Appendix C

Air Pollutant Emission Calculations

Each of the build alternatives will result in both direct and indirect emissions during the construction and operational phases. Sources of emissions during construction include (1) CO, VOC, NO_X, SO_X and PM_{10} from construction equipment and motor vehicle exhaust; and (2) fugitive PM_{10} emissions from entrained dust from vehicle travel on paved roads, from vehicle and equipment travel on unpaved roads and surfaces, from dust generated during earthmoving and handling activities, and from wind erosion of disturbed construction areas. Sources of emissions during project operations include (1) CO, VOC, NO_X, SO_X and PM_{10} from inspection and maintenance crew vehicle exhaust and from spreading basin maintenance equipment exhaust; and (2) fugitive PM_{10} emissions from inspection and maintenance crew travel on unpaved roads and from spreading basin maintenance activities. Emissions associated with these sources have been estimated as described below.

Details of the calculations are shown in the attached spreadsheets. Attachment C-1 lists emission factors used to estimate during construction for all of the build alternatives. Attachments C-2 through C-5 provide details of construction emission estimates for the Eastern, Western, Combination, and Eastern/Canal Alternatives, respectively. Details of the operational emissions estimates, which are the same for all of the build alternatives, are shown in Attachment C-6.

Construction Emissions

Emissions associated with the following sources and activities during construction have been estimated:

1. Construction equipment engine exhaust

2. Motor vehicle exhaust, brake and tire wear

3. Entrained dust from material delivery trucks traveling on unpaved roads

4. Entrained dust from cement trucks traveling on unpaved roads

5. Entrained dust from construction worker buses while traveling on unpaved roads during construction of the conveyance and power transmission facilities

6. Entrained dust from vehicles travelling on paved roads

7. Entrained dust from construction equipment traveling on unpaved surfaces in construction areas

8. Fugitive dust from bulldozing, grading and scraping

9. Fugitive dust from handling of excavated material, such as dropping material into haul trucks

10. Fugitive dust from wind erosion of disturbed areas

Emission Factors

The emission factors applied in the analysis were taken from the US EPA's *Compilation of Air Pollutant Emission Factors* (AP-42), the South Coast Air Quality Management District's (SCAQMD) *California Environmental Quality Act (CEQA) Air Quality Handbook* (1993), the MDAQMD's *Emission Inventory Guidance, Material Handling and Processing Industries* (2000), and the California Air Resources Board's (CARB) Motor Vehicle Emission Factor Model (2000).

Emission factors for construction equipment exhaust were taken from the SCAQMD CEQA Handbook (1993). These factors are in units of pounds of each pollutant emitted per brake-horsepower-hour (bhp-hr) of work produced by the equipment's engine. These emission factors were converted to units of pounds per hour by multiplying them by the equipment engine's horsepower rating and the load factor for the type of equipment, which is the average percentage of the rated output at which the engine typically operates. Average horsepower ratings and load factors for the types of equipment anticipated to be used during project construction, which were also taken from the SCAQMD's CEQA Handbook, are listed in Table EF-1 in Attachment C-1 along with the emission factors in both pounds/bhp-hr and in pounds/hr.

Table EF-2 in Attachment C-1 lists exhaust, tire wear and brake wear emission factors for heavy heavy-duty diesel trucks (on-road haul trucks, on-road equipment and material delivery trucks, on-road cement trucks, on-site dump trucks, and on-site water trucks), medium duty gasoline trucks (on-site pickup trucks), urban buses (construction worker buses), and for light duty gasoline trucks (construction worker commuting vehicles) from the CARB's Motor Vehicle Emission Factor Model for calendar year 2001, EMFAC7G (2000).

Table EF-3 in Attachment C-1 lists the emission factors that were used to estimate fugitive PM_{10} emissions, the input parameters required in addition to activity levels, and values used for those parameters. Fugitive PM_{10} emissions from unpaved roads and surfaces will be controlled through surface compaction and the application of soil stabilizers, which are estimated to reduce uncontrolled emissions by 50 percent. This reduction is incorporated in the emission factors in the table.

Construction Activity Levels and Emissions

The project components that will be constructed are:

- The water conveyance facilities
- The Cadiz pumping facilities
- The spreading basins
- The wellfield
- The overhead power transmission facilities

Construction of each project component will include several different activities, such as site clearing, excavation, concrete work, etc. The types and number of equipment, construction workers, and material delivery and haul truck trips will vary from one activity to another. In order to estimate emissions associated with these construction activities, Black and Veatch (2000, 2001) estimated:

1. The number of each type of construction equipment anticipated to be used for each construction activity during the construction of each component
2. The peak daily hours of use of each piece of construction equipment during each month of construction
3. The number of days each piece of construction equipment is anticipated to be used during each month
4. The peak daily number of construction workers associated with each construction activity during each month

5. The peak daily number of material delivery trips associated with construction of each component

6. The total number of material delivery trips associated with construction of each project component (see Appendix B)

These estimates were used to estimate peak daily and annual emissions associated with construction.

