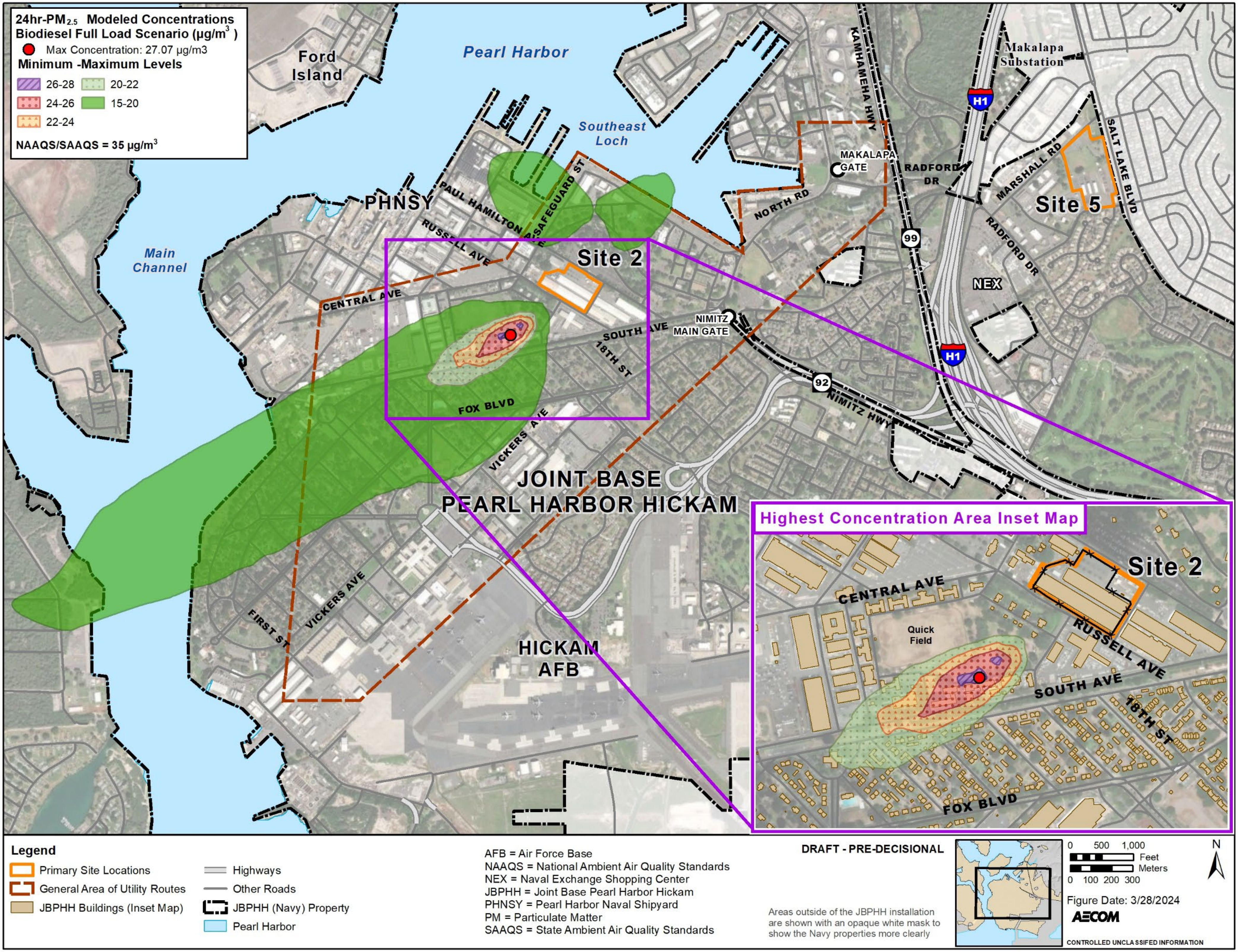
24-hr $PM_{2.5}$ – Biodiesel Full Load Scenario



24hr-PM2.5 Modeled Concentrations
Biodiesel Full Load Scenario (µg/m3)
Max Concentration: 27.07 µg/m3
Minimum -Maximum Levels
26-28
20-22
24-26
15-20
22-24
NAAQS/SAAQS = 35 µg/m3
Pearl Harbor
Ford Island
Southeast Loch
Main Channel
PHNSY
PAUL HAMILTON AVE
SAFEGUARD ST
RUSSELL AVE
CENTRAL AVE
SOUTH AVE
18TH ST
FOX BLVD
VICKERS AVE
FIRST ST
Site 2
Site 5
KAMEHAMEHA HWY
MAKALAPA GATE
Makalapa Substation
RADFORD DR
MARSHALL RD
SALT LAKE BLVD
NORTH RD
NIMITZ MAIN GATE
NIMITZ HWY
NEX
H1
99
92
JOINT BASE PEARL HARBOR HICKAM
HICKAM AFB
Highest Concentration Area Inset Map
Quick Field
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Primary Site Locations
General Area of Utility Routes
JBPHH Buildings (Inset Map)
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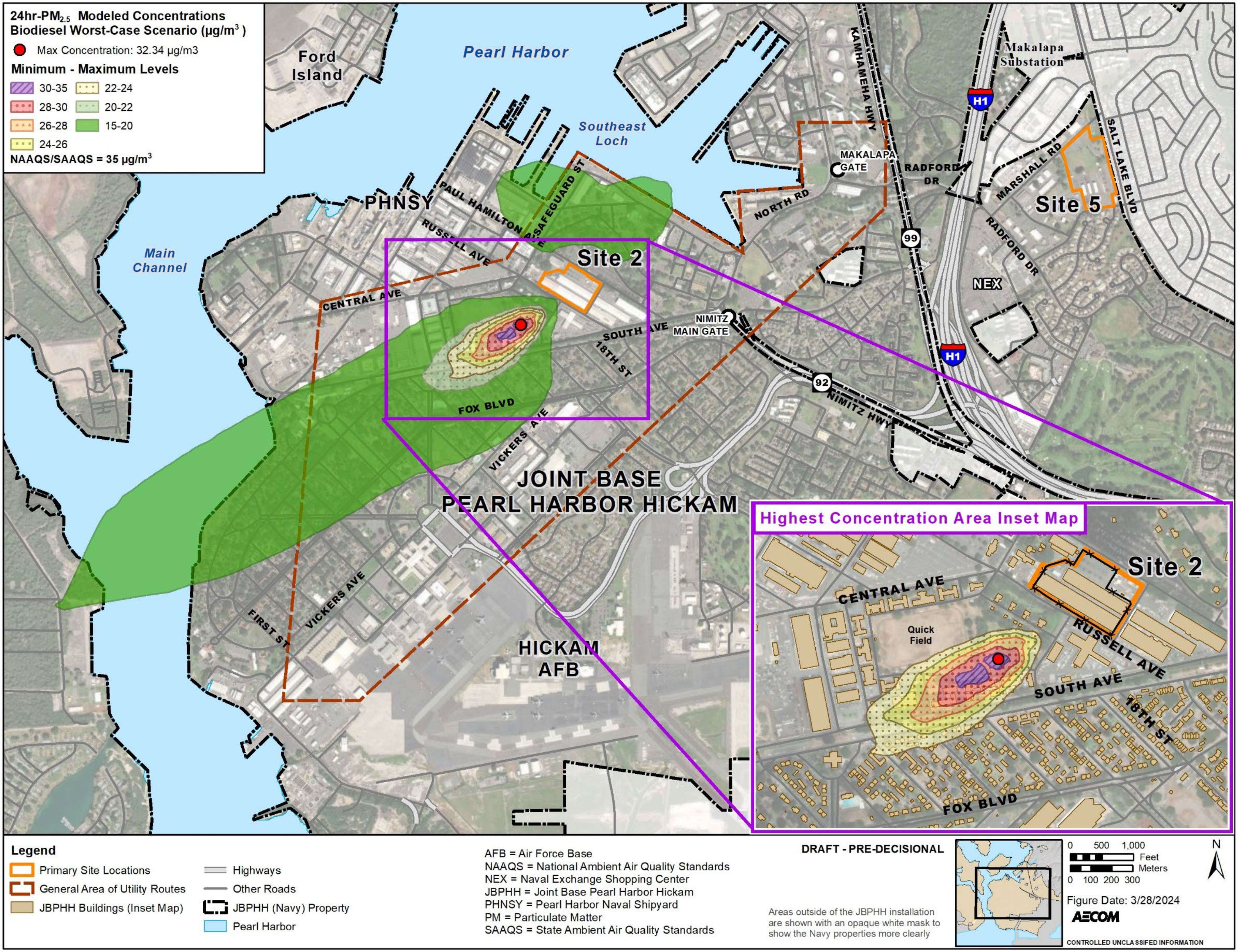
NAAQS = National Ambient Air Quality Standards
NEX = Naval Exchange Shopping Center
JBPHH = Joint Base Pearl Harbor Hickam
PHNSY = Pearl Harbor Naval Shipyard
PM = Particulate Matter
SAAQS = State Ambient Air Quality Standards
DRAFT - PRE-DECISIONAL
Areas outside of the JBPHH installation are shown with an opaque white mask to show the Navy properties more clearly
0 500 1,000 Feet
0 100 200 300 Meters
N
Figure Date: 3/28/2024
AECOM
CONTROLLED UNCLASSIFED INFORMATION

24-hr $PM_{2.5}$ – Biodiesel Worst-Case Scenario


24hr-PM2.5 Modeled Concentrations
Biodiesel Worst-Case Scenario (µg/m3)
Max Concentration: 32.34 µg/m3
Minimum - Maximum Levels
30-35
28-30
26-28
24-26
22-24
20-22
15-20
NAAQS/SAAQS = 35 µg/m3
Ford Island
Pearl Harbor
Southeast Loch
Main Channel
PHNSY
PAUL HAMILTON AVE
SAFEGUARD ST
RUSSELL AVE
CENTRAL AVE
SOUTH AVE
18TH ST
FOX BLVD
VICKERS AVE
FIRST ST
Site 2
Site 5
KAMEHAMEHA HWY
MAKALAPA GATE
NORTH RD
RADFORD DR
MARSHALL RD
SALT LAKE BLVD
Makalapa Substation
H1
99
92
NIMITZ MAIN GATE
NIMITZ HWY
NEX
JOINT BASE PEARL HARBOR HICKAM
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Highest Concentration Area Inset Map
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PHNSY = Pearl Harbor Naval Shipyard
PM = Particulate Matter
SAAQS = State Ambient Air Quality Standards
DRAFT - PRE-DECISIONAL
Areas outside of the JBPHH installation are shown with an opaque white mask to show the Navy properties more clearly
0 500 1,000 Feet
0 100 200 300 Meters
N
Figure Date: 3/28/2024
AECOM
CONTROLLED UNCLASSIFED INFORMATION

Appendix B
Noise Methodology and Calculations

Lease of Land for Energy Generation and Storage, Resiliency, Reliability, and Security

at

Joint Base Pearl Harbor-Hickam, Hawaii

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1 Introduction

Commander Joint Base Pearl Harbor-Hickam (JBPHH),a Command of the United States (U.S.) Navy (hereinafter, jointly referred to as the Navy) proposes to lease Department of Navy (DON) land to a commercial developer to construct and operate renewable energy infrastructure on two separate sites (up to 20 acres) at Joint Base Pearl Harbor-Hickam (JBPHH), Oahu, Hawaii. One site would house a biofuel power generation facility and one site would house a solar array for energy generation with a battery bank. The two sites would be connected to the Hawaiian Electric Company (HECO) electric infrastructure.

The land would be leased for up to 37 years. After the terms of the lease expire, the Navy and the lessee would consider a range of options, including renewing the agreement or decommissioning the system.

The Proposed Action would be located at JBPHH, situated on the eastern shore of Pearl Harbor on the south side of the island of Oahu, Hawaii (Figure 1.3-1). JBPHH consists of Hickam Air Force Base and the Naval Station Pearl Harbor, which merged into a joint base in October 2010 (DON, 2020a).

2 Noise Fundamentals

This discussion of noise includes the types or sources of noise and the associated sensitive receptors in the human environment. Noise in relation to biological resources and wildlife species is discussed in Section 3.4.

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water, and are sensed by the human ear. Sound is all around us. The perception and evaluation of sound involve three basic physical characteristics:

- **Intensity:** The acoustic energy, which is expressed in terms of sound pressure, in decibels (dB)
- **Frequency:** The number of cycles per second the air vibrates, in hertz (Hz)
- **Duration:** The length of time the sound can be detected

Noise is defined as unwanted or annoying sound that interferes with or disrupts normal human activities. Although continuous and extended exposure to high noise levels (e.g., through occupational exposure) can cause hearing loss, the principal human response to noise is annoyance. The response of different individuals to similar noise events is diverse and is influenced by the type of noise, perceived importance of the noise, its appropriateness in the setting, time of day, and type of activity during which the noise occurs, as well as the sensitivity of the individual.

2.1 Basics of Sound and A-Weighted Sound Level

The loudest sounds that can be comfortably heard by the human ear have intensities a trillion times higher than those of sounds barely heard. Because of this vast range, it is unwieldy to use a linear scale to represent the intensity of sound. As a result, a logarithmic unit known as dB is used to represent the intensity of a sound, also referred to as the sound level. A sound level of 0 dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels between 130 and 140 dB are felt as pain (Berglund and Lindvall, 1995).

All sounds have a spectral content, which means their magnitude or level changes with frequency, where frequency is measured in cycles per second or Hz. To mimic the human ear's non-linear sensitivity and perception of different frequencies of sound, the spectral content is weighted. For example, environmental noise measurements are usually on an A-weighted scale, which places less weight on very low and very high frequencies to replicate human hearing sensitivity. The general range of human hearing is from 20 to 20,000 Hz; humans hear best in the range of 1,000 to 4,000 Hz. A-weighting is a frequency-dependent adjustment of sound level used to approximate the natural range and sensitivity of the human auditory system. Table B-1 (Cowan, 1994) provides a comparison of how the human ear perceives changes in loudness on the logarithmic scale.

Table B-1 Subjective Responses to Changes in A-Weighted Decibels

Change	*Change in Perceived Loudness in Sound Intensity*
3 dB	Barely perceptible
5 dB	Quite noticeable
10 dB	Twice or half as loud
20 dB	Fourfold change in loudness

Source: Handbook of Environmental Acoustics, James P. (Cowan, 1994)

Figure B-1 (Cowan, 1994) provides a chart of A-weighted sound levels from typical noise sources. Some noise sources (e.g., air conditioner, vacuum cleaner) are continuous sounds that maintain a constant sound level for some period of time. Other sources (e.g., automobile, heavy truck) are the maximum sound produced during an event like a vehicle pass-by. Other sounds (e.g., urban daytime, urban nighttime) are averages taken over extended periods of time. A variety of noise metrics have been developed to describe noise over different time periods, discussed as follows.

2.2 Noise Metrics and Modeling

A metric is a system for measuring or quantifying a particular characteristic of a subject. Because noise is a complex physical phenomenon, different noise metrics help to quantify the noise levels and environment so they can be compared in a standardized way.

The noise metrics used in this analysis are summarized below. While the day-night average sound Level (DNL) noise metric is the most commonly used for aircraft noise and are the focus of other Navy installation projects, this analysis focuses on the Equivalent Sound Level (L_{eq}) metric which is typically used to assess operational noise from stationary sources, such as the facilities outlined in the Proposed Action.

2.2.1 Equivalent Sound Level

The equivalent sound level (L_{eq}), measured in dB, is a cumulative noise metric that represents the average sound level (on a logarithmic basis) over a specified period of time—for example, an hour, a school day, daytime, nighttime, weekend, facility rush periods, or a full 24-hour day (i.e., the L_{eq} for a full 24-hour day is similar to the DNL metric but for the fact that the DNL metric includes the additional 10 dB for those events during acoustic night). In this analysis, operational and construction noise is predicted and analyzed using L_{eq}, which describes the cumulative noise environment.

