Calculation of Emission factor for Heavy Construction

E =	1.2	tons/acre/month of activity	(ref : AP-42 S13.2.3.3)
or =	2.69	Mg/hectare/month of activity	

Where
E = TSP Emission Factor

Assume

Mitigated (Working Hours)

Active operating area (%):	100	assumed all construction area are in full operation
Mitigation efficiency (%):	91.70%	watering once per hour
E (g/sq.m/day):	7.442E-01	According to AP42 S13.2.3.3, the emission factor is based construction activity occurs 30 days per month
E (g/sq.m/s):	**1.723E-05**	calculated (TSP), 12 working hours per day
	8.149E-06	calculated (RSP), 47.3% of TSP
	1.240E-06	calculated (FSP), 7.2% of TSP

Calculation of Emission factor for Wind Erosion

E =	0.85	Mg/hectare/year	(ref : AP-42 S11.9, Table 11.9.4)
or =	0.2329	g/sqm/day	

Where
E = TSP Emission Factor

Assume

Mitigated (Working Hours)

Active operating area (%):	100	assumed all construction area are in full operation
Mitigation efficiency (%):	91.70%	watering once per hour
E (g/sq.m/s):	**2.237E-07**	calculated (TSP), 12 working hours per day
	1.058E-07	calculated (RSP), 47.3% of TSP
	1.611E-08	calculated (FSP), 7.2% of TSP

Unmitigated (Non-working Hours)

Active operating area (%):	100	assumed all construction area are in full operation
Mitigation efficiency (%):	0.00%	no mitigation measure during non-working hours
E (g/sq.m/s):	**2.695E-06**	calculated (TSP), 12 working hours per day
	1.275E-06	calculated (RSP), 47.3% of TSP
	1.941E-07	calculated (FSP), 7.2% of TSP

Calculation of Emission factor for Material Handling at Stockpile for Barging Facilitiy in East Portion

According to Section 13.2.4 of AP-42

$$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}(kg/megagram)$$

Where

Item	Value		
E	Emission Factor in kg/megagram (Ref. AP42 S13.2.4)		
k	0.74		(Particle size multiplier, k = 0.74 as defined according to Table 2 of S13.2.4)
U	3.72	m/s	(average wind speed of PATH grid 17_31)
M	2	%	(Material moisture content)
			Based on the site monitoring data, the soil moisture content for the project area is high with large variation in a range of 3.6 - 50%. 2% has been assumed for conservative assessment.

Emission Factor 2.340E-03 kg/megagram

Unloading Point

Number of truck	33	per hour/unloading point [1]	
Handling (each truck)	11	tonne [1]	
Total	363	tonne/hour	
H	1	m	Reference: Central Kowloon Route VEP
W	1	m	Reference: Central Kowloon Route VEP
Area	1	sq. m	Reference: Central Kowloon Route VEP
Mitigation	50	%	3-side with top cover and water spraying system is made reference to the approved EIA Report of Central Kowloon Route (Registry No. : AEIAR-171/2013)
Emission rate	1.180E-01	g/sq.m /s (TSP, 100%) [2]	
	5.580E-02	g/sq.m /s (RSP, 47.3% of TSP) [2]	
	8.494E-03	g/sq.m /s (FSP, 7.2% of TSP) [2]	

Stockpile Area

Number of truck	10 [1]		
Handling (each truck)	11	tonne [1]	
Total	110	tonne/hour	
H	26	m [1]	
W	26	m [1]	
Area	676	sq. m	
Mitigation	50	%	watering once per hour [3]
Emission rate	5.288E-05	g/sq.m /s (TSP, 100%) [2]	
	2.501E-05	g/sq.m /s (RSP, 47.3% of TSP) [2]	
	3.808E-06	g/sq.m /s (FSP, 7.2% of TSP) [2]	

Note:
[1] Advised by Project Engineer
[2] Particle distribution made reference to approved EIA (Register No.: AEIAR-185/2014): https://www.epd.gov.hk/eia/register/report/eiareport/eia_2232014/html/Appendix%205.2.3.pdf
[3] Detailed calculation of the required watering intensity is provided on page 3 of this appendix.