Peak daily emissions anticipated during each construction activity each month were estimated first. The emissions associated with each activity were then added together to estimate total peak daily construction emissions each month, and the months with the highest anticipated peak daily emissions of each pollutants was then identified to estimate overall peak daily construction emissions.

Annual emissions were estimated by using the information to estimate construction activity levels during the first 12 months of construction required by the emission factors.

The peak daily and annual activity levels were estimated as follows:

1. <u>Construction Equipment Exhaust Emissions</u> Estimating construction equipment exhaust emissions required estimates of hours of operation by type of equipment. The peak daily number of each type of construction equipment anticipated to be used during each month was multiplied by the peak daily hours of operation anticipated each month to estimate the total peak daily hours of operation each month.

   Annual hours of operation for each type of construction equipment were estimated by first multiplying the peak daily hours of operation of each type of equipment by the number of days of operation anticipated during each month. These monthly total hours of operation were then added together over the first 12 months of construction to estimate annual hours of operation.

2. <u>Construction Worker Commuting Motor Vehicle Emissions</u> Estimating construction worker commuting motor vehicle emissions required estimates of the vehicle-miles-traveled (VMT), the number of vehicle starts, the number of trips, and the number of vehicles. The peak daily number of construction workers anticipated to be required for each construction activity during each month was multiplied by the estimated round-trip commuting distance to estimate the peak daily VMT associated with the construction activity. This estimate is based on the assumption that each construction worker uses an individual vehicle for commuting. The peak daily number of trips during each month were estimated by assuming that each construction worker vehicle

makes two trips each day (one to the project area in the morning and the other back home at the end of the day).

The annual number of construction worker commuting trips was estimated by multiplying the estimated peak daily number of construction workers for each construction activity during each month by the anticipated number of days of each construction activity. These monthly total numbers of trips were then added together for the first 12 months of construction. The resulting annual number of commuting trips for each construction activity was then multiplied by the estimated round-trip travel distances to estimate annual VMT for each construction activity.

3. <u>Material Delivery Vehicle Emissions</u> Estimating exhaust and brake and tire wear emissions from material delivery vehicles required estimates of VMT. Peak daily VMT for material delivery vehicles were estimated by multiplying the estimated peak daily number of delivery vehicle round trips during construction of each project component by the estimated round-trip travel distance. These estimates assume that the peak daily number of material delivery trips could occur anytime during construction of each project component. Annual VMT for material delivery vehicles were estimated by multiplying the total number of anticipated delivery trips (see Appendix B) by the estimated round-trip travel distance.

4. <u>Construction Worker Bus Emissions</u> Buses will be used to transport construction workers from the two end of Rice-Cadiz road during construction of the water conveyance and power transmission facilities. Estimating emissions from these buses required estimates of VMT. Peak daily emissions during each month from construction worker buses were estimated by first dividing the peak daily number of construction workers anticipated to be required for construction of the water conveyance and power transmission facilities during each month by an estimated capacity of 25 commuters per bus to estimate the peak daily number of bus trips each month. This peak daily number of bus trips was then multiplied by the estimated round-trip travel distance to calculate estimated peak daily VMT during each month.

   Annual VMT from worker bus travel on unpaved roads were calculated by first dividing the annual number of construction workers anticipated to be required for construction of the water conveyance and power transmission facilities by an estimated capacity of 25 commuters per bus to estimate the annual number of bus trips. This annual number of bus trips was then multiplied by the estimated round-trip travel distance to calculate estimated annual VMT.

5. Entrained dust from material delivery trucks and cement trucks traveling on unpaved roads Material delivery and cement trucks will travel on unpaved roads and surfaces during construction of the water conveyance and power transmission facilities. Estimating fugitive PM_{10} emissions from the unpaved road travel required estimates of VMT. Peak daily VMT by material delivery and cement trucks traveling on unpaved roads were estimated by multiplying the peak daily number of round trips during construction of each project component by the estimated round-trip travel distance on unpaved roads. Annual VMT for material delivery and cement trucks traveling on unpaved roads were estimated by multiplying the total number of round trips during construction of each project component by the estimated round-trip travel distance on unpaved roads.