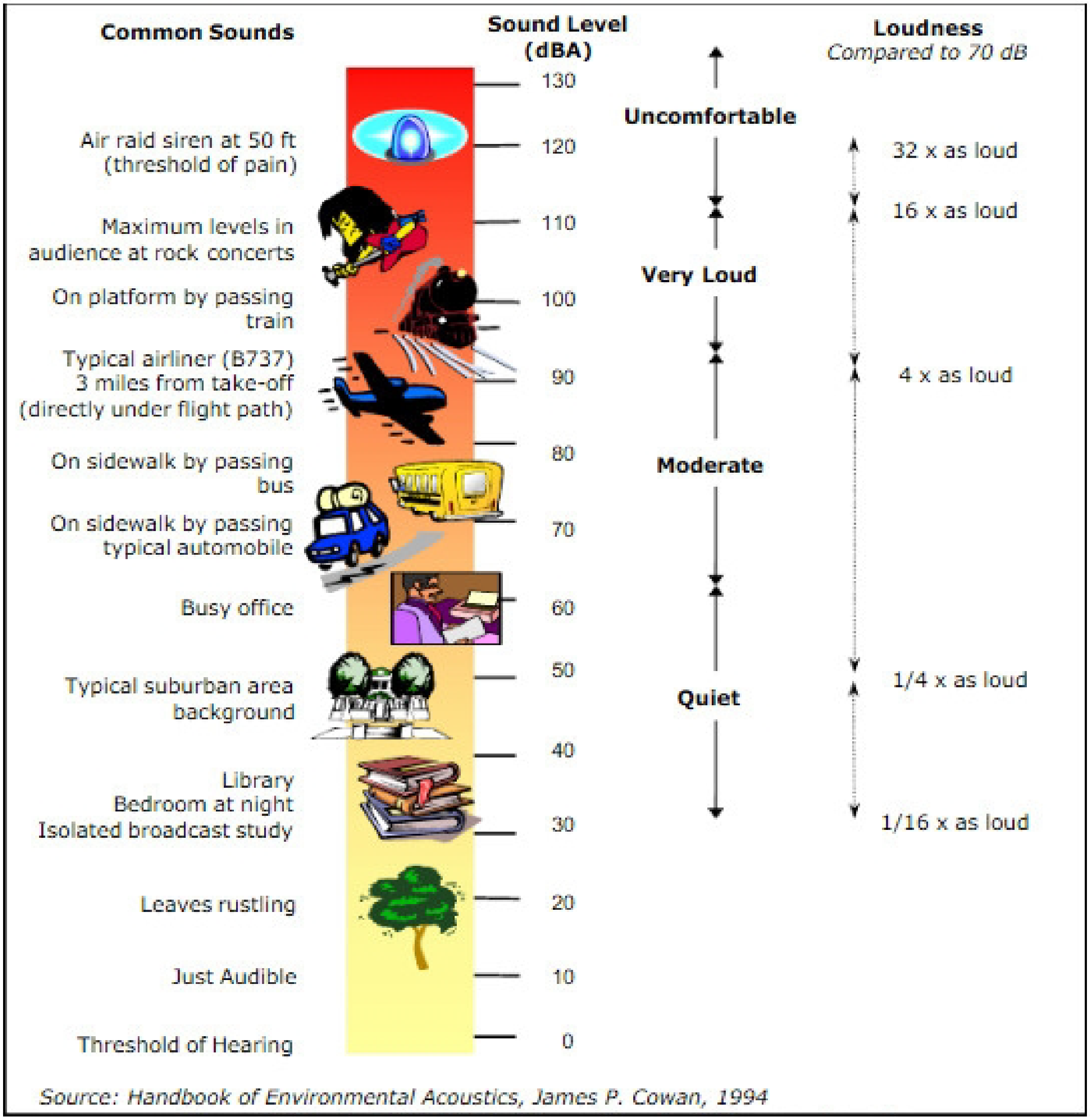

Figure B-1 A-Weighted Sound Levels from Typical Sources

3 Project-Specific Regulatory Setting

The Proposed Action involves operational noise from power generation facilities and its associated construction. Because the proposed FRG plant and BESS are stationary sources, the Hawaii Department of Health (DOH)-established maximum permissible sound levels have been used as the impact assessment criteria for this EA. These assessment criteria have been used by the commercial developer as the design criteria to meet for these new facilities. Therefore, they have been adopted in assessing potential operational noise impacts from the Proposed Action.

In accordance with Hawaii Administrative Rules (HAR) Title 11, Chapter 26 Community Noise Control, a classification of zoning districts has defined maximum permissible sound levels in dBA applicable to stationary noise sources, as well as to equipment related to agriculture, construction, and industrial activities. These levels are shown in Table B-2.

Table B-2 Maximum Permissible Sound Levels (dBA)

Zoning District	*Land Zone*	*Daytime (7 a.m.–10 p.m.)*	*Nighttime (10 p.m.–7 a.m.)*
Class A	Residential, public and open space, etc.	55	45
Class B	Apartment, commercial, hotel, etc.	60	50
Class C	Agriculture, industrial, etc.	70	70

Source: Haw. Code R. § 11-46-4.

4 Affected Environment

Many sources generate noise and warrant analysis as contributors to the total noise impact in the analysis area or Regional of Influence (ROI) The existing noise environment within the ROI includes aircraft and ship operations at JBPHH, aircraft operations at Daniel K. Inouye airport, maintenance equipment, road vehicle traffic, general office and support operations, and construction equipment.

The federal government supports conditions free from noise levels that threaten human health and welfare and the environment. Responses to noise varies depending on the type and characteristics of the noise, distance between the noise source and whoever hears it (the receptor), receptor sensitivity, and time of day. A noise sensitive receptor is defined as a land use where people involved in indoor or outdoor activities may be subject to stress or considerable interference from noise. Such locations or facilities often include residential dwellings, hospitals, nursing homes, educational facilities, and libraries. Sensitive receptors may also include noise-sensitive cultural practices, some domestic animals, or certain wildlife species. The ambient noise environment around Sites 2 and 5 is considered quiet according to **Figure B-1**.

The nearest sensitive receptors at the western side of the ROI which encompasses the proposed FRG facility (Site 2) are officer military housing along Russell Ave and Hale Alii Ave, as well as on-JBPHH residents at Hickam Housing located along Porter Avenue, which is moderately developed housing for military families. These receptors are located between 180 feet and 500 feet from the project site boundary. The nearest sensitive receptors, off-JBPHH and on-JBPHH housing areas, respectively, at the eastern side of the ROI which encompasses the solar array and BESS facility (Site 5) are located along Salt Lake Boulevard and Namur Road. These receptors are located between 60 and 160 feet from the project site boundary.

5 Installation Noise Environment

Aside from aircraft noise, other noise source contributions to the ROI include ship operations from JBPHH and associated maintenance and support equipment, general office and staff training facilities, construction equipment, and road vehicle traffic along South Ave, Porter Ave, Salt Lake Boulevard, and Queen Liliuokalani Freeway (H1), as well as on-base traffic associated with JBPHH. Noise levels adjacent to highways and roads are expected to be the dominant non-aircraft noise sources affecting sensitive receptors within the ROI.

5.1 Noise Monitoring

Long-term ambient noise monitoring was conducted within the ROI between October 27, 2022, and November 8, 2022, to determine baseline noise levels for assessing potential noise impacts from the proposed facilities.

Two monitoring locations were selected for the survey. These locations represent the closest sensitive receivers to Site 2 and Site 5. Figure B-2 and Figure B-3 show the noise monitoring locations, and Table B-3 summarizes the monitored noise levels. The full range of hourly L_{eq} values for the monitoring periods is presented at the end of this report.

The ambient noise measurement was conducted using Quest SoundPro DL-1 sound level meters that meets the American National Standards Institute (ANSI) standards for Type I accuracy and quality. The sound level meter was calibrated before and after each measurement period.

Microphone height was set approximately 1.5 m above ground level. A wind screen was used to minimize wind noise across the face of the microphone. Noise levels were logged over an approximately 5-day duration from Tuesday November 1 to Tuesday November 8, 2022 (Measurement Location 1) and Thursday October 27 to Tuesday November 1 (Measurement Location 2) when the ambient levels are at their lowest due to the weekend period, and the potential for noise impacts is greater. The measurements were recorded with A-weighted L_{eq}, L_{Max}, and L_{Peak}. The data was digitally stored in each analyzer so that it could then be further analyzed.

Table B-3 Monitored Ambient Noise Levels

Location	*Site*	*Average Daytime Ambient Measured L_{eq} (7 a.m. – 10 p.m.)*	*Average Nighttime Ambient Measured L_{eq} (10 p.m. – 7 a.m.)*
M1	2	53.5	45.3
M2	5	55.7	52.1

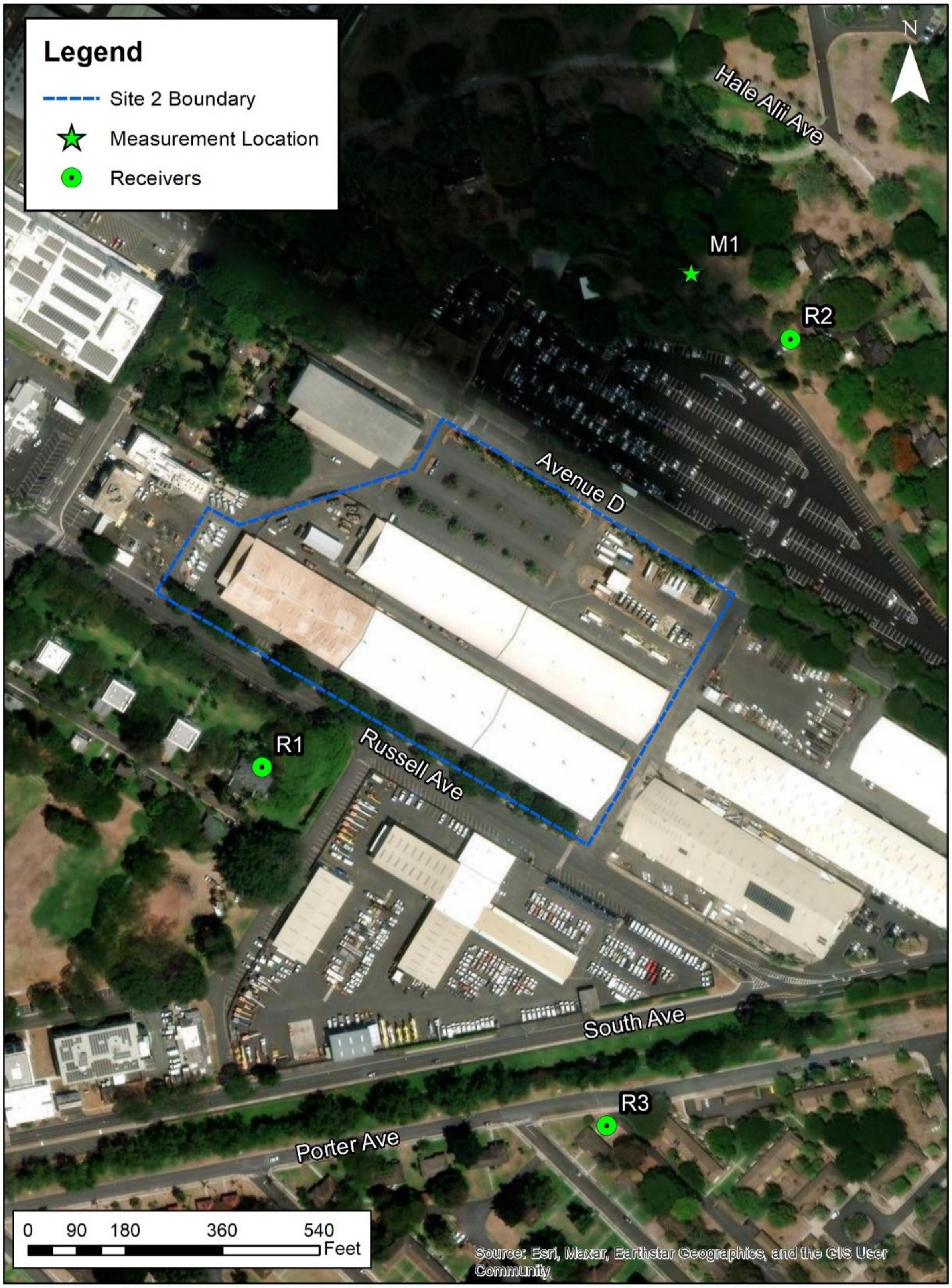

Figure B-2 Site 2 Noise Monitoring Location (M1) and Nearest Sensitive Receivers (R1, R2, and R3)

Figure B-3 Site 5 Noise Monitoring Location (M2) and Nearest Sensitive Receivers (R4, R5, and R6)

6 Environmental Consequences

6.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to baseline noise levels. Therefore, no significant impacts due to the noise environment would occur with implementation of the No Action Alternative.

6.2 Preferred Alternative

6.2.1 Operational Noise Impacts

6.2.1.1 Source Levels

Noise source levels used in this analysis are presented in Table B-4. Source locations are presented in Figure B-4 and Figure B-5. As only preliminary mechanical equipment design was made available for this noise study, conservative assumptions were made about some noise source levels including the cooling radiator field for the FRG facility (Site 2), and transformers, inverters, and HVAC associated with the BESS storage units at both sites. In addition, where mechanical data was not available, test data or manufacturer levels for similar equipment were sourced which may not be used in the final design. Noise prediction calculations will be updated as the design progresses and more information is made available.

The preliminary source levels used in this analysis assume the inclusion of Wartsila model 5R09 35 dB silencers for all engine generator exhausts at the FRG facility (Site 2).

Table B-4 Operational Noise Source Sound Power Levels (at Source)

Source Type	*Project Site*	*Sound Power Level L_w (dBA)*
Engine Generator Exhaust	Site 2	97
Cooling Radiator Field	Site 2	106
Substation Transformer	Site 2	98
BESS Transformer	Sites 2 and 5	82
BESS Inverter	Sites 2 and 5	93
BESS HVAC	Sites 2 and 5	84

Sound levels from these sources would combine to create an overall noise level from Sites 2 and 5. The overall sound level would depend on various operational factors, including whether all, some or just one of the sources is producing sound at a given time. The sound levels decrease with distance between the source and the receptor.

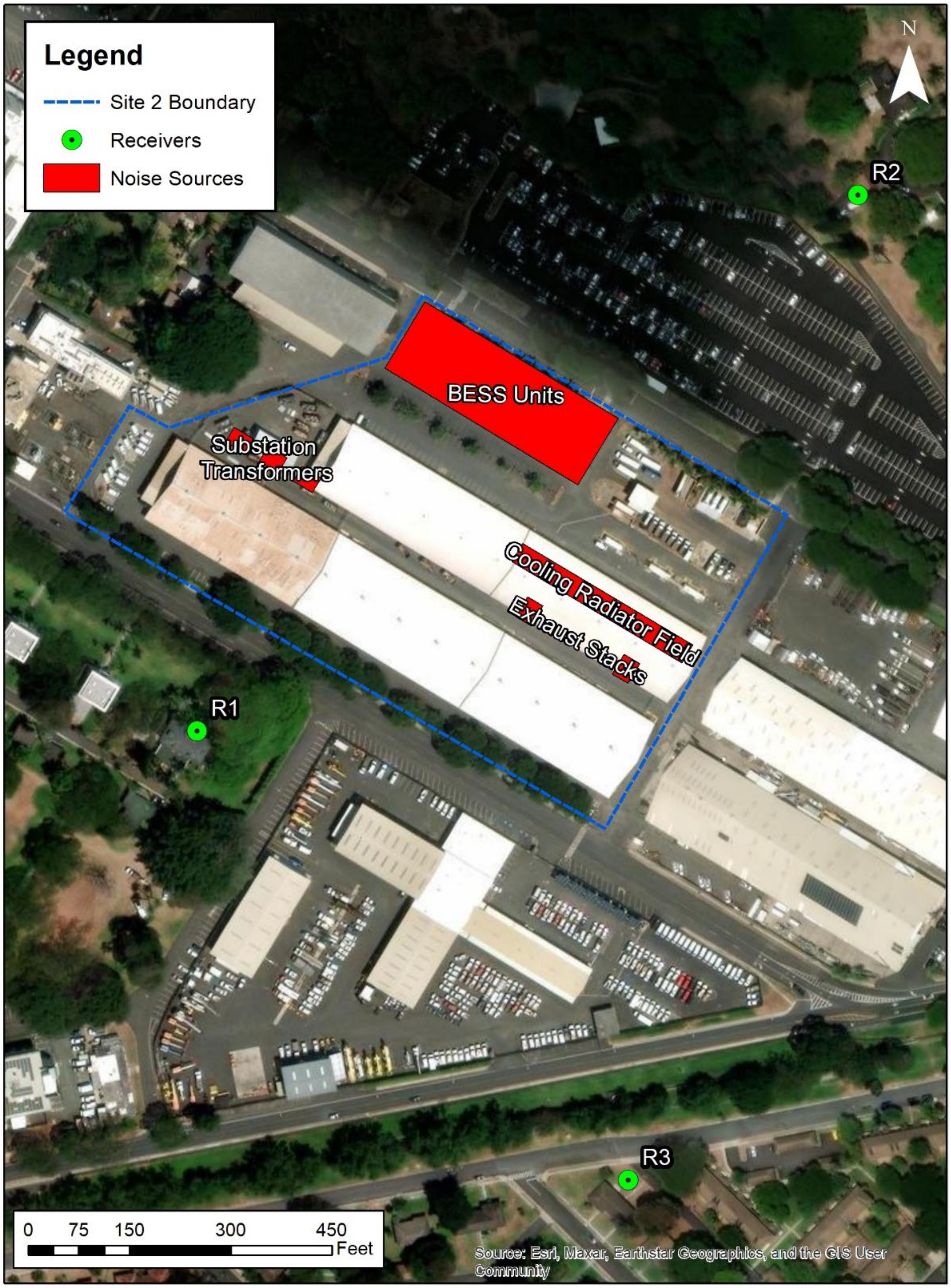

Figure B-4 Site 2 Noise Source Location

Figure B-5 Site 5 Noise Source Locations

6.2.1.2 Noise Impact Prediction

According to the acoustical principle, when the sound propagation occurs, a resulting sound pressure level can be predicted using the following geometric spreading formulas for a single sound source (assuming the propagation surface is reflective with no shielding from any structure, and the source is hemispherical spreading i.e. located on the ground):

$L_p = L_w - A_{div}$ *

$A_{div} = [10 \times \log(4\pi)] + [20 \times \log(d)]$ *(for full spherical spreading i.e. source located above the ground)*

$A_{div} = [10 \times \log(2\pi)] + [20 \times \log(d)]$ *(for hemispherical spreading i.e. source located on the ground)*

Where:

L_p = sound pressure level (in dBA) at Receptor

L_w = sound power level (in dBA) of the noise source

d = distance between receptor to the source in meters

* Source: Engineering Noise Control - Theory and Practice, David Bies and Colin Hansen, 5th Edition, 2017.

