Rosemont Copper Company

Emission Inventory Information

Years 1, 5, 10, 15, and 20

Volume I: Calculation Methodology and Appendices A-G

Rosemont Copper Project

Southeastern Arizona

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1. INTRODUCTION

The planned Rosemont Copper Project (RCP) is an open-pit copper mining, milling, leaching, and solvent extraction/electrowinning facility located approximately 30 miles southeast of Tucson, west of State Highway 83, within Pima County in southeastern Arizona. The facility is anticipated to have a project operating life of over 20 years with peak mining rates of up to 376,000 tons per day (tpd) of total material (ore and waste). Projected annual copper production is expected to be approximately 221 million pounds of copper, with by-products of 4.7 million pounds of molybdenum, 2.4 million ounces of silver and smaller quantities of gold.

The RCP has the potential to emit the following regulated air pollutants throughout the life of the mine: (a) total suspended particulate matter (TSP), (b) particulate matter (PM), (c) particulate matter less than 10 microns in aerodynamic diameter (PM_{10}), (d) particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$), (e) carbon monoxide (CO), (f) nitrogen oxides (NO_x), (g) sulfur dioxide (SO_2), (h) volatile organic compounds (VOCs), (i) sulfuric acid (H_2SO_4), (j) sulfate (SO_4), (k) soot (elemental carbon), (l) hazardous air pollutants (HAPs), and (m) greenhouse gases (GHGs) including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

Emissions of potential pollutants are calculated using emission unit process rates, emission factors, and pollution control efficiencies (if applicable). The emission factors are determined using: (a) emission factors and methods from the latest version of the *Compilation of Air Pollutant Emission Factors, Vol. I: Stationary, Point, and Area Sources* (AP-42); (b) emission limitations and standards; (c) material balances; (d) EPA Tanks Program 4.0; (e) Fugitive Dust Emission Factors for the Mining Industry from the American Mining Congress (07/83); (f) emission rates from comparative equipment; (g) manufacturer's information; and (h) EPA modeling programs.

The methodology used to estimate emissions from the emission units at the RCP in Years 1, 5, 10, 15, and 20 in the life of the mine is presented in Sections 2 through 13. Each section contains the emission units pertaining to a general operation at the mine. The calculation of process rates, determination of emission factors, and application of control efficiencies are discussed for each emission unit to fully explain how uncontrolled and controlled potential emissions are calculated.

Detailed information about operations at the RCP is presented in *Rosemont Copper Company, Application for a Class II Permit, Rosemont Copper Project, Southeastern Arizona*. Please refer to this document for all information regarding descriptions of individual processes at the RCP and process flow diagrams.

A summary of maximum hourly, daily, and annual emissions for all emission sources for Years 1, 5, 10, 15, and 20 in the life of the mine are presented in Table 1.1. Table 1.1 includes all non-fugitive and fugitive emission sources at the RCP including emergency equipment, but excluding tailpipe emissions. Hourly, daily, and annual emissions for individual sources in Years 1, 5, 10, 15, and 20 are presented in the emission tables in Appendix H.

Table 1.1 Summary of Total Controlled Emissions at the RCP [a]

Pollutant	Period	Year 1	Year 5	Year 10	Year 15	Year 20
PM/TSP	lb/hr	1,273.17	1,544.97	1,376.67	1,361.96	1,009.35
	tpd	9.66	12.93	10.91	10.73	6.50
	tpy	2,923.53	3,370.34	2,859.10	2,787.85	1,658.96
PM_{10}	lb/hr	443.43	513.41	470.14	464.83	371.71
	tpd	2.79	3.63	3.11	3.05	1.93
	tpy	852.11	961.72	830.18	801.94	495.68
$PM_{2.5}$	lb/hr	54.88	61.98	57.66	56.84	46.64
	tpd	0.45	0.54	0.49	0.48	0.36
	tpy	141.60	152.52	139.39	135.64	101.67
CO	lb/hr	3,516.38	3,516.38	3,516.38	3,516.38	3,516.38
	tpd	2.13	2.13	2.13	2.13	2.13
	tpy	644.83	615.22	611.73	447.98	184.94

Table 1.1 Summary of Total Controlled Emissions at the RCP [a]

Pollutant	Period	Year 1	Year 5	Year 10	Year 15	Year 20
NO_x	lb/hr	936.57	936.57	936.57	936.57	936.57
	tpd	1.07	1.07	1.07	1.07	1.07
	tpy	178.09	170.58	169.69	128.14	61.40
SO_2	lb/hr	104.07	104.07	104.07	104.07	104.07
	tpd	0.05	0.05	0.05	0.05	0.05
	tpy	19.04	18.15	18.05	13.16	5.31
VOCs	lb/hr	4.48	4.48	4.48	4.48	4.48
	tpd	0.05	0.05	0.05	0.05	0.05
	tpy	5.28	5.28	5.28	5.28	5.28
H_2SO_4	lb/hr	0.004	0.004	0.004	0.004	0.004
	tpd	0.00005	0.00005	0.00005	0.00005	0.00005
	tpy	0.02	0.02	0.02	0.02	0.02

Table 1.1 Summary of Total Controlled Emissions at the RCP [a]

Pollutant	Period	Year 1	Year 5	Year 10	Year 15	Year 20
CO_2	lb/hr	36,818.92	36,818.92	36,818.92	36,818.92	36,818.92
	tpd	103.09	103.09	103.09	103.09	103.09
	tpy	11,415.81	11,165.44	11,135.98	9,751.58	7,527.70
CH_4	lb/hr	1.49	1.49	1.49	1.49	1.49
	tpd	0.004	0.004	0.004	0.004	0.004
	tpy	0.46	0.45	0.45	0.40	0.31
N_2O	lb/hr	0.30	0.30	0.30	0.30	0.30
	tpd	0.0008	0.0008	0.0008	0.0008	0.0008
	tpy	0.09	0.09	0.09	0.08	0.06
HAPs	lb/hr	0.84	0.84	0.84	0.84	0.84
	tpd	0.01	0.01	0.01	0.01	0.01
	tpy	3.37	3.37	3.37	3.37	3.37

[a] Emission totals do not include tailpipe emissions.

2. MINING

2.1 Drilling (Unit ID: MN01)

Process Rate

The annual, maximum daily, and hourly process rates for drilling blasting holes are calculated based on the number of blasts that are performed either annually, daily, and hourly (see Section 2.2) and a drilling rate of 80 holes/blast (see Appendix A).

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from drilling are calculated using the emission factor of 1.3 lb/hole, from AP-42, Table 11.9-4 (10/98) for total suspended particulates (TSP) from drilling of overburden at western surface coal mines. The TSP emission factor is assumed to be applicable for PM. PM_{10} and $PM_{2.5}$ emissions from drilling are not listed in Table 11.9-4. PM_{10} emissions are assumed equal to 33% of PM emissions based on the ratio of PM_{10} to PM emissions for tertiary crushing of high moisture ore in AP-42, Table 11.24-2 (08/82).

$PM_{2.5}$ emissions are estimated to be 18.5% of PM_{10} emissions based on the ratio of $PM_{2.5}$ to PM_{10} controlled emissions for tertiary crushing in AP-42, Table 11.19.2-2 (08/04). This is a higher than actual value because pollution control devices have a lower efficiency for smaller size particulates.

Control Efficiency

Potential fugitive particulate emissions from drilling may be controlled by the addition of water and by shrouds on an as needed basis in order to inhibit the escape of particulate emissions from the top of the hole during the drilling process. However, when calculating worst case potential emissions from drilling, no emission controls are applied.

2.2 Blasting (Unit ID: MN02)

Process Rate

The RCP is capable of performing 365 blasts/year. However, the actual annual process rates for blasting at the RCP will vary from year to year depending on mining needs. The annual quantity of blasts per year anticipated at the RCP is determined by the mine plan of operations and is presented in Appendix A. The maximum daily process rate for blasting during any year in the life of the mine is assumed to be 1 blast per day, the maximum amount of blasts that are possible in one day at the RCP. The hourly process rate is equal to 1 blast per hour, the maximum blasts possible by the RCP in one hour.

The annual process rate for the amount of ANFO used for blasting is calculated by employing the ANFO usage rate for Rosemont, 0.65 tons of ANFO/drill hole, and multiplying it by the amount of holes drilled/year. The maximum daily and hourly process rates are calculated similarly based on the maximum daily and hourly drilling rates (see Section 2.1).

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from blasting are calculated using the emission factor expression from AP-42, Table 11.9-1 (10/98) for blasting at western surface coal mines (Equation 1):

$$EF = (k)(0.000014)(A)^{1.5} \qquad (1)$$

where:

EF = emission factor (lb/blast)

k = scaling factor (1 for TSP, assumed to be equivalent to PM, 0.52 for PM_{10}, 0.03 for $PM_{2.5}$)

A = horizontal area of the blast (ft^2; 81,920 maximum, calculated by multiplying the average amount of holes drilled per blast (80 holes) by the approximate spacing (32 ft) and burden (32 ft) of the drilling pattern)

Uncontrolled CO, NO_x, and SO_2 emissions from blasting are calculated using the emission factors from AP-42, Table 13.3-1 (02/80) for the detonation of ANFO.

Uncontrolled CO_2, CH_4, and N_2O emissions are calculated using the emission factors of 73.96 kg/MMBtu, $3*10^{-3}$ kg/MMBtu, and $6*10^{-4}$ kg/MMBtu, respectively, from 40 CFR 98, Tables C-1 and C-2 for distillate fuel oil No. 2. A diesel fuel oil to ammonium nitrate ratio of 9% and a diesel heating value of 19,300 Btu/pound of diesel fuel were used to express the CO_2, CH_4, and N_2O emission factors in terms of lb/ton of ANFO.

The gaseous emission factors for blasting are presented in Table 2.1.

Table 2.1 Gaseous Emission Factors for Blasting

Regulated Pollutant	Emission Factor (lb/tons of ANFO)
CO	67.00
NO_x	17.00
SO_2	2.00
CO_2	566
CH_4	0.02
N_2O	0.005

Control Efficiency

Besides good operating practices, other pollution control methods cannot be implemented during blasting.

2.3 Loading Concentrate Ore, Leach Ore, and Waste Rock (Unit IDs: MN03, MN04, and MN05)

Process Rate

The annual process rates for loading concentrate ore, leach ore, and waste rock into haul trucks are equal to the annual ore and waste rock mining rates at the RCP. The mining rates (see Appendix A) are based on geologic and pit development studies completed at the RCP and presented in the mine plan of operations. The maximum daily process rates for loading ore and waste rock in Years 5, 10, 15, and 20 in the life of the mine are calculated by dividing the annual loading rates by 365, the quantity of days per year when mining will be performed, and adding a 20% maximum capacity factor. The hourly process rates for loading ore and waste rock are calculated by dividing the maximum daily loading rates by 24 hours/day.

In Year 1 of the life of the mine, the operations at the RCP are not at full capacity, as the mine is still in the developmental stages. Therefore, the RCP does not anticipate the maximum daily and hourly process rates for loading the ore and waste rock to be greater than the average rates (i.e. no added maximum capacity factor). Consequently, the maximum daily process rate for loading ore and waste rock in Year 1 is calculated by dividing the annual loading rates by 365, the quantity of days in Year 1 when mining will be performed. The hourly process rate for loading ore and waste rock in Year 1 is calculated by dividing the maximum daily loading rate by 24 hours/day.

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from loading concentrate ore, leach ore, and waste rock into haul trucks are calculated using the emission factor expression from AP-42, Section 13.2.4.3 (11/06) for aggregate drop processes. This expression (Equation 2) is:

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

where:

EF	=	emission factor (lb/ton)
k	=	particle size multiplier (0.74 for PM_{30} assumed to be equivalent to PM, 0.35 for PM_{10}, 0.053 for $PM_{2.5}$)

U = mean wind speed (The mean wind speed at the Rosemont site is 6.21 mph, the average value calculated from hourly data collected at the meteorological station at the RCP from April 2006 through May 2009. The effective wind speed within the pit will be reduced by a conservative estimate of 33%, or an average of 4.14 mph)

M = material moisture content (4% for concentrate ore, leach ore, and waste rock from the mine as determined by the mine plan of operations)

Control Efficiency

Besides good operating practices, other pollution control methods are not implemented during concentrate ore, leach ore, and waste rock loading.

2.4 Hauling Concentrate Ore, Leach Ore, and Waste Rock (Unit IDs: MN06, MN07, and MN08)

Process Rate

The annual, daily, and hourly process rates for the amount of vehicle miles traveled (VMT) by the haul trucks in order to haul concentrate ore to the primary crusher/run of mine stockpile, leach ore to the leach pad, and waste rock to the waste rock storage area are calculated by multiplying the distance traveled (i.e. the distance from the mining location in the pit to the primary crusher dump hopper/run of mine stockpile, leach pad, or waste rock storage area) by the amount of truckloads needed to haul the material. The number of truckloads is determined by dividing the anticipated annual, daily, or hourly amount of material mined (see Section 2.3) by the average haul truck load (250 tons) and multiplying this number by two to account for the haul trucks returning empty to the mining location. The distances traveled by the haul trucks in order to haul the concentrate ore to the primary crusher/run of mine stockpile, leach ore to the leach pad, and waste rock to the waste rock storage area are determined by the mine plan of operations and presented in Appendix A.

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions resulting from the use of haul trucks on unpaved roads at the RCP are calculated from the emission factor expression (Equation 3a) in AP-42, Section 13.2.2 (11/06):

$$EF = (k)\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b} \quad (3a)$$

where:

EF = emission factor (lb/VMT)

k = particle size multiplier (4.9 lb/VMT for PM_{30}, assumed to be equivalent to total suspended particulate matter and PM, 1.5 lb/VMT for PM_{10}, 0.15 lb/VMT for $PM_{2.5}$)

a = constant (0.7 for PM, 0.9 for PM_{10} and $PM_{2.5}$)

b = constant (0.45 for PM, PM_{10}, and $PM_{2.5}$)

s = surface material silt content (5.0%, a value consistent with recently permitted copper mines)

W = mean vehicle weight (305 tons, calculated by averaging the empty weight of the haul trucks (180 tons) and the loaded weight of the haul trucks (430 tons))

The emission factor for annual emissions is modified by the following precipitation factor to account for days when the roads are wet, and emissions are reduced:

$$EF_{annual} = (EF)\left(\frac{365 - p}{365}\right) \quad (3b)$$

where:

EF_{annual} = emission factor used to estimate annual emissions of particulate matter (lb/VMT)

EF = emission factor used to estimate hourly and daily emissions of particulate matter (lb/VMT, calculated by Equation 3a)

p = number of days per year with greater than 0.01 inch of precipitation (61 days/year, average data from 1950 – 2008 from the Western Region Climate Center, Santa Rita Experimental Range weather station located 8 miles southwest of the RCP at 4,300 feet above mean sea level)

Control Efficiency

Emissions of particulate matter resulting from haul truck traffic on haul roads at the RCP will be controlled by the application of water to the road surface. Based on the EPA document, “Control of Open Fugitive Dust Sources” from September 1988, sufficient watering of unpaved roads can result in a control efficiency up to 95%. At the RCP, the roads will be watered sufficiently to achieve a 90% control efficiency.

2.5 Unloading Concentrate Ore to Run of Mine Stockpile, Leach Ore to Leach Pad, and Waste Rock to Waste Rock Storage Area (Unit IDs: MN09, MN10, and MN11)

Process Rate

The annual, maximum daily, and hourly process rates for unloading leach ore to the leach pad and waste rock to the waste rock storage area are equal to the leach ore and waste rock loading rates (see Section 2.3).

The annual process rates for unloading concentrate ore to the run of mine stockpile are estimated to be 10% of the annual concentrate ore loading rate (see Section 2.3), as it is estimated that a worst case quantity of 10% of the mined concentrate ore will need to be stockpiled prior to primary crushing due to short-term operating disruptions in the crushing and conveying system. The remainder of the concentrate ore will be unloaded directly to the primary crusher dump hopper (see Section 3.2). The maximum daily and hourly process rates are equal to the maximum daily and hourly concentrate ore loading rates (see Section 2.3). This assumes that on a given day or hour, the primary crushing and conveying operations are inoperable and all the mined concentrate ore will be stockpiled.

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from unloading leach ore to the leach pad, concentrate ore to the run of mine stockpile, and waste rock to the storage area are calculated using Equation 2. The material moisture content (M, 4%) is equal to the value used to calculate the emission factor in Section 2.3. An explanation for how this value is determined is presented in Section 2.3. The mean wind speed (6.21 mph) is determined from hourly data collected at the meteorological station at the RCP from April 2006 through May 2009. Since the unloading process at the RCP is unprotected from the wind, the unaltered wind speed is used in the emission factor equation presented in Equation 2.

Control Efficiency

Besides good operating practices, other pollution control methods are not implemented while unloading concentrate ore to the run of mine stockpile, leach ore to the leach pad, and waste rock to the waste rock storage area.

2.6 Bulldozer Use (Unit ID: MN12)

Process Rate

The annual process rates for bulldozer use are calculated by summing the annual amount of hours each type of bulldozer will be used, as determined by mine plan of operations (see Appendix A). The maximum daily process rates are calculated by dividing the annual hours by 365, the quantity of days per year the bulldozers will be used. The hourly process rates are calculated by dividing the maximum daily process rates by 24 hours/day.

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from bulldozing operations are calculated from the emission factor expression in AP-42, Table 11.9-1 (10/98) for the bulldozing of overburden at western surface coal mines. This expression (Equation 4) is:

$$EF = (k)\left(\frac{s^a}{M^b}\right) \qquad (4)$$

where:

EF	=	emission factor (lb/hr)
k	=	particle size multiplier (5.7 for TSP assumed to be equivalent to PM, 0.75 for PM_{10}, 0.60 for $PM_{2.5}$ (5.7*0.105))
s	=	material silt content (Bulldozing operations represent processing primarily of waste rock and ore with a bulldozer. The silt content of these materials is uncertain. AP-42, Table 13.2.4-1 (11/06) provides the silt content of various materials. The silt content of sand in this table is 2.6%. Therefore, as a worst case scenario, a value of 2.5% was assumed for the silt content of the material processed by bulldozers.)
M	=	material moisture content (4% for concentrate ore, leach ore, and waste rock from the mine as determined by the mine plan of operations)
a	=	constant (1.2 for PM and $PM_{2.5}$, 1.5 for PM_{10})
b	=	constant (1.3 for PM and $PM_{2.5}$, 1.4 for PM_{10})

Control Efficiency

Besides good operating practices, other pollution control methods are not implemented during bulldozer use.

2.7 Water Truck Use (Unit ID: MN13)

Process Rate

The annual process rates for water truck use are calculated by multiplying the hours of operation of the water trucks, as determined by the mine plan of operations (see Appendix A), by the average speed the water trucks will be traveling (11 mph). The maximum daily amounts of VMT are calculated by dividing the annual VMT by 365, the quantity of days per year water trucks will be used and adding a 20% maximum capacity factor (except for Year 1 when average mining rates are not expected to be exceeded and no maximum capacity factor is added). The hourly process rates are calculated by dividing the maximum daily water truck use rates by 24 hours/day.

The process rates for water truck use is directly dependent on the ore and waste rock mining and hauling rates (i.e. the water trucks suppress the fugitive emissions from the haul trucks traveling on the haul roads). Therefore, an equivalent maximum capacity factor (20% for Years 5, 10, 15, and 20 and 0% for Year 1) is added to the daily and hourly water truck usage rates to reflect increased usage during maximum daily and hourly mining and hauling.

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions resulting from the use of water trucks on unpaved roads at the RCP are calculated using Equations 3a and 3b. The surface material silt content (s, 5.0%) and number of days per year with greater than 0.01 inches precipitation (p, 61 days/year) are equal to the values used to calculate the emission factor in Section 2.4. Explanations for how these values are determined are presented in Section 2.4.

The mean vehicle weight (W, 187.4 tons) is calculated by averaging the empty (125 tons) and loaded weights (249.8 tons) of the water trucks.

Control Efficiency

Emissions of particulate matter resulting from water truck use on haul roads at the RCP will be controlled by the application of water to the road surface. Based on the EPA document, “Control of Open Fugitive Dust Sources” from September 1988, sufficient watering of unpaved roads can result in a control efficiency up to 95%. At the RCP, the roads will be watered sufficiently to achieve a 90% control efficiency for vehicles traveling on the unpaved roads.

2.8 Grader Use (Unit ID: MN14)

Process Rate

The annual process rates for grader use are calculated by summing the annual amounts of VMT for each type of grader. The VMT are calculated by multiplying the hours of operation of each grader, as determine by the mine plan of operations (see Appendix A) by the average speed the graders will be traveling (5.3 mph and 4.6 mph for the two types of graders). The maximum daily amounts of VMT by the graders are calculated by dividing the annual VMT by 365, the quantity of days per year graders will be used. The hourly process rates are calculated by dividing the daily grader usage rates by 24 hours/day.

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from grader use are calculated from the emission factor expression in AP-42, Table 11.9-1 (10/98) for grading at western surface coal mines. This expression (Equation 5) is:

$$EF = (k)(a)(S)^b \qquad (5)$$

where:

EF = emission factor (lb/VMT)

k = particle size multiplier (1 for TSP assumed to be equivalent to PM, 0.60 for PM_{10}, 0.031 for $PM_{2.5}$)

S = mean vehicle speed (7.83 mph, 4.78 mph, 4.83 mph, 4.83 mph, and 4.95 mph for Years 1, 5, 10, 15, and 20 in the life of the mine, respectively, weighted average value calculated from the hours of operation and average speed of each type of grader (5.3 mph and 4.6 mph))

a = constant (0.040 for PM, 0.051 for PM_{10}, 0.040 for $PM_{2.5}$)

b = constant (2.5 for PM, 2.0 for PM_{10}, 2.5 for $PM_{2.5}$)

Control Efficiency

Besides good operating practices, other pollution control methods are not implemented during grader use.

2.9 Support Vehicle Use (Unit ID: MN15)

Process Rate

The annual, maximum daily, and hourly process rates for support vehicle use on the unpaved roads are calculated by summing the annual, maximum daily, and hourly amount of VMT for each type of support vehicle.

Except for the drills and shipment and delivery vehicles, the annual amount of VMT for each type of support vehicle is based on usage determinations, which are anticipated to be consistent throughout the life of the mine. The maximum daily amount of VMT for each support vehicle is determined by dividing the annual VMT by 365, the quantity of days per year the support vehicle will be used. The hourly process rate is determined by dividing the maximum daily support vehicle use rate by 24 hours/day.

For the drills, the annual, maximum daily, and hourly amounts of VMT is determined by the distance traveled to prepare for a blast and the maximum number of blasts per year, day, or hour (see Section 2.2).

For the shipment and delivery trucks, the annual, maximum daily, and hourly amounts of VMT are calculated by multiplying the amount of shipments and deliveries in any given year, day, or hour by the distance the shipment and delivery trucks have to travel within the RCP property boundaries (estimated at 7.4 VMT per shipment or delivery).

The annual amount of shipments and deliveries are calculated by dividing the quantity of the material being shipped or delivered by the capacity of the shipment or delivery truck. The quantities of material being shipped are assumed to be equal throughout the life of the mine except for the copper and molybdenum concentrate and copper cathodes produced. The daily amounts of shipments and deliveries are calculated by dividing the annual shipments and deliveries by 365 days/year (or 260 days/year if shipments or deliveries only occur during weekdays). Additionally, several daily amounts of shipments and deliveries and the hourly amounts of shipments and deliveries are based on the maximum amount of shipments or deliveries the RCP can accommodate in any one day or hour for each material.

The annual, maximum daily, and hourly VMT process rates, the support vehicle fleet size, and the support vehicle weight are presented in Tables B.1 through B.5 in Appendix B for Years 1, 5, 10, 15, and 20 in the life of the mine, respectively.

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions resulting from the use of support vehicles on unpaved roads at the RCP are calculated using Equations 3a and 3b. The surface material silt content (s, 5.0%) and number of days per year with greater than 0.01 inch of precipitation (p, 61 days/year) are equal to the values used to calculate the emission factor in Section 2.4. Explanations for how these values are determined are presented in Section 2.4.

The mean vehicle weight (W, tons) is the weighted average value for all of the support vehicles that will be used at the RCP, based upon the total vehicle miles traveled for each vehicle. Since equal scaling does not occur for all vehicles in the calculation of annual, maximum daily, and hourly vehicle miles traveled, the mean vehicle weight will vary for these time periods. The mean vehicle weight values for Years 1, 5, 10, 15, and 20 are presented in Tables B.1 through B.5 in Appendix B.