6. Entrained dust from construction worker buses traveling on unpaved roads Estimating emissions from construction worker buses traveling on unpaved roads required estimates of VMT. The peak daily and annual VMTs were estimated in 4 above.

7. Entrained Dust from Vehicles Traveling on Paved Roads Estimating emissions from vehicles traveling on paved roads required estimates of VMT on paved roads. Peak daily VMT during each month and annual VMT for construction worker commuting vehicles and for material delivery trucks were calculated in 2 and 3 above

8. Entrained dust from construction equipment traveling on unpaved surfaces in construction areas Construction equipment will travel on unpaved surfaces during construction of all of the project components. Estimating fugitive PM_{10} emissions from mobile construction equipment traveling on unpaved surfaces required estimates of VMT. Peak daily VMT by construction equipment on unpaved surfaces during each month were calculated from the peak daily hours of operation of each piece of mobile equipment and an average speed of five miles per hour.

   Annual VMT for each piece of construction equipment was estimated by first multiplying the peak daily VMT by the anticipated days of use each month. The values for the first 12 months of construction were then added together to estimate the annual VMT.

9. Fugitive dust from bulldozing, grading and scraping Estimating fugitive PM_{10} from bulldozing required estimates of hours of bulldozer operation, while estimating fugitive PM_{10} emissions from grading and scraping required estimates of VMT. Peak daily hours of bulldozer operation during each construction activity each month were estimated by multiplying the peak daily hours of operation by each bulldozer by the number of bulldozers anticipated to be required. Peak daily hours of operation by

graders and scrapers were estimated in the same way. These hours of operation were multiplied by an assumed speed of five miles-per-hour to estimate peak daily VMT during each month. Annual hours of bulldozer operation and VMT by graders and scrapers were estimated by multiplying the peak daily values during each construction activity each month by the anticipated days of operation during each month and then adding together the results for the first 12 months of construction.

10. <u>Fugitive dust from material handling</u> Estimating fugitive PM_{10} emissions from material handling required estimates of the weight of material handled. Backhoes and loaders will be used for material handling operations. The peak daily weight of material handled by backhoes and loaders during each construction activity each month was calculated from the maximum daily production capacity of each backhoe and loader in use. The peak daily weights during each month were multiplied by the anticipated number of days of use during each month to calculate monthly total weights of materil handled. The total weight for the first 12 months were added together to estimate the annual weight of material handled.

11. <u>Fugitive dust from wind erosion of disturbed surfaces</u> Estimating fugitive PM_{10} emissions from wind erosion of disturbed surfaces required estimates of the number of acre-days of disturbed areas. Black and Veatch (2000, 2001) provided estimates of the peak daily number of disturbed acres during construction of each project component; these values were used to estimate peak daily emissions from wind erosion of disturbed surfaces. The annual disturbed acre-days were calculated by multiplying the maximum daily number of disturbed acres during construction of each project component by the total duration of construction for the component.

Organization of Construction Emissions Attachments

Attachments C-2 through C-5 contain the following spreadsheets for each of the build alternatives:

- Table 1: Summary of Peak Daily Construction Emissions
- Table 2: Construction Equipment and Personnel Requirements by Month
- Table 3: Peak Daily Construction Emissions by Month
- Table 4: Construction Equipment Peak Daily Operating Hours and Emissions by Month

- Table 5: Construction Motor Vehicle Peak Daily Travel and Emissions by Month
- Table 6: Peak Daily Fugitive PM_{10} Source Activity Levels and Emissions by Month
- Table 7 Summary of Estimated Annual Construction Emissions
- Table 8: Construction Equipment Exhaust Annual Emissions
- Table 9: Construction Motor Vehicle Annual Emissions
- Table 10: Construction Fugitive PM_{10} Annual Emissions

Operational Emissions

The activities that are anticipated to generate emissions during the operational phase of the project are (1) personnel inspecting the water conveyance and power transmission facilities and the spreading basins, (2) maintenance of the power transmission facility, and (3) removal of sediments from the spreading basins prior to refilling.

The inspection crew is anticipated to be two persons in one vehicle travelling from the Cadiz pumping facility to the spreading basins once each week. Emission source include vehicle exhaust, brake and tire wear, and entrained unpaved road dust. Each inspection round trip is anticipated to take place during a single day.

The transmission facility maintenance is anticipated to consist of cleaning of the power line insulators once each year. A water truck and pickup truck would be used for this maintenance. These vehicles would travel from the Cadiz pumping facility to the spreading basins. Emission sources include vehicle exhaust, brake and tire wear, and entrained unpaved road dust. Each maintenance round trip is anticipated to take place over two days.

