

APPENDIX B AIR QUALITY AND GREENHOUSE GAS ANALYSIS TECHNICAL REPORT

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Appendix B: Air Quality, Energy, and Greenhouse Gas Analysis Technical Report

B.1. Introduction

B.1.1. Introduction

Montrose Environmental conducted an air quality and greenhouse gas (GHG) analysis for the Oakland Harbor Turning Basins Widening Project (Proposed Project). The scope and methods used in this assessment are consistent with recommended analyses for projects requiring review under the California Environmental Quality Act (CEQA). This appendix describes the scope and methodology for evaluation of air quality and GHG emissions as well as energy consumption for the Proposed Project's construction. This report includes a description of the methodologies and sources used to develop emission factors¹ and formulas used to calculate estimated total emissions. This document summarizes control measure assumptions used in the calculations and summarizes emissions from the various emission sources (based on source type). This document is also used to calculate the emissions used in a Health Risk Assessment (HRA), the details of which, including toxic air contaminants (TAC) emissions are included as Appendix C: Heath Risk Assessment of Oakland Harbor Turning Basin Construction.

Emissions associated with construction of the Proposed Project were estimated using emission factors and methodology from published documents and emission models obtained from various agencies, including but not limited to the California Air Resources Board (CARB), the California Air Pollution Control Officers Association (CAPCOA), the Bay Area Air Quality Management District (BAAQMD), and the United States Environmental Protection Agency (USEPA). The following sections describe the formulas and assumptions used to prepare emissions estimates for each source type.

Emissions were estimated for reactive organic gases (ROG), oxides of nitrogen (NO_x), oxides of sulfur (SO_x), carbon monoxide (CO), particulate matter with aerodynamic diameter of 10 microns or less (PM₁₀), particulate matter with aerodynamic diameter of 2.5 microns or less (PM_{2.5}), carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and TACs.

B.1.2. Document Organization

This document is organized into the following sections:

- **Proposed Project Description:** This section provides a brief description of the Proposed Project outlining key construction activities and Proposed Project construction phasing. It also discusses the differences between different emission calculations for an unmitigated Proposed Project and mitigated Proposed Project, and for the Proposed Project Alternatives, which include Diesel Dredging Alternative, Inner Harbor Only Alternative, and Outer Harbor Only Alternative. There is also a brief description of operations activities (which include maintenance activities).

¹ An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant such as hours of operation or vehicle miles traveled.

- **Concepts Used in Estimating Criteria Air Pollutant and GHG Emissions:** This section outlines the key categories of emissions that were used in the emission inventory. This section includes a brief discussion of the criteria air pollutants and GHGs that are used in this report. Fundamental concepts of emission estimates are described in this section along with introduction of key units of measure of emissions that are typically used for comparison in CEQA analyses.
- **Methods for Estimating Construction Emissions:** This section outlines the specific methodology used to estimate emissions for both criteria pollutants and GHG emissions, including the activity and emission factors, for each source type. The factors used to estimate energy consumption are also described.
- **Methods for Estimating Operations and Maintenance Emissions:** This section qualitatively describes the impact of operation and maintenance for the Proposed Project on air quality compared to existing conditions.
- **Methods for Estimating Sequestration of GHG in Wetlands:** This section outlines the methodology used to estimate the sequestration of carbon in wetlands constructed with beneficial reuse of dredged sediment from the Proposed Project.
- **Methods for Estimating Energy (Fuel) Consumption:** This section outlines the methods used to estimate the gasoline, diesel, and electricity consumption by the Proposed Project.
- **References:** This section provides the references used in this report.
- **Detailed Emissions Tables and Figures:** Detailed Tables and Figures showing the results of quantitative and qualitative analysis using the described methods are included at the end of the report.

B.2. Proposed Project Description

The Port of Oakland (Port), in partnership with the United States Army Corps of Engineers (USACE), is proposing the Oakland Harbor Turning Basins Widening Project (Proposed Project) at the Oakland Seaport (Seaport) in Alameda County, California. The Proposed Project involves construction to widen the diameter of the existing turning basins in the Seaport. The federal deep water Inner Harbor Channel authorized width is 800 feet wide; it includes the IHTB, which is 1,500 feet in diameter and is located approximately 4.0 miles east of the Entrance Channel. The federal deep water Outer Harbor Channel authorized width is 900 feet wide; it includes the OHTB, which is 1,650 feet in diameter and is located approximately 2.3 miles northeast of the Entrance Channel. The channels and turning basins were last improved to provide a water depth of 50 feet mean lower low water (MLLW) and widened turning basins—a construction effort that concluded in 2009 (-50-Foot Project).

The purpose of the Proposed Project is to provide navigational improvements that address inefficiencies and suboptimal conditions currently experienced by vessels in Oakland Harbor. Transportation inefficiencies and high-risk transits occur when channels and maneuvering areas do not fully accommodate the vessels using them and result in cascading effects on economic, environmental, and safety considerations. Current container vessels calling the Port exceed the maximum dimensions of the constructed turning basins. The existing turning basins were designed and constructed for a 6,500 twenty-foot equivalent unit (TEU) container vessel with a 1,139-foot length, 140-foot beam (width), and 48-foot draft (how deep the boat is under the water). The vessels transiting in Oakland Harbor today are longer, wider, and can sit deeper than the design vessel that last served as the basis for improvement of the Oakland Harbor. The limiting factor that has resulted in transit restrictions and

inefficiencies is the existing width of the turning basins. These inefficiencies are projected to not only continue, but to increase in the future because longer vessels are expected to transit the Oakland Harbor with greater frequency and in greater numbers for a variety of reasons including anticipated economic growth, other West Coast port waterway improvement design criteria, fleet turnover, and projected world fleet production.

The Proposed Project is located in both the City of Oakland and in the City of Alameda (Alameda). The Seaport is served by the Oakland Harbor, a federal deep-draft commercial waterway, which generally consists of the Entrance Channel, the Outer Harbor Channel and its Outer Harbor Turning Basin (OHTB), and the Inner Harbor Channel and its Inner Harbor Turning Basin (IHTB). The Outer Harbor Channel is immediately south of the San Francisco-Oakland Bay Bridge, and the Inner Harbor Channel is in the waterway between the Seaport and Alameda. The IHTB and OHTB are widened areas of the Inner and Outer Harbor Channels that allow large container vessels to turn around. Berths 10 and 26 are on the landside of the Outer Harbor.

Expansion of the IHTB consists of widening the existing IHTB an additional 334 feet—from 1,500 feet to 1,834 feet—with a depth of 50 feet MLLW, consistent with the existing depth of the IHTB. In addition to in-water work to widen the IHTB, landside property would be removed in two locations: Howard Terminal, and the Alameda Site. The landside locations of proposed improvements at the IHTB include a portion of property owned by the Port (Howard Terminal) to the north of the IHTB, and a portion of private property owned by FIC Alameda 365 LLC along the Alameda shoreline to the southeast of the IHTB (referred to in this document the “Alameda Site”). Figure 2.5-1 in Chapter 2 of this Draft Environmental Impact Report (EIR) shows the proposed expanded IHTB relative to the current limits of the navigation channel.

The OHTB would be widened an additional 315 feet—from 1,650 feet to 1,965 feet—with a depth of 50 feet MLLW, consistent with the existing depth of the OHTB. Figure 2.5-3 in Chapter 2 of this Draft EIR shows the proposed expanded OHTB relative to the current limits of the navigation channel. Widening the OHTB does not require the removal of landside property. In the Seaport’s Outer Harbor Terminal, the Proposed Project’s landside activities would occur at Berth 26, in the TraPac Terminal; and at Berth 10, at the northeastern end of the Outer Harbor Terminal.

B.2.1. Construction Activities

The widening of the IHTB and OHTB would require work on both landside and in-water locations. These locations include land work at Howard Terminal and Alameda Site for the IHTB. Land work for the OHTB would include electrical infrastructure upgrades near Berth 26. Berth 10 would be used during IHTB work for rehandling dredged material including drying sediment prior² to loading onto trucks for transport to disposal locations. Below is a summary of the scope of construction work that would occur at the key land and water locations.

² Dredged material rehandling at Berth 10 is conducted in accordance with the Port’s Berth 10 Dredge Material Re-handling Facility Maintenance and Operations Plan and is authorized by San Francisco Bay Conservation and Development Commission Permit No. M1992.041.13, the San Francisco Regional Water Quality Control Board Water Quality Certification for the Port’s maintenance dredging program, and San Francisco Regional Water Quality Control Board Order No. R2-2013-0019.

B.2.1.1. Howard Terminal Landside Excavation, Construction, and Dredging

To widen the IHTB, approximately 4 acres of the southwestern corner of Howard Terminal would be removed, and approximately 850 linear feet of new bulkhead would be constructed along the proposed modified shoreline. Activities would include the demolition and removal of the existing asphalt pavement and concrete deck of the existing wharf structure, followed by the installation of a new bulkhead. Construction of the new bulkhead (consisting of sheet piles, batter piles, and/or anchor tie-backs) is assumed to include driving down approximately 70-foot-long sheet piles and 115-foot-long batter piles, most of which would be driven down landside with an estimated 10 percent of piles for the new bulkhead installed through the water. Concurrent with installation of the new bulkhead, piles that supported the demolished wharf structure would be removed. Approximately 24,900 cubic yards (cy) of landside soil would be excavated between the new bulkhead and existing rock dike.

Following installation of the new bulkhead and completion of landside excavation, approximately 244,200 cy of material below water would be dredged, including a portion of the existing rock dike. Lastly, approximately 8,400 cy of rock would be installed in the front of the new bulkhead for slope protection. Dredging would be performed with an electric-powered dredge connected to existing electrical infrastructure adjacent to the Alameda shoreline or alternatively to added electrical infrastructure at Howard Terminal.

Existing utilities that would be impacted by the IHTB widening footprint (i.e., the area that would be excavated or dredged to widen the turning basin, or the construction footprint), such as electric, gas, water, storm drainage, and sanitary sewer, would be cut and capped and/or relocated in the remaining landside area of Howard Terminal, as needed. Site alterations may also include removal, replacement, or redesign of drainage infrastructure such as curbs and gutters resulting from upland excavation and reconfiguration of the shoreline.

B.2.1.2. Alameda Site Demolition, Landside Excavation, Construction, and Dredging

At the Alameda Site, widening of the IHTB would require partial demolition of the western portions of two existing warehouse buildings, estimated to impact two bays in the northern building and three bays in the southern building. Approximately 6 acres of the Alameda Site would be removed, and approximately 1,200 linear feet of new bulkhead would be constructed along the new shoreline. Similar to Howard Terminal, the Alameda Site modifications would include demolition and removal of asphalt and concrete pavement of the existing wharf structure, installation of a new bulkhead along the proposed modified shoreline edge, removal of piles that supported the demolished wharf structure, and excavation of approximately 159,900 cy of landside soil. Construction of the new bulkhead would be similar to Howard Terminal, using approximately 70-foot-long sheet piles and 115-foot-long batter piles, with an estimated 10 percent of piles for the new bulkhead installed through the water. Following installation of the new bulkhead and completion of landside excavation, the existing bulkhead would be removed, and approximately 493,100 cy of material below water would be dredged. Lastly, approximately 11,700 cy of rock would be installed in the front of the new bulkhead for slope protection. Dredging would be performed with an electric-powered dredge connected to existing electrical infrastructure adjacent to the Alameda shoreline, or alternatively to added electrical infrastructure at Howard Terminal.

Similar to Howard Terminal, existing utilities at the Alameda Site that would be impacted would be cut and capped, and/or relocated in the remaining landside area of the Alameda Site. Specific utility replacement/relocation needs would be identified and addressed during the Proposed Project pre-construction engineering and design phase.

B.2.1.3. Inner Harbor Waterway Construction and Dredging

Activities in the Inner Harbor Waterway, in addition to those occurring at Howard Terminal and the Alameda Site, would include installation of a bulkhead structure and dredging. To ensure that widening the IHTB does not compromise the shoreline stability at Schnitzer/Radius Recycling, an approximately 300- to 400-foot-long bulkhead structure is assumed to be required between the northwestern portion of the IHTB footprint and Schnitzer/Radius Recycling property, all of which would be under water. The bulkhead structure would be constructed with approximately 70-foot-long sheet piles. Approximately 6,000 cy of rock would be placed to stabilize the structure. In addition, dredging to -50 feet MLLW to match the current authorized dredged depth of the existing turning basin of approximately 143,300 cy of existing Inner Harbor sediment (areas currently under water) would be required to the north of the existing IHTB between Schnitzer/Radius Recycling and Howard Terminal for widening of the IHTB. The bottom of the channel in this submerged area is currently between -8 and -50 feet MLLW.

B.2.1.4. Outer Harbor Dredging

Approximately 1,342,000 cy of sediment would be dredged northwest of the existing OHTB to widen the OHTB from 1,650 to 1,965 feet, to a depth of -50 feet MLLW, and 3H:1V (three horizontal to one vertical) side slopes. Within the widening footprint for the OHTB, the bottom of the Bay is currently between -9 and -50 feet MLLW. There are no land impacts under the proposed footprint of the expanded OHTB.

B.2.1.5. Howard Terminal and Berth 26 Electrical Infrastructure Installation

To support electrical dredging for widening the IHTB and OHTB, electrical infrastructure would be added at Howard Terminal near Berth 68 and in the Outer Harbor Terminal near Berth 26. A lineup of electrical switchgear would be installed adjacent to the nearest existing substation, from which the dredging operator would then draw power to be used for the electrical dredging activities. The switchgear lineup would allow the Port to control, isolate, and meter power during dredging activities. A switchgear lineup consists of an overall metal enclosure containing circuit breakers, switches, fuses, relays, current transformers, potential transformers, control power transformers, indicating instruments, panelboards, control panels, and other devices that together are referred to as “switchgear” or a “switchgear lineup.” The switchgear would be adjacent to existing electrical infrastructure and would be comparable in height and dimensions to the existing substation. The dredging operator would supply their own 12.47-kilovolt cable and terminations to directly connect to the Port’s switchgear. These cables would then be connected to the dredging operator’s on-board electrical equipment. This on-board electrical equipment would then control the power used during dredging activities. This Project does not involve any sulfur hexafluoride gas-insulated switches.

B.2.1.6. Electrical Dredging

Dredging would be performed with an electric crane-mounted barge and outfitted with a clamshell bucket (referred to as a clamshell dredge). Equipped with a long boom (that acts like an arm) and cables, the crane would lower the clamshell bucket through the water for removing material where needed and bringing the material to the surface, where it would be loaded onto the barge or onto scows (a smaller

type of barge). Clamshell dredges are equipped with a positioning computer system that helps the operator position the bucket at the correct location to remove material. Once the barge or scow is loaded, a single tug would then transport the barge or scow to Berth 10 or beneficial reuse site (further described in sections below). Because dredging would be electric, the crane would connect to the newly built electrical infrastructure at Berth 26 during dredging of the OHTB. The crane would connect to the existing electrical infrastructure in Alameda or new electrical infrastructure installed at Howard Terminal for the dredging of the IHTB. Dredging activities are planned to take place 24 hours a day, 7 days a week during the in-water work season.

B.2.1.7. Dredged Material Beneficial Reuse Placement

All dredged material that is suitable for beneficial reuse would be placed at a permitted beneficial reuse site. Dredged material would be loaded onto scows in the Proposed Project footprint, and would then be transported by a single tug to a beneficial reuse site for placement. After the scow is emptied, the tug would return with the empty scow to pick up a new load. Because this activity takes place during dredging activities, similar to dredging, this activity could take place 24 hours a day, 7 days a week during the in-water work season.

B.2.1.8. Berth 10 and Dredged Material Re-Handling

Dredged material not suitable for beneficial reuse would be placed at Berth 10 for rehandling prior to continued transport to a disposal site. Dredged material would be loaded into a scow; when full, a towboat would transport the material to Berth 10. The crane would then operate diesel engines to move the material from the barge onto land at Berth 10. The tug would then return the crane-mounted barge to the dredging area, where it would be plugged into the electrical power supply to dredge additional material. This is anticipated to take 24 days.

Berth 10 would be used to rehandle dredged material that is not suitable for beneficial reuse. Dredged material handled at Berth 10 must also be confirmed as non-hazardous material. The activities would involve offloading material from barges and/or scows with a dredge-mounted crane. Off-road construction equipment such as dozers and loaders would be used to re-handle the material at Berth 10 to facilitate the drying of the sediment and loading onto trucks for transport to a Class II (non-hazardous) landfill. Because the placement of dredged material at Berth 10 would take place during dredging activities, similar to dredging, this activity would happen 24 hours a day, 7 days a week during the in-water work season. Once on land, material rehandling itself would only occur during normal daytime working hours.

B.2.2. Construction Phasing

Construction is expected to start in July 2027 with an approximate duration of 2 years, 4 months, and be completed in November 2029. Anticipated construction years are 2027 (year 1), 2028 (year 2) and 2029 (year 3). Schedule outlines expected general sequencing of activities over the 3 construction years regardless of actual construction start date. **Table 1** summarizes the anticipated construction activities that would occur each year of construction and provides the location of the activity.

Table 1: Anticipated Schedule of Construction Activities by Construction Year

Construction Year ¹	Construction Activity	Location
Year 1: 2027	Electrical Infrastructure Installation	Berth 26 and Howard Terminal
1	Concrete/Asphalt Pavement Demolition and Pile Removal (including in-water pile removal)	Howard Terminal
1-2	New Bulkhead Installation	Howard Terminal
2	Landside Excavation	Howard Terminal
2	In-Water: New bulkhead Installation, Dredging, and Rock Installation	Howard Terminal
2	In-Water: Bulkhead Installation, and Rock Installation	Inner Harbor Waterway by Schnitzer/Radius Recycling
2	Dredging	Outer Harbor
2	Warehouse and Concrete/Asphalt Pavement Demolition and New Bulkhead Installation	Alameda Site
2	New Bulkhead Installation	Alameda Site
2-3	Landside Excavation and Pile Removal (including in-water pile removal)	Alameda Site
3	In-Water Removal of Existing Bulkhead	Alameda Site
3	In-Water Bulkhead Installation, Dredging, and In-Water Rock Installation	Alameda Site
3	Dredging	Outer Harbor
3	Dredging and Dredged Material Rehandling	Inner Harbor Waterway, Berth 10

Note:

Anticipated construction years are 2027 (year 1), 2028 (year 2), and 2029 (year 3). The schedule outlines expected general sequencing of activities over the three construction years regardless of actual construction start date. The order of activities shown may occur concurrently with other activities within the same construction year; the rows shown are not meant to indicate that the listed activities occur in consecutive order.

Construction, excluding dredging, would occur Monday through Friday between the hours of 7 a.m. and 7 p.m. Dredging would be conducted 24 hours per day, 7 days per week. Activities that would take place during dredging and also would be conducted 24 hours per day, 7 days per week include the transportation of material to beneficial reuse sites and the transportation and placement of dredged material at Berth 10. Dredging and other in-water construction work would be performed during the in-water work window of June 1 through November 30 of each construction year.

The construction equipment and the anticipated number of workers by construction activity are listed in **Table 2**.

Table 2: Anticipated Construction Workforce and Equipment by Activity

Construction Activity	Number of Workers	Equipment Type (Quantity)
Electrical Infrastructure Installation	5 on-site plus 1 truck driver	Backhoe/Loader (1) Dump Truck (1) Concrete Saw (1) Smooth Drum Roller (1)
Warehouse Demolition	13 on-site plus 2 truck drivers	Concrete Saw (2) Dump Truck (2) Excavator (1) Compressor (1) Torch (2)
Pavement Demolition	8 on-site	Backhoe/Loader (1) Concrete Saw (1) Dozer (1) Dump Truck (2)
Warehouse and Pavement Debris Hauling	6 onsite plus 38 truck drivers	Excavator (2) Dump Truck (38)
Bulkhead and In-Water Retaining Structure Installation	6-9 on-site	Backhoe/Loader (1) Crane (1) Dump Truck (1) Impact Driver (1) Vibratory Driver (1) Drilling Rig (1) Dive Vessel (1) Crane (1) Barge (2) Towboat/Pushboat (1)
Landside Excavation	10 on-site	Excavator (2) Dump Truck (2)
Landside Excavation Hauling	6 on-site plus 75 truck drivers	Excavator (2) Dump Truck (75)
Pile Removal (on-land and in-water)	26 on-site	Crane (2) Barge (2) Dive Vessel (2) Excavator (2) Vibratory Driver (2) Compressor (2) Generator (2)
Pile Hauling	10 on site plus 2 truck drivers	Excavator (2) Dump Truck (2)
Bulkhead Removal (on-land and in-water)	14 on-site	Crane (1) Barge (2) Dive Vessel (1) Excavator (1) Towboat/Pushboat (1) Compressor (1) Generator (1) Torch (1)

Construction Activity	Number of Workers	Equipment Type (Quantity)
Dredging (includes removal of material for placement at beneficial reuse site or transport to Berth 10 for rehandling)	26 on-site	Barge (2) Crane with Clamshell (1) Tugboat (2)
Berth 10 Loading and Hauling	28 on-site plus 38 truck drivers	Backhoe/Loader (1) Crane (1) Barge (2) Tug Boat (1) Excavator (1) Dozer (1) Dump Truck (38)
In-Water Rock Installation	5 on-site	Crane (1) Dump Truck (1) Barge (1) Tug Boat (1)

Construction of the Proposed Project involves a total of approximately 2,447,600 cy of excavated and dredged material combined. This material would be sent to Class I (hazardous) landfill, Class II (non-hazardous) landfill, or beneficial re-use (as either cover or non-cover material). The material destined for Class I and Class II landfills would be transported with trucks. Beneficial re-use material would be transported by barges/scows with tug boat assistance to the beneficial re-use sites. Table 3 shows the volume of material anticipated to be generated by the construction activities for these three categories of material.

Table 3: Estimated Amounts of Excavated Terrestrial and Dredged Material and Placement Location

Material	Volume (Cubic Yards)	Placement Location
Potentially hazardous materials requiring Class I landfill placement	10,900	Class I Landfill
Non-hazardous materials requiring Class II landfill placement	187,400	Class II Landfill
Materials suitable for beneficial reuse as foundation/non-cover material (not acceptable for direct contact with water)	1,712,300	Beneficial use site, foundation material
Materials suitable for beneficial reuse as cover material (acceptable for direct contact with water)	454,400	Beneficial use site, cover material
Dredged rock from existing slope protection	82,600	Beneficial reuse site, recycling/reuse
Total	2,447,600	

In addition to the truck trips associated with Class I and Class II landfill material hauling, additional truck trips will be needed to recycle construction and building debris. **Table 4** shows the anticipated number of truck trips based on the anticipated material volume and conservatively assuming that trucks can handle a 10-cubic-yard load.

Table 4: Truck Trips for Hauling Demolished, Excavated, Dredged Materials, and other Supply Hauling

Location	Approximate Cubic Yards ¹	Trips ²
From Howard Terminal to Class I landfill	2,900	290
From Howard Terminal to Class II landfill	25,800	2,580
From Howard Terminal to Recycler	22,900	2,290
From Howard Terminal to Other Hauling	N/A	277
From Alameda to Class I landfill	8,000	800
From Alameda to Class II landfill	151,900	15,190
From Alameda to Recycler	101,600	10,160
From Alameda to Other Hauling	N/A	335
From Inner Harbor Waterway to Class II landfill	9,700	970
From Outer Harbor Other Hauling	N/A	168
Total		
Location Destination	Approximate Cubic Yards ¹	Trips ²
Class I landfill	10,900	1,090
Class II landfill	187,400	18,740
Recycler	124,500	12,450
Other Hauling	N/A	780
All	322,800	33,060

Notes:

- 1 Quantities include 10 percent contingency and an additional applicable bulking factor (0 to 25 percent) and are rounded up to nearest hundredth.
- 2 Trip numbers are based on a 10-cubic-yard truck size and represent a roundtrip to and from the Proposed Project site.

N/A = not applicable

B.2.3. Proposed Project and Proposed Project Alternatives

Several different emission scenarios are included in this report. The Proposed Project consists of an unmitigated and mitigated scenario. The mitigated scenario is split for application of the air quality mitigation measure and the energy mitigation measure. The main difference between the unmitigated and mitigated scenario is the use of Tier 4 final engines for the landside construction equipment, and in the event of electricity supply issues, temporary use of diesel dredging. **Table 5** lists the assumptions for each of the different equipment types used in the construction of the Proposed Project. **Table 6** lists the assumptions of the different equipment types used in construction for each alternative.

Table 5: Construction Equipment Engine Assumptions for the Proposed Project

Construction Equipment Type	Unmitigated	Mitigated
Dredgers	Electric	Same as Unmitigated; up to 240 hours of diesel dredging per year for energy mitigation
Tugs (tow boats)	Main Engine: Diesel Tier 3 (2027); Diesel Tier 4 (2028-2029) Auxiliary Engines: Diesel Tier 3 (2027); Diesel Tier 4 (2028-2029)	Same as Unmitigated
Barges (and scows)	Auxiliary: Diesel Tier 4	Same as Unmitigated
Dive Boats	Main: Diesel Tier 3 Auxiliary: Diesel Tier 3	Same as Unmitigated
Off-Road Construction	OFFROAD Default Mix	Tier 4 final
Hauling Trucks (HHDT)	EMFAC Diesel Default Mix	Same as Unmitigated
Worker Vehicles (50% LDA, 50% LDT)	EMFAC Gasoline Default Mix	Same as Unmitigated

Notes:

- 1 HHDT = heavy, heavy-duty truck, LDT = light duty truck, EMFAC = Emission Factor Model for motor vehicles.

Table 6: Construction Equipment Engine Assumptions for the Proposed Project Alternatives

Construction Equipment Type	Diesel Dredging Mitigated	Inner Harbor Turning Basin Only Mitigated	Outer Harbor Turning Basin Only Mitigated
Dredgers	Main: Diesel Tier 4 Auxiliary: Diesel Tier 3/Tier 4 (2029)	Electric up to 240 hours of diesel dredging per year for energy mitigation	Electric; up to 240 hours of diesel dredging per year for energy mitigation
Tugs (tow boats)	Main: Diesel Tier 3 (2027); Diesel Tier 4 (2028-2029) Auxiliary: Diesel Tier 3 (2027); Diesel Tier 4 (2028-2029)	Main Engine: Diesel Tier 3 (2027); Diesel Tier 4 (2028-2029) Auxiliary Engines: Diesel Tier 3 (2027); Diesel Tier 4 (2028-2029)	Main Engine: Diesel Tier 3 (2027); Diesel Tier 4 (2028-2029) Auxiliary Engines: Diesel Tier 3 (2027); Diesel Tier 4 (2028-2029)
Barges (and scows)	Auxiliary: Diesel Tier 4	Auxiliary: Diesel Tier 4	Auxiliary: Diesel Tier 4
Dive Boats	Main: Diesel Tier 3 Auxiliary: Diesel Tier 3	Main: Diesel Tier 3 Auxiliary: Diesel Tier 3	Main: Diesel Tier 3 Auxiliary: Diesel Tier 3
Off-Road Construction	Tier 4 final	Tier 4 final	Tier 4 final
Hauling Trucks (HHDT)	EMFAC Diesel Default Mix	EMFAC Diesel Default Mix	EMFAC Diesel Default Mix
Worker Vehicles (50% LDA, 50% LDT)	EMFAC Gasoline Default Mix	EMFAC Gasoline Default Mix	EMFAC Gasoline Default Mix

Notes:

- 1 HHDT = heavy, heavy-duty truck, LDT = light duty truck, EMFAC = Emission Factor Model for motor vehicles.

The Port has decided that the use of electric dredging equipment would be a project component of the Proposed Project and include constructing the necessary electrical infrastructure in the outer harbor basin to allow for the use of the electrical dredgers. To potentially minimize the significant energy impact as well as highlighting the air quality benefits of electrical dredging, a diesel dredging alternative showing the emissions using diesel dredgers is provided. The Proposed Project includes widening both the IHTB and OHTB to improve the safety and efficiency of maneuvering larger vessels. Proposed Project alternatives include showing the emissions associated with construction of only the IHTB or OHTB, respectively.

B.2.4. Operations and Maintenance Activities

Although the Proposed Project would not change projected cargo throughput at the Port, in-water operations following widening of the turning basins would have some changes compared to existing conditions. The USACE performed an economic analysis of the impact on the Seaport of widening the turning basins, including a forecast in vessel calls by vessel class for the future with the Proposed Project and future without the Proposed Project scenarios (Appendix C of USACE 2023). The vessel fleet mix is expected to change in the future as a result of other economic and global influences to the shipping industry, including growth, efficiency improvements, and vessel emission improvements as well as the physical change to the turning basins. Projected cargo throughput growth and efficiency improvements are anticipated to occur regardless of implementation of the Proposed Project and were the same for both the Proposed Project and No Project future scenarios. For both scenarios, the trend is toward the use of larger ships, resulting in fewer vessel calls to transport the same volume of cargo; however, under the Proposed Project, total vessel calls would be reduced because the future fleet mix would include a greater percentage of large vessels to transport the same volume of cargo. Refer to Section 3.1.1, Baseline Environmental Conditions, for additional discussion regarding the future operational baseline for vessel calls under the Proposed Project and future without the Proposed Project scenarios.

Throughput is the amount of cargo that can pass through a port, and for a container port, this is usually measured in TEUs. A port's maximum practical throughput is called the terminal's capacity (and for container terminals, its container handling capacity), which is how much cargo (or containers) the terminal could handle given its size, configuration, and equipment. A terminal's capacity is limited by either the number of vessels it can accept ("berth-constrained"), or by how much cargo its landside facilities (e.g., container yard, truck gate, pumps, pipelines, and storage tanks) can handle ("yard-constrained").

Much like widening lanes on a roadway to accommodate wider vehicles does not increase its vehicular handling capacity (i.e., allowing more cars to transit through the roadway), widening the turning basins to accommodate longer vessels does not change the Port's container handling capacity (i.e., the number of containers that can move through the port). Widening the turning basins would not change the number of vessels able to berth, nor would it change the constraints of the yard. The Proposed Project does not include landside improvements to increase the Port's cargo (or container) handling capacity, and as a result, the Port's capacity remains constant with this Proposed Project.