Control Efficiency

Emissions of particulate matter resulting from support vehicle use on haul roads at the RCP will be controlled by the application of water to the road surface. Based on the EPA document, "Control of Open Fugitive Dust Sources" from September 1988, sufficient watering of unpaved roads can result in a control efficiency up to 95%. At the RCP, the roads will be watered sufficiently to achieve a 90% control efficiency.

3. PRIMARY CRUSHING, CONVEYING, COARSE ORE STORAGE, AND RECLAIM CONVEYING

3.1 Wind Erosion of the Run of Mine Stockpile (Unit ID: PC01)

<u>Process Rate</u>

The annual, daily, and hourly process rates for wind erosion of the run of mine stockpile are equal to the maximum area of the land containing the stockpile (26 acres) and continuous operation of the stockpile (i.e. 8,760 hours/year, 24 hours/day, 1 hour/hour).

<u>Emission Factor</u>

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions due to wind erosion of the run of mine stockpile are determined using the following MRI (1978b) equation from the American Mining Congress Report, Fugitive Dust Emission Factors for the Mining Industry (FDEMI) (07/83), Section 3.7:

$$EF = 3400\,(k)\frac{\left(\frac{e}{50}\right)\left(\frac{s}{15}\right)\left(\frac{f}{25}\right)}{\left(\frac{PE}{50}\right)^2}\left(\frac{1}{2000}\right) \qquad (6)$$

where:

EF = emission factor (tons/acre-year)

k = particle size multiplier (1 for PM, 0.5 for PM_{10}, 0.075 for $PM_{2.5}$ from AP-42, Section 13.2.5, Industrial Wind Erosion (11/06), page 3)

e = surface erodibility (tons/acre-year, 38 for concentrate ore, from page 52 of FDEMI)

s = silt content of surface material (The silt content of the concentrate ore is uncertain. AP-42, Table 13.2.4-1 (11/06) provides the silt content of various materials. The silt content of sand in this table is 2.6%. Therefore, as a worst case scenario, a value of 2.5% was assumed for the silt content of the concentrate ore in the run of mine stockpile.)

f = percentage of time the wind speed exceeds 12 mph (4.77%, value calculated from hourly data collected at the meteorological station at the RCP from April 2006 through May 2009)

PE = Thornthwaite's Precipitation-Evaporation Index (22 for the RCP, determined from Figure 14 of FDEMI)

The universal soil loss (USL) equation also presented in Section 3.7 of the FDEMI is modified to Equation 6 for use with fugitive dust sources at mines. It is analogous to the USL equation but eliminates all factors for agricultural crops.

Control Efficiency

Besides good operating practices, other pollution control methods are not used to control emissions from the run of mine stockpile.

3.2 Unloading to Primary Crusher Dump Hopper from Haul Trucks and the Run of Mine Stockpile (Unit ID: PC02)

Process Rate

The annual process rates for unloading concentrate ore to the primary crusher dump hopper are based on the concentrate ore mining rates (see Appendix A). The hourly and maximum daily process rates are based on the maximum capacity of the equipment in the primary crushing plant (6,950 tons/hour) and continuous operation (6,950 tons/hour * 24 hours/day = 166,800 tpd).

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from unloading concentrate ore to the primary crusher dump hopper are calculated using Equation 2. The mean wind speed (U, 6.21 mph) and material moisture content (M, 4%) are equal to the values used to calculate the emission factors in Sections 2.5 and 2.3, respectively. Explanations for how these values are determined are presented in Sections 2.5 and 2.3.

Control Efficiency

Emissions of particulate matter resulting from unloading concentrate ore to the primary crusher will be controlled by water sprays. Based on the AP-42, Section 11.19.1, spray systems at transfer points and material handling operations are estimated to reduce emissions 70 to 95 percent. For unprotected transfer points, such as loading the concentrate ore to the dump hopper, the RCP estimates a mean control efficiency value of 82.5% will be able to be achieved with the use of water sprays.

3.3 Primary Crusher (Unit ID: PC03)

Process Rate

The annual process rate for the primary crusher is based on the maximum capacity of the concentrate ore processing equipment as limited on an annual basis by the filter system designed to remove water from the molybdenum concentrate, copper concentrate, and tailings (4,950 tons/hour) and continuous operation (4,950 tons/hour * 8,760 hour/year = 43,362,000 tons/year). The hourly and maximum daily process rates are based on the maximum capacity of the equipment in the primary crushing plant (6,950 tons/hour) and continuous operation (6,950 tons/hour * 24 hours/day = 166,800 tpd).

Emission Factor

Uncontrolled PM and PM_{10} emissions from primary crushing are calculated using the emission factors of 0.02 lb/ton and 0.009 lb/ton, respectively, from AP-42, Table 11.24-2 (08/82) for primary crushing of high moisture ore. The moisture content of the concentrate ore at the RCP is estimated to be 4%, which according to AP-42, Section 11.24.2 classifies the ore as high moisture. Uncontrolled $PM_{2.5}$ emissions are estimated to be 18.5% of PM_{10} emissions based on the ratio of $PM_{2.5}$ to PM_{10} controlled emissions for tertiary crushing in AP-42, Table 11.19.2-2 (08/04). This is a higher than actual value because pollution control devices have a lower efficiency for smaller size particulates.

Control Efficiency

Emissions of particulate matter resulting from primary crushing are controlled indirectly by the crushing area scrubber system. The primary crusher is designed in a conical shape such that crushing and particulate matter generation occurs near the bottom of the crusher and is emitted through the exit of the crusher. This point is controlled by the crushing area scrubber system (see Section 3.4). The scrubber system has a 100% capture efficiency and picks up and delivers the particulate matter entrained air to the scrubber for processing. Emission calculations for the scrubber system are presented in Section 10.

3.4 Material Transfers from the Primary Crusher to the Coarse Ore Stockpile and from the Coarse Ore Stockpile to the SAG Mill Feed Conveyor (Unit IDs: PC04 through PC08 and PC10 through PC12)

Process Rate

The annual process rates for the material transfers from the primary crusher to the coarse ore stockpile and from the coarse ore stockpile to the SAG mill feed conveyor are equal to the annual process rates for the primary crusher (see Section 3.3). The hourly and maximum daily process rates are based on the maximum capacity of the equipment in the primary crushing plant (6,950 tons/hour) and continuous operation (6,950 tons/hour * 24 hours/day = 166,800 tpd).

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from the material transfers from the primary crusher to the coarse ore stockpile and from the coarse ore stockpile to the SAG mill feed conveyor are calculated using Equation 2. The material moisture content (M, 4%) is equal to the value used to calculate the emission factor in Section 2.3. The explanation for how this value is determined is presented in Section 2.3.

The mean wind speed value (U) used in Equation 2 is determined from the anticipated speed of the wind at the material transfer points from the primary crusher to the coarse ore stockpile and from the coarse ore stockpile to the SAG mill feed conveyor. The wind speeds at the transfer points are considered to be 1.3 mph. A 1.3 mph wind speed, the lowest wind speed input for Equation 2 to remain valid, is used for the material transfer points where the point of transfer is constructed to be fully protected and shielded from the wind (e.g. chutes, covers, enclosures, etc.). At the material transfer points from the primary crusher to the coarse ore stockpile and from the coarse ore stockpile to the SAG mill feed conveyor, chutes and covers are used to facilitate material transfer and minimize the speed of the wind at the material transfer points.

Control Efficiency

Emissions of particulate matter resulting from the material transfers from the primary crusher to the coarse ore stockpile and from the coarse ore stockpile to the SAG mill feed conveyor are controlled by either being in an enclosed area, underground, or collected by scrubber systems. When process material is transferred to an enclosed piece of equipment or the equipment is located underground, particulate emissions are controlled due to the emissions not being able to escape and a 100% control efficiency is assumed. Since this control is inherent to the process, the control efficiency is applied during both uncontrolled and controlled emission calculations. The scrubber systems used at the material transfer points have a 100% capture efficiency and pick up and deliver the particulate matter entrained air to the scrubbers for processing. The particulate matter control method used at each material transfer point from the primary crusher to the coarse ore stockpile and from the coarse ore stockpile to the SAG mill feed conveyor is presented in Table 3.1. Emission calculations for the scrubber systems are presented in Section 10.

Several of the material transfer points from the primary crusher to the coarse ore stockpile and from the coarse ore stockpile to the SAG mill feed conveyor also have water spray control for fugitive particulate emissions not captured by the scrubbers (see Figure B.2 in Appendix B of *Rosemont Copper Company, Application for a Class II Permit, Rosemont Copper Project, Southeastern Arizona*). Furthermore, the material transfer point from the stockpile feed conveyor to the stockpile tripper conveyor is located inside the stockpile building in addition to being controlled by the stockpile area scrubber. However, emission calculations are based on 100% capture efficiency of the scrubber systems and do not incorporate the control efficiency of the water sprays or the enclosure within a building.

Table 3.1 Wind Speeds and Control Methods for the Material Transfers from the Primary Crusher to the Coarse Ore Stockpile and from the Coarse Ore Stockpile to the SAG Mill Feed Conveyor

Unit ID	Unit Description	Wind Speed	Control Method
PC04	Primary Crusher (PCr) to Crusher Discharge Hopper (H-CDs)	1.3 mph	Enclosed
PC05	Crusher Discharge Hopper (H-CDs) to Crusher Discharge Feeder (F-CD)	1.3 mph	Crushing Area Scrubber (PC-CAS) [a]
PC06	Crusher Discharge Feeder (F-CD) to Stockpile Feed Conveyor (CV-SF)	1.3 mph	Crushing Area Scrubber (PC-CAS) [a]
PC07	Stockpile Feed Conveyor (CV-SF) to Stockpile Tripper Conveyor (CV-ST)	1.3 mph	Stockpile Area Scrubber (PC-SAS) [a,b]
PC08	Stockpile Tripper Conveyor (CV-ST) to Covered Coarse Ore Stockpile	1.3 mph	Stockpile Area Scrubber (PC-SAS) [b]
PC10	Coarse Ore Stockpile to Reclaim Feeders (F-R1/R4)	1.3 mph	Underground
PC11	Reclaim Feeders (F-R1/R4) to Reclaim Conveyor (CV-R)	1.3 mph	Reclaim Tunnel Scrubber (PC-RTS)
PC12	Reclaim Conveyor (CV-R) to SAG Mill Feed Conveyor (CV-SMF)	1.3 mph	Pebble Crusher Area Scrubber (PC-PCAS) [a]

[a] These emission units have water spray control for fugitive particulate emissions not captured by the scrubbers. Emission calculations are based on 100% capture efficiency of the scrubbers.

[b] These emission units are located within the coarse ore stockpile building in addition to being controlled by the scrubbers. Emission calculations are based on 100% capture efficiency of the scrubbers.

The stockpile area scrubber system controls particulate emissions within the stockpile building. Since the material transfer point from the stockpile tripper conveyor to the coarse ore stockpile occurs within the stockpile building, the particulate matter emissions resulting from the transfer are indirectly controlled by the stockpile area scrubber system.

3.5 Wind Erosion of the Coarse Ore Stockpile (Unit ID: PC09)

Process Rate

The annual, daily, and hourly process rates for wind erosion of the coarse ore stockpile are equal to the surface area of the stockpile building (5 acres) and continuous operation of the stockpile (i.e. 8,760 hours/year, 24 hours/day, 1 hour/hour).

Emission Factor

Due to the coarse ore stockpile being enclosed within the stockpile building, the PM, PM_{10}, and $PM_{2.5}$ emissions from wind erosion of the coarse ore stockpile are negligible. Therefore, a 0 ton/acre-year emission factor is assumed for PM, PM_{10}, and $PM_{2.5}$.

Control Efficiency

Particulate matter emissions in the stockpile building are controlled by the stockpile area scrubber system. The scrubber system picks up and delivers the particulate matter entrained air from the stockpile building to the scrubber for processing. Emission calculations for the scrubber system are presented in Section 10.

3.6 Material Transfers from Pebble Conveyor No. 3 to the SAG Mill Feed Conveyor and from the SAG Mill Feed Conveyor to the SAG Mill (Unit IDs: PC13 and PC14)

Process Rate

The annual process rates for the material transfer from pebble conveyor No. 3 to the SAG mill feed conveyor are equal to the amounts of material processed by the pebble crusher (see Section 4.3). The hourly and maximum daily process rates are based on the maximum hourly amount of ore processed by the pebble crusher (1,771.15 tons/hour) and continuous operation (1,771.15 tons/hour * 24 hours/day = 42,508 tpd).

The annual, maximum daily, and hourly process rate for the material transfer from the SAG mill feed conveyor to the SAG mill is equal to the sum of the process rates of the three conveyors feeing the SAG mill feed conveyor, the reclaim conveyor (see Section 3.4), Pebble Crusher No. 3 (described above), and Bulk Pebble Lime Silo Screw Conveyor (see Section 9.2).

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from pebble conveyor No. 3 to the SAG mill feed conveyor and from the SAG mill feed conveyor to the SAG mill are calculated using Equation 2. The material moisture content (M, 4%) is equal to the value used to calculate the emission factor in Section 2.3. The mean wind speed (U, 1.3 mph for protected transfer points) is equal to the value used to calculate the emission factor in Section 3.4. The explanation for how the material moisture content and mean wind speed are determined is presented in Sections 2.3 and 3.4, respectively.

Control Efficiency

Emissions of particulate matter resulting from the material transfers from pebble conveyor No. 3 to the SAG mill feed conveyor and from the SAG mill feed conveyor to the SAG mill are controlled by the pebble crusher area scrubber system and the addition of process water, respectively. The scrubber system has a 100% capture efficiency and picks up and delivers the particulate matter entrained air to the scrubber for processing. Emission calculations for the scrubber system are presented in Section 10. Additionally, when process material is transferred to a piece of equipment along with the addition of process water, particulate emissions are controlled due to the moisture that has been added and a 100% control efficiency is assumed. Since this control is inherent to the process, the control efficiency is applied during both uncontrolled and controlled emission calculations.

4. MILLING

4.1 SAG Mill (Unit ID: M01)

<u>Process Rate</u>

The annual, daily, and hourly process rates for the SAG mill are equal to the process rates of the material transfers to the SAG mill (see Section 3.6).

<u>Emission Factor</u>

Uncontrolled PM and PM_{10} emissions from the SAG mill are calculated using the emission factors of 0.05 lb/ton and 0.02 lb/ton, respectively, from AP-42, Table 11.24-2 (08/82) for secondary crushing of high moisture ore. The moisture content of the concentrate ore at the RCP is estimated to be 4%, which according to AP-42, Section 11.24.2 classifies the ore as high moisture. Additionally, the SAG mill is a wet process, which increases the moisture content of the ore. Uncontrolled $PM_{2.5}$ emissions are estimated to be 18.5% of PM_{10} emissions based on the ratio of $PM_{2.5}$ to PM_{10} controlled emissions for tertiary crushing in AP-42, Table 11.19.2-2 (08/04). This is a higher than actual value because pollution control devices have a lower efficiency for smaller size particulates.

<u>Control Efficiency</u>

The SAG mill is a wet process where added moisture causes fine particles in the crushed ore to agglomerate such that no potential particulate emissions are formed and a 100% control efficiency is assumed. Since this control is inherent to the process, the control efficiency is applied during both uncontrolled and controlled emission calculations.

4.2 Trommel Screen and Pebble Wash Screen (Unit IDs: M03 and M06)

<u>Process Rate</u>

The annual, daily, and hourly process rates for the trommel screen are equal to the process rates of the material transfer to the SAG mill (see Section 3.6).

The pebble wash screen processes oversize material from the trommel screen. Therefore, the annual process rate for the pebble wash screen is based on the process rates of the trommel screen (see above) and the estimated fraction of oversize material from the trommel screen (21.2%). The hourly and maximum daily process rates are based on the maximum hourly amount of ore processed by the pebble wash screen (1,851.10 tons/hour) and continuous operation (1,851.10 tons/hour * 24 hours/day = 44,426 tpd).

<u>Emission Factor</u>

Uncontrolled PM and PM_{10} emissions from the trommel and pebble wash screens are calculated using the emission factors of 0.025 lb/ton and 0.0087 lb/ton, respectively, from AP-42, Table 11.19.2-2 (08/04) for screening. Uncontrolled $PM_{2.5}$ emissions are estimated to be 6.8% of PM_{10} emissions based on the ratio of $PM_{2.5}$ to PM_{10} controlled emissions for screening in AP-42, Table 11.19.2-2 (08/04). This is a higher than actual value because pollution control devices have a lower efficiency for smaller size particulates.

Control Efficiency

Both the trommel and pebble wash screens are wet processes. Process water sprays at the screens wash away and control all fine particle matter such that no potential particulate emissions are formed and a 100% control efficiency is assumed. Since this control is inherent to the process, the control efficiency is applied during both uncontrolled and controlled emission calculations.

4.3 Pebble Crusher (Unit ID: M11)

Process Rate

The pebble crusher processes oversize material from the pebble wash screen. Therefore, the annual, maximum daily, and hourly process rates for the pebble crusher are based on the process rates of the pebble wash screen (see Section 4.2) and the estimated fraction of oversize material from the pebble wash screen (59.7%). The hourly and maximum daily process rates are based on the maximum hourly amount of ore processed by the pebble crusher (1,771.15 tons/hour) and continuous operation (1,771.15 tons/hour * 24 hours/day = 42,508 tpd).

Emission Factor

Uncontrolled PM and PM_{10} emissions from the pebble crusher are calculated using the emission factors of 0.06 lb/ton and 0.02 lb/ton, respectively, from AP-42, Table 11.24-2 (08/82) for tertiary crushing of high moisture ore. The moisture content of the concentrate ore at the RCP is estimated to be 4%, which according to AP-42, Section 11.24.2 classifies the ore as high moisture. Additionally, the concentrate ore processed by the pebble crusher is previously processed by the SAG mill, a wet process, which increases the moisture content of the ore.

Uncontrolled $PM_{2.5}$ emissions are estimated to be 18.5% of PM_{10} emissions based on the ratio of $PM_{2.5}$ to PM_{10} controlled emissions for tertiary crushing in AP-42, Table 11.19.2-2 (08/04). This is a higher than actual value because pollution control devices have a lower efficiency for smaller size particulates.

Control Efficiency

Emissions of particulate matter resulting from pebble crushing are indirectly controlled by the pebble crusher area scrubber system. The pebble crusher is designed such that crushing and particulate matter generation that occurs within the crusher will be emitted through either the top entrance or bottom exit of the crusher. The bottom exit is controlled by the pebble crusher area scrubber system while the top entrance is enclosed by the pebble crusher feeder (the entrance to the pebble crusher feeder is controlled by the pebble crusher area scrubber). The scrubber system has a 100% capture efficiency and picks up and delivers the particulate matter entrained air to the scrubber for processing. Emission calculations for the scrubber system are presented in Section 10.

4.4 Material Transfers from the SAG Mill to the Trommel Screen, from the Trommel Screen to the Pebble Wash Screen, from the Pebble Wash Screen to the Pebble Crusher, and from the Pebble Crusher to Pebble Conveyor No. 3 (Unit IDs: M02, M04 through M05, M07 through M10, and M12)

Process Rate

The annual, daily, and hourly process rates for the material transfer from the SAG mill to the trommel screen are equal to the process rates of the material transfer to the SAG mill, as described in Section 3.6. The annual, daily, and hourly process rates for the material transfer from the trommel screen to the pebble wash screen are equal to the process rates of the pebble wash screen, as described in Section 4.2. The annual, daily, and hourly process rates for the material transfers from the pebble wash screen to the pebble crusher and from the pebble crusher to pebble conveyor No. 3 are equal to the process rates of the pebble crusher, as described in Section 4.3.

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from the various material transfers during milling are calculated using Equation 2. Although the concentrate ore conveyed is previously processed by the SAG mill, a wet process that increases the moisture content of the ore, the material moisture content (M, 4%) is assumed to equal to the value used to calculate the emission factor in Section 2.3 as a worst case estimate. The mean wind speed (U, 1.3 mph for protected transfer points) is equal to the value used to calculate the emission factor in Section 3.4. The explanation for how the material moisture content and mean wind speed are determined is presented in Sections 2.3 and 3.4, respectively.

Control Efficiency

Emissions of particulate matter resulting from the material transfers during the milling process are controlled by including only clean, wet ore, being in an enclosed system, or collected by the pebble crusher area scrubber system. The wet processes before the material transfer points during milling contain sufficient amount of moisture such that some fine particles agglomerate and all others are washed away. Therefore, at the material transfer points following the wet processes, the ore is considered cleaned and wet and no potential particulate emissions are formed. However, pebble conveyor No. 2 is a long transfer conveyor and the ore has the potential to dry before being discharged into the SAG oversize surge bin. Therefore, the material transfer points after pebble conveyor No. 2 have the potential to emit particulate emissions and are controlled by the pebble crusher area scrubber system. When process material is transferred to an enclosed piece of equipment, particulate emissions are controlled due to the emissions not being able to escape and a 100% control efficiency is assumed. Since this control is inherent to the process, the control efficiency is applied during both uncontrolled and controlled emission calculations. The scrubber system used at the material transfer points has a 100% capture efficiency and picks up and delivers the particulate matter entrained air to the scrubber for processing. Emission calculations for the scrubber system are presented in Section 10. The particulate matter control method used at each material transfer point during milling is presented in Table 4.1.

Table 4.1 Wind Speeds and Control Methods for the Material Transfers from the SAG Mill to the Trommel Screen, from the Trommel Screen to the Pebble Wash Screen, from the Pebble Wash Screen to the Pebble Crusher, and from the Pebble Crusher to Pebble Conveyor No. 3

Unit ID	Unit Description	Wind Speed	Control Method
M02	SAG Mill (M-SAG) to Trommel Screen (Sn-T)	1.3 mph	Enclosed
M04	Trommel Screen (Sn-T) to Pebble Conveyor No. 1 (CV-Pb1)	1.3 mph	Clean, Wet Ore
M05	Pebble Conveyor No. 1 (CV-Pb1) to Pebble Wash Screen (Sn-PbW)	1.3 mph	Clean, Wet Ore
M07	Pebble Wash Screen (Sn-PbW) to Pebble Conveyor No. 2	1.3 mph	Clean, Wet Ore
M08	Pebble Conveyor No. 2 (CV-Pb2) to SAG Oversize Surge Bin (B-SAGOS)	1.3 mph	Pebble Crusher Area Scrubber (PC-PCAS)
M09	SAG Oversize Surge Bin (B-SAGOS) to Pebble Crusher Feeder (F-PbC)	1.3 mph	Pebble Crusher Area Scrubber (PC-PCAS)
M10	Pebble Crusher Feeder (F-PbC) to Pebble Crusher (PbC)	1.3 mph	Enclosed
M12	Pebble Crusher (PbC) to Pebble Conveyor No. 3 (CV-Pb3)	1.3 mph	Pebble Crusher Area Scrubber (PC-PCAS)

5. COPPER CONCENTRATE DEWATERING AND STACKING

5.1 Material Transfers from Copper Concentrate Filters to Copper Concentrate Loadout Stockpile and from the Copper Concentrate Loadout Stockpile to Shipment Trucks via Front End Loader (Unit IDs: CCD01 through CCD02 and CCD04)

Process Rate

The annual process rates for the material transfers from the copper concentrate filters to the copper concentrate loadout stockpile and from the copper concentrate loadout stockpile to the copper concentrate shipment trucks via front end loaders are based on the annual process rate for the primary crusher (see Section 3.5) and the fraction of the concentrate ore that is copper concentrate (1.27%). The hourly and maximum daily process rates are based on the maximum hourly quantity of copper concentrate produced (138 tons/hour) and continuous operation (138 tons/hour * 24 hours/day = 3,312 tpd).

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from the material transfers from the copper concentrate filters to the copper concentrate loadout stockpile and from the copper concentrate loadout stockpile to the copper concentrate shipment trucks are calculated using Equation 2. The filters are designed to remove 90% of the water from the copper concentrate such that a 10% material moisture content is used in Equation 2. The mean wind speed (U, 1.3 mph for protected transfer points) is equal to the value used to calculate the emission factors in Section 3.4. The explanation for how the mean wind speed is determined is presented in Section 3.4. The mean wind speed value of 1.3 mph applies for the material transfers from the copper concentrate filters to the copper concentrate loadout stockpile and from the copper concentrate loadout stockpile to the copper concentrate shipment trucks due to the transfer points either being enclosed or located inside a building.

