Appendix 20A Methodology for Air Quality and GHG Emissions Calculations

Appendix 20A
Methodology for Air Quality and GHG Emissions Calculations

This appendix includes the methods used for the construction and operations mass emissions analysis for the Project. For the Health Risk Assessment and Ambient Air Quality Analysis methods, please refer to Appendix 20C, *Ambient Air Quality and Health Risk Analysis Technical Report*. For the photochemical modeling and criteria pollutant health analysis, please refer to Appendix 20D, *Photochemical Modeling Study to Support a Health Impact Analysis*. The California Emissions Estimator Model (CalEEMod) was used to quantify estimates for the criteria pollutants and GHG emissions without implementation of best management practices (BMPs) and with implementation of BMPs (ICF 2021).

This appendix discusses the methods used to evaluate daily and yearly emissions to comply with CEQA guidelines in the study area. Pollutants analyzed include ozone (O_3) precursors (reactive organic gases [ROGs[1]] and nitrogen oxides [NO_X]) and criteria pollutants of carbon monoxide (CO), particulate matter (PM10 and PM2.5), and sulfur dioxide (SO_2); and greenhouse gases (GHG) of carbon dioxide (CO_2), methane (CH_4), and nitrous oxides (N_2O). Where applicable, the analysis also quantifies toxic air contaminants (TAC), such as diesel particulate matter (DPM).

20A.1 Construction Mass Emissions

20A.1.1 Construction Schedule

Construction of the Project would occur between 2024 and 2029, depending on the alternative. During peak construction periods, work would occur at several locations within the study area, with overlapping construction occurring at multiple Project facilities. Working hours and workers present at any time would vary, depending on the activities being performed. Table 20A-1 summarizes the expected timeframe for construction of each of the Project components for the purposes of the air quality modeling analysis.

Table 20A-1. General Schedule

Project Feature	Schedule
Dunnigan Pipeline	Alternatives 1 & 3: 2024 to 2025 Alternative 2: 2025 to 2026
Funks Pumping Generating Plant	All Alternatives: 2026 to 2029
Terminal Regulating Reservoir (TRR) Pumping Generating Plants	All Alternatives: 2026 to 2029
Funks and TRR Pipelines	All Alternatives: 2026 to 2027

[1] ROG is synonymous with volatile organic compounds (VOC); both terms are used in this appendix depending on the emissions source.

Project Feature	Schedule
Funks Reservoir	All Alternatives: 2025 to 2028
TRR East (Alternatives 1 & 3); TRR West (Alternative 2)	All Alternatives: 2025 to 2028
Western Area Power Administration (WAPA) Substations	All Alternatives: 2026 to 2027
PG&E Substations	All Alternatives: 2026 to 2027
WAPA Transmission Line	All Alternatives: 2026 to 2028
PG&E Transmission Line	All Alternatives: 2026 to 2028
Red Bluff Pumping Plant	All Alternatives: 2026 to 2027
Glenn-Colusa Irrigation District (GCID) Main Canal Improvements	All Alternatives: 2025 to 2027
Project Concrete Plant at Funks Reservoir	All Alternatives: 2026 to 2028
Funks/TRR Controlled Low Strength Material (CLSM) Plant	All Alternatives: 2026 to 2027
Dunnigan CLSM Plant	All Alternatives: 2025 to 2026
TRR Mixing Plant (East and West)	All Alternatives: 2025 to 2026
Concrete – GCID (offsite)	All Alternatives: 2025 to 2027
Owners and Engineers Contract Management Staff	Alternatives 1 & 3: 2024 to 2029 Alternative 2: 2025 to 2029
Golden Gate and Sites Dams Package General and Management Staff	All Alternatives: 2025 to 2029
Saddle Dams Package General and Management Staff	All Alternatives: 2025 to 2028
Inlet/Outlet Facilities Package General and Management Staff	All Alternatives: 2025 to 2029
Roadways Package General and Management Staff	Alternatives 1 & 3: 2024 to 2027 Alternative 2: 2024 to 2028
Golden Gate Dam	Alternatives 1 & 3: 2024 to 2029 Alternative 2: 2024 to 2028
Sites Dam	All Alternatives: 2025 to 2029
Saddle Dam 3	Alternatives 1 & 3: 2025 to 2029 Alternative 2: 2025 to 2028
Saddle Dam 5	Alternatives 1 & 3: 2025 to 2029 Alternative 2: 2025 to 2028
Saddle Dams 1, 2, 6, 8A, & 8B (Alternatives 1 & 3) Saddle Dams 8A, 8B & Dikes 1, 2, & 3 (Alternative 2)	Alternatives 1 & 3: 2025 to 2029 Alternative 2: 2025 to 2028
Emergency Release Structure-1 (ERS) Facilities (Alternatives 1 & 3 only)	Alternatives 1 & 3: 2025 to 2027
ERS-2 Facilities (Alternatives 1 & 3 only)	Alternatives 1 & 3: 2026 to 2027
Golden Gate Dam Bypass Facilities	All Alternatives: 2025 to 2026
Saddle Dam Diversion Facilities	All Alternatives: 2025 to 2027
Main Inlet/Outlet Facilities	All Alternatives: 2025 to 2029
Roadways	All Alternatives: 2024 to 2027
Reservoir Concrete Plant (Inlet/Outlet Facilities)	All Alternatives: 2026 to 2029
Reservoir Concrete Plant (Golden Gate Dam, Sites Dam, Diversion Facilities)	All Alternatives: 2026 to 2028
Reservoir Concrete Plant (Saddle Dams, ERS-1, ERS-2)	All Alternatives: 2026 to 2027

Project Feature	Schedule
Reservoir Concrete Plant (Sites Lodoga Road Bridge)	All Alternatives: 2024 to 2027
Reservoir Asphalt Concrete Plant (Roadways)	All Alternatives: 2024 to 2027

CLSM = Controlled Low Strength Material; ERS = Emergency Release Structure; GCID = Glenn-Colusa Irrigation District; PG&E = Pacific Gas and Electric Company; TRR = Terminal Regulating Reservoir; WAPA = Western Area Power Administration.

20A.1.2 Activity Data

The engineering teams for reservoir and conveyance facilities have developed Project-specific construction assumptions (e.g., equipment operating hours, cubic yards of soil moved) for the Project facilities. These assumptions define the activity inputs used to estimate construction emissions.

20A.1.3 Emission Sources

Table 20A-2 summarizes the emissions-generating sources expected during construction of the Project. Chapter 2, *Project Description and Alternatives*, and Appendix 2C, *Construction Means, Methods, and Assumptions*, provide additional information on the general construction approach and method.

Table 20A-2. Emissions-Generating Activities during Project Construction

Source	Emissions-Generating Process	Pollutants Analyzed
Offroad equipment	Equipment fuel combustion	ROG, NO_X, CO, PM2.5, PM10, DPM, SO_2, CO_2, CH_4, N_2O
Onroad vehicles	Vehicle fuel combustion	Same as *offroad equipment fuel combustion*
	Tire wear and brake wear	Fugitive dust (PM10 and PM2.5)
	Vehicle travel	Fugitive dust (PM10 and PM2.5)
Helicopters	Vehicle fuel combustion	Same as *offroad equipment fuel combustion*
Electricity consumption	Generation and transmission	CO_2, CH_4, N_2O, SF_6
Striping	Painting of parking lots and roads	VOC
Paving	Application of asphalt	VOC
Demolition	Mechanical dismemberment	Fugitive dust (PM10 and PM2.5)
	Debris loading	Fugitive dust (PM10 and PM2.5)
Land clearing	Scraping	Fugitive dust (PM10 and PM2.5)
	Bulldozing	Fugitive dust (PM10 and PM2.5)
	Truck loading	Fugitive dust (PM10 and PM2.5)
Material storage and processing	Rock crushing and processing	Fugitive dust (PM10 and PM2.5)
	Stockpile wind erosion	Fugitive dust (PM10 and PM2.5)
	Blasting	NO_X, CO, SO_2, CO_2, CH_4, N_2O Fugitive dust (PM10 and PM2.5)
	Concrete processing	Fugitive dust (PM10 and PM2.5), TAC

Source	Emissions-Generating Process	Pollutants Analyzed
Concrete and asphalt batching	Asphalt processing	ROG, NO_X, CO, SO_2, CO_2, CH_4 Fugitive dust (PM10 and PM2.5)
	Stockpile wind erosion	Fugitive dust (PM10 and PM2.5)
	Upstream (lifecycle) activities	CO_2, CH_4, and N_2O
Water use	Electricity generation and transmission	CO_2, CH_4, N_2O, SF_6

ROG = reactive organic gases; VOC = volatile organic compounds; NO_X = nitrogen oxides; CO = carbon monoxide; PM10 = particulate matter; PM2.5 = particulate matter; SO_2 = sulfur dioxide; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxides; SF_6 = sulfur hexafluoride; DPM = diesel particulate matter; TAC = toxic air contaminants.

