RAMBØLL ENVIRON

Appendix 3-2

Calculation of Hourly TSP Emission Rates
of this Project

Appendix 3-2A   Summary Table of Calculated TSP Emissions Modeling Input Data (Unmitigated Scenario)

For both the unmitigated scenario and mitigated scenarios, since there will be no construction activities during restricted hours, and on Sundays and general holidays, the calculated emission rates have been applied to day-time hours during general weekdays only (i.e. 0800 to 1800 hours). While the hours from 1800 to 0800 in the year and on Sunday and general holidays are adopted for impact assessment of wind erosion on the site.

Cut and Cover (day-time only)

						Umitigated *	
Project Site	Ref. ID	X coordiante	Y coordinate	Elevation, m	Release Height, m	Emission rate, g/m^2/s	Int. Vert. Dim.
HEN RD	K1A	823466.8	837094.1	4.8	0	2.17E-04	0
HEN RD	K1B	823389.4	837338.1	6.5	0	2.17E-04	0
HEN RD	K1C	823389.4	837338.1	6.5	0	2.17E-04	0

Wind Erosion

						Unmitigated (night-time only) *		Umitigated (day-time only) *
Project Site	Ref. ID	X coordiante	Y coordinate	Elevation, m	Release Height, m	Emission rate, g/m^2/s	Int. Vert. Dim.	Emission rate, g/m^2/s
HEN RD	K1A	823466.8	837094.1	4.8	0	2.70E-06	0	2.70E-06
HEN RD	K1B	823389.4	837338.1	6.5	0	2.70E-06	0	2.70E-06
HEN RD	K1C	823389.4	837338.1	6.5	0	2.70E-06	0	2.70E-06

Travelling on Haul Road (unpaved) (day-time only)

									Unmitigated *			
Project Site	Road Segment ID	X coordiante	Y coordinate	Ground mPD level, m	X Length, m	Y Length, m	Emission Height, m	Angle, degree	Calculated emission rate, g/m/s	Total emission, g/s	Emission rate, g/m^2/s	Int. Vert. Dim.
					B	C			A	= (A*B)	= (A*B) /(B*C)	
HEN RD	HR13	823394.7	837265.1	5	29	6	0.5	6	1.34E-03	3.89E-02	2.23E-04	0
HEN RD	HR14	823417.9	837263.5	5	35	6	0.5	100	1.34E-03	4.69E-02	2.23E-04	0
HEN RD	HR15	823411.6	837229.1	5	35	6	0.5	100	1.34E-03	4.69E-02	2.23E-04	0
HEN RD	HR16	823405.3	837194.6	5	15	6	0.5	100	1.34E-03	2.01E-02	2.23E-04	0
HEN RD	HR17	823424.4	837269.3	7	35	6	0.5	-84	1.34E-03	4.69E-02	2.23E-04	0
HEN RD	HR18	823428.3	837304.1	7	35	6	0.5	-84	1.34E-03	4.69E-02	2.23E-04	0
HEN RD	HR19	823432.1	837338.9	7	15	6	0.5	-83	1.34E-03	2.01E-02	2.23E-04	0

Remark: * Please refer to Appendix 3-2C for the calculation of emission factors.

Appendix 3-2B   Summary Table of Calculated <u>TSP Emissions</u> Modeling Input Data (Mitigated Scenario)

For both the unmitigated scenario and mitigated scenarios, since there will be no construction activities during restricted hours, and on Sundays and general holidays, the calculated emission rates have been applied to day-time hours during general weekdays only (i.e. 0800 to 1800 hours). While the hours from 1800 to 0800 in the year and on Sunday and general holidays are adopted for impact assessment of wind erosion on the site.