Current landside operations include an appointment system and a comprehensive truck management plan to aid in the administration of cargo movement inside the Seaport. The Proposed Project does not include plans to modify these systems, which are designed to enhance and support efficiencies in container deliveries and pickups (e.g., truck movements), thereby aiding to reduce truck-related emissions on the local community.

Although the Proposed Project would increase efficiencies in waterside operations, it does not involve physical changes to landside cargo handling facilities at the Seaport and would not increase cargo throughput. Therefore, landside operations following widening of the turning basins are assumed to remain the same for the Proposed Project and No Project conditions. Additional discussion of factors that influence throughput at the Seaport, including economic forces and regional, national, and international goods movement, is included in the analysis of the Proposed Project's potential growth-inducing impacts, presented in Section 6.3 of this Draft EIR.

The Proposed Project operation would have some changes associated with in-water operations compared to the future No Project baseline scenario. As described in Section 3.1, the mix of OGVs and number of vessel calls are expected to change when compared to the future No Project baseline scenario. All vessels require tugs to assist them when transiting and maneuvering; however, the number of tugs required for a vessel is related to the size of the vessel and varies based on the power of tugs available as well as if the vessel is traveling in-bound or out-bound. The in-water operations are evaluated in comparison to a future No-Project scenario.

On completion, maintenance of the Proposed Project would involve maintenance dredging, bulkhead inspections, and routine maintenance and repairs of bulkhead. The authorized Oakland Harbor commercial waterway is maintained by USACE. This responsibility will continue, and will apply to the new improvements pursuant to the Proposed Project. USACE performs operations and maintenance (O&M) dredging in accordance with the Long-Term Management Strategy (LTMS)³ and the Final Environmental Assessment/Environmental Impact Report for the Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay Fiscal Years 2015-2024, completed by the San Francisco Regional Water Quality Control Board and USACE in April 2015 (2015 EA/EIR). As previously analyzed in the 2015 EA/EIR, the annual O&M volume for the Oakland Harbor waterway (including both turning basins) was anticipated for up to 1,055,000 cubic yards (cy) per year. However, average O&M dredging for the Oakland Harbor waterway is generally between 500,000 and 700,000 cy. The Proposed Project is estimated to add up to 93,000 cy of O&M material annually, which—combined with the annual average—is within the total volume range for the Oakland Harbor waterway analyzed in the 2015 EA/EIR. A new multi-year EA/EIR is planned for coverage of the USACE O&M dredging program for 2025-2034, and will be completed prior to construction of the Proposed Project. The new bulkheads would require periodic inspections, and if necessary, routine maintenance and repairs. It is expected that the bulkhead would be visually inspected above and below water at an interval not to exceed three years. The inspector would remove any areas of accumulated debris or vegetation along the structure. Routine maintenance for minor wear and tear and to maintain the corrosion protection would be performed as needed.

³ The LTMS program comprises state and federal regulatory agencies with primary authority to review and permit dredging and disposal activities in the San Francisco Bay Area. Participating agencies include USACE, United States Environmental Protection Agency, San Francisco Regional Water Quality Control Board, State Water Resources Control Board, San Francisco Bay Conservation and Development Commission, and State Lands Commission.

B.3. Concepts Used in Estimating Criteria Pollutant and Greenhouse Gas Emissions

Several air pollutants of concern would be associated with Proposed Project activities. These air pollutants fall into three categories: criteria air pollutants, toxic air contaminants, and greenhouse gases (GHGs). These are discussed in more detail in the following sections.

B.3.1. Criteria Air Pollutants

Air pollutants are chemicals that are released into the ambient air that may harm human health or the environment, or cause property damage. The U.S. Clean Air Act requires the US EPA to set National Ambient Air Quality Standards (NAAQS) for six common air pollutants. The US EPA calls these criteria pollutants because it regulates them by developing limits that are based on human health and/or environmental criteria. These six criteria air pollutants are carbon monoxide (CO), ozone, nitrogen dioxide (NO₂), sulfur dioxide (SO₂), lead (Pb) and particulate matter. Particulate matter is classified as coarse with an aerodynamic radius of 10 micrometers or less (PM₁₀), and fine with an aerodynamic radius of 2.5 micrometers or less (PM_{2.5}). California has additional pollutants it regulates in its State Ambient Air Quality Standards including visibility-reducing particles, hydrogen sulfide, sulfates, and vinyl chloride.

Carbon Monoxide

Carbon monoxide (CO) is an odorless, colorless gas that is highly toxic. CO is formed by the incomplete combustion of fuels and is emitted directly into the air. Ambient CO concentrations normally are considered a local effect and typically correspond closely to the spatial and temporal distribution of vehicular traffic. CO concentrations are also influenced by wind speed and atmospheric mixing. Under inversion conditions (when a low layer of warm air, along with its pollutants, is held in place by a higher layer of cool air), CO concentrations may be distributed more uniformly over an area to some distance from vehicular sources. CO binds with hemoglobin, the oxygen-carrying protein in blood, and thereby reduces the blood's capacity to carry oxygen to the heart, brain, and other parts of the body. At high concentrations, CO can cause heart difficulties in people with chronic diseases, impair mental abilities, and cause death.

Ozone

Ozone (O₃) is a reactive gas that, in the troposphere (the lowest region of the atmosphere), is a product of the photochemical process involving the sun's energy. It is a secondary pollutant that is formed when nitrogen oxides and reactive organic gases react in the presence of sunlight. Ozone at the Earth's surface causes numerous adverse health effects and is a criteria pollutant. It is a major component of smog. In the stratosphere, ozone exists naturally and shields the Earth from harmful incoming ultraviolet radiation. High concentrations of ground-level ozone can adversely affect the human respiratory system and aggravate cardiovascular disease and many respiratory ailments. Ozone also damages natural ecosystems such as forests and foothill natural communities, agricultural crops, and some human-made materials (e.g., rubber, paint, and plastics).

Nitrogen Oxides

Nitrogen oxides (NO_x) is a family of gaseous nitrogen compounds that are precursors to the formation of ozone and particulate matter. The major component of NO_x, nitrogen dioxide (NO₂), is a reddish-brown gas that is toxic at high concentrations. NO_x results primarily from the combustion of fossil fuels under

high temperature and pressure. On-road and off-road motor vehicles and fuel combustion (use of natural gas for heating, cooking, and industrial use) are the major sources of this air pollutant.

Reactive Organic Gases

Reactive organic gases (ROG) consist of hydrocarbon compounds that exist in the ambient air. ROG contributes to the formation of smog and/or may itself be toxic. ROG emissions are a major precursor to the formation of ozone. Sources of ROG include consumer products, paints, trees that emit ROGs, and the combustion of fossil fuels.

Particulate Matter

Particulate matter (PM) is a complex mixture of extremely small particles and liquid droplets. PM is made up of various components, including acids, organic chemicals, metals, and soil or dust particles. The size of particles is directly linked to the potential for causing health problems. PM particles that are smaller than 10 micrometers in diameter, called PM₁₀, are of most concern because these particles pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects. PM₁₀ particles are typically found near roadways and industrial operations that generate dust. PM₁₀ particles are deposited in the thoracic region of the lungs. Fine particles, called PM_{2.5}, are particles less than 2.5 micrometers in diameter and are found in smoke and haze. PM_{2.5} particles penetrate deeply into the thoracic and alveolar regions of the lungs. Ultrafine particulate matter, which has a diameter less than 0.1 micrometer (PM_{0.1}), is not federally regulated at this time, although it is a subset of PM₁₀ and PM_{2.5} emissions. It is generally recognized that smaller particles are more harmful to human health. Unlike larger particles, PM_{0.1} can penetrate pulmonary tissue, enter the bloodstream, and circulate throughout the body. Thereby, PM_{0.1} can damage internal systems that may be inaccessible to larger particles.

Sulfur Dioxide

Sulfur dioxide (SO₂) is a colorless, irritating gas with a “rotten egg” smell formed primarily by the combustion of sulfur-containing fossil fuels. Suspended SO₂ particles contribute to poor visibility in the San Francisco Bay Area Air Basin and are a component of PM₁₀.

Lead

Lead (Pb) is a metal that is a natural constituent of air, water, and the biosphere. Lead is neither created nor destroyed in the environment, so it essentially persists forever. There is no known safe exposure level to lead. The health effects of lead poisoning include loss of appetite, weakness, apathy, and miscarriage. Lead poisoning can also cause lesions of the neuromuscular system, circulatory system, brain, and gastrointestinal tract and can reduce mental capacity.

Gasoline-powered automobile engines were a major source of airborne lead through the use of leaded fuels. The use of leaded fuel has been mostly phased out since 1996, which has resulted in dramatic reductions in ambient concentrations of lead. Because lead persists in the environment forever, areas near busy highways continue to have high levels of lead in dust and soil.

Hydrogen Sulfide

Hydrogen sulfide (H₂S) is associated with geothermal activity, oil and gas production, refining, sewage treatment plant operations, and confined animal feeding operations. H₂S is extremely hazardous in high concentrations and can cause death.

Sulfates

Sulfates are the fully oxidized, ionic form of sulfur. Sulfates occur in combination with metal and/or hydrogen ions. In California, emissions of sulfur compounds result primarily from the combustion of petroleum-derived fuels (e.g., gasoline and diesel fuel) that contain sulfur. This sulfur is oxidized to SO₂

during the combustion process and subsequently converted to sulfate compounds in the atmosphere. The conversion of SO₂ to sulfates takes place comparatively rapidly and completely in urban areas of California due to regional meteorological features.

CARB's sulfate standard is designed to prevent aggravation of respiratory symptoms. Effects of sulfate exposure at levels above the standard include a decrease in ventilatory function, aggravation of asthmatic symptoms, and an increased risk of cardiopulmonary disease. Sulfates are particularly effective in degrading visibility; and due to the fact that they are usually acidic, can harm ecosystems and damage materials and property.

Vinyl Chloride

Vinyl chloride is a colorless gas that does not occur naturally. It is formed when other substances, such as trichloroethane, trichloroethylene, and tetrachloroethylene, are broken down. Vinyl chloride is used to make polyvinyl chloride (PVC) for a variety of plastic products, including pipes, wire and cable coatings, and packaging materials.

B.3.1.1. Regional and Local Hot Spots

When discussing criteria air pollutants and their impacts, it is important to consider the appropriate scale for considering impacts.

Some pollutants, such as ozone, which are the result of secondary formation in the atmosphere rather than being directly emitted are considered on a regional scale—for instance, the entire San Francisco Bay Area Air Basin rather than the City of Oakland or Alameda. This is because precursors to ozone, specifically emitted ROG and NO_x, require time in the atmosphere to react to form ozone. During this time that the pollutants are reacting in the air, they have likely dispersed in the atmosphere over a large area.

Other pollutants are directly released into the atmosphere and can cause health or environmental effects in the local area and create a “hot spot” or area of high concentration near the location where it is emitted before dispersing and diluting in the atmosphere. These pollutants include CO, SO₂, and lead. Particulate matter is considered both a regional and local “hot spot” pollutant. This includes both PM₁₀ and PM_{2.5}.

In addition, certain other chemicals, such as NO_x, SO_x, volatile organic compounds, and ammonia, contribute to the formation of secondary fine particulates in the atmosphere. Similar to ozone, these secondary fine particulates take time to form in the atmosphere and are generally formed downstream from the location where they are released. Therefore, these chemicals can have an effect on a regional scale. However, the primary or direct emission of particulate matter can also have a local effect and create a “hot spot” location of high concentration of the pollutant before it disperses in the atmosphere or settles out of the air to deposit on the ground.

Because regional pollutants of concern involve complex chemical reactions that are influenced by a multitude of factors related to atmospheric conditions, project-level estimation of concentrations of these pollutants is difficult and not routinely done. Because these regional pollutants are the result of many varied sources contributing to atmospheric concentrations, air pollution control agencies such as the USEPA, CARB, and BAAQMD use complex regional scale models to determine ambient air concentrations for the region as a whole and predict the impact that larger changes in regulations and policies may have on these regional pollutants. Based on these more complex models, the air pollution control agencies estimate the mass of individual precursor and primary pollutants that can be emitted before causing a significant impact to the ambient air quality. The amount of pollutants that can be

emitted without impacting the ambient air quality are usually detailed as mass emission thresholds used in both stationary-source permitting and designated as suggested CEQA thresholds or *de minimis* thresholds under federal general conformity. Using these mass emission thresholds, one can conclude that if project emissions are below these thresholds, they are unlikely to cause a significant increase or an exceedance in the ambient air quality standards for these identified criteria pollutants of regional concern. The mass emission thresholds are typically noted as an annual limit in tons or pounds or as a shorter-term limit such as daily average in pounds.

B.3.2. Toxic Air Contaminants

Toxic air pollutants, known as Hazardous Air Pollutants (HAPs) at the federal level and Toxic Air Contaminants (TACs) at the state level, are pollutants that may lead to serious illness or increased mortality, even when present in relatively low concentrations. These are known or suspected to cause cancer, serious non-cancer health effects (e.g., reproductive effects or birth defects), or adverse environmental effects.

Hundreds of different types of TACs exist with varying degrees of toxicity. Many TACs are confirmed or suspected carcinogens or are known or suspected to cause birth defects or neurological damage. For some chemicals, such as carcinogens, no thresholds exist below which exposure can be considered risk-free. Examples of TAC sources in the Proposed Project area include fossil fuel combustion sources and other chemicals found in building material such as concrete and metal scraps and excavated and dredged material.

Sources of TACs include stationary sources, area-wide sources, and mobile sources. The USEPA maintains a list of 187 TACs, also known as HAPs. These HAPs are also included on CARB's list of TACs (CARB 2023a). According to the California Almanac of Emissions and Air Quality (CARB 2013), many researchers consider Diesel Particulate Matter (DPM) to be a primary contributor to health risk from TACs because particles in diesel exhaust carry a mixture of many harmful organic compounds (such as benzene, ethylbenzene, toluene, and xylenes) and metals, rather than being a single substance, as are other TACs. Combustion of gasoline emits an array of TACs such as benzene, formaldehyde, toluene, and xylenes.

This report does not present detailed Proposed Project TAC emissions because these are developed only for the HRA. The TAC emissions used in the HRA are based on the Proposed Project information regarding construction equipment types and operating times. Many TAC emissions are based on the fraction of a specific TAC found in the exhaust gas compared to the total amount of organic compounds or particulate matter found in exhaust gases. The details of speciating the organic compounds and particulate matter into individual TACs, as well as accounting for the appropriate considerations of time of day and exposure considerations, are discussed in the context of an HRA, which combines the project emissions with air dispersion, exposure, and toxicity information to provide an estimate of the health impacts, including cancer and non-cancer health effects. Information on the speciation of the Proposed Project emissions into individual TACs are included in the detailed HRA of the Proposed Project construction activities in Appendix C of the Proposed Project EIR.

B.3.3. Greenhouse Gases

Gases that trap heat in the atmosphere are called GHGs. GHGs allow sunlight to enter the atmosphere, but trap a portion of the outward-bound infrared radiation, which warms the air. The process is similar

to the effect of greenhouses, which are used to grow plants year-round even during cold months, which raises the internal temperature—therefore the name “greenhouse gas.”

Global climate change is a change in the prevailing weather patterns on Earth that can be measured by wind patterns, storms, precipitation, and temperature. Climate change is a global problem, and GHGs are global pollutants, unlike criteria air pollutants (such as ozone precursors) and toxic air contaminants (TACs), which are pollutants of regional and local concern. Both natural processes and human activities emit GHGs. The natural accumulation of GHGs in the atmosphere regulates the Earth’s temperature; however, emissions from human activities, such as fossil fuel-based electricity production and the use of internal combustion engines and motor vehicles, have elevated the concentration of GHGs in the atmosphere since the start of the industrial revolution. This human-caused (anthropogenic) accumulation of GHGs has contributed to an increase in the temperature of the Earth’s atmosphere and has contributed to global climate change.

Although there is disagreement as to the rate of global climate change, multiple studies published in peer-reviewed scientific journals show that 97 percent or more of actively publishing scientists agree: climate-warming trends over the past century are very likely due to human activities (NASA 2015). Emissions of carbon dioxide (CO₂) and nitrous oxide (N₂O) are byproducts of fossil fuel combustion but are also emitted from other sources including cement manufacture and land use changes such as converting grassland to urban development. Methane (CH₄), a highly potent GHG, results from off-gassing associated with agricultural practices and landfills, as well as from incomplete combustion of fossil fuels.

The principal GHGs are CO₂, CH₄, N₂O, sulfur hexafluoride (SF₆), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and nitrogen trifluoride (NF₃). CO₂ is the reference gas for estimating GHG emissions; that is, the global warming potential (GWP) of CO₂ is used as the standard by which other GHGs are measured. To account for the GWP of different GHGs, emissions are often quantified and reported as CO₂ equivalents (CO₂e), a measure of how much global warming a given type and mass of GHG may cause compared to the equivalent amount of CO₂. For example, SF₆ is a GHG commonly used in the utility industry as an insulating gas in circuit breakers and other electronic equipment. SF₆, while comprising a small fraction of the total GHGs emitted annually worldwide, is a much more potent GHG with 22,800 times the GWP of CO₂. GHG emissions are commonly reported in units of metric tonnes, rather than the more common U.S. short tons, because GHG emissions are commonly compared on a global scale. Climate change is a global problem, and GHGs are global pollutants, unlike criteria air pollutants (such as ozone precursors) and toxic air contaminants (TACs), which are pollutants of regional and local concern. GHGs include CO₂, CH₄, and N₂O, among other pollutants.

GWP ratios are provided by the Intergovernmental Panel on Climate Change (IPCC). Historically, GHG emission inventories were calculated using ratios from the IPCC’s Second Assessment Report (SAR), published in 1996 (IPCC 1995). The IPCC has since updated the ratios based on the latest science in its Fourth Assessment Report, Fifth Assessment Report and Sixth Assessment Report, published in 2007 (IPCC 2007), 2014 (IPCC 2015) and 2022, respectively (IPCC 2022). The California Air Resources Board (CARB) currently uses GWP ratios in the Fourth Assessment Report for the statewide GHG emissions inventory (CARB 2023b); and in the current version of the California Emissions Estimator Model (CalEEMod) (CAPCOA 2022) that is used to calculate CO₂e values for the Project. Compounds that are regulated as GHGs are discussed below.

Carbon Dioxide. In the atmosphere, carbon generally exists in its oxidized form as CO₂. Natural sources of CO₂ include the respiration (breathing) of humans, animals, and plants; volcanic outgassing;

decomposition of organic matter⁴; and evaporation from the oceans. Human-caused sources of CO₂ include the combustion of fossil fuels and wood, waste incineration, mineral production, and deforestation. Natural CO₂ removal processes, such as photosynthesis by land- and ocean-dwelling plant species, cannot keep pace with this extra input of human-made CO₂; consequently, the gas is building up in the atmosphere. CO₂ accounted for approximately 80 percent of anthropogenic GHG emissions in California in 2019 (CARB 2022).

Methane. CH₄ is produced when organic matter decomposes in environments lacking sufficient oxygen. Natural sources include wetlands, termites, and oceans. Decomposition occurring in landfills accounts for the majority of human-generated CH₄ emissions in California and in the United States as a whole. Agricultural processes such as intestinal fermentation in animals (from cows and other animals), manure management, and rice cultivation are also large sources of CH₄ in California. Methane is also released at points of natural gas extraction and in leakages throughout the gas pipeline system.

The GWP of CH₄ is considered by CARB to be approximately 25 times that of CO₂ as averaged over a 100-year timescale. On this timescale, CH₄ accounted for approximately 9 percent of anthropogenic GHG emissions in California in 2019 (CARB 2022). However, because CH₄ breaks down rapidly into CO₂ and water once in the atmosphere, there is growing recognition among climate scientists that a 20-year time horizon is more relevant. The 20-year GWP of CH₄ is between 84 and 87 times greater than that of CO₂. That means methane is a much larger contributor to California's anthropogenic GHG emissions over the shorter time frame of 20 years than originally calculated over 100 years.

Nitrous Oxide. N₂O is produced naturally by a wide variety of biological sources, particularly microbial action in soils and water. Tropical soils and oceans account for the majority of natural source emissions. N₂O is a product of the reaction that occurs between nitrogen and oxygen during fuel combustion. Both mobile and stationary combustion emit N₂O, and the quantity emitted varies according to the type of fuel, technology, and pollution control device used, as well as maintenance and operating practices. Agricultural soil management and fossil fuel combustion are the primary sources of human-generated N₂O emissions in California. N₂O has a GWP of approximately 298 times that of CO₂, and its emissions accounted for approximately 3 percent of anthropogenic GHG emissions in California in 2019 (CARB 2022).

Hydrofluorocarbons, Perfluorocarbons, and Sulfur Hexafluoride. HFCs are primarily used as substitutes for ozone-depleting substances and have global warming potentials that range from hundreds to thousands of times that of CO₂. PFCs and SF₆ are emitted from various industrial processes, including semiconductor manufacturing and electric power transmission and distribution. These accounted for approximately 6 percent of anthropogenic GHG emissions in California in 2019 (CARB 2022).

Nitrogen Trifluoride. NF₃ is primarily used in manufacturing semiconductor and liquid crystal display (LCD) panels, certain types of solar panels, and chemical lasers. The ability to measure NF₃ atmospheric concentrations has only recently become possible, and this has revealed much higher concentrations than originally assumed. This is a major cause of concern because NF₃ is an extremely potent GHG and has a GWP of 17,200 times that of CO₂ (WRI and WBCSD 2013).

⁴ Organic matter is matter composed of organic compounds that come from the remains of organisms such as plants and animals.

B.3.4. Emission Estimation Principles

Emissions are generally quantified based on the amount of activity that causes pollutants to be released and the rate per unit of time of activity that the pollutants are released. In general, this relationship can be represented in the generic equation as follows:

$$\text{Emissions} = \text{Activity} * \text{Load} * \text{Emission Factor}$$

Where:

Emissions = Total mass of emissions emitted from a given source reported in units of pounds, tons, or metric tonnes.⁵

Activity = Total number of hours a source operated or the total distance traveled in the instance of a vehicle.

Load = How hard a source was working that may influence the amount of emissions, such as the actual horsepower the engine was operating at rather than the design maximum or fuel consumption or speed at which a source was traveling.

Emission Factor = The rate at which a pollutant is emitted per unit of activity and load. for instance, pounds of pollutant per brake-horsepower-hour or grams of pollutant per gallon of fuel.

This report uses this basic equation to estimate the criteria pollutant, TAC, and GHG emissions from the Proposed Project construction and operation. The equation is modified to fit circumstances and becomes more complex in defining different aspects of the emission factors and engine load to characterize the activity, load, and other factors that influence the emission factor, such as deterioration of engines as they age. These details are explained in the next section for each type of source that would be used for the Proposed Project construction and operation.

B.4. Methods and Results for Estimating Construction Emissions

The Proposed Project's construction would use several different types of equipment that would directly or, in the case of electric equipment, indirectly emit pollutants. These source types can be classified as off-road construction equipment that operates on the land, in-water equipment that operates on/in the water or mounted on a vessel on the water, on-road vehicles including heavy, heavy-duty hauling trucks (HHDT), and worker vehicles. In addition to pollutant emissions that these equipment and vehicles would create, they would also create fugitive dust. The emission calculations described below follow standard guidance from USEPA, CARB, and BAAQMD and use site specific information when appropriate and available for the analysis.

B.4.1. Off-Road Construction Equipment

The main type of pollutant-emitting equipment used during land-side construction activities is construction off-road equipment such as loaders, dozers, excavators, drill rigs, generators, pile drivers, cranes, compressors, and concrete saws. Because the majority of off-road construction equipment currently uses diesel fuel, it is assumed that all land-side construction equipment would be diesel fueled.

⁵ GHG emissions are commonly reported in units of metric tonne rather than the more common U.S. short ton because GHG emissions are commonly compared on a global scale.

Although there is alternatively fueled equipment such as natural gas, propane, and hydrogen as well as some hybrid and electric construction equipment, these are not as readily available at the current time and often do not easily have the necessary refueling or recharging infrastructure readily available for use on a temporary construction site. Assuming that all land-side construction equipment would be diesel-fueled is a conservative assumption that overestimates the air pollutant and GHG emissions.

The calculations are based on lists of construction equipment needed for each phase of construction along with the number of construction working days for each phase. Because the Proposed Project is an infrastructure project, it is likely that pieces of off-road equipment used for Proposed Project construction would be larger than those typically used in commercial residential construction. Therefore, in many cases the default horsepower typically used in a model such as the California Emission Estimator Model (CalEEMod) underestimates the horsepower. In these instances, calculations used reasonably expected off-road equipment sizes (horsepower) based on information from similar past projects and input from vendors and contractors with knowledge of this type of work. This includes cranes, excavators, generators, loader, diesel hammer, and vibratory pile driver.

To calculate construction emissions from land-side off-road equipment, each piece of equipment has a specific maximum engine power rating, typically in units of horsepower or kilowatts. Construction equipment rarely operates at the maximum rated engine power, so to account for the amount of power that is actually used, a load factor is applied that represents the typical percentage of the maximum engine power rating that is used during an hour of use. Default load factors used are consistent with those used in CalEEMod and CARB's OFFROAD model. Emission factors for each off-road equipment is complex and involves several factors. The engine tier (defined by USEPA to limit air pollutant emissions to specific levels) of the equipment specifies the levels of emissions during the initial useful life of the equipment to which is applied a deterioration factor based on the degradation of an engine over time based on the amount of activity accumulated on the engine (usually reported in hours of usage). At any given time, there is a range of equipment engine tiers and equipment ages for a given specific off-road equipment type and size. For instance, during construction of a project, several hundred excavators of the same size with different engine tiers and age could be in use. CARB's OFFROAD model makes estimates of the approximate age and engine tiers of a piece of equipment's fleet for a given future calendar year based on CARB's knowledge of fleet composition and anticipated turnover of fleets as the fleet's age. Therefore, the emission factors use a weighted estimate of the emissions for a specific equipment engine and size if no other knowledge about the specific piece of equipment that would be used is known.

The following equation is used to estimate emissions from off-road construction equipment:

$$Emissions_i = \sum_j Activity_j * Horsepower_j * Load Factor_j * EF_{i,j} * CF$$

Where:

- Emissions_i = Emissions of pollutant i in units of (tons)
- Activity_j = Number of total operating hours (hours per day times phase work days) of off-road equipment j
- Horsepower_j = Maximum rated horsepower (hp) or kilowatts (kw) of off-road equipment j
- Load Factor_j = Load factor (fraction of full engine power used) for off-road equipment j
- EF_{i,j} = Emission factor for pollutant i for off-road equipment j (g/bhp-hr or g/kw-hr)
- CF = A factor to convert the units of the emission factor pounds or grams to tons

Table 7 shows the anticipated off-road equipment, the corresponding OFFROAD equipment type, and the representative horsepower and load factors assigned to the land-side equipment anticipated for use in Proposed Project construction as listed in **Table 2**.

Table 7: Land Side Off-Road Equipment Engine Specifications

Off-Road Equipment	OFFROAD2021 Name	Horsepower	Load Factor
Backhoe/Loader	Tractors/Loaders/Backhoe	286	0.37
Compressor	Air Compressor	78	0.48
Concrete Saw	Concrete Industrial Saw	81	0.73
Crane	Cranes	231	0.29
Crane with clamshell	Cranes	755	0.29
Diesel hammer	Other Construction Equipment	172	0.42
Drilling Rig	Bore/Drill Rig	221	0.50
Dozer	Rubber-Tired Dozers	347	0.40
Excavator	Excavator	411	0.38
Generator	Portable Generator	244	0.74
Smooth Drum Roller	Smooth Drum Roller	80	0.38
Torch	Welder	46	0.45
Vibratory Hammer	Other Construction Equipment	595	0.42

The specifications used for cranes, excavators, generators, loader, diesel hammer, and vibratory pile driver were based on reasonably expected equipment to be used for the Proposed Project based on information from similar past projects and input from vendors and contractors with knowledge of this type of work. CARB’s OFFROAD database was used to obtain the weighted emission factors for the land-side off-road equipment based on the horsepower category. In some instances, there was no suitable equipment in the OFFROAD database for a specific horsepower category. In these instances, the equipment population from the next size larger horsepower category was used to determine the age distribution of equipment and the typical annual hours of use. Using the model years of equipment zero-hour emission factor (the emission factor when the equipment is new and not aged) along with the deterioration factor (a factor of percent increase in emissions as the equipment is used and ages), a weighted average emission factor for this equipment was derived. The equation used to derive these emission factors is shown in the following generic equation:

$$\text{Weighted Emission Factor}_i = \sum_k \text{Pop}_k * (\text{EF}_{zhr,i} + \text{Det}_i * \text{CumHours}_k) * \text{FCF}_i$$

Where:

Weighted Emission Factor _i	= Weighted emission factor for a given calendar year based on the weighted population of all equipment model years for pollutant i.
Pop _i	= Fraction of the population of a specific model year in a given calendar year.
EF _{zhr,i}	= Zero-hour emissions factor for a given model year engine when it is brand new for pollutant i.
Det _i	= Deterioration rate for a given engine for a specific pollutant i.
CumHours _k	= Cumulative hours on a specific model year of equipment k
FCF _i	= Fuel correction factor for pollutant i. This adjusts the zero-hour emission factor that may have been tested on a different fuel such as one with higher sulfur content. It typically impacts NO _x , ROG, and PM.

The mitigated scenario assumes all Tier 4 final equipment is used in land-side off-road equipment. To derive the appropriate emission factors, a similar weighted emission factor was derived based on the equipment population in OFFROAD, but restricted to those model years when Tier 4 final equipment was required to be in place and excluded model years that Tier 4 final equipment was not required to be manufactured. Deterioration factors were similarly applied to this Tier 4 final equipment based on the average annual hours added to the equipment each year of its age to calculate the cumulative hours on a specific model year in the desired calendar year.

B.4.2. On-Road Construction Hauling

Construction would require on-road vehicles to haul material to and from the site. This analysis estimated the amount of material that may be sent to a Class I (hazardous) landfill and a Class II (non-hazardous) landfill from Proposed Project construction. It was assumed that much of the building material and concrete debris would be sent to a waste recycler. Equipment and supplies used in construction, such as the delivery of the off-road construction equipment itself—such as an excavator, sheet piles, and other supplies—would need to be delivered to the Proposed Project sites. It was assumed that all of these construction equipment and material supplies would be transported to and from the site using heavy, heavy-duty trucks or HHDT EMFAC class.