20A.1.4 Emissions Estimation

Each of the activities presented in Table 20A-2 was included in the evaluation of air quality and GHG impacts during construction of the Project. Emission rates for the various activities were calculated using a combination of emission factors and methodologies from the CalEEMod model, version 2016.3.2; the Emissions FACtors model (EMFAC2017);[2] the U.S. Environmental Protection Agency's (USEPA) *AP-42 Compilation of Air Pollutant Emission Factors* (AP-42); and other relevant agency guidance and published literature, as discussed further and cited below.

The Authority has included BMPs that would minimize potential air quality and GHG emissions from construction of the Project. Mass emissions have been quantified for construction scenarios both with and without the BMPs. Accordingly, an emission reduction factor was applied to the emission rate calculation for activities that would be affected by the BMPs. Appendix 2D, *Best Management Practices*, presents the BMPs that are incorporated into Project construction. The following sections describe the quantification approach for each emissions source.

20A.1.4.1 Offroad Equipment

Emission factors for diesel-powered offroad equipment (e.g., loaders, graders, bulldozers) were obtained from the CalEEMod model (version 2016.3.2) User's Guide, which provides values per unit of activity (in grams per horsepower-hour) (Trinity Consultants 2017a:Table 3.5).

For the scenario without BMPs, equipment engines are equivalent to calendar year averages that are based on a mix of equipment meeting various engine tiers. Accessory equipment, such as trailers with no engines or emissions-generating components, were excluded from the analysis.

For the BMP scenario (refer to Appendix 2D), Tier 4 emissions rates were modeled, where established, based on the following criteria for equipment:

- For conveyance facilities, all equipment less than 120 horsepower will be equivalent to Tier 4 final standards. All other equipment was assumed to be equivalent to the fleet average.

[2] CARB released EMAFC2021 on January 15, 2021, but this version has not yet been approved by USEPA. Accordingly, this analysis uses EMAFC2017, which was available at the time of notice of preparation and is the current USEPA-approved version of EMFAC.

- For reservoir facilities, all equipment will be equivalent to Tier 4 final standards except mast rotary percussion drills, the auger drill rigs, and grouting drill rigs. The drill equipment would be equivalent to the fleet average.

Equipment exhaust emissions were calculated using the CalEEMod emission factors and Equation 20A-1.

Equation 20A-1 $E_{phase} = \Sigma(Activity * EF_t * LF_t * HP_t) * UC$

Where:

E_{phase} = total exhaust emissions for the phase (pounds per day)

Activity = equipment activity (hours per day)

EF = engine emission factor (grams per horsepower-hour)

LF = engine load factor (unitless)

HP = engine horsepower (unitless)

UC = unit conversion from grams to pounds (0.002205)

t = equipment type (e.g., graders)

CalEEMod does not include emission factors for N_2O for offroad diesel equipment. Emissions of N_2O generated by each diesel-powered equipment piece were determined by scaling the CO_2 emissions quantified by Equation 20A-1 by the ratio of N_2O/CO_2 (0.000046) emissions expected per gallon of diesel fuel according to the Climate Registry (Climate Registry 2020:Tables 2.1 and 2.7).

20A.1.4.2 Onroad Vehicles

20A.1.4.2.1 Vehicle Fuel Combustion

Onroad vehicles (e.g., pickup trucks, flatbed trucks) would be required for material and equipment hauling, onsite crew and material movement, and employee commuting. Exhaust emissions from onroad vehicles were estimated using the EMFAC2017 emissions model and vehicle activity data (trips and miles traveled per day). Running exhaust emission factors for onsite trucks are based on emission rates at 5 miles per hour[3] (mph) for EMFAC's heavy-heavy duty truck (HHDT) and medium-heavy duty truck (MHDT) vehicle categories. Factors for offsite trucks are based on emissions rates in 5-mph "bin" increments for EMFAC's medium duty vehicle (MDV), MHDT, and HHDT vehicle categories, as applicable. Offsite employee commute vehicles are based on light-duty automobile (LDA) and light duty truck (LDT) vehicle categories. Process exhaust (e.g., starting, idle) emissions factors were also derived from EMFAC2017 for each of the Project vehicle categories.

The modeling also includes the BMPs pertaining to onroad trucks, which involves the construction contractors using onroad trucks with engines certified to the 2010 model year or newer heavy-duty diesel engine emissions standards in compliance with California Air Resources Board (CARB) regulations. Thus, for the BMP scenario, the fleet average for onroad trucks was assumed to only include model years from 2010 or newer.

[3] Emission factors are greatest at lower vehicle speeds. It is likely vehicles will travel faster than 5 mph, and thus it is conservative to model emissions at 5 miles per hour, the lowest vehicle speed.

Running emissions were calculated using the EMFAC emission factors and Equations 20A-2 and 20A-3.

Equation 20A-2 $E = \Sigma VMT_t * EF_t * UC$

Where:

E = total running emissions (pounds per day)

VMT = daily VMT by speed (if applicable) (miles per day)

EF = running emissions factor by speed (if applicable) (grams per mile)

UC = unit conversion from grams to pounds (0.002205)

t = vehicle type (e.g., HHDT)

Equation 20A-3 $E = \Sigma Trip_t * EF_t * UC$

Where:

E = Total process emissions (pounds per day)

Trip = daily trips (trips per day)

EF = process emissions factor (grams per trip)

UC = unit conversion from grams to pounds (0.002205)

t = vehicle type (e.g., HHDT)

20A.1.4.2.2 Tire Wear and Brake Wear

Emissions from tire wear and brake wear emissions from onroad vehicles were estimated using the EMFAC2017 emissions model and activity data (miles traveled per day). Emission factors for each of the Project vehicle categories were derived from EMFAC2017 using the same method as described above for vehicle fuel combustion. Equation 20A-2 was used to calculate resulting emissions (as shown in Section 20A.1.4.2.1, *Vehicle Fuel Combustion*).

20A.1.4.2.3 Vehicle Travel

When a vehicle travels over a road, the force of the wheels on the road can resuspend surface material that is entrained by vehicular travel. Entrained road dust contributes to airborne fugitive dust (PM10 and PM2.5). Emission factors for entrained road dust were calculated using the methodology found in Sections 13.2.1 and 13.2.2 of AP-42. Emission factors for onsite vehicles were calculated using Section 13.2.2 for unpaved roads (U.S. Environmental Protection Agency 2006a:Tables 13.2.2-1 and 13.2.2-2). Emission factors for offsite vehicles were calculated using Section 13.2.1 for paved roads (U.S. Environmental Protection Agency 2011:Table 13.2.1-1).

The equation for developing the unpaved road dust emission factors is shown as Equation 20A-4.

