# Appendix 22A
# Air Quality Analysis Assumptions

This appendix discusses the approach and methodology used to assess construction and operational emissions associated with the water conveyance facility. The analysis evaluates maximum daily and yearly emissions to comply with CEQA and NEPA guidelines in the Plan Area (the area covered by the BDCP). Emissions analyzed include criteria pollutants and GHGs ($CO_2$, $CH_4$, $N_2O$, and $SF_6$).

## 22A.1 Construction

Construction of the water conveyance facilities would generate emissions of ROG, $NO_X$, CO, PM10, PM2.5, $SO_2$ and GHGs ($CO_2$, $CH_4$, $N_2O$, and $SF_6$) that would result in short-term impacts on ambient air quality in the Plan area. Emissions would originate from mobile and stationary construction equipment exhaust, employee vehicle exhaust, dust from earthmoving and clearing the land, electricity use, and concrete batching. Construction-related emissions vary substantially depending on the level of activity, length of the construction period, specific construction operations, types of equipment, number of personnel, wind and precipitation conditions, and soil moisture content.

### 22A.1.1 Schedule and Phasing

#### 22A.1.1.1 Alternatives 1A, 2A, 6A (Pipeline/Tunnel Alignment) and Alternatives 1B, 2B, and 6B (East Alignment)

DWR provided data on construction phasing separately as part of an economic analysis ("cost estimate") and construction schedule. The cost estimate includes detailed information on construction activity (e.g., equipment type, hours of operation) by phase, but lacks information on when each phase will specifically occur. The construction schedule outlines the start date for each phase, but does not contain any activity information. The distribution of construction activity in the construction sequence was therefore determined by matching information in the cost estimate with a corresponding schedule entry. For example, the clearing and grubbing phase for Intake 1 was matched with "River Intake 1: Clearing & Grubbing / Demolition" in the constructions schedule, which is anticipated to begin in March 2017 (pipeline/tunnel alignment). In instances where more than one cost estimate phase was matched with the same construction schedule phase, the start dates of sequential phases were staggered based on professional judgment. All scheduling assumptions were verified through email communication with DWR.

While the construction schedule provides construction duration data, the cost estimate provides the most refined representation of the actual construction activities associated with the project. The duration of each construction phase was therefore based on the cost estimate and not the construction schedule. In instances where the cost estimate did not list phase duration, the construction schedule, rather than the cost estimate, was used to define the phase length. Because the construction schedule includes periods of inactivity in the overall phase duration, emissions estimates for these phases are likely conservative in that they overestimate actual emissions. The methodology for determining the phase length was based on guidance provided by DWR.

The cost estimate includes several duplicative entries, as well as phases solely associated with the procurement of materials or equipment that would result in no construction activities. Construction activity that has been duplicated in two identical phases is accounted for twice in the cost estimate, whereas no construction activity (e.g., operation of heavy-duty equipment or vehicles) would occur during phases associated with procurement. Consequently, duplicative and non-activity phases were excluded from the air quality and GHG analysis to avoid double counting.

Several phases in the cost estimate do not have corresponding activity assumptions and are either listed as "zero cost" or "lump sum." Based on guidance provided by DWR, construction activity associated with "zero cost" phases was assumed to be incorporated elsewhere in the construction schedule (i.e., a "duplicative" entry). Because emissions associated with "zero cost" phases are captured elsewhere in the schedule, they were excluded from the air quality and GHG analysis.

"Lump sum" phases can be categorized by their anticipated activity (e.g., "procurement", "grading", "dewatering"). Phases associated solely associated with procurement were excluded from the analysis as no emissions-generating activities would occur (see above). For "lump sum" phases with actual construction activity (e.g., "dewatering"), scheduling assumptions were developed by ICF International and DWR based on professional experience.

Construction phasing assumptions for Alternatives 1A, 2A, and 6A (pipeline/tunnel alignment) and Alternatives 1B, 2B, and 6B (east alignment) are presented in Tables 22B-1 and 22B-2, respectively, in Appendix 22B, *Air Quality Assumptions*. The tables list the total working days and construction start date (month, year).

### 22A.1.1.2 Alternative 9 (Through Delta/Separate Corridors Alignment)

DWR provided data on construction phasing and scheduling as part of an activity analysis and construction schedule. The activity analysis identifies equipment required for construction of the water conveyance facilitates associated with Alternative 9 by major construction phase (e.g., DCC Fish Screen), but lacks information on when each phase will occur. The construction schedule outlines the start date for each phase, but does not contain any activity information. The distribution of each phase in the construction sequence was determined using the methodology described above for the pipeline/tunnel alignment and east alignment. Phase duration was not provided in the activity analysis and was therefore based solely on the construction schedule.

Construction phasing assumptions for Alternative 9 (through Delta/separate corridors alignment) are presented in Table 22B-3 in Appendix 22B, *Air Quality Assumptions*. The table lists the total working days and construction start date (month, year).

### 22A.1.1.3 Alternatives 1C, 2C, and 6C (West Alignment) and Alternatives 3, 5, 7, 8 (Pipeline/Tunnel Alignment)

DWR does not have a detailed construction schedule or cost estimate for Alternatives 1C, 2C, and 6C (west alignment) and Alternatives 3, 5, 7, and 8 (pipeline/tunnel alignment). Consequently, phasing and scheduling assumptions could not be developed. Exhaust emissions from construction of the water conveyance facilities associated with Alternatives 1C, 2C, and 6C and Alternatives 3, 4, 5, 7, and 8 were calculated by scaling emissions estimates for the east alignment and pipeline/tunnel alignment, respectively (see section 22.1.4.2).

### 22A.1.1.4 Alternative 4 (Modified Pipeline/Tunnel Alignment)

The design of Alternative 4 is similar to Alternatives 1A, 2A, and 6A, but has some specific differences related to construction of the tunnels, Clifton Court Forebay, and utilities. For example, seven tunneling contracts will be required under Alternative 4, as compared to eight under Alternatives 1A, 2A, and 6A. Construction of Alternative 4 also includes new siphon and canal connections, which are not required for the pipeline/tunnel alignment. These design differences affect the number and type of construction phases, as well as the overall construction schedule. Scaling exhaust emissions from construction of these facilities by emissions estimates for Alternatives 1A, 2A, and 6A is therefore inappropriate. Accordingly, unique phasing, scheduling, and equipment assumptions for construction of the tunnels, Clifton Court Forebay, utilities, siphons, and canals were provided by DWR for Alternative 4. The construction start date (month, year) and total working days for these components are summarized in Table 22B-4 in Appendix 22B, *Air Quality Assumptions*.

DWR does not have a detailed schedule or equipment assumptions for construction of the intakes, pumping plants, forebays, control structures, and pipelines under Alternative 4. However, construction activities associated these features are anticipated to be similar to construction activities required for Alternative 1A, 2A, and 6A. Consequently, exhaust emissions from construction of the intakes, pumping plants, forebays, control structures, and pipelines were calculated by scaling emissions estimates for the pipeline/tunnel alignment (see section 22.1.4.2).

#### Phase Location

The action alternatives cross three air basins—SFBAAB, SVAB, and SJVAB—and fall under the jurisdiction of four air districts—YSAQMD, SMAQMD, BAAQMD, and SJVAPCD. GIS was used to identify the location of all construction activities associated with the five conveyance options. Tables 22A-1 through 22A-5 summarize the air districts and air basins crossed by each major construction component. Several features cross multiple air districts or air basins. The proportion of activity within each air district and basin was based on the number of miles or acres constructed within each air district and basin. For example, 5.99 miles of tunnel in the pipeline/tunnel alignment will be constructed within Reach 5, of which 0.30 (5%) will be located within the SMAQMD and 5.69 (95%) will be located within the SJVAPCD.