Dust Suppression efficiency

Calculation of Watering Efficiency (for exposed construction area with duct emssion which depends on traffic volume)

With reference to Cowherd et al., "Control of Open Fugitive Dust Sources, EPA-450/3-88-008, U.S. Environmental Protection Agency, Research Triangle Park, NC, percentage of dust mitigation efficiency is calculated from Equation (3-2) :

$$C = 100 - \frac{0.8\,pdt}{i}$$

where

p = Potential average hourly daytime evaporation rate, mm/hour = 0.23676 [1]
d = Average hourly daytime traffic rate per hour = 66 per hour [2]
I = Application intensity = 1.5 L/m2 [3]

Note:
[1] p = 0.0049 x 48.3189 inch, where 48.3189 inch is equivalent to the total evaoporation of 1227.3mm obtained from Hong Kong Observatory
[2] Estimated by Engineer
[3] The assumptions provided are for the purpose of assessment predictions only. Actual figures would be defined in the detailed design stage.

By applying the Equation (3-2) with the above assumptions,

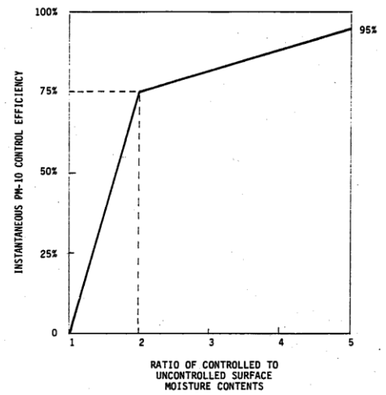
Dust suppression efficiency = 100 – 0.8 x (0.23676 x 66 x t) / 1.5 [t = time between application, hr]

Therefore,

For watering once per hour (i.e. t =1 hour), the estimated dust suppression efficiency is 91.7%.

Calculation of Watering Efficiency (at stockpile area which did not depends on vehicle passes after application)

With reference to Cowherd et al., "Control of Open Fugitive Dust Sources, EPA-450/3-88-008, U.S. Environmental Protection Agency, Research Triangle Park, NC, percentage of dust mitigation efficiency is calculated from Equation (3-3) and Figure 3-3 :



$$C = 75 \times (M - 1) \quad \text{[for 1 ≤ M ≤ 2]}$$

$$C = 62 + 6.7M \quad \text{[for 2 ≤ M ≤ 5]}$$

where c = Instanteous control efficiency (%)
M = Ratio of controlled to uncontrolled surface moisture contents

According to the Equation (3-3), by increasing the surface moisture content by a ratio of 1.67 would achieve 50% dust suppression efficiency :

Dust suppression efficiency = 75 x (1.67 - 1) = 50%

Watering Intensity

Given

Area of Stockpile	=	676	m^2
Dry Fill Density	=	1700	kg/m^3
Uncontrolled Surface Moisture Content	=	2	%
Controlled Surface Moisture Content	=	3.33	%

Assume

Depth of Water Penetrated into Stockpile	=	0.02	m	see Note [1]

Therefore,

Weight of Uncontrolled Wet Stockpile Surface	=	676 x 1700 x 0.02 / (1 - 0.02)	=	23453	kg
Weight of Controlled Wet Stockpile Surface	=	676 x 1700 x 0.02 / (1 - 0.033)	=	23777	kg
Watering Intensity	=	(23777 - 23453) / 676	=	0.5	$L/m^2/hour$

Note [1] Referenced from the Dennis R. Fitz & Kurt Bumiller (2000) "Evaluation of Watering to Control Dust in High Winds", Journal of the Air & Waste Management Assoication

Location and Details of Worksites (Dust Sources assocated with the Project)