Equation 20A-4 $EF = [((k * (s \div 12)^a * (S \div 30)^d) \div (M - 0.5)^c) - C] * ((N - P) \div N) * (1 - CE)$

Where:

EF = emission factor (grams per mile)

k = empirical constant (grams per VMT)

s = surface material silt content (%)

M = surface material moisture content (%)

S = mean vehicle speed (mph)

C = emission factor for vehicle fleet exhaust, brake wear, and tire wear (grams per mile)

a = empirical constant (unitless)

c = empirical constant (unitless)

d = empirical constant (unitless)

N = number of days in the average period (365 days)

P = days per year with at least 0.01 inch of precipitation (days per year)

CE = control efficiency achieved by BMPs (%)

Constants a, b, and d are based on the particle size, and P and C are Project-specific values based on location. Table 20A-3 defines the variables used for this calculation. The control efficiency is achieved through implementation of the BMPs, specifically the measure requiring application of soil stabilizers to be applied to unpaved access roads to minimize visible dust.

Table 20A-3. Variables for Unpaved Road Dust Emission Factor Calculation

Variable	PM10	PM2.5	Source
k (gram/VMT)	816.47	81.65	AP-42, Section 13.2.2 (U.S. Environmental Protection Agency 2006a:Table 13.2.2-2)
s (%)	8.5	8.5	AP-42, Section 13.2.2 (U.S. Environmental Protection Agency 2006a:Table 13.2.2-1)
C (gram/VMT)	0.114 (SVAB)	0.051 (SVAB)	EMFAC2017
a (unitless)	1.0	1.0	AP-42, Section 13.2.2 (U.S. Environmental Protection Agency 2006a:Table 13.2.2-2)
c (unitless)	0.2	0.2	AP-42, Section 13.2.2 (U.S. Environmental Protection Agency 2006a:Table 13.2.2-2)
d (unitless)	0.5	0.5	AP-42, Section 13.2.2 (U.S. Environmental Protection Agency 2006a:Table 13.2.2-2)
P (days/year)	48	48	Western Regional Climate Center 2012
CE (%)	84	84	Countess Environmental 2006

The equation for developing the paved road dust emission factors is shown as Equation 20A-5.

Equation 20A-5 $EF = [k * (sL)^{0.91} * (W)^{1.02}] * (1 - P \div 4N) * UC$

Where:

EF = emission factor (grams per mile)

k = empirical constant (pound per VMT)

sL = road surface silt loading (grams per square meter [g/m^2])

W = mean weight of all vehicles traveling on the road (tons)

P = days per year with at least 0.01 inch of precipitation (days per year)

N = number of days in the average period (365 days)

UC = unit conversion from pounds to grams (453.592)

Constant k varies depending on the particle size, and P varies by project location (air basin). Table 20A-4 defines the variables used for this calculation.

Table 20A-4. Variables for Paved Road Dust Emission Factor Calculation

Variable	PM10	PM2.5	Source
k (lb/VMT)	0.0022	0.00054	AP-42, Section 13.2.1 (U.S. Environmental Protection Agency 2011:Table 13.2.1-1)
sL (g/m^2)	0.1	0.1	CalEEMod default (obtained from the model)
W (tons)	2.4	2.4	CalEEMod (Trinity Consultants 2017a:Table 4.1)
P (days/year)	48	48	Western Regional Climate Center 2012

Equation 20A-2 (as shown in Section 20A.1.4.2.1, *Vehicle Fuel Combustion*) was used to estimate the resulting road dust emissions based on the calculated emission factors.

20A.1.4.3 Helicopters

Helicopters would be required to install either the Western Area Power Administration or PG&E transmission lines. Emission factors per landing and take-off (LTO) and per operational cruising hour for a Bell UH-1H, which is assumed to be a representative type of helicopter for the transmission line activities, were obtained from the Federal Office of Civil Aviation (Federal Office of Civil Aviation 2015:16). Criteria pollutants and GHG emissions generated by LTO were quantified using Equation 20A-6, and emissions generated from cruising were quantified using Equation 20A-7.

Equation 20A-6 **E = EF * LTO * UC**

Where:

E = exhaust emissions (pounds per day)

EF = engine emission factor (grams per LTO)

LTO = daily LTO (landings and takeoffs per day)

UC = unit conversion from grams to pounds (0.000001)

Equation 20A-7 **E = EF * Hr * UC**

Where:

E = exhaust emissions (pounds per day)

EF = engine emission factor (grams per hour)

Hr = daily cruising time (hours per day)

UC = unit conversion from grams to pounds (0.000001)

20A.1.4.4 Electricity Consumption

Construction of the Project would require the use of electricity for portable offices and certain types of equipment. Operation of the concrete batch plants would also consume electricity. GHG emission factors from the generation and transmission of electricity were calculated using data from the USEPA's 2019 Emissions & Generation Resource Integrated Database (eGRID) and account for increases in the renewable energy mix due to the renewables portfolio standard and Senate Bill 100 (United States Environmental Protection Agency 2021).[4] Emissions were calculated using Equation 20A-8.

Equation 20A-8 $E = EF * MWh * UC$

Where:

E = annual emissions (pounds per year)

EF = electricity emission factor (grams per megawatt-hour [MWh])

MWh = electricity consumed per year (MWh per year)

UC = unit conversion from grams to pounds (0.000001)

20A.1.4.5 Striping

Volatile organic compounds (VOC) off-gassing emissions result from the painting of stripes, directional arrows, and other markings on paved surfaces. The VOC emission factor for striping was calculated using the methodology found in the CalEEMod User's Guide (Trinity Consultants 2017b:17). The equation for developing the VOC emission factor is shown as Equation 20A-9.

Equation 20A-9 $EF = C_{VOC} \div UC_1 * UC_2 \div C$

Where:

EF = emission factor (pounds per square foot)

C_{VOC} = VOC content (grams per liter)

UC_1 = unit conversion from pounds to grams (453.592)

UC_2 = unit conversion from gallons to liters (3.785)

C = constant, square feet (180)

VOC emissions were calculated using Equation 20A-10 (Trinity Consultants 2017b:17).

Equation 20A-10 $E_{phase} = EF * A_{PL} * P$

Where:

E_{phase} = VOC emissions for the phase (pounds per day)

EF = VOC emission factor (pounds per square foot)

A_{PL} = parking lot area constructed per day (square feet per day)

P = percent of area that is painted (6%)

---

[4] eGRID does not include emission factors for SF_6. Statewide SF_6 emissions in 2018, which was the most recent year at the time of this analysis, were therefore used to identify an emission factor per MWh by dividing total SF_6 emissions by the total electricity generation in California (California Air Resources Board 2020; California Energy Commission 2019).

20A.1.4.6 Paving

VOC off-gassing emissions result from asphalt paving of roads and parking lots. The VOC emission factor was obtained from the CalEEMod Users' Guide (Trinity Consultants 2017b:17–18). VOC emissions were calculated using Equation 20A-11.

Equation 20A-11 $E_{phase} = EF * A_P$

Where:

E_{phase} = VOC emissions for the phase (pounds per day)

EF = VOC emission factor (2.62 pounds per acre)

A_P = daily area paved (acres per day)

20A.1.4.7 Demolition

20A.1.4.7.1 Mechanical Dismemberment

Fugitive dust emission factors for dismemberment and collapse of a structure are calculated using Equation 20A-12, which is based on the methodology found in Section 13.2.4 of AP-42 and the CalEEMod User's Guide (Trinity Consultants 2017b:12).

Equation 20A-12 $EF = k * (0.0032) * [(U \div 5)^{1.3} \div (M \div 2)^{1.4}] * UC$

Where:

EF = emission factor (pounds per square foot)

k = particle size multiplier (pounds per ton)

U = mean wind speed (mph)

M = material moisture content (%)

UC = unit conversion from tons to square foot debris (0.0460)

Constant k varies depending on the particle size, and U is specific to project location. Table 20A-5 defines the variables used for this calculation.