**Table 22A-1. Location of Major Construction Activity by Air District and Air Basin (Pipeline/Tunnel Alignment)**

| Component | Air District(s) | Air Basin(s) |
|---|---|---|
| Intakes | SMAQMD | SVAB |
| Pumping Plants | SMAQMD | SVAB |
| Intermediate Pumping Plant | SMAQMD | SVAB |
| Intermediate Forebay | SMAQMD | SVAB |
| Byron Tract Forebay | BAAQMD | SFBAAB |
| Control Structures | BAAQMD | SFBAAB |
| Pipeline | SMAQMD | SVAB |
| Head of Old River Barrier[a] | SJVAPCD | SJVAB |
| **Tunnel** | | |
| Reaches 1–4 | SMAQMD | SVAB |
| Reach 5 | SMAMQD (5%)<br>SJVAPCD (95%) | SVAB (5%)<br>SJVAB (95%) |
| Reaches 6–7 | SJVAPCD | SJVAB |
| Reach 8 | SJVAPCD (55%)<br>BAAQMD (45%) | SJVAB (55%)<br>SFBAAB (45%) |
| **Transmission Lines** | | |
| Temporary (12 kV)[b] | SMAQMD (39%)<br>SJVAPCD (52%)<br>BAAQMD (9%) | SVAB (39%)<br>SJVAB (52%)<br>SFBAAB (9%) |
| Temporary (69 kV) | SMAQMD (51%)<br>SJVAPCD (33%)<br>BAAQMD (16%) | SVAB (51%)<br>SJVAB (33%)<br>SFBAAB (16%) |
| Permanent (69 kV) | SMAQMD | SVAB |
| Permanent (230 kV) | SMAQMD (23%)<br>SJVAPCD (44%)<br>BAAQMD (33%) | SVAB (23%)<br>SJVAB (44%)<br>SFBAAB (33%) |

[a] Barrier only included for Alternative 2A.
[b] Temporary lines will only be used during construction.

**Table 22A-2. Location of Major Construction Activity by Air District and Air Basin (Modified Pipeline/Tunnel Alignment)**

| Component | Air District(s) | Air Basin(s) |
|---|---|---|
| Intakes | SMAQMD | SVAB |
| Pumping Plants | SMAQMD | SVAB |
| Outlet Control | SMAQMD | SVAB |
| Intermediate Forebay | SMAQMD | SVAB |
| Byron Tract/Clifton Court Forebay | BAAQMD | SFBAAB |
| Control Structures | BAAQMD | SFBAAB |
| Pipeline | SMAQMD | SVAB |
| Siphons | BAAQMD | SFBAAB |
| Canals | BAAQMD | SFBAAB |
| Head of Old River Barrier | SJVAPCD | SJVAB |
| **Tunnel** | | |
| Reaches 1–3 | SMAQMD | SVAB |
| Reach 4 | SMAMQD (68%)<br>SJVAPCD (32%) | SVAB (68%)<br>SJVAB (32%) |
| Reaches 5–6 | SJVAPCD | SJVAB |
| Reach 7 | SJVAPCD (90%)<br>BAAQMD (10%) | SJVAB (90%)<br>SFBAAB (10%) |
| **Transmission Lines** | | |
| Temporary (34.5 kV)[a] | SJVAPCD (100%) | SJVAB (100%) |
| Temporary (230 kV) | SMAQMD (11%)<br>SJVAPCD (54%)<br>BAAQMD (35%) | SVAB (11%)<br>SJVAB (54%)<br>SFBAAB (35%) |
| Permanent (69 kV) | SMAQMD (100%) | SVAB (100%) |
| Permanent (230 kV) | SMAQMD (100%) | SVAB (100%) |

[a] Temporary lines will only be used during construction.

**Table 22A-3. Location of Major Construction Activity by Air District and Air Basin (East Alignment)**

| Component | Air District(s) | Air Basin(s) |
|---|---|---|
| Intakes | SMAQMD | SVAB |
| Pumping Plants | SMAQMD | SVAB |
| Intermediate Pumping Plant | SJVAPCD | SJVAB |
| Forebay | BAAQMD | SFBAAB |
| Pipeline | SMAQMD | SVAB |
| Canals | SMAMQD (20%)<br>SJVAPCD (80%) | SVAB (20%)<br>SJVAB (80%) |
| Siphons | SJVAPCD | SJVAB |
| Head of Old River Barrier[a] | SJVAPCD | SJVAB |
| **Bridges** | | |
| Scribner | SMAQMD | SVAB |
| Hood-Franklin | SMAQMD | SVAB |
| Lambert | SMAQMD | SVAB |
| Dierssen | SMAQMD | SVAB |
| Twin Cities | SMAQMD | SVAB |
| West Barber | SJVAPCD | SJVAB |
| West Walnut Grove | SJVAPCD | SJVAB |
| North Blossom | SJVAPCD | SJVAB |
| West Woodbridge | SJVAPCD | SJVAB |
| SR12 | SJVAPCD | SJVAB |
| North Guard | SJVAPCD | SJVAB |
| West Eight Mile | SJVAPCD | SJVAB |
| West McDonald | SJVAPCD | SJVAB |
| SR4 | SJVAPCD | SJVAB |
| West Bacon Island | SJVAPCD | SJVAB |
| South Tracy | SJVAPCD | SJVAB |
| Cal Pack | SJVAPCD | SJVAB |
| Clifton Court | SJVAPCD | SJVAB |
| **Tunnels** | | |
| Mokelumne River | SMAMQD (12%)<br>SJVAPCD (88%) | SVAB (12%)<br>SJVAB (88%) |
| Old River | SJVAPCD (38%)<br>BAAQMD (62%) | SJVAB (38%)<br>SFBAAB (62%) |
| San Joaquin River | SJVAPCD | SJVAB |
| **Transmission Lines** | | |
| Temporary (12 kV)[b] | SMAQMD (25%)<br>SJVAPCD (70%)<br>BAAQMD (5%) | SVAB (25%)<br>SJVAB (70%)<br>SFBAAB (5%) |
| Temporary (69 kV)[b] | SJVAPCD (86%)<br>BAAQMD (14%) | SJVAB (86%)<br>SFBAAB (14%) |
| Permanent (69 kV) | SMAQMD (40%)<br>SJVAPCD (60%) | SVAB (40%)<br>SJVAB (60%) |
| Permanent (230 kV) | SJVAPCD (75%)<br>BAAQMD (25%) | SJVAB (75%)<br>SFBAAB (25%) |

[a] Barrier only included for Alternative 2B.
[b] Temporary lines will only be used during construction.

1 **Table 22A-4. Location of Major Construction Activity by Air District and Air Basin (West Alignment)**

| Component | Air District(s) | Air Basin(s) |
|---|---|---|
| Intakes | YSAQMD | SVAB |
| Pumping Plants | YSAQMD | SVAB |
| Intermediate Pumping Plant | YSAQMD | SVAB |
| Forebay | BAAQMD | SFBAAB |
| Pipeline | YSAQMD | SVAB |
| Head of Old River Barrier[a] | SJVAPCD | SJVAB |
| Canals | YSAQMD (75%)<br>BAAQMD (25%) | SVAB (75%)<br>SFBAAB (25%) |
| Siphons | SMAQMD (37%)<br>BAAQMD (63%) | SVAB (37%)<br>SFBAAB (63%) |
| Bridges | YSAQMD (49%)<br>BAAQMD (51%) | SVAB (49%)<br>SFBAAB (51%) |
| Tunnels | YSAQMD (29%)<br>SMAQMD (16%)<br>BAAQMD (56%) | SVAB (44%)<br>SFBAAB (56%) |
| **Transmission Lines** | | |
| Temporary (12 kV)[b] | SMAQMD (11%)<br>YSAQMD (46%)<br>BAAQMD (43%) | SVAB (57%)<br>SFBAAB (43%) |
| Temporary (69 kV)[b] | SMAQMD (33%)<br>YSAQMD (43%)<br>BAAQMD (24%) | SVAB (76%)<br>SFBAAB (24%) |
| Permanent (230 kV) | YSAQMD (93%)<br>BAAQMD (7%) | SVAB (93%)<br>SFBAAB (7%) |

[a] Barrier only included for Alternative 2C.
[b] Temporary lines will only be used during construction.