To calculate emissions from these on-road construction trucks, the total number of trips and distance to the destination needs to be known. The estimate uses emission factors from CARB’s EMFAC2021 for the BAAQMD fleet. It was assumed that all HHDT operate using diesel fuel. The trip lengths for the different types of truck trips are shown in **Table 8**.

Table 8: On-Road Vehicle Trip Lengths

Trip Type	One-Way Trip Length (miles)
Class I (hazardous) Landfill ¹	201
Class II (non-hazardous) Landfill ²	32
Recycler ³	10
Other Hauling Vendor Trips ⁴	20
Workers ⁴	10.8

Notes:

- 1 The Class I landfill location is assumed to be Kettleman Hills Landfill located in Kettleman City, California.
- 2 The Class II landfill location is assumed to be Keller Canyon Landfill located near Pittsburg, California
- 3 Material acceptable for recycling or reuse would be hauled to Argent Materials located in Oakland, California or another local recycler.
- 4 The default CalEEMod trip lengths were used for vendor trips and workers.

Construction emissions from material hauling are determined by multiplying the number of trips times the trip length times the running emission factors as shown in the following equation:

$$Emission_i = \sum_m Trip_m * TripLength_m * EF_{run,i}$$

Some vehicles have starting emissions (emissions that occur based on starting the engine) as well as hotsoak⁶ and running loss emissions. These are assumed to be one start per trip and are calculated by multiplying the number of trips by the starting exhaust emission factors as shown in the following equation:

$$Emission_i = \sum_m Trip_m * EF_{start,i}$$

Diurnal⁷ and idling emissions were not included in emission calculations. Diurnal emissions are not included because they occur whether the vehicle is used or not by the Proposed Project, and are quantified based on the existence of the equipment rather than a specific use. Idling emissions are not included because it is unknown how much idling would be done along the full travel path, and it is limited by regulations to be less than 5 minutes.

EMFAC also estimates fugitive dust emissions from tire and brake wear. These are calculated based on the trips times the trip length and the emission factor as shown in the following equation:

$$Emission_i = \sum_m Trip_m * TripLength_m * EF_i$$

⁶ Hotsoak emissions are evaporative emissions for a one-hour period after termination of engine operation.

⁷ Diurnal emissions are evaporative emissions resulting from the daily cycling of ambient temperatures and include resting losses, and permeation emissions.

B.4.3. Worker Vehicles

Workers traveling to and from the site were assumed to make only a single trip to the site and from the site daily. The worker vehicles were assumed to all be gasoline, and a 75 percent mix of light-duty automobiles (LDA) and a 25 percent mix of light-duty truck 1 (LDT1). The trip length for workers is shown in **Table 8**. Worker vehicles use the same equations as material hauling, except for using the emission factors for the LDA and LDT1 EMFAC vehicle classes.

B.4.4. In-Water Equipment

The in-water work would require the use of different types of harbor craft vessels. This includes dredging equipment, dive boats, barges or smaller barges known as scows, and tug boats specifically of the towboat type, which are smaller than ship-assist tug boats used to assist ships.

B.4.4.1. Dredging Equipment

The unmitigated and mitigated Proposed Project scenarios would use electric dredging equipment. This equipment would use electricity as a power source except for the period of time a crane is working at Berth 10 to offload dredged material (Class II [non-hazardous]) for rehandling prior to its transport to a landfill. The diesel emissions from this crane working at Berth 10 are included in the off-road calculations for a crane of this size.

Electricity use does not result in direct emissions of criteria pollutants, and is not included in the emission inventory because their impact is in the area where the work is occurring, and the location of power generation can be far removed from the project site. However, electricity use is considered to result in indirect GHG emissions for the emissions that would occur at the location where the electricity is generated. Because GHG emissions are a global issue, it is important to include these indirect emissions to have a global accounting of the GHG emissions. Because criteria pollutants and TAC emissions are felt at either the local or regional level, indirect emissions are typically not quantified for these pollutants.

The electric dredgers are expected to need 1,247 kilowatts of electricity per hour of operation. The power content label for the utility company that is responsible for delivering the electricity used by the dredgers is used to estimate the GHG emissions in terms of CO₂e per megawatt-hour. For the inner harbor dredging activities, the electricity would be drawn from the connection on Alameda. These emissions use the carbon intensity reported in 2021 for Alameda Municipal Power of 117 pounds CO₂e per megawatt-hour. In the alternative using Howard Terminal as source of electrical power, the carbon intensity would use the Port of Oakland Municipal Power carbon intensity reported in 2021 of 314 pounds per megawatt-hour. For the Outer Harbor dredging, this would draw electricity from the Proposed Project's constructed connection near Berth 26 and use the Port of Oakland Municipal Power carbon intensity reported in 2021 of 314 pounds per megawatt-hour.

For the Proposed Project Alternatives, emissions are calculated assuming diesel dredgers are used. Diesel dredgers emissions are based on the engine size, load factor, and emission factor. The emission factor depends on the zero-hour emission factor, deterioration rate based on the fraction of the useful life, and fuel correction factors. This is represented by the following equation below:

$$\text{Weighted Emission Factor}_i = \sum_k \text{Pop}_k * \left(EF_{zhr,i} + Det_i * \frac{Age}{UL} \right) * FCF_i$$

CO and ROG do not have a fuel correction factor. To convert PM₁₀ to PM_{2.5}, a factor of 0.97 is applied. The zero-hour emission factors, deterioration rate, and fuel correction factor (FCF) are from CARB’s latest harbor craft emission inventory methodology (CARB 2021).

The diesel dredger consists of a large crane with clamshell (considered a main engine), two other main engines, and an auxiliary engine. **Table 9** shows the horsepower, load factors, useful life, and age of the engines assumed in this analysis.

Table 9: Diesel Dredger Engine Specifications

Off-Road Equipment	Horsepower	Load Factor	Age in 2027	Useful Life
Crane with Clamshell	755	0.44	9	15
Main Engine	300	0.44	19	15
Main Engine	300	0.44	19	15
Auxiliary Engine ⁴	325	0.57	19/1 (2029)	13

Notes:

- 1 The dredge is assumed to be the current model year engines in 2027, and it is assumed that in 2029 the auxiliary engines would be upgraded based on the harbor craft regulation. It was assumed that they would be upgraded to Tier 4 final, but not necessarily have incorporated the diesel particulate filters.

B.4.4.2. Tug Boats

The Proposed Project construction would use two different sized tug boats, called towboats because their purpose is to tow and orient barges and scows into position and transport them to the beneficial reuse site. For the purposes of this emission estimation, the towboat that would operate in the IHTB and OHTB to move barges and scows around was reasonably expected to be similar to the Becky T towboat. The representative towboat to transport the barges/scows to the beneficial reuse area was assumed to be Sarah Reed towboat. The engine characteristics of these tugs are shown in **Table 10**. Towboats (Becky T) were assumed to operate 4 hours during a given shift, because this is consistent with the ratio in the Port’s emission inventory.

Table 10: Tow Boat Engine Specifications

Off-Road Equipment	Quantity	Horsepower	Load Factor	Age in 2027 ¹	Useful Life (years)
<i>Sarah Reed</i> Main Engine	2	640	0.33	19/1	14
<i>Sarah Reed</i> Auxiliary Engine	1	132	0.37	18/1	16
<i>Heidi Brusco</i> Main Engine	1	3000	0.33	19/1	14
<i>Heidi Brusco</i> Auxiliary	1	161	0.37	18/1	16

Notes:

- 1 The tow boats are assumed to be the current model year engines in 2027; it is assumed that in 2028 the engines would be upgraded based on the harbor craft regulation. It was assumed that they would be upgraded to Tier 4 final, but not necessarily have incorporated the diesel particulate filters.

B.4.4.3. Other In-Water Equipment

Dive boats are another type of harbor craft equipment that would be used in Proposed Project construction. Emissions from these boats are calculated similarly to the methods used for other harbor craft vessels (e.g., tugboats and dredgers). The engine specifications for these dive boats are shown in **Table 11**.

Barges and scows generally only have auxiliary engines on them because they do not move on their own power. The specifications assumed for the barges and scows are also shown in **Table 11**.

Table 11: Dive Boat Engine Specifications

Off-Road Equipment	Horsepower	Load Factor	Age in 2027	Useful Life
Dive Boat Main	622	0.33	19	22
Dive Boat Auxiliary	464	0.32	19	28
Barge/Scow Auxiliary	225	0.31	19	14

Barge and scow auxiliary engines were assumed to only operate 1 hour per day because this type of craft rarely uses its engine for this work.

B.4.5. Fugitive Dust Emissions

Fugitive dust is generated by the various source activities occurring at a construction site, contributing to PM₁₀ and PM_{2.5} emissions. Fugitive dust emissions are distinguished from exhaust particulate matter emissions. The types of fugitive dust emissions that can occur at a construction site include fugitive dust from equipment passing over the ground, dozers and excavators pushing dirt into piles, loading dirt and other material from piles into trucks, and dust from wind-blown soil erosion of storage piles. Road dust from vehicles traveling on roads is another form of fugitive dust that occurs in addition to the generation of tire and brake wear discussed in Section 4.2.

B.4.5.1. Grading

Fugitive dust emissions from equipment passes over land are estimated using the methodology described in Section 11.9 of USEPA’s AP-42, which is a compilation of air pollutant emission factors (USEPA 1998). Section 11.9 provides guidance to estimate the emission factor of PM₁₀ by applying a scaling factor to PM₁₅. Similarly, the emission factor of PM_{2.5} is scaled from that of total suspended particulates (TSP). The following presents the equations used to calculate the emission factors for PM₁₅ and TSP and the scaling factors for PM₁₀ and PM_{2.5}.

$$EF_{PM10} = 0.051 * S^{2.0} * F_{PM10}$$

$$EF_{PM2.5} = 0.04 * S^{2.5} * F_{PM2.5}$$

Where:

- EF = Emission factor for PM₁₀ or PM_{2.5} in units of (lb/vehicle miles traveled [VMT])
- S = Mean vehicle speed (mph) the AP-42 default is 7.1 mph
- F_{PM2.5} = PM_{2.5} scaling factor. The AP-42 default value is 0.031
- F_{PM10} = PM₁₀ scaling factor. The AP-42 default value is 0.6

Grading dust emission are calculated by multiplying the emission factors with the total vehicle miles traveled (VMT) for the grading equipment. To calculate the VMT, the number of acres or square feet of a work site area is divided by the assumed width of an equipment pass of 12 feet and unit conversions to from feet to miles. The calculation results in a VMT for the Howard terminal site of 6.27 miles and for the Alameda site of 6.12 miles.

B.4.5.2. Bulldozing

The bulldozing, which is moving dirt around into piles, emission factors for fugitive dust are based on the AP-42 Section 11.9 and use the following equations:

$$EF_{PM10} = \frac{C_{PM15} * S^{1.2}}{M^{1.3}} * F_{PM10}$$

$$EF_{PM2.5} = \frac{C_{TSP} * S^{1.2}}{M^{1.3}} * F_{PM2.5}$$

Where:

- EF = Emission factor in pounds/hour
- C = Arbitrary coefficient used by AP-42.
- M = Material moisture content (%)
- s = Material silt content (%)
- F = Scaling factor

Typical values for overburden material or top layer of soil for these variables are shown in **Table 12**. These emission factors are multiplied by the number of hours that a bulldozer or other equipment doing similar activity is working. For the Proposed Project, all dozer and excavator activity was assumed to generate fugitive dust from bulldozing.

Table 12: Bulldozing Fugitive Emission Factors

Variable	Value
C _{TSP}	5.7
C _{PM15}	1.0
M	7.9%
s	6.9%
F _{PM10}	0.75
F _{PM2.5}	0.105

B.4.5.3. Truck Loading

Dumping earthen materials (soil or other material) on a pile or loading such material from a pile to a truck with a front-end loader causes fugitive dust emissions. The method used is based on Section 13.2.4

of USEPA AP-42 (USEPA 2006). The emission factor is based on the material moisture content and mean wind speed, and is calculated using the following equation.

$$EF = k * 0.0032 * \left(\frac{U}{5}\right)^{1.3} / \left(\frac{M}{2}\right)^{1.4}$$

Where:

- EF = Emission factor in pound per short ton (typical ton used in the United States representing 2,000 pounds)
- k = Particulate size multiplier. The AP-42 default value for PM₁₀ is 0.35 and PM_{2.5} is 0.053.
- U = Mean wind speed. This was assumed to be 3.2 miles per hour.
- M = Material moisture content (%). The moisture content of the loaded material was assumed to be 12%.

Fugitive dust emissions are calculated by multiplying the emission factor with the amount of material loaded and unloaded in short tons.

B.4.5.4. Building Demolition and Debris Loading

Building demolition is estimated using AP-42 equation for batch drop operations as suggested in a report from the Midwest Research Institute (1988) as follows:

$$EF_D = k * 0.0032 * \left(\frac{U}{5}\right)^{1.3} / \left(\frac{M}{2}\right)^{1.4}$$

Where:

- EF = Emission factor in pound per short ton of debris
- k = Particulate size multiplier. The AP-42 default value for PM₁₀ is 0.35 and PM_{2.5} is 0.053.
- U = Mean wind speed. This was assumed to be 3.2 miles per hour.
- M = Material moisture content (%). The moisture contents used was 2%.

The dust emissions are calculated by multiplying the above emission factors with the total weight of building waste.

The debris loading emission factors for fugitive dust are scaled from the emission factor for TSP according to the following equation:

$$EF_L = k * EF_{L-TSP}$$

Where:

- EF_L = Loading dust emission factor in units of pounds per short ton of debris loaded.
- k = Particle size multiplier. The AP-42 default values are 0.35 for PM₁₀ and 0.053 for PM_{2.5}.
- EF_{L,TSP} = Loading TSP emission factor (pounds per short ton. The default value is 0.058 pound per short ton.

The PM₁₀ and PM_{2.5} fugitive dust emission from debris loading are then calculated by multiplying the calculated emission factor by the short tons of material to be loaded.

B.4.5.5. Storage Pile

Fugitive dust emissions from storage piles as a result of wind erosion were calculated based on the emission factor 1.7 pounds PM₁₀ per acre-day, as described in the BAAQMD permitting handbook. It was assumed that control of piles with watering would result in a 70 percent control efficiency, which corresponds to the maximum allowed by BAAQMD in its permitting guidance. It should be noted that many other air districts allow up to 90 percent control efficiencies, which is supported by Western Regional Air Partnership (WRAP) (WRAP 2006). Therefore, the estimate of fugitive dust from storage piles is conservative in its assumption of control. It was assumed that there would be up to acre of storage piles at both the Howard Terminal location and Alameda location. It was assumed that Berth 10 could have up to 4.4 acres of storage piles.

B.4.5.6. Road Dust

Vehicles that drive on roads generate fugitive dust by dispersing the silt from the roads. Fugitive dust emission factors for travel on paved roads are calculated using the methodology described in Section 13.2.1 of USEPA AP-42 as shown below:

$$EF_{paved} = k * sL^{0.91} * W^{1.02}$$

Where:

- EF_{paved} = Paved road dust emission factor in grams per mile
- k = Particle size multiplier for particle size range. The AP-42 default values are 0.25 g/VMT for PM_{2.5} and 1.00 g/VMT for PM₁₀.
- sL = Road surface silt loading (grams/cubic meter). The AP-42 default value is 0.1 g/m², which corresponds to vehicle travel on roads with at least 5000 vehicles per day under normal conditions.
- W = Average weight (short tons) of all the vehicles traveling the road. It was assumed that there would be a large percentage of trucks on the roads used by the Proposed Project and therefore the average weight was chosen to be 20 tons.

It was assumed that all roads were paved roads used by construction hauling equipment. The emission factor for paved roads is multiplied by the VMT (miles traveled) to get total emissions from paved road dust.

B.4.6. Total Air Quality and GHG Emissions Results – Proposed Project

The total criteria air pollutant emissions are shown in **Table 13** and **Table 15**. Detailed tables showing the specific equipment activity by phase and emission factors are included at the end of this report in **Table 25** through **Table 31**.

B.4.7. Total Air Quality and GHG Emissions Results – Proposed Project Alternatives

The total criteria air pollutant emissions for Proposed Project Alternatives are provided in **Table 15** through **Table 17**. Detailed tables detailing the specific equipment activity by phase and emission factors for the Alternatives are included at the end of this report in **Table 32** through **Table 38**. For the diesel dredging alternative, only the diesel dredging emissions are different than the mitigated emission calculation details and is the only table shown.

Table 13: Unmitigated Proposed Project Construction Emissions

	Emissions (tons)							Emissions (Metric Tonnes)			
	CO	ROG	NO _x	Ex PM ₁₀	Ex PM _{2.5}	Fug PM ₁₀	Fug PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO ₂ e
Totals by Category											
Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	610
In Water	1.61	0.22	4.66	0.77	0.75	0.00	0.00	1,129	0.00	0.04	1,142
OffRoad	6.52	1.15	6.47	0.73	0.71	12.76	9.11	1,603	0.47	0.42	1,741
Roads	0.96	0.09	3.66	0.06	0.05	2.84	0.72	3,114	0.01	0.46	3,252
Tugs to Reuse	10.33	1.40	15.99	1.32	1.28	0.00	0.00	7,280	0.02	0.36	7,387
Totals by Location											
Howard Terminal	3.78	0.46	5.76	0.42	0.40	2.77	0.76	2178.16	0.03	0.14	2299.66
Schnitzer/Radius	0.42	0.04	0.66	0.12	0.11	0.18	0.14	191.43	0.00	0.01	193.81
Alameda	7.31	0.91	12.49	0.98	0.94	5.28	1.89	5524.14	0.05	0.47	5725.39
Inner Harbor	0.71	0.09	1.17	0.12	0.12	0.09	0.02	572.91	0.00	0.04	636.74
Outer Harbor	6.75	0.91	10.25	0.78	0.76	6.83	6.57	4659.70	0.02	0.21	5143.98
Berth 26	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.41	0.41	0.41	131.69
Totals by Year											
2027	2.37	0.67	3.04	0.67	0.66	3.19	1.35	621	0.42	0.43	760
2028	10.04	1.27	14.91	1.03	0.99	4.54	1.81	6,680	0.05	0.39	7,271
2029	7.00	0.93	12.83	1.17	1.13	7.88	6.68	5,825	0.03	0.46	6,101
TOTAL	19.42	2.86	30.77	2.87	2.78	15.60	9.83	13,127	0.50	1.28	14,131
Average Daily Emissions (lb/day)											
2027	27	8	35	8	8	36	15	7098	5	5	8681
2028	55	7	82	6	5	25	10	36604	0	2	39841
2029	42	6	77	7	7	47	40	34883	0	3	36531

Table 14: Mitigated Proposed Project Construction Emissions

	Emissions (tons)							Emissions (Metric Tonnes)			
	CO	ROG	NO _x	Ex PM ₁₀	Ex PM _{2.5}	Fug PM ₁₀	Fug PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO ₂ e
Totals by Category											
Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	610
Diesel Dredging	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	-
In Water	1.61	0.22	4.66	0.77	0.74	0.00	0.00	1,129	0.00	0.04	1,142
OffRoad	1.71	0.26	0.67	0.21	0.20	12.45	8.79	1,603	0.18	0.14	1,648
Roads	0.96	0.09	3.66	0.06	0.05	2.84	0.72	3,114	0.01	0.46	3,252
Tugs to Reuse	10.33	1.40	15.99	1.32	1.28	0.00	0.00	7,280	0.02	0.36	7,387
Totals by Location											
Howard Terminal	2.25	0.27	3.90	0.35	0.34	2.77	0.76	2,178	0.03	0.14	2,300
Schnitzer/Radius	0.28	0.03	0.52	0.11	0.11	0.18	0.14	191	0.00	0.01	194
Alameda	4.54	0.55	9.09	0.85	0.82	5.28	1.89	5,524	0.05	0.47	5,725
Inner Harbor	0.70	0.09	1.17	0.12	0.12	0.09	0.02	573	0.00	0.04	637
Outer Harbor	6.70	0.90	10.18	0.78	0.76	6.83	6.57	4,660	0.02	0.21	5,144
Berth 26	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0	0.12	0.12	39
Totals by Year											
2027	0.80	0.19	1.16	0.30	0.29	2.87	1.03	621	0.14	0.14	667
2028	8.18	1.05	12.85	0.95	0.92	4.54	1.81	6,680	0.05	0.39	7,271
2029	5.62	0.73	10.98	1.10	1.07	7.88	6.68	5,825	0.03	0.46	6,101
TOTAL	14.60	1.97	24.98	2.35	2.28	15.29	9.51	13,127	0.22	1.00	14,039
Average Daily Emissions (lb/day)											
2027	9	2	13	3	3	33	12	7095	2	2	7623
2028	45	6	70	5	5	25	10	36604	0	2	39841
2029	34	4	66	7	6	47	40	34883	0	3	36531

Table 15: Mitigated with Energy Mitigation Proposed Project Construction Emissions

	Emissions (tons)							Emissions (Metric Tonnes)			
	CO	ROG	NO _x	Ex PM ₁₀	Ex PM _{2.5}	Fug PM ₁₀	Fug PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO ₂ e
Totals by Category											
Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	610
Diesel Dredging	0.42	0.08	1.11	0.32	0.31	0.00	0.00	198	0.00	0.01	201
In Water	1.61	0.22	4.66	0.77	0.74	0.00	0.00	1,129	0.00	0.04	1,142
OffRoad	1.71	0.26	0.67	0.21	0.20	12.45	8.79	1,603	0.18	0.14	1,648
Roads	0.96	0.09	3.66	0.06	0.05	2.84	0.72	3,114	0.01	0.46	3,252
Tugs to Reuse	10.33	1.40	15.99	1.32	1.28	0.00	0.00	7,280	0.02	0.36	7,387
Totals by Location											
Howard Terminal	2.35	0.29	4.17	0.43	0.42	2.77	0.76	2,228	0.03	0.14	2,350
Schnitzer/Radius	0.28	0.03	0.52	0.11	0.11	0.18	0.14	191	0.00	0.01	194
Alameda	4.59	0.56	9.23	0.88	0.85	5.28	1.89	5,549	0.05	0.48	5,751
Inner Harbor	0.76	0.10	1.31	0.17	0.16	0.09	0.02	598	0.00	0.04	662
Outer Harbor	6.91	0.94	10.73	0.95	0.92	6.83	6.57	4,759	0.02	0.22	5,244
Berth 26	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0	0.12	0.12	39
Totals by Year											
2027	0.80	0.19	1.16	0.30	0.29	2.87	1.03	621	0.14	0.14	667
2028	8.39	1.08	13.40	1.11	1.07	4.54	1.81	6,779	0.05	0.40	7,371
2029	5.83	0.77	11.53	1.26	1.22	7.88	6.68	5,924	0.04	0.46	6,201
TOTAL	15.02	2.04	26.09	2.67	2.59	15.29	9.51	13,324	0.22	1.00	14,240
Average Daily Emissions (lb/day)											
2027	9	2	13	3	3	33	12	7095	2	2	7623
2028	46	6	73	6	6	25	10	37146	0	2	40391
2029	35	5	69	8	7	47	40	35475	0	3	37132

Table 16: Diesel Dredging Alternative Construction Emissions

	Emissions (tons)							Emissions (Metric Tonnes)			
	CO	ROG	NO _x	Ex PM ₁₀	Ex PM _{2.5}	Fug PM ₁₀	Fug PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO ₂ e
Totals by Category											
Diesel Dredging	7.96	1.41	20.95	6.21	6.02	0.00	0.00	3739.57	0.02	0.18	3,795
In Water	1.61	0.22	4.66	0.77	0.75	0.00	0.00	1130.07	0.00	0.04	1,143
OffRoad	1.70	0.26	0.67	0.21	0.20	12.45	8.79	589.01	0.18	0.14	634
Roads	0.96	0.09	3.66	0.06	0.05	2.84	0.72	3113.97	0.01	0.46	3,252
Tugs to Reuse	10.33	1.40	15.99	1.32	1.28	0.00	0.00	7280.30	0.02	0.36	7,387
Totals by Location											
Howard Terminal	3.13	0.42	6.24	1.03	0.99	2.77	0.76	2257.59	0.03	0.16	2,306
Schnitzer/Radius	0.28	0.03	0.52	0.11	0.11	0.18	0.14	166.63	0.00	0.01	169
Alameda	6.31	0.86	13.80	2.28	2.21	5.28	1.89	5713.02	0.06	0.52	5,868
Inner Harbor	1.29	0.20	2.72	0.60	0.58	0.09	0.02	848.22	0.00	0.05	864
Outer Harbor	11.42	1.74	22.53	4.40	4.27	6.83	6.57	6867.34	0.03	0.32	6,964
Berth 26	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12	39
Totals by Year											
2027	0.80	0.19	1.16	0.30	0.29	2.87	1.03	353	0.14	0.14	399
2028	13.49	1.99	26.76	5.00	4.85	4.54	1.81	8,774	0.06	0.51	8,928
2029	8.27	1.20	18.01	3.25	3.16	7.88	6.68	6,727	0.04	0.52	6,883
TOTAL	22.57	3.38	45.93	8.56	8.30	15.29	9.51	15,853	0.24	1.18	16,210
Average Daily Emissions (lb/day)											
2027	9	2	13	3	3	33	12	4,029	2	2	4,557
2028	74	11	147	27	27	25	10	48,075	0	3	48,923
2029	50	7	108	19	19	47	40	40,280	0	3	41,216

Table 17: Inner Harbor Turning Basin Only Alternative Construction Emissions

	Emissions (tons)							Emissions (Metric Tonnes)			
	CO	ROG	NO _x	Ex PM ₁₀	Ex PM _{2.5}	Fug PM ₁₀	Fug PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO ₂ e
Totals by Category											
Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	190
Diesel Dredging	1.25	0.17	4.01	0.69	0.67	0.00	0.00	874	0.00	0.04	887
In Water	1.57	0.12	0.54	0.07	0.07	11.68	8.17	589	0.06	0.02	595
OffRoad	0.84	0.08	3.65	0.06	0.05	2.73	0.69	3,077	0.01	0.46	3,215
Roads	4.17	0.57	6.48	0.62	0.60	0.00	0.00	3,238	0.01	0.16	3,285
Tugs to Reuse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	190
Totals by Location											
Howard Terminal	2.35	0.29	4.17	0.43	0.42	2.77	0.76	1,985	0.03	0.15	2,108
Schnitzer/Radius	0.28	0.03	0.52	0.11	0.11	0.18	0.14	167	0.00	0.01	169
Alameda	4.59	0.56	9.23	0.88	0.86	5.28	1.89	5,070	0.05	0.48	5,274
Inner Harbor	0.76	0.10	1.31	0.17	0.16	0.09	0.02	640	0.00	0.04	705
Berth 26	0.05	0.00	0.01	0.00	0.00	6.08	6.06	15	0.00	0.00	15
Totals by Year											
2027	0.64	0.06	1.02	0.17	0.16	2.08	0.41	341	0.02	0.02	348
2028	2.88	0.34	4.88	0.46	0.44	4.44	1.78	2,658	0.03	0.23	2,805
2029	4.51	0.59	9.32	0.97	0.94	7.89	6.68	4,878	0.03	0.43	5,119
TOTAL	8.03	0.98	15.23	1.59	1.54	14.41	8.87	7,877	0.08	0.68	8,272
Average Daily Emissions (lb/day)											
2027	7	1	12	2	2	24	5	3,896	0	0	3,976
2028	16	2	27	3	2	24	10	14,563	0	1	15,369
2029	27	4	55.8	6	6	47	40	29,211	0	3	30,654

Table 18: Outer Harbor Turning Basin Only Alternative Mitigated Construction Emissions

	Emissions (tons)							Emissions (Metric Tonnes)			
	CO	ROG	NO _x	Ex PM ₁₀	Ex PM _{2.5}	Fug PM ₁₀	Fug PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO ₂ e
Totals by Category											
Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	420
Diesel Dredging	0.21	0.04	0.55	0.17	0.16	0.00	0.00	98.93	0.00	0.00	100
In Water	0.36	0.05	0.65	0.08	0.08	0.00	0.00	255.88	0.00	0.00	256
OffRoad	0.13	0.01	0.04	0.00	0.00	0.63	0.49	29.80	0.00	0.00	30
Roads	0.15	0.01	0.02	0.00	0.00	0.14	0.03	43.58	0.00	0.00	44
Tugs to Reuse	6.16	0.84	9.37	0.62	0.60	0.00	0.00	4787.52	0.02	0.23	4,857
Totals by Location											
Outer Harbor	7.01	0.94	10.63	0.87	0.84	0.77	0.52	5,216	0.02	0.24	5,708
Totals by Year											
2027	0.15	0.01	0.05	0.00	0.00	0.65	0.49	38	0.00	0.00	39
2028	6.87	0.93	10.57	0.87	0.84	0.12	0.03	5,178	0.02	0.24	5,669
2029	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	-
TOTAL	7.01	0.94	10.63	0.87	0.84	0.77	0.52	5,216	0.02	0.24	5,708
Average Daily Emissions (lb/day)											
2027	1.66	0.08	0.58	0.02	0.02	7.39	5.61	436	0.04	0.02	442
2028	38	5.11	58	4.76	4.61	0.68	0.17	28,370	0.10	1.31	31,066
2029	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	-

B.5. Methods and Results for Estimating Operation and Maintenance Emissions

The Proposed Project operation would have some changes associated with in-water operations compared to the future No Project baseline scenario. The use of the future operational baseline rather than the existing baseline is appropriate for this situation, and allowed under CEQA because the vessel fleet will likely change in the future as a result of other economic and global influences to the shipping industry, including growth, efficiency improvements, and vessel emission improvements as well as the physical change to the turning basins. The difference between the Proposed Project and No Project future information is the physical changes to the size of the turning basins. With or without the Proposed Project, the Port will experience a 2.1 percent growth in cargo annually. It also includes planned harbor improvements, including the future upgrades and improvements that would be anticipated to occur under both the Proposed Project and No Project future scenarios. Most importantly for air quality emissions, the mix of OGVs and number of vessel calls are expected to change when compared to the future No Project baseline scenario, and will be substantially different than the current mix of OGVs and number of vessel calls. To evaluate the change in criteria pollutant emissions for the in-water operation, the vessel fleet mix and ship calls as reported in Table 3.1-1 of this Draft EIR were used. In addition to the vessel fleet mix and number of vessels calls per year, additional assumptions are required to estimate criteria pollutant emissions associated with vessels calling the Seaport. Information from the 2020 Seaport Emission Inventory was used as a basis for establishing several key assumptions (Port of Oakland 2021, with updates in 2023). The average vessel transit and maneuvering time per call were averaged over all vessel size classes consistent with the assumption used in the 2020 Seaport Emission Inventory. The future fleet engine tier levels were determined based on carrying forward the 2020 vessel age distribution. The load factors for the vessels and tugs were updated to reflect current CARB emission inventory methods (CARB 2021). Vessel engine sizes were determined for each vessel class using representative main and auxiliary engine sizes by vessel TEU capacity. Vessels were assumed to have 95 percent shore power utilization with 3 hours of auxiliary engine use allocated to account for connect and disconnect time consistent with the CARB At-Berth regulations. The remaining 5 percent of vessels were assumed to not use shore power⁸. Time at anchorage was not included in this analysis because anchorage events exhibited significant temporal variability that was impossible to determine if ship size was a causative factor in making the decision to go to anchor or in deciding how long to anchor. With these assumptions and criteria pollutant and GHG emission factors for the representative vessels based on the 2020 Seaport Emission Inventory, criteria pollutant emissions were developed for the Proposed Project and No-Project future baseline scenarios for the in-water operations.