Control Efficiency

Emissions of particulate matter resulting from the material transfers from the copper concentrate filters to the copper concentrate loadout stockpile and from the copper concentrate loadout stockpile to the copper concentrate shipment trucks are controlled by either being in an enclosed system or indirectly collected by the copper concentrate scrubber systems. When process material is transferred to an enclosed piece of equipment, particulate emissions are controlled due to the emissions not being able to escape and a 100% control efficiency is assumed. Since this control is inherent to the process, the control efficiency is applied during both uncontrolled and controlled emission calculations. The scrubber systems used at the material transfer points have a 100% capture efficiency and pick up and deliver the particulate matter entrained air to the scrubbers for processing. Emission calculations for the scrubber systems are presented in Section 10. The particulate matter control method used at each material transfer point from the copper concentrate filters to the copper concentrate loadout stockpile and from the copper concentrate loadout stockpile to the copper concentrate shipment trucks is presented in Table 5.1.

Table 5.1 Wind Speeds and Control Methods for the Material Transfers from the Copper Concentrate Filters to the Copper Concentrate Loadout Stockpile and from the Copper Concentrate Loadout Stockpile to the Copper Concentrate Shipment Trucks

Unit ID	Unit Description	Wind Speed	Control Method
CCD01	Copper Concentrate Filters (Ft-CC1/CC4) to Copper Concentrate Conveyor (CV-CC)	1.3 mph	Enclosed
CCD02	Copper Concentrate Conveyor (CV-CC) to Copper Concentrate Loadout Stockpile	1.3 mph	Copper Concentrate Scrubbers (PC-CCS1/PC-CCS2)
CCD04	Copper Concentrate Loadout Stockpile to Shipment Trucks via Front End Loaders	1.3 mph	Copper Concentrate Scrubbers (PC-CCS1/PC-CCS2)

The copper concentrate scrubber systems control particulate emissions within the copper concentrate loadout building. Since the material transfer points from the copper concentrate conveyor to the copper concentrate loadout stockpile and from the copper concentrate loadout stockpile to the copper concentrate shipment trucks occur within the copper concentrate loadout building, the particulate matter emissions resulting from the transfer are indirectly controlled by the copper concentrate scrubber systems.

5.2 Copper Concentrate Loadout Stockpile (Unit ID: CCD03)

<u>Process Rate</u>

The annual, daily, and hourly process rates for wind erosion of the copper concentrate loadout stockpile are equal to the area of the copper concentrate loadout building (1.17 acres) and continuous operation of the stockpile (i.e. 8,760 hours/year, 24 hours/day, 1 hour/hour).

<u>Emission Factor</u>

Due to the copper concentrate loadout stockpile being enclosed within the copper concentrate loadout building, the PM, PM_{10}, and $PM_{2.5}$ emissions from wind erosion of the copper concentrate loadout stockpile are negligible. Therefore, a 0 ton/acre-year emission factor is assumed for PM, PM_{10}, and $PM_{2.5}$.

<u>Control Efficiency</u>

Particulate matter emissions in the copper concentrate loadout building are controlled by the copper concentrate scrubber systems. The scrubber systems pick up and deliver the particulate matter entrained air from the copper concentrate loadout building to the scrubbers for processing.

6. MOLYBDENUM DEWATERING AND PACKAGING

6.1 Material Transfers from the Molybdenum Concentrate Filter to the Molybdenum Dryer and from the Molybdenum Dryer to the Molybdenum Concentrate Packaging and Weigh System (Unit IDs: MD01 and MD03 through MD06)

Process Rate

The annual process rates for the material transfers from the molybdenum concentrate plate and frame filter to the molybdenum dryer and from the molybdenum dryer to the molybdenum concentrate packaging and weigh system are based on the annual process rate for the primary crusher (see Section 3.5) and the fraction of the concentrate ore that is molybdenum concentrate (1.27%). The hourly and maximum daily process rates are based on the maximum hourly quantity of molybdenum concentrate produced (1.90 tons/hour) and continuous operation (1.90 tons/hour * 24 hours/day = 45.6 tpd).

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from the material transfers from the molybdenum concentrate filter to the molybdenum dryer and from the molybdenum dryer to the molybdenum concentrate packaging and weigh system are calculated using Equation 2. The plate and frame filter is designed to remove 85% of the water from the molybdenum concentrate such that a 15% material moisture content is used in Equation 2 for the material transfer before the dryer. The dryer removes an additional 3% to 5% of moisture and a material moisture content of 10% is used in Equation 2 for material transfers after the dryer as a worst case estimate.

The mean wind speeds (U, 1.3 mph for protected transfer points and 6.21 mph for unprotected transfer points) are equal to the value used to calculate the emission factors in Sections 3.4 and 2.5, respectively. The explanation for how the mean wind speeds are determined is presented in Sections 3.4 and 2.5.

Control Efficiency

Emissions of particulate matter resulting from the material transfers from the molybdenum concentrate filter to the molybdenum dryer and from the molybdenum dryer to the molybdenum concentrate packaging and weigh system are controlled by good operating practices, enclosures, or the molybdenum dust collection system. When process material is transferred to an enclosed piece of equipment, particulate emissions are controlled due to the emissions not being able to escape and a 100% control efficiency is assumed. Since this control is inherent to the process, the control efficiency is applied during both uncontrolled and controlled emission calculations. The dust collection system has a 100% capture efficiency and picks up and delivers the particulate matter entrained air to the dust collector for processing. Emissions calculations for the molybdenum dust collection system are presented in Section 10. The wind speed and particulate matter control method used at each material transfer point from the molybdenum concentrate filter to the molybdenum concentrate packaging and weigh system is presented in Table 6.1.

Table 6.1 Material Moisture Contents, Wind Speeds, and Control Methods for the Material Transfers from the Molybdenum Concentrate Filter to the Molybdenum Dryer and from the Molybdenum Dryer to the Molybdenum Concentrate Supersacks or Drums

Unit ID	Unit Description	Material Moisture Content	Wind Speed	Control Method
MD01	Molybdenum Concentrate Filter (Ft-MC) to Molybdenum Concentrate Dryer (D-MC)	15%	1.3 mph	Enclosed
MD03	Molybdenum Concentrate Dryer (D-MC) to Molybdenum Concentrate Bin (B-MC)	6%	1.3 mph	Molybdenum Dust Collector (PC-MDC)
MD04	Molybdenum Concentrate Bin (B-MC) to Molybdenum Concentrate Hopper (H-MC)	6%	6.21 mph	Good Operating Practices
MD05	Molybdenum Concentrate Hopper (H-MC) to Molybdenum Concentrate Conveyor (CV-MC)	6%	1.3 mph	Enclosed
MD06	Molybdenum Concentrate Conveyor (CV-MC) to Molybdenum Concentrate Packaging and Weigh System (MPS)	6%	6.21 mph	Molybdenum Dust Collector (PC-MDC)

6.2 Molybdenum Drying (Unit ID: MD02)

Process Rate

The annual, maximum daily, and hourly process rates for the molybdenum dryer are equal to the molybdenum concentrate material transfer process rates (see Section 6.1).

Emission Factor

Uncontrolled PM and PM_{10} emissions from the molybdenum dryer are calculated using the emission factors of 19.7 lb/ton and 12.0 lb/ton, respectively, from AP-42, Table 11.24-2 (08/82) for drying of all high moisture minerals except titanium/zirconium sands. The moisture content of the molybdenum concentrate is 15% prior to drying, which according to AP-42, Section 11.24.2 classifies the concentrate as high moisture. Uncontrolled $PM_{2.5}$ emissions are estimated to be 30% of PM emissions based on the information presented for Category 4, material handling and processing of processed ore, in AP-42, Appendix B.2 (08/04). Since the molybdenum dryer is heated using an electric hot oil heater, there are no combustion emissions from the molybdenum drying operations.

Control Efficiency

Emissions of particulate matter resulting from the molybdenum drying are collected and processed by the molybdenum scrubber system and electrostatic precipitator designed in series. The scrubber system has a 100% capture efficiency and picks up and delivers the particulate matter entrained air to the scrubber for processing. After processing by the scrubber system, the exhaust air from the scrubber is transferred to the electrostatic precipitator for further particulate matter removal before being exhaust to the atmosphere. Emission calculations for the molybdenum scrubber and electrostatic precipitator systems in series are presented in Section 10.

7. TAILINGS DEWATERING AND PLACEMENT

7.1 Material Transfers from Tailings Filters to Tailings Storage (Unit IDs: TDS01 through TDS09)

Process Rate

The annual process rate for the material transfers from the from the tailings plate and frame filters to the tailings storage is based on the annual process rate for the primary crusher (see Section 3.5) and the fraction of the concentrate ore that is tailings (98.7%). The hourly and maximum daily process rates are based on the maximum hourly quantity of tailings produced (10,722 tons/hour) and continuous operation (10,722 tons/hour * 24 hours/day = 257,328 tpd).

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from the material transfers from the tailings plate and frame filters to the tailings storage are calculated using Equation 2. The plate and frame filters remove 82-85% of the water from the tailings. The material moisture content value used in Equation 2 is determined to be 15% as a worst case estimate.

The mean wind speeds (U, 1.3 mph for protected (covered or enclosed) transfer points and 6.21 mph for unprotected transfer points) are equal to the value used to calculate the emission factors in Sections 3.4 and 2.5, respectively. The explanation for how the mean wind speeds are determined is presented in Sections 3.4 and 2.5, respectively. The fixed tailings conveyors and the relocatable conveyors in the tailings dewatering and placement system have covers on the discharge points and therefore a reduced wind speed of 1.3 mph can be used at the material transfer point.

There are two tailings conveying and placement systems at the RCP (see Figure B.11 in Appendix B of *Rosemont Copper Company, Application for a Class II Permit, Rosemont Copper Project, Southeastern Arizona*). The primary system (System #1) has one more conveyor than the alternate system (System #2). Therefore, particulate emissions from the material transfers from the tailings plate and frame filters to the tailings storage assume all tailings are processed through System #1 as a worst case emission estimate.

Control Efficiency

Emissions of particulate matter resulting from the material transfers from the tailings plate and frame filters to the tailings storage are controlled by good operating practices and enclosures. When process material is transferred to an enclosed piece of equipment, particulate emissions are controlled due to the emissions not being able to escape and a 100% control efficiency is assumed. Since this control is inherent to the process, the control efficiency is applied during both uncontrolled and controlled emission calculations. The wind speed and particulate matter control method used at each material transfer point from the tailings filters to the tailings storage is presented in Table 7.1.

Table 7.1 Wind Speeds and Control Methods for the Material Transfers from the Tailings Filters to the Tailings Storage

Unit ID	Unit Description	Wind Speed	Control Method
TDS01	Tailings Filters (Ft-T1/T14) to Tailings Belt Feeders (F-T1/T14)	1.3 mph	Enclosed
TDS02	Tailings Belt Feeders (F-T1/T14) to Fixed Tailings Conveyor No. 1 (CV-F1)	1.3 mph	Enclosed
TDS03	Fixed Tailings Conveyor No. 1 (CV-F1) to Fixed Tailings Conveyor No. 2 (CV-F2)	1.3 mph	Enclosed
TDS04	Fixed Tailings Conveyor No. 2 (CV-F2) to Fixed Tailings Conveyor No. 3 (CV-F3)	1.3 mph	Good Operating Practices
TDS05	Fixed Tailings Conveyor No. 3 (CV-F3) to Relocatable Conveyor (CV-R1)	1.3 mph	Good Operating Practices
TDS06	Relocatable Conveyors (CV-R1) to Shiftable Conveyor (CV-S1)	1.3 mph	Good Operating Practices
TDS07	Shiftable Conveyor (CV-S1) to Belt Wagon Conveyor (CV-BW1)	6.21 mph	Good Operating Practices
TDS08	Belt Wagon Conveyor (CV-BW1) to Spreader Crawler Mounted Conveyor (CV-SP1)	6.21 mph	Good Operating Practices
TDS09	Spreader Crawler Mounted Conveyor (CV-SP1) to Tailings Storage	6.21 mph	Good Operating Practices

7.2 Tailings Storage (Unit ID: TDS10)

Process Rate

The annual, daily, and hourly process rates for wind erosion of the tailings storage are equal to the maximum area of the land containing the tailings (1,500 acres) and continuous operation of the storage area (i.e. 8,760 hours/year, 24 hours/day, 1 hour/hour).

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from the tailings storage are calculated using the methodology and equations from AP-42, Section 13.2.5 (11/06), including:

$$EF = (k)\left(\sum_{i=1}^{N} P_i\right)\left(\frac{1\,lb}{453.59\,g}\right)\left(\frac{4{,}4046.86\,m^2}{1\,acre}\right) \quad (7a)$$

$$P = (58)(u^* - u_t^*)^2 + (25)(u^* - u_t^*) \qquad \text{for } u^* > u_t^* \quad (7b)$$

$$P = 0 \qquad \text{for } u^* \leq u_t^* \quad (7c)$$

$$u^* = (0.053)(u_{10}^+) \quad (7d)$$

where:

EF	=	emission factor (lb/acre-year), the PM emission factor is assumed to be equal to the emission factor for PM_{30}
k	=	particle size multiplier (1 for PM, 0.5 for PM_{10}, 0.075 for $PM_{2.5}$)
P	=	erosion potential function
N	=	number of disturbances (1, the tailings storage area will only be disturbed when the tailings are added)
u^*	=	friction velocity (m/s)
u_t^*	=	threshold friction velocity (0.43 m/s, the smallest value from Table 13.2.5-1, assumed to approximate the tailings)
u_{10}^+	=	fastest mile for the time period between disturbances (10.70 m/s, the fastest mile recorded from hourly data collected at the meteorological station at the RCP from April 2006 through May 2009)

Control Efficiency

Emissions of particulate matter resulting from wind erosion of the tailings storage are controlled by constructing the tailings storage area using waste rock material. The waste rock breaks up the air flow and reduces exposure of the tailings storage area to windy conditions.

8. FUEL BURNING EQUIPMENT

8.1 Diesel Electrowinning Hot Water Generator (Unit ID: FB01)

<u>Process Rate</u>

The annual, daily, and hourly process rates for the diesel electrowinning hot water generator are based on the hot water generator heat input rate (6.0 MMBtu/hour) and continuous operation (8,760 hours/year, 24 hours/day, and 1 hour/hour). The process rates are consistent for all years of the life of the mine.

<u>Emission Factor</u>

Uncontrolled filterable PM, condensable PM, CO, NO_x, SO_2, VOC, and HAP emissions resulting from the diesel electrowinning hot water generator are calculated using emission factors from AP-42, Tables 1.3-1, 1.3-2, 1.3-3, 1.3-8, and 1.3-10, (05/10) for either distillate oil or No. 2 fuel oil fired boilers rated less than 100 MMBtu/hr (industrial boilers).

The total PM emission factor is calculated by summing the filterable and condensable emission factors. The uncontrolled PM_{10} and $PM_{2.5}$ emission factors are calculated using the particle size distribution data in AP-42 Table 1.3-6 (10/96) for uncontrolled industrial boilers firing distillate oil and applying it to the filterable PM emission factor. All condensable PM is assumed to be less than 1.0 micron in diameter.

The SO_2 emission factor includes an input for the sulfur content of the diesel fuel used in the electrowinning hot water generator. The electrowinning hot water generator operates on ultra low sulfur diesel fuel with a sulfur content of 0.0015%. The VOC emission factor is assumed to be equal to the non-methane total organic compound (TOC) emission factor. The formaldehyde emission factor is assumed to be equal to the high end value of the formaldehyde range as a worst case scenario.

Uncontrolled CO_2, CH_4, and N_2O emissions are calculated using the emission factors of 73.96 kg/MMBtu, $3*10^{-3}$ kg/MMBtu, and $6*10^{-4}$ kg/MMBtu, respectively, from 40 CFR 98, Tables C-1 and C-2 for distillate fuel oil No. 2. A diesel heating value of 19,300 Btu/pound of diesel fuel and a diesel fuel density of 7.3775 lb/gallon were used to calculate the CO_2, CH_4, and N_2O emission factor in terms of lb/10^3 gallons.

The emission factors for the electrowinning hot water generator and the corresponding reference tables are presented in Table 8.1. A diesel heating value of 137,000 Btu/gallon (AP-42, Appendix A, page A-5 (09/85)) is used in the calculation of emissions from the electrowinning hot water generator.

Regulated Pollutant	Emission Factor	Units	Reference
PM	3.30	lb/10^3 gallons	AP-42, Tables 1.3-1 and 1.3-2
PM_{10}	2.30	lb/10^3 gallons	AP-42, Tables 1.3-1, 1.3-2, and 1.3-6
$PM_{2.5}$	1.54	lb/10^3 gallons	AP-42, Tables 1.3-1, 1.3-2, and 1.3-6
CO	5	lb/10^3 gallons	AP-42, Table 1.3-1
NO_x	20	lb/10^3 gallons	AP-42, Table 1.3-1
SO_2	0.21	lb/10^3 gallons	AP-42, Table 1.3-1
VOC	0.2	lb/10^3 gallons	AP-42, Table 1.3-3
CO_2	23,217	lb/10^3 gallons	40 CFR 98, Table C-1
CH_4	0.94	lb/10^3 gallons	40 CFR 98, Table C-2
N_2O	0.19	lb/10^3 gallons	40 CFR 98, Table C-2
Total HAPs	500.59	lb/10^{12} Btu	1.3-8 and 1.3-10

Table 8.1 Emission Factors for Diesel Electrowinning Hot Water Generator

Control Efficiency

Besides good operating practices, other pollution control methods are not implemented during the use of the diesel electrowinning hot water generator.

8.2 Thickener Area Emergency Generator, PLS Pond Area Emergency Generator, Main Substation Emergency Generator, and Administration Building Emergency Generator (Unit IDs: FB02 through FB05)

Process Rate

The annual, daily, and hourly process rates for the diesel fueled emergency generators are based on the power ratings of the generators and the hours of operation. The thickener area emergency generator and PLS pond area emergency generator have power ratings of 1,000 kW. The main substation emergency generator and the administration building emergency generator have power ratings of 750 kW. All emergency generators will only be used in emergency power situations and for periodic testing and maintenance purposes, estimated at 500 hours/year (see EPA memorandum distributed on September 6, 1995 providing guidance on calculating the PTE for emergency generators). However, the emergency generators are capable of operating 24 hours/day and 1 hour/hour.

Emission Factor

Uncontrolled PM, PM_{10}, $PM_{2.5}$, CO, NO_x, and VOC emissions from the emergency generators are calculated using the exhaust emission standards for nonroad engines from the new source performance standards (NSPS), 40 CFR 89, Section 112. The emission standards for the emergency generators with engines rated greater than 560 kW and manufactured after 2006 (Tier 2) are presented in Table 8.2. PM_{10} and $PM_{2.5}$ emissions from internal combustion engines are not listed as emission standards and are assumed to be equal to PM emissions. The NO_x and VOC emission standards are combined in the NSPS as a single emission standard. Based on EPA documentation (*Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition*), NO_x and VOC emissions for engines greater than 560 kW are assumed to be equal to 93.75% and 6.25%, respectively, of the combined NO_x and VOC emission standard.

Uncontrolled SO_2 emissions are calculated assuming all the sulfur in the diesel fuel is converted to SO_2 emissions and the sulfur content of the diesel fuel is 0.0015%. This leads to an uncontrolled SO_2 emission factor of 0.00003 pound SO_2 per pound of diesel fuel (or 0.0066 grams of SO_2 per kW-hr). Uncontrolled HAP emissions are calculated using the emission factors from AP-42, Tables 3.4-3 and 3.4-4 (10/96) for large (> 600 hp) stationary, diesel engines.

Uncontrolled CO_2, CH_4, and N_2O emissions are calculated using the emission factors of 73.96 kg/MMBtu, $3*10^{-3}$ kg/MMBtu, and $6*10^{-4}$ kg/MMBtu, respectively, from 40 CFR 98, Tables C-1 and C-2 for distillate fuel oil No. 2.

A diesel heating value of 19,300 Btu/pound of diesel fuel, an average brake-specific fuel consumption value of 7,000 Btu/hp-hr, and a diesel fuel density of 7.3775 lb/gallon were used to calculate the HAP emissions and the SO_2, CO_2, CH_4, and N_2O emission factors in terms of g/kW-hr.

Table 8.2 Emission Standards for Diesel Internal Combustion Engines (> 560 kW, Tier 2)

Regulated Pollutant	Emission Factor	Units
PM	0.20	g/kW-hr
PM_{10}	0.20	g/kW-hr
$PM_{2.5}$	0.20	g/kW-hr
CO	3.5	g/kW-hr
NO_x + VOC	6.4	g/kW-hr

Control Efficiency

Besides good operating practices, other pollution control methods are not implemented during the use of the diesel emergency generators.

8.3 *Electrowinning Building Emergency Generator (Unit ID: FB06)*

Process Rate

The annual, daily, and hourly process rates for the diesel fueled electrowinning building emergency generator are based on the power rating of the generator and the hours of operation. The electrowinning building emergency generator has a power rating of 50 kW and will only be used in emergency power situations and for periodic testing and maintenance purposes, estimated at 500 hours/year (see EPA memorandum distributed on September 6, 1995 providing guidance on calculating the PTE for emergency generators). However, the emergency generator is capable of operating 24 hours/day and 1 hour/hour.

Emission Factor

Uncontrolled PM, PM_{10}, $PM_{2.5}$, CO, NO_x, and VOC emissions from the electrowinning building emergency generator are calculated using the exhaust emission standards for nonroad engines from NSPS, 40 CFR 89, Section 112. The emission standards for engines rated between 37 and 75 kW and manufactured after 2008 (Tier 3) are presented in Table 8.3. PM_{10} and $PM_{2.5}$ emissions from internal combustion engines are not listed as emission standards and are assumed to be equal to PM emissions. The NO_x and VOC emission standards are combined in the NSPS as a single emission standard. Based on EPA documentation (*Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition*), NO_x and VOC emissions for engines between 37.3 and 74.6 kW are assumed to be equal to 94.29% and 5.71%, respectively, of the combined NO_x and VOC emission standard.

Uncontrolled SO_2 emissions are calculated assuming all the sulfur in the diesel fuel is converted to SO_2 emissions and the sulfur content of the diesel fuel is 0.0015%. This leads to an uncontrolled SO_2 emission factor of 0.00003 pound SO_2 per pound of diesel fuel (or 0.0066 grams of SO_2 per kW-hr). Uncontrolled HAP emissions are calculated using the emission factors from AP-42, Table 3.3-2 (10/96) for industrial diesel engines.

Uncontrolled CO_2, CH_4, and N_2O emissions are calculated using the emission factors of 73.96 kg/MMBtu, $3*10^{-3}$ kg/MMBtu, and $6*10^{-4}$ kg/MMBtu, respectively, from 40 CFR 98, Tables C-1 and C-2 for distillate fuel oil No. 2.

A diesel heating value of 19,300 Btu/pound of diesel fuel, an average brake-specific fuel consumption value of 7,000 Btu/hp-hr, and a diesel fuel density of 7.3775 lb/gallon were used to calculate the HAP emissions and the SO_2, CO_2, CH_4, and N_2O emission factors in terms of g/kW-hr.

Table 8.3 Emission Standards for Diesel Internal Combustion Engines (37 ≤ kW < 75, Tier 3)		
Regulated Pollutant	Emission Factor	Units
PM	0.40	g/kW-hr
PM_{10}	0.40	g/kW-hr
$PM_{2.5}$	0.40	g/kW-hr
CO	5.0	g/kW-hr
NO_x + VOC	4.7	g/kW-hr

Control Efficiency

Besides good operating practices, other pollution control methods are not implemented during the use of the electrowinning building emergency generator.

8.4 Primary Crusher Fire Water Pump and SX/EW Fire Water Pump (Unit IDs: FB07 and FB08)

Process Rate

The annual, daily, and hourly process rates for the diesel fueled primary crusher fire water pump and the diesel fueled SX/EW fire water pump are based on the power ratings of the fire pumps and the hours of operation. Both fire water pumps have power ratings of 400 hp (298.4 kW) and will only be used in emergency situations and for periodic testing and maintenance purposes, estimated at 500 hours/year (see EPA memorandum distributed on September 6, 1995 providing guidance on calculating the PTE for emergency generators). However, the fire water pumps are capable of operating 24 hours/day and 1 hour/hour.