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**Table 22A-5. Location of Major Construction Activity by Air District and Air Basin (Through Delta/Separate Corridors Alignment)**

| Phase | Air District(s) | Air Basin(s) |
|---|---|---|
| DCC Fish Screen Intake Facility | SMAQMD | SVAB |
| Georgiana Slough Fish Screen Intake Facility | SMAQMD | SVAB |
| San Joaquin at Old River Pumping Plant | SJVAPCD | SJVAB |
| Middle River Diversion Pumping Plant | SJVAPCD | SJVAB |
| Old River Siphon | SJVAPCD (41%)<br>BAAQMD (59%) | SJVAB (41%)<br>SFBAAB (59%) |
| West Canal Siphon | BAAQMD | SFBAAB |
| Coney Island Canal | SJVAPCD (58%)<br>BAAQMD (42%) | SJVAB (58%)<br>SFBAAB (42%) |
| Flood Gate at SJR at Old River | SJVAPCD | SJVAB |
| Tidal Gate at Middle River | SJVAPCD | SJVAB |
| Flood Gate at Sacramento River at Meadows Slough | SJVAPCD | SJVAB |
| Tidal Gate w/Boat Lock at Snodgrass Slough | SJVAPCD | SJVAB |
| Control Gate at Mokelumne River near Lost Slough w/Boat Lock | SJVAPCD | SJVAB |
| Frank's Tract | SJVAPCD (45%)<br>BAAQMD (55%) | SJVAB (45%)<br>SFBAAB (55%) |
| Three Mile Slough | SMAQMD | SVAB |
| Fisherman's Cut | BAAQMD | SFBAAB |
| Victoria Canal / North Canal | SJVAPCD | SJVAB |
| Connection Slough | SJVAPCD | SJVAB |
| Railroad Cut | SJVAPCD | SJVAB |
| Woodward Canal / North Victoria Canal | SJVAPCD | SJVAB |
| Intertie Channel from CCF to DMC Approach | BAAQMD | SFBAAB |
| Control Gate in DMC Approach | BAAQMD | SFBAAB |
| Victoria Canal Dredging | SJVAPCD | SJVAB |
| Middle River Dredging | SJVAPCD | SJVAB |
| Re-Channeling for River's End Marina Diversion | BAAQMD | SFBAAB |
| Levee for Victoria Canal Enlargement | SJVAPCD | SJVAB |
| Intertie Channel at CCF Perimeter Road Bridge | BAAQMD | SFBAAB |
| Intertie Channel at Herdlyn Road Bridge | BAAQMD | SFBAAB |
| Transmission Lines | | |
| Temporary (12 kV)[a] | SMAQMD (36%)<br>SJVAPCD (57%)<br>BAAQMD (7%) | SVAB (36%)<br>SJVAB (57%)<br>SFBAAB (7%) |

[a] Temporary lines will only be used during construction.

# 22A.1.2 Emissions Calculations

## 22A.1.2.1 Heavy-Duty Offroad Equipment

The CalEEMod emissions model was used to calculate exhaust emissions from heavy-duty construction equipment without project commitments. DWR provided equipment assumptions for each construction phase as part of the cost estimates (pipeline/tunnel alignment and east alignment) and activity analyses (through Delta/separate corridors alignment). Equipment assumptions for the modified pipeline/tunnel alignment were provided for construction of the tunnels, Clifton Court Forebay, utilities, siphons, and canals (see Section 22A.1.1.4). Equipment descriptions were frequently model specific (e.g., CAT 963), and were not grouped into generic operating types (e.g., bulldozer). To estimate emissions using CalEEMod emission factors, which are given for generic equipment, individual equipment provided by DWR was assigned a generic type based on the model description, industry resources, and professional experience.

Tables 22B-5 through 22B-8 in Appendix 22B, *Air Quality Assumptions,* summarizes the heavy-duty equipment assumed in the emissions modeling for Alternatives 1A, 2A, and 6A (pipeline/tunnel alignment); Alternative 4 (modified pipeline/tunnel alignment); Alternatives 1B, 2B, and 6B (east alignment); and Alternative 9 (through Delta/separate corridors alignment), respectively. Key assumptions include:

- Equipment load factors were based on latest Carl Moyer Program Guidelines[1] (California Air Resources Board 2011:236-237).
- Equipment summarized in Appendix 22B, *Air Quality Assumptions,* was assumed to be diesel powered.
- Equipment summarized in Appendix 22B, *Air Quality Assumptions,* would operate 8 hours per day.
- Accessory equipment (e.g., trailers, clamshell bucket) with no engines or emissions-generating components were excluded from the analysis.
- Tunnel boring machines, tunnel fans, tunnel lights, certain air compressors, and pumps were assumed to be electric and were included in the electricity analysis (see section 22.1.3.6).

Criteria pollutant, $CO_2$, and $CH_4$ emissions for each phase were calculated using the information summarized in Tables 22B-5 through 22B-8 and Equation 22A-1.

**Equation 22A -1** $$E_{phase} = \Sigma(\text{Activity} \times EF_i \times LF_i \times HP_i) \times \text{Conv}$$

Where:

| | |
|---|---|
| $E_{phase}$ | = Total exhaust emissions for the phase, pounds per day |
| Activity | = Equipment activity, hours per day |
| EF | = Engine emissions factor, grams/horsepower-hour (CalEEMod) |
| LF | = Engine load factor, unitless (Carl Moyer Program) |
| HP | = Engine horsepower, unitless (Tables 22B-4 through 22B-6) |

[1] The Carl Moyer Program provides funding to encourage the voluntary purchase of cleaner-than-required engines. Load factors provided in the guidelines account for the most recent engine technologies and regulations.

Conv = Conversion from grams to pounds, 0.002205

*i* = Equipment type (Tables 22B-4 through 22B-6)

CalEEMod does not include emission factors for $N_2O$ for off-road equipment. Emissions of $N_2O$ were determined by scaling the $CO_2$ emissions quantified by Equation 22A-1 by the ratio of $N_2O/CO_2$ (0.000026) emissions expected per gallon of diesel fuel according to the California Climate Action Registry (CCAR) (California Climate Action Registry 2009).

#### 22A.1.2.2 Marine Vessels

Exhaust emissions from marine vessels without project commitments were quantified using emission factors developed by ICF International (2009:3-8) and activity data provided by DWR. Similar to the heavy-duty equipment, generic vessel types were not provided. To estimate emissions using emission factors developed by ICF International (2009:3-8), individual vessels provided by DWR were assigned a generic type based on the model description, industry resources, and professional experience.

Tables 22B-5 through 22B-8 summarize the marine vessels assumed in the emissions modeling for Alternatives 1A, 2A, and 6A (pipeline/tunnel alignment); Alternative 4 (modified pipeline/tunnel alignment);Alternatives 1B, 2B, and 6B (east alignment); Alternative 9 (through Delta/separate corridors alignment), respectively. Key assumptions include:

- Vessels summarized in Appendix 22B, *Air Quality Assumptions,* were assumed to be Tier 0 Category 1 workboats.
- Vessel horsepower and load factors are based on information provided by ICF International (2009:3-8).
- Vessels summarized in Appendix 22B, *Air Quality Assumptions,* were assumed to operate 8 hours per day.
- Barges are assumed to be either pushed or pulled by tug-boats; no emissions are generated by the barge.

Criteria pollutant, $CO_2$, and $CH_4$ emissions for each phase were calculated using the information summarized in Tables 22B-5 through 22B-8 and Equation 22A-2. $N_2O$ emissions were calculated by scaling the $CO_2$ emissions quantified by the $N_2O/CO_2$ identified in section 22.1.3.1.