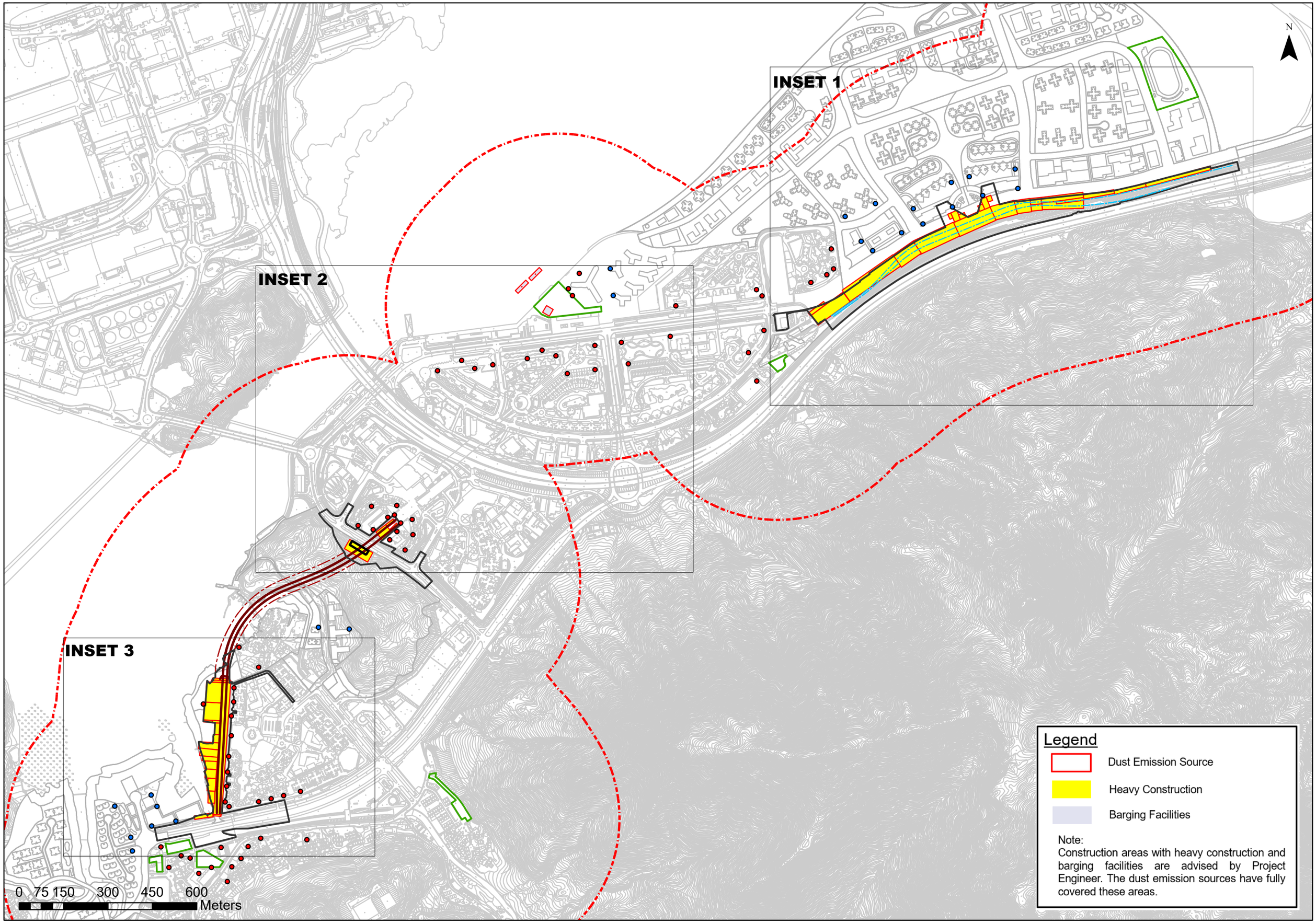
Area	Source ID	Source Type	Coordinates of		Dimension (m)		Height	Angle	TSP Emission Rate (g/s/sq.m)		RSP Emission Rate (g/s/sq.m)		FSP Emission Rate (g/s/sq.m)		Working Hour	
			X1	Y1	X2	Y2			Heavy Construction	Wind Erosion (Non-working	Heavy Construction	Wind Erosion (Non-working	Heavy Construction	Wind Erosion (Non-working	Start Hour	End Hour
			(m)	(m)	(m)	(m)	(m)									
TCE station and realignment	TE1_001	AREA	814386	817753	12	227	0	75	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_002	AREA	814280	817728	12	109	0	76	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_003	AREA	814176	817714	13	105	0	80	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_004	AREA	814033	817706	19	143	0	83	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_005	AREA	814085	817693	9	93	0	82	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_006	AREA	813996	817702	22	38	0	84	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_007	AREA	813942	817695	45	55	0	82	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_008	AREA	813861	817675	48	83	0	75	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_009	AREA	813738	817621	51	135	0	66	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_010	AREA	813602	817560	52	149	0	65	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_011	AREA	813533	817511	50	82	0	55	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_012	AREA	813362	817393	47	209	0	55	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_013	AREA	813257	817308	41	133	0	54	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_014	AREA	813248	817316	12	65	0	53	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_015	AREA	813729	817654	33	22	0	67	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_016	AREA	813755	817647	17	21	0	68	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_017	AREA	813718	817649	19	10	0	65	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_018	AREA	813829	817700	37	20	0	68	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_019	AREA	813848	817708	19	16	0	70	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE1_020	AREA	813819	817677	20	18	0	66	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE2_001	AREA	814036	817690	25	141	0	88	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	TE2_002	AREA	813998	817687	28	38	0	85	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