Emission Factor

Uncontrolled PM, PM_{10}, $PM_{2.5}$, CO, NO_x, and VOC emissions from the fire water pumps are calculated using the emission standards for stationary fire pump engines from NSPS, 40 CFR 60, Subpart IIII, Table 4. The emission standards for fire pump engines rated between 225 and 450 kW and manufactured after 2009 are presented in Table 8.4. PM_{10} and $PM_{2.5}$ emissions from fire pump engines are not listed as emission standards and are assumed to be equal to PM emissions. The NO_x and VOC emission standards are combined in the NSPS as a single emission standard. Based on EPA documentation (*Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition*), NO_x and VOC emissions for engines between 300 and 600 hp are assumed to be equal to 93.33% and 6.67%, respectively, of the combined NO_x and VOC emission standard.

Uncontrolled SO_2 emissions are calculated assuming all the sulfur in the diesel fuel is converted to SO_2 emissions and the sulfur content of the diesel fuel is 0.0015%. This leads to an uncontrolled SO_2

emission factor of 0.00003 pound SO_2 per pound of diesel fuel (or 0.0066 grams of SO_2 per kW-hr). Uncontrolled HAP emissions are calculated using the emission factors from AP-42, Table 3.3-2 (10/96) for industrial diesel engines.

Uncontrolled CO_2, CH_4, and N_2O emissions are calculated using the emission factors of 73.96 kg/MMBtu, $3*10^{-3}$ kg/MMBtu, and $6*10^{-4}$ kg/MMBtu, respectively, from 40 CFR 98, Tables C-1 and C-2 for distillate fuel oil No. 2.

A diesel heating value of 19,300 Btu/pound of diesel fuel, an average brake-specific fuel consumption value of 7,000 Btu/hp-hr, and a diesel fuel density of 7.3775 lb/gallon were used to calculate the HAP emissions and the SO_2, CO_2, CH_4, and N_2O emission factors in terms of g/kW-hr.

Table 8.4 Emission Standards for Stationary Fire Pump Engines (225 ≤ kW < 450, Tier 3)

Regulated Pollutant	Emission Factor	Units
PM	0.20	g/kW-hr
PM_{10}	0.20	g/kW-hr
$PM_{2.5}$	0.20	g/kW-hr
CO	3.5	g/kW-hr
NO_x + VOC	4.0	g/kW-hr

Control Efficiency

Besides good operating practices, other pollution control methods are not implemented during the use of the fire water pumps.

9. MISCELLANEOUS SOURCES

9.1 Lime Loading (Unit IDs: MS01 and MS04)

Process Rate

The annual process rates for the lime loading are based on an annual lime usage rate of 56,700 tons. The usage rate is consistent throughout the life of the mine. The maximum daily process rate is calculated from the annual usage rate divided by 365 days/year, the quantity of days per year lime will be used at the RCP and adding a 20% maximum capacity factor. The hourly process rate is determined by dividing the maximum daily usage rate by 24 hours/day. Lime is loaded into two different storage vessels at the RCP, the bulk pebble lime silo (Unit ID MS01) and the lime storage bin (Unit ID MS05). The annual, daily, and hourly process rates for loading lime into each of the two storage vessels are assumed to be 2/3 and 1/3 of the total lime usage rate for the bulk pebble lime silo and lime storage bin, respectively.

Emission Factor

Uncontrolled PM emissions from the lime loading are calculated using the emission factor of 0.61 lb/ton, from AP-42, Table 11.17-4 (02/98) for lime product loading, enclosed truck. Uncontrolled PM_{10} and $PM_{2.5}$ emissions are estimated to be 47% and 7.2%, respectively, of PM emissions based on the particle size fractions in AP-42, Section 13.2.4.3 (11/06) for aggregate drop processes.

Control Efficiency

Emissions of particulate matter resulting from loading lime into the storage vessels are controlled by bin vent systems. The bulk pebble lime silo is controlled by the bulk pebble lime silo bin vent and the lime storage bin is controlled by the lime storage bin vent. The bin vent systems are designed to be used as collectors to prevent the loss of material, but also treat the dust entrained displacement air generated during the loading process. The bin vent systems have a pick up efficiency of 100% (they are located directly on the storage containers) and a 90% control efficiency, as determined by the bin vent vendors. Since this control is inherent to the process, the control efficiency is applied during both uncontrolled and controlled emission calculations.

9.2 Reagent Material Transfer Points (Unit IDs: MS02 through MS03 and MS05 through MS08)

Process Rate

The annual process rates for the reagent material transfer points are based on the annual reagent usage rates presented in Table 9.1. The usage rates are consistent throughout the life of the mine. The maximum daily process rates are calculated from the annual usage rates divided by 365 days/year, the quantity of days per year reagents will be used at the RCP, and adding a 20% maximum capacity factor. The hourly process rate is determined by dividing the maximum daily usage rate by 24 hours/day.

The lime usage rate in Table 9.1 is for two different lime systems. The division of the usage rate between the two systems is described in Section 9.1.

Table 9.1 Annual Reagent Usage Rates

Reagent	Annual Usage
Calcium Oxide - High Calcium Pebble Lime	56,700 tons
Sodium Metasilicate	3,000 tons
Nonionic Polyacrylamide	1,100 tons
Cobalt Sulfate	6.0 tons
Guar Gum	150 tons

Emission Factor

Uncontrolled PM, PM_{10}, and $PM_{2.5}$ emissions from the reagent material transfer points are calculated using Equation 2. The mean wind speed (U, 6.21 mph for unprotected transfer points) is equal to the value used to calculate the emission factor in Section 2.5. The explanation for how the mean wind speed is determined is presented in Section 2.5. The material moisture content value used in Equation 2 is unknown for the different chemicals. A 1% material moisture content is used as a worst case scenario.

Control Efficiency

Emissions of particulate matter resulting from the reagent material transfer points are controlled by good operating practices, enclosures, or bin vent systems. When process material is transferred to an enclosed piece of equipment, particulate emissions are controlled due to the emissions not being able to escape and a 100% control efficiency is assumed. The bin vent systems provide a 100% pick up efficiency (as explained in Section 9.1) and a 90% control efficiency of particulate emissions (as determined by the bin vent vendors). Since these control methods are inherent to the processes, the control efficiency is applied during both uncontrolled and controlled emission calculations. The particulate matter control method used at each reagent material transfer point is presented in Table 9.2.

Table 9.2 Control Methods for the Reagent Material Transfer Points

Unit ID	Unit Description	Control Method
MS02	Bulk Pebble Lime Silo (S-BPL) to Bulk Pebble Lime Silo Screw Conveyor (CV-BPLS)	Enclosed
MS03	Bulk Pebble Lime Silo Screw Conveyor (CV-BPLS) to SAG Mill Feed Conveyor (CV-SMF)	Good Operating Practices
MS05	Transfer of Sodium Metasilicate to the Sodium Metasilicate Storage Bin (B-SM)	Sodium Metasilicate Storage Bin Vent
MS06	Transfer of Flocculant from Supersacks to Flocculant Storage Bins (B-F1/F2)	Good Operating Practices
MS07	Transfer of Guar from Bags to Guar Feeder (F-Gu)	Good Operating Practices
MS08	Transfer of Granular Cobalt Sulfate from Bags to Cobalt Sulfate Feeder (F-CoS)	Good Operating Practices

10. PARTICULATE MATTER POLLUTION CONTROL EQUIPMENT WITH EMISSION LIMITATIONS (UNIT IDS: PCL01 THROUGH PCL11)

Process Rate

The annual, daily, and hourly process rates for the particulate matter pollution control equipment with emission limitations are based on the exhaust flow rate of the equipment and/or the hours of operation. The exhaust flow rate and the operating hours for each piece of pollution control equipment is presented in Table 10.1. The particulate matter pollution control equipment is assumed to operate at maximum capacity and continuous operation throughout the life of the mine even if the processes being controlled are operating at less than maximum capacity.

Table 10.1 Process Rates for Particulate Matter Pollution Control Equipment

Unit ID	Pollution Control Equipment	Exhaust Flow Rate	Operating Hours	
			Annual	Daily
PCL01	Crushing Area Scrubber (PC-CAS)	18,000 acfm	8,760	24
PCL02	Stockpile Area Scrubber (PC-SAS)	36,500 acfm	8,760	24
PCL03	Reclaim Tunnel Scrubber (PC-RTS)	15,000 acfm	8,760	24
PCL04	Pebble Crusher Area Scrubber (PC-PCAS)	22,000 acfm	8,760	24
PCL05	Copper Concentrate Scrubber 1 (PC-CCS1)	50,000 acfm	8,760	24
PCL06	Copper Concentrate Scrubber 2 (PC-CCS2)	50,000 acfm	8,760	24
PCL07	Molybdenum Scrubber (PC-MS) / Electrostatic Precipitator (PC-EP)	500 acfm	8,760	24
PCL08	Molybdenum Dust Collector (PC-MDC)	1,500 acfm	8,760	24
PCL09	Laboratory Dust Collector 1 (PC-L1)	10,000 acfm	8,760	24
PCL10	Laboratory Dust Collector 2 (PC-L2)	10,000 acfm	8,760	24
PCL11	Laboratory Dust Collector 3 (PC-L3)	10,000 acfm	8,760	24

Emission Factor

Particulate matter emissions from the pollution control devices are based on lb/hour emission limits or PM_{10} outlet grain loadings voluntarily accepted by the RCP. The PM and $PM_{2.5}$ fractions of PM_{10} emissions are estimated based on the control efficiencies of the pollution control equipment in each particulate size range (from manufacturer's information) and the emission units being controlled. The voluntarily accepted emission limits and outlet grain loadings and the parameters needed to calculate the appropriate exhaust flow rate for each piece of pollution control device with a voluntarily accepted grain loading is presented in Table 10.2. The PM and $PM_{2.5}$ fraction of PM_{10} emissions for each pollution control devices is presented in Table 10.3. The following equations are used to calculate the appropriate exhaust flow rate:

$$Q_{dscfm} = \frac{(Q_{acfm})(460 + T_{st})(P_{PC})}{(460 + T_{PC})(P_{st})}\left(1 - \frac{x_m}{100}\right) \tag{8a}$$

$$P_{PC} = \left(P_{MSL} - \frac{GE + SH}{1000}\right)\left(\frac{1\,\text{psi}}{2.036\ \text{inches of Hg}}\right) \tag{8b}$$

where:

Q_{dscfm} = exhaust flow rate of the pollution control device at dry, standard conditions (dscfm)

Q_{acfm} = actual exhaust flow rate of the pollution control device

T_{st} = standard temperature (68°F, definition in 40 CFR 60.2)

T_{PC} = temperature of the pollution control device exhaust (see Table 10.2)

P_{st} = standard pressure (14.7 psi, definition in 40 CFR 60.2)

P_{PC} = pressure of the dust collector exhaust (psi)

x_m = percent of moisture in the exhaust flow (The moisture percentages are uncertain. As a worst case scenario, a moisture content of 0% is assumed.)

P_{MSL} = pressure at mean sea level (29.92 in. Hg)

GE = ground elevation (5,350 feet at the RCP)

SH = stack height (see Table 10.2)

Equation 8b is based on the estimate that for every 1,000 feet above sea level, the pressure decreases by 1 inch of mercury.

Table 10.2 Voluntarily Accepted PM_{10} Emission Limits and Outlet Grain Loadings and Particulate Matter Pollution Control Equipment Properties

Unit ID	Pollution Control Equipment	PM_{10} Outlet Grain Loading / Emission Limit	Exhaust Temperature (°F)	Stack Height (ft)
PCL01	Crushing Area Scrubber (PC-CAS)	1.28 lb/hr	Ambient [a]	24
PCL02	Stockpile Area Scrubber (PC-SAS)	2.59 lb/hr	Ambient [a]	24
PCL03	Reclaim Tunnel Scrubber (PC-RTS)	1.07 lb/hr	Ambient [a]	24
PCL04	Pebble Crusher Area Scrubber (PC-PCAS)	1.56 lb/hr	Ambient [a]	24
PCL05	Copper Concentrate Scrubber 1 (PC-CCS1)	3.55 lb/hr	Ambient [a]	24
PCL06	Copper Concentrate Scrubber 2 (PC-CCS2)	3.55 lb/hr	Ambient [a]	24
PCL07	Molybdenum Scrubber (PC-MS) / Electrostatic Precipitator (PC-EP)	0.014 lb/hr	202	55
PCL08	Molybdenum Dust Collector (PC-MDC)	0.010 grains/dscf	Ambient [a]	20
PCL09	Laboratory Dust Collector 1 (PC-L1)	0.005 grains/dscf	Ambient [a]	20
PCL10	Laboratory Dust Collector 2 (PC-L2)	0.005 grains/dscf	Ambient [a]	20
PCL11	Laboratory Dust Collector 3 (PC-L3)	0.005 grains/dscf	Ambient [a]	20

[a] The average ambient temperature at the RCP is 62.43 °F (calculated from hourly data collected at the meteorological station at the RCP from April 2006 through May 2009).

The molybdenum scrubber and electrostatic precipitator are designed to operate in series. Therefore, they are treated as a single emission point. The pollution control equipment properties listed in the above tables are for the electrostatic precipitator, since it is the final piece of pollution control equipment exhausted to the atmosphere.

Table 10.3 PM and $PM_{2.5}$ Fractions of PM_{10} Emissions from the Particulate Matter Pollution Control Equipment

Unit ID	Pollution Control Equipment	PM Fraction	$PM_{2.5}$ Fraction
PCL01	Crushing Area Scrubber (PC-CAS)	1.01	0.88
PCL02	Stockpile Area Scrubber (PC-SAS)	1.01	0.81
PCL03	Reclaim Tunnel Scrubber (PC-RTS)	1.01	0.81
PCL04	Pebble Crusher Area Scrubber (PC-PCAS)	1.02	0.84
PCL05	Copper Concentrate Scrubber 1 (PC-CCS1)	1.01	0.86
PCL06	Copper Concentrate Scrubber 2 (PC-CCS2)	1.01	0.86
PCL07	Molybdenum Scrubber (PC-MS) / Electrostatic Precipitator (PC-EP)	1.10	0.94
PCL08	Molybdenum Dust Collector (PC-MDC)	2.11	0.15
PCL09	Laboratory Dust Collector 1 (PC-L1)	1.65	0.49
PCL10	Laboratory Dust Collector 2 (PC-L2)	1.65	0.49
PCL11	Laboratory Dust Collector 3 (PC-L3)	1.65	0.49

11. SOLVENT EXTRACTION AND ELECTROWINNING

11.1 Solvent Extraction Mix Tanks and Settlers (Unit IDs: SXE01)

Process Rate

The annual, daily, and hourly process rates for the solvent extraction mix tanks and settlers are equal to the surface area of the tanks and continuous operation of the solvent extraction system (i.e. 8,760 hours/year, 24 hours/day, 1 hour/hour). The surface area of the solvent extraction mix tanks and settlers is presented in Table 11.1.

Table 11.1 Surface Area of the Solvent Extraction Mix Tanks and Settlers

Solvent Extraction Mix Tank or Settler	Surface Area (ft^2)
E1 Primary Mix Tank - 7.75' D x 9.75' H	47.2
E1 Secondary Mix Tank - 9.5' D x 9.75' H	70.9
E1 Tertiary Mix Tank - 9.5' D x 9.75' H	70.9
E1 Extraction Settler - 64' L x 33' W x 3.33' H	2,112
E1-P Primary Mix Tank - 7.75' D x 9.75' H	47.2
E1-P Secondary Mix Tank - 9.5' D x 9.75' H	70.9
E1-P Tertiary Mix Tank - 9.5' D x 9.75' H	70.9
E1-P Extraction Settler - 64' L x 33' W x 3.33' H	2,112
E2 Primary Mix Tank - 7.75' D x 9.75' H	47.2
E2 Secondary Mix Tank - 9.5' D x 9.75' H	70.9
E2 Tertiary Mix Tank - 9.5' D x 9.75' H	70.9
E2 Extraction Settler - 64' L x 33' W x 3.33' H	2,112
S1 Primary Mix Tank - 7.75' D x 9.75' H	47.2
S1 Secondary Mix Tank - 9.5' D x 9.75' H	70.9
S1 Strip Settler - 64' L x 33' W x 3.33' H	2,112
Total	**9,132.9**

Emission Factor

Uncontrolled VOC and HAP emissions from the solvent extraction tanks are calculated using the methodology and equations from the *Hydrometallurgy of Copper*, presented at an international copper mining convention in 1999. The methodology presented in the paper is a more accurate way to estimate the evaporative loss of diluent than using the EPA Tanks program to model the mixers and settlers as tanks. The following equations (Equations 9a and 9b) and data (Table 11.2) are used to calculate VOC and HAP emissions from the solvent extraction mix tanks and settlers. The full paper is presented in Appendix C.

$$F_i = \frac{\left(C_i^0 - C_i^H\right)\left(\frac{D_i}{100^2}\right)}{(H)}\left(\frac{60\ \text{sec}}{1\ \text{min}}\right)\left(\frac{60\ \text{min}}{1\ \text{hr}}\right)\left(\frac{1\ \text{lb}}{453.59\ \text{g}}\right)\left(\frac{1\ \text{m}^2}{(3.2808\ \text{ft})^2}\right) \quad (9a)$$

$$D_i = \left(10^{-3}\right)\left(T^{1.75}\right)\left(\frac{\left(\frac{(M_i + M_A)}{(M_i)(M_A)}\right)^{1/2}}{\left((P)\left(V_i^{1/3} + V_A^{1/3}\right)\right)^2}\right) \quad (9b)$$

where:

F_i	=	diffusive flux of component i in the air (lb/ft^2-hr)
C_i^0	=	component concentration at the surface (g/m^3, see Table 11.2)
C_i^H	=	component concentration at the measured height (g/m^3, see Table 11.2)
H	=	height at which concentration measurement was taken (1 m)
D_i	=	diffusivity of component i in the air (m^2/s)
T	=	temperature (335.6 K, the average value calculated from hourly data collected at the meteorological station at the RCP from April 2006 through May 2009)
M_i	=	molecular weight of the component in the air (gram/gram-mole, see Table 11.2)
M_A	=	molecular weight of the air (28.97 gram/gram-mole)
P	=	pressure (0.8 atm, calculated based on the elevation at the RCP (5,350 ft) and the estimate that for every 1,000 feet above sea level, the pressure decreases by 1 inch of mercury.)
V_i	=	sum of atmospheric diffusion volume increments by atom and structure for the component in the air (see Table 11.2)
V_A	=	sum of atmospheric diffusion volume increments by atom and structure for air (20.10)

Table 11.2 Data Used to Calculate VOC and HAP Emissions from the Solvent Extraction Mix Tanks and Settlers

Data	Benzene	Toluene	Ethylbenzene	Xylenes	others (including Hexane) [a]
C_i^0 (ppm_v)	25	350	1400	1912	2500
C_i^H (ppm_v)	0.0018	0.0668	0.0568	0.0371	16.9210
M_i (g/g-mole)	78.11	92.13	106.16	106.16	--
V_i	90.68	111.14	131.6	131.6	--

[a] The diffusivity of the "other" component (D_{other}) is given in the *Hydrometallurgy of Copper* as 0.07. It is corrected for the temperature and pressure at the RCP to be 0.10.

Control Efficiency

Emissions of VOCs and HAPs resulting from the mix tanks and settlers used in the solvent extraction system are controlled by the use of covers. As described in the *Hydrometallurgy of Copper*, it is estimated that the use of covers allows 33% of the potential emissions to be released to the atmosphere. Therefore, a 67% control efficiency is assumed for the solvent extraction mix tanks and settlers.

11.2 Electrowinning Commercial Cells (Unit ID: SXE02)

Process Rate

The annual, daily, and hourly process rates for the electrowinning commercial cells are equal to the surface area of the cells and continuous operation of the electrowinning system (i.e. 8,760 hours/year, 24 hours/day, 1 hour/hour). There are 30 electrowinning cells each with a length of 22 feet and a width of 4 feet. Therefore the total surface area of the electrowinning cells is 2,640 ft^2.

Emission Factor

Uncontrolled H_2SO_4 emissions from electrowinning are calculated using the emission factor of 0.000157 lb/hr-ft^2, from a report entitled "Measurement of Sulfuric Acid Mist Emissions from the Cyprus Twin Buttes Copper Company Electrowinning Tankhouse" (02/98) produced by Applied Environmental Consultants, Inc. The emission factor includes the control efficiency from dispersion balls used in the electrowinning tankhouse at the Copper Twin Buttes facility. At the RCP, an acid mist suppressant is used during electrowinning, which has a greater control efficiency than the use of dispersion balls. Therefore, as a worst case scenario, it is assumed that the measurements found at the Cyprus Twin Buttes Copper Company Electrowinning Tankhouse apply to the RCP electrowinning cells.

Uncontrolled cobalt compound emissions from electrowinning are determined by calculating the fraction of cobalt sulfate in the electrolyte solution sent to the electrowinning cells (approximated by 150 ppm). It is assumed that the H_2SO_4 mist emissions from the electrowinning cells contain the same fraction of cobalt compounds.

<u>Control Efficiency</u>

Emissions of H_2SO_4 and cobalt compounds resulting from electrowinning are controlled by five cell ventilation scrubber systems. The scrubber systems have a 100% capture efficiency and control the H_2SO_4 and cobalt compound emissions with a 99% efficiency.

12. TANKS

12.1 Significant Storage Tanks (Unit IDs: T01 through T04)

Process Rate

There are four storage tanks at the RCP that have the potential to emit VOC and HAP emissions:

- C7 Distribution Tank
- MIBC Storage Tank
- Diesel Fuel Storage Tank – Heavy Vehicles 1
- Diesel Fuel Storage Tank – Heavy Vehicles 2

The annual, daily, and hourly process rates for the tanks are equal to the operating hours of the tanks, or continuous operation (i.e. 8,760 hours/year, 24 hours/day, 1 hour/hour).

Emission Factor

Uncontrolled VOC and HAP emissions from the tanks are calculated using the EPA's TANKS program for vertical fixed roof tanks. The following information was used in the program to calculate the emissions from the tanks. The other tank parameters needed to execute the EPA TANKS program are presented in Table 12.1.

(a) The tanks are not heated;

(b) The paint characteristics include white color paint and good paint conditions;

(c) The tank roofs are flat (cone roof type with a height of 0 ft and slope of 0 ft/ft);

(d) The vacuum and pressure settings are 0 psig; and

(e) The meteorological data corresponds to Tucson, Arizona;

The EPA TANKS output files showing the annual emission from the tanks are presented in Appendix D. Hourly and daily emission rates were estimated from the annual emission values of the EPA TANKS program by assuming continuous operation (24 hours/day and 8,760 hours/year).

Control Efficiency

Besides good operating practices, other pollution control methods are not implemented on the tanks.

Table 12.1 Tank Parameters for the EPA TANKS Program

Unit ID	Tank	Shell Height (ft)	Shell Diameter (ft)	Liquid Height (ft) [a]	Average Liquid Height (ft) [a]	Turnovers/ year [b]	Tanks Contents
T01	C7 Distribution Tank (T-C7D)	14.00	12.00	13.50	13.50	37.71 [b]	Sodium Akylmonothio-phosphate Collector
T02	MIBC Storage Tank (T-MIBCS)	14.00	12.00	13.50	13.50	15.54 [b]	Methyl Isobutyl Carbinol
T03	Diesel Fuel Storage Tank - Heavy Vehicles 1 (T-DFS-HV1)	20.00	30.00	19.00	19.00	67.19 [b]	Distillate Fuel Oil No. 2
T04	Diesel Fuel Storage Tank - Heavy Vehicles 2 (T-DFS-HV2)	20.00	30.00	19.00	19.00	67.19 [b]	Distillate Fuel Oil No. 2

[a] The liquid height and average liquid height are either determined by using the shell diameter and calculating the height of the liquid needed to equal the capacity of the tank or assuming the tank contents will average 0.5 feet less than the tank shell height (the tank capacities are presented in Appendix D).

[b] The turnovers per year are calculated based on the capacity of the tanks (presented in Appendix D) and the chemical usage rates. Usage rates for C7 and MIBC are 430,733 gallons/year and 177,521 gallons/year, respectively. The diesel fuel usage rates for heavy vehicles are estimated to be 13,500,000 gallons/year, equally divided between the two storage tanks.