The above formulas were used to predict the operational noise levels with the Proposed Action at both Site 2 and Site 5 as summarized in Table B-5 and Table B-6. These tables also summarize the subjective responses to the predicted daytime operational noise level increases, as referenced in Table B-1.

Noise prediction calculations indicate potential noise impacts that exceed the HAR 11-46 criteria for Class A zoning districts (e.g., residential, public and open space) of 55 dBA during the daytime and 45 dBA during the nighttime, which has been used as the design criteria for both facilities at Sites 2 and 5. Potential noise impacts range from 3 to 16 dBA and 1 to 14 dBA above the design criteria at Site 2 and Site 5, respectively.

Table B-5 Predicted Proposed Action Daytime Operational Noise Levels and Noise Code Compliance

Receiver	*Project Site*	*Average Daytime Ambient Measured L_{eq} (dBA)*	*Predicted Preferred Alternative Noise Contribution L_{eq} (dBA)*	*Predicted Total Noise with Preferred Alternative L_{eq} (dBA)*	*Daytime Criteria L_{eq} (dBA)*	*Net Increase above Daytime Criteria (dB)*	*Subjective Response[1]*
R1	Site 2 (FRG)	53.5	60.5	61.3	55.0	6.3	Quite Noticeable
R2	Site 2 (FRG)	53.5	59.3	60.3	55.0	5.3	Quite Noticeable
R3	Site 2 (FRG)	55.7*	54.9	58.3	55.0	3.3	Barely Perceptible
R4	Site 5 (BESS)	55.7	39.9	55.8	55.0	0.8	Barely Perceptible
R5	Site 5 (BESS)	55.7	47.2	56.3	55.0	1.3	Barely Perceptible
R6	Site 5 (BESS)	55.7	57.4	59.7	55.0	4.7	Quite Noticeable

Table B-6 Predicted Proposed Action Nighttime Operational Noise Levels and Noise Code Compliance

Receiver	*Project Site*	*Average Nighttime Ambient Measured L_{eq} (dBA)*	*Predicted Preferred Alternative Noise Contribution L_{eq} (dBA)*	*Predicted Total Noise with Preferred Alternative L_{eq} (dBA)*	*Nighttime Criteria L_{eq} (dBA)*	*Net Increase above Nighttime Criteria (dB)*	*Subjective Response[1]*
R1	Site 2 (FRG)	45.3	60.5	60.7	45.0	15.7	Twice as Loud
R2	Site 2 (FRG)	45.3	59.3	59.4	45.0	14.4	Twice as Loud
R3	Site 2 (FRG)	52.1*	54.9	56.7	45.0	11.7	Twice as Loud
R4	Site 5 (BESS)	52.1	39.9	52.4	45.0	7.4	Quite Noticeable
R5	Site 5 (BESS)	52.1	47.2	53.3	45.0	8.3	Quite Noticeable
R6	Site 5 (BESS)	52.1	57.4	58.6	45.0	13.6	Twice as Loud

[1] Subjective descriptor from Figure B-1 (Cowan 1994).
* Ambient level measured at M2 (Site 5) is used given the similar location adjacent to roadway traffic.

Daytime noise levels at the public sensitive receptor sites (R4 and R5) would increase slightly (from barely perceptible to noticeable) during the daytime and the resulting level would be slightly over the State's Class A Zoning level for daytime noise. Nighttime noise levels at the public sensitive receptor sites would be between quite noticeable and twice as loud given relatively low nighttime ambient noise levels and would be several decibels over the State's Class A Zoning level for nighttime noise. These effects and more substantive effects on daytime and nighttime noise at receptors that are on JBPHH (R1, R2, R3 and R6) would generate the need for analyzing and including measures to reduce noise generation at the source and noise levels at the receptors during the design phases of the Proposed Action.

6.2.1.3 Mitigation Measures

In order to meet Hawaii Noise Code criteria, noise mitigation measures will need to be implemented as part of the Preferred Alternative.

FRG Facility (Site 2)

Dominant noise sources at Site 2 are the exhaust stacks and cooling radiator field associated with the engine generators, as the BESS units are not the overall dominant source of noise from Site 2. Noting that a 35 dB silencer has already been assumed in the source levels for the exhaust stacks, additional silencers/mufflers may need to be implemented. This mitigation measure is dependent on static pressure allowances on the system.

It is assumed that typical fiberglass ductwork lining in the engine generator ductwork is not feasible due to fire and particle stream concerns. However, if fiber-glass free acoustical lining can be used, this should be considered in the final design for the exhaust stacks.

Airflow requirements around the cooling radiator field preclude the use of acoustic shrouds. It is recommended to select low-noise fans in the final design as a mitigation measure.

Noise barriers are not an effective mitigation solution for this facility, due to the heights of the exhaust stacks (approximately 110 feet), cooling radiator field (approximately 20 feet high) and substation transformers (approximate 30 feet high). To break line-of-sight to the nearest sensitive receptors, noise barriers would need to be above these heights, which is not feasible. Mitigation measures to reduce operational noise at this FRG Plant facility include insulation in the engine hall walls, doors, and roof, acoustical attenuation for air intake and exhaust, low-noise fans, engineer exhaust mufflers, ultra-low noise radiators, and other manufacturer-provided mitigation solutions where possible.

However, a noise barrier on the northern side of the site adjacent to the BESS units could be considered as a preliminary mitigation option. Noise barriers should be continuous with no gaps, constructed out of perforated metal with interior acoustical fill on the interior side (source side) and solid non-perforated metal on the outside (receptor side), and extend at least 3 feet above the top of the BESS units. This type of barrier will be most effective at residences to the north of the site which are closest to the BESS units. The likely overall reductions achieved of noise from the BESS units will be 3 to 5 dB. This barrier would need to be considered in addition to other options, as the BESS units are not the overall dominant source of noise from Site 2.

BESS Facility (Site 5)

Dominant noise sources at Site 5 are the BESS units, which each consist of an inverter, transformer, and cooling fans associated with the storage blocks. The solar field itself and the FRG Plant facility are not significant sources of noise at this site.

A noise barrier or three-sided enclosure would be considered around the BESS units at the southern end of the site. Noise barriers or enclosures would be continuous with no gaps, constructed out of perforated metal with interior acoustical fill on the interior side (source side) and solid non-perforated metal on the outside (receptor side), and extend at least 3 feet above the top of the BESS units. This type of barrier will be most effective at residences to the south of the site which are closest to the BESS units. The likely overall reductions achieved of noise from the BESS units will be between 3 to 5 dB. Mitigation measures, including constructing an acoustical building with acoustical panels or concrete and solid sound walls around the BESS facility, would be implemented.

With implementation of the anticipated mitigation, noise levels at the six receptor sites can be reduced. The resulting noise levels require feasibility analysis of the measures, design of the actual measures and further analysis to quantify the overall noise level reduction benefit at the receptors site. The goal of this effort would be to reduce noise levels to the degree that the resulting levels are within the State's zoning classification levels or as close as possible (an inaudible difference).

6.3 Construction Noise

The construction activities associated with Site 2 of the Proposed Action would last slightly less than three years, while the construction of Site 5 would approximately nine months. Construction of the transmission backbone would occur over two years as construction moves along the transmission line with short-duration exposure to adjacent receptors. Construction activity and associated noise levels would vary at each location as the work progresses. Construction would result in short-term, intermittent noise impacts from the operation of heavy equipment, power and hand tools, and construction vehicles throughout the project area. Heavy equipment operation would occur sporadically throughout daytime hours. Noise would also be generated by trucks delivering materials to the construction sites and by construction worker vehicles.

Table B-7 outlines the construction noise levels from different sound sources at the nearest sensitive receptors to the Proposed Action. Table B-8 outlines the construction noise levels from construction equipment at the nearest residential receptors to the Proposed Action, assuming a nominal 50-foot distance for residences adjacent to the electrical transmission backbone. The nearest residential receptors to Site 2 and the electrical transmission backbone are on-base; the nearest residential receptors to Site 5 are off-base.

Construction noise level increases over the existing ambient noise environment range from 2 – 33 dBA depending on equipment source type and distance to the Proposed Action, as shown in Table B-8. Worst-case impacts would be subjectively described as between a doubling and fourfold increase in noise to on-base residences at Site 2 and along the electrical transmission backbone, and off-base residents at Site 5. Construction noise on Site 2 is not likely to be audible to residents outside JBPHH because of the distances between the construction noise sources and receptors and relatively high background noise levels where off-site (public) receptors exist.

Although short-term, temporary adverse noise impacts are anticipated during construction, mufflers would be used on construction equipment and vehicles to minimize noise impacts during construction activities. When pile driving occurs with loud impulsive noise, using a vibratory or hydraulic driver with shrouds would be considered to the extent practical to mitigate pile driving noise. The construction contractor would prepare a construction noise mitigation and management plan as a best management practice to address noise to communities adjacent to the Proposed Action and commit to these mitigation strategies.

The Hawaii Department of Health regulates excessive noise sources, including equipment related to construction activities under Chapter 342F, Hawaii Revised Statutes (HRS) (Noise Pollution) and Hawaii Administrative Rules (HAR) 11-46 (Community Noise Control). As a federal agency, the Navy considers Hawaii Department of Health construction noise provisions as local best practices and would exert best efforts to comply with applicable State construction noise regulations.

Table B-7 Construction Equipment Noise Levels at Nearest Sensitive Receptors

Sound Source	*Usage Factor (%)*	*Maximum Sound Pressure Level @ 50 feet (L_{max} in dBA)**	*Equivalent Time Average Sound Pressure Level @ 50 feet (L_{eq} in dBA)*	*Equivalent Time Average Sound Pressure Level Closest Residence To Site 2 Boundary @ 180 feet (L_{eq} in dBA)*	*Equivalent Time Average Sound Pressure Level Closest Residence To Site 5 Boundary @ 60 feet (L_{eq} in dBA)*	*Equivalent Time Average Sound Pressure Level @ 50 feet Distance from Electrical Transmission Backbone (L_{eq} in dBA)*
Backhoe	40	80	76	65	74	76
Excavator	40	85	81	70	79	81
Grader	40	85	81	70	79	81
Pile Driver	20	95	88	77	86	88
Directional Drill	40	85	81	70	79	81
Crane	16	85	77	66	75	77
Skid Steer	40	80	76	65	74	76
Telehandler	40	85	81	70	79	81
Dozer	40	85	81	70	79	81
Compactor	40	80	76	65	74	76
Paver	50	85	82	71	80	82
Generator (Mobile)	50	70	67	56	65	67
Loader	40	80	76	65	74	76
Pump	50	77	74	63	72	74
Truck	40	84	80	69	78	80

*Source: Federal Highway Administration, Highway Construction Noise Handbook, August 2006.

Table B-8 Construction Noise Increase over Existing Ambient Noise Levels

Sound Source	*Equivalent Time Average Sound Pressure Level Closest Residence To Site 2 Boundary @ 180 feet (L_{eq} in dBA)*	*Increase over Existing Daytime Ambient Noise Level*[1]	*Equivalent Time Average Sound Pressure Level Closest Residence To Site 5 Boundary @ 60 feet (L_{eq} in dBA)*	*Increase over Existing Daytime Ambient Noise Level*[1]	*Equivalent Time Average Sound Pressure Level @ 50 feet Distance from Electrical Transmission Backbone (L_{eq} in dBA)*	*Increase over Existing Daytime Ambient Noise Level*[2]
Backhoe	65	11	74	19	76	21
Excavator	70	16	79	24	81	26
Grader	70	16	79	24	81	26
Pile Driver	77	23	86	31	88	33
Directional Drill	70	16	79	24	81	26
Crane	66	12	75	20	77	22
Skid Steer	65	11	74	19	76	21
Telehandler	70	16	79	24	81	26
Dozer	70	16	79	24	81	26
Compactor	65	11	74	19	76	21
Paver	71	17	80	25	82	27
Generator (Mobile)	56	2	65	10	67	12
Loader	65	11	74	19	76	21
Pump	63	9	72	17	74	19
Truck	69	15	78	23	80	25

[1]Existing daytime monitored noise levels from Table B-3 compared to construction noise level from each piece of equipment.
[2]Ambient conditions will vary at receptors along the electrical transmission backbone. An average of the existing monitored noise levels from Table B-3 have been used here as a typical baseline.

7 Expanded Measurement Data

Table B-9 Hourly L_{eq} Data at M1 (Site 2) FRG Facility

Date	*Time*	*Hourly Average Ambient Measured L_{eq} (dBA)*
11/3/2022	16:00	47.6
11/3/2022	17:00	48.2
11/3/2022	18:00	47.6
11/3/2022	19:00	45.3
11/3/2022	20:00	45.9
11/3/2022	21:00	46.1
11/3/2022	22:00	44.3
11/3/2022	23:00	42.5
11/4/2022	0:00	41.4
11/4/2022	1:00	42.4
11/4/2022	2:00	42.8
11/4/2022	3:00	42.6
11/4/2022	4:00	41.9
11/4/2022	5:00	44.1
11/4/2022	6:00	47.9
11/4/2022	7:00	50.3
11/4/2022	8:00	49.5
11/4/2022	9:00	53.2
11/4/2022	10:00	48.9
11/4/2022	11:00	48.6
11/4/2022	12:00	68.2*
11/4/2022	13:00	57.7
11/4/2022	14:00	52.8
11/4/2022	15:00	48.9
11/4/2022	16:00	48.7
11/4/2022	17:00	48.3
11/4/2022	18:00	45.5
11/4/2022	19:00	45.4
11/4/2022	20:00	49.7
11/4/2022	21:00	44.9
11/4/2022	22:00	43.9
11/4/2022	23:00	43.9
11/5/2022	0:00	43.7
11/5/2022	1:00	44.8
11/5/2022	2:00	44.8
11/5/2022	3:00	46.2
11/5/2022	4:00	45.2
11/5/2022	5:00	45.0
11/5/2022	6:00	48.1
11/5/2022	7:00	48.4
11/5/2022	8:00	54.3
11/5/2022	9:00	50.1
11/5/2022	10:00	49.7
11/5/2022	11:00	47.3
11/5/2022	12:00	50.0

Table B-9 Hourly L_{eq} Data at M1 (Site 2) FRG Facility

Date	*Time*	*Hourly Average Ambient Measured L_{eq} (dBA)*
11/5/2022	13:00	47.4
11/5/2022	14:00	49.4
11/5/2022	15:00	55.0
11/5/2022	16:00	50.1
11/5/2022	17:00	48.1
11/5/2022	18:00	46.1
11/5/2022	19:00	46.5
11/5/2022	20:00	46.7
11/5/2022	21:00	48.7
11/5/2022	22:00	44.5
11/5/2022	23:00	45.0
11/6/2022	0:00	43.7
11/6/2022	1:00	44.2
11/6/2022	2:00	44.0
11/6/2022	3:00	43.0
11/6/2022	4:00	43.9
11/6/2022	5:00	43.8
11/6/2022	6:00	47.0
11/6/2022	7:00	47.8
11/6/2022	8:00	46.7
11/6/2022	9:00	48.1
11/6/2022	10:00	48.2
11/6/2022	11:00	48.6
11/6/2022	12:00	47.0
11/6/2022	13:00	47.4
11/6/2022	14:00	47.0
11/6/2022	15:00	48.9
11/6/2022	16:00	47.8
11/6/2022	17:00	47.6
11/6/2022	18:00	46.3
11/6/2022	19:00	45.2
11/6/2022	20:00	46.1
11/6/2022	21:00	46.4
11/6/2022	22:00	45.7
11/6/2022	23:00	45.9
11/7/2022	0:00	44.6
11/7/2022	1:00	44.3
11/7/2022	2:00	45.1
11/7/2022	3:00	44.8
11/7/2022	4:00	46.7
11/7/2022	5:00	47.8
11/7/2022	6:00	49.6
11/7/2022	7:00	50.3
11/7/2022	8:00	52.5
11/7/2022	9:00	56.0
11/7/2022	10:00	50.2
11/7/2022	11:00	50.4
11/7/2022	12:00	49.7

Table B-9 Hourly L_{eq} Data at M1 (Site 2) FRG Facility

Date	*Time*	*Hourly Average Ambient Measured L_{eq} (dBA)*
11/7/2022	13:00	50.2
11/7/2022	14:00	61.0
11/7/2022	15:00	51.4
11/7/2022	16:00	49.5
11/7/2022	17:00	47.8
11/7/2022	18:00	47.8
11/7/2022	19:00	44.8
11/7/2022	20:00	45.6
11/7/2022	21:00	49.5
11/7/2022	22:00	46.7
11/7/2022	23:00	45.4
11/8/2022	0:00	45.2
11/8/2022	1:00	46.1
11/8/2022	2:00	45.2
11/8/2022	3:00	45.9
11/8/2022	4:00	45.7
11/8/2022	5:00	48.6
11/8/2022	6:00	50.3
11/8/2022	7:00	50.9
11/8/2022	8:00	51.0
11/8/2022	9:00	56.4
11/8/2022	10:00	54.6
11/8/2022	11:00	53.4
11/8/2022	12:00	53.6
11/8/2022	13:00	58.9
11/8/2022	14:00	55.5
11/8/2022	15:00	51.6

* Measurement excluded from L_{eq} average used to establish impact assessment criteria, due to likely extraneous noise not indicative of ambient noise environment.