EAP/EPP near Tung Chung Crescent (including TBM launching shaft)	EAP_001	AREA	811821	816602	11	32	0	53	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	EAP_002	AREA	811833	816584	10	33	0	48	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	EAP_003	AREA	811788	816576	33	41	0	52	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	EAP_004	AREA	811681	816520	91	36	0	30	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
TCW station including TBM retrieving shaft)	CON_001	AREA	811238	815624	28	446	0	4	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_002	AREA	811206	815942	58	61	0	3	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_003	AREA	811212	816002	55	68	0	3	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_004	AREA	811234	815933	28	8	0	3	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_005	AREA	811242	815893	17	39	0	4	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_006	AREA	811236	815866	21	28	0	5	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_007	AREA	811189	815845	67	23	0	3	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_008	AREA	811192	815822	61	26	0	6	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_009	AREA	811200	815805	52	16	0	5	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_010	AREA	811210	815777	40	27	0	3	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_011	AREA	811211	815747	37	30	0	4	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_012	AREA	811217	815703	27	42	0	4	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_013	AREA	811220	815662	23	41	0	1	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_014	AREA	811232	816070	66	7	0	2	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_015	AREA	811236	816077	57	7	0	3	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_016	AREA	811205	815935	29	7	0	2	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_017	AREA	811238	815618	26	5	0	4	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_018	AREA	811218	815626	13	18	0	80	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19
	CON_019	AREA	811174	815618	12	44	0	81	1.723E-05	2.695E-06	8.149E-06	1.275E-06	1.240E-06	1.941E-07	7	19