13. TAILPIPE EMISSIONS FROM MOBILE ENGINES

Process Rate

The annual, daily, and hourly process rates for the mobile engines at the RCP are based on the hours of operation and VMT for the nonroad and on-road engines, respectively, when calculating PM, PM_{10}, $PM_{2.5}$, CO, NO_x, and VOC tailpipe emissions. When calculating SO_2, CO_2, and SO_4 tailpipe emissions, the annual, daily, and hourly process rates are based solely on hours of operation.

The process rates for the dozers, water trucks, and graders are presented in Sections 2.6, 2.7, and 2.8, respectively. The VMT process rates for the on-road support vehicles are presented in Section 2.9. The hours of operation for the shipment and delivery vehicles are calculated by dividing the VMT by an estimated average travel speed of 25 miles per hour.

All other annual process rates (hours of operation and VMT) are based on usage determinations, which are anticipated to be consistent throughout the life of the mine. Except for the haul trucks and emergency pumps, the daily process rates are calculated by dividing the annual process rates by 365, the quantity of days per year the mobile engines will be used. The hourly process rates are calculated by dividing the daily process rate by 24 hours/day.

The daily and hourly process rates for the haul trucks are calculated assuming all haul trucks are operating 24 hours/day and 1 hour/hour. The emergency pumps will only be used in emergency power situations and for testing and maintenance purposes, estimated at 500 hours/year. However, the emergency pumps are capable of operating 24 hours/day and 1 hour/hour.

In order to calculate tailpipe emissions, the horsepower rating, load factor and fleet size are also needed for each type of mobile engine. Except for the emergency pumps, the load factors are obtained from the average medium or typical load factors from the manufacturer's information (see Appendix F) or from the EPA document *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling*. The emergency pumps are assumed to operate at 100% load during emergency situations.

The process rates and supporting information for the mobile engines are presented in Table E.1 of Appendix E.

Emission Factor

Uncontrolled PM, PM_{10}, $PM_{2.5}$, CO, NO_x, SO_2, VOC, CO_2, SO_4, and soot emissions are calculated using emission factors from the following sources:

1. Nonroad Engine Emission Standards (PM, PM_{10}, $PM_{2.5}$, CO, NO_x, and VOC);

2. EPA Mobile6 program output (PM, PM_{10}, $PM_{2.5}$, CO, NO_x, and VOC);

3. 100% conversion of the sulfur in the fuel to SO_2;

4. 99% conversion of the carbon in the fuel to CO_2; and

5. The EPA document *"MOBILE6.1 Particulate Emission Factor Model Technical Description Final Report"* (SO_4 and soot)

Nonroad Engine Emission Standards

The RCP has committed to using Tier 4 engines in all nonroad engines except the haul trucks and the 2,000 hp front end loaders, which will use Tier 2 engines.

Uncontrolled PM, PM_{10}, $PM_{2.5}$, CO, NO_x, and VOC emissions from the Tier 2 engines are calculated using the exhaust emission standards for nonroad engines from NSPS, 40 CFR 89, Section 112. Uncontrolled PM, PM_{10}, $PM_{2.5}$, CO, NO_x, and VOC emissions from the Tier 4 engines are calculated using the final exhaust emission standards for nonroad engines from NSPS, 40 CFR 1039.

PM_{10} and $PM_{2.5}$ emissions from the Tier 2 and Tier 4 engines are not listed as emission standards and are assumed to be equal to PM emissions. The NO_x and VOC emission factors are combined in the Tier 2 nonroad engine emission standard. The EPA document *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition* includes information on the fraction of NO_x and VOC emissions in the combined Tier 2 emission standard and is used to separate the NO_x and VOC emissions.

EPA Mobile6 Program Output

The emission factors for on-road engines were developed using the EPA Mobile6 vehicle emission modeling program. The inputs for the program included:

- Hourly temperature data (average values collected at the meteorological station at the RCP from April 2006 through May 2009);
- 2010 calendar year;
- Gasoline RVP of 9.0 (maximum value for Arizona);
- Designation to run the program for PM_{10} (it is assumed that PM and $PM_{2.5}$ emissions are equal to PM_{10}); and
- 15 ppm sulfur content of the diesel fuel.

The output of the Mobile6 program is presented in Appendix G. The on-road gasoline fuel vehicles at the RCP are considered Class 3/4 Light Duty Gasoline Trucks (LDGT34). The on-road diesel fuel vehicles are considered Heavy Duty Diesel Vehicles (HDDV).

100% Conversion of the Sulfur in the Fuel to SO_2

The SO_2 emissions from all mobile engines are calculated assuming 100% of the sulfur in the fuel used in the engines is converted to SO_2. The RCP is expected to use 13,650,000 gallons of diesel fuel per year for the mobile engines with a sulfur content of 15 ppm. Gasoline usage is expected to be 150,000 gallons per year with a sulfur content of 30 ppm. The total SO_2 emissions from diesel and gasoline fuel can be distributed to each mobile engine based on the individual horsepower of the engine compared to the total horsepower of all mobile engines at the RCP using either diesel or gasoline fuel.

99% Conversion of the Carbon in the Fuel to CO_2

CO_2 emissions from the diesel fuel mobile engines are calculated using the emission factor of 22.3 lb/gallon, from AP-42, Table 1.3-12 (05/10) for No. 2 diesel fuel. The CO_2 emission factor is a default value for diesel fuel combustion (independent of internal or external combustion) and is based on an average No. 2 diesel fuel carbon content of 87.25%.

CO_2 emissions from the gasoline fuel mobile engines are calculated using the emission factor of 1.08 lb/hp-hr, from AP-42, Table 3.3-1 (10/96), which is based on an average gasoline carbon content of 86%.

Both CO_2 emission factors assume 99% of the carbon in the fuel used in the engines is converted to CO_2.

MOBILE6.1 Particulate Emission Factor Model

SO_4 and soot emissions are only calculated for the diesel fuel mobile engines. The SO_4 emissions are calculated using the same methodology for the calculation of SO_2 emissions, except assuming only 2% of the sulfur in the diesel fuel is converted to SO_4. This assumption is from Section 3.2.6.4 of the EPA document *"MOBILE6.1 Particulate Emission Factor Model Technical Description Final Report"*.

Soot (or elemental carbon) emissions are calculated using the methodology from Sections 3.2.1 through 3.2.3 of the EPA document *"MOBILE6.1 Particulate Emission Factor Model Technical Description Final Report"*. The methodology includes the use of the following equations:

$$\text{Soot} = \text{Exhaust PM - Sulfate - Organic Carbon - Lead} \qquad (10a)$$

$$\text{Organic Carbon} = (\text{Exhaust PM - Sulfate - Lead})(\text{O Fraction}) \qquad (10b)$$

where:

Soot = soot emissions (lb/hr, tons/day, or tons/year)

Exhaust PM	=	PM emissions (lb/hr, tons/day, or tons/year, see Nonroad Engine Emission Standards section)
Sulfate	=	SO_4 emissions (lb/hr, tons/day, or tons/year, see MOBILE6.1 Particulate Emission Factor Model section)
Organic Carbon	=	organic carbon emissions (lb/hr, tons/day, or tons/year)
Lead	=	lead emissions (lb/hr, tons/day, or tons/year, assumed to be 0 due to diesel fuel subsequent to 1991 being free of lead)
O Fraction	=	organic carbon fraction (values are a function of vehicle class, which is dependent on vehicle weight, see Section 3.2.1 of the EPA MOBILE6.1 document)

Control Efficiency

Besides good operating practices, other pollution control methods are not implemented on the mobile engines.

APPENDIX A

PROCESS RATES FROM THE MINE PLAN OF OPERATIONS

Annual Process Rates at the RCP Determined by the Mine Plan of Operations

Process Category	Year 1	Year 5	Year 10	Year 15	Year 20
Mining					
Concentrate Ore Mined (tons)	21,535,000	27,375,000	27,375,000	27,375,000	27,375,000
Leach Ore Mined (tons)	20,805,000	1,825,000	0	0	0
Waste Mined (tons)	73,000,000	80,300,000	81,577,500	52,012,500	4,380,000
Total Material Mined (tons)	115,340,000	109,500,000	108,952,500	79,387,500	31,755,000
Drilling and Blasting					
Number of Holes Drilled	29,200	27,840	27,680	20,160	8,080
ANFO Usage (tons)	18,980	18,096	17,992	13,104	5,252
Blasts	365	348	346	252	101
Bulldozer Use					
D11T Crawler Dozers (hours)	12,000	12,000	12,000	12,000	6,000
D10T Crawler Dozers (hours)	18,000	18,000	18,270	18,000	12,000
D8T Crawler Dozer (hours)	6,570	6,570	6,570	6,570	6,570
834H Rubber Tired Dozers (hours)	18,450	18,600	18,525	15,225	6,090
Total all Bulldozers (hours)	55,020	55,170	55,365	51,795	30,660

Annual Process Rates at the RCP Determined by the Mine Plan of Operations					
Process Category	Year 1	Year 5	Year 10	Year 15	Year 20
Motor Grader Use					
24M Motor Grader (5.3 mph) (hours)	6,000	6,000	6,000	6,000	6,000
16M Motor Graders (4.6 mph) (hours)	18,000	12,000	12,000	12,000	6,000
Total all Graders (hours)	24,000	18,000	18,000	18,000	12,000
Water Truck Use					
Total all Water Trucks (hours)	13,000	13,000	13,000	13,000	8,000
Haul Truck Use					
Distance from Mining Location to Primary Crusher / Run of Mine Stockpile (feet)	3,620 (inside the pit) 6,033 (outside the pit)	9,000 (inside the pit) 5,205 (outside the pit)	10,701 (inside the pit) 3,385 (outside the pit)	14,720 (inside the pit) 3,088 (outside the pit)	16,770 (inside the pit) 4,595 (outside the pit)
Distance from Mining Location to Leach Pad (feet)	2,787 (inside the pit) 6,783 (outside the pit)	3,990 (inside the pit) 6,584 (outside the pit)	0 (inside the pit) 0 (outside the pit)	0 (inside the pit) 0 (outside the pit)	0 (inside the pit) 0 (outside the pit)
Distance from Mining Location to Waste Rock Storage Area (feet)	2,628 (inside the pit) 12,081 (outside the pit)	6,461 (inside the pit) 11,442 (outside the pit)	5,200 (inside the pit) 8,006 (outside the pit)	7,620 (inside the pit) 10,876 (outside the pit)	18,100 (inside the pit) 16,226 (outside the pit)
Concentrate Ore (VMT)	314,966	589,185	584,249	738,627	886,162
Leach Ore (VMT)	301,673	29,239	0	0	0
Waste (VMT)	1,626,905	2,178,198	1,632,292	1,457,611	227,800
Total (VMT)	2,243,543	2,796,622	2,216,540	2,196,238	1,113,962

APPENDIX B

SUPPORT VEHICLE INFORMATION

Table B.1 Support Vehicle Total VMT and Weighted Average - Year 1								
Support Vehicle Description	**Fleet Size**	**Vehicle Weight (tons)**	**VMT Traveled (total) - Year 1**			**Weight * VMT Traveled (total) - Year 1**		
			Annual	**Daily**	**Hourly**	**Annual**	**Daily**	**Hourly**
Diesel Blasthole Drill, 12.25 inches	2	190.0	133	0.37	0.37	25,363	69.49	69.49
Electric Blasthole Drill, 12.25 inches	1	200.0	67	0.18	0.18	13,349	36.57	36.57
Hydraulic DML 45 Drill	1	50.0	67	0.18	0.18	3,337	9.14	9.14
Front End Loaders	2	253.0	41,391	113.40	4.73	10,471,923	28,690.20	1,195.43
Stemming Truck	2	20.0	5,000	13.70	0.57	100,000	273.97	11.42
ANFO/Slurry Truck, 20 tons	2	20.0	5,000	13.70	0.57	100,000	273.97	11.42
Powder Truck, 2 tons	2	10.0	5,000	13.70	0.57	50,000	136.99	5.71
Front End Loaders, 8 yd^3	2	26.1	8,000	21.92	0.91	209,016	572.65	23.86
Hydraulic Excavator, 385 Cat CL	2	93.7	22,075	60.48	2.52	2,068,005	5,665.77	236.07
Backhoe/Loader, 2 yd^3	1	12.1	1,500	4.11	0.17	18,106	49.60	2.07
All-Terrain Crane, 75 tons	1	36.0	2,000	5.48	0.23	72,000	197.26	8.22
Transporter with Tractor, 200 tons	1	98.4	2,000	5.48	0.23	196,800	539.18	22.47
Fuel/Lube Trucks, 6,000 gallons	2	73.1	30,000	82.19	3.42	2,193,990	6,010.93	250.46

Table B.1 Support Vehicle Total VMT and Weighted Average - Year 1								
Support Vehicle Description	Fleet Size	Vehicle Weight (tons)	VMT Traveled (total) - Year 1			Weight * VMT Traveled (total) - Year 1		
			Annual	Daily	Hourly	Annual	Daily	Hourly
Mechanic Field Service Trucks	5	9.8	75,000	205.48	8.56	731,250	2,003.42	83.48
Tire Handler	1	8.0	1,000	2.74	0.11	8,000	21.92	0.91
Shop Forklift, 12,000 lbs	1	8.0	1,000	2.74	0.11	8,000	21.92	0.91
Integrated Tool Carrier, 140 hp	1	16.0	3,000	8.22	0.34	48,000	131.51	5.48
Primary Crushing Mobile Crane - 400 tons	1	225.0	92	0.25	0.01	20,700	56.71	2.36
Copper Concentrate Area Front End Loader - Cat 930	1	14.4	11,680	32.00	1.33	168,192	460.80	19.20
Molybdenum Packaging Forklift, 7,000 lbs	1	5.8	3,000	8.22	0.34	17,340	47.51	1.98
Copper Cathode Forklift	1	11.0	3,000	8.22	0.34	33,000	90.41	3.77
Boom Trucks 10 tons, 45 foot boom	1	13.0	3,000	8.22	0.34	39,000	106.85	4.45
Boom Trucks 15 tons, 60 foot boom	1	16.5	3,000	8.22	0.34	49,500	135.62	5.65
Front End Loader, 6 yd^3	1	33.6	6,000	16.44	0.68	201,882	553.10	23.05
Front End Loader, 5 yd^3	1	14.4	3,500	9.59	0.40	50,269	137.72	5.74
Bob Cats, 2,400 lbs	2	1.2	7,000	19.18	0.80	8,400	23.01	0.96

Table B.1 Support Vehicle Total VMT and Weighted Average - Year 1								
Support Vehicle Description	Fleet Size	Vehicle Weight (tons)	VMT Traveled (total) - Year 1			Weight * VMT Traveled (total) - Year 1		
			Annual	Daily	Hourly	Annual	Daily	Hourly
Fork Lift, 2,000 lbs	1	3.0	3,000	8.22	0.34	9,000	24.66	1.03
Fork Lift, 5,000 lbs	1	4.0	3,000	8.22	0.34	12,000	32.88	1.37
Fork Lift, 3,000 lbs	2	3.0	6,000	16.44	0.68	18,000	49.32	2.05
Flat Bed Trucks, 10 tons	2	13.0	6,000	16.44	0.68	77,700	212.88	8.87
Dump Truck, 10 tons	1	25.7	3,000	8.22	0.34	77,220	211.56	8.82
Mobile Hydraulic Crane, 60 tons	1	47.9	2,000	5.48	0.23	95,800	262.47	10.94
CS683 Soil Compactor / Roller	2	20.4	60,000	164.38	6.85	1,223,550	3,352.19	139.67
246C Skid Steer Loader	2	3.7	131,400	360.00	15.00	491,436	1,346.40	56.10
Off-Road Tire Handling Truck	1	54.6	7,500	20.55	0.86	409,500	1,121.92	46.75
Contractor Haul Trucks, 25 tons	2	78.5	48,000	131.51	5.48	3,768,000	10,323.29	430.14
Copper Concentrate Shipment Vehicles	--	24.0	169,872	1,021.20	29.60	4,076,928	24,508.80	710.40
Molybdenum Concentrate Shipment Vehicles	--	19.0	2,145	15.34	7.40	40,752	291.43	140.60
Sulfuric Acid Delivery Vehicles	--	22.0	52,021	142.52	22.20	1,144,454	3,135.49	488.40

Table B.1 Support Vehicle Total VMT and Weighted Average - Year 1								
Support Vehicle Description	**Fleet Size**	**Vehicle Weight (tons)**	**VMT Traveled (total) - Year 1**			**Weight * VMT Traveled (total) - Year 1**		
			Annual	**Daily**	**Hourly**	**Annual**	**Daily**	**Hourly**
Lime Delivery Vehicles	--	22.0	19,072	52.25	14.80	419,580	1,149.53	325.60
SAG Mill and Ball Mill Grinding Balls Delivery Vehicles	--	24.0	5,858	22.53	14.80	140,600	540.77	355.20
Diesel Fuel Delivery Vehicles	--	25.0	17,136	46.95	14.80	428,398	1,173.69	370.00
Copper Cathode Shipment Vehicles	--	22.0	4,997	42.17	14.80	109,931	927.75	325.60
Ammonium Nitrate Delivery Vehicles	--	22.0	6,384	24.55	7.40	140,452	540.20	162.80
Miscellaneous Consumables Delivery Vehicles	--	10.0	12,486	48.02	7.40	124,861	480.23	74.00
Miscellaneous Fuels and Lubricants Delivery Vehicles	--	15.0	1,110	7.40	7.40	16,650	111.00	111.00
Pickup Trucks	20	7.5	240,000	657.53	27.40	1,800,000	4,931.51	205.48
Crew Van	3	4.4	24,000	65.75	2.74	105,600	289.32	12.05
Lot Pick-Up Trucks	20	3.0	60,000	164.38	6.85	180,000	493.15	20.55
Total:	--	--	**1,127,486**	**3,714.46**	**236.78**	31,815,833	101,827	6,048
Weighted Average:						**28.22**	**27.41**	**25.54**

Table B.2 Support Vehicle Total VMT and Weighted Average - Year 5								
Support Vehicle Description	Fleet Size	Vehicle Weight (tons)	VMT Traveled (total) - Year 5			Weight * VMT Traveled (total) - Year 5		
			Annual	Daily	Hourly	Annual	Daily	Hourly
Diesel Blasthole Drill, 12.25 inches	2	190.0	127	0.37	0.37	24,181	69.49	69.49
Electric Blasthole Drill, 12.25 inches	1	200.0	64	0.18	0.18	12,727	36.57	36.57
Hydraulic DML 45 Drill	1	50.0	64	0.18	0.18	3,182	9.14	9.14
Front End Loaders	2	253.0	41,391	113.40	4.73	10,471,923	28,690.20	1,195.43
Stemming Truck	2	20.0	5,000	13.70	0.57	100,000	273.97	11.42
ANFO/Slurry Truck, 20 tons	2	20.0	5,000	13.70	0.57	100,000	273.97	11.42
Powder Truck, 2 tons	2	10.0	5,000	13.70	0.57	50,000	136.99	5.71
Front End Loaders, 8 yd^3	2	26.1	8,000	21.92	0.91	209,016	572.65	23.86
Hydraulic Excavator, 385 Cat CL	2	93.7	22,075	60.48	2.52	2,068,005	5,665.77	236.07
Backhoe/Loader, 2 yd^3	1	12.1	1,500	4.11	0.17	18,106	49.60	2.07
All-Terrain Crane, 75 tons	1	36.0	2,000	5.48	0.23	72,000	197.26	8.22
Transporter with Tractor, 200 tons	1	98.4	2,000	5.48	0.23	196,800	539.18	22.47
Fuel/Lube Trucks, 6,000 gallons	2	73.1	30,000	82.19	3.42	2,193,990	6,010.93	250.46

Table B.2 Support Vehicle Total VMT and Weighted Average - Year 5								
Support Vehicle Description	**Fleet Size**	**Vehicle Weight (tons)**	**VMT Traveled (total) - Year 5**			**Weight * VMT Traveled (total) - Year 5**		
			Annual	**Daily**	**Hourly**	**Annual**	**Daily**	**Hourly**
Mechanic Field Service Trucks	5	9.8	75,000	205.48	8.56	731,250	2,003.42	83.48
Tire Handler	1	8.0	1,000	2.74	0.11	8,000	21.92	0.91
Shop Forklift, 12,000 lbs	1	8.0	1,000	2.74	0.11	8,000	21.92	0.91
Integrated Tool Carrier, 140 hp	1	16.0	3,000	8.22	0.34	48,000	131.51	5.48
Primary Crushing Mobile Crane - 400 tons	1	225.0	92	0.25	0.01	20,700	56.71	2.36
Copper Concentrate Area Front End Loader - Cat 930	1	14.4	11,680	32.00	1.33	168,192	460.80	19.20
Molybdenum Packaging Forklift, 7,000 lbs	1	5.8	3,000	8.22	0.34	17,340	47.51	1.98
Copper Cathode Forklift	1	11.0	3,000	8.22	0.34	33,000	90.41	3.77
Boom Trucks 10 tons, 45 foot boom	1	13.0	3,000	8.22	0.34	39,000	106.85	4.45
Boom Trucks 15 tons, 60 foot boom	1	16.5	3,000	8.22	0.34	49,500	135.62	5.65
Front End Loader, 6 yd^3	1	33.6	6,000	16.44	0.68	201,882	553.10	23.05
Front End Loader, 5 yd^3	1	14.4	3,500	9.59	0.40	50,269	137.72	5.74
Bob Cats, 2,400 lbs	2	1.2	7,000	19.18	0.80	8,400	23.01	0.96

Table B.2 Support Vehicle Total VMT and Weighted Average - Year 5								
Support Vehicle Description	**Fleet Size**	**Vehicle Weight (tons)**	**VMT Traveled (total) - Year 5**			**Weight * VMT Traveled (total) - Year 5**		
			Annual	**Daily**	**Hourly**	**Annual**	**Daily**	**Hourly**
Fork Lift, 2,000 lbs	1	3.0	3,000	8.22	0.34	9,000	24.66	1.03
Fork Lift, 5,000 lbs	1	4.0	3,000	8.22	0.34	12,000	32.88	1.37
Fork Lift, 3,000 lbs	2	3.0	6,000	16.44	0.68	18,000	49.32	2.05
Flat Bed Trucks, 10 tons	2	13.0	6,000	16.44	0.68	77,700	212.88	8.87
Dump Truck, 10 tons	1	25.7	3,000	8.22	0.34	77,220	211.56	8.82
Mobile Hydraulic Crane, 60 tons	1	47.9	2,000	5.48	0.23	95,800	262.47	10.94
CS683 Soil Compactor / Roller	2	20.4	60,000	164.38	6.85	1,223,550	3,352.19	139.67
246C Skid Steer Loader	2	3.7	131,400	360.00	15.00	491,436	1,346.40	56.10
Off-Road Tire Handling Truck	1	54.6	7,500	20.55	0.86	409,500	1,121.92	46.75
Contractor Haul Trucks, 25 tons	2	78.5	48,000	131.51	5.48	3,768,000	10,323.29	430.14
Copper Concentrate Shipment Vehicles	--	24.0	169,872	1,021.20	29.60	4,076,928	24,508.80	710.40
Molybdenum Concentrate Shipment Vehicles	--	19.0	2,145	15.34	7.40	40,752	291.43	140.60
Sulfuric Acid Delivery Vehicles	--	22.0	52,021	142.52	22.20	1,144,454	3,135.49	488.40

Table B.2 Support Vehicle Total VMT and Weighted Average - Year 5								
Support Vehicle Description	**Fleet Size**	**Vehicle Weight (tons)**	**VMT Traveled (total) - Year 5**			**Weight * VMT Traveled (total) - Year 5**		
			Annual	**Daily**	**Hourly**	**Annual**	**Daily**	**Hourly**
Lime Delivery Vehicles	--	22.0	19,072	52.25	14.80	419,580	1,149.53	325.60
SAG Mill and Ball Mill Grinding Balls Delivery Vehicles	--	24.0	5,858	22.53	14.80	140,600	540.77	355.20
Diesel Fuel Delivery Vehicles	--	25.0	17,136	46.95	14.80	428,398	1,173.69	370.00
Copper Cathode Shipment Vehicles	--	22.0	4,997	42.17	14.80	109,931	927.75	325.60
Ammonium Nitrate Delivery Vehicles	--	22.0	6,384	24.55	7.40	140,452	540.20	162.80
Miscellaneous Consumables Delivery Vehicles	--	10.0	12,486	48.02	7.40	124,861	480.23	74.00
Miscellaneous Fuels and Lubricants Delivery Vehicles	--	15.0	1,110	7.40	7.40	16,650	111.00	111.00
Pickup Trucks	20	7.5	240,000	657.53	27.40	1,800,000	4,931.51	205.48
Crew Van	3	4.4	24,000	65.75	2.74	105,600	289.32	12.05
Lot Pick-Up Trucks	20	3.0	60,000	164.38	6.85	180,000	493.15	20.55
Total:	--	--	**1,127,473**	**3,714.46**	**236.78**	31,813,875	101,827	6,048
Weighted Average:						**28.22**	**27.41**	**25.54**