All vessels require tugs to assist them when transiting and maneuvering; however, the number of tugs required for a vessel is related to the size of the vessel and varies based on the power of tugs available, as well as if the vessel is traveling in-bound or out-bound and if the vessel requires a turnaround. The average number of tugs for each vessel type was determined consistent with assumptions in the 2020 Seaport Emissions Inventory and ranged from an average of 3.5 tugs per call (e.g., 1 to 2 tugs for vessels in bound and 1 to 2 tugs for vessels outbound) to 7.5 tugs per call (e.g., 3 to 4 tugs inbound and 3 to 4 tugs outbound). The number of tugs needed depends on the power rating of the tugs, if the vessel is turning, and if the vessel is inbound or outbound, among other factors. All tugs were assumed to have 6,772 hp main engine power.

⁸ Due to reasons that may include being unequipped, the unavailability of equipment or staff, or other reasons.

The engine and load factor in units of horsepower or kilowatts, the hours of transiting and maneuvering, and the emission factors used by CARB in its latest Harbor Craft and OGV emissions inventories were multiplied together to calculate the criteria pollutant emissions from in-water activities. Further supporting information is contained in Attachment A to this technical report.

Table 23 shows the in-water operational criteria pollutant emissions for the Proposed Project and the No-Project future baseline scenario. **Figure 1** shows that in all future baseline scenarios the Proposed Project would result in a reduction of criteria pollutant emissions compared to the No-Project scenario. **Table 24** shows the in-water operational GHG emissions for the Proposed Project and the No-Project future baseline scenarios.

Table 19: In-Water Operational Criteria Pollutant Emissions—Tons Per Year

Year	Scenario	CO	ROG	NO _x	SO _x	DPM	PM ₁₀	PM _{2.5}
2030	No Project	150	78	1,262	65.6	13	21	19.5
2030	Proposed Project	147	75	1,226	64.3	13	21	19.1
2040	No Project	185	96	1,486	81.3	17	26	24.1
2040	Proposed Project	172	87	1,367	75.8	15	24	22.5
2050	No Project	218	111	1,721	95.9	19	31	28.5
2050	Proposed Project	196	96	1,531	87.0	17	28	25.9

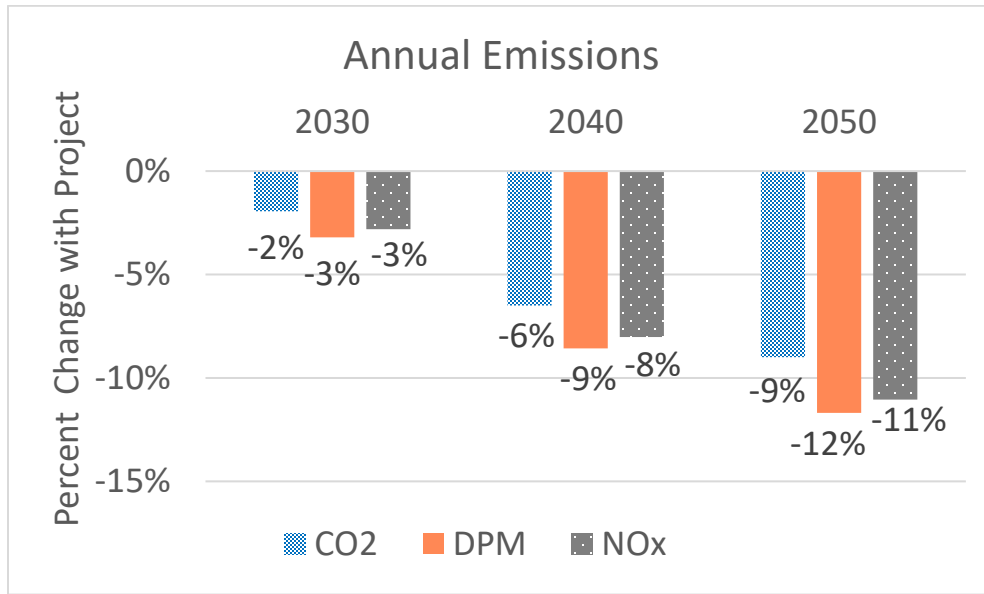
Source: Attachment A

Table 20: In-Water Operational GHG Emissions – Metric Tonnes Per Year

Future Operational Year	Proposed Project (metric tonnes CO ₂ e per year)	No-Project (metric tonnes CO ₂ e per year)
2030	114,302	116,298
2040	134,724	144,100
2050	155,038	170,386

Source: Attachment A

Figure 1: In-Water Operational Criteria Pollutant Emissions Percent Reduction



Maintenance dredging is anticipated to require an annual increase of up to 93,000 cubic yards of additional dredging of the turning basins. Emissions for this additional maintenance dredging was estimated assuming that 6,000 cubic yards of material is dredged a day. Dredging will use a diesel dredger that uses an offroad engine and has the same characteristics described in Section 4.4.1 for diesel dredgers. Electric dredging is not possible due to the continued movement of dredgers during diesel dredging. A barge is assumed to be used as well as a tow boat to move the dredgers and barge. This uses the same assumptions for the barge and Sarah Reed towboat described in Section 4.4. A second tow boat assumed to be the Heidi Brusco, will be used to transport the filled barge to a beneficial reuse site conservatively assumed to be 50 miles away. Twenty-six workers are assumed to be needed during dredging and emission estimates include these worker trips using the same CalEEMod default trip length. The offroad and on-road emissions were estimated similar to the methods for these categories described under construction described in Sections 4.1, 4.2, and 4.3. **Table 21** shows the criteria pollutant and GHG emissions from maintenance dredging. Detailed calculations of the maintenance emissions are included at the end of the report in **Table 39** through **Table 42**.

Table 21: Maintenance Dredging Annual Increase in Emissions Average Daily and Tons (Metric Tonnes for GHGs) per Year

Project Maintenance Dredging	ROG	NO _x	PM ₁₀ (exhaust)	PM _{2.5} (exhaust)	CO _{2e}
Total Tons	0.16	0.65	0.67	0.33	1,718
Average Daily Pounds	1.12	6.27	3.67	1.83	4.7

B.6. Methods and Results for Estimating Sequestration of GHG in Wetlands

Sediment from the dredging activities would be transported by scow and a tug boat to a permitted beneficial reuse site for placement. The placement of sediment in wetland areas can result in increased carbon sequestration. An estimate of the potential increased carbon sequestration based on the estimated volume of dredged sediment material is included in the analysis based on methods for carbon sequestration in tidal coastal wetlands (Charpentier et al. 2010). This analysis assumed the sequestration rate would be 210 grams CO₂ per square meter per year using a 50-year life span for the Proposed Project. The analysis assumed that the depth of wetland to determine acres was 5 feet. This analysis also assumes that the wetland area would expand landward with sea level rise over the Proposed Project lifetime by using thin placement (marsh spraying) techniques to grow the wetland landward ahead of inundation due to sea level rise.

The amount of dredged sediment that could be placed for beneficial reuse is 2,166,700 cy of material. Assuming the material is added at a depth of 5 feet, a total of 1,086,982 square meters or 228 acres of wetland would be created or enhanced. Assuming that 210 grams CO₂ per square meter per year (Charpentier et al. 2010) are sequestered over 50 years, the amount of carbon sequestered would be 237 metric tonnes CO₂e per year for a total of 11,848 metric tons CO₂e over the course of 50 years from placement of dredged sediment for beneficial reuse to enhance wetlands.

B.7. Methods for Estimating Fuel Consumption

B.7.2. Off-Road Equipment

For the off-road equipment, the brake-specific fuel consumption factor was based on values used by CARB in its OFFROAD model. These brake-specific fuel consumption factors are multiplied by the horsepower, load factor, and hours of activity to determine the amount of diesel fuel used.

B.7.3. On-Road Vehicles

The truck and worker vehicle miles traveled is multiplied by the fuel efficiency of the vehicles based on EMFAC 2021 fuel consumption for heavy-heavy duty trucks, light duty autos and light duty trucks.

Table 22 shows the fuel efficiency in miles per gallon.

Table 22: On-Road Vehicles Fuel Efficiency in Miles per Gallon

Vehicle Class	2027	2028	2029
HHDT	6.12	6.23	6.34
LDA	32.00	32.62	33.20
LDT1	26.58	27.04	27.50

Notes:

1 HHDT= heavy, heavy-duty truck, LDA = light duty auto, LDT1 = light duty truck 1.

B.7.4. In-Water Equipment

For the off-road equipment used by in-water based equipment, the brake-specific fuel consumption factor was based on values used by CARB in its OFFROAD model and in the latest harbor craft emission inventory. These brake-specific fuel consumption factors are multiplied by the horsepower, load factor, and hours of activity to determine the amount of diesel fuel used.

B.7.5. Total Fuel Consumption Results—Proposed Project

The total fuel consumption during the Proposed Project construction is shown in **Table 26**. The total fuel consumption for Alternatives is shown in **Table 27**. Fuel consumption for the unmitigated and mitigated Proposed Project do not differ because Tier 4 engines are not necessarily any more energy efficient than other tier engines.

Table 23: Construction Fuel Consumption – Proposed Project

Equipment Type	Diesel Fuel (gallons)	Gasoline Fuel (gallons)
Off-Road Equipment (Land-Based and In-Water Based)	983,041	-
On-Road Vehicles (Truck Hauling)	304,6232	-
On-Road Vehicles (Workers)	-	24,588
Total	1,287,274	24,588
Energy Mitigation Diesel Dredging	19,336	-
Total with Energy Mitigation	1,306,610	24,588

Maintenance dredging is anticipated to require an annual increase of up to 93,000 cubic yards of additional dredging of the turning basins. The increase in fuel consumption from this additional maintenance dredging using diesel dredgers, barges, towboats, and disposal 50 miles away is 44,562 gallons of diesel and 285 gallons of gasoline for worker commutes.

B.7.6. Total Fuel Consumption Results—Proposed Project Alternatives

The total fuel consumption the Proposed Project alternatives are shown in Table 27.

Table 24: Construction Fuel Consumption—Proposed Project Alternatives

Alternative	Diesel Gallons	Gasoline Gallons
Diesel Dredger	1,653,257	24,588
Inner Harbor Turning Basin Only	831,897	20,926
Outer Harbor Turning Basin Only	456,751	4,413

B.8. References

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B.9. Detailed Emissions Tables

Table 25: Unmitigated Off-road and In-water Emissions Detailed Calculations

Phase	Location	Description	Equipment	Equipment Category	Quantity	Area Adjustment					EF g/bhp-hr															tons						
						Hp	LF	Work Days	Hours Per Day	factor	Type	Year	Avg	AERMOD SrcGRP	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	Fuel Consumption	
O1H	Howard Terminal	Concrete Pavement Removal	Backhoe/Front Ldr	Offroad	1	286	0.37	45	10	1	OFFROAD	2027	12.5	IHCONS	1.1950	0.1560	1.1810	0.0470	0.0430	527.2670	0.0210	0.0040	0.0622	0.0081	0.0614	0.0024	0.0022	27.4250	0.0011	0.0002	2,435.95	
O1H	Howard Terminal	Concrete Pavement Removal	Concrete Saw	Offroad	1	81	0.73	45	10	1	OFFROAD	2027	12.5	IHCONS	4.2910	0.3900	3.4300	0.0710	0.0650	574.3320	0.0230	0.0050	0.1247	0.0113	0.0997	0.0021	0.0019	16.6924	0.0007	0.0001	1,513.22	
O1H	Howard Terminal	Concrete Pavement Removal	Dozer	Offroad	1	347	0.4	45	10	1	OFFROAD	2027	12.5	IHCONS	2.6560	0.3430	3.0910	0.1350	0.1250	532.5590	0.0220	0.0040	0.1812	0.0234	0.2109	0.0092	0.0085	36.3333	0.0015	0.0003	3,195.14	
O1H-1	Howard Terminal	Concrete Pavement Hauling	Excavator	Offroad	2	78	0.38	4	10	1	OFFROAD	2027	12.5	IHCONS	1.0410	0.1120	0.6200	0.0220	0.0200	527.0120	0.0210	0.0040	0.0030	0.0003	0.0018	0.0001	0.0001	1.5356	0.0001	0.0000	151.71	
O2H	Howard Terminal	Sheetpile/ Bulkhead Installation	Backhoe/Front Ldr	Offroad	1	286	0.37	62	10	1	OFFROAD	2027	12.5	IHCONS	1.1950	0.1560	1.1810	0.0470	0.0430	527.2670	0.0210	0.0040	0.0858	0.0112	0.0848	0.0034	0.0031	37.8676	0.0015	0.0003	3,363.49	
O2H	Howard Terminal	Sheetpile/ Bulkhead Installation	Crane	Offroad	1	231	0.29	62	10	1	OFFROAD	2027	12.5	IHCONS	1.4460	0.2340	2.2510	0.0940	0.0860	527.5600	0.0210	0.0040	0.0657	0.0106	0.1023	0.0043	0.0039	23.9857	0.0010	0.0002	2,129.28	
O2H	Howard Terminal	Sheetpile/ Bulkhead Installation	Diesel Hammer	Offroad	1	172	0.42	62	10	1	OFFROAD	2027	12.5	IHCONS	3.1540	0.2140	1.8310	0.0950	0.0880	527.7590	0.0210	0.0040	0.1546	0.0105	0.0898	0.0047	0.0043	25.8752	0.0010	0.0002	2,296.15	
O2H	Howard Terminal	Sheetpile/ Bulkhead Installation	Backhoe/Front Ldr	Offroad	1	286	0.37	24	10	1	OFFROAD	2028	12.5	IHCONS	1.1850	0.1480	1.0320	0.0420	0.0390	527.1700	0.0210	0.0040	0.0332	0.0041	0.0289	0.0012	0.0011	14.7582	0.0006	0.0001	1,311.10	
O2H	Howard Terminal	Sheetpile/ Bulkhead Installation	Crane	Offroad	1	231	0.29	24	10	1	OFFROAD	2028	12.5	IHCONS	1.4160	0.2260	2.1030	0.0880	0.0810	527.5430	0.0210	0.0040	0.0251	0.0040	0.0373	0.0016	0.0014	9.3494	0.0004	0.0001	830.00	
O2H	Howard Terminal	Sheetpile/ Bulkhead Installation	Diesel Hammer	Offroad	1	172	0.42	24	10	1	OFFROAD	2028	12.5	IHCONS	3.1600	0.2110	1.7580	0.0910	0.0840	527.1540	0.0210	0.0040	0.0604	0.0040	0.0336	0.0017	0.0016	10.0747	0.0004	0.0001	895.05	
O3H	Howard Terminal	Land Excavation	Excavator	Offroad	2	78	0.38	17	10	1	OFFROAD	2028	12.5	IHCONS	1.0400	0.1100	0.5790	0.0210	0.0190	527.0400	0.0210	0.0040	0.0113	0.0012	0.0063	0.0002	0.0002	5.7047	0.0002	0.0000	563.56	
O4H	Howard Terminal	Land Excavation Hauling	Excavator	Offroad	2	78	0.38	17	10	1	OFFROAD	2028	12.5	IHCONS	1.0400	0.1100	0.5790	0.0210	0.0190	527.0400	0.0210	0.0040	0.0113	0.0012	0.0063	0.0002	0.0002	5.7047	0.0002	0.0000	563.56	
O5H	Howard Terminal	Batter Pile Installation	Backhoe/Front Ldr	Offroad	1	286	0.37	22	10	1	OFFROAD	2028	12.5	IHCONS	1.1850	0.1480	1.0320	0.0420	0.0390	527.1700	0.0210	0.0040	0.0307	0.0038	0.0268	0.0011	0.0010	13.6719	0.0005	0.0001	1,214.59	
O5H	Howard Terminal	Batter Pile Installation	Crane	Offroad	1	231	0.29	22	10	1	OFFROAD	2028	12.5	IHCONS	1.4160	0.2260	2.1030	0.0880	0.0810	527.5430	0.0210	0.0040	0.0232	0.0037	0.0345	0.0014	0.0013	8.6612	0.0003	0.0001	768.90	
O5H	Howard Terminal	Batter Pile Installation	Diesel Hammer	Offroad	1	172	0.42	22	10	1	OFFROAD	2028	12.5	IHCONS	3.1600	0.2110	1.7580	0.0910	0.0840	527.1540	0.0210	0.0040	0.0559	0.0037	0.0311	0.0016	0.0015	9.3331	0.0004	0.0001	829.16	
O5H	Howard Terminal	Batter Pile Installation	Drilling Rig	Offroad	1	221	0.5	22	10	1	OFFROAD	2028	12.5	IHCONS	1.0510	0.1120	1.0080	0.0330	0.0300	524.5520	0.0210	0.0040	0.0285	0.0030	0.0273	0.0009	0.0008	14.2056	0.0006	0.0001	1,268.31	
O5H	Howard Terminal	Batter Pile Installation	Vibratory Hammer	Offroad	1	46	0.42	22	10	1	OFFROAD	2028	12.5	IHCONS	1.2500	0.1430	1.1120	0.0430	0.0400	530.0820	0.0220	0.0040	0.0007	0.0007	0.0053	0.0002	0.0002	2.5099	0.0001	0.0000	246.53	
O6H	Howard Terminal	Howard Pile Removal Activity	Barge	Water	2	225	0.31	40	10	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	3.4100	0.6671	0.6471	531.0000	0.0018	0.0259	0.0420	0.0057	0.2091	0.0409	0.0397	32.5592	0.0001	0.0016	2,871.66	
O6H	Howard Terminal	Howard Pile Removal Activity	Towboat/Pushboat- Main	Water	2	640	0.33	40	4	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	4.0150	0.9593	0.9305	531.0000	0.0018	0.0259	0.0541	0.0073	0.3168	0.0757	0.0734	41.8999	0.0001	0.0020	3,685.41	
O6H	Howard Terminal	Howard Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	40	4	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	3.3775	0.5650	0.5481	554.0000	0.0018	0.0270	0.0063	0.0008	0.0308	0.0052	0.0050	5.0545	0.0000	0.0002	444.75	
O6H	Howard Terminal	Howard Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	40	4	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	4.3575	0.5188	0.5032	628.0000	0.0018	0.0306	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-
O6H	Howard Terminal	Howard Pile Removal Activity	Compressor	Offroad	2	78	0.48	40	10	1	OFFROAD	2027	12.5	IHCONS	4.7900	0.4820	3.5380	0.0810	0.0750	568.3220	0.0230	0.0050	0.1577	0.0159	0.1164	0.0027	0.0025	18.7053	0.0008	0.0002	1,713.63	
O6H	Howard Terminal	Howard Pile Removal Activity	Crane	Offroad	2	231	0.29	40	10	1	OFFROAD	2027	12.5	IHCONS	1.4460	0.2340	2.2510	0.0940	0.0860	527.5600	0.0210	0.0040	0.0852	0.0138	0.1326	0.0055	0.0051	31.0683	0.0012	0.0002	2,758.03	
O6H	Howard Terminal	Howard Pile Removal Activity	Dive Vessel-Main	Water	2	622	0.33	40	2	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	3.9114	0.6286	0.6098	531.0000	0.0018	0.0248	0.0247	0.0034	0.1412	0.0227	0.0220	19.1630	0.0001	0.0009	1,612.63	
O6H	Howard Terminal	Howard Pile Removal Activity	Dive Vessel-Auxiliary	Water	2	464	0.32	40	2	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	3.3625	0.5246	0.5089	531.0000	0.0018	0.0248	0.0179	0.0024	0.0878	0.0137	0.0133	13.8621	0.0000	0.0006	1,166.54	
O6H	Howard Terminal	Howard Pile Removal Activity	Excavator	Offroad	2	78	0.38	40	10	1	OFFROAD	2027	12.5	IHCONS	1.0410	0.1120	0.6200	0.0220	0.0200	527.0120	0.0210	0.0040	0.0271	0.0029	0.0162	0.0006	0.0005	13.7320	0.0005	0.0001	1,356.63	
O6H	Howard Terminal	Howard Pile Removal Activity	Generator	Offroad	2	244	0.74	40	10	1	OFFROAD	2027	12.5	IHCONS	1.4460	0.2340	2.2510	0.0940	0.0860	568.3330	0.0230	0.0050	0.2295	0.0371	0.3573	0.0149	0.0137	90.2110	0.0037	0.0008	7,433.78	
O6H	Howard Terminal	Howard Pile Removal Activity	Vibratory Hammer	Offroad	2	46	0.42	40	10	1	OFFROAD	2027	12.5	IHCONS	1.2450	0.1460	1.2050	0.0460	0.0420	529.1370	0.0210	0.0040	0.0211	0.0025	0.0205	0.0008	0.0007	8.9869	0.0004	0.0001	884.28	
O7H1-W	Howard Terminal	Bulkhead Installation - In water	Backhoe/Front Ldr	Offroad	1	286	0.37	9	10	1	OFFROAD	2028	12.5	IHCONS	1.1850	0.1480	1.0320	0.0420	0.0390	527.1700	0.0210	0.0040	0.0118	0.0015	0.0103	0.0004	0.0004	5.2422	0.0002	0.0000	465.71	
O7H1-W	Howard Terminal	Bulkhead Installation - In water	Crane	Offroad	1	231	0.29	9	10	1	OFFROAD	2028	12.5	IHCONS	1.4160	0.2260	2.1030	0.0880	0.0810	527.5430	0.0210	0.0040	0.0089	0.0014	0.0132	0.0006	0.0005	3.3210	0.0001	0.0000	294.82	
O7H1-W	Howard Terminal	Bulkhead Installation - In water	Diesel Hammer	Offroad	1	172	0.42	9	10	1	OFFROAD	2028	12.5	IHCONS	3.1600	0.2110	1.7580	0.0910	0.0840	527.1540	0.0210	0.0040	0.0215	0.0014	0.0119	0.0006	0.0006	3.5786	0.0001	0.0000	317.93	
O7H2-W	Howard Terminal	Batter Pile Installation - In Water	Backhoe/Front Ldr	Offroad	1	286	0.37	2	10	1	OFFROAD	2028	12.5	IHCONS	1.1850	0.1480	1.0320	0.0420	0.0390	527.1700	0.0210	0.0040	0.0031	0.0004	0.0027	0.0001	0.0001	1.3672	0.0001	0.0000	121.46	
O7H2-W	Howard Terminal	Batter Pile Installation - In Water	Crane	Offroad	1	231	0.29	2	10	1	OFFROAD	2028	12.5	IHCONS	1.4160	0.2260	2.1030	0.0880	0.0810	527.5430	0.0210	0.0040	0.0023	0.0004	0.0035	0.0001	0.0001	0.8661	0.0000	0.0000	76.89	
O7H2-W	Howard Terminal	Batter Pile Installation - In Water	Diesel Hammer	Offroad	1	172	0.42	2	10	1	OFFROAD	2028	12.5	IHCONS	3.1600	0.2110	1.7580	0.0910	0.0840	527.1540	0.0210	0.0040	0.0056	0.0004	0.0031	0.0002	0.0001	0.9333	0.0000	0.0000	82.92	
O7H2-W	Howard Terminal	Batter Pile Installation - In Water	Dive Vessel-Main	Water	1	62																										

Phase	Location	Description	Equipment	Category	Quantity	Hp	LF	Work Days	Hours Per Day	Area Adjustment factor	EF g/bhp-hr										tons												
											Type	Year	Avg	AERMOD			CO				NOx			PM			CO ₂			Fuel Consumption			
														SrcGRP	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O						
05A1	Alameda	Removal Existing Batter Pile	Excavator	Offroad	1	78	0.38	11	10	1	OFFROAD	2029	12	5	IHCONSS	1.0410	0.1080	0.5490	0.0200	0.0180	527.3040	0.0210	0.0040	0.0037	0.0004	0.0019	0.0001	0.0001	0.0017	11.3406	0.0005	0.0001	1,006.71
05A1	Alameda	Removal Existing Batter Pile	Generator	Offroad	1	244	0.74	11	10	1	OFFROAD	2029	12	5	IHCONSS	1.4110	0.2250	2.0390	0.0860	0.0790	527.5780	0.0210	0.0040	0.0303	0.0048	0.0438	0.0018	0.0017	11.3406	0.0005	0.0001	1,006.71	
05A1	Alameda	Removal Existing Batter Pile	Vibratory Hammer	Offroad	1	46	0.42	11	10	1	OFFROAD	2029	12	5	IHCONSS	1.2460	0.1450	1.0950	0.0430	0.0390	529.8130	0.0210	0.0040	0.0029	0.0003	0.0025	0.0001	0.0001	1.2186	0.0000	0.0000	119.75	
06A	Alameda	Alameda Pile Removal Activity	Barge	Water	2	225	0.31	30	10	1	OFFROAD	2028	12	5	IHCONSS	0.6851	0.0931	3.4200	0.6986	0.6776	531.0000	0.0018	0.0259	0.0315	0.0043	0.1573	0.0321	0.0312	24.4242	0.0001	0.0012	2,154.17	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Main	Water	2	640	0.33	30	4	1	OFFROAD	2028	12	5	IHCONSS	0.6851	0.0931	1.0550	0.0702	0.0681	531.0000	0.0018	0.0259	0.0406	0.0055	0.0624	0.0042	0.0040	31.4311	0.0001	0.0015	2,764.60	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	30	4	1	OFFROAD	2028	12	5	IHCONSS	0.6851	0.0931	1.0488	0.0499	0.0484	554.0000	0.0018	0.0270	0.0047	0.0006	0.0072	0.0003	0.0003	3.7916	0.0000	0.0002	333.63	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	30	4	1	OFFROAD	2028	12	5	IHCONSS	0.6851	0.0931	1.0438	0.0417	0.0405	628.0000	0.0018	0.0306	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-
06A	Alameda	Alameda Pile Removal Activity	Compressor	Offroad	2	78	0.48	30	10	1	OFFROAD	2028	12	5	IHCONSS	4.7600	0.4570	3.4400	0.0650	0.0600	568.3400	0.0230	0.0050	0.1175	0.0113	0.0849	0.0016	0.0015	14.0322	0.0006	0.0001	1,285.48	
06A	Alameda	Alameda Pile Removal Activity	Crane	Offroad	2	231	0.29	30	10	1	OFFROAD	2028	12	5	IHCONSS	1.4160	0.2260	2.1030	0.0880	0.0810	527.5430	0.0210	0.0040	0.0626	0.0100	0.0929	0.0039	0.0036	23.3050	0.0009	0.0002	2,068.93	
06A	Alameda	Alameda Pile Removal Activity	Dive Vessel-Main	Water	2	622	0.33	30	2	1	OFFROAD	2028	12	5	IHCONSS	0.6851	0.0931	3.9209	0.6591	0.6393	531.0000	0.0018	0.0248	0.0185	0.0025	0.1061	0.0178	0.0173	14.3751	0.0000	0.0007	1,209.71	
06A	Alameda	Alameda Pile Removal Activity	Dive Vessel-Auxiliary	Water	2	464	0.32	30	2	1	OFFROAD	2028	12	5	IHCONSS	0.6851	0.0931	3.3700	0.5486	0.5321	531.0000	0.0018	0.0248	0.0134	0.0018	0.0660	0.0107	0.0104	10.3986	0.0000	0.0005	875.08	
06A	Alameda	Alameda Pile Removal Activity	Excavator	Offroad	2	78	0.38	30	10	1	OFFROAD	2028	12	5	IHCONSS	1.0400	0.1100	0.5790	0.0210	0.0190	527.0400	0.0210	0.0040	0.0203	0.0113	0.0004	0.0004	10.3016	0.0004	0.0001	1,017.67		
06A	Alameda	Alameda Pile Removal Activity	Generator	Offroad	2	244	0.74	30	10	1	OFFROAD	2028	12	5	IHCONSS	1.4160	0.2260	2.1030	0.0880	0.0810	527.5430	0.0210	0.0040	0.1686	0.0269	0.2504	0.0105	0.0096	62.8147	0.0025	0.0005	5,576.43	
06A	Alameda	Alameda Pile Removal Activity	Vibratory Hammer	Offroad	2	46	0.42	30	10	1	OFFROAD	2028	12	5	IHCONSS	1.2500	0.1430	1.1120	0.0430	0.0400	530.0820	0.0220	0.0040	0.0159	0.0018	0.0142	0.0005	0.0005	6.7536	0.0003	0.0001	663.34	
06A	Alameda	Alameda Pile Removal Activity	Barge	Water	2	225	0.31	75	10	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	3.4300	0.7300	0.7081	531.0000	0.0018	0.0259	0.0788	0.0107	0.3944	0.0839	0.0814	61.0606	0.0002	0.0030	5,385.42	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Main	Water	2	640	0.33	75	4	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.1014	0.0138	0.1583	0.0175	0.0170	78.5777	0.0003	0.0038	6,911.51	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	75	4	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0117	0.0016	0.0181	0.0013	0.0013	9.4791	0.0000	0.0005	834.08	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	75	4	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	1.0475	0.0611	0.0593	628.0000	0.0018	0.0306	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-
06A	Alameda	Alameda Pile Removal Activity	Compressor	Offroad	2	78	0.48	75	10	1	OFFROAD	2029	12	5	IHCONSS	4.7340	0.4360	3.3800	0.0550	0.0500	568.3090	0.0230	0.0050	0.2922	0.0269	0.2086	0.0034	0.0031	35.0786	0.0014	0.0003	3,213.70	
06A	Alameda	Alameda Pile Removal Activity	Crane	Offroad	2	231	0.29	75	10	1	OFFROAD	2029	12	5	IHCONSS	1.4110	0.2250	2.0390	0.0860	0.0790	527.5780	0.0210	0.0040	0.1558	0.0248	0.2252	0.0095	0.0087	58.2665	0.0023	0.0004	5,172.32	
06A	Alameda	Alameda Pile Removal Activity	Dive Vessel-Main	Water	2	622	0.33	75	2	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	3.9305	0.6895	0.6689	531.0000	0.0018	0.0248	0.0464	0.0063	0.2660	0.0467	0.0453	35.9378	0.0001	0.0017	3,024.28	
06A	Alameda	Alameda Pile Removal Activity	Dive Vessel-Auxiliary	Water	2	464	0.32	75	2	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	3.3775	0.5725	0.5553	531.0000	0.0018	0.0248	0.0335	0.0046	0.1654	0.0280	0.0272	25.9965	0.0001	0.0012	2,187.69	
06A	Alameda	Alameda Pile Removal Activity	Excavator	Offroad	2	78	0.38	75	10	1	OFFROAD	2029	12	5	IHCONSS	1.0410	0.1080	0.5490	0.0200	0.0180	527.3040	0.0210	0.0040	0.0509	0.0053	0.0268	0.0010	0.0009	25.7669	0.0010	0.0002	2,544.18	
06A	Alameda	Alameda Pile Removal Activity	Generator	Offroad	2	244	0.74	75	10	1	OFFROAD	2029	12	5	IHCONSS	1.4110	0.2250	2.0390	0.0860	0.0790	527.5780	0.0210	0.0040	0.4200	0.0670	0.2566	0.0235	0.0235	157.0473	0.0063	0.0012	13,941.09	
06A	Alameda	Alameda Pile Removal Activity	Vibratory Hammer	Offroad	2	46	0.42	75	10	1	OFFROAD	2029	12	5	IHCONSS	1.2460	0.1450	1.0950	0.0430	0.0390	529.8130	0.0210	0.0040	0.0397	0.0046	0.0349	0.0014	0.0012	16.8753	0.0007	0.0001	1,658.35	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Barge	Water	2	225	0.31	50	10	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	3.4300	0.7300	0.7081	531.0000	0.0018	0.0259	0.0788	0.0107	0.3944	0.0839	0.0814	61.0606	0.0002	0.0030	5,385.42	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Towboat/Pushboat- Main	Water	2	640	0.33	50	4	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.0681	0.0092	0.1063	0.0117	0.0114	52.7534	0.0002	0.0026	4,640.06	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	50	4	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0079	0.0011	0.0121	0.0009	0.0009	6.3638	0.0000	0.0003	559.96	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	50	4	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	1.0475	0.0611	0.0593	628.0000	0.0018	0.0306	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Compressor	Offroad	1	78	0.48	50	10	1	OFFROAD	2029	12	5	IHCONSS	4.7340	0.4360	3.3800	0.0550	0.0500	568.3090	0.0230	0.0050	0.0981	0.0090	0.0700	0.0011	0.0010	11.7751	0.0005	0.0001	1,078.76	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Crane	Offroad	1	231	0.29	50	10	1	OFFROAD	2029	12	5	IHCONSS	1.4110	0.2250	2.0390	0.0860	0.0790	527.5780	0.0210	0.0040	0.0523	0.0083	0.0756	0.0032	0.0029	19.5587	0.0008	0.0001	1,736.22	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Dive Vessel-Main	Water	1	622	0.33	50	2	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	3.9305	0.6895	0.6689	531.0000	0.0018	0.0248	0.0156	0.0021	0.0893	0.0157	0.0152	12.0635	0.0000	0.0006	1,015.18	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Dive Vessel-Auxiliary	Water	1	464	0.32	50	2	1	OFFROAD	2029	12	5	IHCONSS	0.6851	0.0931	3.3775	0.5725	0.5553	531.0000	0.0018	0.0248	0.0113	0.0015	0.0555	0.0094	0.0091	8.7264	0.0000	0.0004	734.36	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Excavator	Offroad	1	78	0.38	50	10	1	OFFROAD	2029	12	5	IHCONSS	1.0410	0.1080	0.5490	0.0200	0.0180	527.3040	0.0210	0.0040	0.0171	0.0018	0.0090	0.0003	0.					