**Equation 22A -2** $$E_{phase} = \Sigma(Activity_i \text{ X } EF_i \text{ X } LF_i \text{ X } [HP_i \text{ X } Conv_1]) \text{ X } Conv_2$$

Where:

$E_{phase}$ = Total exhaust emissions for the phase, pounds per day

Activity = Vessel activity, hours per day

EF = Engine emissions factor, grams/kWh (ICF International 2009:3-8)

LF = Engine load factor, unitless (ICF International 2009)

HP = Engine kW, unitless (Tables 22B-4 through 22B-6)

$Conv_1$ = Conversion from horsepower to kilowatts, 0.75

$Conv_2$ = Conversion from grams to pounds, 0. 002205

### 22A.1.2.3 Locomotives

Small, mining-type locomotives would be used to convey excavated material and personnel in rail cars through the tunnel alignments. Emissions from these diesel-powered locomotives without project commitments were quantified using EPA Tier 0 off-road diesel emission standards (ICF International 2009:4-13-4-17). Locomotive engine rating, based on engineering specifications (25-ton), were assumed to be 150 horsepower.

Tables 22B-5 through 22B-7 in Appendix 22B, *Air Quality Assumptions,* identify the number days in which locomotives would operate during each tunneling phase for Alternatives 1A, 2A, and 6A (pipeline/tunnel alignment); Alternative 4 (modified pipeline/tunnel alignment); and Alternatives 1B, 2B, and 6B (east alignment), respectively (no locomotives would be required for construction of Alternative 9). Criteria pollutant, $CO_2$, and $CH_4$ emissions for each phase requiring locomotives were calculated using Equation 22A-3. $N_2O$ emissions were calculated by scaling the $CO_2$ emissions quantified by the $N_2O/CO_2$ identified in section 22.1.3.1.

**Equation 22A -3** $$E_{phase} = \Sigma(\text{Activity} \times EF \times HP) \times \text{Conv}$$

Where:

$E_{phas}$ = Total exhaust emissions for the phase, pounds per day

Activity = Engine activity, hours per day

EF = Engine emissions factor, grams/horsepower-hour (ICF International 2009)

HP = Engine horsepower, 150

Conv = Conversion from grams to pounds, 0. 002205

### 22A.1.2.4 On-Road Vehicles

On-road vehicles include vehicles used for materials hauling and general crew movement, as well as vehicles used for employee commuting to the project site. Emissions from materials hauling and general crew movement without project commitments were estimated using the EMFAC2011 emissions model and activity data provided by DWR. Similar to heavy-duty equipment and marine vessels, generic vehicle types were not provided. To estimate emissions using EMFAC emission factors, individual vehicles provided by DWR was assigned a generic type based on the model description, industry resources, and professional experience. Emissions from employee commuting were estimated using EMFAC2011 and the total number of personnel required to complete construction of each phase, which was provided by DWR.

Tables 22B-5 through 22B-8 in Appendix 22B, *Air Quality Assumptions,* summarize the number of employees and vehicles assumed in the emissions modeling for Alternatives 1A, 2A, and 6A (pipeline/tunnel alignment); Alternative 4 (modified pipeline/tunnel alignment); Alternatives 1B, 2B, and 6B (east alignment); and Alternative 9 (through Delta/separate corridors alignment), respectively. Key assumptions include:

- Vehicles used for materials hauling and general crew movement would each make a maximum of 8 trips per day. This value represents a conservative estimate of vehicle activity and is based on consultation with Fehr & Peers, the project traffic engineer.
- Vehicle trips used for materials hauling and general crew movement would be 9.5 miles in all air districts, based on Plan area CalEEMod default trips lengths for "commercial work" trips.

- Each employee would make 2 trips to the project site per day.
- Passenger vehicles were assumed to be used for employee commute trips. Based on CalEEMod defaults for the Plan area, 82% of passenger vehicles were assumed to be light-duty automobiles (LDA) and 18% were assumed to be light-duty trucks (LDT).
- Employee vehicle trips would be 10.8 miles in the YSAQMD, SMAQMD, and SJVAPCD, based on Plan area CalEEMod default trips lengths for “home based work” trips.
- Employee vehicle trips would be 12.4 miles in the BAAQMD, based on Plan area CalEEMod default trips lengths for “home based work” trips.
- Vehicle emission factors were based on EMFAC2011 for the air district in which activity would occur, as determined by GIS (see Section 22A.1.2).

Criteria pollutant and $CO_2$ emissions for each phase were calculated using the information summarized in Tables 22B-5 through 22B-8 and Equation 22A-4.

**Equation 22A -4** $$E_{phase} = \Sigma(EF \times Trips \times Trip\ Distance) \times Conv$$

Where:

$E_{phase}$ = Total exhaust emissions for the phase, pounds per day

EF = Engine emissions factor, grams/mile (EMFAC2011)

Trips = Vehicle trips per day

Trip Distance = Default trip length, miles (CalEEMod)

Conv = Conversion from grams to pounds, 0.0002205

EMFAC2011 does not include emission factors for $CH_4$ or $N_2O$. Emissions of $CH_4$ and $N_2O$ from diesel-powered vehicles were determined by scaling the $CO_2$ emissions quantified by Equation 22A-4 by the ratio of $CH_4/CO_2$ and $N_2O/CO_2$ (0.000026) emissions expected per gallon of diesel fuel according to the CCAR (California Climate Action Registry 2009). Emissions of $CH_4$ and $N_2O$ emissions from gasoline-powered vehicles were determined by dividing the $CO_2$ emissions quantified by Equation 22A-4 by 0.95. This statistic is based on EPA’s recommendation that $CH_4$, $N_2O$, and other GHG emissions account for approximately 5% of on-road emissions (U.S. Environmental Protection Agency 2011).

### 22A.1.2.5 Helicopters

Helicopters would be used during line stringing activities for the 230 kV transmission lines. Based on guidance provided by DWR, two light-duty helicopters were assumed to operate four hours a day to install new poles and lines (see Appendix 22B, *Air Quality Assumptions*). Helicopter emissions were estimated using expected fuel consumption for a MD 500 D/E (U.S. Department of Interior National Business Center 2006) and emission factors derived from the California Public Utilities Commission (2006 and 2007) and the U.S. Department of Energy (2008). Table 22A-6 summaries the fuel consumption data and emission factors used in the analysis.

**Table 22A-6. Helicopter Fuel Consumption (gallon/hour) and Emission Factors (pounds/hour)**

| Helicopter | Fuel Use | ROG | $NO_X$ | CO | PM10[a] | $SO_2$ | $CO_2$[b] |
|---|---|---|---|---|---|---|---|
| MD 500 D/E | 28 | 0.66 | 1.75 | 2.07 | 0.10 | 0.14 | 18.36 |

Notes

[a] Emission factors for PM2.5 are currently unavailable. Consequently, PM2.5 emissions were assumed to equal PM10 emissions. Because PM2.5 represents a fraction of PM10, this approach represents a conservative assessment of PM2.5 emissions from electricity consumption.

[b] Emission factor in pounds per gallon of fuel consumed. Emissions of $CH_4$ and $N_2O$ were determined by scaling the $CO_2$ emissions by the CCAR ratios discussed in Section 22.1.3.4,

### 22A.1.2.6 Fugitive Dust from Land Disturbance

Fugitive dust emissions (without project commitments) from land disturbance were quantified using CalEEMod. Estimates of the acres disturbed as a result of construction of the major water conveyance features (e.g., Intakes, pumping plants) were obtained using GIS. As shown in the construction schedules for the proposed action (see Appendix 22B, *Air Quality Assumptions*), construction of the water conveyance features would require multiple phases with the potential to disturb land. The duration of phases with land disturbance activity for each water conveyance feature were summed to obtain the total number of days in which fugitive dust could be generated. PM10 and PM2.5 emissions estimated for the water conveyance features were divided by the total number of activity days to determine average PM10 and PM2.5 emissions per day. For example, under Alternative 1A, land disturbance associated with Intake 1 would generate 203 pounds of PM10 and occur over a period of 381 days. Average daily PM10 emissions would equate to 0.53 pounds per day (203/381).