Table B.3 Support Vehicle Total VMT and Weighted Average - Year 10								
Support Vehicle Description	Fleet Size	Vehicle Weight (tons)	VMT Traveled (total) - Year 10			Weight * VMT Traveled (total) - Year 10		
			Annual	Daily	Hourly	Annual	Daily	Hourly
Diesel Blasthole Drill, 12.25 inches	2	190.0	127	0.37	0.37	24,042	69.49	69.49
Electric Blasthole Drill, 12.25 inches	1	200.0	63	0.18	0.18	12,654	36.57	36.57
Hydraulic DML 45 Drill	1	50.0	63	0.18	0.18	3,163	9.14	9.14
Front End Loaders	2	253.0	41,391	113.40	4.73	10,471,923	28,690.20	1,195.43
Stemming Truck	2	20.0	5,000	13.70	0.57	100,000	273.97	11.42
ANFO/Slurry Truck, 20 tons	2	20.0	5,000	13.70	0.57	100,000	273.97	11.42
Powder Truck, 2 tons	2	10.0	5,000	13.70	0.57	50,000	136.99	5.71
Front End Loaders, 8 yd^3	2	26.1	8,000	21.92	0.91	209,016	572.65	23.86
Hydraulic Excavator, 385 Cat CL	2	93.7	22,075	60.48	2.52	2,068,005	5,665.77	236.07
Backhoe/Loader, 2 yd^3	1	12.1	1,500	4.11	0.17	18,106	49.60	2.07
All-Terrain Crane, 75 tons	1	36.0	2,000	5.48	0.23	72,000	197.26	8.22
Transporter with Tractor, 200 tons	1	98.4	2,000	5.48	0.23	196,800	539.18	22.47
Fuel/Lube Trucks, 6,000 gallons	2	73.1	30,000	82.19	3.42	2,193,990	6,010.93	250.46

Table B.3 Support Vehicle Total VMT and Weighted Average - Year 10								
Support Vehicle Description	**Fleet Size**	**Vehicle Weight (tons)**	**VMT Traveled (total) - Year 10**			**Weight * VMT Traveled (total) - Year 10**		
			Annual	**Daily**	**Hourly**	**Annual**	**Daily**	**Hourly**
Mechanic Field Service Trucks	5	9.8	75,000	205.48	8.56	731,250	2,003.42	83.48
Tire Handler	1	8.0	1,000	2.74	0.11	8,000	21.92	0.91
Shop Forklift, 12,000 lbs	1	8.0	1,000	2.74	0.11	8,000	21.92	0.91
Integrated Tool Carrier, 140 hp	1	16.0	3,000	8.22	0.34	48,000	131.51	5.48
Primary Crushing Mobile Crane - 400 tons	1	225.0	92	0.25	0.01	20,700	56.71	2.36
Copper Concentrate Area Front End Loader - Cat 930	1	14.4	11,680	32.00	1.33	168,192	460.80	19.20
Molybdenum Packaging Forklift, 7,000 lbs	1	5.8	3,000	8.22	0.34	17,340	47.51	1.98
Copper Cathode Forklift	1	11.0	3,000	8.22	0.34	33,000	90.41	3.77
Boom Trucks 10 tons, 45 foot boom	1	13.0	3,000	8.22	0.34	39,000	106.85	4.45
Boom Trucks 15 tons, 60 foot boom	1	16.5	3,000	8.22	0.34	49,500	135.62	5.65
Front End Loader, 6 yd^3	1	33.6	6,000	16.44	0.68	201,882	553.10	23.05
Front End Loader, 5 yd^3	1	14.4	3,500	9.59	0.40	50,269	137.72	5.74
Bob Cats, 2,400 lbs	2	1.2	7,000	19.18	0.80	8,400	23.01	0.96

Table B.3 Support Vehicle Total VMT and Weighted Average - Year 10								
Support Vehicle Description	Fleet Size	Vehicle Weight (tons)	VMT Traveled (total) - Year 10			Weight * VMT Traveled (total) - Year 10		
			Annual	Daily	Hourly	Annual	Daily	Hourly
Fork Lift, 2,000 lbs	1	3.0	3,000	8.22	0.34	9,000	24.66	1.03
Fork Lift, 5,000 lbs	1	4.0	3,000	8.22	0.34	12,000	32.88	1.37
Fork Lift, 3,000 lbs	2	3.0	6,000	16.44	0.68	18,000	49.32	2.05
Flat Bed Trucks, 10 tons	2	13.0	6,000	16.44	0.68	77,700	212.88	8.87
Dump Truck, 10 tons	1	25.7	3,000	8.22	0.34	77,220	211.56	8.82
Mobile Hydraulic Crane, 60 tons	1	47.9	2,000	5.48	0.23	95,800	262.47	10.94
CS683 Soil Compactor / Roller	2	20.4	60,000	164.38	6.85	1,223,550	3,352.19	139.67
246C Skid Steer Loader	2	3.7	131,400	360.00	15.00	491,436	1,346.40	56.10
Off-Road Tire Handling Truck	1	54.6	7,500	20.55	0.86	409,500	1,121.92	46.75
Contractor Haul Trucks, 25 tons	2	78.5	48,000	131.51	5.48	3,768,000	10,323.29	430.14
Copper Concentrate Shipment Vehicles	--	24.0	169,872	1,021.20	29.60	4,076,928	24,508.80	710.40
Molybdenum Concentrate Shipment Vehicles	--	19.0	2,145	15.34	7.40	40,752	291.43	140.60
Sulfuric Acid Delivery Vehicles	--	22.0	52,021	142.52	22.20	1,144,454	3,135.49	488.40

Table B.3 Support Vehicle Total VMT and Weighted Average - Year 10								
Support Vehicle Description	**Fleet Size**	**Vehicle Weight (tons)**	**VMT Traveled (total) - Year 10**			**Weight * VMT Traveled (total) - Year 10**		
			Annual	**Daily**	**Hourly**	**Annual**	**Daily**	**Hourly**
Lime Delivery Vehicles	--	22.0	19,072	52.25	14.80	419,580	1,149.53	325.60
SAG Mill and Ball Mill Grinding Balls Delivery Vehicles	--	24.0	5,858	22.53	14.80	140,600	540.77	355.20
Diesel Fuel Delivery Vehicles	--	25.0	17,136	46.95	14.80	428,398	1,173.69	370.00
Copper Cathode Shipment Vehicles	--	22.0	4,997	42.17	14.80	109,931	927.75	325.60
Ammonium Nitrate Delivery Vehicles	--	22.0	6,384	24.55	7.40	140,452	540.20	162.80
Miscellaneous Consumables Delivery Vehicles	--	10.0	12,486	48.02	7.40	124,861	480.23	74.00
Miscellaneous Fuels and Lubricants Delivery Vehicles	--	15.0	1,110	7.40	7.40	16,650	111.00	111.00
Pickup Trucks	20	7.5	240,000	657.53	27.40	1,800,000	4,931.51	205.48
Crew Van	3	4.4	24,000	65.75	2.74	105,600	289.32	12.05
Lot Pick-Up Trucks	20	3.0	60,000	164.38	6.85	180,000	493.15	20.55
Total:	--	--	**1,127,472**	**3,714.46**	**236.78**	31,813,645	101,827	6,048
Weighted Average:						**28.22**	**27.41**	**25.54**

Table B.4 Support Vehicle Total VMT and Weighted Average - Year 15								
Support Vehicle Description	Fleet Size	Vehicle Weight (tons)	VMT Traveled (total) - Year 15			Weight * VMT Traveled (total) - Year 15		
			Annual	Daily	Hourly	Annual	Daily	Hourly
Diesel Blasthole Drill, 12.25 inches	2	190.0	129	0.37	0.37	24,459	69.49	69.49
Electric Blasthole Drill, 12.25 inches	1	200.0	64	0.18	0.18	12,873	36.57	36.57
Hydraulic DML 45 Drill	1	50.0	64	0.18	0.18	3,218	9.14	9.14
Front End Loaders	2	253.0	41,391	113.40	4.73	10,471,923	28,690.20	1,195.43
Stemming Truck	2	20.0	5,000	13.70	0.57	100,000	273.97	11.42
ANFO/Slurry Truck, 20 tons	2	20.0	5,000	13.70	0.57	100,000	273.97	11.42
Powder Truck, 2 tons	2	10.0	5,000	13.70	0.57	50,000	136.99	5.71
Front End Loaders, 8 yd^3	2	26.1	8,000	21.92	0.91	209,016	572.65	23.86
Hydraulic Excavator, 385 Cat CL	2	93.7	22,075	60.48	2.52	2,068,005	5,665.77	236.07
Backhoe/Loader, 2 yd^3	1	12.1	1,500	4.11	0.17	18,106	49.60	2.07
All-Terrain Crane, 75 tons	1	36.0	2,000	5.48	0.23	72,000	197.26	8.22
Transporter with Tractor, 200 tons	1	98.4	2,000	5.48	0.23	196,800	539.18	22.47
Fuel/Lube Trucks, 6,000 gallons	2	73.1	30,000	82.19	3.42	2,193,990	6,010.93	250.46

Table B.4 Support Vehicle Total VMT and Weighted Average - Year 15								
Support Vehicle Description	Fleet Size	Vehicle Weight (tons)	VMT Traveled (total) - Year 15			Weight * VMT Traveled (total) - Year 15		
			Annual	Daily	Hourly	Annual	Daily	Hourly
Mechanic Field Service Trucks	5	9.8	75,000	205.48	8.56	731,250	2,003.42	83.48
Tire Handler	1	8.0	1,000	2.74	0.11	8,000	21.92	0.91
Shop Forklift, 12,000 lbs	1	8.0	1,000	2.74	0.11	8,000	21.92	0.91
Integrated Tool Carrier, 140 hp	1	16.0	3,000	8.22	0.34	48,000	131.51	5.48
Primary Crushing Mobile Crane - 400 tons	1	225.0	92	0.25	0.01	20,700	56.71	2.36
Copper Concentrate Area Front End Loader - Cat 930	1	14.4	11,680	32.00	1.33	168,192	460.80	19.20
Molybdenum Packaging Forklift, 7,000 lbs	1	5.8	3,000	8.22	0.34	17,340	47.51	1.98
Copper Cathode Forklift	1	11.0	3,000	8.22	0.34	33,000	90.41	3.77
Boom Trucks 10 tons, 45 foot boom	1	13.0	3,000	8.22	0.34	39,000	106.85	4.45
Boom Trucks 15 tons, 60 foot boom	1	16.5	3,000	8.22	0.34	49,500	135.62	5.65
Front End Loader, 6 yd^3	1	33.6	6,000	16.44	0.68	201,882	553.10	23.05
Front End Loader, 5 yd^3	1	14.4	3,500	9.59	0.40	50,269	137.72	5.74
Bob Cats, 2,400 lbs	2	1.2	7,000	19.18	0.80	8,400	23.01	0.96

Table B.4 Support Vehicle Total VMT and Weighted Average - Year 15								
Support Vehicle Description	Fleet Size	Vehicle Weight (tons)	VMT Traveled (total) - Year 15			Weight * VMT Traveled (total) - Year 15		
			Annual	Daily	Hourly	Annual	Daily	Hourly
Fork Lift, 2,000 lbs	1	3.0	3,000	8.22	0.34	9,000	24.66	1.03
Fork Lift, 5,000 lbs	1	4.0	3,000	8.22	0.34	12,000	32.88	1.37
Fork Lift, 3,000 lbs	2	3.0	6,000	16.44	0.68	18,000	49.32	2.05
Flat Bed Trucks, 10 tons	2	13.0	6,000	16.44	0.68	77,700	212.88	8.87
Dump Truck, 10 tons	1	25.7	3,000	8.22	0.34	77,220	211.56	8.82
Mobile Hydraulic Crane, 60 tons	1	47.9	2,000	5.48	0.23	95,800	262.47	10.94
CS683 Soil Compactor / Roller	2	20.4	60,000	164.38	6.85	1,223,550	3,352.19	139.67
246C Skid Steer Loader	2	3.7	131,400	360.00	15.00	491,436	1,346.40	56.10
Off-Road Tire Handling Truck	1	54.6	7,500	20.55	0.86	409,500	1,121.92	46.75
Contractor Haul Trucks, 25 tons	2	78.5	48,000	131.51	5.48	3,768,000	10,323.29	430.14
Copper Concentrate Shipment Vehicles	--	24.0	169,872	1,021.20	29.60	4,076,928	24,508.80	710.40
Molybdenum Concentrate Shipment Vehicles	--	19.0	2,145	15.34	7.40	40,752	291.43	140.60
Sulfuric Acid Delivery Vehicles	--	22.0	52,021	142.52	22.20	1,144,454	3,135.49	488.40

Table B.4 Support Vehicle Total VMT and Weighted Average - Year 15								
Support Vehicle Description	**Fleet Size**	**Vehicle Weight (tons)**	**VMT Traveled (total) - Year 15**			**Weight * VMT Traveled (total) - Year 15**		
			Annual	**Daily**	**Hourly**	**Annual**	**Daily**	**Hourly**
Lime Delivery Vehicles	--	22.0	19,072	52.25	14.80	419,580	1,149.53	325.60
SAG Mill and Ball Mill Grinding Balls Delivery Vehicles	--	24.0	5,858	22.53	14.80	140,600	540.77	355.20
Diesel Fuel Delivery Vehicles	--	25.0	17,136	46.95	14.80	428,398	1,173.69	370.00
Copper Cathode Shipment Vehicles	--	22.0	4,997	42.17	14.80	109,931	927.75	325.60
Ammonium Nitrate Delivery Vehicles	--	22.0	6,384	24.55	7.40	140,452	540.20	162.80
Miscellaneous Consumables Delivery Vehicles	--	10.0	12,486	48.02	7.40	124,861	480.23	74.00
Miscellaneous Fuels and Lubricants Delivery Vehicles	--	15.0	1,110	7.40	7.40	16,650	111.00	111.00
Pickup Trucks	20	7.5	240,000	657.53	27.40	1,800,000	4,931.51	205.48
Crew Van	3	4.4	24,000	65.75	2.74	105,600	289.32	12.05
Lot Pick-Up Trucks	20	3.0	60,000	164.38	6.85	180,000	493.15	20.55
Total:	--	--	**1,127,476**	**3,714.46**	**236.78**	31,814,336	101,827	6,048
Weighted Average:						**28.22**	**27.41**	**25.54**

Table B.5 Support Vehicle Total VMT and Weighted Average - Year 20								
Support Vehicle Description	**Fleet Size**	**Vehicle Weight (tons)**	**VMT Traveled (total) - Year 20**			**Weight * VMT Traveled (total) - Year 20**		
			Annual	**Daily**	**Hourly**	**Annual**	**Daily**	**Hourly**
Diesel Blasthole Drill, 12.25 inches	2	190.0	37	0.37	0.37	7,018	69.49	69.49
Electric Blasthole Drill, 12.25 inches	1	200.0	18	0.18	0.18	3,694	36.57	36.57
Hydraulic DML 45 Drill	1	50.0	18	0.18	0.18	923	9.14	9.14
Front End Loaders	2	253.0	41,391	113.40	4.73	10,471,923	28,690.20	1,195.43
Stemming Truck	2	20.0	5,000	13.70	0.57	100,000	273.97	11.42
ANFO/Slurry Truck, 20 tons	2	20.0	5,000	13.70	0.57	100,000	273.97	11.42
Powder Truck, 2 tons	2	10.0	5,000	13.70	0.57	50,000	136.99	5.71
Front End Loaders, 8 yd^3	2	26.1	8,000	21.92	0.91	209,016	572.65	23.86
Hydraulic Excavator, 385 Cat CL	2	93.7	22,075	60.48	2.52	2,068,005	5,665.77	236.07
Backhoe/Loader, 2 yd^3	1	12.1	1,500	4.11	0.17	18,106	49.60	2.07
All-Terrain Crane, 75 tons	1	36.0	2,000	5.48	0.23	72,000	197.26	8.22
Transporter with Tractor, 200 tons	1	98.4	2,000	5.48	0.23	196,800	539.18	22.47
Fuel/Lube Trucks, 6,000 gallons	2	73.1	30,000	82.19	3.42	2,193,990	6,010.93	250.46

Table B.5 Support Vehicle Total VMT and Weighted Average - Year 20								
Support Vehicle Description	Fleet Size	Vehicle Weight (tons)	VMT Traveled (total) - Year 20			Weight * VMT Traveled (total) - Year 20		
			Annual	Daily	Hourly	Annual	Daily	Hourly
Mechanic Field Service Trucks	5	9.8	75,000	205.48	8.56	731,250	2,003.42	83.48
Tire Handler	1	8.0	1,000	2.74	0.11	8,000	21.92	0.91
Shop Forklift, 12,000 lbs	1	8.0	1,000	2.74	0.11	8,000	21.92	0.91
Integrated Tool Carrier, 140 hp	1	16.0	3,000	8.22	0.34	48,000	131.51	5.48
Primary Crushing Mobile Crane - 400 tons	1	225.0	92	0.25	0.01	20,700	56.71	2.36
Copper Concentrate Area Front End Loader - Cat 930	1	14.4	11,680	32.00	1.33	168,192	460.80	19.20
Molybdenum Packaging Forklift, 7,000 lbs	1	5.8	3,000	8.22	0.34	17,340	47.51	1.98
Copper Cathode Forklift	1	11.0	3,000	8.22	0.34	33,000	90.41	3.77
Boom Trucks 10 tons, 45 foot boom	1	13.0	3,000	8.22	0.34	39,000	106.85	4.45
Boom Trucks 15 tons, 60 foot boom	1	16.5	3,000	8.22	0.34	49,500	135.62	5.65
Front End Loader, 6 yd^3	1	33.6	6,000	16.44	0.68	201,882	553.10	23.05
Front End Loader, 5 yd^3	1	14.4	3,500	9.59	0.40	50,269	137.72	5.74
Bob Cats, 2,400 lbs	2	1.2	7,000	19.18	0.80	8,400	23.01	0.96

Table B.5 Support Vehicle Total VMT and Weighted Average - Year 20								
Support Vehicle Description	**Fleet Size**	**Vehicle Weight (tons)**	**VMT Traveled (total) - Year 20**			**Weight * VMT Traveled (total) - Year 20**		
			Annual	**Daily**	**Hourly**	**Annual**	**Daily**	**Hourly**
Fork Lift, 2,000 lbs	1	3.0	3,000	8.22	0.34	9,000	24.66	1.03
Fork Lift, 5,000 lbs	1	4.0	3,000	8.22	0.34	12,000	32.88	1.37
Fork Lift, 3,000 lbs	2	3.0	6,000	16.44	0.68	18,000	49.32	2.05
Flat Bed Trucks, 10 tons	2	13.0	6,000	16.44	0.68	77,700	212.88	8.87
Dump Truck, 10 tons	1	25.7	3,000	8.22	0.34	77,220	211.56	8.82
Mobile Hydraulic Crane, 60 tons	1	47.9	2,000	5.48	0.23	95,800	262.47	10.94
CS683 Soil Compactor / Roller	2	20.4	60,000	164.38	6.85	1,223,550	3,352.19	139.67
246C Skid Steer Loader	2	3.7	131,400	360.00	15.00	491,436	1,346.40	56.10
Off-Road Tire Handling Truck	1	54.6	7,500	20.55	0.86	409,500	1,121.92	46.75
Contractor Haul Trucks, 25 tons	2	78.5	48,000	131.51	5.48	3,768,000	10,323.29	430.14
Copper Concentrate Shipment Vehicles	--	24.0	169,872	1,021.20	29.60	4,076,928	24,508.80	710.40
Molybdenum Concentrate Shipment Vehicles	--	19.0	2,145	15.34	7.40	40,752	291.43	140.60
Sulfuric Acid Delivery Vehicles	--	22.0	52,021	142.52	22.20	1,144,454	3,135.49	488.40

Table B.5 Support Vehicle Total VMT and Weighted Average - Year 20								
Support Vehicle Description	**Fleet Size**	**Vehicle Weight (tons)**	**VMT Traveled (total) - Year 20**			**Weight * VMT Traveled (total) - Year 20**		
			Annual	**Daily**	**Hourly**	**Annual**	**Daily**	**Hourly**
Lime Delivery Vehicles	--	22.0	19,072	52.25	14.80	419,580	1,149.53	325.60
SAG Mill and Ball Mill Grinding Balls Delivery Vehicles	--	24.0	5,858	22.53	14.80	140,600	540.77	355.20
Diesel Fuel Delivery Vehicles	--	25.0	17,136	46.95	14.80	428,398	1,173.69	370.00
Copper Cathode Shipment Vehicles	--	22.0	4,997	42.17	14.80	109,931	927.75	325.60
Ammonium Nitrate Delivery Vehicles	--	22.0	6,384	24.55	7.40	140,452	540.20	162.80
Miscellaneous Consumables Delivery Vehicles	--	10.0	12,486	48.02	7.40	124,861	480.23	74.00
Miscellaneous Fuels and Lubricants Delivery Vehicles	--	15.0	1,110	7.40	7.40	16,650	111.00	111.00
Pickup Trucks	20	7.5	240,000	657.53	27.40	1,800,000	4,931.51	205.48
Crew Van	3	4.4	24,000	65.75	2.74	105,600	289.32	12.05
Lot Pick-Up Trucks	20	3.0	60,000	164.38	6.85	180,000	493.15	20.55
Total:	--	--	**1,127,293**	**3,714.46**	**236.78**	31,785,420	101,827	6,048
Weighted Average:						**28.20**	**27.41**	**25.54**

APPENDIX C

HYDROMETALLURGY OF COPPER

PROCEEDINGS OF THE COPPER 99 – COBRE 99
INTERNATIONAL CONFERENCE — VOLUME IV
OCTOBER 10-13, 1999, PHOENIX, ARIZONA, USA

Hydrometallurgy of Copper

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Investigation of evaporative losses in solvent extraction circuits

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ABSTRACT

Loss of organic solvent extraction circuits occurs through several accepted methods. Losses are commonly attributed to entrainment of the plant organic and evaporative loss of diluent. Evaporative losses of diluent have been estimated using various models or by considering all losses over and above entrainment to be due to evaporation. Other possible loss mechanisms are discussed and data on losses during weather conditions are presented.

Accurate estimation of evaporative loss is vitally important to the industry due to both cost factors and environmental concerns. Data for and description of the Diffusive Flux Model are presented as an improved method of estimating evaporative losses.

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INTRODUCTION

Currently operational solvent extraction plants use organic compounds to extract copper, nickel, cobalt, zinc, beryllium, and other metals from an impure leach solution, concentrating and purifying it for electrowinning or other recovery techniques. The active chemical in the extraction of the metal, the extractant, is typically dissolved in a non-reactive carrier organic, the diluent, in a 1 to 30% by volume ratio forming the plant organic. The organic phase is lost over time and must be replenished. Yearly organic usage varies with operating conditions and the experience of the operators. In general, operators reduce consumption of organic as they gain experience running their particular operation. Improved plant design has also contributed to reduced organic loss.

The barren or lean (containing low concentrations of metal species) organic phase in a solvent extraction plant is vigorously mixed with the solution containing the species to be extracted (the pregnant solution). Through the process of ion exchange, the extractant exchanges a hydrogen ion with a metal ion from the aqueous phase, chelating the metal of interest. The metal ion is thus extracted into the organic phase. This loaded organic is then contacted with a higher acid content (lower pH) aqueous phase in the stripper section. This reverses the process in the extraction stage, the extractant gives up the metal ion and takes up an hydrogen ion. While individual plants vary the most typical arrangement is two extraction stages and one stripper stage.

Loss of organic in solvent extraction circuits occurs through several accepted methods. Losses are commonly attributed to entrainment of the plant organic and evaporative loss of diluent. Evaporative losses of diluent have been estimated using various models or by considering all losses over and above entrainment levels to be due to evaporation.