Table B-10 Hourly L_{eq} Data at M2 (Site 5) BESS Facility

Date	*Time*	*Hourly Average Ambient Measured L_{eq} (dBA)*
10/27/2022	9:00	57.9
10/27/2022	10:00	56.0
10/27/2022	11:00	55.4
10/27/2022	12:00	57.0
10/27/2022	13:00	54.3
10/27/2022	14:00	57.3
10/27/2022	15:00	56.3
10/27/2022	16:00	58.9
10/27/2022	17:00	56.7
10/27/2022	18:00	55.4
10/27/2022	19:00	54.0
10/27/2022	20:00	52.6
10/27/2022	21:00	53.0
10/27/2022	22:00	51.7
10/27/2022	23:00	47.5
10/28/2022	0:00	44.3
10/28/2022	1:00	48.6
10/28/2022	2:00	45.1
10/28/2022	3:00	45.0
10/28/2022	4:00	52.0
10/28/2022	5:00	54.3
10/28/2022	6:00	56.5
10/28/2022	7:00	57.2
10/28/2022	8:00	54.8
10/28/2022	9:00	54.1
10/28/2022	10:00	53.7
10/28/2022	11:00	54.2
10/28/2022	12:00	56.6
10/28/2022	13:00	57.5
10/28/2022	14:00	56.5
10/28/2022	15:00	56.7
10/28/2022	16:00	56.2
10/28/2022	17:00	56.6
10/28/2022	18:00	56.0
10/28/2022	19:00	54.0
10/28/2022	20:00	54.8
10/28/2022	21:00	52.7
10/28/2022	22:00	53.6
10/28/2022	23:00	52.7
10/29/2022	0:00	49.5
10/29/2022	1:00	47.9
10/29/2022	2:00	42.7
10/29/2022	3:00	48.6
10/29/2022	4:00	50.2
10/29/2022	5:00	54.0
10/29/2022	6:00	54.8
10/29/2022	7:00	52.6
10/29/2022	8:00	54.0

Table B-10 Hourly L_{eq} Data at M2 (Site 5) BESS Facility

Date	*Time*	*Hourly Average Ambient Measured L_{eq} (dBA)*
10/29/2022	9:00	55.6
10/29/2022	10:00	56.4
10/29/2022	11:00	56.5
10/29/2022	12:00	55.9
10/29/2022	13:00	56.2
10/29/2022	14:00	56.3
10/29/2022	15:00	55.5
10/29/2022	16:00	55.8
10/29/2022	17:00	58.3
10/29/2022	18:00	56.0
10/29/2022	19:00	56.1
10/29/2022	20:00	54.8
10/29/2022	21:00	52.8
10/29/2022	22:00	53.5
10/29/2022	23:00	50.9
10/30/2022	0:00	50.9
10/30/2022	1:00	46.8
10/30/2022	2:00	48.7
10/30/2022	3:00	46.8
10/30/2022	4:00	50.8
10/30/2022	5:00	54.2
10/30/2022	6:00	54.4
10/30/2022	7:00	51.6
10/30/2022	8:00	53.5
10/30/2022	9:00	55.6
10/30/2022	10:00	54.7
10/30/2022	11:00	55.4
10/30/2022	12:00	54.9
10/30/2022	13:00	54.0
10/30/2022	14:00	56.0
10/30/2022	15:00	54.8
10/30/2022	16:00	55.0
10/30/2022	17:00	55.2
10/30/2022	18:00	54.7
10/30/2022	19:00	55.3
10/30/2022	20:00	52.4
10/30/2022	21:00	52.8
10/30/2022	22:00	52.6
10/30/2022	23:00	51.9
10/31/2022	0:00	47.5
10/31/2022	1:00	44.4
10/31/2022	2:00	49.2
10/31/2022	3:00	45.9
10/31/2022	4:00	51.3
10/31/2022	5:00	54.7
10/31/2022	6:00	57.3
10/31/2022	7:00	56.0
10/31/2022	8:00	54.5

Table B-10 Hourly L_{eq} Data at M2 (Site 5) BESS Facility

Date	*Time*	*Hourly Average Ambient Measured L_{eq} (dBA)*
10/31/2022	9:00	56.6
10/31/2022	10:00	55.1
10/31/2022	11:00	56.1
10/31/2022	12:00	58.0
10/31/2022	13:00	54.9
10/31/2022	14:00	56.1
10/31/2022	15:00	57.6
10/31/2022	16:00	56.8
10/31/2022	17:00	60.6
10/31/2022	18:00	57.3
10/31/2022	19:00	53.1
10/31/2022	20:00	55.5
10/31/2022	21:00	55.8
10/31/2022	22:00	53.6
10/31/2022	23:00	56.0
11/1/2022	0:00	45.6
11/1/2022	1:00	43.6
11/1/2022	2:00	42.0
11/1/2022	3:00	48.2
11/1/2022	4:00	52.7
11/1/2022	5:00	56.4
11/1/2022	6:00	57.4
11/1/2022	7:00	56.2
11/1/2022	8:00	54.8
11/1/2022	9:00	56.0
11/1/2022	10:00	53.4
11/1/2022	11:00	53.9

Appendix C
Endangered Species Act Documentation

Lease of Land for Energy Generation and Storage, Resiliency, Reliability, and Security

at

Joint Base Pearl Harbor-Hickam, Hawaii

TABLE OF CONTENTS

List of Tables

Attachment

Endangered Species Act Section 7 Consultation Letters

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1 Potential Stressors to Terrestrial Wildlife

Potential stressors analyzed for wildlife and special status species are identified below in Table C-1 and in Table C-2. Each existing potential stressor is addressed in the appropriate subsection within the corresponding project area(s) unless dismissed within Table C-1 (those cells containing "No").

Table C-1 Potential Stressors to Wildlife and/or Special Status Species from the Proposed Action Alternative

Potential Stressor	***Potential stressor at Site 2 (Yes/No)***		***Potential stressor at Site 5 (Yes/No)***		***Potential stressor at IKC Electrical Transmission Backbone Development***	
	Construction	***Operations***	***Construction***	***Operations***	***Construction***	***Operations***
Noise disturbance	Yes	Yes	Yes	Yes	Yes	No
Physical disturbance and strikes	Yes	No	Yes	No	Yes	No
Entanglement	No	Yes	No	Yes	No	No
Secondary stressors	Yes	Yes	Yes	No	Yes	No
Glare	No	Yes	No	Yes	No	No
Light disturbance	No	Yes	No	Yes	No	No
Emissions	Yes	Yes	Yes	Yes	Yes	No

Definitions: Noise disturbance (pile driving, vehicular use, construction equipment); Physical disturbance and strikes (vehicles, construction equipment); Entanglement (wires and cables; fencing); Secondary stressors (impacts to habitat, impacts to prey availability); Glare (disturbance due to lights reflected off surfaces); Light disturbance (fallout due to disorientation from artificial lighting); Emissions (inhalation of particulates; reduced air quality).

Table C-2 Federally- and SOH-Listed Species with Potential to Occur at JBPHH Main Base and Surrounding Areas

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Bird Species				
Anas wyvilliana	Hawaiian Duck	Koloa maoli	FE, SE, MBTA	Potential
Asio flammeus sandwichensis	Hawaiian Short-eared Owl	Pueo	SE	Confirmed
Branta sandvicensis	Hawaiian Goose	Nene	FE, SE, MBTA	Potential
Fulica alai	Hawaiian Coot	Alae keokeo	FE, SE, MBTA	Confirmed
Gallinula chloropus sandvicensis	Hawaiian Gallinule	Alae ula	FE, SE	Confirmed
Gygis alba	White Tern	Manu o Ku	SE, MBTA	Confirmed
Himantopus mexicanus knudseni	Hawaiian Stilt	Aeo	FE, SE	Confirmed
Oceanodroma castro	Band-rumped Storm Petrel	Akeake	FE, SE	Potential
Pterodroma sandwichensis	Hawaiian Petrel	Uau	FE, SE, MBTA	Potential
Puffinus newelli	Newell's Shearwater	Ao	FT, ST, MBTA	Potential
Terrestrial Mammal Species				
Lasiurus cinereus semotus	Hawaiian Hoary Bat	Opeapea	FE, SE	Confirmed
Marine Mammal Species				
Balaenoptera borealis	Sei Whale	—	FE, SGCN	Within 5 miles nearshore waters
Balaenoptera musculus	Blue Whale	Kohola Polu	FE, SGCN	Within 5 miles nearshore waters
Balaenoptera physalus	Fin Whale	—	FE, SE, SGCN	Within 5 miles nearshore waters
Megaptera novaeangliae	Humpback Whale	—	SE, SGCN, MMPA	Confirmed
Neomonachus schauinslandi	Hawaiian Monk Seal	Ilioholoikauaua	FE, SE, SGCN, MMPA	Confirmed
Physeter macrocephalus	Sperm Whale	Palaoa, Kohola Kepama	FE, SE SGCN, MMPA	Within 5 miles nearshore waters
Pseudorca crassidens	Main Hawaiian Islands Insular False Killer Whale DPS	—	FE, SE, SGCN	Confirmed
Stenella longirostris	Spinner Dolphin	Naia	SGCN, MMPA	Confirmed in nearshore waters
Reptilian Species				
Caretta	Loggerhead Turtle (North Pacific DPS)	—	FE, ST	Within 5 miles nearshore waters
Chelonia mydas	Green Sea Turtle (Central North Pacific DPS)	Honu	FT, ST	Confirmed
Dermochelys coriacea	Leatherback Turtle	—	FE	Within 5 miles nearshore waters

Table C-2 Federally- and SOH-Listed Species with Potential to Occur at JBPHH Main Base and Surrounding Areas

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Eretmochelys imbricata	Hawksbill Turtle	Honuea	FE, SE	Confirmed
Lepidochelys olivacea	Olive Ridley Turtle	—	FT, ST	Within 5 miles nearshore waters
Fish Species				
Atherinomorus insularum	Hawaiian Silverside	Iao	SGCN	Confirmed
Caranx ignobilis	Giant Trevally	Ulua Aukea	SGCN	Confirmed
Carcharhinus longimanus	Oceanic Whitetip Shark	—	FT	Within 5 miles nearshore waters
Chlorurus perspicillatus	Spectacled Parrotfish	Uhu Uliuli, Uhu Ahuula	SGCN	Confirmed
Coris venusta	Elegant Coris	Hinalea	SGCN	Confirmed
Elops hawaiensis	Hawaiian Tenpounder	Awa aua	SGCN	Confirmed
Encrasicholina purpurea	Hawaiian Anchovy	Nehu	SGCN	Confirmed
Hippocampus kuda	Smooth Seahorse	—	SGCN	Confirmed
Kuhlia xenura	Hawaiian Flagtail	Aholehole	SGCN	Confirmed
Manta birostris	Giant Manta Ray	Hahalua	FT	Within 5 miles nearshore waters
Oxyurichthys lonchotus	Goby	Oopu	SGCN	Confirmed
Parupeneus porphyreus	Whitesaddle Goatfish	Kumu	SGCN	Confirmed
Coral Species				
Cyphastrea ocellina	Ocellated Coral	Akoakoa	SGCN	Confirmed
Leptastrea bewickensis	Crust Coral	Akoakoa	SGCN	Within 5 miles nearshore waters
Leptastrea purpurea	Crust Coral	Koa, akoakoa	SGCN	Confirmed
Leptoseris incrustans	Swelling Coral	Koa, akoakoa	SGCN	Confirmed
Montipora capitata	Rice Coral	Koa, akoakoa	SGCN	Confirmed
Montipora dilatata	Purple Rice Coral	Akoakoa	SGCN, RT	Confirmed
Montipora flabellata	Blue Rice Coral	Koa, akoakoa	SGCN, RT	Confirmed
Montipora patula	Spreading Coral	—	SGCN	Confirmed
Montipora tuberculosa	Pore Coral	Akoakoa	SGCN	Within 5 miles nearshore waters
Montipora turgescens	Pore Coral	Akoakoa	SGCN, RT	Confirmed

Table C-2 Federally- and SOH-Listed Species with Potential to Occur at JBPHH Main Base and Surrounding Areas

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Montipora verrilli	Pore Coral	Akoakoa	SGCN	Within 5 miles nearshore waters
Pavona duerdeni	Flat Lobe Coral	Akoakoa	SGCN	Confirmed
Pavona varians	Corrugated Coral	Akoakoa	SGCN	Confirmed
Pocillopora damicornis	Lace Coral	Koa, akoakoa	SGCN	Confirmed
Pocillopora ligulata	Hawaiian Cauliflower Coral	Akoakoa	SGCN	Within 5 miles nearshore waters
Pocillopora meandrina	Cauliflower Coral	—	SGCN, RT	Confirmed
Pocillopora verrucosa	Warty Bush Coral	—	SGCN	Confirmed
Porites compressa	Finger Coral	Po haku puna, akoakoa	SGCN	Confirmed
Porites evermanni	Evermann's Coral	Po haku puna, akoakoa	SGCN	Confirmed
Porites lobata	Lobe Coral	Po haku puna, akoakoa	SGCN	Confirmed
Psammocora nierstraszi	—	—	SGCN	Within 5 miles nearshore waters
Non-Coral Invertebrates				
Nerita picea	Black Nerite	Pipipi Kai	SGCN	Confirmed
Octopus cyanea	Octopus	Hee Mauli	SGCN	Within 5 miles nearshore waters
Pinctada margaritifera	Black-lipped Pearl Oyster	—	SGCN	Confirmed

Legend: FE = federally-listed endangered; FT = federally-listed threatened; MBTA = Migratory Bird Treaty Act; SE = SOH-listed endangered; SOH = State of Hawaii; ST = SOH-listed threatened.

Appendix D
National Historic Preservation Act Section 106 Documentation
(will be provided in the Final EA)

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Appendix E
Native Hawaiian Organization-Government Documentation
(will be provided in the Final EA)

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Appendix F
Coastal Zone Management Area Consistency Determination
(will be provided in the Final EA)

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Appendix G
Public and Agency Participation
(will be provided in the Final EA)

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Appendix H
Regulatory Setting

Lease of Land for Energy Generation and Storage, Resiliency, Reliability, and Security

at

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1 Air Quality and Greenhouse Gases

1.1 National Standards

The Clean Air Act (CAA) is the primary federal statute governing the control of air quality. The 1970 CAA Amendments designate six pollutants as “criteria pollutants” for which the U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) to protect public health and welfare (Table H-1). The criteria pollutants are carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone, suspended particulate matter less than or equal to 10 micrometers in aerodynamic diameter (PM_{10}), fine particulate matter less than or equal to 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$), and lead. CO, SO_2, NO_2, lead, PM_{10}, and $PM_{2.5}$ are emitted directly into the atmosphere from emissions sources. Ozone, NO_2 transformation from NO, and some additional particulate matter are formed through atmospheric chemical reactions from other pollutant emissions (called precursors) that are influenced by weather, ultraviolet light, and other atmospheric processes.

NAAQS are classified as primary or secondary. Primary standards protect against adverse health effects; secondary standards are designed to protect public welfare, such as prevention of damage to farm crops, vegetation, and buildings. Some pollutants have long-term and short-term standards. Short-term standards are designed to protect against acute, or short-term, health effects, while long-term standards were established to protect against chronic health effects. Ambient air is defined as that portion of the atmosphere, external to buildings, to which the general public is exposed. All ambient air quality standards (AAQS) have their own criteria, known as the form of the standards, related to if and how many times they may be exceeded before the AAQS are considered violated.

Areas in compliance with the NAAQS are designated as attainment areas. Areas that do not meet the NAAQS are designated as nonattainment areas for that pollutant. Areas that have transitioned from nonattainment to attainment are designated as maintenance areas and are required to adhere to maintenance plans to ensure continued attainment. Federal actions are subject to the CAA General Conformity Rule if their emissions occur in a NAAQS nonattainment or maintenance area.

The EPA General Conformity Rule applies to federal actions occurring in nonattainment or maintenance areas when the total direct and indirect emissions of nonattainment pollutants (or their precursors) exceed specified thresholds. Since the EPA has classified the SOH as being in attainment of the national standards, the General Conformity Rule does not apply to the Proposed Action.

EPA has identified 188 HAPs, also referred to as toxic air pollutants or air toxics, that are known or suspected to cause cancer or other serious health and environmental effects. AAQS have not been established for HAPs because EPA’s strategy is to use reductions of HAP emissions from stationary, industrial, mobile, and indoor sources as a means to provide nationwide health protections. The potential risk of health effects from HAP exposure can be estimated using inhalation exposure values developed by EPA to perform screening-level assessments of incremental lifetime cancer risk and the level of hazard associated with adverse health effects other than cancer (e.g., hazard quotient) (EPA, 2018). National emission standards exist for HAPs emitted from stationary sources, which are regulated under Section 112(b) of the 1990 CAA Amendments (40 CFR Part 61 and Part 63). An example would be 40 CFR Part 63, Subpart ZZZZ, which regulates stationary reciprocating internal combustion engines. The primary control methodologies for these pollutants for mobile sources involves reducing their content in fuel and altering the engine operating characteristics to reduce the volume of pollutant generated during combustion.