<u>Cut and Cover (day-time only)</u>

Project Site	Ref. ID	X coordiante	Y coordinate	Elevation,m	Release Height, m	Mitigated * Emission rate, g/m^2/s	Int. Vert. Dim.
HEN RD	K01	823442.356	837180.936	4.8	0	2.17E-05	0
HEN RD	K02	823486.063	837120.747	4.8	0	2.17E-05	0
HEN RD	K03	823468.132	837094.394	4.8	0	2.17E-05	0
HEN RD	K04	823440.358	837108.061	4.8	0	2.17E-05	0
HEN RD	K05	823409.614	837123.639	4.8	0	2.17E-05	0
HEN RD	K06	823391.253	837167.776	4.8	0	2.17E-05	0
HEN RD	K07	823446.016	837188.662	4.8	0	2.17E-05	0
HEN RD	K08	823432.052	837256.738	4.8	0	2.17E-05	0
HEN RD	K09	823432.124	837256.778	4.8	0	2.17E-05	0
HEN RD	K10	823488.454	837233.747	6.5	0	2.17E-05	0
HEN RD	K11	823502.807	837267.363	6.5	0	2.17E-05	0
HEN RD	K12	823524.194	837299.377	6.5	0	2.17E-05	0
HEN RD	K13	823498.225	837337.744	6.5	0	2.17E-05	0
HEN RD	K14	823464.458	837397.307	6.5	0	2.17E-05	0
HEN RD	K15	823473.949	837297.017	6.5	0	2.17E-05	0
HEN RD	K16	823452.457	837248.458	6.5	0	2.17E-05	0
HEN RD	K17	823391.456	837390.555	6.5	0	2.17E-05	0
HEN RD	K18	823389.837	837337.404	6.5	0	2.17E-05	0

<u>Wind Erosion</u>

Project Site	Ref. ID	X coordiante	Y coordinate	Elevation,m	Release Height, m	Unmitigated (night-time only) * Emission rate, g/m^2/s	Int. Vert. Dim.	Unmitigated (day-time only) * Emission rate, g/m^2/s
HEN RD	K01	823442.356	837180.936	4.8	0	2.70E-06	0	2.70E-06
HEN RD	K02	823486.063	837120.747	4.8	0	2.70E-06	0	2.70E-06
HEN RD	K03	823468.132	837094.394	4.8	0	2.70E-06	0	2.70E-06
HEN RD	K04	823440.358	837108.061	4.8	0	2.70E-06	0	2.70E-06
HEN RD	K05	823409.614	837123.639	4.8	0	2.70E-06	0	2.70E-06
HEN RD	K06	823391.253	837167.776	4.8	0	2.70E-06	0	2.70E-06
HEN RD	K07	823446.016	837188.662	4.8	0	2.70E-06	0	2.70E-06
HEN RD	K08	823432.052	837256.738	4.8	0	2.70E-06	0	2.70E-06
HEN RD	K09	823432.124	837256.778	4.8	0	2.70E-06	0	2.70E-06
HEN RD	K10	823488.454	837233.747	6.5	0	2.70E-06	0	2.70E-06
HEN RD	K11	823502.807	837267.363	6.5	0	2.70E-06	0	2.70E-06
HEN RD	K12	823524.194	837299.377	6.5	0	2.70E-06	0	2.70E-06
HEN RD	K13	823498.225	837337.744	6.5	0	2.70E-06	0	2.70E-06
HEN RD	K14	823464.458	837397.307	6.5	0	2.70E-06	0	2.70E-06
HEN RD	K15	823473.949	837297.017	6.5	0	2.70E-06	0	2.70E-06
HEN RD	K16	823452.457	837248.458	6.5	0	2.70E-06	0	2.70E-06
HEN RD	K17	823391.456	837390.555	6.5	0	2.70E-06	0	2.70E-06
HEN RD	K18	823389.837	837337.404	6.5	0	2.70E-06	0	2.70E-06

<u>Inputs to the ISCST Model:</u>

		Calculated Emission Rate *	Emission Rate Factor **
General Workdays	Day-time (A)	2.17E-05	
	Night-time (B)	2.70E-06	0.1244 =B/A

Remark: * Please refer to Appendices 3-2C for the calculation of emission factors.

** For general workdays, in order to simulate calculated emission rate due to wind erosion during nightime period, the "Emission Rate Factor" is applied from 1800 to 0800 hours in the ISCST model.

Travelling on Haul Road (paved) (day-time only)

Project Site	Road Segment ID	X coordiante	Y coordinate	Ground mPD level, m	X Length, m	Y Length, m	Emission Height, m	Angle, degree	Mitigated * Calculated emission rate, g/m/s	Total emission, g/s	Emission rate, g/m²/s	Int. Vert. Dim.
					B	C			D	= (D*B)	=(D*B)/ (B*C)	
HEN RD	HR13	823394.7	837265.1	4.8	29	6	0.5	6	1.34E-04	3.89E-03	2.23E-05	0
HEN RD	HR14	823417.9	837263.5	4.8	35	6	0.5	100	1.34E-04	4.69E-03	2.23E-05	0
HEN RD	HR15	823411.6	837229.1	4.8	35	6	0.5	100	1.34E-04	4.69E-03	2.23E-05	0
HEN RD	HR16	823405.3	837194.6	4.8	15	6	0.5	100	1.34E-04	2.01E-03	2.23E-05	0
HEN RD	HR17	823424.4	837269.3	6.5	35	6	0.5	-84	1.34E-04	4.69E-03	2.23E-05	0
HEN RD	HR18	823428.3	837304.1	6.5	35	6	0.5	-84	1.34E-04	4.69E-03	2.23E-05	0
HEN RD	HR19	823432.1	837338.9	6.5	15	6	0.5	-83	1.34E-04	2.01E-03	2.23E-05	0

