(A) Construction works outside cavern

1.) Site formation for Portal Enclosure and Auxiliary Buildings, Actively operating area / Water mains laying works

1.1 Heavy Construction

TSP emission factor (Mg/hectare/month of activity)	2.69	*from AP-42, S13.2.3, 1/95 ed.*
TSP emission factor ($g/m^2/s$)	2.0756E-04	*Assume 30 working days per month and 12 working hours a day during unit conversion*
RSP/TSP Ratio	0.473	*from USEPA AP-42, 5th ed. 11/06 ed. S13.2.4*
FSP/TSP Ratio	0.072	*from USEPA AP-42, 5th ed. 11/06 ed. S13.2.4*

Unmitigated	**TSP emission factor ($g/m^2/s$) =**	**2.0756E-04**
	RSP emission factor ($g/m^2/s$) =	**9.8177E-05**
	FSP emission factor ($g/m^2/s$) =	**1.4944E-05**

1.2 Wind Erosion

TSP emission factor (Mg/hectare/yr)	0.85	*AP-42, 5th ed., Table 11.9-4*
TSP emission factor ($g/m^2/s$)	2.6953E-06	*Assume 365 days per year and 24 hours a day during unit conversion*
RSP/TSP Ratio	0.473	*from USEPA AP-42, 5th ed. 11/06 ed. S13.2.4*
FSP/TSP Ratio	0.072	*from USEPA AP-42, 5th ed. 11/06 ed. S13.2.4*
TSP emission factor ($g/m^2/s$) =	**2.6953E-06**	
RSP emission factor ($g/m^2/s$) =	**1.2749E-06**	
FSP emission factor ($g/m^2/s$) =	**1.9406E-07**	

(B) Construction works within cavern

2.) Rock Crushing

2.1 Truck Unloading - Fragmented Stone

RSP emission factor (kg/Mg)	8.0000E-06	*from EPA AP-42, 5th ed. 8/04 ed., S11.19.2 Table 11.19.2-1*
Loading rate (ton/hr)	3.8750	*from engineer (maximum 93 ton/day)*
TSP/RSP Ratio	2.1	*from EPA AP-42, 5th ed. 8/04 ed., S11.19.2 Table 11.19.2-1*
Mg/ton	1	
tonne/ton	1.10231131	

Unmitigated	**TSP emission rate (g/s)**	**1.6405E-05**	
	RSP emission rate (g/s)	**7.8119E-06**	
	FSP emission rate (g/s)	**7.8119E-06**	*adopt RSP emission factor as upper limit*

2.2 Tertiary Crushing

TSP emission factor (kg/Mg)	0.0027	*from EPA AP-42, 5th ed. 8/04 ed., S11.19.2 Table 11.19.2-1*
RSP emission factor (kg/Mg)	0.0012	*from EPA AP-42, 5th ed. 8/04 ed., S11.19.2 Table 11.19.2-1*
Crushing rate (ton/hr)	3.8750	*from engineer*
Mg/ton	1	
tonne/ton	1.10231131	

Unmitigated	**TSP emission rate (g/s)**	**2.6365E-03**	
	RSP emission rate (g/s)	**1.1718E-03**	
	FSP emission rate (g/s)	**1.1718E-03**	*adopt RSP emission factor as upper limit*

2.3 Fines Screening (controlled with wet suppression)

TSP emission factor (kg/Mg)	0.0018	*from EPA AP-42, 5th ed. 8/04 ed., S11.19.2 Table 11.19.2-1*
RSP emission factor (kg/Mg)	0.0011	*from EPA AP-42, 5th ed. 8/04 ed., S11.19.2 Table 11.19.2-1*
Crushing rate (ton/hr)	3.8750	*from engineer*
Mg/ton	1	
tonne/ton	1.10231131	

Unmitigated	**TSP emission rate (g/s)**	**1.7577E-03**	
	RSP emission rate (g/s)	**1.0741E-03**	
	FSP emission rate (g/s)	**1.0741E-03**	*adopt RSP emission factor as upper limit*

Total emission from Rock Crusher (2.1) + (2.2) + (2.3)

Unmitigated	**TSP emission rate (g/s) =**	**4.4106E-03**
	RSP emission rate (g/s) =	**2.2537E-03**
	FSP emission rate (g/s) =	**2.2537E-03**

3.) Blasting (USEPA AP-42, Section 11.9, Table 11.9-1)

$E = 0.000014 (A)^{1.5}$ .....(1)

where

E = emission factor in lb/blast

A = horizontal area (ft^2)

Assumptions:

A = $165 m^2 = 1776 ft^2$

frequency = 1 blasting per day (7am to 7pm - Monday to Saturday (subject to condition))

$E = 0.000014 (1776)^{1.5}$

E = 1.0478 lb/blast

E = 1.3203E-01 g/s (only one blast in one hour)

Unmitigated	**TSP emission rate (g/s) =**	**1.3203E-01**		
	RSP emission rate (g/s) =	**6.8654E-02**	RSP/TSP Ratio	0.52 *from USEPA AP-42, Section 11.9, Table 11.9-1*
	FSP emission rate (g/s) =	**3.9608E-03**	FSP/TSP Ratio	0.03 *from USEPA AP-42, Section 11.9, Table 11.9-1*