All commercial diluents currently used by the industry are hydrocarbons and, as such, are classified as volatile organic compounds (VOCs). Accurate estimation of evaporative loss is vitally important to the industry due to both cost factors and environmental concerns. This paper discusses additional mechanisms of diluent loss and proposes data and models which support an improved method of estimating evaporative losses.

LOSS MECHANISMS FOR EXTRACTANTS

The extractant in copper solvent extraction is based on oxime chemistry (R-CNOH-R' where R' is either H or a short carbon chain). While the chemistry of extractants for other metals varies from diethyl hexyl phosphoric acid (DEHPA) to quaternary amines, the same basic loss mechanisms still apply. The extractant can be lost from chemical attack, entrainment into an aqueous stream, dissolution into an aqueous stream, or evaporation.

Chemical attack mechanisms for oximes include attack from oxygen, acid, nitrates, or ultraviolet radiatoion. Attack by oxygen and ultraviolet will usually leave the oxime as a water-soluble species such as an alcohol, amine, semicarbazone or carboxylic acid. Strongly acid solutions can convert the oxime into an aldehyde or ketone as described in Beyer and Walter (1). The acid strength to do this at a high reaction rate is normally 4 or 6 times the normal operating plant's g/l acid value. However, a small percentage (probably 1% or less) of the oxime can be expected to be converted each year. All of the breakdown products can be surface-active reagents that will either cause a froth, decrease surface tension, or both. Frothiness or decreased surface tension promotes entrainment and increases break times.

Another form of chemical attack is the failure to uncouple from some metal species in the strip stage. Generally, this occurs at some fixed ratio with the metal being extracted. This creates a fixed ratio of "active" to "inactive" extractant. Thus, this ratio will not effect the extractant usage once the plant reaches equilibrium after the initial fill. For some extractants, a contaminant species exists that may tie up the extractant. Unless such contaminants exist in very small amounts, there will probably be excessive extractant usage.

Extractants can also be lost by aqueous entrainment to the depleted aqueous phase (raffinate) or in the strip stage. Extractant entrained in the raffinate will generally separate in the raffinate storage pond. A thin layer of organic is often seen on many raffinate ponds. This layer is very susceptible to chemical attack mechanisms and should be recovered promptly. This layer often contains breakdown products. It should be clay treated prior to introduction to the circuit in order to remove surface-active agents (polar compounds) which contribute to additional losses. In heap leach operations entrained organic not recovered from the raffinate is lost in the heaps.

The solubilities of extractants in water are often less than 1 ppm. Surface active agents from the breakdown of oxime and diluent can promote solubility. Soluble organic will not be recovered in filters or in the organic layer of the raffinate pond. In heap leach operations, molds, fungi or bacteria living in the heaps may utilize such organic species. Extractants may also come out of solution in the heaps due to the change in pH and total dissolved solids that occurs in the leach process. If either is the case, the heaps represent a possible sink for the organic phase over and above that represented by entrainment losses.

Extractants can be lost by being tied up in a solid-organic-aqueous phase that is politely called a "gunk" or "crud" layer. This layer represents a loss of organic to the circuit until it is recovered. Some of the organic loss in this layer may never be recovered. Organic recovered from a gunk layer should be clay treated to remove degradation products before it is returned to the circuit.

Extractants generally have very low vapor pressures at room temperature. Extractant losses from evaporation should be small to negligible.

LOSS MECHANISMS FOR DILUENTS

Losses for diluent are very similar in nature to losses in extractant. All commercially used diluents, regardless of manufacturer, are very similar chemically. They are mixtures of aromatic and aliphatic hydrocarbons having carbon numbers in the range of 8 to 20 (C8 to C20) with the majority of the diluent in the C12 to C16 range. All commercial diluents are hydrogenated to eliminate any reactive double bonds.

Oxygen and strong oxidizing agents will attack many organics including diluents. They can attack the end of alkane chains to form carboxylic acids or alcohols. Bacteria, fungi, and molds are known to feed on and degrade hydrocarbons resulting in shorter chain alkanes, alcohols, ketones, aldehydes, and carboxylic acids as described in Atlas (2). With the exception of shorter alkane chains, all of the products of biological degradation are surface-active agents. Biological degradation is believed to be a significant source of diluent loss. This is evidenced by the large amounts of biological material found in plant crud.

Diluents can be entrained in either the raffinate or the strip phase. Entrainment is not known to be selective to any one component of the organic phase Thus, entrainment should remove organic that is similar in composition to the overall organic phase rather than enrich or deplete any one particular molecule.

The overall solubility of all commercial diluents is typically less than 5 ppm. Shorter alkane chain components of the diluent are more water-soluble than longer chains. As the organic phase ages in a plant, more surface-active agents will be formed by chemical and biological means. This will tend to increase the overall solubility of the organic phase. Also, degradation of diluent can result in shorter alkane chain length.

Diluents are trapped in the solid-organic-aqueous gunk layer along with the extractant. As mentioned above, organic phase material from this layer must be treated before being put back into the circuit. Some losses must be expected.

Diluent is composed of lower molecular weight compounds and has a lower boiling point than an extractant. It has been common practice to assign any losses of diluent above that needed to form a solution with the lost extractant as loss to evaporation. For example, if a plant using a 10% solution of extractant requires an annual make-up of 200,000 gallons of plant organic it would consume 180,000 gallons of diluent and 20,000 gallons of extractant provided there were no differential loss. If it actually consumed 200,000 gallons of diluent and 20,000 gallons of extractant, it would assign 20,000 gallons of diluent to evaporation loss. This assumes that the only other major loss mechanism was entrainment. As already pointed out, chemical attack and solubility mechanisms also exist which can promote differential loss rates between diluent and extractant.

EVAPORATIVE LOSS

All commercial diluents are hydrocarbons and as such are classified as volatile organic compounds (VOCs). Environmental regulations may consider diluents as a source of VOC emissions. Therefore, accurate estimation of evaporative loss is vitally important to the industry due to cost factors and environmental concerns.

Solvent extraction settling tanks appear at first glance to be an ideal situation to promote evaporation. They are large areas with a proportionally thin layer of volatile organic. However, there are some factors that mitigate evaporation. All commercial plants have walls higher than the organic level promoting a relatively still air space layer. This stillness of this air space is enhanced, in most commercial plants, by a cover. The diluent vapors are relatively heavy compared to air and tend to stratify very close to the liquid surface. If the layer of air and vapor immediately over the settler is stagnant VOCs emissions will be minimized.

WEATHER DATA

The simplest model of organic losses says that organics, especially diluent, are lost mainly to evaporation. If this model was true, one would expect that the copper solvent extraction plants of the Southwest would experience significantly higher losses in the hot summer months than in the cool winter months. Data for six major copper SX-EW plants in the southern Arizona - eastern New Mexico region from the year 1995 were examined. Plotting the total diluent usage of these plants along with the average mean temperature and average mean high temperature for each month yielded Figure 1. There is some correlation between the temperature and usage. However, the relatively cool month of December had the third highest usage, while the hot months of June and July were barely over the monthly average usage. The upward spike in the month of May and downward spike in the month of September are also hard to explain.

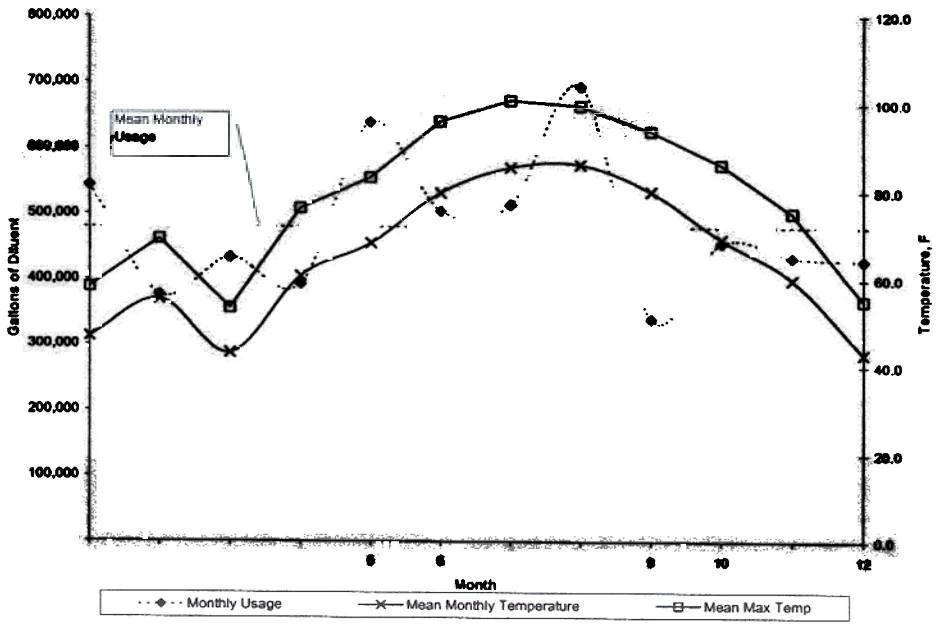

Figure 1 – Monthly Diluent Usage, Mean Temperature and Mean Maximum Temperature for Selected Copper SX-EW Plants

The other possible weather related loss mechanism is the effect of rainfall. Rain can promote organic losses through introduction of solids into the circuit. These solids promote gunk layer formation. The excess water introduced by the rainfall can increase overall aqueous stream flows promoting losses due to entrainment and organic solubility. The monthly diluent usage, total monthly rainfall, and maximum single day rainfall for the same 6 mines are plotted in Figure 2. This graph suggests that some of the high usage is probably due to rainfall. However, the spikes in May and September are still hard to explain. The above data do not appear to support attributing all differential diluent loss to evaporation as higher summer temperatures should increase evaporative losses.

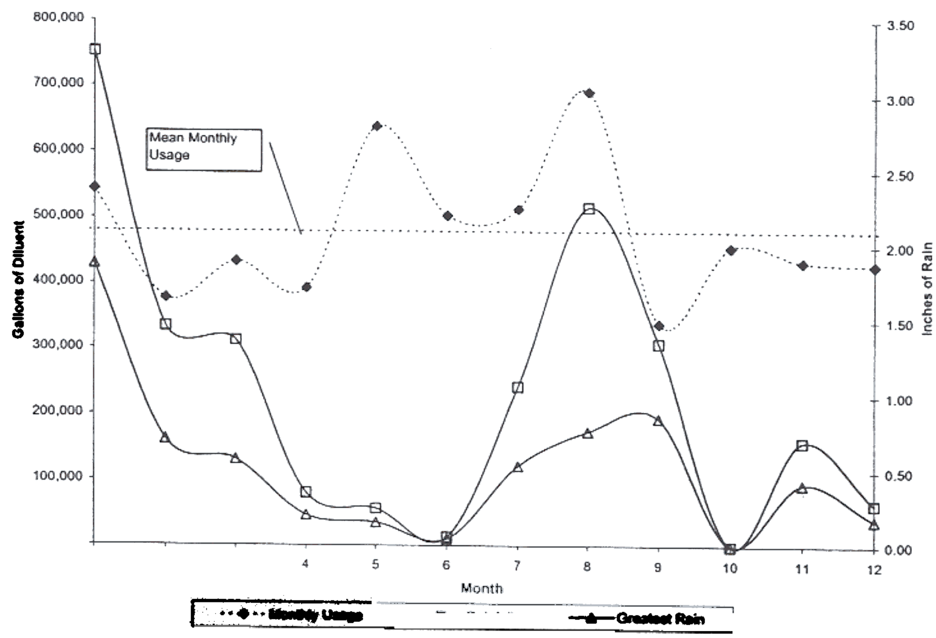

Figure 2 – Monthly Usage, Total Rainfall and Highest Single Day Rainfall for Selected Mines

DIFFUSIVE FLUX MODEL

Various models including the EPA Tanks model have been used to estimate emissions from SX operations. The validity of using these models for SX operations is debatable as the factors used in the model do not necessarily correspond to the factors present in SX operations. For example, the Tanks model is based on losses from closed tanks and incorporates tank breathing losses, tank headspace, tank cycling, etc. These conditions are not found in SX plants. These models tend to overestimate emissions based on plant experience.

Consideration of the above factors led BHP to enlist the services of Emcon to evaluate alternate modeling methods. They determined that a Diffusive Flux Model may be more suitable for modeling SX operations and more accurately reflect evaporative losses.

Phillips Mining Chemicals was concurrently investigating methods to evaluate evaporative losses. A method based on the ASTM Standard Test Method for Evaporation Loss of Lubricating Greases and Oils (ASTM D 972) was evaluated. This method incorporates controlled temperature and airflow over a sample of diluent. The loss per air exchange can be calculated based on the air flow rate. Discussions between representatives from BHP, Emcon, and Phillips indicated general agreement between the Diffusivity model and data obtained using a modification of ASTM D 972. (3)

Diluent left in a open container with some positive airflow over the container will, of course, eventually evaporate. Diluent kept in a closed container will never evaporate. Diluent kept in an open top container with little to no airflow across the surface will slowly evaporate, dependent on the diffusion of the vapor into the open air.

The solvent extraction tanks of most plants are essentially enclosed by a cover, and walls on three sides, while the fourth side (weir side) is normally left open. Most plants' raffinate ponds have high side walls, have a protective berm, or are situated in a natural valley. This minimizes air movement across the surface of the pond. This was confirmed by the measurement of little of no wind speed within the enclosed headspace. Thus, diffusion should be the major factor influencing diluent loss.

The driving force behind diffusion is the concentration gradient between a given VOC at the surface of the liquid and the same vapor at a given height above the surface. Standard chemical calculation techniques can be used to determine the loss due to diffusion if these concentrations are known. Fick's First Law can be written as

$$F_i = (C_i^0 - C_i^H) D_i / H \qquad (1)$$

where:
F_i= Diffusive flux of component 'i' in air (g/m^2-s)
C_i^0 = Component concentration at the surface (g/m^3)
C_i^H = Component concentration at the measured height
D_i = Diffusivity of the chemical 'i' in air (m^2/s)
H = Height at which concentration measurement was taken (m)

The diffusivity of a given species in air (D_i) can be calculated by a number of different methods. The Fuller, Schettler, and Giddings (FSG) method was selected for this project. This method was selected over the more compound-specific Chapman-Enskog model due to a lack of parameter data for several constituents. Diffusivities were calculated using the following formula.

$$Di = 10^{-3} * T^{1.75} * [(M_i + M_A)/(M_i * M_A)]^{1/2} / [P(V_i^{1/3} + V_A^{1/3})]^2 \qquad (2)$$

where:
D_i = Diffusivity of the chemical 'i' in air (m^2/s)
T = Temperature (K)
M_i = Molecular weight of the species (gram/gram-mole)
M_A = Molecular weight of the air (gram/gram-mole)
P = Pressure (atmosphere)
V_i = Sum of atomic diffusion volume increments by atom and structure for species
V_A = Sum of atomic diffusion volume increments by atom and structure for air

Diffusivities (D_i) of components of a diluent can be determined from fundamental considerations. One can use concentration data from the solvent in the solution to generate the C_i^0 numbers for Fick's Law, Equation 1. The C_i^H can be determined by physical measurement and the diffusive flux determined by Equation 1. Yearly emissions can then be estimated by multiplying the diffusive flux (F_i) of a component by the square meters of surface area and by the number of seconds in a year.

PROCEDURE

Given the concentration data, the diffusive flux calculation technique can be used to estimate the amount of volatile organic compounds (VOCs) and hazardous air pollutants (HAPs). These were determined at San Manuel over both the settling tanks and raffinate ponds by a combination of Tedlar® bags sampling with offsite gas chromatography-mass spectrometry (GC-MS) and on site analysis by Fourier transform infrared spectrometry (FTIR). The FTIR system employed used an open path configuration consisting of optical components, a computer, special software, and spectral references against which field measurements were compared. FTIR data points were taken at the same time as Tedlar® bag samples for comparison purposes.

Concurrent with the FTIR sampling, climate data was collected. The climate data collected included air temperature (dry bulb), wet bulb temperature, solution temperature, wind speed and direction, and solar radiation. Statistical analyses were performed to determine whether the concentrations of VOCs over the settlers were dependent on climatological conditions. This study indicated no dependence exists.

Assumptions

Several assumptions were made in performing these calculations. The list of potential chemicals that can potentially volatilize from the tanks were limited to those with a significant vapor pressure. A list of concentrations and vapor pressures of HAPs components of the diluent are listed in Table I. Napthalene's low vapor pressure eliminated it from further consideration in this study.

Table I – Concentration and Vapor Pressure of San Manuel Diluent Constituents

Component	Concentration (ppm)	Vapor Pressure (mm Hg)
Benzene	25	77.2
Toluene	350	22.4
Ethylbenzene	1,400	7.5
m-Xylene	410	6.4
o-Xylene	770	4.97
p-Xylene	732	6.9
Octane	2,300	10.6
Heptane	67	36.4
Hexane	67	126.6
Pentane	67	430.7
Napthalene	1,000	0.054
1,2,4 trimethylbenzene	385	2.04
1,3,5 trimethylbenzene	385	7.34

A second assumption was that the initial concentration at the surface of the liquid in the headspace was equal to the initial concentration of the component in the diluent. This is likely to overpredict the flux of VOCs from the surface. This assumption can be tested in future work by careful sampling of the air just above the organic phase. Careful experimental design will be necessary to ensure the exclusion of organic phase droplets in the surface air phase sample.

Calculation of Diffusivities

The diffusivities, calculated by the use of Equation (2) for the selected species, are shown in Table II. Because the GC-MS could not differentiate between higher molecular weight hydrocarbons, these were reported as GC-MS kerosene. For this analysis any constituent component listed by Phillips as being in the diluent but not reported specifically on the GC-MS analysis was in this category. These are noted as 'others' throughout this analysis. The diffusivity for each of these constituents listed by Phillips in this category was calculated, and a weighted average diffusivity for this category was derived, based on the concentration of the component in the diluent. The calculated diffusivities are shown in Table II.

Table II – Calculated Chemical Diffusivities

Component	Molecular Weight (M_i)	Diffusion Volume (V_i)	Diffusivity (D_i)
Air	28.97	20.1	
Benzene	78.11	90.68	0.0894
Toluene	92.13	111.14	0.0804
Ethylbenzene	106.16	131.6	0.0736
m-Xylene	106.16	131.6	0.0736
o-Xylene	106.16	131.6	0.0736
p-Xylene	106.16	131.6	0.0736
Octane	114.22	167.64	0.0656
Heptane	100.2	147.18	0.0705
Hexane	86.17	129.72	0.0758
Pentane	72.15	106.26	0.0846
1,2,4 trimethylbenzene	120.19	172.26	0.0645
1,3,5 trimethylbenzene	120.19	172.26	0.0645
Others			0.07

Typically, single components will behave differently in a mixture than they do in a binary system. The diffusivities for three chemicals were calculated to determine the effects of the mixture on the binary system calculations. The diffusivities in the mixture were not significantly different than those for the binary system. Thus, the binary calculated diffusivities were used.

Calculation of Diffusive Fluxes

The calculated diffusivities shown in Table II above were then plugged into Equation (1) along with the average concentrations by GC-MS of the constituents at one meter. This gave the diffusive flux for each constituent as shown in Table III for the solvent extraction settlers. Table IV shows the diffusive fluxes for the raffinate pond.

Table III – Settler Tanks Concentration Data and Calculated Chemical Diffusive Fluxes

Component	cm^2/s Diffusivity (D_i)	ppmv Concentration at Surface (C_i^0)	ppmv Concentration at 1-meter (C_i^1)	G/m^2-s Diffusive Flux (F_i)
Benzene	0.0894	25	0.0018	7.15×10^{-7}
Toluene	0.0804	350	0.0668	1.06×10^{-5}
Ethylbenzene	0.0736	1400	0.0568	4.48×10^{-5}
Xylenes	0.0736	1912	0.0371	6.12×10^{-5}
1,2,4 trimethylbenzene	0.0645	385	0.0230	1.22×10^{-5}
1,3,5 trimethylbenzene	0.0645	385	0.0101	1.22×10^{-5}
Others	0.07	2500	16.921	7.98×10^{-5}

Table IV – Raffinate Pond Data and Calculated Chemical Diffusive Fluxes

Component	cm^2/s Diffusivity (D_i)	ppmv Concentration at Surface (C_i^0)	ppmv Concentration at 1-meter (C_i^1)	G/m^2-s Diffusive Flux (F_i)
Benzene	0.0894	25	0.0011	7.15×10^{-7}
Toluene	0.0804	350	0.0645	1.06×10^{-5}
Ethylbenzene	0.0736	1400	0.001	4.48×10^{-5}
Xylenes	0.0736	1912	0.00198	6.12×10^{-5}
1,2,4 trimethylbenzene	0.0645	385	0.0022	1.22×10^{-5}
1,3,5 trimethylbenzene	0.0645	385	0.00103	1.22×10^{-5}
Others	0.07	2500	3.983	8.02×10^{-5}

These calculated annual fluxes would produce the emissions shown in Table V per year for San Manuel. The emissions per year for the settler ponds are calculated for 12 ponds of 298.8 square meters. In considering the effect of partial enclosure on the evaporative loss rate of VOCs from the settler tanks, it was conservatively estimated that approximately 66 percent of the headspace in each tank is affected by the enclosure. It was also assumed that the enclosure allows only 50 percent of the affected headspace to vent to the atmosphere. Thus, it was assumed that only 33 percent of the potential-to-emit occurs from the partially enclosed tanks. The raffinate pond has a surface area of 447 square meters.

Table V – Yearly Emissions at San Manuel

Component	G/m^2-s Diffusive Flux (F_i)	Settler Tanks Uncontrolled Tons/Year	Settler Tanks Controlled Tons/Year	Raffinate Pond Uncontrolled Tons/Year
Benzene	7.15×10^{-7}	0.09	0.03	0.011
Toluene	1.06×10^{-5}	1.32	0.44	0.164
Ethylbenzene	4.48×10^{-5}	5.31	1.77	0.662
Xylenes	6.12×10^{-5}	7.25	2.42	0.904
1,2,4 trimethylbenzene	1.22×10^{-5}	1.42	0.47	0.177
1,3,5 trimethylbenzene	1.22×10^{-5}	1.42	0.47	0.177
Others	8.02×10^{-5}	9.94	3.31	1.246
	Total:	26.74	2.23	3.341

The raffinate pond, since it is an uncontrolled source, would appear to be a major source of emissions. However, the number shown above may be an overstatement of the raffinate pond emissions since it assumes that the diluent in the raffinate pond has the same composition as fresh diluent. This may not be the case since it is known that raffinate reclaim must be treated before it can be reused. Analyses for the constituents of interest on representative samples of raffinate organic could be conducted to test the hypothesis.

CONCLUSIONS

There are many possible loss mechanisms for organic phases from SX plants besides evaporative losses. Chemical and biological degradation will not only destroy diluent and extractant molecules but also enhance losses due to entrainment and solubility of the organic phase into the aqueous phase. Formation of the solid-aqueous-organic gunk phase is also a loss mechanism.

From the examination of monthly use versus weather data, evaporative losses do not appear to be a linked to climatological changes. This suggests that diluent losses are not linked to evaporation. Despite an approximately 30° C (60° F) difference in temperature between the average temperature from winter to summer, no obvious trend between usage and mean daily temperature appears to exist for dessert Southwest SX plants. Nor did air samples taken from above the settlers show a correlation between temperature and quantity.

The Diffusive Flux Model should be considered as a method to quantify evaporative losses for any VOC. With diffusivity numbers and concentration data, diffusive fluxes can be determined for chemical species of interest. Such methods as the Fuller, Schettler, and Giddings Method can derive the diffusivity for a particular chemical from fundamental numbers. Careful sampling and analyses of the air above a settler tank can provide the needed concentration data. The Diffusive Flux number obtained can then be used to calculate emissions for a given chemical.