Table 20A-5. Variables for Mechanical Dismemberment Emission Factor Calculation

Variable	PM10	PM2.5	Source
k (lb/ton)	0.35	0.053	AP-42, Section 13.2.4 (U.S. Environmental Protection Agency 2006b:13.2.4-4)
U (mph)	4.6	4.6	California Irrigation Management Information System 2021
M (%)	2	2	CalEEMod User's Guide (Trinity Consultants 2017b:12)

Dust emissions from mechanical dismemberment were calculated using Equation 20A-13 (Trinity Consultants 2017b:12).

Equation 20A-13 $E_{phase} = EF * SF$

Where:

E_{phase} = emissions for the phase (pounds per day)

EF = emission factor (pounds per square foot demolished)

SF = floor area demolished per day (square feet per day)

20A.1.4.7.2 Debris Loading

Fugitive dust emission factors for debris loading are calculated using Equation 20A-14, which is based on the methodology found in the CalEEMod User's Guide (Trinity Consultants 2017b:13).

Equation 20A-14 $EF = k * EF_{L\text{-}TSP} * UC$

Where:

EF = emission factor (pounds per square foot)

k = particle size multiplier (unitless)

$EF_{L\text{-}TSP}$ = default factor for total suspended particles (0.058 pounds per ton)

UC = unit conversion from tons to square foot debris (0.0460)

Equation 20A-12 (as shown above in *Mechanical Dismemberment*) was used to estimate the resulting debris loading emissions based on the calculated emission factors.

Emissions generated by vehicles removing debris from the Project site are accounted for in the onroad vehicle analysis above.

20A.1.4.8 Land Clearing

20A.1.4.8.1 Scraping

Fugitive dust emission factors from grading equipment passes are calculated using Equation 20A-15, which is based on the methodology found in Section 11.9 of AP-42 and the CalEEMod User's Guide (Trinity Consultants 2017b:8–9).

Equation 20A-15 $EF = [(C * S^a) * F * (As \div Wb) * (UC_1 \div UC_2)] (1 - CE)$

Where:

EF = emission factor (pounds per acre)

C = coefficient (unitless)

S = mean vehicle speed (mph)

a = empirical constant (unitless)

F = particle scaling factor

As = unitized acreage (1 acre)

Wb = blade width of the grading equipment (12 feet)

UC_1 = unit conversion from acres to square feet (43,560)

UC_2 = unit conversion from miles to feet (5,280)

CE = control efficiency achieved by BMPs (%)

Constants C, a, and F vary depending on the particle size. Table 20A-6 define the variables used for this calculation. The control efficiency is achieved through implementation of BMPs, specifically the measure requiring water application at land clearing areas, earth movement areas, and other areas that are visibly dry.

Table 20A-6. Variables for Scraping Calculation

Variable	PM10	PM2.5	Source
C	0.051	0.04	AP-42, Section 11.9 (U.S. Environmental Protection Agency 1998:11.9-5)
S (mph)	7.1	7.1	AP-42, Section 11.9 (U.S. Environmental Protection Agency 1998:11.9-9)
a	2	2.5	AP-42, Section 11.9 (U.S. Environmental Protection Agency 1998:11.9-5)
F	0.6	0.031	AP-42, Section 11.9 (U.S. Environmental Protection Agency 1998:11.9-5)
CE (%)	61	61	Countess Environmental 2006:Table 3-7

Dust emissions from scraping were calculated using Equation 20A-16.

Equation 20A-16 $E_{phase} = EF * A$

Where:

E_{phase} = emissions for the phase (pounds per day)

EF = emission factor (pounds per acre)

A = daily acres graded (acres per day)

20A.1.4.8.2 Bulldozing

Fugitive dust emission factors from bulldozing are calculated using Equation 20A-17, which is based on the methodology found in Section 11.9 of AP-42 and the CalEEMod User's Guide (Trinity Consultants 2017b:10).

Equation 20A-17 $EF = (C * s^a \div M^b * F)$

Where:

EF = emission factor (pounds per hour)

C = coefficient (unitless)

s = material silt content (%)

a = empirical constant (unitless)

M = material moisture content (%)

F = particle scaling factor

Constants C, a, and F vary depending on the particle size. Table 20A-7 define the variables used for this calculation.

Table 20A-7. Variables for Bulldozing Calculation

Variable	PM10	PM2.5	Source
C	1.0	5.7	AP-42, Section 11.9 (U.S. Environmental Protection Agency 1998:11.9-5)
s (%)	6.9	6.9	AP-42, Section 11.9 (U.S. Environmental Protection Agency 1998:11.9-9)
a	1.5	1.2	AP-42, Section 11.9 (U.S. Environmental Protection Agency 1998:11.9-5)
M (%)	7.9	7.9	AP-42, Section 11.9 (U.S. Environmental Protection Agency 1998:11.9-9)
F	0.75	0.105	AP-42, Section 11.9 (U.S. Environmental Protection Agency 1998:11.9-5)

Dust emissions from bulldozing were calculated using Equation 20A-18.

Equation 20A-18 $E_{phase} = EF * Activity$

Where:

E_{phase} = emissions for the phase (pounds per day)

EF = emission factor (pounds per hour)

Activity = equipment activity (hours per day)

20A.1.4.8.3 Truck Loading

Fugitive dust emission factors from loading and unloading overburden onto a truck were calculated following the same methodology as used for mechanical dismemberment (refer to Section 20A.1.4.7.1, *Mechanical Dismemberment*). The material moisture content (M) in Equation 20A-12 was revised to 12% to appropriately characterize overburden (U.S. Environmental Protection Agency 2006b:13.2.4-2). Additionally, the unit conversion (UC) was revised to convert tons to cubic yards (1.2641662) (Trinity Consultants 2017b:11). Dust emissions from truck loading were calculated using Equation 20A-19.

Equation 20A-19 $E_{phase} = EF * Activity$

Where:

E_{phase} = emissions for the phase (pounds per day)

EF = emission factor (pounds per cubic yard)

Activity = daily cut and fill (cubic yards per day)

20A.1.4.9 Materials Storage and Processing

20A.1.4.9.1 Rock Crushing and Processing

Onsite crushing and processing of rock material would be required, which generates fugitive dust emissions. The emissions from this activity are calculated using the method outlined in Section 11.19.2 of AP-42, as shown in Equation 20A-20 (U.S. Environmental Protection Agency 2004a).

Equation 20A-20 $E_{phase} = EF * UC$

Where:

E_{phase} = emissions for the phase (pounds per day)

EF = emission factor (tertiary crushing)

UC = unit conversion from tons to cubic yards of stone (1.35)

Emission factors for "controlled" crushing were used in estimating the emissions from this activity.

20A.1.4.9.2 Stockpile Wind Erosion

Stockpiles would be used to store soil and other earthen materials. These stockpiles can generate particulate emissions as they are exposed to wind. The annual particulate matter emissions factor is calculated using Equation 20A-21, which is based on the methodology found in Section 9.3 of the Fugitive Dust Handbook (Countess Environmental 2006:9-8).

Equation 20A-21 $EF = 1.7 * (s \div 1.5) * (N[N-P] \div 235) * (f \div 15) * (1 – CE) * R$

Where:

EF = PM10 emission factor (pounds per acre per year)

s = silt content of the material (%)

N = number of days in the average period (365 days)

P = days per year with at least 0.01 inch of precipitation (days per year)

f = percent of time unobstructed wind speed is greater than 12 mph at pile height

CE = control efficiency achieved by BMPs (%)

R = ratio of total suspended particles to PM10 (unitless)

P is location specific to the study area and f varies by pile height. Tables 20A-8 and 20A-9 define the variables used for this calculation. The control efficiency is achieved through implementation of BMPs, specifically the measure requiring soil pile surfaces to be watered and/or secured with tarps, plastic or other material to prevent visible dust

Table 20A-8. Variables for Stockpile Wind Erosion PM10 Emission Factor Calculation

Variable	PM10	PM2.5	Source
s (%)	9	9	Countess Environmental 2006
P (days/year)	48	48	Western Regional Climate Centers 2012
f	See Table 20A-9		
CE (%)	90		Countess Environmental 2006:Table 9-4
R	0.5	–	Countess Environmental 2006:9-8

PM10 emissions were calculated using Equation 20A-22. PM2.5 emissions were calculated assuming PM2.5 emissions are equal to 0.15 the PM10 emissions (Countess Environmental 2006:9-8).