Tables 22B-9 through 22B-12 in Appendix 22B, *Air Quality Assumptions,* summarize the construction phases assumed in the emissions calculations for Alternatives 1A, 2A, and 6A (pipeline/tunnel alignment); Alternative 4 (modified pipeline/tunnel alignment); Alternatives 1B, 2B, and 6B (east alignment); and Alternative 9 (through Delta/separate corridors alignment), respectively. Total acres disturbed for each major water conveyance feature are also provided.

### 22A.1.2.7 Electricity Usage

Construction of the water conveyance facility will require the use of electricity for lighting, tunnel ventilation, boring, and certain types of equipment. Annual electric demand for all alternatives was provided by DWR and is summarized in Table 22A-7. Generation of this electricity will result in criteria pollutant and GHG emissions at regional power plants.

The EPA (2012)[2] and University of California, Davis (Delucchi 1996:110) have developed emission factors for the current generation of electricity within California. Table 22A-8 summarizes the criteria pollutant and GHG emission factors used in the unmitigated analysis. Emissions associated with the generation of electricity were estimated by multiplying the expected annual electricity usage (Table 22A-7) by the emission factors show in Table 22A-8.

[2] Power will be supplied to BDCP by multiple utilities. The quantity of power supplied by each utility is currently unknown. Consequently, average statewide emission factors, as opposed to utility-specific factors, were used to quantify emissions associated with electricity consumption.

**Table 22A-7. Annual Electric Demand for Construction (megawatt-hours [MWh])**

| Alternative | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8[a] | Year 9[a] |
|---|---|---|---|---|---|---|---|---|---|
| Alternative 1A, 2A, 6A | 20,442 | 32,058 | 56,446 | 220,100 | 324,230 | 376,487 | 236,181 | 81,058 | 81,058 |
| Alternative 4 | 73,692 | 196,604 | 345,322 | 449,466 | 480,470 | 483,411 | 363,354 | 129,168 | 27,600 |
| Alternative 7, 8 | 13,628 | 21,372 | 45,760 | 209,414 | 313,544 | 365,801 | 230,648 | 78,386 | 78,386 |
| Alternative 3 | 10,221 | 16,029 | 40,417 | 204,071 | 308,201 | 360,458 | 227,882 | 77,050 | 77,050 |
| Alternative 5 | 6,814 | 10,686 | 23,818 | 112,424 | 170,294 | 196,937 | 123,770 | 42,574 | 42,574 |
| Alternative 1C, 2C, 6C | 21,642 | 33,858 | 45,314 | 121,262 | 168,602 | 196,436 | 119,944 | 42,151 | 42,151 |
| Alternative 1B, 2B, 6B | 22,042 | 41,205 | 66,314 | 83,391 | 70,391 | 62,072 | 26,160 | 17,598 | 17,598 |
| Alternative 9[b] | 11,021 | 20,603 | 33,157 | 41,696 | 35,196 | 31,036 | 13,080 | - | - |

- No construction

[a] Based on guidance provided by DWR, electrical demand assumed to be one-quarter the demand for year 5.

[b] Based on guidance provided by DWR, electrical demand assumed to be half the demand of alternatives 1B, 2B, 6B (east alignment).

**Table 22A-8. Criteria Pollutant and GHG Emission Factors (2009) for Electricity Generation**

| Pollutant | Value | Unit | Source |
|---|---|---|---|
| $CO_2$ | 298.772 | MT/GWh | EPA 2012 |
| $CH_4$ | 0.013 | MT/GWh | EPA 2012 |
| $N_2O$ | 0.003 | MT/GWh | EPA 2012 |
| $SF_6$ | 0.0001 | MT/GWh | ARB 2010; CEC 2012[a] |
| NMHC[b] | 0.0014 | g/kWh | Delucchi 1996 |
| CO | 0.0134 | g/kWh | Delucchi 1996 |
| NOx | 0.2321 | g/kWh | Delucchi 1996 |
| PM10[c] | 0.0155 | g/kWh | Delucchi 1996 |
| $SO_2$ | 0.4267 | g/kWh | Delucchi 1996 |

MT/GWh = metric tons gigawatt-hour

g/kWh = grams per kilowatt-hour

NMHC = non-methane hydrocarbons

[a] Neither the EPA nor the University of California, Davis have a published emission factor for SF6. Statewide $SF_6$ emissions in 2008 were therefore used to identify an emission factor per megawatt-hour by dividing total $SF_6$ emissions by the total electricity generation in California (California Air Resources Board 2010; California Energy Commission 2012)

[b] Emission factor used to quantify ROG (because ROG only represents a fraction of NMHC, this assumption is conservative).

[c] Emission factor used to quantify PM2.5 (because PM2.5 only represents a fraction of PM10, this assumption is conservative).

Adopted and proposed statewide legislation will increase future energy efficiency and the proportion of renewable energy supplied to the electrical grid. Actual emissions from construction of the water conveyance facilities will therefore likely be less than those estimated using emission factors presented in Table 22A-8. This analysis thus provides a worst-case scenario of criteria pollutants and GHG emissions associated with electricity use.

### 22A.1.2.8 Concrete Batching

#### Particulate Matter

Concrete required to construct the water conveyance facility will be manufactured at batch plants that store, convey, and discharge water, cement, fine aggregate, and coarse aggregate. PM10 and PM2.5 may be emitted through the transfer of aggregate, truck loading, mixer loading, vehicle traffic, and wind erosion. The amount of PM10 and PM2.5 generated during concrete batching depends primarily on the surface moisture content of surface materials, and the extent of fugitive emission controls.

PM10 emissions from concrete batching were estimated using emission factors provided the EPA's *Compilation of Air Pollutant Emission Factors* (AP-42) (U.S. Environmental Protection Agency 2006:11.12-11; Sacramento Metropolitan Air Quality Management District 2011) and concrete data provided by DWR. The total volume of concrete required to construct the major water conveyance features (e.g., Intake, pumping plants) is summarized in Table 22A-8. Daily PM10 and PM2.5 emissions from concrete batching were calculated by multiplying the anticipated volume of concrete produced at each batch plant by the AP-42 dust emission factors. Based on information provided by DWR, process rates of 480 cubic yards per day and 1,920 cubic yards per day were assumed for small (<2-acres) and large (>2-acres) batch plants. Annual emissions were quantified based on the daily production rates and the total volume of concrete required to construct the project features.

#### Carbon Dioxide

Cement manufacturing produces $CO_2$ through fuel combustion and calcination. Emissions generated by on-site fuel combustion account for approximately 40% of total emissions generated by a batching facility, whereas calcination accounts for the reaming 60%. Calcination involves heating raw materials to over 2,500 ˚F, which liberates $CO_2$ and other trace materials (Portland Cement Association 2011).

Emissions generated by concrete batching were calculated using information provided by the Portland Cement Association and data presented in Table 22A-9. It was assumed that the batching of 1 cubic yard of concrete generates 400 pounds of $CO_2$ through both combustion and calcination. $CO_2$ emissions generated by concrete manufacturing were therefore calculated by multiplying the volume of required concrete by 400 pounds (Portland Cement Association 2011).