Phase	Location	Description	Equipment	Category	Area				EF g/bhp-hr											tons					Fuel Consumption							
					Quantity	Hp	LF	Work Days	Hours Per Day	Adjustment factor	Type	Year	Avg	AERMOD																		
														SrcGRP	CO	ROG	NOx	PM10	PM2.5	CO2	CH4	N2O	CO	ROG		NOx	PM10	PM2.5	CO2	CH4	N2O	
03S-W	Schnitzer	Rip Rap Installation	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	19	4	1	OFFROAD	2028	12_5	IHCONSN	0.6851	0.0931	1.0488	0.0499	0.0484	554.0000	0.0018	0.0270	0.0029	0.0004	0.0045	0.0002	0.0002	2.3755	0.0000	0.0001	209.03	
03S-W	Schnitzer	Rip Rap Installation	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	19	4	1	OFFROAD	2028	12_5	IHCONSN	0.6851	0.0931	1.0438	0.0417	0.0405	628.0000	0.0018	0.0306	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-
12IN	Outer Harbor	Hauling (Berth 10)	Dozer	Offroad	1	347	0.4	13	12	1	OFFROAD	2029	12_5	OHCONS125	2.6270	0.3340	2.8570	0.1280	0.1180	532.4250	0.0220	0.0040	0.0623	0.0079	0.0678	0.0030	0.0028	12.6293	0.0005	0.0001	1,110.90	
12IN	Outer Harbor	Hauling (Berth 10)	Excavator	Offroad	1	78	0.38	13	12	1	OFFROAD	2029	12_5	OHCONS125	1.0410	0.1080	0.5490	0.0200	0.0180	527.3040	0.0210	0.0040	0.0053	0.0005	0.0028	0.0001	0.0001	2.6710	0.0001	0.0000	263.73	
OHEL	Berth 26	Infrastructure for Electric Dredging Variation	Backhoe/Front Ldr	Offroad	1	286	0.37	84	10	1	OFFROAD	2027	12_5	EINFRA	1.1950	0.1560	1.1810	0.0470	0.0430	527.2670	0.0210	0.0040	0.1171	0.0153	0.1157	0.0046	0.0042	51.6633	0.0021	0.0004	4,588.86	
OHEL	Berth 26	Infrastructure for Electric Dredging Variation	Concrete Saw	Offroad	1	81	0.73	84	10	1	OFFROAD	2027	12_5	EINFRA	4.2910	0.3900	3.4300	0.0710	0.0650	574.3320	0.0230	0.0050	0.2349	0.0214	0.1878	0.0039	0.0036	31.4452	0.0013	0.0003	2,850.62	
OHEL	Berth 26	Infrastructure for Electric Dredging Variation	Roller	Offroad	1	80	0.38	84	10	1	OFFROAD	2027	12_5	EINFRA	3.4110	0.2210	2.3840	0.1050	0.0970	568.2970	0.0230	0.0050	0.0960	0.0062	0.0671	0.0030	0.0027	15.9968	0.0006	0.0001	1,465.56	
08H	Howard Terminal	Dredging (below 15')	Barge	Water	2	225	0.31	41	1	1	OFFROAD	2028	24_7	HTDREDGE	0.6851	0.0931	3.4200	0.6986	0.6776	531.0000	0.0018	0.0259	0.0043	0.0006	0.0214	0.0044	0.0042	3.3226	0.0000	0.0002	293.04	
08H	Howard Terminal	Dredging (below 15')	Towboat/Pushboat- Main	Water	2	640	0.33	41	4	1	OFFROAD	2028	24_7	HTDREDGE	0.6851	0.0931	1.0550	0.0702	0.0681	531.0000	0.0018	0.0259	0.0552	0.0075	0.0850	0.0057	0.0055	42.7577	0.0001	0.0021	3,760.86	
08H	Howard Terminal	Dredging (below 15')	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	41	4	1	OFFROAD	2028	24_7	HTDREDGE	0.6851	0.0931	1.0488	0.0499	0.0484	554.0000	0.0018	0.0270	0.0064	0.0009	0.0098	0.0005	0.0005	5.1580	0.0000	0.0003	453.86	
08H	Howard Terminal	Dredging (below 15')	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	41	4	1	OFFROAD	2028	24_7	HTDREDGE	0.6851	0.0931	1.0488	0.0499	0.0484	554.0000	0.0018	0.0270	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-	
08A	Alameda	Dredging (Below 15')	Barge	Water	2	225	0.31	82	1	1	OFFROAD	2029	24_7	ALADREDG	0.6851	0.0931	3.4300	0.7300	0.7081	531.0000	0.0018	0.0259	0.0087	0.0012	0.0433	0.0092	0.0089	6.7102	0.0000	0.0003	591.83	
08A	Alameda	Dredging (Below 15')	Towboat/Pushboat- Main	Water	2	640	0.33	82	4	1	OFFROAD	2029	24_7	ALADREDG	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.1114	0.0151	0.1740	0.0192	0.0186	86.3527	0.0003	0.0042	7,595.38	
08A	Alameda	Dredging (Below 15')	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	82	4	1	OFFROAD	2029	24_7	ALADREDG	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0129	0.0017	0.0199	0.0015	0.0014	10.4170	0.0000	0.0005	916.61	
08A	Alameda	Dredging (Below 15')	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	82	4	1	OFFROAD	2029	24_7	ALADREDG	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-	
08IN	Inner Harbor	Dredging	Barge	Water	2	225	0.31	24	1	1	OFFROAD	2029	24_7	IHDREDGE	0.6851	0.0931	3.4300	0.7300	0.7081	531.0000	0.0018	0.0259	0.0025	0.0003	0.0126	0.0027	0.0026	1.9500	0.0000	0.0001	171.99	
08IN	Inner Harbor	Dredging	Towboat/Pushboat- Main	Water	2	640	0.33	24	4	1	OFFROAD	2029	24_7	IHDREDGE	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.0324	0.0044	0.0506	0.0056	0.0054	25.0946	0.0001	0.0012	2,207.26	
08IN	Inner Harbor	Dredging	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	24	4	1	OFFROAD	2029	24_7	IHDREDGE	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0037	0.0005	0.0058	0.0004	0.0004	3.0272	0.0000	0.0001	266.37	
08IN	Inner Harbor	Dredging	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	24	4	1	OFFROAD	2029	24_7	IHDREDGE	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-	
11IN	Inner Harbor	Berth 10 Class II Loading	Backhoe/Front Ldr	Offroad	1	286	0.37	2	24	1	OFFROAD	2029	24_7	OHCONS	1.2120	0.1530	1.0250	0.0430	0.0390	527.2880	0.0210	0.0040	0.0068	0.0009	0.0057	0.0002	0.0002	2.9523	0.0001	0.0000	262.22	
11IN	Inner Harbor	Berth 10 Class II Loading	Barge	Water	2	225	0.31	2	1	1	OFFROAD	2029	24_7	OHCONS	0.6851	0.0931	3.4300	0.7300	0.7081	531.0000	0.0018	0.0259	0.0002	0.0000	0.0010	0.0002	0.0002	0.1582	0.0000	0.0000	13.96	
11IN	Inner Harbor	Berth 10 Class II Loading	Crane	Water	1	755	0.42	2	24	1	OFFROAD	2029	24_7	OHCONS	0.9500	0.0600	1.1940	0.5137	0.4983	530.0000	0.0011	0.0259	0.0154	0.0010	0.0194	0.0084	0.0081	8.6164	0.0000	0.0004	761.38	
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Main	Water	2	640	0.33	2	4	0.52213496	OFFROAD	2029	24_7	IHTUG	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.0026	0.0004	0.0041	0.0005	0.0004	2.0363	0.0000	0.0001	179.11	
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	2	4	0.52213496	OFFROAD	2029	24_7	IHTUG	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0003	0.0000	0.0005	0.0000	0.0000	0.2456	0.0000	0.0000	21.62	
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	2	4	0.52213496	OFFROAD	2029	24_7	IHTUG	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-	
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Main	Water	2	640	0.33	2	4	0.09533856	OFFROAD	2029	24_7	IHTUGARE	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270										
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	2	4	0.09533856	OFFROAD	2029	24_7	IHTUGARE	0.9500	0.0600	1.1800	0.4690	0.4550	530.0000	0.0011	0.0259										
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	2	4	0.09533856	OFFROAD	2029	24_7	IHTUGARE	0.9500	0.0600	1.1800	0.4690	0.4550	530.0000	0.0011	0.0259										
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Main	Water	2	640	0.33	2	4	0.14628026	OFFROAD	2029	24_7	OHTUGB	0.9500	0.0600	1.1940	0.5137	0.4983	530.0000	0.0011	0.0259										
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	2	4	0.14628026	OFFROAD	2029	24_7	OHTUGB	1.0770	0.2700	3.9960	0.8987	0.8717	531.0000	0.0051	0.0259										
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	2	4	0.14628026	OFFROAD	2029	24_7	OHTUGB	1.0770	0.2700	4.0100	0.9433	0.9150	531.0000	0.0051	0.0259										
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Main	Water	2	640	0.33	2	4	0.23624622	OFFROAD	2029	24_7	OHTUGA	1.0770	0.2700	4.0240	0.9880	0.9584	531.0000	0.0051	0.0259										
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	2	4	0.23624622	OFFROAD	2029	24_7	OHTUGA	1.0600	0.2700	3.5269	1.0492	1.0178	518.0000	0.0051	0.0253										
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	2	4	0.23624622	OFFROAD	2029	24_7	OHTUGA	1.0600	0.2700	3.5431	1.1008	1.0677	518.0000	0.0051	0.0253										
08OH	Outer Harbor	Dredging	Barge	Water	2	225	0.31	182	1	1	OFFROAD	2028	24_7	OHDREDGR	0.6851	0.0931	3.4200	0.6986	0.6776	531.0000	0.0018	0.0259	0.0192	0.0026	0.0957	0.0196	0.0190	14.8609	0.0000	0.0007	1,310.70	
08OH	Outer Harbor	Dredging	Towboat/Pushboat- Main	Water	2	640	0.33	182	4	1	OFFROAD	2028	24_7	OHDREDGR	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.2467	0.0335	0.3854	0.0425	0.0413	191				

Table 26: Unmitigated On-Road Emissions Detailed Calculations

Location	Trip Type	Year	Trips	Length miles	EMFAC Category	EF g/mile											EF g/trip											Emissions (tons)											Fuel (gallons)			
						CO	ROG	NOX	Ex PM10	Ex PM2.5	Fug PM10	Fug PM2.5	SO2	Fuel gal/mile	CO ₂	CH ₄	N ₂ O	CO	ROG	NOX	Ex PM10	Ex PM2.5	Fug PM10	Fug PM2.5	SO2	CO ₂	CH ₄	N ₂ O	CO	ROG	NOX	Ex PM10	Ex PM2.5	Fug PM10	Fug PM2.5	SO2	CO ₂	CH ₄		N ₂ O		
HT	Worker Trips LDA	2027	3837.75	10.8	LDA	0.62	0.0067	0.0332	0.0012	0.0011	0.8888	0.2229	0.0026	31.9995	265.2288	0.0018	0.0041	2.8446	0.5904	0.2317	0.0019	0.0018	0.0000	0.0000	0.0007	66.7295	0.0621	0.0309	0.0403	0.0028	0.0025	0.0001	0.0001	0.0406	0.0102	0.0001	12.4001	0.0003	0.0003	1,295		
HT	Worker Trips LDT1	2027	1279.25	10.8	LDT1	1.07	0.0188	0.0911	0.0016	0.0015	0.8904	0.2235	0.0031	26.5768	316.4909	0.0044	0.0073	4.4595	1.0175	0.3363	0.0026	0.0023	0.0000	0.0000	0.0008	82.2732	0.0899	0.0362	0.0227	0.0017	0.0019	0.0000	0.0000	0.0136	0.0034	0.0000	4.9360	0.0002	0.0002	520		
HT	Hauling Class I Landfill	2027	0	84	HHDT	0.07	0.0156	1.7419	0.0266	0.0255	0.9882	0.2550	0.0148	6.1245	1557.8881	0.0007	0.2454	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-	
HT	Hauling Class II Landfill	2027	0	318	HHDT	0.07	0.0156	1.7419	0.0266	0.0255	0.9882	0.2550	0.0148	6.1245	1557.8881	0.0007	0.2454	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-
HT	Hauling Class I Landfill	2027	0	64	HHDT	0.07	0.0156	1.7419	0.0266	0.0255	0.9882	0.2550	0.0148	6.1245	1557.8881	0.0007	0.2454	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-
HT	Hauling Class II Landfill	2027	0	64	HHDT	0.07	0.0156	1.7419	0.0266	0.0255	0.9882	0.2550	0.0148	6.1245	1557.8881	0.0007	0.2454	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-
HT	Hauling Recycler	2027	2290	20	HHDT	0.07	0.0156	1.7419	0.0266	0.0255	0.9882	0.2550	0.0148	6.1245	1557.8881	0.0007	0.2454	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	7,478
HT	Other Hauling	2027	123	40	HHDT	0.07	0.0156	1.7419	0.0266	0.0255	0.9882	0.2550	0.0148	6.1245	1557.8881	0.0007	0.2454	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	803	
HT	Worker Trips LDA	2028	4757.25	10.8	LDA	0.59	0.0061	0.0310	0.0011	0.0010	0.8888	0.2229	0.0026	32.6158	261.0764	0.0017	0.0039	2.7089	0.5652	0.2234	0.0019	0.0017	0.0000	0.0000	0.0006	65.5192	0.0588	0.0303	0.0478	0.0033	0.0029	0.0001	0.0001	0.0503	0.0126	0.0001	15.1296	0.0004	0.0004	1,575		
HT	Worker Trips LDT1	2028	1585.75	10.8	LDT1	1.00	0.0169	0.0820	0.0015	0.0014	0.8904	0.2235	0.0031	27.0381	311.8943	0.0039	0.0068	4.1692	0.9710	0.3189	0.0024	0.0022	0.0000	0.0000	0.0008	80.6854	0.0843	0.0352	0.0262	0.0020	0.0021	0.0000	0.0000	0.0168	0.0042	0.0001	6.0291	0.0002	0.0002	633		
HT	Hauling Class I Landfill	2028	290	84	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3,908	
HT	Hauling Class II Landfill	2028	290	318	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	14,793	
HT	Hauling Class II Landfill	2028	2580	64	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	26,486	
HT	Other Hauling	2028	116	40	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	744	
HT	Infrastructure for Electric Dredging Variation	2027	168	20	HHDT	0.07	0.02	1.68	0.03	0.03	0.99	0.25	0.01	6.1245	1529.6889	0.0007	0.2410	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	549	
HT	Worker Trips LDA electrical	2027	756	10.8	LDA	0.62	0.0067	0.0332	0.0012	0.0011	0.8888	0.2229	0.0026	31.9995	265.2288	0.0018	0.0041	2.8446	0.5904	0.2317	0.0019	0.0018	0.0000	0.0000	0.0007	66.7295	0.0621	0.0309	0.0478	0.0033	0.0029	0.0001	0.0001	0.0503	0.0126	0.0001	15.1296	0.0004	0.0004	1,575		
HT	Worker Trips LDT1 electrical	2027	252	10.8	LDT1	1.07	0.0188	0.0911	0.0016	0.0015	0.8904	0.2235	0.0031	26.5768	316.4909	0.0044	0.0073	4.4595	1.0175	0.3363	0.0026	0.0023	0.0000	0.0000	0.0008	82.2732	0.0899	0.0362	0.0262	0.0020	0.0021	0.0000	0.0000	0.0168	0.0042	0.0001	6.0291	0.0002	0.0002	633		
Alameda	Worker Trips LDA	2028	18774	10.8	LDA	0.59	0.0061	0.0310	0.0011	0.0010	0.8888	0.2229	0.0026	32.6158	261.0764	0.0017	0.0039	2.7089	0.5652	0.2234	0.0019	0.0017	0.0000	0.0000	0.0006	65.5192	0.0588	0.0303	0.1885	0.0131	0.0116	0.0003	0.0003	0.1986	0.0498	0.0006	59.7075	0.0016	0.0015	6,217		
Alameda	Worker Trips LDT1	2028	6258	10.8	LDT1	1.00	0.0169	0.0820	0.0015	0.0014	0.8904	0.2235	0.0031	27.0381	311.8943	0.0039	0.0068	4.1692	0.9710	0.3189	0.0024	0.0022	0.0000	0.0000	0.0008	80.6854	0.0843	0.0352	0.1034	0.0080	0.0083	0.0001	0.0001	0.0663	0.0167	0.0002	23.7931	0.0009	0.0008	2,500		
Alameda	Hauling Class I Landfill	2028	144	84	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1,940	
Alameda	Hauling Class II Landfill	2028	144	318	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	7,345	
Alameda	Hauling Class II Landfill	2028	2734.2	64	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	28,069	
Alameda	Hauling Recycler	2028	5080	20	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	16,297	
Alameda	Other Hauling	2028	238	40	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1,527	
Schnitzer	Worker Trips LDA	20																																								

Table 27: Unmitigated Tugs to Beneficial Reuse Emissions Detailed Calculations

Location	Description	Equipment	Quantity	Amount (cy)	Distance	Hours	Year	Engine Size	Load Factor	EF g/bhp-hr							Emissions (tons)						Fuel Use (gallons)			
										CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO	ROG	NOx	PM ₁₀	PM _{2.5}		CO ₂	CH ₄	N ₂ O
HT	Tow Boat Heidi Brusco	Main	1	280,770	43.45	1,626.59	2028	3000	0.33	0.6851	0.0931	1.0550	0.0702	0.0681	531.0000	0.0018	0.0259	1.2161	0.1652	1.8727	0.1247	0.1209	942.5699	0.0031	0.0460	82,906
HT	Tow Boat Heidi Brusco	Auxiliary	1	280,770	43.45	1,626.59	2028	161	0.37	0.6851	0.0931	1.0488	0.0499	0.0484	554.0000	0.0018	0.0270	0.0732	0.0099	0.1120	0.0053	0.0052	59.1727	0.0002	0.0029	5,207
OH	Tow Boat Heidi Brusco	Main	1	1,090,256	43.45	6,316.21	2028	3000	0.33	0.6851	0.0931	1.0550	0.0702	0.0681	531.0000	0.0018	0.0259	4.7223	0.6415	7.2719	0.4841	0.4695	3660.0849	0.0122	0.1785	321,932
OH	Tow Boat Heidi Brusco	Auxiliary	1	1,090,256	43.45	6,316.21	2028	161	0.37	0.6851	0.0931	1.0488	0.0499	0.0484	554.0000	0.0018	0.0270	0.2841	0.0386	0.4350	0.0207	0.0201	229.7729	0.0007	0.0112	20,218
ALA	Tow Boat Heidi Brusco	Main	1	493,077	43.45	2,856.56	2029	3000	0.33	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	2.1357	0.2901	3.3355	0.3681	0.3571	1655.3034	0.0055	0.0807	145,597
ALA	Tow Boat Heidi Brusco	Auxiliary	1	493,077	43.45	2,856.56	2029	161	0.37	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.1285	0.0175	0.1984	0.0145	0.0141	103.9167	0.0003	0.0051	9,144
IH	Tow Boat Heidi Brusco	Main	1	133,602	43.45	774.00	2029	3000	0.33	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.5787	0.0786	0.9038	0.0997	0.0967	448.5138	0.0015	0.0219	39,450
IH	Tow Boat Heidi Brusco	Auxiliary	1	133,602	43.45	774.00	2029	161	0.37	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0348	0.0047	0.0537	0.0039	0.0038	28.1568	0.0001	0.0014	2,478
OH	Tow Boat Heidi Brusco	Main	1	251,597	43.45	1,457.59	2029	3000	0.33	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	1.0898	0.1480	1.7020	0.1878	0.1822	844.6350	0.0028	0.0412	74,292
OH	Tow Boat Heidi Brusco	Auxiliary	1	251,597	43.45	1,457.59	2029	161	0.37	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0656	0.0089	0.1012	0.0074	0.0072	53.0245	0.0002	0.0026	4,666