Remark: * Please refer to Appendices 3-2C for the calculation of emission factors.

Appendix 3-2C Calculation of TSP Emission Rates of the Project Site (Both Unmitigated and Mitigated Scenarios)

Type of Work	Type of Emission Source	Parameter		Remark
Wind Erosion on Exposed Ground	(1) Wind Erosion (day-time)	TSP emission factor (Mg/hectare/year)	0.85	USEPA AP-42, S11.9, Table 11.9-4, 7/98 ed.
		Emission rate, g/m²/s (unmitigated)	**2.70E-06**	={(0.85*1000000)/10000m²/(365*24*60*60)}
	(1) Wind Erosion (night-time)	TSP emission factor (Mg/hectare/year)	0.85	USEPA AP-42, S11.9, Table 11.9-4, 7/98 ed.
		Emission rate, g/m²/s (unmitigated)	**2.70E-06**	={(0.85*1000000)/10000m²/(365*24*60*60)}
Cut and Cover Activites	(2) Bulldozing & Surface Compacting (day-time only)	Eqn.: $E = 2.6 \, (s)^{1.2}/ (M)^{1.3}$		USEPA AP-42, S11.9, Table 11.9-2, 7/98 ed. *
		Material moisture content (%), M	2.2	To represent the worst case scenario, the lowest moisture content within the range specified for overburden in the USEPA AP-42, S11.9, Table 11.9-3, 7/98 ed., is adopted
		Material silt content (%), s	15.1	To represent the worst case scenario, the highest silt content within the range specified for overburden in the USEPA AP-42, S11.9, Table 11.9-3, 7/98 ed., is adopted
		Calculated Emission Factor (kg/hr), E	**2.42E+01**	
		Site Area (m²), A	37650	Area of the whole project site
		Calculated emission rate (unmitigated) (g/m²/s)	**1.79E-04**	= (E*1000)/A/(60*60)
		% of dust supression [#]	90.0%	for watering eight times during day-time [#]
		Calculated emission rate, g/m²/s (mitigated)	**1.79E-05**	Due to % of dust supression.
	(3) Removal/ unloading soil materials by excavators (day-time only)	Emission Factor of excavator unloading topsoil (kg/Mg), E1	0.02	USEPA AP-42, S11.9, Table 11.9-4, 7/98 ed. (scraper unloading topsoil is adopted). *
		Emission Factor of Topsoil removal by excavator (kg/Mg), E2	0.029	USEPA AP-42, S11.9, Table 11.9-4, 7/98 ed. (Topsoil removal by scraper is adopted). *
		Total Emission by excavator (kg/Mg), E= E1+E2	4.90E-02	
		Total quantity of materials involved (m³), Q	78000	The total amount of excavated materials and imported fill materials from Engineer
		No. of months for site formation (Phase B to D), m	7.5	Duration of site formation works for the Project Site
		No. of working days per month, d	25	From Project Engineer
		No. of working hours per day, h	10	From Project Engineer (working hours = 0800 hr to 1800 hr)
		Average hourly output (m³/hr), O1	41.60	= Q/(m*d*h)
		Average hourly output (Mg/hr), O2	104.00	= O1 x 2.5Mg/m³. Assuming the truck capacity of 6m3 and 15 tons (i.e. soil density of 2.5 Mg/m3).
		Site Area (m²), A	37650	Area of the whole project site
		Calculated emission rate (unmitigated) (g/m²/s)	**3.76E-05**	= (O2 x (E x 1000)/ A)/(60*60)
		% of dust supression [#]	90.0%	for watering eight times during day-time [#]
		Calculated emission rate (mitigated) (g/m²/s)	**3.76E-06**	