1.2 State Standards

States may also establish their own State Ambient Air Quality Standards (SAAQS) that are more stringent than those set by federal law. The Hawaii Administrative Rules (HAR) 11-59 provides details regarding ambient air pollution standards in consideration of public health, safety, and welfare in the State of Hawaii (SOH) (Table H-1).

Table H-1 State and National Ambient Air Quality Standards

Air Pollutant	*Averaging Time*[(1)]	*State of Hawaii Standard*	*National Primary Standard*[(2)]	*National Secondary Standard*[(3)]
Carbon Monoxide	1-hour[(5)] 8-hour[(5)]	10 mg/m³ (9 ppm) 5 mg/m³ (4.4 ppm)	35 ppm 9 ppm	None
Nitrogen Dioxide	1-hour[(6)] Annual[(7)]	— 70 µg/m³ (0.04 ppm, 40 ppb)	100 ppb 53 ppb	— 53 ppb
PM_{10}	24-hour[(8)] Annual[(9)]	150 µg/m³ 50 µg/m³	150 µg/m³ —	150 µg/m³ —
$PM_{2.5}$	24-hour[(10)] Annual[(11)]	—	35 µg/m³ 12 µg/m³	35 µg/m³ 15 µg/m³
Ozone	8-hour[(12)]	157 µg/m³ (0.08 ppm)	0.070 ppm (2015)	0.070 ppm (2015)
Sulfur Dioxide	1-hour[(13)] 3-hour[(5)] 24-hour[(5)] Annual[(7)]	— 1,300 µg/m³ (0.5 ppm, 500 ppb) 365 µg/m³ (0.14 ppm, 140 ppb) 80 µg/m³ (0.03 ppm, 30 ppb)	75 ppb — — —	— 0.5 ppm (500 ppb) — —
Lead	Rolling 3-month[(14)]	1.5 µg/m³ [(4)]	0.15 µg/m³	0.15 µg/m³
Hydrogen sulfide	1-hour[(5)]	35 µg/m³ (25 ppb)	None	None

Notes:
(1) Short-term standards are designed to protect against acute or short-term effects, while long-term standards were established to protect against chronic effects.
(2) Primary standards set limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly.
(3) Secondary standards set limits to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.
(4) The state standard is based on calendar quarter.
(5) May not be exceeded more than once per year.
(6) The 3-year average of the 98th percentile daily maximum 1-hour averages must not exceed the standard.
(7) The average of all 1-hour values in the year may not exceed the level of the standard.
(8) Must not be exceeded more than 1 day per year, after compensating for days when monitoring did not occur (estimated number of exceedances).
(9) The average of all 24-hour values in the year may not exceed the level of the standard.
(10) The 3-year average of the 98th percentile 24-hour concentrations must not exceed the level of the standard.
(11) The 3-year average of 24-hour values must not exceed the level of the standard.
(12) The 3-year average of the fourth highest daily maximum value must not exceed the level of the standard.
(13) The 3-year average of the 99th percentile daily maximum 1-hour averages must not exceed the standard.
(14) Average of all 24-hour values in any rolling 3-month period may not exceed the level of the standard.
Key: µg/m³ =microgram per cubic meter; mg/m³ = milligram per cubic meter; PM_{10} = particles with aerodynamic diameters less than or equal to a nominal 10 micrometers; $PM_{2.5}$ = particles with aerodynamic diameters less than or equal to a nominal 2.5 micrometers; ppb = part per billion; ppm = part per million.
Sources: EPA (2023a); HDOH (2001).

1.3 Hawaii Administrative Rules for Air Pollution Control

The State of Hawaii Department of Health (HDOH) regulates air pollution in accordance with HAR Chapter 11-60.1. These regulations implement the actions required of Hawaii by the CAA, including a permitting program, and laws enacted by the Hawaii Legislature. The HAR includes New Source Review permit requirements (CAA and Hawaii) for stationary sources that are not exempt from these requirements. Stationary sources of air pollution that exceed the major source emission thresholds, as well as other non-major sources specified in a particular regulation, are required to obtain a Title V permit that is referred to as a covered source permit in the HAR. The covered source permit includes all applicable requirements, including those necessary to comply with stationary source regulations and the air toxics program. HAR Chapter 11-60.1-179 limits ambient air concentrations of HAPs for some stationary sources subject to air permitting. In addition, HAR Chapter 11-60.1-61(2) requires application of best available control technology (BACT) to control regulated air pollutants for new covered sources.

1.4 Greenhouse Gases Regulations

GHGs are gas emissions that trap heat in the atmosphere. These emissions occur from natural processes and human activities. Scientific evidence indicates a trend of increasing global temperature over the past century due to an increase in GHG emissions from human activities. The climate change associated with this global warming is predicted to produce negative economic and social consequences across the globe.

A variety of regulations and guidance are in place to implement U.S. policy with respect to GHG emissions. Under 40 CFR 98, Mandatory Reporting of Greenhouse Gases Rule, the EPA requires mandatory reporting of GHG emissions for facilities that emit more than 25,000 metric tons of carbon dioxide (CO_2) equivalent (CO_2e) emissions per year. Since January 2021, the Biden administration has issued Executive Orders and taken other actions to reinstate previous policies and guidance associated with GHG emissions and climate change. Executive Order 13990, issued on January 25, 2021, stated the policy of the federal government is to take a variety of actions, including reducing GHG emissions, to protect public health and the environment. The order also directed the CEQ to review, revise, and update the previous "Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews," dated August 5, 2016. CEQ issued an interim *National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change* on January 9, 2023, (CEQ, 2023) to assist agencies in analyzing GHG and climate change effects. Executive Order 14008, issued on January 27, 2021, is intended to promote safe global temperature, increase climate resilience, and financially support a pathway towards low greenhouse gas emissions and climate-resilient development by re-instating the Presidential Memorandum of September 21, 2016, establishing the Climate Policy Office within the Executive Office of the President, and establishing a National Climate Task Force. Executive Order 14057, issued on December 8, 2021, states that the federal government should lead by example to achieve a carbon pollution-free electricity sector by 2035 and net-zero emissions economy-wide by 2050.

GHG emissions have been calculated to determine overall magnitude of emissions due to the construction and operation of the Proposed Action.

In an effort to reduce energy consumption, reduce GHGs, reduce dependence on petroleum, and increase the use of renewable energy resources, the Navy has implemented a number of renewable energy projects. In 2022, the Navy unveiled Climate Action 2030 focused on reducing greenhouse gases with a target to achieve a 65 percent reduction by 2030 and net-zero greenhouse gases by 2050.

Examples of Navy-wide GHG reduction projects include energy efficient construction, thermal and PV solar systems, geothermal power plants, and the generation of electricity using wind energy. The Navy continues to promote and install new renewable energy projects and work to electrify its vehicle fleet.

2 Cultural Resources

Cultural resources are governed by federal laws, regulations, and Executive Orders, including the Archeological and Historic Preservation Act, Archaeological Resources Protection Act of 1979, Executive Order 13007, Native American Graves Protection and Repatriation Act of 1990, and National Historic Preservation Act (NHPA). For the purposes of this analysis, the term “cultural resource” refers to all resources of cultural importance protected by these Federal laws and Executive Orders.

The Advisory Council on Historic Preservation regulates treatment of cultural resources, including archaeological and architectural resources, through the regulations governing protection of historic properties (36 CFR part 800). The category of “historic properties” is a subset of cultural resources that is defined in the NHPA (54 USC § 306108) as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places, including artifacts, records, and material remains related to such a property or resource.

Section 106 of the NHPA, and its implementing regulations, 36 CFR 800, require federal agencies to consider the effects of federal undertakings on historic properties and to afford the Advisory Council an opportunity to comment, consistent with the regulations. Section 110 of the NHPA and 36 CFR 800.10 require federal agencies to minimize harm to the maximum extent possible to National Historic Landmarks (NHLs). The Navy developed the *Programmatic Agreement among the Commander Navy Region Hawaii, the Advisory Council on Historic Preservation, and the State Historic Preservation Office Regarding Navy Undertakings in Hawaii*, a Section 106 program alternative consistent with 36 CFR 800.14 (COMNAVREG, 2012). The assessment and resolution of historic properties will be addressed through implementation consistent with Stipulation IX of the PA. Consistent with Section 110, the Navy has undertaken mission planning for facilities and operations with the goal of minimizing harm to the Pearl Harbor National Historic Landmark (PHNHL).

- In 1964, the U.S. Naval Base at Pearl Harbor was designated as an NHL. An NHL is a property of national historic significance as designated by the U.S. Secretary of the Interior under the authority of the Historic Sites Act of 1935. The NHL district boundary is delineated as “those water and land areas historically, intimately, and directly associated with its function” as an active naval base supporting the Pacific Fleet (DON, 2008).
- The 2008 Integrated Cultural Resources Management Plan (ICRMP) provides an overarching framework for historic and cultural preservation concerns are properly considered and integrated into the Navy’s decision-making process. The ICRMP identifies historic properties and provide guidance on compliance processes and management procedures for cultural resource management, based on active agreement documents and applicable laws and regulations.
- A portion of the Hickam side of JBPHH is listed as Hickam NHL, encompassing the flight line, four hangars, and HQ PACAF. These areas and their management documents are detailed in the Hickam AFB ICRMP.
- The ICRMPs list in detail all other applicable federal regulatory guidance and Navy and DoD manuals, policies, and directives.

3 Biological Resources

3.1 Marine Biological Resources

All marine mammals are protected under the provisions of the Marine Mammal Protection Act (MMPA). The MMPA prohibits any person or vessel from "taking" marine mammals in the United States or the high seas without authorization from National Marine Fisheries Service (NMFS). The MMPA defines "take" to mean "to harass, hunt, capture, or kill or attempt to harass, hunt, capture, or kill any marine mammal." When an action is likely to result in the incidental taking of a marine mammal, an application to NMFS requesting authorization for the take is required. The U.S. Fish and Wildlife Service (USFWS) and NMFS share federal jurisdiction for sea turtles, with the USFWS having lead responsibility for the nesting beaches and NMFS for the marine environment.

The Magnuson-Stevens Fishery Conservation and Management Act, or Magnuson-Stevens Act, establishes guidelines to assist the Regional Fishery Management Councils (Councils) and the Secretary of Commerce (Secretary) in the description and identification of Essential Fish Habitat (EFH) in fishery management plans. The guidelines also assist the Councils and Secretary in the identification of adverse effects to EFH and the identification of actions required to conserve and enhance EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." Sites 2 and 5 drain to the East Loch, which flows into Pearl Harbor.

3.2 Terrestrial Biological Resources

Biological resources are divided into the following categories and defined in detail below: *Vegetation, Wildlife, and Special-Status Species.*

- *Vegetation* includes plant associations and dominant constituent species that are known or potentially occurring in the project area and region of influence. Potential "stressors" (i.e., potential project-related effects) to existing vegetation on JBPHH may be caused by direct and indirect sources, such as construction-related removal of vegetation, disturbance to vegetation, and indirect effects such as changes to storm water volumes and pollutant loads.
- *Wildlife* includes the characteristic animal species that are known or potentially occurring in the project area and region of influence. Special consideration is given to bird species protected under the Migratory Bird Treaty Act (MBTA) and Executive Order (EO) 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds.* Under the MBTA it is unlawful by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, [or] possess migratory birds or their nests or eggs at any time, unless permitted by regulation. Potential stressors to wildlife may include those described above for vegetation (direct disturbance, vegetation removal, and impacts to habitat through increased storm water volumes), lighting related to construction and operations, nesting/breeding season disturbance, potential vehicle or machinery strikes, and changes in the noise environment.

Special-Status Species are defined in this EA as species that are listed, have been proposed for listing, or are candidates for listing as threatened or endangered under the federal ESA and other species of concern as recognized by state (SOH) or federal agencies. Stressors for special-status species are similar to those described above for vegetation and wildlife but can vary by species.

The purpose of the ESA is to conserve the ecosystems upon which threatened and endangered species depend and to conserve and recover listed species. Section 7 of the ESA requires action proponents to consult with the USFWS and/or NMFS to ensure that their actions are not likely to jeopardize the continued existence of federally listed threatened and endangered species or result in the destruction or adverse modification of designated critical habitat. Critical habitat cannot be designated on any areas owned, controlled, or designated for use by the DoD where an Integrated Natural Resources Management Plan (INRMP) has been developed that, as determined by the Department of the Interior or Department of Commerce Secretary, provides a benefit to the species subject to critical habitat designation. See Appendix F for a discussion regarding the Coastal Zone Management Act.

The 2003 National Defense Authorization Act gave the Secretary of the Interior authority to prescribe regulations to exempt the Armed Forces from the incidental taking of migratory birds during authorized military readiness activities. The final rule authorizing the DoD to take migratory birds in such cases includes a requirement that the Armed Forces must confer with the USFWS to develop and implement appropriate conservation measures to minimize or mitigate adverse effects of the Proposed Action if the action will have a significant negative effect on the sustainability of a population of a migratory bird species. MBTA compliance requires site review, including monitoring for migratory bird nests. Removal, pruning, or trimming of trees during nesting season would be avoided or monitored to ensure compliance with MBTA.

4 Visual

Under NEPA, federal agencies should consider visual impacts of proposed projects on scenic resources, historic properties and scenic experiences of the public who view the landscape.

Aesthetics and views of proposed projects within the JBPHH installation are mainly guided by the JBPHH Area Development Plan (ADP) and Installation Development Plan (IDP). ADPs identify capacity for future development at various areas of JBPHH. The IDP serves as a combined plan that consolidates all ADPs. Features of these documents that influence visual resources are as follows:

- Both the JBPHH ADPs and IDP promote planning projects that would maintain historic and cultural patterns of development, viewsheds, and landscapes.
- The IDP recommends planning projects to construct connected green open space network and mirror regional building styles in color, materiality and design where appropriate.
- The JBPHH Southside ADP aims to create a safe and accessible waterfront district with compatible development, convenient parking, complete streets, and flexible open spaces that reflects the historic character of the area and enhances quality of life for Service members and civilians.

Regulations regarding viewsheds within NHL District at JBPHH are described in Section 3.3.

The City and County of Honolulu’s Primary Urban Center Development Plan (PUCDP) identifies significant mountain and ocean views and vistas that should be protected for projects within the Primary Urban Center (in which JBPHH is located). Although the PUCDP does not apply to projects on federal property, these mountain and ocean views are considered important visual resources.

5 Noise

Under the Noise Control Act of 1972, the Occupational Safety and Health Administration established workplace standards for noise. The minimum requirement states that constant noise exposure must not exceed 90 A-weighted decibels (dBA) over an 8-hour period. The highest allowable sound level to which workers can be constantly exposed is 115 dBA, and exposure to this level must not exceed 15 minutes within an 8-hour period. The standards limit instantaneous exposure, such as impact noise, to 140 dBA.

If noise levels exceed these standards, employers are required to provide hearing protection equipment that would reduce sound levels to acceptable limits.

The joint instruction, Office of the Chief of Naval Operations Instruction 11010.36C and Marine Corps Order 11010.16, *Air Installations Compatible Use Zones Program,* provides guidance for administering the Air Installations Compatible Use Zones (AICUZ) program, which recommends land uses that are compatible with aircraft noise levels. Office of the Chief of Naval Operations Instruction 3550.1A and Marine Corps Order 3550.11 provide guidance for a similar program, Range Air Installations Compatible Use Zones. This program includes range safety and noise analyses, and provides land use recommendations that are compatible with Range Compatibility Zones and noise levels associated with military range operations. Per Office of the Chief of Naval Operations Instruction 11010.36D, NOISEMAP is the best noise modeling science currently available for fixed-wing aircraft until the new advanced acoustic model is approved for use and would be used for developing noise contours.

As the Proposed Action involves operational noise from power generation facilities and its associated construction, the regulatory setting that is typically applied to Navy installations is not relevant as it is focused on aircraft noise impacts under Air Installations Compatible Use Zones or Range Air Installations Compatible Use Zones programs. Because the proposed Firm Renewable Generation Plant and battery energy storage system are stationary sources, the HDOH-established maximum permissible sound levels have been used as the impact assessment criteria for this EA. These assessment criteria have been used by the commercial developer as the design criteria to meet for these new facilities. Therefore, they have been adopted in assessing potential operational noise impacts from the Proposed Action.

In accordance with HAR Title 11, Chapter 26, Community Noise Control, a classification of zoning districts has defined maximum permissible sound levels in dBA applicable to stationary noise sources, as well as to equipment related to agriculture, construction, and industrial activities. These levels are shown in Table H-2.

Table H-2 Maximum Permissible Sound Levels (dBA)

Zoning District	*Land Zone*	*Daytime (7 a.m.–10 p.m.)*	*Nighttime (10 p.m.–7 a.m.)*
Class A	Residential, public and open space, etc.	55	45
Class B	Apartment, commercial, hotel, etc.	60	50
Class C	Agriculture, industrial, etc.	70	70

Source: Haw. Code R. § 11-46-4.

6 Transportation

The following are the regulatory settings for transportation. The Unified Facilities Criteria (UFC) 4-022-01 document provides planning and design criteria and guidance for all construction, renovation, modernization, and repair projects for entry control facilities (ECF)/access control points (ACP). For previous projects, the Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) was contacted about issues at the ECF. During the construction of the proposed alternative, it is assumed that the construction workers would be accessing the site through the JBPHH main gate, the Nimitz Gate. Both the specific UFC may be referenced and the SDDCTEA may be contacted if issues are encountered with construction traffic at the Nimitz Gate.