REFERENCES

1. H. Beyer and W. Walter, Handbook of Organic Chemistry, Prentice Hall, New York, NY, USA, 1996, 197.

2. Ronald M. Atlas, Ed., Petroleum Microbiology, Macmillan Publishing Company, New York, NY, USA, 1984, 20-26.

3. M.D. Bishop, "Solvent Extraction Diluents What Are They And How Do They Affect SX Plant Costs?", Paper Presented at Randall Hydromet Roundtable, November 1998, Vancouver, B.C., Canada

APPENDIX D

EPA TANKS PROGRAM OUTPUT FILES

C7 DISTRIBUTION TANK

TANKS 4.0.9d
Emissions Report - Summary Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	Rosemont - C7 Distribution Tank
City:	
State:	Arizona
Company:	Rosemont Copper Company
Type of Tank:	Vertical Fixed Roof Tank
Description:	

Tank Dimensions

Shell Height (ft):	14.00
Diameter (ft):	12.00
Liquid Height (ft) :	13.50
Avg. Liquid Height (ft):	13.50
Volume (gallons):	11,421.40
Turnovers:	37.71
Net Throughput(gal/yr):	430,735.25
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Cone
Height (ft)	0.00
Slope (ft/ft) (Cone Roof)	0.00

Breather Vent Settings

Vacuum Settings (psig):	0.00
Pressure Settings (psig)	0.00

Meterological Data used in Emissions Calculations: Tucson, Arizona (Avg Atmospheric Pressure = 13.41 psia)

TANKS 4.0.9d
Emissions Report - Summary Format
Liquid Contents of Storage Tank

Rosemont - C7 Distribution Tank - Vertical Fixed Roof Tank

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
C7 - Flomin C4343 Collector	All	70.84	63.74	77.95	68.42	0.3752	0.2962	0.4775	248.2550			248.26	Option 1: VP70 = .3631005 VP80 = .507017

TANKS 4.0.9d
Emissions Report - Summary Format
Individual Tank Emission Totals

Emissions Report for: Annual

Rosemont - C7 Distribution Tank - Vertical Fixed Roof Tank

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
C7 - Flomin C4343 Collector	919.17	22.57	941.73

MIBC STORAGE TANK

TANKS 4.0.9d
Emissions Report - Summary Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	Rosemont - MIBC Storage Tank
City:	
State:	Arizona
Company:	Rosemont Copper Company
Type of Tank:	Vertical Fixed Roof Tank
Description:	

Tank Dimensions

Shell Height (ft):	14.00
Diameter (ft):	12.00
Liquid Height (ft) :	13.50
Avg. Liquid Height (ft):	13.50
Volume (gallons):	11,421.40
Turnovers:	15.54
Net Throughput(gal/yr):	177,488.55
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Cone
Height (ft)	0.00
Slope (ft/ft) (Cone Roof)	0.00

Breather Vent Settings

Vacuum Settings (psig):	0.00
Pressure Settings (psig)	0.00

Meterological Data used in Emissions Calculations: Tucson, Arizona (Avg Atmospheric Pressure = 13.41 psia)

TANKS 4.0.9d
Emissions Report - Summary Format
Liquid Contents of Storage Tank

Rosemont - MIBC Storage Tank - Vertical Fixed Roof Tank

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Methyl Isobutyl Carbinol	All	70.84	63.74	77.95	68.42	0.0682	0.0514	0.0911	102.1760			102.18	Option 1: VP70 = .065495 VP80 = .097729

TANKS 4.0.9d
Emissions Report - Summary Format
Individual Tank Emission Totals

Emissions Report for: Annual

Rosemont - MIBC Storage Tank - Vertical Fixed Roof Tank

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Methyl Isobutyl Carbinol	29.45	1.43	30.88

DIESEL FUEL STORAGE TANK – HEAVY VEHICLES 1 AND 2

TANKS 4.0.9d
Emissions Report - Summary Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	Rosemont - Diesel Fuel ST - Heavy Vehicles
City:	
State:	Arizona
Company:	Rosemont Copper Company
Type of Tank:	Vertical Fixed Roof Tank
Description:	

Tank Dimensions

Shell Height (ft):		20.00
Diameter (ft):		30.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		19.00
Volume (gallons):		100,466.02
Turnovers:		67.19
Net Throughput(gal/yr):		6,750,010.33
Is Tank Heated (y/n):	N	

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Cone	
Height (ft)		0.00
Slope (ft/ft) (Cone Roof)		0.00

Breather Vent Settings

Vacuum Settings (psig):	0.00
Pressure Settings (psig)	0.00

Meterological Data used in Emissions Calculations: Tucson, Arizona (Avg Atmospheric Pressure = 13.41 psia)

TANKS 4.0.9d
Emissions Report - Summary Format
Liquid Contents of Storage Tank

Rosemont - Diesel Fuel ST - Heavy Vehicles - Vertical Fixed Roof Tank

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	70.84	63.74	77.95	68.42	0.0093	0.0074	0.0114	130.0000			188.00	Option 1: VP70 = .009 VP80 = .012
1,2,4-Trimethylbenzene						0.0312	0.0237	0.0407	120.1900	0.0100	0.0488	120.19	Option 2: A=7.04383, B=1573.267, C=208.56
Benzene						1.5658	1.2942	1.8828	78.1100	0.0000	0.0020	78.11	Option 2: A=6.905, B=1211.033, C=220.79
Ethylbenzene						0.1568	0.1235	0.1975	106.1700	0.0001	0.0032	106.17	Option 2: A=6.975, B=1424.255, C=213.21
Hexane (-n)						2.5196	2.1071	2.9958	86.1700	0.0000	0.0004	86.17	Option 2: A=6.876, B=1171.17, C=224.41
Toluene						0.4589	0.3705	0.5644	92.1300	0.0003	0.0229	92.13	Option 2: A=6.954, B=1344.8, C=219.48
Unidentified Components						0.0079	0.0071	0.0075	134.5118	0.9866	0.8634	189.60	
Xylene (-m)						0.1310	0.1029	0.1655	106.1700	0.0029	0.0594	106.17	Option 2: A=7.009, B=1462.266, C=215.11

TANKS 4.0.9d
Emissions Report - Summary Format
Individual Tank Emission Totals

Emissions Report for: Annual

Rosemont - Diesel Fuel ST - Heavy Vehicles - Vertical Fixed Roof Tank

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	118.54	2.94	121.47
Hexane (-n)	0.05	0.00	0.05
Benzene	0.23	0.01	0.24
Toluene	2.72	0.07	2.79
Ethylbenzene	0.38	0.01	0.39
Xylene (-m)	7.04	0.17	7.21
1,2,4-Trimethylbenzene	5.78	0.14	5.92
Unidentified Components	102.34	2.53	104.88

APPENDIX E

PROCESS RATES AND SUPPORTING INFORMATION FOR MOBILE ENGINES

Table E.1 Process Rates and Supporting Information for the Mobile Engines

Fuel Burning Mobile Engine Description	Fleet Size	HP Rating	Process Rates [a] - Year 1			Process Rates [a] - Year 5			Process Rates [a] - Year 10			Process Rates [a] - Year 15			Process Rates [a] - Year 20			Units	Load Factor
			Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual		
Haulage Trucks, 250 tons	31	2,650	1.00	24	6,600	1.00	24	6,600	1.00	24	6,600	1.00	24	6,600	1.00	24	6,600	hours	0.32
Crawler Dozers, D11T Class	3	850	0.46	11	4,000	0.46	11	4,000	0.46	11	4,000	0.46	11	4,000	0.23	5	2,000	hours	0.575
Crawler Dozers, D10T Class	3	580	0.68	16	6,000	0.68	16	6,000	0.70	17	6,090	0.68	16	6,000	0.46	11	4,000	hours	0.575
Crawler Dozer, D8T Class	1	310	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.575
Rubber Tired Dozers, 834H Class	3	498	0.70	17	6,150	0.71	17	6,200	0.70	17	6,175	0.58	14	5,075	0.23	6	2,030	hours	0.575
Motor Graders, 24M Class	1	533	0.68	16	6,000	0.68	16	6,000	0.68	16	6,000	0.68	16	6,000	0.68	16	6,000	hours	0.575
Motor Graders, 16M Class	3	297	0.68	16	6,000	0.46	11	4,000	0.46	11	4,000	0.46	11	4,000	0.23	5	2,000	hours	0.575
Water Trucks, 30,000 gallons	4	1,348	0.37	9	3,250	0.45	11	3,250	0.45	11	3,250	0.45	11	3,250	0.27	7	2,000	hours	0.35
Diesel Blasthole Drill, 12.25 inches	2	1,500	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.43
Hydraulic DML 45 Drill	1	425	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.43
Front End Loaders	2	2,000	0.90	22	7,884	0.90	22	7,884	0.90	22	7,884	0.90	22	7,884	0.90	22	7,884	hours	0.59
Stemming Truck	2	450	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.43
ANFO/Slurry Truck, 20 tons	2	450	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.43
Powder Truck, 2 tons	2	350	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.43
Front End Loaders, 8 yd^3	2	262	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.575
Hydraulic Excavator, 385 Cat CL	2	513	0.90	22	7,884	0.90	22	7,884	0.90	22	7,884	0.90	22	7,884	0.90	22	7,884	hours	0.35
Backhoe/Loader, 2 yd^3	1	124	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.35
All-Terrain Crane, 75 tons	1	230	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.43
Transporter with Tractor, 200 tons	1	1,350	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.59
Fuel/Lube Trucks, 6,000 gallons	2	703	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.35
Mechanic Field Service Trucks	5	370	1.71	41	15,000	1.71	41	15,000	1.71	41	15,000	1.71	41	15,000	1.71	41	15,000	VMT	0.43
			0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	

Table E.1 Process Rates and Supporting Information for the Mobile Engines																			
Fuel Burning Mobile Engine Description	Fleet Size	HP Rating	Process Rates [a] - Year 1			Process Rates [a] - Year 5			Process Rates [a] - Year 10			Process Rates [a] - Year 15			Process Rates [a] - Year 20			Units	Load Factor
			Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual		
Tire Handler	1	90	0.11	3	1,000	0.11	3	1,000	0.11	3	1,000	0.11	3	1,000	0.11	3	1,000	VMT	0.43
			0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	
Shop Forklift, 12,000 lbs	1	90	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.59
Integrated Tool Carrier, 140 hp	1	138	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.59
Light Plant, 6 kW	15	35	0.40	10	3,504	0.40	10	3,504	0.40	10	3,504	0.40	10	3,504	0.40	10	3,504	hours	0.43
Primary Crushing Mobile Crane - 400 tons	1	320	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.43
Copper Concentrate Area Front End Loader - Cat 930	1	160	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.59
Molybdenum Packaging Forklift, 7,000 lbs	1	93	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.59
Copper Cathode Forklift	1	92.5	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.59
Boom Trucks 10 tons, 45 foot boom	1	200	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.21
Boom Trucks 15 tons, 60 foot boom	1	210	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.21
Front End Loader, 6 yd^3	1	349	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.35
Front End Loader, 5 yd^3	1	149	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.25
Bob Cats, 2,400 lbs	2	82	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.59
Fork Lift, 2,000 lbs	1	50	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.59
Fork Lift, 5,000 lbs	1	63	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.59
Fork Lift, 3,000 lbs	2	50	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.59
Flat Bed Trucks, 10 tons	2	350	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.43
Dump Truck, 10 tons	1	250	0.34	8	3,000	0.34	8	3,000	0.34	8	3,000	0.34	8	3,000	0.34	8	3,000	VMT	0.43
			0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	
Mobile Hydraulic Crane, 60 tons	1	267	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.43
Truck Shop Bridge Crane, 60 tons	1	75	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.43

Table E.1 Process Rates and Supporting Information for the Mobile Engines																				
Fuel Burning Mobile Engine Description	Fleet Size	HP Rating	Process Rates [a] - Year 1			Process Rates [a] - Year 5			Process Rates [a] - Year 10			Process Rates [a] - Year 15			Process Rates [a] - Year 20			Units	Load Factor
			Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual		
Truck Shop Bridge Crane, 25 tons	1	24.1	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.43
CS683 Soil Compactor / Roller	2	173	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.40
246C Skid Steer Loader	2	73	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.30
RH200/340 O & K Shovel / Hitachi EX5500	1	2,520	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	0.59
Off-Road Tire Handling Truck	1	450	0.86	21	7,500	0.86	21	7,500	0.86	21	7,500	0.86	21	7,500	0.86	21	7,500	VMT	0.43
			0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	
Contractor Haul Trucks, 25 tons	2	511	2.74	66	24,000	2.74	66	24,000	2.74	66	24,000	2.74	66	24,000	2.74	66	24,000	VMT	0.43
			0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	0.75	18	6,570	hours	
Motivator for Mine Shovels	1	3,308	0.91	22	8,000	0.91	22	8,000	0.91	22	8,000	0.91	22	8,000	0.91	22	8,000	hours	0.43
Storm Water Pond Pump	1	200	1.00	24	500	1.00	24	500	1.00	24	500	1.00	24	500	1.00	24	500	hours	1
Mine Pit Dewatering Pump	4	100	1.00	24	500	1.00	24	500	1.00	24	500	1.00	24	500	1.00	24	500	hours	1
Copper Concentrate Shipment Vehicles	--	450	29.60	1021	169,872	29.60	1021	169,872	29.60	1021	169,872	29.60	1021	169,872	29.60	1021	169,872	VMT	0.43
			1.00	19	6,795	1.00	19	6,795	1.00	19	6,795	1.00	19	6,795	1.00	19	6,795	hours	
Molybdenum Concentrate Shipment Vehicles	--	450	7.40	15	2,145	7.40	15	2,145	7.40	15	2,145	7.40	15	2,145	7.40	15	2,145	VMT	0.43
			1.00	1	86	1.00	1	86	1.00	1	86	1.00	1	86	1.00	1	86	hours	
Sulfuric Acid Delivery Vehicles	--	450	22.20	143	52,021	22.20	143	52,021	22.20	143	52,021	22.20	143	52,021	22.20	143	52,021	VMT	0.43
			1.00	6	2,081	1.00	6	2,081	1.00	6	2,081	1.00	6	2,081	1.00	6	2,081	hours	
Lime Delivery Vehicles	--	450	14.80	52	19,072	14.80	52	19,072	14.80	52	19,072	14.80	52	19,072	14.80	52	19,072	VMT	0.43
			1.00	2	763	1.00	2	763	1.00	2	763	1.00	2	763	1.00	2	763	hours	
SAG Mill and Ball Mill Grinding Balls Delivery Vehicles	--	450	14.80	23	5,858	14.80	23	5,858	14.80	23	5,858	14.80	23	5,858	14.80	23	5,858	VMT	0.43
			1.00	1	234	1.00	1	234	1.00	1	234	1.00	1	234	1.00	1	234	hours	

Table E.1 Process Rates and Supporting Information for the Mobile Engines

Fuel Burning Mobile Engine Description	Fleet Size	HP Rating	Process Rates [a] - Year 1			Process Rates [a] - Year 5			Process Rates [a] - Year 10			Process Rates [a] - Year 15			Process Rates [a] - Year 20			Units	Load Factor
			Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual	Hourly	Daily	Annual		
Diesel Fuel Delivery Vehicles	--	500	14.80	47	17,136	14.80	47	17,136	14.80	47	17,136	14.80	47	17,136	14.80	47	17,136	VMT	0.43
			1.00	2	685	1.00	2	685	1.00	2	685	1.00	2	685	1.00	2	685	hours	
Copper Cathode Shipment Vehicles	--	450	14.80	42	4,997	14.80	42	4,997	14.80	42	4,997	14.80	42	4,997	14.80	42	4,997	VMT	0.43
			1.00	1	200	1.00	1	200	1.00	1	200	1.00	1	200	1.00	1	200	hours	
Ammonium Nitrate Delivery Vehicles	--	450	7.40	25	6,384	7.40	25	6,384	7.40	25	6,384	7.40	25	6,384	7.40	25	6,384	VMT	0.43
			1.00	1	255	1.00	1	255	1.00	1	255	1.00	1	255	1.00	1	255	hours	
Miscellaneous Consumables Delivery Vehicles	--	450	7.40	48	12,486	7.40	48	12,486	7.40	48	12,486	7.40	48	12,486	7.40	48	12,486	VMT	0.43
			1.00	1	499	1.00	1	499	1.00	1	499	1.00	1	499	1.00	1	499	hours	
Miscellaneous Fuels and Lubricants Delivery Vehicles	--	450	7.40	7	1,110	7.40	7	1,110	7.40	7	1,110	7.40	7	1,110	7.40	7	1,110	VMT	0.43
			1.00	1	44	1.00	1	44	1.00	1	44	1.00	1	44	1.00	1	44	hours	
Pickup Trucks (gasoline)	20	350	1.37	33	12,000	1.37	33	12,000	1.37	33	12,000	1.37	33	12,000	1.37	33	12,000	VMT	0.54
			0.25	6	2,190	0.25	6	2,190	0.25	6	2,190	0.25	6	2,190	0.25	6	2,190	hours	
Crew Van (gasoline)	3	350	0.91	22	8,000	0.91	22	8,000	0.91	22	8,000	0.91	22	8,000	0.91	22	8,000	VMT	0.54
			0.25	6	2,190	0.25	6	2,190	0.25	6	2,190	0.25	6	2,190	0.25	6	2,190	hours	
Lot Pick-Up Trucks (gasoline)	20	250	0.34	8	3,000	0.34	8	3,000	0.34	8	3,000	0.34	8	3,000	0.34	8	3,000	VMT	0.54
			0.25	6	2,190	0.25	6	2,190	0.25	6	2,190	0.25	6	2,190	0.25	6	2,190	hours	

[b] Except for the shipment and delivery vehicles, the process rates are for a single mobile engine. The process rates for the shipment and delivery vehicles are representative of the entire fleet.

APPENDIX F

MANUFACTURER'S INFORMATION

	Updated Feasibility Study Reference	Machine Model	Engine	Engine Family	Tier	Load factor @ application Low	Med	Hi	Typical Load Factor	Emissions @ full load (g/hp-hr) NO_x+VOC	CO	PM
1	Motor Graders - 16M Class	*16M (B9H)	C13	8CPXL12.5ESK	TIER 3	35%-50%	50%-65%	65%-80%	**N/A**	2.60	2.10	0.06
2	Motor Graders - 24M Class	24M	C18	8CPXL18.1ESK	TIER 2	35%-50%	50%-65%	65%-80%	**N/A**	2.72	2.15	0.10
3	Hydraulic Excavator - 385 Cat CL	385CL	C18	5CPXL18.1ESK	TIER 3	20%-30%	30%-40%	40%-50%	**N/A**	2.80	1.70	0.12
4	Water Trucks - 30,000 gallons	785DWT	3512C	9CPXL58.6T2E	TIER 2	20%-30%	30%-40%	40%-50%	**N/A**	4.70	2.59	0.15
5	Backhoe/Loader - 2 yd^3	450E	C4.4	8PKXL04.4NJ1	TIER 3	20%-30%	30%-40%	40%-50%	**30-40%**	3.70	1.30	0.17
6	Crawler Dozer - D8T Class	D8T	C15	9CPXL15.2ESW	TIER 3	35%-50%	50%-65%	65%-80%	**N/A**	2.80	1.90	0.10
7	Front End Loaders - 8 yd^3	966H	C11	9CPXL11.1ESK	TIER 3	35%-50%	50%-65%	65%-80%	**N/A**	2.70	2.20	0.13
8	Compactor	CS683	C6.6	8PKXL06.6PJ2	TIER 3	30%-50%	50%-80%	80%-100%	**40%**	3.80	3.90	0.23
9	Skid Steer Loaders 246C	246C	C3.3	8MVCL03.3AAH	TIER 4I	35%-50%	50%-65%	65%-80%	**30%**	5.85	1.36	0.38
10	O&K Shovel (dual engine)	RH200								7.87	8.50	0.40
11	Rubber Tired Dozers - 834H Class	834H	C18	5CPXL18.1ESK	TIER 3	35%-50%	50%-65%	65%-80%	**N/A**	2.80	1.70	0.10
12	Front End Loaders - 5 yd^3	930H	C6.6	8PKXL06.6PJ2	TIER 3	35%-50%	50%-65%	65%-80%	**25%**	3.80	3.90	0.23
13	Front End Loaders - 6 yd^3	980H	C15	8CPXL15.2ESW	TIER 3	20%-30%	30%-40%	40%-50%	**N/A**	2.60	2.10	0.13
14	Crawler Dozers - D10T Class	D10T	C27	5CPXL27.0ESK	TIER 3	35%-50%	50%-65%	65%-80%	**N/A**	2.90	2.10	0.11
15	Crawler Dozers - D11T Class	D11T	C32	8CPXL32.0ESX	TIER 2	35%-50%	50%-65%	65%-80%	**N/A**	4.30	2.10	0.13
16	Fuel/Lube Trucks - 6,000 gallons	773FLT	C27	6CPXL27.0ESK / 8CPXL27.0ESK	TIER 3	20%-30%	30%-40%	40%-50%	**N/A**	2.7 ('07, EED) /2.8	1.9/2.2	0.09/.13
17	Haulage Trucks - 250 tons	793F	C175	ACPXL106.T2M	TIER 2	20%-30%	30%-40%	40%-50%	**32%**	6.10	2.30	0.19

Gray Cell = Values (g/kw-hr) taken directly from engine certification letter for engine parent family

APPENDIX G

MOBILE6 PROGRAM OUTPUT

```
*****************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                                *
* Input file: ROSEMONT.IN (file 1, run 1).                                  *
*****************************************************************************
  M603 Comment:
             User has disabled the calculation of REFUELING emissions.


* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rosemont

* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #

* Reading PM Gas Carbon ZML Levels
* from the external data file PMGZML.CSV

* Reading PM Gas Carbon DR1 Levels
* from the external data file PMGDR1.CSV

* Reading PM Gas Carbon DR2 Levels
* from the external data file PMGDR2.CSV

* Reading PM Diesel Zero Mile Levels
* from the external data file PMDZML.CSV

* Reading the First PM Deterioration Rates
* from the external data file PMDDR1.CSV

* Reading the Second PM Deterioration Rates
* from the external data file PMDDR2.CSV
  M 48 Warning:
            there are no sales for vehicle class HDGV8b

* Reading Ammonia (NH3) Basic Emissiion Rates
* from the external data file PMNH3BER.D

* Reading Ammonia (NH3) Sulfur Deterioration Rates
* from the external data file PMNH3SDR.D

                  Calendar Year:  2010
                          Month:  Jan.
                       Altitude:  Low
            Minimum Temperature:  55.3 (F)
            Maximum Temperature:  70.0 (F)
              Absolute Humidity:   75. grains/lb
               Nominal Fuel RVP:   9.0 psi
                  Weathered RVP:   9.0 psi
```

Fuel Sulfur Content: 30. ppm

Exhaust I/M Program: No
Evap I/M Program: No
ATP Program: No
Reformulated Gas: No

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.3540	0.3855	0.1315		0.0357	0.0003	0.0019	0.0856	0.0054	1.0000

Composite Emission Factors (g/mi):										
Composite VOC :	0.716	0.756	1.329	0.902	0.843	0.183	0.454	0.403	2.03	0.796
Composite CO :	9.55	10.88	15.51	12.06	9.54	0.907	0.777	1.870	13.80	10.192
Composite NOX :	0.553	0.718	1.145	0.827	2.427	0.432	0.764	7.394	1.34	1.352

```
****************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                               *
* Input file: ROSEMONT.IN (file 1, run 1).                                 *
****************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rosemont

* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
```

Calendar Year:	2010
Month:	Jan.
Gasoline Fuel Sulfur Content:	30. ppm
Diesel Fuel Sulfur Content:	15. ppm
Particle Size Cutoff:	10.00 Microns
Reformulated Gas:	No

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.3540	0.3855	0.1315		0.0357	0.0003	0.0019	0.0856	0.0054	1.0000
Composite Emission Factors (g/mi):										
Lead:	0.0000	0.0000	0.0000	0.0000	0.0000	------	------	------	0.0000	0.0000
GASPM:	0.0040	0.0040	0.0044	0.0041	0.0400	------	------	------	0.0205	0.0051
ECARBON:	------	------	------	------	------	0.0416	0.0256	0.1143	------	0.0099
OCARBON:	------	------	------	------	------	0.0117	0.0368	0.0580	------	0.0050
SO4:	0.0003	0.0005	0.0005	0.0005	0.0015	0.0002	0.0003	0.0009	0.0001	0.0005
Total Exhaust PM:	0.0043	0.0045	0.0050	0.0046	0.0416	0.0535	0.0627	0.1733	0.0206	0.0205
Brake:	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
Tire:	0.0080	0.0080	0.0080	0.0080	0.0087	0.0080	0.0080	0.0259	0.0040	0.0095
Total PM:	0.0249	0.0251	0.0255	0.0252	0.0628	0.0741	0.0832	0.2117	0.0371	0.0426
SO2:	0.0068	0.0088	0.0114	0.0095	0.0167	0.0029	0.0056	0.0132		

0.0033 0.0091
NH3: 0.1017 0.1013 0.1005 0.1011 0.0451 0.0068 0.0068 0.0270
0.0113 0.0923