Type of Work	Type of Emission Source	Parameter		Remark
	(4) Earth Handling/ Loading, Unloading, and stockpiling (day-time only)	Eqn.: E = k x (0.0016) x ((U/2.2)^1.3 / (M/2)^1.4		USEPA AP-42, S13.2.4, 11/06 ed. *
		Particle size multiplier, k	0.74	USEPA AP-42, S13.2.4, 11/06 ed.
		Mean wind speed (m/s), U	1.85	Based on year 2010 average wind speed recorded at Wetland Park Station of Hong Kong Observatory.
		Material moisture content (%), M	2.2	Pls. refer to Emission Source no. (2) above
		Calculated Emission Factor (kg/Mg), E	0.00083	E = k x (0.0016) x ((U/2.2)^1.3 / (M/2)^1.4
		Total quantity of materials involved (m^3), Q	78000	The total amount of excavated materials and imported fill materials from Engineer
		No. of months for site formation, m	7.5	Duration of site formation works for the Project Site
		No. of working days per month, d	25	From Project Engineer
		No. of working hours per day, h	10	From Project Engineer (working hours = 0800 hr to 1800 hr)
		Average hourly output (m^3/hr), O1	41.60	= Q/(m*d*h)
		Average hourly output (Mg/hr), O2	104.00	= O1 x 2.5Mg/m^3. Assuming the truck capacity of 6m3 and 15 tons (i.e. soil density of 2.5 Mg/m3).
		Site Area (m^2), A	37650	Area of the whole project site
		Calculated emission rate (unmitigated) (g/m^2/s)	6.37E-07	= (O2 x (E x 1000)/ A)/(60*60)
		% of dust supression #	90.0%	for watering eight times during day-time #
		Calculated emission rate (mitigated) (g/m^2/s)	6.37E-08	
	Total Emission for "Cut and Cover" (= (2) + (3) + (4))	Unmitigated Total Emission rate, g/m^2/s, (day-time only)	2.17E-04	Calculated total unmitigated emission factor for "Cut and Cover".
		Mitigated Total Emission rate, g/m^2/s (day-time only)	2.17E-05	Calculated total mitigated emission factor for "Cut and Cover" ##.

Vehicle movement on Haul Road	(5) Paved Haul Road (day-time only)	Eqn.: E = k x (sL)^0.91 x (W)^1.02		USEPA AP-42, S13.2.1, 11/06 ed.
		Particle size multiplier (g/VKT), k	3.23	USEPA AP-42, S13.2.1, 11/06 ed., Table 13.2.1-1 for PM-30.
		Road surface silt loading (g/m^2), sL	14	To represent the worst case scenario, the highest silt loading within the range of typical values specified for quarry operation in the USEPA AP-42, S13.2.1, 1/11 ed., Table 13.2.1-3, is adopted. **
		Mean vehicle weight (tons), W	16	The average weight of the empty truck and full load truck.
		Calculated Emission Factor (g/VKT), E1	603.09	E = k x (sL)^0.91 x (W)^1.02
		Calculated emission factor (g/v-m), E2	0.603	= E1/1000
		Average no. of trucks (veh./hr), T	8	Estimated maximum no. of trucks per hour from Engineer
		Calculated emission rate (unmitigated), g/m/s	1.34E-03	= E2*(T/60*60)
		% of dust supression #	90.0%	for watering eight times during day-time #
		Calculated emission rate (mitigated), g/m/s	1.34E-04	

Remark:

Please refer to Appendix 3-9 for calculation of dust supression efficiency.   90% dust supression efficiency is assumed.

Due to the phased construction area, only limited space and construction plants will be available for construction in any one time. Thus, the construction activities under the "Cut and Cover" category that would contribute to dust emissions will unlikely to operate at the same time. In fact, only one of the above activities will operate in any one time. However, to be conservative, air quality impacts due to simultaneous construction of these activities has been taken into account in the assessment.

* The equation recommended for concerned particular construction activity as per Section 13.2.3 of USEPA AP-42 regarding heavy construction operation.

** The concerned construction activity of this Project during site formation stage will involve earth movement activities and transportation of excavated/ fill materials, etc. The nature of these activities is similar to that of quarry operation.   Thus, the typical silt loading within the range of typical values from quarry site, as stipulated in USEPA AP-42, Table 13.2.1-3, S13.2.1, 11/06 ed., is adopted in the above equation.   The reported highest silt loading value has been used in this exercise for worst case scenario. It is noted that similar assumption has also been adopted for paved construction haul road in the approved EIA report, Appendix F of the "EIA-032/1999 - East Rail Extension Hung Hom to Tsim Sha Tsui - Environmental Impact Assessment".