Table 28: Mitigate Off-road and In-Water Emissions Detailed Calculations

Phase	Location	Description	Equipment	Equipment Category	Quantity	Area					EF g/bhp-hr														tons					
						Hp	LF	Work Days	Hours Per Day	Adjustment factor	Type	Year	Avg	AERMOD		PM										CO ₂				
														Src	GRP	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄
01H	Howard Terminal	Concrete Pavement Removal	Backhoe/Front Ldr	Offroad	1	286	0.37	45	10	1	OFFROAD	2027	12.5	IHCONS	0.3838	0.0351	0.1008	0.0037	0.0034	527.2670	0.0210	0.0040	0.0200	0.0018	0.0052	0.0002	0.0002	27.4250	0.0011	0.0002
01H	Howard Terminal	Concrete Pavement Removal	Concrete Saw	Offroad	1	81	0.73	45	10	1	OFFROAD	2027	12.5	IHCONS	1.1100	0.0322	0.3447	0.0277	0.0254	574.3320	0.0230	0.0050	0.0323	0.0009	0.0100	0.0008	0.0007	16.6924	0.0007	0.0001
01H	Howard Terminal	Concrete Pavement Removal	Dozer	Offroad	1	347	0.4	45	10	1	OFFROAD	2027	12.5	IHCONS	0.4355	0.0547	0.1156	0.0046	0.0042	532.5590	0.0220	0.0040	0.0297	0.0037	0.0079	0.0003	0.0003	36.3333	0.0015	0.0003
01H-1	Howard Terminal	Concrete Pavement Hauling	Excavator	Offroad	2	78	0.38	4	10	1	OFFROAD	2027	12.5	IHCONS	0.3825	0.0343	0.1038	0.0038	0.0035	527.0120	0.0210	0.0040	0.0011	0.0001	0.0003	0.0000	0.0000	1.5356	0.0001	0.0000
02H	Howard Terminal	Sheetpile/ Bulkhead Installation	Backhoe/Front Ldr	Offroad	1	286	0.37	62	10	1	OFFROAD	2027	12.5	IHCONS	0.3838	0.0351	0.1008	0.0037	0.0034	527.2670	0.0210	0.0040	0.0276	0.0025	0.0072	0.0003	0.0002	37.8676	0.0015	0.0003
02H	Howard Terminal	Sheetpile/ Bulkhead Installation	Crane	Offroad	1	231	0.29	62	10	1	OFFROAD	2027	12.5	IHCONS	0.2916	0.0237	0.0776	0.0028	0.0026	527.5600	0.0210	0.0040	0.0133	0.0011	0.0035	0.0001	0.0001	23.9857	0.0010	0.0002
02H	Howard Terminal	Sheetpile/ Bulkhead Installation	Diesel Hammer	Offroad	1	172	0.42	62	10	1	OFFROAD	2027	12.5	IHCONS	0.4126	0.0341	0.1124	0.0041	0.0037	527.7590	0.0210	0.0040	0.0202	0.0017	0.0055	0.0002	0.0002	25.8752	0.0010	0.0002
ELECT	Howard Terminal	Infrastructure for Electric Dredging Variation	Backhoe/Front Ldr	Offroad	1	286	0.37	84	10	1	OFFROAD	2027	12.5	ELECTHT	0.3838	0.0351	0.1008	0.0037	0.0034	527.2670	0.0210	0.0040	0.0376	0.0034	0.0099	0.0004	0.0003	51.6633	0.0021	0.0004
ELECT	Howard Terminal	Infrastructure for Electric Dredging Variation	Concrete Saw	Offroad	1	81	0.73	84	10	1	OFFROAD	2027	12.5	ELECTHT	1.1100	0.0322	0.3447	0.0277	0.0254	574.3320	0.0230	0.0050	0.0608	0.0018	0.0189	0.0015	0.0014	31.4452	0.0013	0.0003
ELECT	Howard Terminal	Infrastructure for Electric Dredging Variation	Roller	Offroad	1	80	0.38	84	10	1	OFFROAD	2027	12.5	ELECTHT	1.2219	0.0372	0.5152	0.0040	0.0037	568.2970	0.0230	0.0050	0.0344	0.0010	0.0145	0.0001	0.0001	15.9968	0.0006	0.0001
02H	Howard Terminal	Sheetpile/ Bulkhead Installation	Backhoe/Front Ldr	Offroad	1	286	0.37	24	10	1	OFFROAD	2028	12.5	IHCONS	0.3838	0.0351	0.1008	0.0037	0.0034	527.1700	0.0210	0.0040	0.0107	0.0010	0.0028	0.0001	0.0001	14.7582	0.0006	0.0001
02H	Howard Terminal	Sheetpile/ Bulkhead Installation	Crane	Offroad	1	231	0.29	24	10	1	OFFROAD	2028	12.5	IHCONS	0.2916	0.0237	0.0776	0.0028	0.0026	527.5430	0.0210	0.0040	0.0052	0.0004	0.0014	0.0000	0.0000	9.3494	0.0004	0.0001
02H	Howard Terminal	Sheetpile/ Bulkhead Installation	Diesel Hammer	Offroad	1	172	0.42	24	10	1	OFFROAD	2028	12.5	IHCONS	0.4126	0.0341	0.1124	0.0041	0.0037	527.1540	0.0210	0.0040	0.0079	0.0007	0.0021	0.0001	0.0001	10.0747	0.0004	0.0001
03H	Howard Terminal	Land Excavation	Excavator	Offroad	2	78	0.38	17	10	1	OFFROAD	2028	12.5	IHCONS	0.3825	0.0343	0.1038	0.0038	0.0035	527.0400	0.0210	0.0040	0.0041	0.0004	0.0011	0.0000	0.0000	5.7047	0.0002	0.0000
04H	Howard Terminal	Land Excavation Hauling	Excavator	Offroad	2	78	0.38	17	10	1	OFFROAD	2028	12.5	IHCONS	0.3825	0.0343	0.1038	0.0038	0.0035	527.0400	0.0210	0.0040	0.0041	0.0004	0.0011	0.0000	0.0000	5.7047	0.0002	0.0000
05H	Howard Terminal	Batter Pile Installation	Backhoe/Front Ldr	Offroad	1	286	0.37	22	10	1	OFFROAD	2028	12.5	IHCONS	0.3838	0.0351	0.1008	0.0037	0.0034	527.1700	0.0210	0.0040	0.0100	0.0009	0.0026	0.0001	0.0001	13.6719	0.0005	0.0001
05H	Howard Terminal	Batter Pile Installation	Crane	Offroad	1	231	0.29	22	10	1	OFFROAD	2028	12.5	IHCONS	0.2916	0.0237	0.0776	0.0028	0.0026	527.5430	0.0210	0.0040	0.0048	0.0004	0.0013	0.0000	0.0000	8.6612	0.0003	0.0001
05H	Howard Terminal	Batter Pile Installation	Diesel Hammer	Offroad	1	172	0.42	22	10	1	OFFROAD	2028	12.5	IHCONS	0.4126	0.0341	0.1124	0.0041	0.0037	527.1540	0.0210	0.0040	0.0073	0.0006	0.0020	0.0001	0.0001	9.3331	0.0004	0.0001
05H	Howard Terminal	Batter Pile Installation	Drilling Rig	Offroad	1	221	0.5	22	10	1	OFFROAD	2028	12.5	IHCONS	0.4988	0.0382	0.1336	0.0048	0.0044	524.5520	0.0210	0.0040	0.0135	0.0010	0.0036	0.0001	0.0001	14.2056	0.0006	0.0001
05H	Howard Terminal	Batter Pile Installation	Vibratory Hammer	Offroad	1	46	0.42	22	10	1	OFFROAD	2028	12.5	IHCONS	0.4126	0.0341	0.1124	0.0041	0.0037	530.0820	0.0220	0.0040	0.0020	0.0002	0.0005	0.0000	0.0000	2.5099	0.0001	0.0000
06H	Howard Terminal	Howard Pile Removal Activity	Barge	Water	2	225	0.31	40	10	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	3.4100	0.6671	0.6471	531.0000	0.0018	0.0259	0.0420	0.0057	0.2091	0.0409	0.0397	32.5592	0.0001	0.0016
06H	Howard Terminal	Howard Pile Removal Activity	Towboat/Pushboat- Main	Water	2	640	0.33	40	4	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	4.0150	0.9663	0.9373	531.0000	0.0018	0.0259	0.0541	0.0073	0.3168	0.0762	0.0740	41.8999	0.0001	0.0020
06H	Howard Terminal	Howard Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	40	4	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	3.3775	0.5650	0.5481	554.0000	0.0018	0.0270	0.0063	0.0008	0.0308	0.0052	0.0050	5.0545	0.0000	0.0002
06H	Howard Terminal	Howard Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	40	4	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	4.3575	0.5188	0.5032	628.0000	0.0018	0.0306	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
06H	Howard Terminal	Howard Pile Removal Activity	Compressor	Offroad	2	78	0.48	40	10	1	OFFROAD	2027	12.5	IHCONS	1.1100	0.0322	0.3447	0.0277	0.0254	568.3220	0.0230	0.0050	0.0365	0.0011	0.0113	0.0009	0.0008	18.7053	0.0008	0.0002
06H	Howard Terminal	Howard Pile Removal Activity	Crane	Offroad	2	231	0.29	40	10	1	OFFROAD	2027	12.5	IHCONS	0.2916	0.0237	0.0776	0.0028	0.0026	527.5600	0.0210	0.0040	0.0172	0.0014	0.0046	0.0002	0.0002	31.0683	0.0012	0.0002
06H	Howard Terminal	Howard Pile Removal Activity	Dive Vessel-Main	Water	2	622	0.33	40	2	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	3.9114	0.6286	0.6098	531.0000	0.0018	0.0248	0.0247	0.0034	0.1412	0.0227	0.0220	19.1630	0.0001	0.0009
06H	Howard Terminal	Howard Pile Removal Activity	Dive Vessel-Auxiliary	Water	2	464	0.32	40	2	1	OFFROAD	2027	12.5	IHCONS	0.6851	0.0931	3.3625	0.5046	0.4895	531.0000	0.0018	0.0248	0.0179	0.0024	0.0878	0.0132	0.0128	13.8621	0.0000	0.0006
06H	Howard Terminal	Howard Pile Removal Activity	Excavator	Offroad	2	78	0.38	40	10	1	OFFROAD	2027	12.5	IHCONS	0.3825	0.0343	0.1038	0.0038	0.0035	527.0120	0.0210	0.0040	0.0100	0.0009	0.0027	0.0001	0.0001	13.7320	0.0005	0.0001
06H	Howard Terminal	Howard Pile Removal Activity	Generator	Offroad	2	244	0.74	40	10	1	OFFROAD	2027	12.5	IHCONS	0.3678	0.0461	0.0628	0.0042	0.0039	568.3330	0.0230	0.0050	0.0584	0.0073	0.0100	0.0007	0.0006	90.2110	0.0037	0.0008
06H	Howard Terminal	Howard Pile Removal Activity	Vibratory Hammer	Offroad	2	46	0.42	40	10	1	OFFROAD	2027	12.5	IHCONS	0.4126	0.0341	0.1124	0.0041	0.0037	529.1370	0.0210	0.0040	0.0070	0.0006	0.0019	0.0001	0.0001	8.9869	0.0004	0.0001
07H1-W	Howard Terminal	Bulkhead Installation - In water	Backhoe/Front Ldr	Offroad	1	286	0.37	9	10	1	OFFROAD	2028	12.5	IHCONS	0.3838	0.0351	0.1008	0.0037	0.0034	527.1700	0.0210	0.0040	0.0038	0.0003	0.0010	0.0000	0.0000	5.2422	0.0002	0.0000
07H1-W	Howard Terminal	Bulkhead Installation - In water	Crane	Offroad	1	231	0.29	9	10	1	OFFROAD	2028	12.5	IHCONS	0.2916	0.0237	0.0776	0.0028	0.0026	527.5430	0.0210	0.0040	0.0018	0.0001	0.0005	0.0000	0.0000	3.3210	0.0001	0.0000
07H1-W	Howard Terminal	Bulkhead Installation - In water	Diesel Hammer	Offroad	1	172	0.42	9	10	1	OFFROAD	2028	12.5	IHCONS	0.4126	0.0341	0.1124	0.0041	0.0037	527.1540	0.0210	0.0040	0.0028	0.0002	0.0008	0.0000	0.0000	3.5786	0.0001	0.0000
07H2-W	Howard Terminal	Batter Pile Installation - In Water	Backhoe/Front Ldr	Offroad	1	286	0.37	2	10	1	OFFROAD	2028	12.5	IHCONS	0.3838	0.0351	0.1008	0.0037	0.0034	527.1700	0.0210	0.0040	0.0010	0.0001	0.0003	0.0000	0.0000	1.3672	0.0001	0.0000
07H2-W	Howard Terminal	Batter Pile Installation - In Water	Crane	Offroad	1	231	0.29	2	10	1	OFFROAD	2028	12.5	IHCONS	0.2916	0.0237	0.0776	0.0028	0.0026	527.5430	0.0210									

Phase	Location	Description	Equipment	Equipment Category	Quantity	Hp	LF	Work Days	Hours Per Day	Area Adjustment Factor	EF g/bhp-hr											tons									
											Type	Year	Avg	AERMOD			PM ₁₀					PM _{2.5}									
														SrcGRP	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	
05A1	Alameda	Removal Existing Batter Pile	Dive Vessel-Main	Water	1	622	0.33	11	2	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	3.9305	0.6895	0.6689	531.0000	0.0018	0.0248	0.0033	0.0005	0.0192	0.0034	0.0033	2.5951	0.0000	0.0001	
05A1	Alameda	Removal Existing Batter Pile	Dive Vessel-Auxiliary	Water	1	464	0.32	11	2	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	3.3775	0.5525	0.5359	531.0000	0.0018	0.0248	0.0024	0.0003	0.0119	0.0020	0.0019	1.8772	0.0000	0.0001	
05A1	Alameda	Removal Existing Batter Pile	Excavator	Offroad	1	78	0.38	11	10	1	OFFROAD	2029	12.5	IHCNSS	0.3825	0.0343	0.1038	0.0038	0.0035	527.3040	0.0210	0.0040	0.0013	0.0001	0.0004	0.0000	0.0000	1.8607	0.0001	0.0000	
05A1	Alameda	Removal Existing Batter Pile	Generator	Offroad	1	244	0.74	11	10	1	OFFROAD	2029	12.5	IHCNSS	0.3678	0.0461	0.0628	0.0042	0.0039	527.5780	0.0210	0.0040	0.0009	0.0010	0.0013	0.0001	0.0001	11.3406	0.0005	0.0001	
05A1	Alameda	Removal Existing Batter Pile	Vibratory Hammer	Offroad	1	46	0.42	11	10	1	OFFROAD	2029	12.5	IHCNSS	0.4126	0.0341	0.1124	0.0041	0.0037	529.8130	0.0210	0.0040	0.0009	0.0001	0.0003	0.0000	0.0000	1.2186	0.0000	0.0000	
06A	Alameda	Alameda Pile Removal Activity	Barge	Water	2	225	0.31	30	10	1	OFFROAD	2028	12.5	IHCNSS	0.6851	0.0931	3.4200	0.6986	0.6776	531.0000	0.0018	0.0259	0.0315	0.0043	0.1573	0.0321	0.0312	24.4242	0.0001	0.0012	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Main	Water	2	640	0.33	30	4	1	OFFROAD	2028	12.5	IHCNSS	0.6851	0.0931	1.0550	0.0702	0.0681	531.0000	0.0018	0.0259	0.0406	0.0055	0.0624	0.0042	0.0040	31.4311	0.0001	0.0015	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	30	4	1	OFFROAD	2028	12.5	IHCNSS	0.6851	0.0931	1.0488	0.0499	0.0484	554.0000	0.0018	0.0270	0.0047	0.0006	0.0072	0.0003	0.0003	3.7916	0.0000	0.0002	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	30	4	1	OFFROAD	2028	12.5	IHCNSS	0.6851	0.0931	1.0438	0.0417	0.0405	628.0000	0.0018	0.0306	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
06A	Alameda	Alameda Pile Removal Activity	Compressor	Offroad	2	78	0.48	30	10	1	OFFROAD	2028	12.5	IHCNSS	1.1100	0.0322	0.3447	0.0277	0.0254	568.3400	0.0230	0.0050	0.0274	0.0008	0.0085	0.0007	0.0006	14.0322	0.0006	0.0001	
06A	Alameda	Alameda Pile Removal Activity	Crane	Offroad	2	231	0.29	30	10	1	OFFROAD	2028	12.5	IHCNSS	0.2916	0.0237	0.0776	0.0028	0.0026	527.5430	0.0210	0.0040	0.0129	0.0010	0.0034	0.0001	0.0001	23.3050	0.0009	0.0002	
06A	Alameda	Alameda Pile Removal Activity	Dive Vessel-Main	Water	2	622	0.33	30	2	1	OFFROAD	2028	12.5	IHCNSS	0.6851	0.0931	3.9209	0.6591	0.6393	531.0000	0.0018	0.0248	0.0185	0.0025	0.1061	0.0178	0.0173	14.3751	0.0000	0.0007	
06A	Alameda	Alameda Pile Removal Activity	Dive Vessel-Auxiliary	Water	2	464	0.32	30	2	1	OFFROAD	2028	12.5	IHCNSS	0.6851	0.0931	3.3700	0.5286	0.5127	531.0000	0.0018	0.0248	0.0134	0.0018	0.0660	0.0104	0.0100	10.3986	0.0000	0.0005	
06A	Alameda	Alameda Pile Removal Activity	Excavator	Offroad	2	78	0.38	30	10	1	OFFROAD	2028	12.5	IHCNSS	0.3825	0.0343	0.1038	0.0038	0.0035	527.0400	0.0210	0.0040	0.0075	0.0007	0.0020	0.0001	0.0001	10.3016	0.0004	0.0001	
06A	Alameda	Alameda Pile Removal Activity	Generator	Offroad	2	244	0.74	30	10	1	OFFROAD	2028	12.5	IHCNSS	0.3678	0.0461	0.0628	0.0042	0.0039	527.5430	0.0210	0.0040	0.0438	0.0055	0.0075	0.0005	0.0005	62.8147	0.0025	0.0005	
06A	Alameda	Alameda Pile Removal Activity	Vibratory Hammer	Offroad	2	46	0.42	30	10	1	OFFROAD	2028	12.5	IHCNSS	0.4126	0.0341	0.1124	0.0041	0.0037	530.0820	0.0220	0.0040	0.0053	0.0004	0.0014	0.0001	0.0000	6.7536	0.0003	0.0001	
06A	Alameda	Alameda Pile Removal Activity	Barge	Water	2	225	0.31	75	10	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	3.4300	0.7300	0.7081	531.0000	0.0018	0.0259	0.0788	0.0107	0.3944	0.0839	0.0814	61.0606	0.0002	0.0030	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Main	Water	2	640	0.33	75	4	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.1014	0.0138	0.1583	0.0175	0.0170	78.5777	0.0003	0.0038	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	75	4	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0117	0.0016	0.0181	0.0013	0.0013	9.4791	0.0000	0.0005	
06A	Alameda	Alameda Pile Removal Activity	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	75	4	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	1.0475	0.0611	0.0593	628.0000	0.0018	0.0306	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
06A	Alameda	Alameda Pile Removal Activity	Compressor	Offroad	2	78	0.48	75	10	1	OFFROAD	2029	12.5	IHCNSS	1.1100	0.0322	0.3447	0.0277	0.0254	568.3090	0.0230	0.0050	0.0685	0.0020	0.0213	0.0017	0.0016	35.0786	0.0014	0.0003	
06A	Alameda	Alameda Pile Removal Activity	Crane	Offroad	2	231	0.29	75	10	1	OFFROAD	2029	12.5	IHCNSS	0.2916	0.0237	0.0776	0.0028	0.0026	527.5780	0.0210	0.0040	0.0322	0.0026	0.0086	0.0003	0.0003	58.2665	0.0023	0.0004	
06A	Alameda	Alameda Pile Removal Activity	Dive Vessel-Main	Water	2	622	0.33	75	2	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	3.9305	0.6895	0.6689	531.0000	0.0018	0.0248	0.0464	0.0063	0.2660	0.0467	0.0453	35.9378	0.0001	0.0017	
06A	Alameda	Alameda Pile Removal Activity	Dive Vessel-Auxiliary	Water	2	464	0.32	75	2	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	3.3775	0.5525	0.5359	531.0000	0.0018	0.0248	0.0335	0.0046	0.1654	0.0270	0.0262	25.9965	0.0001	0.0012	
06A	Alameda	Alameda Pile Removal Activity	Excavator	Offroad	2	78	0.38	75	10	1	OFFROAD	2029	12.5	IHCNSS	0.3825	0.0343	0.1038	0.0038	0.0035	527.3040	0.0210	0.0040	0.0187	0.0017	0.0051	0.0002	0.0002	25.7669	0.0010	0.0002	
06A	Alameda	Alameda Pile Removal Activity	Generator	Offroad	2	244	0.74	75	10	1	OFFROAD	2029	12.5	IHCNSS	0.3678	0.0461	0.0628	0.0042	0.0039	527.5780	0.0210	0.0040	0.1095	0.0137	0.0187	0.0013	0.0012	157.0473	0.0063	0.0012	
06A	Alameda	Alameda Pile Removal Activity	Vibratory Hammer	Offroad	2	46	0.42	75	10	1	OFFROAD	2029	12.5	IHCNSS	0.4126	0.0341	0.1124	0.0041	0.0037	529.8130	0.0210	0.0040	0.0131	0.0011	0.0036	0.0001	0.0001	16.8753	0.0007	0.0001	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Barge	Water	2	225	0.31	50	10	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	3.4300	0.7300	0.7081	531.0000	0.0018	0.0259	0.0529	0.0072	0.2648	0.0564	0.0547	40.9932	0.0001	0.0020	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Towboat/Pushboat- Main	Water	2	640	0.33	50	4	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.0681	0.0092	0.1063	0.0117	0.0114	52.7534	0.0002	0.0026	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	50	4	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	1.0575	0.0774	0.0750	554.0000	0.0018	0.0270	0.0079	0.0011	0.0121	0.0009	0.0009	6.3638	0.0000	0.0003	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	50	4	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	1.0475	0.0611	0.0593	628.0000	0.0018	0.0306	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Compressor	Offroad	2	78	0.48	50	10	1	OFFROAD	2029	12.5	IHCNSS	1.1100	0.0322	0.3447	0.0277	0.0254	568.3090	0.0230	0.0050	0.0230	0.0007	0.0071	0.0006	0.0005	11.7751	0.0005	0.0001	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Crane	Offroad	1	231	0.29	50	10	1	OFFROAD	2029	12.5	IHCNSS	0.2916	0.0237	0.0776	0.0028	0.0026	527.5780	0.0210	0.0040	0.0108	0.0009	0.0029	0.0001	0.0001	19.5587	0.0008	0.0001	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Dive Vessel-Main	Water	1	622	0.33	50	2	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	3.9305	0.6895	0.6689	531.0000	0.0018	0.0248	0.0156	0.0021	0.0893	0.0157	0.0152	12.0635	0.0000	0.0006	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Dive Vessel-Auxiliary	Water	1	464	0.32	50	2	1	OFFROAD	2029	12.5	IHCNSS	0.6851	0.0931	3.3775	0.5525	0.5359	531.0000	0.0018	0.0248	0.0113	0.0015	0.0555	0.0091	0.0088	8.7264	0.0000	0.0004	
06A-W	Alameda	Sheetpile/ Bulkhead Removal	Excavator	Offroad	1	78	0.38	50	10	1	OFFROAD	2029	12.5	IHCNSS	0.3825	0.0343	0.1038	0.0038	0.0035	527.3040	0.0210	0.0040	0.0063</								

Phase	Location	Description	Equipment	Equipment Category	Quantity	Hp	LF	Work Days	Hours Per Day	Area Adjustment factor	EF g/bhp-hr											tons								
											Type	Year	Avg	AERMOD					PM					CO						
														SrcGRP	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O
02S-W	Schnitzer	Batter Pile Installation - In Water	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	5	4	1	OFFROAD	2028	12.5	IHCONS	0.6851	0.0931	1.0488	0.0499	0.0484	554.0000	0.0018	0.0270	0.0008	0.0001	0.0013	0.0001	0.0001	0.6704	0.0000	0.0000
02S-W	Schnitzer	Batter Pile Installation - In Water	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	5	4	1	OFFROAD	2028	12.5	IHCONS	0.6851	0.0931	1.0438	0.0417	0.0405	628.0000	0.0018	0.0306	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
03S-W	Schnitzer	Rip Rap Installation	Barge	Water	1	225	0.31	19	10	1	OFFROAD	2028	12.5	IHCONS	0.6851	0.0931	3.4200	0.6986	0.6776	531.0000	0.0018	0.0259	0.0099	0.0013	0.0493	0.0101	0.0098	7.6512	0.0000	0.0004
03S-W	Schnitzer	Rip Rap Installation	Crane	Offroad	1	231	0.29	19	10	1	OFFROAD	2028	12.5	IHCONS	0.2916	0.0237	0.0776	0.0028	0.0026	527.5430	0.0210	0.0040	0.0040	0.0003	0.0011	0.0000	0.0000	7.3006	0.0003	0.0001
03S-W	Schnitzer	Rip Rap Installation	Towboat/Pushboat- Main	Water	2	640	0.33	19	4	1	OFFROAD	2028	12.5	IHCONS	0.6851	0.0931	1.0550	0.0702	0.0681	531.0000	0.0018	0.0259	0.0254	0.0035	0.0391	0.0026	0.0025	19.6923	0.0001	0.0010
03S-W	Schnitzer	Rip Rap Installation	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	19	4	1	OFFROAD	2028	12.5	IHCONS	0.6851	0.0931	1.0488	0.0499	0.0484	554.0000	0.0018	0.0270	0.0029	0.0004	0.0045	0.0002	0.0002	2.3755	0.0000	0.0001
03S-W	Schnitzer	Rip Rap Installation	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	19	4	1	OFFROAD	2028	12.5	IHCONS	0.6851	0.0931	1.0438	0.0417	0.0405	628.0000	0.0018	0.0306	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12IN	Outer Harbor	Hauling (Berth 10)	Dozer	Offroad	1	347	0.4	13	12	1	OFFROAD	2029	12.5	OHCONS125	0.4355	0.0547	0.1156	0.0046	0.0042	532.4250	0.0220	0.0040	0.0103	0.0013	0.0027	0.0001	0.0001	12.6293	0.0005	0.0001
12IN	Outer Harbor	Hauling (Berth 10)	Excavator	Offroad	1	78	0.38	13	12	1	OFFROAD	2029	12.5	OHCONS125	0.3825	0.0343	0.1038	0.0038	0.0035	527.3040	0.0210	0.0040	0.0019	0.0002	0.0005	0.0000	0.0000	2.6710	0.0001	0.0000
OHEL	Berth 26	Infrastructure for Electric Dredging Variation	Backhoe/Front Ldr	Offroad	1	286	0.37	84	10	1	OFFROAD	2027	12.5	EINFRA	0.3838	0.0351	0.1008	0.0037	0.0034	527.2670	0.0210	0.0040	0.0376	0.0034	0.0099	0.0004	0.0003	51.6633	0.0021	0.0004
OHEL	Berth 26	Infrastructure for Electric Dredging Variation	Concrete Saw	Offroad	1	81	0.73	84	10	1	OFFROAD	2027	12.5	EINFRA	1.1100	0.0322	0.3447	0.0277	0.0254	574.3320	0.0230	0.0050	0.0608	0.0018	0.0189	0.0015	0.0014	31.4452	0.0013	0.0003
OHEL	Berth 26	Infrastructure for Electric Dredging Variation	Roller	Offroad	1	80	0.38	84	10	1	OFFROAD	2027	12.5	EINFRA	1.2219	0.0372	0.5152	0.0040	0.0037	568.2970	0.0230	0.0050	0.0344	0.0010	0.0145	0.0001	0.0001	15.9968	0.0006	0.0001
08H	Howard Terminal	Dredging (below 15')	Barge	Water	2	225	0.31	41	1	1	OFFROAD	2028	24.7	IHDREDGE	0.6851	0.0931	3.4200	0.6986	0.6776	531.0000	0.0018	0.0259	0.0043	0.0006	0.0214	0.0044	0.0042	3.3226	0.0000	0.0002
08H	Howard Terminal	Dredging (below 15')	Towboat/Pushboat- Main	Water	2	640	0.33	41	4	1	OFFROAD	2028	24.7	IHDREDGE	0.6851	0.0931	1.0550	0.0702	0.0681	531.0000	0.0018	0.0259	0.0552	0.0075	0.0850	0.0057	0.0055	42.7577	0.0001	0.0021
08H	Howard Terminal	Dredging (below 15')	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	41	4	1	OFFROAD	2028	24.7	IHDREDGE	0.6851	0.0931	1.0531	0.0499	0.0484	554.0000	0.0018	0.0270	0.0064	0.0009	0.0098	0.0005	0.0005	5.1580	0.0000	0.0003
08H	Howard Terminal	Dredging (below 15')	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	41	4	1	OFFROAD	2028	24.7	IHDREDGE	0.6851	0.0931	1.0531	0.0499	0.0484	554.0000	0.0018	0.0270	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
08A	Alameda	Dredging (Below 15')	Barge	Water	2	225	0.31	82	1	1	OFFROAD	2029	24.7	ALADREDG	0.6851	0.0931	3.4300	0.7300	0.7081	531.0000	0.0018	0.0259	0.0087	0.0012	0.0433	0.0092	0.0089	6.7102	0.0000	0.0003
08A	Alameda	Dredging (Below 15')	Towboat/Pushboat- Main	Water	2	640	0.33	82	4	1	OFFROAD	2029	24.7	ALADREDG	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.1114	0.0151	0.1740	0.0192	0.0186	86.3527	0.0003	0.0042
08A	Alameda	Dredging (Below 15')	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	82	4	1	OFFROAD	2029	24.7	ALADREDG	0.6851	0.0931	1.0663	0.0774	0.0750	554.0000	0.0018	0.0270	0.0129	0.0017	0.0200	0.0015	0.0014	10.4170	0.0000	0.0005
08A	Alameda	Dredging (Below 15')	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	82	4	1	OFFROAD	2029	24.7	ALADREDG	0.6851	0.0931	1.0663	0.0774	0.0750	554.0000	0.0018	0.0270	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
08IN	Inner Harbor	Dredging	Barge	Water	2	225	0.31	24	1	1	OFFROAD	2029	24.7	IHDREDGE	0.6851	0.0931	3.4300	0.7300	0.7081	531.0000	0.0018	0.0259	0.0025	0.0003	0.0126	0.0027	0.0026	1.9500	0.0000	0.0001
08IN	Inner Harbor	Dredging	Towboat/Pushboat- Main	Water	2	640	0.33	24	4	1	OFFROAD	2029	24.7	IHDREDGE	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.0324	0.0044	0.0506	0.0056	0.0054	25.0946	0.0001	0.0012
08IN	Inner Harbor	Dredging	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	24	4	1	OFFROAD	2029	24.7	IHDREDGE	0.6851	0.0931	1.0663	0.0774	0.0750	554.0000	0.0018	0.0270	0.0037	0.0005	0.0058	0.0004	0.0004	3.0272	0.0000	0.0001
08IN	Inner Harbor	Dredging	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	24	4	1	OFFROAD	2029	24.7	IHDREDGE	0.6851	0.0931	1.0663	0.0774	0.0750	554.0000	0.0018	0.0270	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
11IN	Inner Harbor	Berth 10 Class II Loading	Backhoe/Front Ldr	Offroad	1	286	0.37	2	24	1	OFFROAD	2029	24.7	OHCONS	0.3838	0.0351	0.1008	0.0037	0.0034	527.2880	0.0210	0.0040	0.0021	0.0002	0.0006	0.0000	0.0000	2.9523	0.0001	0.0000
11IN	Inner Harbor	Berth 10 Class II Loading	Barge	Water	2	225	0.31	2	1	1	OFFROAD	2029	24.7	OHCONS	0.6851	0.0931	3.4300	0.7300	0.7081	531.0000	0.0018	0.0259	0.0002	0.0000	0.0010	0.0002	0.0002	0.1582	0.0000	0.0000
11IN	Inner Harbor	Berth 10 Class II Loading	Crane	Water	1	755	0.42	2	24	1	OFFROAD	2029	24.7	OHCONS	0.9500	0.0600	1.1940	0.5137	0.4983	530.0000	0.0011	0.0259	0.0154	0.0010	0.0194	0.0084	0.0081	8.6164	0.0000	0.0004
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Main	Water	2	640	0.33	2	4	0.522135	OFFROAD	2029	24.7	IHTUG	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.0026	0.0004	0.0005	0.0004	0.0005	2.0363	0.0000	0.0001
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	2	4	0.522135	OFFROAD	2029	24.7	IHTUG	0.6851	0.0931	1.0663	0.0774	0.0750	554.0000	0.0018	0.0270	0.0003	0.0000	0.0005	0.0000	0.0000	0.2456	0.0000	0.0000
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	2	4	0.522135	OFFROAD	2029	24.7	IHTUG	0.6851	0.0931	1.0663	0.0774	0.0750	554.0000	0.0018	0.0270	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Main	Water	2	640	0.33	2	4	0.0953386	OFFROAD	2029	24.7	IHTUGARE	0.6851	0.0931	1.0663	0.0774	0.0750	554.0000	0.0018	0.0270								
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	2	4	0.0953386	OFFROAD	2029	24.7	IHTUGARE	0.9500	0.0600	1.1800	0.4690	0.4550	530.0000	0.0011	0.0259								
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	2	4	0.0953386	OFFROAD	2029	24.7	IHTUGARE	0.9500	0.0600	1.1800	0.4690	0.4550	530.0000	0.0011	0.0259								
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Main	Water	2	640	0.33	2	4	0.1462803	OFFROAD	2029	24.7	OHTUGB	0.9500	0.0600	1.1940	0.5137	0.4983	530.0000	0.0011	0.0259								
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	2	4	0.1462803	OFFROAD	2029	24.7	OHTUGB	1.0770	0.2700	3.9960	0.8987	0.8717	531.0000	0.0051	0.0259								
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Auxiliary	Water	1	0	0.37	2	4	0.1462803	OFFROAD	2029	24.7	OHTUGB	1.0770	0.2700	4.0100	0.9433	0.9150	531.0000	0.0051	0.0259								
11IN	Inner Harbor	Berth 10 Class II Loading	Towboat/Pushboat- Main	Water	2	640	0.33	2	4	0.2362462	OFFROAD	2029	24.7	OHTUGA	1.0770	0.2700	4.0240	0.9880	0.9584	531.0000										