Sediments and algae are anticipated to accumulate on the spreading basins while they contain water. This deposited particulate matter will remain on the surface of the basins when they empty through percolation of the water. Experience with pilot tests has shown that this sediment forms a crust on the surface because of the presence of algae and other materials. This accumulated sediment and algae reduces the percolation rate, so it must be removed prior to refilling of the basins.

The sediments will be removed by laser fine grading by a scraper to a depth of approximately 0.5 inches just prior to refilling of the basin. The removed material will be loaded into haul trucks by a front-end loader for transport and dumping at the Cadiz agricultural holdings. Emissions during these operations include:

- Scraper exhaust
- Fugitive emissions from the scraper operation
- Front-end loader exhaust
- Fugitive PM_{10} emissions from dumping material into the haul trucks
- Haul truck exhaust, brake and tire wear
- Fugitive PM_{10} emissions from entrained unpaved road dust during haul truck travel
- Fugitive PM_{10} emissions when the material is unloaded from the haul trucks

Watering will used to reduce PM_{10} emissions by an estimated 50 percent of uncontrolled emissions during sediment removal by the scraper. Additionally, the unpaved roads used by the haul trucks will be watered once each hour during truck travel to reduce fugitive PM_{10} emissions by an estimated 73 percent from uncontrolled emissions. The haul trucks will be covered when they transport material, so PM_{10} emissions from loss of material are not anticipated to occur.

The PM_{10} emission reduction resulting from hourly watering of the roads used by the haul trucks was calculated from the following equation provided in Section K of the MDAQMD's *Emission Inventory Guidance, Material Handling and Processing Industries* (2000):

$C_f = 100 - (0.0012 \times A \times D \times T / I)$

where:

C_f	=	Control efficiency (percent)
A	=	Average annual class A pan evaporation (70 inches MDAQMD default value)
D	=	Average hourly vehicle traffic (vehicles/hour)
T	=	Time between water application (hours)
I	=	Water application intensity (0.11 gallons/yd^2 MDAQMD default value)

The sediment hauling activities are anticipated to be conducted over eight eight-hour working days. It is anticipated that a total of 1,158 haul truck round trips will be required, or 290 one-way trips per working day, resulting in 36.25 trips per hour. Therefore, the control efficiency is given by:

100 - (0.0012 x 70 x 36.25 x 1 / 0.11) = 73 percent

It is anticipated that sediment would not be removed from the spreading basins every year, although sediment will be removed from all of the basins prior to spreading operations. A significant increase in PM_{10} emissions from current levels is not anticipated to occur through wind erosion of the spreading basins, because of the formation of the crust on the surface when the basins dry out after emptying. Current operation of the pilot spreading basins has not appeared to result in a noticeable increase in dust generation in the area. The PM_{10} emissions from the Project spreading basins are estimated to be minimal because disturbance will be infrequent and the emissions from the undisturbed Project spreading basins are estimated to be similar to the surrounding undeveloped landscape. Should the crust prove ineffective at controlling the potential for significant wind blown dust emissions from the spreading basins, a soil binder would be applied following water spreading operations.

Wind erosion from the unpaved access roads on the Cadiz Project site are also anticipated to be similar to the existing wind erosion emissions from the surrounding undeveloped, sparsely vegetated landscape. There, the Cadiz Project is anticipated to result in air quality impacts that are below a level of significance related to wind erosion of Project spreading basins and access roads during operations.

Organization of Operational Emissions Attachments

Attachment C-6 contains the following spreadsheets:

- Table 1: Summary of Operational Annual Emissions
- Table 2: Operations Parameters
- Table 3: Spreading Basin Maintenance Equipment Emission Factors
- Table 4: Operational Motor Vehicle Exhaust, Tire and Brake Wear Emission Factors
- Table 5: Operational Fugitive PM_{10} Emission Factors
- Table 6: Operational Maintenance Equipment Exhaust Annual Emissions

- Table 7 Operational Motor Vehicle Exhaust, Tire and Brake Wear Annual Emissions
- Table 8: Operational Fugitive PM_{10} Annual Emissions

References

CARB (2000). EMFAC7G On-Road Motor Vehicle Emission Factor Model, 2/10/2000 version.

Black and Veatch (2000). Personal communications from Randall C. Hill, June.

Black and Veatch (2001). Personal communications from Randall C. Hill, March and April.

MDAQMD (2000). Emission Inventory Guidance, Material Handling and Processing Industries, Mojave Desert Air Quality Management District, Victorville, CA.

SCAQMD (1993). CEQA Air Quality Handbook, South Coast Air Quality Management District, Diamond Bar, CA 91765.

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