**Table 22A-9. Concrete Required for Project Construction (cubic yards)**

| Type | Alternatives 1A, 2A, 6A | Alternative 4 | Alternatives 7, 8 | Alternative 3 | Alternative 5 | Alternatives 1C, 2C, 6C | Alternatives 1B, 2B, 6B | Alternative 9 |
|---|---|---|---|---|---|---|---|---|
| Intakes | 147,500 | 88,500 | 88,500 | 59,000 | 29,500 | 147,500 | 147,500 | - |
| Pumping Plants | 442,035 | 265,221 | 265,221 | 176,814 | 88,407 | 442,035 | 442,035 | - |
| Pipelines | 161,608 | 79,526 | 161,608 | 161,608 | 161,608 | 187,500 | 107,000 | - |
| Canals | 0 | 52,711 | 0 | 0 | 0 | 251,915 | 282,422 | - |
| Siphons | 0 | 229,233 | 0 | 0 | 0 | 768,538 | 644,846 | - |
| Control Structures/Forebay | 239,961 | 147,008 | 239,961 | 239,961 | 239,961 | 110,008 | 110,008 | - |
| Tunnels | 3,741,459 | 4,046,481 | 3,741,459 | 3,425,200 | 1,119,249 | 1,681,659 | 477,120 | - |
| Bridges | 0 | 0 | 0 | 0 | 0 | 54,341 | 51,291 | - |
| Intermediate PP | 171,143 | 2,857[d] | 171,143 | 171,143 | 171,143 | 169,043 | 195,373 | - |
| Total | 4,903,706 | 4,911,537 | 4,667,892 | 4,233,726 | 1,809,868 | 3,812,539 | 2,457,595 | 1,400,502 |

- Component assumption unavailable

[a] Assumes the construction of three intakes/pumping plants

[b] Assumes the construction of two intakes/pumping plants

[c] Assumes the construction of one intakes/pumping plants

[d] Inlet control structure

Studies have calculated the $CO_2$ absorption rates of hardened concrete. These studies assume a 70 year service life and a 30-year demolition and recycling period for concrete materials. Given these assumptions up to 57% of the $CO_2$ emitted during the cement manufacturing calcination is re-absorbed by concrete over the 100 year life cycle. All $CO_2$ released by calcination will be re-absorbed by carbonation in a geologic time frame (Haselbach 2009).

#### 22A.1.2.9 Project Commitments

The lead agency has identified several project commitments to reduce construction-related criteria pollutants and GHG emissions. Pursuant to the project commitments discussed in Appendix 3B, *Environmental Commitments,* the following assumptions were made to quantify emissions reductions achieved by project commitments.

- Electrification of 5% of equipment in the following general categories:
  - Air compressors
  - Cranes
  - Excavators
  - Pumps
  - Other construction equipment
  - Loaders
  - Dozers
- Electrification of all materials-handling equipment and welders.
- Electrification of 75% of general industrial equipment.
- Electrification of 10% of light duty on-road vehicles.
- Use of diesel particulate filters on 100% of all non-electrified off-road, marine, and locomotive equipment.
- Use of compressed natural gas (CNG) in approximately 10% of heavy-duty trucks and 50% of forklifts.
- Use of Tier 4 engines in diesel locomotives.
- Implementation of fugitive dust control measures to achieve a 75% reduction in dust from land disturbance.
- Implementation of fugitive dust control measures to achieve a 70% reduction in dust from concrete batching.
- Implementation of fugitive dust control measures to achieve an 80% reduction in dust from aggregate and sand pile erosion at the concrete batch plants.
- Use of a hood system vented to a fabric filter/baghouse during cement delivery and hopper and central mix loading.

Based on guidance provided by DWR, annual electric demand identified in Table 22A-6 would be sufficient to support new electrification commitments. Emissions associated with the electrification of project equipment were therefore assumed to be accounted for in the electricity analysis (see Section 22.1.3.7).

Diesel particulate filters were assumed to result in an 85% reduction in PM10 and PM2.5 exhaust (California Air Resources Board 2012). Emissions generated by use of Tier 4 locomotive engines were calculated using EPA Tier 4 off-road diesel emission standards in place of Tier 0 emissions standards (see section 22.1.3.3). Emissions from use of CNG were calculated by multiplying emissions generated by diesel equipment (see section 22.1.3.1) by the percent reduction achieved by switching from diesel to CNG (see Table 22A-10). Note that for some pollutants, CNG results in an emissions increase, relative to diesel fuel.

**Table 22A-10. Change in Emissions Due to Fuel Switch from Diesel to CNG**

| Equipment | ROG | $NO_X$ | CO | PM | $SO_2$ | $CO_2e$ |
|---|---|---|---|---|---|---|
| Forklift | -16% | +17% | +696% | -45% | 0% | +21% |
| Heavy Truck | -8% | +3% | +485% | -44% | 0% | +19% |

Source: California Air Pollution Control Officers Association 2010

## 22A.1.2.10 State Mandates to Reduce GHG Emissions

Actions undertaken by the state will contribute to project-level GHG reductions. For example, the state requires electric utility companies to increase their procurement of renewable resources by 2020. Renewable resources, such as wind and solar power, produce the same amount of energy as coal and other traditional sources, but do not emit any GHGs. By generating a greater amount of energy through renewable resources, electricity provided to the project will be cleaner and less GHG intensive than if the state hadn't required the renewable standard.

The analysis assumes implementation of Pavley, LCFS, and RPS. Pavley will improve the efficiency of automobiles and light duty trucks, whereas LCFS will reduce the carbon intensity of diesel and gasoline transportation fuels. To account for GHG reductions achieved by Pavley and LCFS, emissions generated by construction equipment and vehicles were calculated using adjusted emission factors from EMFAC2011.

The RPS will increase the proportion of renewable energy supplied to the electrical grid. The emission factors summarized in Table 22A-8 are based on the statewide renewable energy mix in 2009 (12%). Implementation of the RPS will increase the proportion of renewable energy within the state to 33% by 2020. To account for emissions reductions achieved by increases in renewable energy, annual electricity emission factors were calculated assuming a linear increase in statewide renewables between 2007 and 2020 (see Table 22A-11). Because RPS requirements end in 2020, the percentage of renewable energy after 2020 was assumed to remain constant at 33%.

Electricity emissions with implementation of RPS were estimated by multiplying the expected annual electricity usage (Table 22A-7) by the emission factors show in Table 22A-11. Note that implementation of the RPS will affect criteria pollutants, in addition to GHG emissions.

**Table 22A-11. Annual Criteria Pollutant and GHG Emission Factors with Implementation of RPS[a]**

| Year | % Renewable | $CO_2$ *MT/MWh* | $CH_4$ *MT/MWh* | $N_2O$ *MT/MWh* | NMHC[b] *g/kWh* | CO *g/kWh* | $NO_X$ *g/kWh* | PM10[c] *g/kWh* | $SO_X$ *g/kWh* |
|---|---|---|---|---|---|---|---|---|---|
| 2014 | 0.21 | 0.266790 | 0.000012 | 0.000002 | 0.0012 | 0.0118 | 0.2042 | 0.0136 | 0.3755 |
| 2015 | 0.23 | 0.260237 | 0.000011 | 0.000002 | 0.0012 | 0.0115 | 0.1992 | 0.0133 | 0.3663 |
| 2016 | 0.25 | 0.253685 | 0.000011 | 0.000002 | 0.0012 | 0.0112 | 0.1942 | 0.0130 | 0.3570 |
| 2017 | 0.27 | 0.247132 | 0.000011 | 0.000002 | 0.0011 | 0.0109 | 0.1892 | 0.0126 | 0.3478 |
| 2018 | 0.29 | 0.240580 | 0.000011 | 0.000002 | 0.0011 | 0.0106 | 0.1842 | 0.0123 | 0.3386 |
| 2019 | 0.31 | 0.234027 | 0.000010 | 0.000002 | 0.0011 | 0.0103 | 0.1792 | 0.0120 | 0.3294 |
| 2020+ | 0.33 | 0.227474 | 0.000010 | 0.000002 | 0.0011 | 0.0101 | 0.1741 | 0.0116 | 0.3201 |

[a] No change in $SF_6$ emission factor (see Table 22A-6)

[b] Emission factor used to quantify ROG (because ROG only represents a fraction of NMHC, this assumption is conservative

[c] Emission factor used to quantify PM2.5 (because PM2.5 only represents a fraction of PM10, this assumption is conservative).