Table 29: Mitigated On-Road Emissions Detailed Calculations

Location	Trip Type	Year	Trips	Length miles	EMFAC Category	CO	EF g/mile															EF g/trip															Emissions (tons)								
							ROG	NOX	Ex PM10	Ex PM2.5	Fug PM10	Fug PM2.5	SO2	Fuel gal/mile	CO ₂	CH ₄	N ₂ O	CO	ROG	NOX	Ex PM10	Ex PM2.5	Fug PM10	Fug PM2.5	SO2	CO ₂	CH ₄	N ₂ O	CO	ROG	NOX	Ex PM10	Ex PM2.5	Fug PM10	Fug PM2.5	SO2	CO ₂	CH ₄	N ₂ O						
							0.62	0.0067	0.0332	0.0012	0.0011	0.8888	0.2229	0.0026	31.9995	265.2288	0.0018	0.0041	2.8446	0.5904	0.2317	0.0019	0.0018	0.0000	0.0000	0.0007	66.7295	0.0621	0.0309	0.0403	0.0028	0.0025	0.0001	0.0001	0.0406	0.0102	0.0001	0.0003	0.0003						
HT	Worker Trips LDA	2027	3837.75	10.8	LDA	0.62	0.0067	0.0332	0.0012	0.0011	0.8888	0.2229	0.0026	31.9995	265.2288	0.0018	0.0041	2.8446	0.5904	0.2317	0.0019	0.0018	0.0000	0.0000	0.0007	66.7295	0.0621	0.0309	0.0403	0.0028	0.0025	0.0001	0.0001	0.0406	0.0102	0.0001	0.0003	0.0003							
HT	Worker Trips LDT1	2027	1279.25	10.8	LDT1	1.07	0.0188	0.0911	0.0016	0.0015	0.8904	0.2235	0.0031	26.5768	316.4909	0.0044	0.0073	4.4595	1.0175	0.3363	0.0026	0.0023	0.0000	0.0000	0.0008	82.2732	0.0899	0.0362	0.0227	0.0017	0.0019	0.0000	0.0000	0.0136	0.0034	0.0000	4.9360	0.0002	0.0002						
HT	Hauling Class I Landfill	2027	0	84	HHDT	0.07	0.0156	1.7419	0.0266	0.0255	0.9882	0.2550	0.0148	6.1245	1557.8881	0.0007	0.2454	0.0000	0.0000	2.9550	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
HT	Hauling Class II Landfill	2027	0	318	HHDT	0.07	0.0156	1.7419	0.0266	0.0255	0.9882	0.2550	0.0148	6.1245	1557.8881	0.0007	0.2454	0.0000	0.0000	2.9550	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
HT	Hauling Recycler	2027	2290	20	HHDT	0.07	0.0156	1.7419	0.0266	0.0255	0.9882	0.2550	0.0148	6.1245	1557.8881	0.0007	0.2454	0.0000	0.0000	2.9550	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
HT	Other Hauling	2027	123	40	HHDT	0.07	0.0156	1.7419	0.0266	0.0255	0.9882	0.2550	0.0148	6.1245	1557.8881	0.0007	0.2454	0.0000	0.0000	2.9550	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
HT	Infrastructure for Electric Dredging Variation	2027	168	20	HHDT	0.07	0.02	1.74	0.03	0.03	0.99	0.26	0.01	6.1245	1557.8881	0.0007	0.2454	0.0000	0.0000	2.9550	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0001	0.0070	0.0001	0.0001	0.0037	0.0009	0.0001	5.7701	0.0000	0.0009					
HT	Worker Trips LDA electrical	2027	756	10.8	LDA	0.62	0.01	0.03	0.00	0.00	0.89	0.22	0.00	31.9995	265.2288	0.0018	0.0041	2.8446	0.5904	0.2317	0.0019	0.0018	0.0000	0.0000	0.0007	66.7295	0.0621	0.0309	0.0079	0.0006	0.0005	0.0000	0.0000	0.0080	0.0020	0.0000	2.4427	0.0001	0.0001						
HT	Worker Trips LDT1 electrical	2027	252	10.8	LDT1	1.07	0.02	0.09	0.00	0.00	0.89	0.22	0.00	26.5768	316.4909	0.0044	0.0073	4.4595	1.0175	0.3363	0.0026	0.0023	0.0000	0.0000	0.0008	82.2732	0.0899	0.0362	0.0045	0.0003	0.0004	0.0000	0.0000	0.0027	0.0007	0.0000	9.9723	0.0000	0.0000						
HT	Worker Trips LDA	2028	4757.25	10.8	LDA	0.59	0.0061	0.0310	0.0011	0.0010	0.8888	0.2229	0.0026	32.6158	261.0764	0.0017	0.0039	2.7089	0.5652	0.2234	0.0019	0.0017	0.0000	0.0000	0.0006	65.5192	0.0588	0.0303	0.0478	0.0033	0.0029	0.0001	0.0001	0.0503	0.0126	0.0001	15.1296	0.0004	0.0004						
HT	Worker Trips LDT1	2028	1585.75	10.8	LDT1	1.00	0.0169	0.0820	0.0015	0.0014	0.8904	0.2235	0.0031	27.0381	311.8943	0.0039	0.0068	4.1692	0.9710	0.3189	0.0024	0.0022	0.0000	0.0000	0.0008	80.6854	0.0843	0.0352	0.0262	0.0020	0.0021	0.0000	0.0000	0.0168	0.0042	0.0001	6.0291	0.0002	0.0002						
HT	Hauling Class I Landfill	2028	290	84	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	2.9390	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
HT	Hauling Class II Landfill	2028	290	318	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	2.9390	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
HT	Hauling Recycler	2028	2580	64	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	2.9390	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
HT	Other Hauling	2028	116	40	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	2.9390	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
Alameda	Worker Trips LDA	2028	18774	10.8	LDA	0.59	0.0061	0.0310	0.0011	0.0010	0.8888	0.2229	0.0026	32.6158	261.0764	0.0017	0.0039	2.7089	0.5652	0.2234	0.0019	0.0017	0.0000	0.0000	0.0006	65.5192	0.0588	0.0303	0.1885	0.0131	0.0116	0.0003	0.0003	0.1986	0.0498	0.0006	59.7075	0.0016	0.0015						
Alameda	Worker Trips LDT1	2028	6258	10.8	LDT1	1.00	0.0169	0.0820	0.0015	0.0014	0.8904	0.2235	0.0031	27.0381	311.8943	0.0039	0.0068	4.1692	0.9710	0.3189	0.0024	0.0022	0.0000	0.0000	0.0008	80.6854	0.0843	0.0352	0.1034	0.0080	0.0083	0.0001	0.0001	0.0663	0.0167	0.0002	23.7931	0.0009	0.0008						
Alameda	Hauling Class I Landfill	2028	144	84	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	2.9390	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
Alameda	Hauling Class II Landfill	2028	144	318	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	2.9390	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
Alameda	Hauling Recycler	2028	5080	20	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	2.9390	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
Alameda	Other Hauling	2028	238	40	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.0145	6.2342	1529.6889	0.0007	0.2410	0.0000	0.0000	2.9390	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
Schnitzer	Worker Trips LDA	2028	600.02138	10.8	LDA	0.59	0.0061	0.0310	0.0011	0.0010	0.8888	0.2229	0.0026	32.6158	261.0764	0.0017	0.0039	2.7089	0.5652	0.2234	0.0019	0.0017	0.0000	0.0000	0.0006	65.5192	0.0588	0.0303	0.0060	0.0004	0.0004	0.0000	0.0000	0.0000	0.0063	0.0016	0.0000	1.9083	0.0001	0.0000					
Schnitzer	Worker Trips LDT1	2028	200.00713	10.8	LDT1	1.00	0.0169	0.0820	0.0015	0.0014	0.8904	0.2235	0.0031	27.0381	311.8943	0.0039	0.0068	4.1692	0.9710	0.3189	0.0024	0.0022	0.0000	0.0000	0.0008	80.6854	0.0843	0.0352	0.0033	0.0003	0.0003	0.0000	0.0000	0.0021	0.0005	0.0000	0.7604	0.0000	0.0000						
Schnitzer	Other Hauling	2028	38	20	HHDT	0.07	0.0151	1.6845	0.0264	0.0253	0.9887	0.2484	0.01																																

Table 30: Mitigated Tugs to Beneficial Reuse Emissions Detailed Calculations

Location	Description	Equipment	Quantity	Amount (cy)	Distance	Hours	Year	AVG	EF g/bhp-hr										Emissions (tons)							
									Engine Size	Load Factor	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O
HT	Tow Boat Heidi Brusco	Main	1	280,770	43.45	1,626.59	2028	24/7	3000	0.33	0.6851	0.0931	1.0550	0.0702	0.0681	531.0000	0.0018	0.0259	1.2161	0.1652	1.8727	0.1247	0.1209	942.5699	0.0031	0.0460
HT	Tow Boat Heidi Brusco	Auxiliary	1	280,770	43.45	1,626.59	2028	24/7	161	0.37	0.6851	0.0931	1.0531	0.0499	0.0484	554.0000	0.0018	0.0270	0.0732	0.0099	0.1125	0.0053	0.0052	59.1727	0.0002	0.0029
OH	Tow Boat Heidi Brusco	Main	1	1,090,256	43.45	6,316.21	2028	24/7	3000	0.33	0.6851	0.0931	1.0550	0.0702	0.0681	531.0000	0.0018	0.0259	4.7223	0.6415	7.2719	0.4841	0.4695	3660.0849	0.0122	0.1785
OH	Tow Boat Heidi Brusco	Auxiliary	1	1,090,256	43.45	6,316.21	2028	24/7	161	0.37	0.6851	0.0931	1.0531	0.0499	0.0484	554.0000	0.0018	0.0270	0.2841	0.0386	0.4368	0.0207	0.0201	229.7729	0.0007	0.0112
ALA	Tow Boat Heidi Brusco	Main	1	493,077	43.45	2,856.56	2029	24/7	3000	0.33	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	2.1357	0.2901	3.3355	0.3681	0.3571	1655.3034	0.0055	0.0807
ALA	Tow Boat Heidi Brusco	Auxiliary	1	493,077	43.45	2,856.56	2029	24/7	161	0.37	0.6851	0.0931	1.0663	0.0774	0.0750	554.0000	0.0018	0.0270	0.1285	0.0175	0.2000	0.0145	0.0141	103.9167	0.0003	0.0051
IH	Tow Boat Heidi Brusco	Main	1	133,602	43.45	774.00	2029	24/7	3000	0.33	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	0.5787	0.0786	0.9038	0.0997	0.0967	448.5138	0.0015	0.0219
IH	Tow Boat Heidi Brusco	Auxiliary	1	133,602	43.45	774.00	2029	24/7	161	0.37	0.6851	0.0931	1.0663	0.0774	0.0750	554.0000	0.0018	0.0270	0.0348	0.0047	0.0542	0.0039	0.0038	28.1568	0.0001	0.0014
OH	Tow Boat Heidi Brusco	Main	1	251,597	43.45	1,457.59	2029	24/7	3000	0.33	0.6851	0.0931	1.0700	0.1181	0.1145	531.0000	0.0018	0.0259	1.0898	0.1480	1.7020	0.1878	0.1822	844.6350	0.0028	0.0412
OH	Tow Boat Heidi Brusco	Auxiliary	1	251,597	43.45	1,457.59	2029	24/7	161	0.37	0.6851	0.0931	1.0663	0.0774	0.0750	554.0000	0.0018	0.0270	0.0656	0.0089	0.1021	0.0074	0.0072	53.0245	0.0002	0.0026

Table 31: Energy Mitigation Diesel Dredging Emissions Detailed Calculations

Location	Description	Equipment	Equipment		Hp	LF	Work Days	Hours Per Day	Area Adjustment	Type	Year	Avg	SrcGRP	Emission Factors g/bhp-hr								Emissions (tons)					Fuel Consumption				
			Category	Quantity										CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO	CO	ROG	NOx	PM ₁₀		PM _{2.5}	CO ₂	CH ₄	N ₂ O
Howard Terminal	Dredging	Crane with Clam Shell	In-Water	1	755	0.44	5	24	1	OFFROAD	2028	24_7	HTDREDGE	0.95	0.06	1.18	0.469038	0.454967	530	0.00114	0.025898	0.001204	0.041745	0.002637	0.051852	0.020611	0.019992	23.28956	5.01E-05	0.001138	2057.967084
Howard Terminal	Dredging	Main (x2)	In-Water	2	300	0.44	5	24	1	OFFROAD	2028	24_7	HTDREDGE	1.077	0.27	4.01	0.943333	0.915033	531	0.005128	0.025898	0.001085	0.03761	0.009429	0.140034	0.032942	0.031954	18.54318	0.000179	0.000904	1635.47053
Howard Terminal	Dredging	Auxiliary	In-Water	1	325	0.57	5	24	1	OFFROAD	2028	24_7	HTDREDGE	1.06	0.27	3.543077	1.100769	1.067746	518	0.005128	0.025332	0.000749	0.025975	0.006616	0.086821	0.026974	0.026164	12.69328	0.000126	0.000621	1147.617105
Alameda	Dredging	Crane with Clam Shell	In-Water	1	755	0.44	3	24	1	OFFROAD	2029	24_7	ALADREDGE	0.95	0.093062	1.055	0.070228	0.068121	531	0.001768	0.025898	0.000602	0.020873	0.002045	0.02318	0.001543	0.001497	11.66675	3.88E-05	0.000569	1028.983542
Alameda	Dredging	Main (x2)	In-Water	2	300	0.44	3	24	1	OFFROAD	2029	24_7	ALADREDGE	1.077	0.27	4.024	0.988	0.95836	531	0.005128	0.025898	0.000542	0.018805	0.004714	0.070262	0.017251	0.016734	9.271592	8.95E-05	0.000452	817.7352652
Alameda	Dredging	Auxiliary	In-Water	1	325	0.57	3	24	1	OFFROAD	2029	24_7	ALADREDGE	1.06	0.27	3.559231	1.152308	1.117738	518	0.005128	0.025332	0.000375	0.012987	0.003308	0.043608	0.014118	0.013695	6.34664	6.28E-05	0.00031	573.8085525
Inner Harbor	Dredging	Crane with Clam Shell	In-Water	1	755	0.44	3	24	1	OFFROAD	2029	24_7	IHDREDGE	0.95	0.06	1.12341	0.513704	0.498293	530	0.00114	0.025898	0.000602	0.020873	0.001318	0.024683	0.011287	0.010948	11.64478	2.5E-05	0.000569	1028.983542
Inner Harbor	Dredging	Main (x2)	In-Water	2	300	0.44	3	24	1	OFFROAD	2029	24_7	IHDREDGE	1.077	0.27	4.024	0.988	0.95836	531	0.005128	0.025898	0.000542	0.018805	0.004714	0.070262	0.017251	0.016734	9.271592	8.95E-05	0.000452	817.7352652
Inner Harbor	Dredging	Auxiliary	In-Water	1	325	0.57	3	24	1	OFFROAD	2029	24_7	IHDREDGE	1.06	0.27	3.559231	1.152308	1.117738	518	0.005128	0.025332	0.000375	0.012987	0.003308	0.043608	0.014118	0.013695	6.34664	6.28E-05	0.00031	573.8085525
Outer Harbor	Dredging	Crane with Clam Shell	In-Water	1	755	0.44	5	24	1	OFFROAD	2028	24_7	OHDREDGE	0.95	0.06	1.10941	0.469038	0.454967	530	0.00114	0.025898	0.001204	0.041745	0.002637	0.04875	0.020611	0.019992	23.28956	5.01E-05	0.001138	2057.967084
Outer Harbor	Dredging	Main (x2)	In-Water	2	300	0.44	5	24	1	OFFROAD	2028	24_7	OHDREDGE	1.077	0.27	4.01	0.943333	0.915033	531	0.005128	0.025898	0.001085	0.03761	0.009429	0.140034	0.032942	0.031954	18.54318	0.000179	0.000904	1635.47053
Outer Harbor	Dredging	Auxiliary	In-Water	1	325	0.57	5	24	1	OFFROAD	2028	24_7	OHDREDGE	1.06	0.27	3.543077	1.100769	1.067746	518	0.005128	0.025332	0.000749	0.025975	0.006616	0.086821	0.026974	0.026164	12.69328	0.000126	0.000621	1147.617105
Outer Harbor	Dredging	Crane with Clam Shell	In-Water	1	755	0.44	5	24	1	OFFROAD	2029	24_7	OHDREDGE	0.95	0.06	1.12341	0.513704	0.498293	530	0.00114	0.025898	0.001204	0.041745	0.002637	0.049366	0.022573	0.021896	23.28956	5.01E-05	0.001138	2057.967084
Outer Harbor	Dredging	Main (x2)	In-Water	2	300	0.44	5	24	1	OFFROAD	2029	24_7	OHDREDGE	1.077	0.27	4.024	0.988	0.95836	531	0.005128	0.025898	0.001085	0.03761	0.009429	0.140523	0.034502	0.033467	18.54318	0.000179	0.000904	1635.47053
Outer Harbor	Dredging	Auxiliary	In-Water	1	325	0.57	5	24	1	OFFROAD	2029	24_7	OHDREDGE	1.06	0.27	3.559231	1.152308	1.117738	518	0.005128	0.025332	0.000749	0.025975	0.006616	0.087217	0.028237	0.02739	12.69328	0.000126	0.000621	1147.617105

Table 32: Diesel Dredging Alternative Dredging Emissions Detailed Calculations

Location	Description	Equipment	Equipment Category	Quantity	Hp	LF	Work Days	Hours Per Day	Area Adjustment	Type	Year	Avg	SrcGRP	CO	ROG	NOx	EF g/bhp-hr						tons							
																	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	Fuel Consumption
Howard Terminal	Dredging	Crane with Clam Shell	In-Water	1	755	0.44	1	1008	1	OFFROAD	2028	24_7	HTDREDGE	0.95	0.06	1.18	0.469038	0.454967	530	0.00114	0.025898	0.350662	0.022147	0.435559	0.17313	0.167936	195.6323	0.000421	0.00956	17286.92351
Howard Terminal	Dredging	Main (x2)	In-Water	2	300	0.44	1	1008	1	OFFROAD	2028	24_7	HTDREDGE	1.077	0.27	4.01	0.943333	0.915033	531	0.005128	0.025898	0.315926	0.079201	1.176287	0.276716	0.268415	155.7627	0.001504	0.007597	13737.95245
Howard Terminal	Dredging	Auxiliary	In-Water	1	325	0.57	1	1008	1	OFFROAD	2028	24_7	HTDREDGE	1.06	0.27	3.543077	1.100769	1.067746	518	0.005128	0.025332	0.218187	0.055576	0.729296	0.226579	0.219782	106.6235	0.001056	0.005214	9639.983683
Alameda	Dredging	Crane with Clam Shell	In-Water	1	755	0.44	1	2016	1	OFFROAD	2029	24_7	ALADREDG	0.95	0.06	1.194	0.513704	0.498293	530	0.00114	0.025898	0.701323	0.044294	0.881453	0.379235	0.367858	391.2647	0.000841	0.019119	34573.84701
Alameda	Dredging	Main (x2)	In-Water	2	300	0.44	1	2016	1	OFFROAD	2029	24_7	ALADREDG	1.077	0.27	4.024	0.988	0.95836	531	0.005128	0.025898	0.631851	0.158403	2.360788	0.579637	0.562248	311.5255	0.003009	0.015194	27475.90491
Alameda	Dredging	Auxiliary	In-Water	1	325	0.57	1	2016	1	OFFROAD	2029	24_7	ALADREDG	1.06	0.27	3.559231	1.152308	1.117738	518	0.005128	0.025332	0.436374	0.111152	1.465243	0.474375	0.460144	213.2471	0.002111	0.010428	19279.96737
Inner Harbor	Dredging	Crane with Clam Shell	In-Water	1	755	0.44	1	672	1	OFFROAD	2029	24_7	IHDREDGE	0.95	0.06	1.12341	0.513704	0.498293	530	0.00114	0.025898	0.233774	0.014765	0.276447	0.126412	0.122619	130.4216	0.00028	0.006373	11524.61567
Inner Harbor	Dredging	Main (x2)	In-Water	2	300	0.44	1	672	1	OFFROAD	2029	24_7	IHDREDGE	1.077	0.27	4.024	0.988	0.95836	531	0.005128	0.025898	0.210617	0.052801	0.786929	0.193212	0.187416	103.8418	0.001003	0.005065	9158.63497
Inner Harbor	Dredging	Auxiliary	In-Water	1	325	0.57	1	672	1	OFFROAD	2029	24_7	IHDREDGE	1.06	0.27	3.559231	1.152308	1.117738	518	0.005128	0.025332	0.145458	0.037051	0.488414	0.158125	0.153381	71.08236	0.000704	0.003476	6426.655788
Outer Harbor	Dredging	Crane with Clam Shell	In-Water	1	755	0.44	1	5040	1	OFFROAD	2028	24_7	OHDREDG	0.95	0.06	1.10941	0.469038	0.454967	530	0.00114	0.025898	1.753309	0.110735	2.047514	0.86565	0.839681	978.1617	0.002103	0.047798	86434.61753
Outer Harbor	Dredging	Main (x2)	In-Water	2	300	0.44	1	5040	1	OFFROAD	2028	24_7	OHDREDG	1.077	0.27	4.01	0.943333	0.915033	531	0.005128	0.025898	1.579628	0.396007	5.881437	1.38358	1.342073	778.8137	0.007522	0.037985	68689.76227
Outer Harbor	Dredging	Auxiliary	In-Water	1	325	0.57	1	5040	1	OFFROAD	2028	24_7	OHDREDG	1.06	0.27	3.543077	1.100769	1.067746	518	0.005128	0.025332	1.090936	0.27788	3.646481	1.132895	1.098908	533.1177	0.005278	0.026071	48199.91841
Outer Harbor	Dredging	Crane with Clam Shell	In-Water	1	755	0.44	1	336	1	OFFROAD	2029	24_7	OHDREDG	0.95	0.06	1.12341	0.513704	0.498293	530	0.00114	0.025898	0.116887	0.007382	0.138223	0.063206	0.06131	65.21078	0.00014	0.003187	5762.307835
Outer Harbor	Dredging	Main (x2)	In-Water	2	300	0.44	1	336	1	OFFROAD	2029	24_7	OHDREDG	1.077	0.27	4.024	0.988	0.95836	531	0.005128	0.025898	0.105309	0.0264	0.393465	0.096606	0.093708	51.92092	0.000501	0.002532	4579.317485
Outer Harbor	Dredging	Auxiliary	In-Water	1	325	0.57	1	336	1	OFFROAD	2029	24_7	OHDREDG	1.06	0.27	3.559231	1.152308	1.117738	518	0.005128	0.025332	0.072729	0.018525	0.244207	0.079063	0.076691	35.54118	0.000352	0.001738	3213.327894

Table 33: Inner Barrel Only Alternative Off-road and In-water Emissions Detailed Calculations

Phase	Location	Description	SCGNP	Equipment	Equipment Category	Quantity	Hr	LF	Work Days	Hours Per Day	Area Adjustment	Type	Year	Aug	Emissions (lb/hr/yr)										Tons										
															CO	NOx	PM10	PM2.5	CH4	N2O	CO2	CO2e	SO2	NO2	PM10	PM2.5	CH4	N2O	CO2	CO2e					
Q1H	Howard Terminal	Concrete Pavement Removal	HCNONS	Backhoe/Front Ldr	Offroad	1	286	37	45	10	1	OFFROAD	2027	12	5	HCNONS	0.383808	0.051233	0.10078	0.037657	0.025443	194.1536	0.021	0.004	0.019563	0.001827	0.005242	0.000194	0.000779	10.0956	0.001092	0.002028	2435.95006		
Q1H	Howard Terminal	Concrete Pavement Removal	HCNONS	Concrete Saw	Offroad	1	81	0.73	45	10	1	OFFROAD	2027	12	5	HCNONS	1.109596	0.032209	0.044733	0.027657	0.025443	166.7744	0.023	0.005	0.032226	0.000936	0.000004	0.000079	0.000004	0.000004	0.000004	4.847133	0.000668	0.001273	1531.22184
Q1H	Howard Terminal	Concrete Pavement Removal	HCNONS	Dozer	Offroad	1	347	0.4	45	10	1	OFFROAD	2027	12	5	HCNONS	0.435482	0.054702	0.115649	0.040584	0.040218	211.7871	0.022	0.004	0.029711	0.003732	0.000789	0.000313	0.000288	14.48986	0.001501	0.002773	3195.14145		
Q1H-1	Howard Terminal	Concrete Pavement Hauling	HCNONS	Excavator	Offroad	2	78	0.38	4	10	1	OFFROAD	2027	12	5	HCNONS	0.382494	0.03428	0.103776	0.038004	0.0035	201.4268	0.021	0.004	0.001155	0.00095	0.000020	0.000004	0.000004	0.000004	0.000004	1.11E-05	0.000115	0.000175	511.706056
Q2H	Howard Terminal	Sheetpile/ Bulkhead Installation	HCNONS	Backhoe/Front Ldr	Offroad	1	286	37	62	10	1	OFFROAD	2027	12	5	HCNONS	0.383808	0.051233	0.10078	0.037657	0.025443	194.1536	0.021	0.004	0.027565	0.002523	0.000728	0.000268	0.000247	13.94386	0.001508	0.002027	3365.49311		
Q2H	Howard Terminal	Sheetpile/ Bulkhead Installation	HCNONS	Excavator	Offroad	2	78	0.38	7	10	1	OFFROAD	2027	12	5	HCNONS	0.382494	0.03428	0.103776	0.038004	0.0035	201.4268	0.021	0.004	0.001155	0.00095	0.000020	0.000004	0.000004	0.000004	0.000004	1.11E-05	0.000115	0.000175	511.706056
Q2H	Howard Terminal	Sheetpile/ Bulkhead Installation	HCNONS	Diesel Hammer	Offroad	1	172	0.62	10	10	1	OFFROAD	2027	12	5	HCNONS	0.412629	0.034099	0.112447	0.040457	0.037322	220.5232	0.021	0.004	0.020231	0.001673	0.000519	0.000199	0.000199	10.8119	0.001303	0.001568	2926.15141		
Q2H	Howard Terminal	Sheetpile/ Bulkhead Installation	HCNONS	Backhoe/Front Ldr	Offroad	1	286	37	24	10	1	OFFROAD	2028	12	5	HCNONS	0.383808	0.051233	0.10078	0.037657	0.025443	194.1536	0.021	0.004	0.017405	0.000983	0.000281	0.000104	0.000104	9.61E-05	0.001537	0.000588	0.00112	3111.10221	
Q2H	Howard Terminal	Sheetpile/ Bulkhead Installation	HCNONS	Crane	Offroad	1	231	0.29	24	10	1	OFFROAD	2028	12	5	HCNONS	0.29158	0.023707	0.077613	0.028004	0.02579	152.0781	0.021	0.004	0.005168	0.00042	0.000175	0.000079	0.000079	4.97E-05	0.002509	0.00027	7.09E-05	830.001294	
Q2H	Howard Terminal	Sheetpile/ Bulkhead Installation	HCNONS	Diesel Hammer	Offroad	1	172	0.62	10	10	1	OFFROAD	2028	12	5	HCNONS	0.412629	0.034099	0.112447	0.040457	0.037322	220.5232	0.021	0.004	0.007884	0.000652	0.000249	0.000091	0.000091	7.75E-05	0.001415	0.000417	6.46E-05	895.048417	
Q3H	Howard Terminal	Land Excavation Hauling	HCNONS	Excavator	Offroad	2	78	0.38	17	10	1	OFFROAD	2028	12	5	HCNONS	0.382494	0.03428	0.103776	0.038004	0.0035	201.4268	0.021	0.004	0.004044	0.000371	0.000123	0.000044	0.000044	4.42E-05	0.001123	0.000371	3.19E-05	563.558558	
Q3H	Howard Terminal	Land Excavation Hauling	HCNONS	Excavator	Offroad	2	78	0.38	17	10	1	OFFROAD	2028	12	5	HCNONS	0.382494	0.03428	0.103776	0.038004	0.0035	201.4268	0.021	0.004	0.004044	0.000371	0.000123	0.000044	0.000044	4.42E-05	0.001123	0.000371	3.19E-05	563.558558	
Q5H	Howard Terminal	Batter Pile Installation	HCNONS	Backhoe/Front Ldr	Offroad	1	286	37	22	10	1	OFFROAD	2028	12	5	HCNONS	0.383808	0.051233	0.10078	0.037657	0.025443	194.1536	0.021	0.004	0.009594	0.000911	0.000214	0.000084	0.000084	9.9E-05	0.003267	0.00045	0.000104	1214.59052	
Q5H	Howard Terminal	Batter Pile Installation	HCNONS	Crane	Offroad	1	231	0.29	22	10	1	OFFROAD	2028	12	5	HCNONS	0.29158	0.023707	0.077613	0.028004	0.02579	152.0781	0.021	0.004	0.004787	0.000389	0.000164	0.000064	0.000064	4.23E-05	0.002498	0.000345	6.57E-05	768.903977	
Q5H	Howard Terminal	Batter Pile Installation	HCNONS	Diesel Hammer	Offroad	1	172	0.62	22	10	1	OFFROAD	2028	12	5	HCNONS	0.412629	0.034099	0.112447	0.040457	0.037322	220.5232	0.021	0.004	0.007305	0.000604	0.000199	0.000079	0.000079	7.18E-05	0.002461	0.000345	6.92E-05	826.162909	
Q5H	Howard Terminal	Batter Pile Installation	HCNONS	Drilling Rig	Offroad	1	221	0.5	22	10	1	OFFROAD	2028	12	5	HCNONS	0.498755	0.03816	0.133617	0.04771	0.043899	263.8454	0.021	0.004	0.013507	0.001033	0.000319	0.000129	0.000129	0.000119	0.0014308	0.000569	0.001088	1268.30705	
Q5H	Howard Terminal	Batter Pile Installation	HCNONS	Vibratory Hammer	Offroad	1	46	0.42	22	10	1	OFFROAD	2028	12	5	HCNONS	0.412629	0.034099	0.112447	0.040457	0.037322	220.5232	0.021	0.004	0.004958	0.000161	0.000053	1.92E-05	1.77E-05	1.04E-06	9.94E-06	1.89E-05	246.25653		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Barge	Water	2	225	0.31	40	10	1	OFFROAD	2027	12	5	HCNONS	0.685098	0.093062	3.41	0.671443	0.471212	531	0.001768	0.025898	0.042008	0.005706	0.29009	0.04007	0.03928	41.95927	0.001018	0.001287	2871.65826		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Towboat/Pushboat - Main	Water	2	640	0.33	40	4	1	OFFROAD	2027	12	5	HCNONS	0.685098	0.093062	4.015	0.929286	0.930507	531	0.001768	0.025898	0.045049	0.007343	0.316814	0.075965	0.793244	82.22992	0.001319	0.00244	3685.41252		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Towboat/Pushboat - Auxiliary	Water	1	132	0.37	40	4	1	OFFROAD	2027	12	5	HCNONS	0.685098	0.093062	3.3775	0.565	0.54805	554	0.001768	0.02703	0.006251	0.000849	0.030815	0.005515	0.0005	0.504537	1.61E-05	0.000247	444.754274		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Towboat/Pushboat - Auxiliary	Water	1	0	0.37	40	4	1	OFFROAD	2027	12	5	HCNONS	0.685098	0.093062	4.3575	0.51875	0.503188	628	0.001768	0.030639	0	0	0	0	0	0	0	0	0	0	
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Compressor	Offroad	2	78	0.48	40	10	1	OFFROAD	2027	12	5	HCNONS	1.109596	0.032209	0.344133	0.027657	0.025445	166.7744	0.023	0.005	0.036532	0.00106	0.00146	0.00091	0.000877	5.489992	0.000757	0.001265	1715.63444		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Diesel Hammer	Offroad	1	172	0.62	22	10	1	OFFROAD	2027	12	5	HCNONS	0.412629	0.034099	0.112447	0.040457	0.037322	220.5232	0.021	0.004	0.004958	0.000161	0.000053	1.92E-05	1.77E-05	1.04E-06	9.94E-06	1.89E-05	246.25653		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Dive Vessel-Main	Water	2	622	0.33	40	2	1	OFFROAD	2027	12	5	HCNONS	0.685098	0.093062	3.911364	0.263856	0.699777	531	0.001768	0.024778	0.024724	0.003358	0.141146	0.022887	0.022006	19.16303	0.000861	0.000816	61.62046		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Dive Vessel-Auxiliary	Water	2	644	0.32	40	2	1	OFFROAD	2027	12	5	HCNONS	0.685098	0.093062	3.3625	0.324643	0.589804	531	0.001768	0.024778	0.017885	0.002429	0.08778	0.013696	0.13225	18.6206	0.001605	0.000614	1156.53693		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Excavator	Offroad	2	78	0.38	40	10	1	OFFROAD	2027	12	5	HCNONS	0.382494	0.03428	0.103776	0.038004	0.0035	201.4268	0.021	0.004	0.009966	0.000893	0.000274	0.000104	0.000104	9.12E-05	0.002484	0.000547	10.13662726		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Generator	Offroad	2	244	0.74	40	10	1	OFFROAD	2027	12	5	HCNONS	0.367765	0.046133	0.062765	0.004221	0.003884	166.7744	0.023	0.005	0.058735	0.007323	0.009963	0.00067	0.00066	26.47197	0.003651	0.007094	7433.78143		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Diesel Hammer	Offroad	1	172	0.62	22	10	1	OFFROAD	2027	12	5	HCNONS	0.412629	0.034099	0.112447	0.040457	0.037322	220.5232	0.021	0.004	0.004958	0.000161	0.000053	1.92E-05	1.77E-05	1.04E-06	9.94E-06	1.89E-05	246.25653		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Dive Vessel-Main	Water	2	622	0.33	40	2	1	OFFROAD	2027	12	5	HCNONS	0.685098	0.093062	3.911364	0.263856	0.699777	531	0.001768	0.024778	0.024724	0.003358	0.141146	0.022887	0.022006	19.16303	0.000861	0.000816	61.62046		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Dive Vessel-Auxiliary	Water	2	644	0.32	40	2	1	OFFROAD	2027	12	5	HCNONS	0.685098	0.093062	3.3625	0.324643	0.589804	531	0.001768	0.024778	0.017885	0.002429	0.08778	0.013696	0.13225	18.6206	0.001605	0.000614	1156.53693		
Q6H	Howard Terminal	Howard Pile Removal Activity	HCNONS	Excavator	Offroad	2	78	0.38	40	10	1	OFFROAD	2027	12	5	HCNONS	0.382494	0.03428	0.103776	0.038004	0.0035	201.4268	0.021	0.004	0.009966	0.000893	0.000274	0.0							