Barging Facility

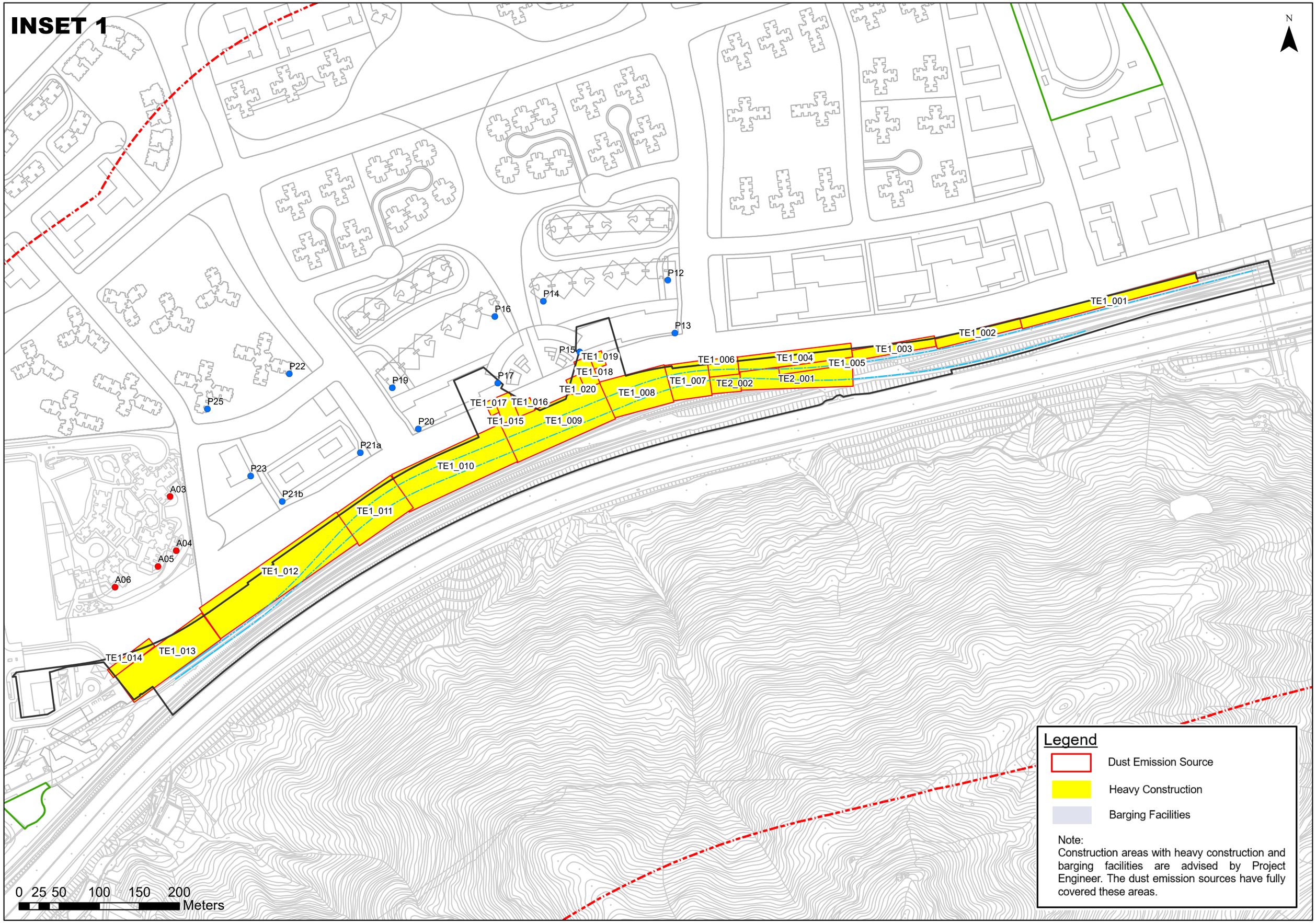
Area	Source ID	Source Type	Coordinates of		Dimension (m)		Height	Angle	TSP Emission Rate (g/s/sq.m)				RSP Emission Rate (g/s/sq.m)				FSP Emission Rate (g/s/sq.m)				Working Hour	
									Stockpiling			Unloading Point	Stockpiling			Unloading Point	Stockpiling			Unloading Point		
			X1	Y1	X2	Y2			Stockpiling	Wind Erosion			Stockpiling	Wind Erosion			Stockpiling	Wind Erosion				
			(m)	(m)	(m)	(m)	(m)		Working Hours	Working Hours	Non-working Hours		Working Hours	Working Hours	Non-working Hours		Working Hours	Working Hours	Non-working Hours		Start Hour	End Hour
Stockpile Area	BP_SP	AREA	812351	817319	26	26	0	31	5.288E-05	2.237E-07	2.695E-06		2.501E-05	1.058E-07	1.275E-06		3.808E-06	1.611E-08	1.941E-07		7	19
Barging Points	BP_LUPE	AREA	812325	817447	1	1	0.5	45				1.180E-01				5.580E-02				8.494E-03	7	19
	BP_LUPW	AREA	812280	817405	1	1	0.5	45				1.180E-01				5.580E-02				8.494E-03	7	19
	BP_BDE	AREA	812304	817434	13	50	0.0	45		2.695E-06 [1]	2.695E-06			1.275E-06 [1]	1.275E-06			1.941E-07 [1]	1.941E-07		7	19
	BP_BDW	AREA	812258	817392	13	50	0.0	45		2.695E-06 [1]	2.695E-06			1.275E-06 [1]	1.275E-06			1.941E-07 [1]	1.941E-07		7	19