Equation 20A-22 $E = EF_h * A_h$

Where:

E = PM10 emissions (pounds per year)

EF = emission factor (pounds per acre per year)

A = storage pile acres (acres)

h = pile height (feet)

Table 20A-9. Percent of Time Unstructured Wind Speeds Exceed 12 mph for the Stockpile Wind Erosion Emission Factor Calculation (%)

Pile Height	Sacramento Valley Air Basin
1 foot	< 0.1
2 feet	0.3
3 feet	0.9
4 feet	1.7
5 feet	2.4
6 feet	3.1
7 feet	3.9
8 feet	4.5
9 feet	4.8
10 feet	5.6
11 feet	6.1
12 feet	6.6
13 feet	7.1
14 feet	7.1
15 feet	7.5
16 feet	8.1
17 feet	8.1
18 feet	8.7
19 feet	8.7
20 feet	9.3
21 feet	9.3
22 feet	10.1
23 feet	10.1
24 feet	10.1
25 feet	10.8
26 feet	10.8
27 feet	10.8
28 feet	11.6
29 feet	11.6
30 feet	11.6

Sources: California Irrigation Management Information System 2021

20A.1.4.9.3 Blasting

Blasting activities would be required during dam construction, particularly during the embankment operations involving rockfill. The use of blasting would generate fugitive dust from waste rock and emissions from the combustion of the blasting agent.

Fugitive dust emissions from waste rock were calculated using Equation 20A-23.

Equation 20A-23 $E = 0.000014 * (A)^{1.5} * F * B$

Where:

E = emissions (pounds per blast)

A = horizontal blast area (square feet)

F = particle scaling factor

B = number of blasts

Constant F depends on the particle size. Table 20A-10 defines the variables used for this calculation.

Table 20A-10. Variables for Blasting Calculation

Variable	PM10	PM2.5	Source
F	0.52	0.03	AP-42, Section 11.9 (U.S. Environmental Protection Agency 1998)

Emissions from the use of the blasting agent were calculated using Equation 20A-24.

Equation 20A-24 $E = EF_p * B$

Where:

E = emissions (pounds per day)

EF = emission factor (lbs. of pollutant per ton of blasting agent)

B = amount of blasting agent per day (tons/day)

p = pollutant

EF_p depends on the pollutant. Table 20A-11 define the variables used for this calculation.

Table 20A-11. Variables for Blasting Calculation

Pollutant (p)	Emission Factor (lbs. per ton of blasting agent)	Source	Notes
CO	67	AP-42, Section 13.3 (U.S. Environmental Protection Agency 1995)	None

NO_X	71	AP-42 Section 13.3 (U.S. Environmental Protection Agency 1995)	None
SO_2	2	AP-42 Section 13.3 (U.S. Environmental Protection Agency 1995)	None
CO_2	566	40 CFR 98, Table C-1	Ammonium nitrate with 9% fuel oil. Based on emission factor for distillate fuel oil #2
CH_4	0.02	40 CFR 98, Table C-2	Ammonium nitrate with 9% fuel oil. Based on emission factor for fuel gas
N_2O	0.005	40 CFR 98, Table C-2	Ammonium nitrate with 9% fuel oil. Based on emission factor for fuel gas

20A.1.4.10 Concrete and Asphalt Batching

20A.1.4.10.1 Concrete Processing

Concrete required to construct the Project would be manufactured at batch plants that store, convey, and discharge water, cement, fine aggregate, and coarse aggregate. Fugitive dust and metal emissions from concrete batching at onsite temporary batch plants were quantified using USEPA's AP-42, Section 11.12 (U.S. Environmental Protection Agency 2006c: Tables 11.12-2 and 11.12-8). AP-42 provides emissions factors per ton of material for each emission source. The particulate matter sources of emissions are sand transfer; aggregate transfer; cement unloading, cement supplement unloading, weight hopper loading, and truck mix loading. The metal sources are cement silo filing, cement supplement silo filing, and truck loading.

A portion of concrete may be provided by existing batch plants. These facilities are regulated and permitted to emit a maximum amount of criteria pollutants, including particulate matter. Therefore, fugitive dust emissions associated with concrete batching at existing facilities are not included in the analysis, because these emissions have already been evaluated and accounted for in existing permit and environmental documents.

The equation for quantifying particulate matter and metal emissions is given as Equation 20A-25. Emission factors for "controlled" batching operations were used in estimating the emissions from this activity, based on the anticipated features that would be present at the batch plants to control emissions. PM2.5 emissions were calculated by assuming PM2.5 emissions are equal to 0.15 the PM10 emissions (Bay Area Air Quality Management District 2018:205).

Equation 20A-25 $\mathbf{E_{plant} = Br * \Sigma EF_m * MW_m * UC}$

Where:

E_{plant} = emissions for the batch plant (pounds per day)

Br = batch rate (cubic yards concrete per day per plant)

EF = source emission factor (pounds per ton of material)

MW = material weight per cubic yard of concrete (pound per cubic yard concrete)

UC = unit conversion from pounds to tons (0.005)

m = material (e.g., sand, aggregate)

The materials assumed in each emission source and their weights per cubic yard of concrete are shown in Table 20A-12.

Table 20A-12. Concrete Batching Material Assumptions

Emission Source	Material	Pounds per Cubic Yard Concrete
Sand transfer	Sand	1,428
Aggregate transfer	Aggregate	1,865
Cement unloading	Cement	491
Cement supplement unloading	Cement supplement	73
Weight hopper loading	Aggregate and sand	3,293
Transit truck mix loading	Cement and cement supplement	564

Source: U.S. Environmental Protection Agency 2006c:Table 11.12-2.

20A.1.4.10.2 Asphalt Processing

Asphalt required for Project roadways would be manufactured at a batch plant onsite or from offsite commercial sources. To represent a conservative scenario, the analysis assumes that asphalt would be sourced from an onsite batch plant. Fugitive dust and other pollutant emissions from asphalt batching at onsite temporary batch plants were quantified using USEPA's AP-42, Sections 11.1 (Hot Mix Asphalt) and 11.19.2 (Crushed Stone Processing and Pulverized Mineral Processing) (U.S. Environmental Protection Agency 2004a and 2004b). AP-42 provides emissions factors per ton of material for each emission source. The sources of emissions for the asphalt batch plant are truck loading; conveyance transfer; drum mix hot mix asphalt plant dryer; silo filling and loadout.

It is possible that the asphalt may be provided by existing, offsite batch plants from commercial sources. These facilities are regulated and permitted to emit a maximum amount of criteria pollutants. Therefore, emissions associated with asphalt batching at existing facilities are not included in the analysis, because these emissions have already been evaluated and accounted for in existing permit and environmental documents. As such, the Project analysis is conservative, because it assumes that the asphalt would be sourced from the onsite batch plant rather than the offsite sources.

The equation for emissions is given as Equation 20A-26. Emission factors for "controlled" batching operations were used in estimating the emissions from this activity, based on the anticipated features that would be present at the batch plant to control emissions.

Equation 20A-26 $E_{plant} = Br * \Sigma EF_p$

Where:

E_{plant} = emissions for the batch plant (pounds per day)

Br = batch rate (cubic yards asphalt per day)

EF = source emission factor (pounds per ton of material)

p = process (e.g., truck loading, conveyance transfer, etc.)

20A.1.4.10.3 Stockpile Wind Erosion

Fugitive dust emission factors from wind erosion of aggregate and sand storage piles were calculated following the same methodology used for stockpile wind erosion above.