Table 35: Inner Harbor Only Alternative Tugs to Beneficial Reuse Emissions Detailed Calculations

Location	Description	Equipment	Quantity	Amount (cy)	Distance	Hours	Year	AVG	Engine		Area	CO	ROG	NOx	EF g/bhp-hr			tons										Fuel Use	
									Size	LF					SRCGRP	Adjust	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂		CH ₄
HT	Tow Boat Heidi Bruscd	Main	1	280770	43.45	1626.594	2028	24/7	3000	0.33	IHTUG	Yes	0.685098	0.093062	1.055	0.070228	0.068121	531	0.001768	0.025898	1.216108	0.165193	1.872714	0.124661	0.120921	942.5699	0.003138	0.045972	82,906
HT	Tow Boat Heidi Bruscd	Auxiliary	1	280770	43.45	1626.594	2028	24/7	161	0.37	IHTUG	Yes	0.685098	0.093062	1.04875	0.049871	0.048375	554	0.001768	0.02703	0.073175	0.00994	0.112017	0.005327	0.005167	59.17267	0.000189	0.002887	5,207
ALA	Tow Boat Heidi Bruscd	Main	1	493077	43.45	2856.559	2029	24/7	3000	0.33	IHTUG	Yes	0.685098	0.093062	1.07	0.118085	0.114543	531	0.001768	0.025898	2.135679	0.290105	3.335545	0.368111	0.357068	1655.303	0.00551	0.080734	145,597
ALA	Tow Boat Heidi Bruscd	Auxiliary	1	493077	43.45	2856.559	2029	24/7	161	0.37	IHTUG	Yes	0.685098	0.093062	1.0575	0.077371	0.07505	554	0.001768	0.02703	0.128507	0.017456	0.198361	0.014513	0.014077	103.9167	0.000332	0.00507	9,144
IH	Tow Boat Heidi Bruscd	Main	1	133602	43.45	774.0009	2029	24/7	3000	0.33	IHTUG	Yes	0.685098	0.093062	1.07	0.118085	0.114543	531	0.001768	0.025898	0.578674	0.078606	0.903785	0.099742	0.09675	448.5138	0.001493	0.021875	39,450
IH	Tow Boat Heidi Bruscd	Auxiliary	1	133602	43.45	774.0009	2029	24/7	161	0.37	IHTUG	Yes	0.685098	0.093062	1.0575	0.077371	0.07505	554	0.001768	0.02703	0.03482	0.00473	0.053747	0.003932	0.003814	28.15681	8.98E-05	0.001374	2,478

Table 36: Outer Harbor Only Alternative Off-road and In-water Equipment Emissions Detailed Calculations

Phase	Location	Description	Equipment	Equipment			Work Days	Hours Per Day	Area Adjustment	Type	Year	Avg	SrcGRP	EF g/bhp-hr						tons						Fuel Consumption					
				Category	Quantity	Hp								LF	CO	ROG	NOx	PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO	ROG	NOx		PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O
12IN	Outer Harbor	Hauling (Berth 10)	Dozer	Offroad	1	347	0.4	13	12	1	OFFROAD	2029	12_5	OHCONS125	0.435482	0.054702	0.115649	0.004584	0.004218	211.7871	0.022	0.004	0.01033	0.001298	0.002743	0.000109	0.0001	5.023659	0.000522	9.49E-05	1110.896279
12IN	Outer Harbor	Hauling (Berth 10)	Excavator	Offroad	1	78	0.38	13	12	1	OFFROAD	2029	12_5	OHCONS125	0.382494	0.03428	0.103776	0.003804	0.0035	201.4268	0.021	0.004	0.001937	0.000174	0.000526	1.93E-05	1.77E-05	1.020297	0.000106	2.03E-05	263.7280624
OHEL	Outer Harbor	Infrastructure for Electric Dredging Variation	Backhoe/Front Ldr	Offroad	1	286	0.37	84	10	1	OFFROAD	2027	12_5	EINFRA	0.383808	0.035123	0.10078	0.003732	0.003433	194.1536	0.021	0.004	0.037607	0.003441	0.009875	0.000366	0.000336	19.0238	0.002058	0.000392	4588.85773
OHEL	Outer Harbor	Infrastructure for Electric Dredging Variation	Concrete Saw	Offroad	1	81	0.73	84	10	1	OFFROAD	2027	12_5	EINFRA	1.109956	0.032209	0.344713	0.027657	0.025445	166.7744	0.023	0.005	0.060771	0.001763	0.018873	0.001514	0.001393	9.131059	0.001259	0.000274	2850.616627
OHEL	Outer Harbor	Infrastructure for Electric Dredging Variation	Roller	Offroad	1	80	0.38	84	10	1	OFFROAD	2027	12_5	EINFRA	1.221935	0.037242	0.515236	0.004038	0.003715	166.7744	0.023	0.005	0.034396	0.001048	0.014503	0.000114	0.000105	4.694473	0.000647	0.000141	1,466
08OH	Outer Harbor	Dredging	Barge	Water	2	225	0.31	182	1	1	OFFROAD	2028	24_7	OHDREDGR	0.685098	0.093062	3.42	0.698571	0.677614	531	0.001768	0.025898	0.019174	0.002604	0.095714	0.019551	0.018964	14.86089	4.95E-05	0.000725	1,311
08OH	Outer Harbor	Dredging	Towboat/Pushboat- Main	Water	2	640	0.33	182	4	1	OFFROAD	2028	24_7	OHDREDGR	0.685098	0.093062	1.07	0.118085	0.114543	531	0.001768	0.025898	0.246741	0.033517	0.385365	0.042529	0.041253	191.242	0.000637	0.009327	16,821
08OH	Outer Harbor	Dredging	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	182	4	1	OFFROAD	2028	24_7	OHDREDGR	0.685098	0.093062	1.0575	0.077371	0.07505	554	0.001768	0.02703	0.028529	0.003875	0.044037	0.003222	0.003125	23.07015	7.36E-05	0.001126	2,030
08OH	Outer Harbor	Dredging	Barge	Water	2	225	0.31	42	1	1	OFFROAD	2028	24_7	OHDREDGR	0.685098	0.093062	3.43	0.73	0.7081	531	0.001768	0.025898	0.004425	0.000601	0.022152	0.004715	0.004573	3.429435	1.14E-05	0.000167	302
08OH	Outer Harbor	Dredging	Towboat/Pushboat- Main	Water	2	640	0.33	42	4	1	OFFROAD	2028	24_7	OHDREDGR	0.685098	0.093062	1.07	0.118085	0.114543	531	0.001768	0.025898	0.05694	0.007735	0.08893	0.009814	0.00952	44.13278	0.000147	0.002152	3,882
08OH	Outer Harbor	Dredging	Towboat/Pushboat- Auxiliary	Water	1	132	0.37	42	4	1	OFFROAD	2028	24_7	OHDREDGR	0.685098	0.093062	1.0575	0.077371	0.07505	554	0.001768	0.02703	0.006584	0.000894	0.010162	0.000744	0.000721	5.32388	1.7E-05	0.00026	468

Table 37: Outer Harbor Only Alternative On-road Emissions Detailed Calculations

Location	Howard Terminal	Year	Trips	Length miles	EMFAC Category	Time Schedule	EF g/mile														EF g/trip														Emissions (tons)													
							CO	ROG	NOX	Ex PM10	Ex PM2.5	Fug PM10	Fug PM2.5	SO2	Fuel gal/m	CO ₂	CH ₄	N ₂ O	CO	ROG	NOX	Ex PM10	Ex PM2.5	Fug PM10	Fug PM2.5	SO2	CO ₂	CH ₄	N ₂ O	CO	ROG	NOX	Ex PM10	Ex PM2.5	Fug PM10	Fug PM2.5	SO2	CO ₂	CH ₄	N ₂ O	Fuel (gallons)							
OH	Worker Trips LDA	2028	7098	10.8	LDA	12hr/5day/week	0.59	0.0061	0.03	0.00	0.00	0.89	0.22	0.00	32.61577	261.08	0.0017	0.0039	2.71	0.57	0.22	0.00	0.00	0.00	0.00	0.00	0.00	65.52	0.06	0.03	0.071282	0.004936	0.004371	0.000107	9.88E-05	0.075101	0.018837	0.000223	22.57398	0.000603	0.000569	2350.347774						
OH	Worker Trips LDT1	2028	2366	10.8	LDT1	12hr/5day/week	1.00	0.0169	0.08	0.00	0.00	0.89	0.22	0.00	27.03808	311.89	0.0039	0.0068	4.17	0.97	0.32	0.00	0.00	0.00	0.00	0.00	80.69	0.08	0.04	0.039099	0.003008	0.003141	4.8E-05	4.42E-05	0.02508	0.006295	8.89E-05	8.995612	0.000331	0.000284	945.0670987							
OH	Infrastructure for Electric Dredging Variation	2027	168	20	HHDT	12hr/5day/week	0.07	0.0151	1.68	0.03	0.03	0.99	0.25	0.01	6.124452	1557.89	0.0007	0.2454	0.00	0.00	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000255	5.6E-05	0.006783	9.79E-05	9.37E-05	0.003662	0.00092	5.36E-05	5.770058	2.69E-06	0.000909	548.6205563							
OH	Worker Trips LDA	2027	756	10.8	LDA	12hr/5day/week	0.62	0.0067	0.03	0.00116	0.00107	0.888758	0.2229217	0.002622	31.99954	265.2288	0.0018	0.0041	2.844588	0.590421	0.231664	0.00194	0.001783	0	0	0.00066	66.72949	0.062066	0.030945	0.007934	0.000552	0.000492	1.21E-05	1.11E-05	0.007999	0.002006	2.41E-05	2.44271	6.81E-05	6.25E-05	255.153668							
OH	Worker Trips LDT1	2027	252	10.8	LDT1	12hr/5day/week	1.07	0.0188	0.09	0.00158	0.001453	0.8903898	0.2234929	0.003129	26.57684	316.4909	0.0044	0.0073	4.459546	1.017486	0.336281	0.00255	0.002345	0	0	0.000813	82.27316	0.089855	0.036174	0.004463	0.000339	0.000367	5.45E-06	5.01E-06	0.002671	0.00067	9.61E-06	0.972343	3.81E-05	3.2E-05	102.4049473							
OH	Worker Trips LDA	2028	1638	10.8	LDA	12hr/5day/week	0.57	0.0056	0.03	0.00	0.00	0.89	0.22	0.00	32.61577	261.08	0.0017	0.0039	2.59	0.54	0.22	0.00	0.00	0.00	0.00	0.00	64.40	0.06	0.03	0.015809	0.001081	0.00096	2.34E-05	2.15E-05	0.017331	0.004347	5.08E-05	5.207359	0.000134	0.00013	542.3879478							
OH	Worker Trips LDT1	2028	546	10.8	LDT1	12hr/5day/week	0.93	0.0150	0.07	0.00	0.00	0.89	0.22	0.00	27.03808	311.89	0.0039	0.0068	3.89	0.92	0.30	0.00	0.00	0.00	0.00	0.00	79.15	0.08	0.03	0.00841	0.000649	0.000659	1.04E-05	9.54E-06	0.005788	0.001453	2.02E-05	2.074988	7.33E-05	6.49E-05	218.0924074							

Table 38: Outer Harbor Only Tugs to Beneficial Reuse Emissions Detailed Calculations

Location	Description	Equipment	Quantity	Amount (cy)	Distance	Hours	Year	AVG	Engine Size	Load Factor	SRCGRP	Area Adjust	CO	ROG	NOx	EF g/bhp-hr					tons					Fuel Use			
																PM ₁₀	PM _{2.5}	CO ₂	CH ₄	N ₂ O	CO	ROG	NOx	PM ₁₀	PM _{2.5}		CO ₂	CH ₄	N ₂ O
OH	Tow Boat Heidi Bruscd	Main	1	1090255.563	43.45	6316.214	2028	24/7	3000	0.33	OHTUGB	Yes	0.685098	0.093062	1.055	0.070228	0.068121	531	0.001768	0.025898	4.722257	0.641458	7.27192	0.48407	0.469548	3660.085	0.012183	0.178512	321932.331
OH	Tow Boat Heidi Bruscd	Auxiliary	1	1090255.563	43.45	6316.214	2028	24/7	161	0.37	OHTUGB	Yes	0.685098	0.093062	1.04875	0.049871	0.048375	554	0.001768	0.02703	0.284146	0.038598	0.434972	0.020684	0.020064	229.7729	0.000733	0.011211	20218.0505
OH	Tow Boat Heidi Bruscd	Main	1	251597.4375	43.45	1457.588	2028	24/7	3000	0.33	OHTUGB	Yes	0.685098	0.093062	0.98441	0.070228	0.068121	531	0.001768	0.025898	1.089752	0.148029	1.565851	0.111708	0.108357	844.635	0.002812	0.041195	74292.0764
OH	Tow Boat Heidi Bruscd	Auxiliary	1	251597.4375	43.45	1457.588	2028	24/7	161	0.37	OHTUGB	Yes	0.685098	0.093062	0.97816	0.049871	0.048375	554	0.001768	0.02703	0.065572	0.008907	0.093622	0.004773	0.00463	53.02452	0.000169	0.002587	4665.70397

Attachment A: Future Vessel Call Air Emissions with and without Oakland Turning Basins Widening Project Memorandum

DRAFT MEMORANDUM

Date: 31 July 2023

To: Khamly Chuop, Port of Oakland

From: Chris Lindhjem and Till Stoeckenius

Subject: Future Vessel Call Air Emissions with and without Oakland Turning Basins Widening Project

INTRODUCTION

This memorandum documents the data sources, assumptions, and procedures used to calculate annual criteria pollutant emissions from vessel visits to the Port of Oakland under two future year scenarios as defined in the April 2023 *Revised Draft Integrated Feasibility Report and Environmental Assessment* for the Oakland Harbor Turning Basins Widening project:¹

- 1) Without completion of the Oakland Turning Basins Widening project (the “no project” scenario) and
- 2) with completion of the Oakland Turning Basins Widening project (the “proposed project” scenario).

While annual cargo throughput (commonly measured in terms of the equivalent number of 20-foot-long containers or TEUs) is the same under both scenarios, the proposed project scenario includes a greater number of calls by larger container ships which is more than offset by a smaller number of calls by smaller container ships as compared to the no project scenario (see Table 2 below).

This emissions analysis used the results of vessel emission estimates provided in the Port of Oakland’s 2020 Seaport Air Emissions Inventory (“2020 Inventory”)² segregated by vessel size (in terms of TEU carrying capacity). For this analysis, we used results corresponding to the “best estimation method” for container ship emissions as shown in Table 2-11 of the 2020 Inventory together with recently revised estimates of Harbor Craft (ship assist tugs) emissions³ based on the most recent 2021 California Air Resources Board emission inventory methods⁴. This analysis was only performed on diesel propulsion ships; steam ships were not included.

Container Ship Activity and Emissions

We segregated the 2020 container ship by-vessel emissions by the vessel classes shown in Tables 1 and 2 to estimate per-voyage emissions rates. The San Francisco Marine Exchange defines a voyage as a full round trip into and out of the San Francisco Bay (SF Bay),

¹ <https://www.spn.usace.army.mil/Missions/Projects-and-Programs/Current-Projects/Oakland-Harbor-Turning-Basins-Widening/>

² <https://www.portoakland.com/community/environmental-stewardship/seaport-air-emissions-inventory-2005/>

³ https://www.portoakland.com/files/PDF/CHCEmissionsUpdateMemo_20230124.pdf

⁴ <https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/road-documentation/msei-documentation-road>

including all port calls and anchorages inland of the Golden Gate, as well as transits to and between those points. In practice nearly but not all container ships called to only one Port of Oakland berth in 2020 and did not call to any other berths during the same voyage⁵. Each vessel class defined in Table 1 is unique with respect to TEU capacity range; while vessels with greater capacity typically have a greater length overall (LOA), there is some overlap in LOA between the different vessel classes.

Table 1. Container Vessel Class Summary

Class	Description	TEU Capacity (Min / Max)	Length Overall (feet)
SPX	Sub Panamax	<2,800	222 to 813.3
PX	Panamax	2,801 to 4,800	572 to 970
PPX1	Post-Panamax Generation I (Post-Panamax)	4,801 to 6,800	661 to 1,045
PPX2	Post-Panamax Generation II (Super Post-Panamax)	6,801 to 9,900	911 to 1,205
PPX3	Post-Panamax Generation III (New Panamax, or Ultra Post-Panamax)	9,901 to 15,000	Up to 1,220
PPX4	Post-Panamax Generation IV (New Post-Panamax)	15,001+	1,295 to 1,315

Source: Summarized from Table 2-8 of Appendix C, Economics, of the April 2023 *Revised Draft Integrated Feasibility Report and Environmental Assessment*.

TEU = a unit representing a 20-foot-long container

Table 2. Forecast of Container Vessel Voyages by Vessel Class for Years 2030, 2040, and 2050.

Class	TEU Capacity (Min / Max)	No Project	Proposed Project	No Project	Proposed Project	No Project	Proposed Project
		2030		2040		2050	
SPX	<2,800	150	106	132	66	149	52
PX	2,801 to 4,800	231	170	224	123	126	26
PPX1	4,801 to 6,800	532	323	600	231	518	92
PPX2	6,801 to 9,900	563	544	658	515	701	397
PPX3	9,901 to 15,000	321	488	498	725	675	880
PPX4	15,001+	24	52	69	191	257	502
Total:		1,821	1,683	2,181	1,851	2,426	1,949

Source: Prepared based on data provided in Tables 2-8, 3-10, and 4-7 of Appendix C, Economics, of the April 2023 *Revised Draft Integrated Feasibility Report and Environmental Assessment*.

Emissions from all transiting legs (or links) as defined in the 2020 Inventory were included, but the anchorage mode was not included. Anchorage events exhibited significant temporal variability in 2020, making it impossible to determine if ship size was a causative factor in making the decision to go to anchor or in deciding how long to anchor in SF Bay.

⁵ Less than 10 voyages in 2020 included ships calling at two Port of Oakland berths during the same voyage.

We used our per-voyage estimates of berthing emissions assuming no use of shore power as a starting point to estimate the expected future year shoreside power use. By 2025, all container ships and terminals are expected conform with California at-berth regulation⁶ requiring no more than 5% of calls without at-berth emission controls (e.g., use of shorepower or other equivalent method) and fewer than 3 hours total emission control equipment connection/disconnection time during each call. Since all or nearly all container ships currently rely on shorepower to comply with the at-berth regulation and our likely to continue to so, our calculation assumes shorepower is the only approach used. Using the per-call and per-call-hour uncontrolled berthing emission rates segregated by ship class, we estimated future year emissions assuming the minimum required use of at-berth control via the following equation:

$$\text{Berthing Emissions} = 0.05 \times \text{Calls} \times \text{Emissions/call} + 0.95 \times \text{Calls} \times 3 \text{ hours} \times \text{Emissions/call-hr}$$

The berthing emissions estimates for 2020 implicitly account for the berthing time by ship class with larger ships expected to have longer berth times as shown in Table 3.

Table 3. Port of Oakland 2020 Berthing Time by Ship Class

Class	TEU Capacity (Min / Max)	Length Overall (feet)	Average Berthing (Hours)
SPX	<2,800	222 to 813.3	20.1
PX	2,801 to 4,800	572 to 970	22.7
PPX1	4,801 to 6,800	661 to 1,045	26.5
PPX2	6,801 to 9,900	911 to 1,205	35.8
PPX3	9,901 to 15,000	Up to 1,220	46.2
PPX4	15,001+	1,295 to 1,315	59.7

Ship NOx emissions from ocean going vessels are regulated by the International Maritime Organization (IMO)⁷ by Tier level based on the build year of the vessel. We took this into account in our calculations of future year emissions by forecasting fleet age distributions for 2030, 2040, and 2050 by applying the vessel age distribution from the 2020 Inventory to each future year. The resulting fleet age distribution forecasts are shown in Table 4. Only NOx emissions vary by Tier level; emission rates for other pollutants do not depend significantly on Tier level.

Table 4. Vessel Age Distribution by NOx Tier Level

NOx Tier Level	Model Year Group	2030	2040	2050
Precontrol	<2000	6%	4%	0%
Tier I	2000 - 2010	8%	3%	4%
Tier II	2011 - 2015	13%	1%	3%
Tier III	2016+	73%	93%	94%

⁶ <https://ww2.arb.ca.gov/our-work/programs/ocean-going-vessels-berth-regulation/ocean-going-vessels-berth-regulatory>

⁷ [https://www.imo.org/en/OurWork/Environment/Pages/Nitrogen-oxides-\(NOx\)-%E2%80%93-Regulation-13.aspx](https://www.imo.org/en/OurWork/Environment/Pages/Nitrogen-oxides-(NOx)-%E2%80%93-Regulation-13.aspx)

Some studies have shown that NOx control technology used on Tier III vessel main engines is not fully effective at low engine loads.⁸ We addressed this potential issue by applying Tier II emission factors to Tier III main engines throughout each voyage. Using the NOx emission factors in Table 5 and age distributions from Table 4, we determined fleet average NOx emission factors by vessel source category (main propulsion engines, auxiliary generator engines, and boilers) as shown in Table 5. We applied these factors to the engine power (kWh) demanded per call for each source category as calculated for the 2020 inventory. No low load adjustment factors were applied for NOx emissions⁹ but low load adjustment factors were applied for all other pollutants as described in the 2020 Inventory.

Table 5. Fleet Average NOx Emission Factor (g/kWh)

NOx Tier Level	NOx Main	NOx Auxiliary	Boiler
Precontrol	17	13.8	N/A
Tier I	16	12.2	N/A
Tier II	14.4	10.5	N/A
Tier III	14.4 ^a	2.6	N/A
Fleet Average			
2030	14.69	5.11	1.995
2040	14.54	3.36	1.995
2050	14.46	3.17	1.995

^a Would be 3.4 g/kWh if NOx controls were assumed to operate effectively at lower engine loads.

Tug Activity and Emissions

Our emissions calculations account for the fact that larger ships require more assist tug activity as shown in Table 6. We chose the emissions rates from a Tier 4 tug to represent the future year fleet consistent with California regulations¹⁰, but we did not assume the use of an additional diesel particulate filter (DPF) that may be mandated for these vessels.

Table 6. Port of Oakland 2020 Assist Tug use by Vessel Class

Class	TEU Capacity (Min / Max)	Length Overall (feet)	Average Tug-Assists ^a Per Vessel Voyage
SPX	<2,800	222 to 813.3	3.73
PX	2,801 to 4,800	572 to 970	3.49
PPX1	4,801 to 6,800	661 to 1,045	3.88
PPX2	6,801 to 9,900	911 to 1,205	4.71
PPX3	9,901 to 15,000	Up to 1,220	6.05
PPX4	15,001+	1,295 to 1,315	7.45

⁸ Carr, E.W. 2023. Oakland Harbor Turning Basins Widening: Peer review services for evaluating air quality, emissions, and economic analysis: operations and emissions. June 12.

⁹ This was done to avoid difficulties in applying the Tier II NOx emission factors to Tier III vessels. Note the minimum engine load factor used in the calculations was 2%. The NOx low-load adjustment factor at 2% load is 1.86 and is closer to 1.00 at higher loads. By comparison, the Tier II NOx emission factor is 4.2 times greater than the Tier III emission factor, so ignoring the NOx low-load adjustment does not significantly reduce the degree of conservativeness introduced by applying Tier II NOx emission factors to Tier III engines at all loads.

¹⁰ <https://ww2.arb.ca.gov/our-work/programs/commercial-harbor-craft/chc-regulatory-documents>

^a A “tug-assist” is defined here as one tug assisting a vessel on one voyage leg. Thus, a vessel using two (2) assist tugs on both the in-bound and out-bound leg would require a total of four (4) tug-assists per vessel voyage. In the SF Bay, more tug-assists are usually required for the in-bound voyage leg than the out-bound voyage leg.

Average per-voyage emissions by vessel class (i.e., by TEU capacity) calculated via the procedures described above were multiplied by the forecast number of vessel voyages by vessel class under the No Project and Proposed Project scenarios as shown in Table 2 to arrive at the total annual emissions shown in Table 7. The projected emissions for DPM and NOx are shown in Figures 1 and 2.

Table 7. Emissions (tons) by Calendar Year

Scenario	Calendar Year	ROG	CO	NOx	SOx	PM10	PM2.5	DPM
No Project	2030	78	150	1,262	66	21	19.5	13.4
Proposed Project	2030	75	147	1,226	64	21	19.1	13.0
No Project	2040	96	185	1,486	81	26	24.1	16.4
Proposed Project	2040	87	172	1,367	76	24	22.5	15.1
No Project	2050	111	218	1,721	96	31	28.5	19.1
Proposed Project	2050	96	196	1,531	87	28	25.9	16.9

ROG = reactive organic gases, CO = carbon monoxide, NOx = nitrogen oxides, SOx = oxides of sulfur; PM10 = particulate matter with aerodynamic diameter of 10 microns or less, PM2.5 = particulate matter with aerodynamic diameter of 2.5 microns or less; DPM = diesel particulate matter (PM10 from exhaust)

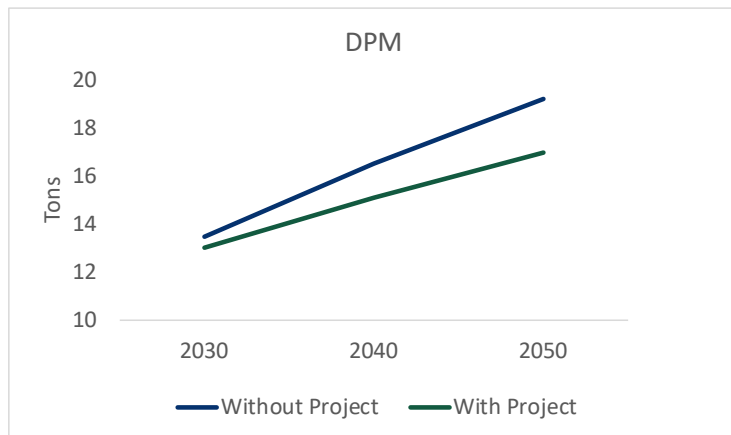


Figure 1. DPM emissions - Tons

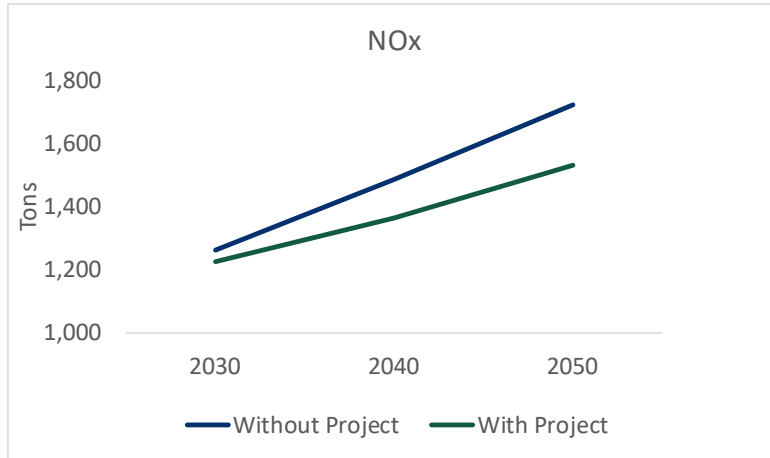


Figure 2. NOx emissions - Tons