There would be minimal impacts to the State of Hawaii Department of Transportation (HDOT) roads during the construction and operations for the proposed alternative, but if any guidance would be needed, can refer to the HDOT standards.

Similarly for the City and County of Honolulu bus system, TheBus, would not have impacts during construction activity and there would be little to no impacts to bus operations, but can refer to the Department of Transportation Services (DTS) guidance if any impacts were to arise.

Table H-3 Regulatory Setting for Transportation

Agency	***Law, Regulation, or Guidance***	***Relevance to the Project***
Commander, Navy Region Hawaii-Joint Base Pearl Harbor Hickam	Navy Region Hawaii has typically relied on ECF standards, such as Unified Facilities Criteria (UFC) 4-022-01, applied by the Military Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA).	Recent experience indicates that Navy Region Hawaii-JBPHH is interested in impacts at Entry Control Facilities (ECF) (Gates) to JBPHH.
State of Hawaii Department of Transportation (HDOT)	HDOT traffic operational and safety standards. HDOT roadway design standards.	Regional and Sub-regional roadways providing access to JBPHH are under the jurisdiction of HDOT.
City and County of Honolulu Department of Transportation Services (DTS)	DTS standards for public transit operation (physical and operational).	DTS operates TheBus, the public transit system that provide service to JBPHH.

7 Hazardous Materials and Wastes

The following are DoD regulations for hazardous materials and waste transport, handling, and storage.

DoD Inst. 4715.06 – Environmental Compliance in the United States establishes policies, assigns responsibilities, and provides procedures for achieving and maintaining environmental compliance in the U.S.

DoD Inst. 6050.05 – DoD Hazard Communication Program manages hazardous substances to minimize health and environmental risks and operational costs. Provides known hazard information to military personnel and civilian employees using hazardous chemicals, including engineered nanomaterials.

NAVSUP Pub. 573 (Defense Logistics Agency Instruction 4145.11) – Storage and Handling of Hazardous Materials are procedures for the receipt, storage, and handling of hazardous materials and wastes by DoD components, installation, and activities.

Defense Explosives Safety Regulation 6055.09 establishes explosives safety standards for the DoD that are designed to manage explosives related risk associated with DoD operations and installations by providing protection criteria.

Appendix I
Resources with Negligible Impacts

Lease of Land for Energy Generation and Storage, Resiliency, Reliability, and Security

at

Joint Base Pearl Harbor-Hickam, Hawaii

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1 Resources with Negligible Impacts

The following disciplines are addressed with less detail because negligible effects are expected are: water resources, geological and topographic resources, soils, land use, airspace, infrastructure and utilities, public health and safety, hazardous materials and wastes, socioeconomics, recreation, and environmental justice.

1.1 Water Resources

Sites 2 and 5 are located near the eastern shoreline of Pearl Harbor. Regional water resources consist of the immediate shoreline of the East Loch, groundwater, the Halawa watershed, and general storm water runoff. The main hydrologic store on Oahu is the basal lens aquifer. The aquifer is delineated by geohydrologic barriers, which define seven major regional aquifer systems (Nichols, Shade, and Hunt Jr., 1996).

Site 2 overlies the Waimalu aquifer system, a subdivision of the greater Pearl Harbor aquifer. Site 5 overlies the Moanalua aquifer system, a subdivision of the greater Honolulu aquifer. Both Sites 2 and 5 fall within the Halawa sub-watershed and are located south of the main Halawa stream entrance into the bay. Both Waimalu and Moanalua aquifer systems are used for drinking water.

The Red Hill Underground Storage Facility is located within the Moanalua aquifer system. As noted above, Site 2 is located within a separate aquifer system that is hydrologically not connected to the Red Hill Underground Storage Facility. Although Site 5 and the Red Hill Underground Storage Facility share the same aquifer system, the Red Hill Underground Storage Facility is currently undergoing a defueling process and is on track to be completely empty by March 2024 (DoD, 2023a; HNN, 2024). Therefore, the Red Hill Underground Storage Facility will have no effect on Site 5.

Mean annual rainfall in this area ranges from an average of 6 to 7 millimeters in the regional lowlands of both Sites 2 and 5 (Giambelluca et al., 2013). The proposed use areas are on relatively flat, previously developed land with adequate space to properly manage storm water. The Proposed Action would not substantially increase impervious surfaces and a storm water management plan would be implemented.

During construction, standard operating procedures (SOPs) and best management practices (BMPs), including immediate cleanup of any fuel leaks/spills and disposal of hazardous materials, would be implemented to avoid, contain, and prevent contamination of water resources. Descriptions of water and waste management BMPs are provided in Table 2.7-1 and SOPs are provided in Table 2.7-2. Prior to any ground-disturbing activities, the United States (U.S.) Department of the Navy (Navy) would establish and enforce compliance under the conditions of the Notice of General Permit Coverage applicable to Sites 2 and 5 for any discharges of storm water associated with construction activities. Design details for Sites 2 and 5 would include the storm water conveyance and management systems needed to handle incremental increases in storm water.

SOPs for construction and operations would comply with Oil Pollution Prevention (OPP) Regulations, including Spill Prevention, Control and Countermeasure (SPCC) requirements under Section 311 of the Clean Water Act (CWA). The Navy would ensure the construction contractors and lessee follow these stipulations during construction and operations for immediate response actions to take during an Oil or Hazardous Substance (OHS) release (CNRH, 2019). CNRH would use the National Incident Management System (NIMS) Incident Command System (ICS) for all incident management, including prevention, preparedness, response, recovery, and mitigation.

Once operational, the fuel tanks would have built-in leak detection, and the Firm Renewable Generation (FRG) Plant and battery energy storage system (BESS) would have extensive metering, monitoring, and alarms on all critical systems in case of an emergency such as fire or release of hazardous materials. During operations, routine maintenance would be performed on the FRG Plant and associated facilities, the photovoltaic (PV) system, and BESS. Biofuel and renewable natural gas (RNG) delivery, storage, and handling safety procedures would be followed including proper storage with a secondary containment berm and alarm system. SOPs including proper training and oversight of handling, inspection, and disposal of oils and hazardous substances would be implemented. Refueling of equipment would be permitted only at approved fueling facilities. BMPs are listed in Table 2.7-1 and SOPs are listed Table 2.7-2 relating to spill prevention and fuels management during construction and operations.

The Proposed Action would result in less than significant impacts to surface water, groundwater, and storm water with implementation of anticipated engineering and design details, with SOPs during and after construction, and through adherence to the proposed BMPs as listed above.

1.2 Geology and Topography Resources

Sites 2 and 5 are in the East Loch region of Pearl Harbor, a narrow embayment known traditionally as Ke awa lau o Puuloa. The lochs that exist in the inlet are the remains of an ancient river system, formed through a combination of geohydrologic erosion in between periods of sea level advance and retreat (Walker, 1990). This periodic cycle of fluctuating sea levels and hydro-erosion formed Pearl Harbor into a narrow inlet bay with three lochs (West, Middle, and East) that now provide natural drainage for several streams.

The main geologic units of the East Loch are indicative of the regional history, consisting of alluvium (loose material deposited through means of running water) reef and lagoon deposits (calcareous remains of ancient reef systems), tuff (igneous rock, lithified ash fall from explosive eruptions) and artificial fill (non-organic rock fill from recent development) (Stearns and Vaksvik, 1935).

The topography of the East Loch region generally consists of low-lying coastal plains, with little elevation gain. Site 2 rests near sea level at a slightly lower elevation point than Site 5. Sites 2 and 5 are not located on or near seismically sensitive areas. Both sites have been graded and developed. Site 5 slopes slightly toward Pearl Harbor.

Planned construction involving Sites 2 and 5 would not result in significant impacts to the topography or geology of the surrounding region. At Site 2, proposed construction would occur mostly in previously disturbed areas, including the FRG Plant, BESS, and electrical transmission backbone. Minimal grading would be expected due to the site being previously disturbed, graded, and leveled. Site 5 is also previously disturbed, consisting of storage facilities, parking lots, open weedy areas, and a baseball field. Minimal grading is expected to be required to accommodate the proposed PV systems. The 46 kV electrical transmission backbone would be installed in previously disturbed areas using a combination of open trench, trenchless horizontal direction drilling, and micro-tunnel drilling to minimize impact on site infrastructure and reduce the need for site restoration and disruption during implementation. No ground disturbance would be required for the other proposed IKC projects. Therefore, impacts related to topography and geology are expected to be negligible.

1.3 Soils

The soils found in the Joint Base Pearl Harbor-Hickam (JBPHH) region of the East Loch are expressive of their geohydrologic history and relative proximity to Salt Lake Crater. The principal soil types at the East Loch are the Makalapa soil series and mixed fill land. Makalapa soil series consists of moderately deep, well-draining soils that formed from weathered materials of preexisting volcanic tuff. Fill land is prevalent in the area due to the extensive development history of JBPHH. Site 2 predominantly overlays Makalapa clay with 2 to 6 percent slopes. The area also contains a portion of fill land in the Northeast corner of the site location. Site 5 overlays exclusively Makalapa clay, 2 to 6 percent slopes.

Construction activities would be managed in accordance with the JBPHH Soils Policy (DON, 2022). Implementation of BMPs would reduce the potential for soil contamination and exposure of workers to previously unidentified contaminated sites (see BMP HAZ MGMT-2 in Table 2.7-1). National Pollutant Discharge Elimination System BMPs for soil erosion and sedimentation control related to the National Pollutant Discharge Elimination System Construction Storm Water General Permit would be followed (see BMP WATER MGMT-1 in Table 2.7-1).

Per the JBPHH Soils Policy, site soils would be tested for pesticides and other anticipated contaminants. Management and disposal of contaminated soils would adhere to all applicable regulations. Erosion controls plans would be prepared and followed. Water would be used for dust control.

Soils and Sites 2 and 5 were disturbed by previous site grading and developed. Both sites would be cleared and graded. The electrical transmission backbone would be installed using a combination of open trench and micro-tunneling methods. No ground disturbance would be required for the other proposed IKC projects.

Impacts to soils would be inconsequential with implementation of anticipated engineering and design details, SOPs during and after construction (Table 2.7-2) and adherence to the BMPs proposed in Table 2.7-1.

1.4 Land Use

The land use of the Proposed Action study area sites is currently industrial. The sites are entirely on Navy-owned lands characterized as Category 2, “Highly developed or industrialized areas with limited natural value,” of the three Navy land use categories (DON, 2018). Because the sites are located on JBPHH (federal) installation lands, they are not subject to municipal or state land use policies or zoning regulations but are subject to the JBPHH Area Development Plan (ADP) and JBPHH Installation Development Plan (IDP) land use constraints and operating procedures (DoD, 2013).

The provisions of the City and County of Honolulu (CCH) land Use ordnance, in accordance with adopted land use policies from the CCH General Plan, are intended to provide reasonable development and design standards. Sites 2 and 5 are located within land zoned F-1, Federal and Military. The sites would not encroach into the CCH Special Management Area, as conferred by Hawaii Revised Statutes § 205A, designed to preserve, protect, and restore the natural resources of Hawaii’s coastal zone.

The construction of a biofuel powered FRG Plant, BESS and PV system under the Proposed Action would not result in any changes to land use or ownership. In addition, like other PV systems of this scale planned for Oahu, the use of the proposed PV system for this project would be considered an interim use (i.e., 37-year lease) after which the Navy and lessee would consider a range of options, including renewing the agreement or decommissioning the system. In the event of decommissioning, the process would not have an adverse effect on land use. Because decommissioning would involve the removal of all applicable structures and improvements, the sites are expected to revert to their pre-development industrial use.

With no changes in land uses or ownership in either the Proposed Action or No Action Alternative, no impacts are anticipated. Therefore, land use does not require further analysis in this EA.

1.5 Airspace

Neither Site 2 nor 5 are located in an Accident Potential Zone 1 or 2, Accident Clear Zone, or other restricted airspace zone and associated airfield operations sites (DoD, 2013). The Proposed Action would not result in flight line restrictions.

The tallest structure constructed would be the exhaust stacks for the FRG Plant at Site 2 that would reach up to 110 feet in height. Because structures of a similar height, such as the portal cranes, currently exist on JBPHH, the Proposed Action would not create a requirement for nor affect existing airspace. Therefore, impacts to airspace is not analyzed further in this EA.

1.6 Infrastructure and Utilities

JBPHH maintains potable water, wastewater, solid waste, storm water, and information technology (IT)/communications infrastructure and utility services. Potable water is received through several off-site sources and then treated and distributed on base. Wastewater systems include a traditional sanitary sewer system connecting facilities with wastewater services to the on-base wastewater treatment plant (DON, 2022b). Solid waste is collected on base and disposed of via the integrated Solid Waste Collection and Disposal Services at Various Locations JBPHH or the JBPHH Recycle Center. IT/communications systems operate base-wide and storm water management systems include conveyance pipes, outfalls, inlets, culverts and retention/detention areas. Neither Site 2 nor Site 5 would require a substantial number of new personnel to operate the Proposed Action. Therefore, neither site would require substantial alterations or upgrades to existing utilities and infrastructure systems.

The FRG Plant would connect to the existing JBPHH infrastructure and utilities such as wastewater, solid waste, sewage facilities, and IT/communications. All infrastructure is adequate to accommodate any additional loads from the Proposed Action.

The FRG plant would connect to the Navy's existing potable water supply infrastructure. The project would be designed to minimize water use. The current average day demand for JBPHH ranges from 12,000 to 18,000 kilogallons per day. The FRG Plant could use up to 470 gallons of water per hour, or 11–12 kilogallons per day, which is between 0.07 percent to 0.1 percent of the total daily JBPHH potable water consumption. The existing potable water system would be able to accommodate this additional demand (Naval Facilities Engineering Systems Command, Hawaii, personal communication, March 2024). Assuming the FRG Plant runs about 4,000 hours per year, the total consumption of the FRG Plant would be about 1.88 million gallons per year. Water would primarily be required to make the urea solution needed for the SCR emissions control system. Other minor water uses would include:

- Makeup water for air radiator cooling system
- Washdown of equipment
- Landscaping
- Hose bibs
- Periodic additions to the on-site fire water tank
- Drinking and cleaning water for an anticipated staff of three people per shift (e.g., sinks, toilets, and showers)
- Eyewash stations

The largest water load would be the SCR system. To maintain air emissions required by the air permit, a liquid solution of 40 percent urea is injected into the exhaust duct before the exhaust gases enter the SCR. If all eleven engines were operating at full power, a total of approximately 514 gallons per hour of urea solution would be required. This urea solution would be made on-site, by mixing dry urea pellets and demineralized water. The demineralized water would be generated on-site by using potable water and passing it through a reverse-osmosis water treatment system.

Approximately 470 gallons per hour of potable water would be required to generate the maximum anticipated flow rate of 514 gallons of 40-percent urea solution per hour.

The plant itself would use service water for cooling the generators and lube oil systems. SGSP engines would employ closed-loop air radiators for cooling, so water losses would be minimal and independent of ambient conditions. It is estimated that 0.05 gallon per minute would be used for makeup water when all engines are in operation. Cooling water from the engines circulates through tube bundles with fins that radiate heat and are cooled by fans circulating the air. The coolant is a solution of water and a rust inhibitor. Frequency converters control the fans to minimize parasitic load and noise. This system uses little water, and the engine coolant systems are filled from isolated maintenance water tanks. Any necessary treatment is done in the maintenance water tanks. During maintenance, the coolant is pumped back to the tanks to enable water recycling without discharge.

Existing storm water management systems may require alterations or upgrades, but these would be insubstantial. The construction phase of this project would be covered under the National Pollutant Discharge Elimination System (NPDES), administered by the Environmental Protection Agency and the State of Hawaii, Department of Health, Clean Water Branch. Because the sites are more than 1 acre in size, a Notice of Intent would be filed with the Clean Water Branch and a storm water management plan would be developed to consider runoff generated from new impermeable surfaces resulting from the Proposed Action. The storm water management plan would be consistent with low-impact development and in compliance with Section 438 of the Energy Independence and Security Act, United Facilities Criteria 3-210-10. Of the two sites, Site 5 has the higher potential for storm water ponding; however, a storm water retention basin exists adjacent to Site 5 to alleviate this type of event. Furthermore, new infrastructure at Site 5 would primarily consist of pole-mounted PVs and would not significantly increase impervious surfaces at the site. Consideration of sea level rise and associated implications for flooding and storm water management at these sites is addressed in Section 3.2 and addressed where relevant in each of the assessed resource sections.

As part of the Proposed Action, existing facilities at both Sites 2 and 5 would be demolished. During demolition, temporary disruption of services would occur at these facilities. The DLA tenants would not occupy these facilities during the period of service disruption and no tenants currently occupy the facilities at Site 5; therefore, demolition of these facilities would have no impact on utility services to existing tenants.

The Proposed Action would have a net beneficial impact on infrastructure and utilities as it would generate additional electrical utility capacity for the existing system and new facilities would be designed to meet Leadership in Energy and Environmental Design (LEED) standards and criteria to improve efficiency, sustainability, and energy conservation. Impacts to existing utilities would be avoided through project design, and beneficial impacts include increased electrical utility capacity and design efficiency. Therefore, impacts to infrastructure and utilities is not analyzed further in this EA.