20A.1.4.10.4 Upstream Lifecycle Activity

The air quality and GHG analysis accounts for all emissions directly and indirectly generated by construction activities for which the Authority has control over. Emissions generated upstream (e.g., material manufacturing) and downstream (e.g., recycling) of construction, otherwise known as "lifecycle emissions", are not included in the analysis, consistent with guidance from the California Natural Resources Agency (California Natural Resources Agency 2018:41–42). While the origin of most raw materials is not known, and thus an emissions analysis would be speculative, lifecycle emissions for cement and aggregate manufacturing, which is upstream of the concrete batching process, have been studied in various literature. Accordingly, upstream CO_2 emissions resulting from cement and aggregate manufacturing have been quantified for disclosure purposes using emission factors from Marceau et al. (Marceau et al. 2007:Tables E1b and G1b) and Equation 20A-27. It was assumed that precast segments would require a compression strength of 7,500 pounds per square inch (psi) and all other infrastructure would require a compression strength of 5,000 psi. The upstream emissions are presented for informational purposes only.

Equation 20A-27 $E = EF_{cs} * Br_{cs} * UC$

Where:

E = CO_2 emissions (metric tons per year)

EF = upstream emission factor (pounds per cubic yard)

Br = batch rate (cubic yards per year)

UC = unit conversion from pounds to metric tons (0.000453592)

cs = compression strength

20A.1.4.11 Water Use

During construction water would be required for dust suppression and other purposes. The use of water requires electricity to supply, pre-treat, and distribute the water to its ultimate end use. As such, water use results in electricity consumption and thus GHG emissions. To quantify electricity consumption from water use, water energy factors from the CalEEMod User's Guide were used (Trinity Consultants 2017a:Table 9-2). These factors are shown in Table 20A-13 and were multiplied by the total amount of water that is expected to be used for construction. Because the water would be used outdoors, it was assumed that no wastewater treatment would occur for the construction water. After calculating the electricity, the same methods described above were used to calculate GHG emissions associated with the water-related electricity use (see *Electricity Consumption* above).

Table 20A-13. Water Energy Factors for Water Electricity Calculations

Process	Value (kilowatt hours per million gallon)
Supply	2,117
Treat	111
Distribute	1,272

Source: Trinity Consultants 2017a:Table 9-2.

20A.1.5 Emissions by Alternative

The air quality analysis estimates emissions for all three Project alternatives (ICF 2021). The approach to construction and overall techniques are expected to be the same among all alternatives. Construction activities for Alternatives 1 and 3 are anticipated to be the same, because the construction footprint would be the same between these two alternatives. However, there would be differences in the physical components constructed between Alternatives 1 and 3 and Alternative 2. Alternative 2 does not include construction activities associated with the emergency release structure facilities, has fewer dams, and does not include the reservoir bridge roadway.

20A.1.6 Emissions by Air District

The Project is located in the SVAB — and falls under the jurisdiction of five air districts—Colusa County Air Pollution Control District (CCAPCD), Glenn County Air Pollution Control District (GCAPCD), Yolo-Solano Air Quality Management District (YSAQMD), Tehama County Air Pollution Control District (TCAPCD), and Feather River Air Quality Management District (FRAQMD). Geographic information system (GIS) was used to identify the location of all construction activities. Emissions generated by construction of components that would occur exclusively within one air district were wholly assigned to that air district. Emissions estimates for construction components that span more than one air district were apportioned based on the location of construction activity (ICF 2021).

20A.1.7 Daily and Annual Emissions Estimates

The analysis assumes that Project construction would occur over multiple phases between 2024 and 2029. Daily criteria pollutant and GHG emissions generated by construction were quantified using the methods described above. Daily emissions values were converted to annual totals based on the detailed construction schedule, and the maximum daily emissions were identified based on concurrent construction activity within the YSAQMD and FRAQMD, consistent with air district requirements (Yolo-Solano Air Quality Management District 2007; Feather River Air Quality Management District 2010). The highest daily emissions in each construction year were selected as the maximum day to evaluate with respect to the air districts' thresholds. This approach is conservative and based on available information; therefore, such an approach is not necessarily representative of actual daily emissions that would occur during the construction period. Average daily emissions per year in CCAPCD, GCAPCD, and TCAPCD were calculated by dividing annual emissions by the number of working days per year.

20A.2 Operations and Maintenance Mass Emissions

Operation of the Project would begin in 2030 and consist of multiple components. Operation activities include those associated with maintenance of facilities and use of recreation areas. Overall, the duration analyzed for operation is 2030 to 2040 (i.e., the first 10 years of operation). Operation of the Project is expected to occur post-2040, but the emissions in the first 10 years would represent a worst-case scenario because emission factors decline annually. Table 20A-14 summarizes the emissions generating sources expected during operation of the Project.

Table 20A-14. Emissions Generating Activities during Project Operation

Source	Emissions Generating Process	Pollutants Analyzed
Offroad equipment	Equipment fuel combustion	ROG, NO_X, CO, PM2.5, PM10, DPM, SO_2, CO_2, CH_4, N_2O
Onroad vehicles	Vehicle fuel combustion	Same as *offroad equipment fuel combustion*
	Tire wear and brake wear	Fugitive dust (PM10 and PM2.5)
	Vehicle travel	Fugitive dust (PM10 and PM2.5)
Helicopters	Vehicle fuel combustion	Same as *offroad equipment fuel combustion*
Land clearing	Scraping	Fugitive dust (PM10 and PM2.5)
Water conveyance	Electricity consumption - Generation and transmission	CO_2, CH_4, N_2O, SF_6
Recreational boating	Equipment fuel combustion	ROG, NO_X, CO, PM2.5, PM10, DPM, SO_2, CO_2, CH_4, N_2O
Water use	Electricity generation	CO_2, CH_4, N_2O, SF_6
Solid waste	Anaerobic decomposition	CH_4
Wastewater treatment	Anaerobic decomposition	CH_4

ROG = reactive organic gases; VOC = volatile organic compounds; NO_X = nitrogen oxides; CO = carbon monoxide; PM10 = particulate matter; PM2.5 = particulate matter; SO_2 = sulfur dioxide; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxides; SF_6 = sulfur hexafluoride; DPM = diesel particulate matter.

20A.2.1 Maintenance Activities

Maintenance will be conducted varying frequencies and beginning in different years, depending on the type of activity and Project feature. The general activities and schedule needed to operate and maintain the Project for the reservoir facilities and conveyance facilities are shown in Table 20A-15 and Table 20A-16, respectively.

Table 20A-15. General Maintenance Schedule – Reservoir Facilities

Project Feature and Operation Activity	Frequency of Activity	Start Year
Dams and Abutments (All Alternatives)		
Inspections - initial filling period	Daily	2030
Inspections - five years after filling	Weekly	2035
Inspections - long-term	Monthly	2040
Monument surveys – initial filling period	Semi-annually	2030