# 22A.1.3 Emissions Scaling

## 22A.1.3.1 Alternatives 3, 5, 7, and 8 (Pipeline/Tunnel Alignment)

Assumptions for off-road equipment, marine vessels, locomotives, and on-road vehicles for the pipeline/tunnel alignment correspond to construction of the water conveyance facilities associated with Alternatives 1A, 2A, and 6A (15,000 cfs option).[3] Criteria pollutant and GHG emissions associated with these sources were calculated for Alternatives 3, 5, 7, and 8 by scaling emissions estimates for Alternatives 1A, 2A, and 6A. For example, Alternatives 1A, 6A, and 2A will construct five intakes during intake construction, whereas Alternative 3 will construct only two. For each construction component, the ratio of identified project features between Alternatives 1A, 6A, and 2A and the other alternatives was calculated (e.g., two intakes to five intakes).

Table 22A-12 summarizes the scaling factors for the Alternatives 3, 5, 7, and 8 by major construction component.

## 22A.1.3.2 Alternative 4 (Modified Pipeline/Tunnel Alignment)

Assumptions for off-road equipment, marine vessels, locomotives, and on-road vehicles for the intakes, pumping plants, forebays, control structures, and pipelines under Alternative 4 correspond to construction activities associated with Alternatives 1A, 2A, and 6A (15,000 cfs option). Criteria pollutant and GHG emissions associated with these components were calculated for Alternative 4 by scaling emissions estimates for Alternatives 1A, 2A, and 6A. Table 22A-12 summarizes the scaling factors for the Alternative 4 by construction component.

[3] Note that emissions associated with Alternative 1A and 2A are identical except for the Head of Old River Barrier, which occurs under Alternative 2A. Emissions associated with the Head of Old River Barrier were added to the emission estimates for Alternative 1A to evaluate Alternative 2A.

### 22A.1.3.3 Alternatives 1C, 2C, and 6C (West Alignment)

Assumptions for off-road equipment, marine vessels, locomotives, on-road vehicles, and land disturbance for the west alignment were unavailable. Criteria pollutant and GHG emissions for the alternatives using this conveyance were calculated by scaling emissions estimates for the east alignment conveyance and tunnel conveyance, due to similarities between the alternatives. The scaling analysis was based on project features unique to each construction component, which were identified for all the west alignment alternatives. For each construction component, the ratio of identified project features between the east alignment or pipeline/tunnel alignment and the west alignment alternatives was calculated.

Table 22A-13 summarizes the scaling factors for the west alignment alternatives by major construction component.

1 **Table 22A-12. Scaling Factors for Alternatives 3, 5, 7, and 8 (Pipeline/Tunnel Conveyance) and Alternative 4 (Modified Pipeline/Tunnel Conveyance)**

| | | Value | | | | | Ratio (to Alt 1A, 2A, 6A) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Feature | Scaling Method | *1A, 2A, 6A* | *4* | *7,8* | *3* | *5* | *4* | *7,8* | *3* | *5* |
| Intakes(number) | | | | | | | | | | |
| Intake 1 | Scale by whether the feature is built | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Intake 2 | Scale by whether the feature is built | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Intake 3 | Scale by whether the feature is built | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| Intake 4 | Scale by whether the feature is built | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Intake 5 | Scale by whether the feature is built | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| Pumping Plants (number) | | | | | | | | | | |
| Pumping Plant 1 | Scale by whether the feature is built | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pumping Plant 2 | Scale by whether the feature is built | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Pumping Plant 3 | Scale by whether the feature is built | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| Pumping Plant 4 | Scale by whether the feature is built | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| Pumping Plant 5 | Scale by whether the feature is built | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Intermediate Pumping Plant | Scale by whether the feature is built | 1 | 1[a] | 1 | 1 | 1 | 0.07[a] | 1 | 1 | 1 |
| Pipelines (Length) | Scale by length of pipeline built | 8.00 | 0.34 | | 2.48 | 1.96 | 0.04 | 0.79 | 0.31 | 0.25 |
| Tunnels (acres) | | | | | | | | | | |
| Reach 1 | Scale by length of reach built | 0.26 | -[b] | 0.26 | 0.26 | 0.26 | -[b] | 1 | 1 | 1 |
| Reach 2 | Scale by length of reach built | 5.53 | -[b] | 5.53 | 5.53 | 5.53 | -[b] | 1 | 1 | 1 |
| Reach 3 | Scale by length of reach built | 5.37 | -[b] | 5.37 | 5.37 | 2.69 | -[b] | 1 | 1 | 0.50 |
| Reach 4 | Scale by length of reach built | 5.47 | -[b] | 5.47 | 5.47 | 2.74 | -[b] | 1 | 1 | 0.50 |
| Reach 5 | Scale by length of reach built | 5.99 | -[b] | 5.99 | 5.99 | 3.00 | -[b] | 1 | 1 | 0.50 |
| Reach 6 | Scale by length of reach built | 5.81 | -[b] | 5.81 | 5.81 | 2.91 | -[b] | 1 | 1 | 0.50 |
| Reach 7 | Scale by length of reach built | 5.99 | -[b] | 5.99 | 5.99 | 3.00 | -[b] | 1 | 1 | 0.50 |
| Reach 8 | Scale by length of reach built | 4.78 | -[b] | 4.78 | 4.78 | 2.39 | -[b] | 1 | 1 | 0.50 |
| Forebays (number) | | | | | | | | | | |
| Intermediate Forebay | Scale by acres of forebay built | 1,892 | 250 | 1,892 | 1,892 | 1,892 | 0.13 | 1 | 1 | 1 |
| Byron Tract Forebay | Scale by acres of forebay built | 1,489 | - | 1,489 | 1,489 | 745 | - | 1 | 1 | 0.50 |
| Control Structures(number) | | | | | | | | | | |
| Structure 1 | Scale by whether the feature is built | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Structure 2 | Scale by whether the feature is built | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Structure 3 | Scale by whether the feature is built | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Structure 4 | Scale by whether the feature is built | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

[a] The Intermediate Pumping Plant would be replaced by an outlet structure under Alternative 4. This assumption is reflected in the scaling factors.
[b] The component was not scaled. Emissions were calculated based on alternative-specific construction data (see Section 22A.1.1.4).

1 **Table 22A-13. Scaling Factors for Alternatives 1C, 2C, and 6C (West Alignment)**

| Feature | Method | Alignment Scaled | Value | | Ratio (to East/PTO) |
|---|---|---|---|---|---|
| | | | East/PTO | West | West |
| Intakes(number) | | | | | |
| Intake 1 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Intake 2 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Intake 3 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Intake 4 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Intake 5 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Pumping Plants (number) | | | | | |
| Pumping Plant 1 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Pumping Plant 2 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Pumping Plant 3 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Pumping Plant 4 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Pumping Plant 5 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Intermediate Pumping Plant | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Pipelines | Scale by length of pipeline built | East | 3.45 | 7.55 | 2.19 |
| Canals | Scale by acres of canal built | East | 16,656 | 10,681 | 0.64 |
| Culvert Siphons | Scale by acres of siphon built | East | 1,043 | 1,231 | 1.18 |
| Control Structures(number) | | | | | |
| Structure 1 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Structure 2 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Structure 3 | Scale by whether the feature is built | East | 1 | 1 | 1 |
| Structure 4 | Scale by whether the feature is built | East | 1 | 0 | 0 |
| Bridges | Scale by acres of bridge built | East | 456 | 473 | 1.03 |
| Tunnels | Scale by length of tunnel built | East | 2.38 | 16.98 | 7.12 |
| Forebay | Scale by acres of forebay built | East | 1,625 | 1,484 | 0.91 |

# 22A.2 Operation

## 22A.2.1 Maintenance Activities

### 22A.2.1.1 Alternatives 1A, 2A, 3, 5, 6A, 7, and 8 (Pipeline/Tunnel Conveyance), Alternative 4 (Modified Pipeline/Tunnel Conveyance), Alternatives 1B, 2B, and 6B (West Alignment), and Alternatives 1C, 2C, and 6C (East Alignment)

Operations and maintenance (O&M) include both routine activities and major inspections. Routine activities would occur on a daily basis throughout the year, whereas major inspections would occur annually.