1.7 Public Health and Safety

Sites 2 and 5 are located on federal land with perimeter security gates. The base provides security facilities and safety services to address the wide range of facility and activities that occur within JBPHH boundaries. The JBPHH Federal Fire Station and JBPHH Urgent Care provide fire protection and non-life-threatening medical services to the installation. The Honolulu Emergency Services Department is responsible for providing emergency medical treatment and safety for all residents and visitors of Oahu.

The Proposed Action sites are located within the JBPHH installation property and would impact neither the workload nor service area limits for public services such as police or fire protection, nor the demand for health, educational, or recreational services or facilities. The construction sites would be restricted and not accessible to members of the public.

During construction, ground disturbance would occur from activities such as trenching and site clearing that could increase emissions of airborne dust and result in the release of hazardous materials into the water or air. BMPs identified in the air resources analysis (Section 3.2) and SOPs designed to meet regulatory requirements (Table 2.7-2) would reduce air emissions and enable compliance with public safety standards for construction sites.

As discussed in Section 3.6, noise generated by construction equipment would be well below the levels that could affect public health and safety. Best management practices for construction noise management would include the preparation of a noise mitigation and management plan, use of muffler systems, and routine equipment maintenance (see MM NOISE-1 in Table 3.8-2). Therefore, construction activities would result in no significant impacts to public health and safety.

The operation of the FRG Plant at Site 2 and BESS at Sites 2 and 5 create new potential spill, fire, and explosion risks, but these and other risks associated with fuel delivery, handling, disposal, and facility operations would be properly addressed through engineering design, BMPs, and SOPs related to compliance with applicable laws, regulations, and codes, as well as through the availability of JBPHH and local emergency service providers.

During operations, BMPs listed in Table 2.7-1 and SOPs described in Table 2.7-2 would minimize spill risks for fuel delivery through the implementation of a spill prevention and response plan and of SPCCs as required under Section 311 of the CWA. The tanks would have leak detection and the FRG Plant would have extensive metering, monitoring, and alarms on all critical systems. The Navy would ensure the construction contractors and lessee follow these stipulations for immediate response actions to take during an Oil or Hazardous Substance (OHS) release (CNRH, 2019). Should a spill occur, the implementation of the spill prevention and response plan and SPCCs would ensure quick containment of spills to reduce impacts to public health and safety. Concerns associated with hazardous materials and waste are discussed in the following section.

Once operational, and with the implementation of the BMPs listed in Table 2.7-1 and SOPs listed in Table 2.7-2, the Proposed Action would pose no significant public health risks. All safety measures pertaining to access of the sites would be incorporated into the project design, including authorized access and adequate security fencing and lighting.

The manufacturing of biodiesel fuels and associated odors are not considered in this EA as the FRG Plant would not manufacture biodiesel fuels; as such, no additional odor mitigation is required beyond standard emissions controls. Other types of public safety risks are expected to be minimal on JBPHH and in surrounding areas served by the CCH. Therefore, with implementation of BMPs in Table 2.7-1 and

SOPs listed in Table 2.7-2, the Proposed Action would not result in significant impacts to public health and safety.

1.8 Hazardous Materials and Wastes

A description of the regulatory setting for hazardous materials and wastes is included in Appendix H. No known Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Installation Restoration Program sites occur in the Site 2 or Site 5 project area (DON, 2022a). Contaminated soil could be disturbed during trenching and microtunneling for the electrical transmission backbone. CERCLA Installation Restoration Program subsurface fuel plumes (Site 00051) are known to occur in the area of the proposed electrical transmission backbone alignment along Central Avenue, and Land Use Controls (LUCs) are in place. Additional LUCs are in place in the vicinity of the electrical transmission backbone alignment along Vickers Avenue.

LUCs are physical, legal, or administrative mechanisms that restrict the use of, or limit access to, real property to prevent or reduce effects to human health and the environment from contamination at the site. The location of the proposed electrical transmission backbone overlaps with LUCs in various places. All construction activities occurring in locations with LUCs in place must adhere to the specific controls at that site. Additionally, the potential exists to discover new impacted sites not previously identified by the CERCLA Installation Restoration Program; however, new hazardous substances discovered and deemed to be a risk to public health and safety would be permanently removed from the site and properly disposed of, resulting in a net beneficial impact due to improved soil conditions. Potential short-term impacts would be negligible following the implementation of SOPs in Table 2.7-2 and long-term beneficial effects would result from the identification and cleanup of contaminated sites.

Some hazardous materials and wastes would be generated during construction due to the demolition of existing facilities and disposal of construction materials; workers could be exposed to hazardous building materials like asbestos, lead, and per- and polyfluoroalkyl substances (PFAS). PFAS-containing products have been used historically on base in aqueous film-forming foam and other fire suppressants. A base-wide initial site investigation was completed to identify and evaluate sites potentially impacted by PFAS releases at JBPHH (DON, 2019). No PFAS are known to occur on the location of the project sites including the electrical transmission backbone. Newly discovered sites would be remediated of PFAS, resulting in long-term beneficial environmental effects. The Proposed Action would not result in the disturbance of impacted soils or other materials that could cause an exceedance of regulatory permitted levels because appropriate regulatory safety measures would be followed.

BESS batteries typically contain hazardous and explosive substances such as lead-acid, sodium sulfur, and lithium-ion batteries. During operation, hazardous materials could be exposed if inverters, transformers, or the BESS become broken or damaged or are not properly disposed of. The BESS batteries are anticipated to last approximately 20 years; however, batteries experience capacity degradation over time. To account for this, the BESS system would be augmented with additional batteries throughout the term of the Lease to maintain capacity. At their end of life, batteries would be disposed of through a third-party recycler. The 2014 Energy Storage Safety Strategic Plan would be followed to minimize the risks associated with BESS (DOE, 2014). These exposure risks would be minimized using BMPs and proper handling SOPs as listed in Table 2.7-1 (HAZ MGMT-1) and Table 2.7-2, respectively. Additionally, all project activities would comply with the Navy's Hazardous Material Control and Management Program and Hazardous Waste Minimization Program (42 U.S.C. §133) for management and disposal of hazardous materials.

During construction, SOPs and BMPs, including immediate cleanup of any leaks or spills and disposal of hazardous materials, would be implemented to avoid, contain, and prevent contamination of water resources. The tanks would have leak detection and the FRG Plant would have extensive metering, monitoring, and alarms on all critical systems. Descriptions of water and waste management BMPs are provided in Table 2.7-1 and SOPs are provided in Table 2.7-2. All construction workers would be trained on spill prevention and notification measures in accordance with DoD pollution control requirements to reduce the potential for accidental spills.

During operations, fuels would be transported via a fuel barge from Washington State to Oahu. BMPs listed in Table 2.7-1 (BMP WATER MGMT-2) and SOPs described in Table 2.7-2 would be implemented to manage the transport and handling of hazardous materials and wastes. For on-site activities, portable catch basins and/or portable containment berms would be used for refueling equipment and fuel storage. The Navy would ensure the construction contractors and lessee follow these stipulations for immediate response actions to take during an Oil or Hazardous Substance (OHS) release (CNRH, 2019). The implementation of a spill prevention and response plan and use of secondary containment berms or catchment basins would minimize the impact of an accidental release of fuels or other hazardous materials and wastes. Absorbent pads, spill kits, and containment booms would be stored on-site for response to accidental releases.

No impacts from hazardous materials and wastes are expected to occur given implementation of applicable regulations, management plans, BMPs listed in Table 2.7-1 (BMP HAZ MGMT-1), and handling and transport procedures in Table 2.7-2 (OPP Regulations including SPCC requirements under Section 311 of the CWA, Resource Conservation and Recovery Act, 42 U.S.C. § 6901 et seq. and 49 Code of Federal Regulations [CFR] 100-185). Therefore, the Proposed Action would not result in significant impacts to hazardous materials and wastes.

1.9 Socioeconomics

The Proposed Action is located within Honolulu's Primary Urban Center (PUC) of the City and County of Honolulu. The PUC is the center of economic activity, with tourism representing the largest contribution to the county gross product and holds the majority of the island of Oahu's population. The selected sites for the Proposed Action are located within the JBPHH military installation property, from which access is restricted to authorized personnel. The Proposed Action would replace existing Department of Defense (DoD)-operated facilities, namely storage facilities and warehouses, with the FRG Plant, PV system, and BESS facilities, having a beneficial socioeconomic impact on the surrounding community by generating and storing renewable energy for immediate off-base (public) consumption. Due to its location within a restricted area and nature, the Proposed Action is not anticipated to result in noticeable changes to population demographics, school enrollment, housing occupancy status, economic activity, or tax revenue. Temporary jobs would be generated during construction and some permanent jobs during operation of the facilities. Additional socioeconomic impacts are not anticipated and are not further analyzed in this EA.

1.10 Recreation

The project occurs primarily on Navy property that does not provide public access for recreation or other purposes. A Navy softball/baseball field with parking for users is located on the north side of Site 5. This field would be displaced by the proposed solar panels to be installed on the site. This field is an auxiliary facility and other, more developed fields for recreational users exist on base, such as Millican

Field. This recreation impact has been anticipated by the Navy and, because other fields exist on base suitable for similar recreational activities, this is not considered a significant effect to recreational resources.

1.11 Environmental Justice

Executive Order 13045 (April 21, 1997) requires federal agencies to make it a high priority for policies, programs, activities, and standards to address disproportionate risks to children that result from environmental health or safety risks. Executive Order 14096 (April 21, 2023) states that every person in the nation must have clean air to breathe; clean water to drink; safe and healthy foods to eat; and an environment that is healthy, sustainable, climate-resilient, and free from harmful pollution and chemical exposure. USEPA's EJScreen (EPA, 2023d) and data from the U.S. Census Bureau's American Community Survey were used to identify communities facing adverse risk and exposure within a 1-mile radius of Proposed Action. The environmental justice analysis evaluates the potential for the Proposed Action to have disproportionately high and adverse human health or environmental impacts on low-income populations, minority populations, or the Native Hawaiian population (Executive Order 12898). At both sites, resource areas with potential relevance to environmental justice communities would be air emissions, hazardous waste generation, and traffic and transportation. Potential impacts on these resources are analyzed in further detail in Sections 3.2 and 3.7 of this EA. An analysis of the potential effects on environmental justice communities as a result of impacts from the Proposed Action on these resource areas is provided below.

EJScreen is USEPA's environmental justice mapping and screening tool which combines U.S. Census Bureau data with environmental and demographic socioeconomic indicators in a nationally consistent dataset and approach for evaluating a selected study area. This data is used to assign index scores for 12 specific pollution indicators (listed in Table I-1) based on the geographical location of the study area, and provides for comparison to the nation as a whole. The resulting index scores are used to identify communities with a high combination of environmental burdens and vulnerable populations. While EJScreen does not designate an area as an "environmental justice community" or "environmental justice facility", nor does it provide a determination of the existence or absence of environmental justice concerns (EPA, 2017), the resulting index scores aid in identifying communities where further consideration and analysis for environmental justice concerns may be warranted due to pollution burden. High index scores indicate Census block groups with large numbers of low-income and minority residents, which also have high environmental burdens (EPA, 2023d). While the project site itself is not located in a community with environmental justice concerns, there are adjacent communities to Site 5 (within a one-mile radius) that are in the upper quartile percentile for the following indicators: toxic releases to air, traffic proximity, superfund proximity, hazardous waste proximity and wastewater discharge (Table 1.111). In addition to the high environmental burdens, the upper quartile percentiles also indicate that low-income and/or minority populations exceed the 50th percentile for those demographics (EPA, 2023d).

Military bases can have a significant environmental impact on their surroundings, including air and water pollution, noise pollution, and habitat disruption. Communities with environmental justice concerns, which are often low-income and minority populations, are more vulnerable to these environmental impacts, as they may lack the resources to mitigate or adapt to them. Additionally, these communities often bear a disproportionate burden of environmental and health risks due to their historical marginalization, proximity to pollution sources and lack of political power.

Based on the environmental justice indexes, the neighborhood east of Salt Lake Boulevard also falls into many of the environmental risk and exposure categories identified by EJScreen and outlined in Table 1.11 1 below. On-base housing to the south of the site, across Namur road, is located slightly closer to the site boundary and to the planned infrastructure (e.g. BESS units) to be located on-site.

At Site 2, construction and operation activities would be located entirely within the JBPHH. On base officer housing is located in the vicinity of Site 2. No other residential communities are present in or adjacent to the site. No environmental justice communities are present in or adjacent to the site.

At Site 5, the closest off-base residential area is approximately 120 feet from the site boundary, located east of the site across Salt Lake Boulevard. This area is a section of Urban Honolulu (Census Tract 70, Block Group 2) that is considered a minority area due to the high percentage of people of color (U.S. Census, 2023).[4] Based on the environmental justice analysis, the neighborhood east of Salt Lake Boulevard also falls into many of the environmental risk and exposure categories identified by EJScreen and outlined in Table I-1. On-base housing to the south of the site, across Namur road, it located slightly closer to the site boundary and to the planned infrastructure (e.g., BESS units) to be located on-site.

Table I-1 EJScreen Results for JBPHH EUL Energy EA (1-mile radius)

Pollution Sources	***Measurement Units***	***Value***		***Percentile[5] in USA***
		1-Mile Study Area	***USA Average***	***1-Mile Study Area***
Particulate Matter (PM) 2.5	μg/m^3	n/a	8.08	n/a
Ozone	ppm	n/a	61.6	n/a
Diesel Particulate Matter	μg/m^3	0.282	0.261	65
Air Toxics Cancer Risk	lifetime risk per million	36	25	52
Air Toxics Releases to Air	average annual toxicity-weighted concentration	1,600	410	96
Traffic Proximity	daily traffic count/distance to road	450	210	77
Lead Paint	% Pre-1960 Housing	0.23	0.16	51
Superfund Proximity	site count/km distance	0.24	0.13	86
RMP Facility Proximity	facility count/km distance	0.087	0.43	24
Hazardous Waste Proximity	facility count/km distance	2.8	1.9	80
Underground Storage Tanks	count/km^2	2.7	3.9	64
Wastewater Discharge	toxicity-weighted concentration/ m distance	2.2	22	93

Note: Red highlights represent percentiles in the top quartile.
Source: (US Environmental Protection Agency (US EPA), 2023)

At Site 2, construction and operation activities would be located entirely within the JBPHH. On base officer housing is located in the vicinity of Site 2. No other residential communities are present in or adjacent to the site. No environmental justice communities are present in or adjacent to the site.

[4] High populations of Asian Alone (37.8%), Two or More Races (24.0%), and Native Hawaiian and Other Pacific Islander (10.1%) (U.S. Census, 2023)

[5] A percentile is a type of quantile. It describes how a score compares to other scores from the same set. For example, a percentile of 82 for Hazardous Waste Proximity means that only 22% of other areas in the nation have higher values in terms of proximity to a hazardous waste site than this area.

At Site 5, the closest off-base residential area is approximately 120 feet from the site boundary, located east of the site across Salt Lake Boulevard. This area is a section of Urban Honolulu (Census Tract 70, Block Group 2) that is considered a minority area due to the high percentage of people of color (U.S. Census, 2023).[6] Many other Census block groups within a 1-mile radius of Site 5 also contain large minority populations and would be considered minority areas, based on the "Fifty Percent and Meaningfully Greater" analysis conducted in accordance with best practices published by the Federal Interagency Working Group on Environmental Justice (EPA, 2016). The "Fifty Percent" analysis considers whether the percentage of minorities residing in the affected environment exceeds 50 percent. For this analysis, the affected environment consists of the 19 block groups located within a 1-mile radius of Site 5. Following this determination, the "Meaningfully Greater" analysis compares the minority population of the affected environment to a reference community (in this case, Honolulu County) to determine if the percent of minorities in the affected environment is meaningfully greater than that within the reference community (EPA, 2016). Data on minority populations from the U.S. Census Bureau, 2022 American Community Survey 5-Year Estimates were used to complete this analysis (Table 1.11 2) (U.S. Census, 2023).