Monument surveys – long-term	Semi-annually	2035
Management, Maintenance & Repair	Annually	2031
Replacement Instrumentation[a]	Every 25 years	2040
Storm Event Repair[a]	Every 25 years	2040
Reservoir Rim (All Alternatives)		
Inspections - initial filling period	Weekly	2030
Inspections - five years after filling	Monthly	2035
Inspections - long-term	Quarterly	2040
Management, Maintenance & Repair	Annually	2031
Spillway, Approach and Discharge Channel (All Alternatives)		
Inspections - initial filling period	Weekly	2030
Inspections - five years after filling	Monthly	2035
Inspections - long-term	Quarterly	2040
Management, Maintenance & Repair	Annually	2031
Inlet/Outlet (I/O) Works and Sites Dam Outlet (All Alternatives)		
Inspections of I/O - initial filling period	Weekly	2030
Inspections of I/O - five years after filling	Monthly	2035
Inspections of I/O - long-term	Quarterly	2040
Inspections of mechanical equipment, gates, and valves - initial filling period through first 5 years	Semi-Annually	2030
Inspections of mechanical equipment, gates, and valves - long-term	Annually	2035
Inspections of tunnels	Every 5 years	2030
Management, Maintenance & Repair – minor activities	Annually	2031
Management, Maintenance & Repair – replacement of mechanical equipment, gates, and valves[a]	Every 25 years	2040
Management, Maintenance & Repair – Tunnels[a]	Every 25 years	2040
Emergency Release Structures (Alternatives 1 & 3 only)		
Inspections - initial filling period	Weekly	2030
Inspections - five years after filling	Monthly	2035
Inspections - long-term	Quarterly	2040
Inspections of mechanical equipment, gates, and valves - initial filling period through first 5 years	Semi-Annually	2030
Inspections of mechanical equipment, gates, and valves - long-term	Annually	2035
Inspections of tunnels	Every 5 years	2030
Management, Maintenance & Repair – minor activities	Annually	2031
Management, Maintenance & Repair – replacement of mechanical equipment, gates, and valves[a]	Every 25 years	2040
Management, Maintenance & Repair – Tunnels[a]	Every 25 years	2040
Roads (All Alternatives)		
Inspections - initial filling period through first 5 years	Every 3 months	2030
Inspections - long-term	Every 6 months	2035

	Management, Maintenance & Repair	Every 3 years	2031
Bridges (Alternatives 1 & 3 only)			
	Inspections – first 6 months	Weekly	2030
	Inspections – next 54 months	Monthly	2030
	Inspections – long-term	Every 3-6 months	2035
	Management, Maintenance & Repair	Annually	2031

Notes: [a] These activities would be required 25 years after operations begin and beyond and were conservatively assumed to occur in 2040, when equipment would be less clean that it otherwise would be 25 years from the start of operations. Over time, vehicles and equipment tend to become lower-emitting due to technological advancements and turnover of older, higher-emitting vehicles and equipment.

Table 20A-16. General Maintenance Schedule – Conveyance Facilities

Project Feature and Operation Activity		Frequency of Activity	Start Year
Total System (All Alternatives)			
	Routine operation and maintenance	Daily	2030
	Debris removal	Annually	2030
Transmission Lines (All Alternatives)			
	Infrared Inspection	Annually	2030
	Aerial Inspection	Annually	2030
	Foot patrol	Every 5 years	2035
	Tower inspection and tower footer repair[a]	Every 20 years	2040
Funks Reservoir Substation (All Alternatives)			
	Inspections	Annually	2030
Terminal Regulating Reservoir Electrical Substations (All Alternatives)			
	Inspections	Annually	2030
Connection of Reservoirs, Pipelines, and Pump Generating Plant to I/O Works (All Alternatives)			
	Inspections	Monthly	2030
	Inspection of cathodic protection system	Annually	2030
Funks Reservoir (All Alternatives)			
	Maintenance of facilities and pump to generate power–Funks Reservoir	10-60 days per year	2030
Terminal Regulating Reservoir East (Alternatives 1 & 3 only)			
	Vegetation Control	Quarterly	2030
	Rodent Control	Quarterly	2030
	Maintenance of facilities and pump to generate power	10-20 days per year	2030
	Inspections – safety and leak location survey	Annually	2030
	Inspections – dam safety inspection	Every 5 years	2035
	Instrumentation monitoring and maintenance	Every 2 months	2030
	Motor replacement	Annually, after 7 years	2037
Terminal Regulating Reservoir West (Alternative 2 only)			

Vegetation Control	Quarterly	2030
Rodent Control	Quarterly	2030
Maintenance of facilities and pump to generate power	10-20 days per year	2030
Inspections – leak location survey	Annually	2030
Instrumentation monitoring and maintenance	Every 2 months	2030
Motor replacement	Annually, after 7 years	2037
Terminal Regulating Reservoir Pump Generating Plants (All Alternatives)		
Motor replacement	Annually, after 7 years	2037
Funks Reservoir Pump Generating Plant (All Alternatives)		
Motor replacement	Annually, after 7 years	2037
Dunnigan Pipeline (All Alternatives)		
Inspections	Monthly	2030
Inspection of discharge structures	Weekly	2030
Inspection of cathodic protection system	Annually	2030

Notes: [a] These activities would be required 20 years after operations begin and beyond and were conservatively assumed to occur in 2040, when equipment would be less clean that it otherwise would be 20 years from the start of operations. Over time, vehicles and equipment tend to become lower-emitting due to technological advancements and turnover of older, higher-emitting vehicles and equipment.

Depending on the type of activity, Project maintenance will generate emissions from offroad equipment, onroad vehicles, helicopters, and scraping or grading. The Authority developed Project-specific assumptions (e.g., number of truck trips and miles, equipment operating hours) for all expected maintenance activities by Project feature (ICF 2021). Emissions were quantified using the same general methods as described in Section 20A.1.4, *Emissions Estimation*.

As discussed in Section 20A.1.6, *Emissions by Air District*, the Project is located in multiple air districts. For Project maintenance, activities would only occur in three air districts (CCAPCD, GCAPCD, and YSAQMD). Maintenance emissions were assigned to an air district based on the location of the site at which the maintenance activity would occur. Emissions were quantified for each air district based on the frequency and duration of each maintenance activity.

20A.2.2 Water Conveyance

Operation of the Project would require the use of electricity for pumping, which would result in GHG emissions from the generation, distribution, and transmission of this electricity. Annual electricity consumption values required for water conveyance are presented in Chapter 17, *Energy,* Tables 17-9 through 17-11. The electricity values from Chapter 17 were used to calculate GHG emissions using the same methods described above for construction, (see *Electricity Consumption* above).

20A.2.3 Recreational Activities

20A.2.3.1 Onroad Vehicles

The Project would result in a change in the number of vehicle trips and thus vehicle miles traveled (VMT) associated with recreational areas throughout the state. To evaluate regional increases in criteria pollutant emissions that would occur, VMT data for roadways in Colusa and Glenn Counties were used. The analysis of GHG emissions relies on VMT data at the scale of multi-region population centers, because GHG are global pollutants that do not ascribe to air district boundaries. Chapters 20, *Air Quality*, and 21, *Greenhouse Gas Emissions*, provide more detail on the difference in analysis level between criteria pollutants and greenhouse gases.

With the VMT data, emissions were calculated using the same methods described above for construction (see *Onroad Vehicles – Vehicle Fuel Combustion*, *Tire wear and Brake wear*, and *Vehicle Travel*). For vehicle fuel combustion emissions, emission factors from EMFAC2017 were used for the overall vehicle fleet, rather than specific vehicle types as was done for construction.

20A.2.3.2 Recreational Boating

Recreational boating would result in an increase in emissions at Sites Reservoir, and emissions from recreational boating activity were estimated based on the anticipated number of visitor days that would involve the use of boats. The number of annual visitor days for boating purposes was translated into an estimate of annual boating hours using the U.S. Coast Guard's recreational survey data (U.S. Coast Guard 2012), using assumptions for the number of visitors per boat (2.4) and the number of hours per visit (4.9 or 5.1, depending on boat type). Emission factors for the GHGs are from CARB's PC2014 Model, which an emissions inventory database for recreational watercraft (California Air Resources Board 2014). Emission factors were developed for boats using the total emissions and activity hours from the PC2014 Model. Criteria pollutants and GHG emissions generated by the boats were quantified using Equation 20A-28.

Equation 20A-28 $$E = EF * BH$$

Where:

E = total running emissions (pounds per day)

EF = boat emission factor (pounds per hour)

BH = boating hours per day

20A.2.3.3 Public Services and Utilities

The Project would include recreational areas that would be used by visitors for various purposes. Emissions from public services and utilities would result from the use of water and from the generation of waste and wastewater. At the publicly accessible recreational areas and at the administrative and operations building, visitors and staff would use water and generate waste.