**Routine Maintenance**

DWR provided labor and equipment estimates for maintenance, management, repair, and operating crews. One of each crew type is required to cover daily O&M activities at all pumping plants and intakes. Table 22A-14 summarizes the number of employees, vehicles, and equipment included in each crew for Alternatives 1A, 1B, 1C, 2A, 2B, 2C, 6A, 6B, and 6C.

**Table 22A-14. Routine O&M Assumptions for Alternatives 1A-C, 2B-C, and 6A-C**

| Crew Type | Number of Employees | Vehicles (number) | Equipment (number) |
|---|---|---|---|
| Maintenance | 5 | Crew Truck (1)<br>Foreman Truck (1) | - |
| Management | 3 | - | - |
| Repair | 7 | Crew Truck (1)<br>Foreman Truck (1)<br>600 truckloads[a] | Backhoe (1) |
| Operating | 9 | - | - |

[a] 600 truckloads would be required per intake

Operational emissions associated with vehicle traffic and maintenance equipment were estimated using the EMFAC2011 and CalEEMod models, respectively. Emissions were quantified for both the ELT and LLT periods. Key assumptions include:

- Routine O&M activities for Alternatives 3, 4, 5, 7, and 8 were scaled based on the number of intakes relative to Alternatives 1A, 1B, 1C, 2A, 2B, 2C, 6A, 6B, and 6C.
- Employees would make two trips to the project site per day, 250 days per year.
- Employee vehicle trips would be 10.8 miles in the YSAQMD, SMAQMD, and SJVAPCD, based on Plan area CalEEMod default trips lengths for "home based work" trips.
- Employee vehicle trips would be 12.4 miles in the BAAQMD, based on Plan area CalEEMod default trips lengths for "home based work" trips.

- Crew, foreman, and dump trucks would make a maximum of eight trips per day. This value represents a conservative estimate of vehicle activity and is based on consultation with Fehr & Peers, the project traffic engineers.
- Crew and foreman trucks trips would be 9.5 miles in all air district, based on Plan area CalEEMod default trips lengths for "commercial work" trips. Dump truck trips would be 20 miles in all air districts.
- Vehicle emission factors were based on EMFAC2011 for the air district in which activity would occur, as determined by GIS (see Section 22A.1.2).
- The backhoe would operate a maximum of 8 hours per day, 250 days per year.

**Yearly Maintenance**

Yearly maintenance includes both annual inspections and half-decadal tunnel dewatering. Annual inspections are limited to work on the gate control structure and inspection by a remotely operated vehicle (ROV). Tunnel dewatering would include a physical inspection, as well as sediment removal. Table 22A-15 summarizes the number of employees, vehicles, and equipment required for annual inspections and tunnel dewatering.

**Table 22A-15. Yearly Maintenance Assumptions for Alternatives 1A-C, 2B-C, 3, 4, 5, 6A-C, 7 and 8**

| O&M Type | Number of Employees | Vehicles (number) | Equipment (number) |
|---|---|---|---|
| Annual Inspections | 6 | 1 crew truck[a] | Crane (1)[b] |
| Tunnel Dewatering | 18 (sediment crew)<br>11 (inspection crew) | 1 crew truck | Crane (2) |

[a] Four electric vehicles (EV) would also be required. Emissions associated with these vehicles are included in the electricity analysis (see section 22A.2.2)

[b] ROV assumed to be electric

Operational emissions associated with vehicle traffic and maintenance equipment were estimated using the EMFAC2011 and CalEEMod models, respectively. Emissions were quantified for both the ELT and LLT periods. Key assumptions include:

- Annual inspections would occur over a period of one month for the pipeline/tunnel and modified pipeline/tunnel alignments, two weeks for the west alignment, and one week for the east alignment. Work would occur five days per week.
- Sediment removal would occur over a period of one to two months for the pipeline/tunnel and modified pipeline/tunnel alignments[4], one month for the west alignment, and two weeks for the east alignment. Work would occur seven day days per week.
- Tunnel dewatering inspections would cover one mile of tunnel per day.
- Each employee would make two trips to the project site per day according to the inspection and dewatering schedules identified above.
- Employee vehicle trips would be 10.8 miles in the YSAQMD, SMAQMD, and SJVAPCD, based on Plan area CalEEMod default trips lengths for "home based work" trips.

[4] Two months for alternatives with two tunnels; one month for alternatives with one tunnel

- Employee vehicle trips would be 12.4 miles in the BAAQMD, based on Plan area CalEEMod default trips lengths for "home based work" trips.
- Each crew truck would make a maximum of eight trips per day. This value represents a conservative estimate of vehicle activity and is based on consultation with Fehr & Peers, the project traffic engineers.
- Crew trucks trips would be 9.5 miles in all air district, based on Plan area CalEEMod default trips lengths for "commercial work" trips.
- The cranes would operate a maximum of 8 hours per day according to the inspection and dewatering schedules identified above.

### 22A.2.1.2 Alternative 9 (Separate Corridors)

Specific activity assumptions for Alternative 9 are not available. However, DWR provided a cost estimate for O&M associated with Alternative 9. Total costs for routine O&M were 26% of total costs for routine O&M for all other alternatives. Zero cost was given for yearly maintenance. Based on this information, O&M emissions associated with Alternative 9 were assumed to be 26% of emissions quantified for all other alternatives.

## 22A.2.2 Electricity Usage

Construction of the water conveyance facility would modify BDCP operations and cause the BDCP alternatives to have slightly different energy requirements within the ELT and LLT periods. Increases in annual electricity consumption for all alternatives relative to the No Action Alternative (CVP only) and existing conditions (SWP only) were calculated in Chapter 21, *Energy*, and is summarized in Table 22A-16. Generation of this additional electricity would result in criteria pollutant and GHG emissions at regional power plants.

**Table 22A-16. Additional Annual Electricity Consumption for all Alternatives, Early Late and Late Long-Term (GWh)**

| Alternative | State Water Project | | Central Valley Project | |
|---|---|---|---|---|
| | Early Late | Late Long | Early Late | Late Long |
| Alt 1A | 1,336 | 708 | 196 | 167 |
| Alt 1B | 1,218 | 593 | 196 | 167 |
| Alt 1C | 1,350 | 714 | 196 | 167 |
| Alt 2A | 669 | 227 | 109 | 103 |
| Alt 2B | 528 | 89 | 109 | 103 |
| Alt 2C | 667 | 221 | 109 | 103 |
| Alt 3 | 1,034 | 425 | 180 | 153 |
| Alt 4 | 332 | -108 | 89 | 83 |
| Alt 5 | 137 | -400 | 75 | 57 |
| Alt 6A | -1,019 | -1,428 | -115 | -113 |
| Alt 6B | -1,223 | -1,605 | -115 | -113 |
| Alt 6C | -1,042 | -1,436 | -115 | -113 |
| Alt 7 | -1,334 | -1,663 | -122 | -113 |
| Alt 8 | -2,247 | -2,546 | -234 | -222 |
| Alt 9 | -669 | -1,006 | -16 | -11 |
| No Action | 6,867 | 0 | 780 | 733 |

Criteria pollutant and GHG emissions generated by increased electricity consumption were calculated using adjusted emission factors for state renewable energy mandates (see Table 22A-9).

# 22A.3 References

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