Table I-2 Minority Populations in the Affected Environment and Reference Community

Location	Total Population (#)	Non-Hispanic White Alone (%)	Minority Population (%)[1]
Honolulu County, Hawaii	1,010,100	17.4	82.6
Census Tract 68.06, Block Group 1	973	7.5	92.5
Census Tract 68.06, Block Group 2	763	9.4	90.6
Census Tract 68.10, Block Group 1	2,861	39.8	60.2
Census Tract 68.13, Block Group 4	1,659	13.9	86.1
Census Tract 68.16, Block Group 1	2,105	3.2	96.8
Census Tract 68.17, Block Group 1	1,353	4.1	95.9
Census Tract 68.17, Block Group 2	2,098	3.0	97.0
Census Tract 68.17, Block Group 3	1,110	0.7	99.3
Census Tract 70.01, Block Group 1	982	60.6	39.4
Census Tract 70.01, Block Group 2	630	37.9	62.1
Census Tract 70.02, Block Group 1	849	69.4	30.6
Census Tract 70.02, Block Group 2	1,771	44.0	56.0
Census Tract 71.00, Block Group 1	1,600	59.2	40.8
Census Tract 74.00, Block Group 1	5,034	55.4	44.6
Census Tract 75.04, Block Group 1	1,233	3.8	96.2
Census Tract 75.08, Block Group 2	818	10.6	89.4
Census Tract 75.08, Block Group 3	1,052	8.5	91.5
Census Tract 75.08, Block Group 4	2,777	2.6	97.4
Census Tract 75.08, Block Group 5	1,090	19.4	80.6
Total Population for All Block Groups[3]	**30,758**	**26.5**	**73.5**

[6] High populations of Asian Alone (37.8%), Two or More Races (24.0%), and Native Hawaiian and Other Pacific Islander (10.1%) (U.S. Census, 2023)

Location	Total Population (#)	Non-Hispanic White Alone (%)	Minority Population (%)[1]
1. Table shading reflects the minority population for each block group. Honolulu County has been selected as the reference community. Those block groups that exceed the minority population of Honolulu County are shaded **red**. Those block groups that have a minority population greater than 50% but not greater than Honolulu County are shaded **orange**. 2. Minority population includes the following non-white races: Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, and Two or More Races. It also incorporates the population of Hispanic or Latino ethnicity. 3. Honolulu County is not included in this total as it is used exclusively as a reference community and to avoid double-counting populations. Source: (U.S. Census, 2022a; 2022b)			

As shown in Table 1.11 2, most of the block groups within the affected environment have a minority population that exceeds 50 percent, with only four block groups not containing a minority community. Additionally, of those 15 block groups, 11 block groups also exceed the percentage of minorities in the reference community of Honolulu County (82.6 percent). While these 11 block groups may not "meaningfully exceed" the population in Honolulu County, given the substantial minority populations, it is reasonable to consider all of these block groups as minority areas and potential environmental justice communities. The combined minority population of the affected environment (73.5 percent) does not exceed the minority population of Honolulu County.

Communities in the vicinity of Site 5 are also between the 80th to 95th percentile for "Limited English-Speaking Households" which impacts how the base should communicate educational and outreach material about the project to the community. Approximately 65% of households in the area speak English as a first language, with Tagalog and other Asian and Pacific Island languages making up a significant percentage of other languages spoken in local households (3).

Table I-3 Primary Language Spoken by Households within a 1-mile Radius of Project Sites

Language	***Percent***
English	65%
Spanish	4%
French, Haitian, or Cajun	1%
Korean	1%
Chinese (including Mandarin, Cantonese)	3%
Vietnamese	1%
Tagalog (including Filipino)	10%
Other Asian and Pacific Island	14%
Total Non-English	35%

The environmental justice analysis evaluates the potential for the Proposed Action to have disproportionately high and adverse human health or environmental impacts on low-income populations, minority populations, or the Native Hawaiian population (Executive Order 12898).

Proposed infrastructure at Site 5 would include solar panels and a BESS unit. Potential sources of impact on local populations from the Proposed Action at Site 5 would include generation of waste and temporary increases in air emissions and traffic associated with construction of the project. The PV system would not be a source of air emissions or other negative environmental effects once constructed, and would require minimal operations and maintenance activity.

Potential impacts on these resources are analyzed in further detail in Sections 3.2 and 3.7 of this EA. These topics are discussed briefly below with respect to the environmental justice communities and existing environmental risks identified in the vicinity of Site 5.

- **Air Emissions:** Based on the magnitude of emission rates, the temporary duration of emission-generating activities, and fluctuating wind directions, anticipated air quality impact from construction at Sites 2 and 5 are not expected to interfere with the attainment of NAAQS/SAAQS. Furthermore, hazardous air pollutants emitted during the operations phase would not appreciably increase human health risks in areas where sensitive receptors and/or public presence are anticipated. Emissions during the operations phase of the project would primarily be generated by energy production at Site 2. This site is not located close to environmental justice communities. Emissions at Site 5, which is closer to communities that have a higher baseline exposure to air toxics, would be minimal. JBPHH is listed by the US EPA on its Toxic Release Inventory (TRI) given its emissions of toxic chemicals regulated under the Emergency Planning and Community Right-to-Know Act (EPCRA). In 2022, the most recent reporting year, no violations of the CAA, CWA, or RCRA from emitted air toxics were identified (EPA, 2023e). Given the low level of hazardous air pollutants and lower level overall of emissions at the site located near more vulnerable communities, as well as a record of compliance with relevant legislation, the Proposed Action would not generate a disproportionately high or adverse impact on air quality for environmental justice communities.
- **Hazardous Waste:** Communities near Site 5 have been identified to have elevated risk of exposure to hazardous wastes from proximity to Superfund sites and other hazardous waste sites (Table I-1). The Pearl Harbor Naval Complex has been listed as an active Superfund site on the National Priorities List (NPL) since 1992 due to various military and industrial activities. Since its designation, the US Navy, US EPA, and Hawaii Department of Health have been working to clean up the site, and there are no threats to human health or the environment present at the site (EPA, 2024). The Proposed Action at JBPHH would not interfere with ongoing clean-up activities nor would the existence of the Superfund site affect implementation of the Proposed Action or result in new impacts to surrounding communities. In addition to the Superfund site, JBPHH also handles hazardous wastes in various capacities during day-to-day operations and contains RCRA-regulated facilities (EPA, 2023e). The Proposed Action would not modify the regulated status of any hazardous waste handlers and would not change the exposure of nearby communities to hazardous waste. As described earlier in this section, the Proposed Action is not expected to generate hazardous waste under standard operations, and no hazardous materials would be generated that could leave the project site to impact neighboring communities. Required SOPs and handling procedures for hazardous materials during construction and operation are described in more detail under Hazardous Materials and Wastes. With these measures in place, and given that ongoing Superfund clean-up activities are a separate action and that the Proposed Action would not modify existing regulated hazardous waste handlers, no impacts are anticipated on neighboring communities. In addition, no communities are located downstream of JBPHH that could be impacted by surface or wastewater discharges and pollutants. Therefore, no disproportionately high or adverse impacts due to hazardous waste are expected for environmental justice communities.
- **Traffic and Transportation:** Construction phase effects at both sites may include increasing user delay and travel times at both internal and external intersections when construction traffic travels to

and from the site. Construction at Site 5 is anticipated to span less than a year, with the peak construction traffic occurring in the middle of 2025 before being virtually complete two months later. The primary effects that are expected to occur are the arrival of construction workers and trucks to and from the site. The added volumes may increase user delay and travel times along Salt Lake Boulevard and the roadways around the site for a few months during the construction period but are not expected to substantially worsen the level of service on the roads. No construction traffic would be routed through the residential neighborhoods across Salt Lake Boulevard. Increases in vehicle numbers would be higher and last longer at Site 2, where environmental justice communities are not present. At both sites, workers can be scheduled to arrive and depart outside of the commuter peak periods to reduce impacts (BMP TRANS MGMT-1 in Table 2.71). Additionally, due to the temporary nature of construction traffic, there would be no permanent changes in traffic volumes that could subsequently affect local air quality and increase the risk of respiratory or cardiovascular illness for nearby communities. With this measure in place and given the short duration and limited range of traffic impacts near Site 5, there would not be a disproportionately high or adverse impact on environmental justice communities.

Based on this analysis, no long-term, disproportionately high or adverse impacts on environmental justice communities in the vicinity of the Proposed Action are anticipated. Consequently, environmental justice is not further analyzed in this EA.

Appendix J
Site Selection and Screening Criteria

Lease of Land for Energy Generation and Storage, Resiliency, Reliability, and Security

at

Joint Base Pearl Harbor-Hickam, Hawaii

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1 FRG Power Plant Location Screening Criteria

The Navy investigated 15 different sites on JBPHH for compatibility with an outlease to a developer to design energy production, storage capacity, and transmission/distribution capabilities. These capabilities must be compatible with the installation operational mission. To identify potential sites at JBPHH, a team conducted site visits and a thorough review of the Commander, Navy Region Hawaii Regional Integration Plan (2012) and the JBPHH Installation Development Plan (IDP) (2013).

The power plant analysis and site selection study identified site characteristics critical for analyzing and evaluating potential locations for a power plant at JBPHH. The screening criteria for site selection included:

- Proximity to Station C (Navy Electrical Station)
- Size
- Tsunami evacuation zone/Federal Emergency Management Agency Flood Zones
- Slope/topography
- Proximity to emissions and noise-sensitive land uses
- Conflict with/displacement of existing functions
- Environmental constraints
- Impact on cultural resources
- Impact on natural resources
- Proximity to major roadways/utilities
- Developability

Proximity to Station C was a high priority screening criteria due to the electrical station's servicing of mission critical waterfront loads and CNO Mission Assurance Assessment recommendation to interconnect a power generating source to Station C to address energy security and resiliency.

2 Site Selection Study Summary

The Joint Base Pearl Harbor-Hickam Power Plant Analysis and Site Selection Study was initiated to determine the feasibility of implementing a 50-megawatt (MW) power plant, a 100 MW FRG power plant, 1 and a Liquid Air Energy Storage (LAES) plant for Joint Base Pearl Harbor-Hickam (JBPHH). The study also included an analysis of mooring a 100 MW power barge proposed by Hawaii Electric Companies (HECO) in Pearl Harbor adjacent to the HECO Waiau Power Plant.

After the Navy selected the 15 compatible sites, a power plant analysis and site selection study were developed to analyze, evaluate, and rank the sites. The 15 potential locations were analyzed against the site characteristics and ranked (Table J-1).

Table J-1 Phase 1 Site Evaluation Matrix

Criterion/Site	A	B	C	D	E	F	G	H	I	J	L	M	N	O
Proximity to Station C	0	0	2	3	3	2	2	2	0	0	3	1	2	2
Size	3	1	1	3	3	1	Infeas.	Infeas.	3	Infeas.	2	2	2	Infeas.
Tsunami Evacuation Zone/FEMA Flood Zones	3	3	1	3	3	3	1	1	Infeas.	1	3	3	3	3
Conflict with/Displacement of Existing Functions	3	2	2	1	0	2	2	2	Infeas.	3	0	1	1	2
Environmental Constraints	1	3	3	3	3	1	1	1	3	3	3	2	1	3
Impact on Cultural Resources	2	3	1	0	1	3	2	1	3	3	0	2	2	1
Impact on Natural Resources	0	3	3	3	3	3	3	3	1	2	3	3	3	3
Near Major Roadways/Utilities	2	3	3	3	1	3	3	3	1	1	3	3	3	3
Slope/Topography	2	3	3	3	3	Infeas.	3	3	3	3	3	3	3	3
Developability	1	2	3	1	0	3	3	0	0	3	3	2	3	0
Proximity to Emissions- and Noise-Sensitive Land Uses	1	1	1	1	1	1	2	3	3	3	1	3	3	1
Total Score	18	24	23	24	21	Infeas.	Infeas.	Infeas.	Infeas.	Infeas.	24	25	26	Infeas.

General Scores: 3 = Good (green); 2 = Fair (yellow); 1 = Constrained (orange); 0 = Heavily Constrained (light maroon); Infeasible (dark maroon).

Site Names:
A = Makalapa Crater
B = NAVFAC Hawaii Baseball Field
C = Ward Field
D = Buildings 158 and 159 Site
E = Quick Field, Marine Barracks
F = Former Fuel Storage Area
G = DLA Disposition Open Storage
H = At/Near Building 177
I = Near Fort Kamehameha WWTP
J = Adjacent to Beckoning Point, Waipio Peninsula
K = Near Waiau Power Plant (considered in a separate study)
L = Russell Avenue Parking Area
M = Near Halawa Gate
N = Lake Erie Parking Area
O = Open Space near Hospital Point

(perfect score = 33)

Of the 15 potential sites in the phase one site evaluation, six sites were identified as infeasible and were eliminated from further consideration. The eight remaining potential sites went through a second phase of site evaluations using the same criteria for phase one weighted by the Naval Facilities Engineering Systems Command, Hawaii engineers according to their level of importance. The results of these site evaluations were presented in status briefs to JBPHH leadership and discussed extensively among Navy stakeholders. Once the sites were analyzed and ranked in the power plant analysis and site selection study, the Navy proceeded with six of the sites for further consideration as preferred sites:

- **Site D Buildings 158 and 159 Site:** 100-MW plant
- **Site L:** Russell Avenue Parking Area: 100-MW plant
- **Site N:** Lake Erie Avenue Parking Area: 100-MW plant
- **Site M:** Near Halawa Gate: 50-MW plant
- **Site B:** Naval Facilities Engineering Systems Command, Hawaii Compound Baseball Field: 100-MW plant
- **Site E:** Quick Field, Marine Barracks: 100-MW plant

These six sites best met the site characteristics required for siting a 100 MW Power Plant (Figure 1.2-1). Of the six sites deemed suitable for a 100 MW power plant, three sites were identified for further consideration due to Proximity to Station C.

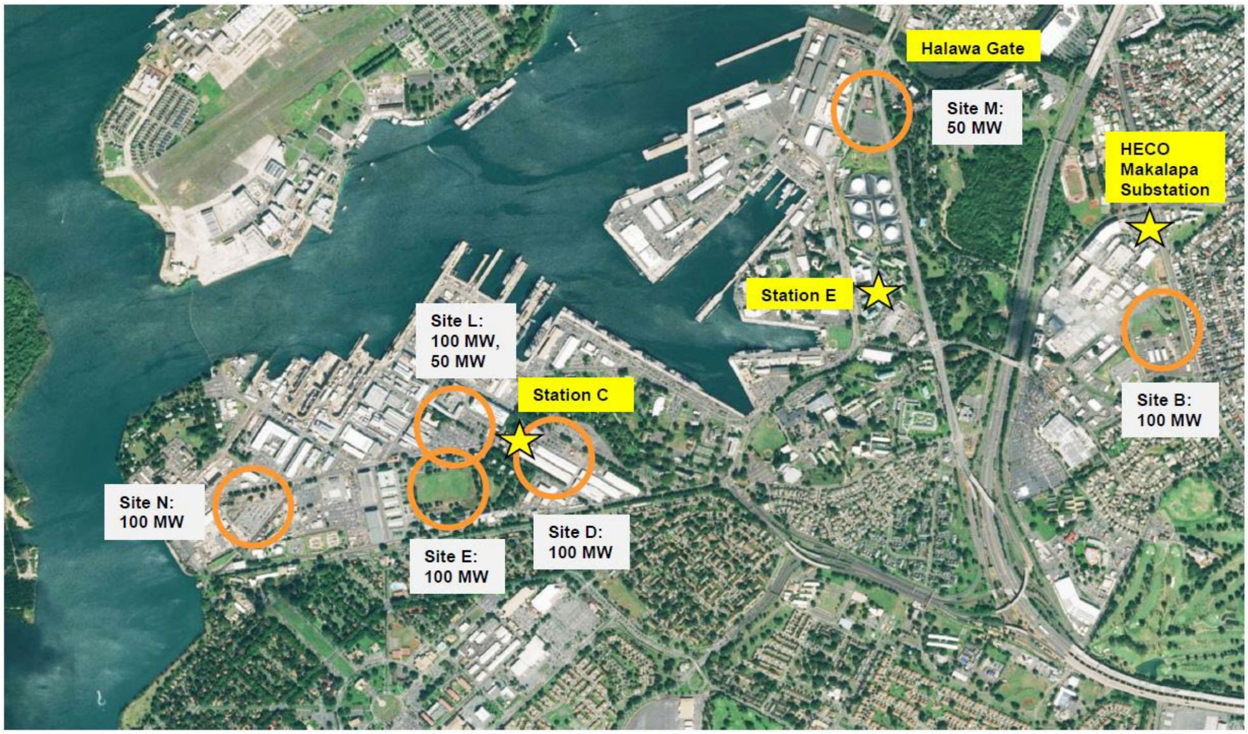

Figure 1.11-1 Location of Preferred Sites, Electrical Substations, and Halawa Gate

Market surveys and industry research provided the Navy with information to further reduce the number of potential locations for the power plant based on developers' interest. On May 19, 2019, the Navy released the Request for Qualifications. The Request for Qualifications allowed the Navy to determine eligibility for prospective lessees to perform the work. After the Navy reviewed the responses submitted through the Request for Qualification process, the Navy provided the respondents with a preliminary eligibility qualification. The Request for Qualifications provided six sites for bidders to propose. Site 5 was included as a required site for proposal submission. The bidders then selected one additional site (Facilities YA and YB [Site 2], Russell Avenue Parking Area, Quick Field, Marine Barracks, and Lake Erie Avenue Parking Area) to include in the proposal. Of the six sites included in the RFQ, Navy only received proposals for a 100 MW Power Plant at Site 2 and a Battery Storage Project at Site 5. Due to developer responses, the Navy proceeded with issuing an outlease Request for Proposal to include Sites 2 and 5.

After completing the Request for Qualifications process, the Navy released an RFP on October 15, 2020, which included Sites 2 and 5. The RFP made available for lease non-excess real property at JBPHH under the authority of 10 United States Code (U.S.C.) § 2667 and selected a lessee. The Navy reviewed the proposals submitted in response to the RFP and then selected a lessee. When the lessee is selected, the Navy and the lessee would then enter into negotiations and ultimately sign a lease.

3 DoD-HECO Energy Partnership Charter

On December 1, 2004, the Department of Defense entered into a partnership with HECO to work together to bring beneficial utility changes to Hawaii (Navy 2004). Some aspects of this DoD-HECO Energy Partnership Charter include a focus to maintain and enhance Energy Security and the effort to reduce costs, ensure reliable service, pursue renewable technologies, and exercise responsible environmental stewardship. The Proposed Action was developed with this partnership in mind.

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