20A.2.3.3.1 Water Use

To quantify emissions associated with water use at the recreational areas, water use estimates from Chapter 26, *Public Services and Utilities,* were used to calculate GHG emissions and the same methods described above for construction (see *Water Use* above).

20A.2.3.3.2 Solid Waste

Emissions from the generation of solid waste at the recreational areas were calculated using the CalEEMod model directly (ICF 2021).

20A.2.3.3.3 Wastewater Treatment

Wastewater would be generated at the recreational areas and would be sent for treatment at wastewater treatment plants. This process generates GHG emissions as the wastewater is treated. To quantify emissions associated with the wastewater at recreational areas, the CalEEMod model was used directly (ICF 2021).

Septic tanks would be used to treat wastewater that is generated at the administration and operations building and at the maintenance building. Septic systems use microbes to decompose wastewater anaerobically, which can produce fugitive CH_4. These emissions were quantified based on the expected volume of treated wastewater and Equation 20A-29 (Trinity Consultants 2017b:45).

Equation 20A-29 $$E = Vol * BOD_5 * Bo * MCF_{septic} * UC_1 * UC_2$$

Where:

E = annual CH_4 emissions (metric tons per year)

Vol = volume of wastewater (liters per year)

BOD_5 = concentration of dissolved oxygen (200 milligrams per liter)

Bo = maximum CH_4-producing capacity (0.6 kilogram CH_4/kilogram BOD_5)

MCF_{septic} = CH_4 correction factor for septic system (0.5)

UC_1 = unit conversion from milligrams to kilograms (0.000001)

UC_2 = unit conversion from kilograms to metric tons (0.001)

20A.3 References Cited

20A.3.1 Printed References

Bay Area Air Quality Management District. 2018. *Permit Handbook*. San Francisco, CA. Available: https://www.baaqmd.gov/~/media/files/engineering/permit-handbook/baaqmd-permit-handbook.pdf?la=en. Accessed: June 9, 2021.

California Air Resources Board. 2014. *Appendix J: Recreational Watercraft Emissions Inventory Methodology*. November. Available: https://ww3.arb.ca.gov/msei/pc2014_technical_document.pdf. Accessed: April 22, 2021.

California Air Resources Board. 2020. California High GWP Gases Inventory for 2000-2018—by Category as Defined in the 2008 Scoping Plan. Last Revised: October 15, 2020. Available: https://ww3.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_scopingplan_2000-18hgwp.pdf. Accessed: April 20, 2021.

California Energy Commission. 2019. 2018 Total System Electric Generation. Last Revised: June 24, 2019. Available: https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2019-total-system-electric-generation/2018. Accessed: June 8, 2021.

California Irrigation Management Information System. 2021. CIMIS Hourly Report. Available: https://cimis.water.ca.gov/usercontrols/reports/hourlyreportviewer.aspx. Accessed: February 8, 2021.

California Natural Resources Agency. 2018. *Final Statement of Reasons for Regulatory Action—Amendments to the State CEQA Guidelines*. https://resources.ca.gov/CNRALegacyFiles/ceqa/docs/2018_CEQA_Final_Statement_of%20Reasons_111218.pdf. Accessed: May 13, 2021.

Climate Registry. 2020. 2020 Default Emission Factors. Tables 2.1 and 2.7. Available: https://www.theclimateregistry.org/wp-content/uploads/2020/04/The-Climate-Registry-2020-Default-Emission-Factor-Document.pdf. Accessed: February 25, 2021.

Countess Environmental. 2006. *WRAP Fugitive Dust Handbook*. Tables 3-7, 6-6, 9-4 and page 9-8. Available: https://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf. Accessed: June 8, 2021.

Feather River Air Quality Management District. 2010. Indirect Source Review Guidelines. Available: https://www.fraqmd.org/files/8c3d336a1/FINAL+version+ISR+Amendments.pdf. Accessed: May 24, 2021.

Federal Office of Civil Aviation. 2015. *Guidance on the Determination of Helicopter Emissions*. Reference: COO.2207.111.2.2015750. December. Available: https://www.bazl.admin.ch/dam/bazl/de/dokumente/Fachleute/Regulationen_und_Grundlagen/guidance_on_the_determinationofhelicopteremissions.pdf.download.pdf/guidance_on_the_determinationofhelicopteremissions.pdf. Accessed: June 9, 2021.

ICF. Construction Modeling Output Files. July 2021.

Marceau, M. L., M. A. Nisbet, and M. G. VanGeem. 2007. Life Cycle Inventory of Portland Cement Concrete. Tables E1b and G1b. PCA R&D Serial No. 3007. Portland Cement Association. Skokie, IL.

Trinity Consultants. 2017a. California Emissions Estimator Model Appendix D Default Data Tables. Tables 3.5, 4.1, and 9-2. Available: http://www.aqmd.gov/docs/default-source/caleemod/05_appendix-d2016-3-2.pdf?sfvrsn=4. Accessed: August 10, 2020.

Trinity Consultants. 2017b. California Emissions Estimator Model Appendix A Calculation Details for CalEEMod. Available: http://www.aqmd.gov/docs/default-source/caleemod/02_appendix-a2016-3-2.pdf?sfvrsn=6. Accessed: August 10, 2020.

U.S. Environmental Protection Agency. 1995. *Compilation of Air Pollutant Emission Factors.* Section 13.3, Explosives Detonation. Available: https://www.epa.gov/sites/default/files/2020-10/documents/13.3_explosives_detonation.pdf. Accessed: June 10, 2021.

U.S. Environmental Protection Agency. 1998. *Compilation of Air Pollutant Emission Factors.* Section 11.9, Western Surface Coal Mining. Available: https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf. Accessed: June 10, 2021.

U.S. Environmental Protection Agency. 2004a. *Compilation of Air Pollutant Emission Factors.* Section 11.19.2, Crushed Stone Processing and Pulverized Mineral Processing. Table 11.19.2-2. Available: https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s1902.pdf. Accessed: June 10, 2021.

U.S. Environmental Protection Agency. 2004b. *Compilation of Air Pollutant Emission Factors.* Section 11.1, Hot Mix Asphalt Plants. Available: https://www.epa.gov/sites/production/files/2020-10/documents/c11s01.pdf. Accessed: June 10, 2021.

U.S. Environmental Protection Agency. 2006a. *Compilation of Air Pollutant Emission Factors.* Section 13.2.2, Unpaved Roads. Tables 13.2.2-1 and 13.2.2-2. Available: https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf. Accessed: June 10, 2021.

U.S. Environmental Protection Agency. 2006b. *Compilation of Air Pollutant Emission Factors.* Section 13.2.4, Aggregate Handling and Storage Piles. Available: https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0204.pdf. Accessed: June 10, 2021.

U.S. Environmental Protection Agency. 2006c. *Compilation of Air Pollutant Emission Factors.* Section 11.12, Concrete Batching. Available: https://www3.epa.gov/ttn/chief/ap42/ch11/final/c11s12.pdf. Accessed: June 10, 2021.

U.S. Environmental Protection Agency. 2011. *Compilation of Air Pollutant Emission Factors.* Section 13.2.1, Paved Roads. Table 13.2.1-1. Available: https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf. Accessed: June 10, 2021.

U.S. Environmental Protection Agency. 2021. Emissions & Generation Resource Integrated Database (eGRID). Last revised: February 23, 2021. Table 13.2.1-1. Available: https://www.epa.gov/egrid. Accessed: April 20, 2021.

Western Regional Climate Centers. 2012. Williams, California, Period of Record General Climate Summary – Precipitation. Available: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca9677. Accessed: June 8, 2021.

Yolo-Solano Air Quality Management District. 2007. *Handbook for Assessing and Mitigating Air Quality Impacts.* July 11. Available: http://www.ysaqmd.org/wp-content/uploads/Planning/CEQAHandbook2007.pdf. Accessed: May 23, 2021.