4.) Wet Drilling (USEPA AP-42, Section 11.19.2, Table 11.19.2-1)

TSP: **$E = 4.0 \times 10^{-4}$ kg/Mg ..... (2)**

RSP: **$E = 4.0 \times 10^{-5}$ kg/Mg ..... (3)** *from USEPA AP-42, Section 11.19.2, Table 11.19.2-1*

Assumptions: handling rate = 21 m^3/hr x 2700kg/m^3 x 0.001 Mg/kg = 56.7000 Mg/hr

TSP emission rate (g/s) =	**6.3000E-03**
RSP emission rate (g/s) =	**6.3000E-04**
FSP emission rate (g/s) =	**6.3000E-04** *adopt RSP emission factor as upper limit*

5.) Materials Handling (USEPA AP-42, Section 13.2.4.3)

$E = k\ (0.0016)\ (u/2.2)^{1.3}\ /(M/2)^{1.4}$ .....(5)

where
- E = emission factor in kilograms per Megagram (Mg)
- k = particle size multiplier
- u = wind speed in metres per second
- M = material moisture content in percent

Assumptions:
- k = 0.74 for TSP; 0.35 for RSP; 0.053 for FSP
- M = 0.7 % (USEPA AP-42, Table 13.2.4-1)
- u = 0.1 m/s (air flow rate within cavern provided by engineer)
- handling rate = 21 m^3/hr x 2700kg/m^3 x 0.001 Mg/kg = 56.7000 Mg/hr

TSP: $E = 0.74\ (0.0016)\ (0.1/2.2)^{1.3}\ /(0.7/2)^{1.4}$		**RSP:** $E = 0.35\ (0.0016)\ (0.1/2.2)^{1.3}\ /(0.7/2)^{1.4}$		**FSP:** $E = 0.053\ (0.0016)\ (0.1/2.2)^{1.3}\ /(0.7/2)^{1.4}$	
E = 9.2578E-05	kg/Mg	E = 4.3787E-05	kg/Mg	E = 6.6306E-06	kg/Mg
E = 5.2492E-03	kg/hr	E = 2.4827E-03	kg/hr	E = 3.7595E-04	kg/hr
E = 1.4581E-03	**g/s**	**E = 6.8964E-04**	**g/s**	**E = 1.0443E-04**	**g/s**

Unmitigated

TSP emission rate (g/s) =	**1.4581E-03**
RSP emission rate (g/s) =	**6.8964E-04**
FSP emission rate (g/s) =	**1.0443E-04**

6.) Vehicle movements on unpaved road (USEPA AP-42, Section 13.2.2.2)

$E = k\ (s/12)^a\ (W/3)^b$ .....(6)

where k, a, and b are empirical constants and
- E = size-specific emission factor (lb/VMT) Note: 1 lb/VMT = 281.9 g/VKT (g per vehicle kilometer traveled)
- s = surface material slit content
- W = mean vehicle weight (tons)

Assumptions:
- s = 8.5 % (Table 13.2.2-1 of USEPA AP-42, Section 13.2.2.2)
- W (loaded) = 30 tonnes (from engineer) = 33.1 ton
- W (empty) = 10 tons (from engineer) = 11 ton
- Truck flow = 3.5 veh/hr (one way)
- distance traveled 750 m (oneway)

k = 4.9 for TSP; 1.5 for RSP; 0.15 for FSP (Table 13.2.2-2 of USEPA AP-42, Section 13.2.2.2)

a = 0.7 for TSP; 0.9 for RSP; 0.9 for FSP (Table 13.2.2-2 of USEPA AP-42, Section 13.2.2.2)

b = 0.45 for TSP; 0.45 for RSP; 0.45 for FSP (Table 13.2.2-2 of USEPA AP-42, Section 13.2.2.2)

6.1 For trucks with loading

TSP: $E = 4.9\ (8.5/12)^{0.7}\ (33.1/3)^{0.45}$		**RSP:** $E = 1.5\ (8.5/12)^{0.9}\ (33.1/3)^{0.45}$		**FSP:** $E = 0.15\ (8.5/12)^{0.9}\ (33.1/3)^{0.45}$	
E = 11.3344	lb/VMT	E = 3.2385	lb/VMT	E = 0.3238	lb/VMT
E = 2.3298E+00	g/s	E = 6.6568E-01	g/s	E = 6.6568E-02	g/s

Unmitigated

TSP emission rate (g/s) =	**2.3298E+00**
RSP emission rate (g/s) =	**6.6568E-01**
FSP emission rate (g/s) =	**6.6568E-02**

6.2 For trucks without loading

TSP: $E = 4.9\ (8.5/12)^{0.7}\ (11.02/3)^{0.45}$		**RSP:** $E = 1.5\ (8.5/12)^{0.9}\ (11.02/3)^{0.45}$		**FSP:** $E = 0.15\ (8.5/12)^{0.9}\ (11.02/3)^{0.45}$	
E = 6.9134	lb/VMT	E = 1.9753	lb/VMT	E = 0.1975	lb/VMT
E = 1.4211E+00	g/s	E = 4.0603E-01	g/s	E = 4.0603E-02	g/s

Unmitigated

TSP emission rate (g/s) =	**1.4211E+00**
RSP emission rate (g/s) =	**4.0603E-01**
FSP emission rate (g/s) =	**4.0603E-02**