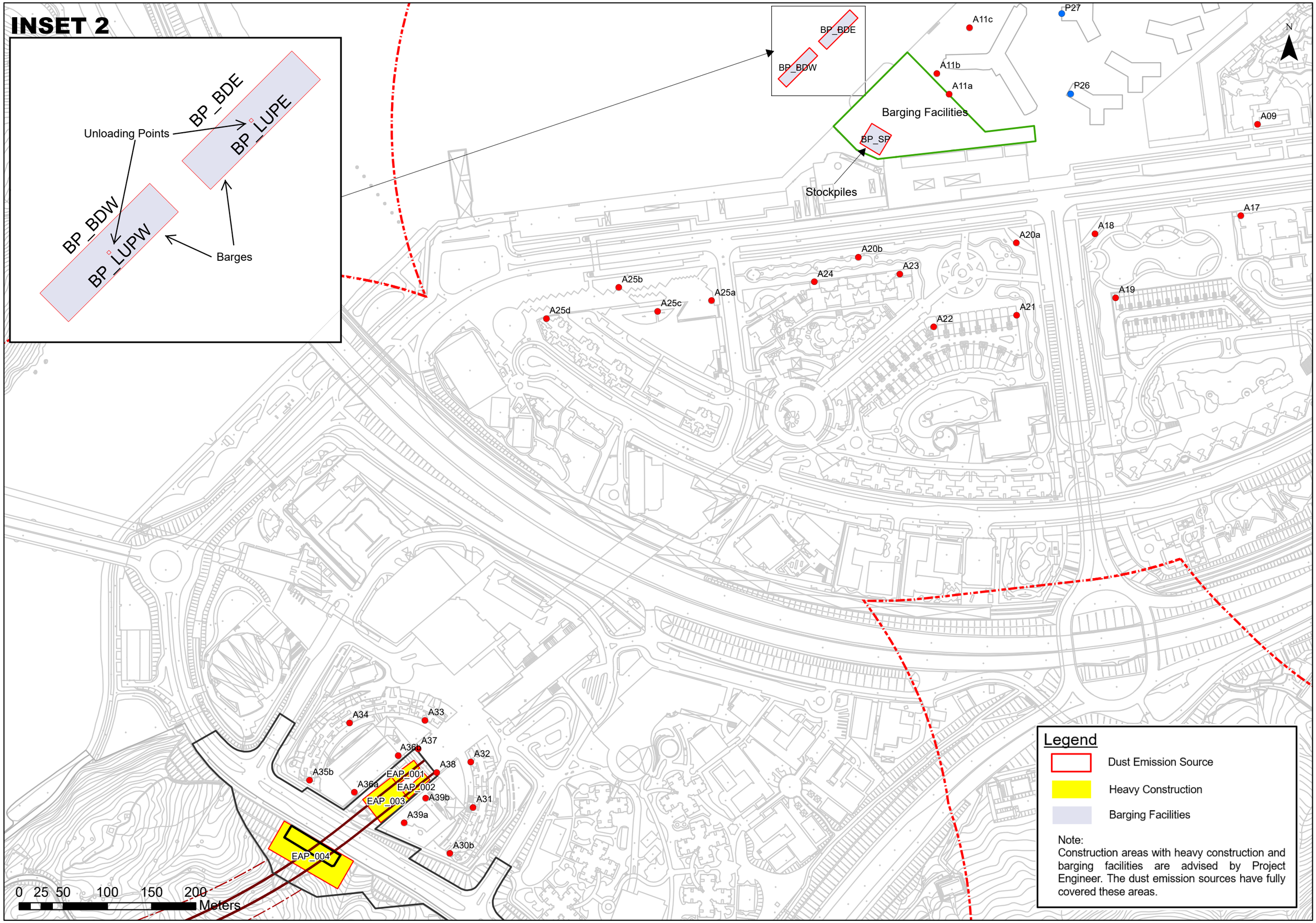
Notes:

[1] Since it is not practical to conduct watering over the deck of the barge, unmitigated emission rates of wind erosion are adopted during working hours.

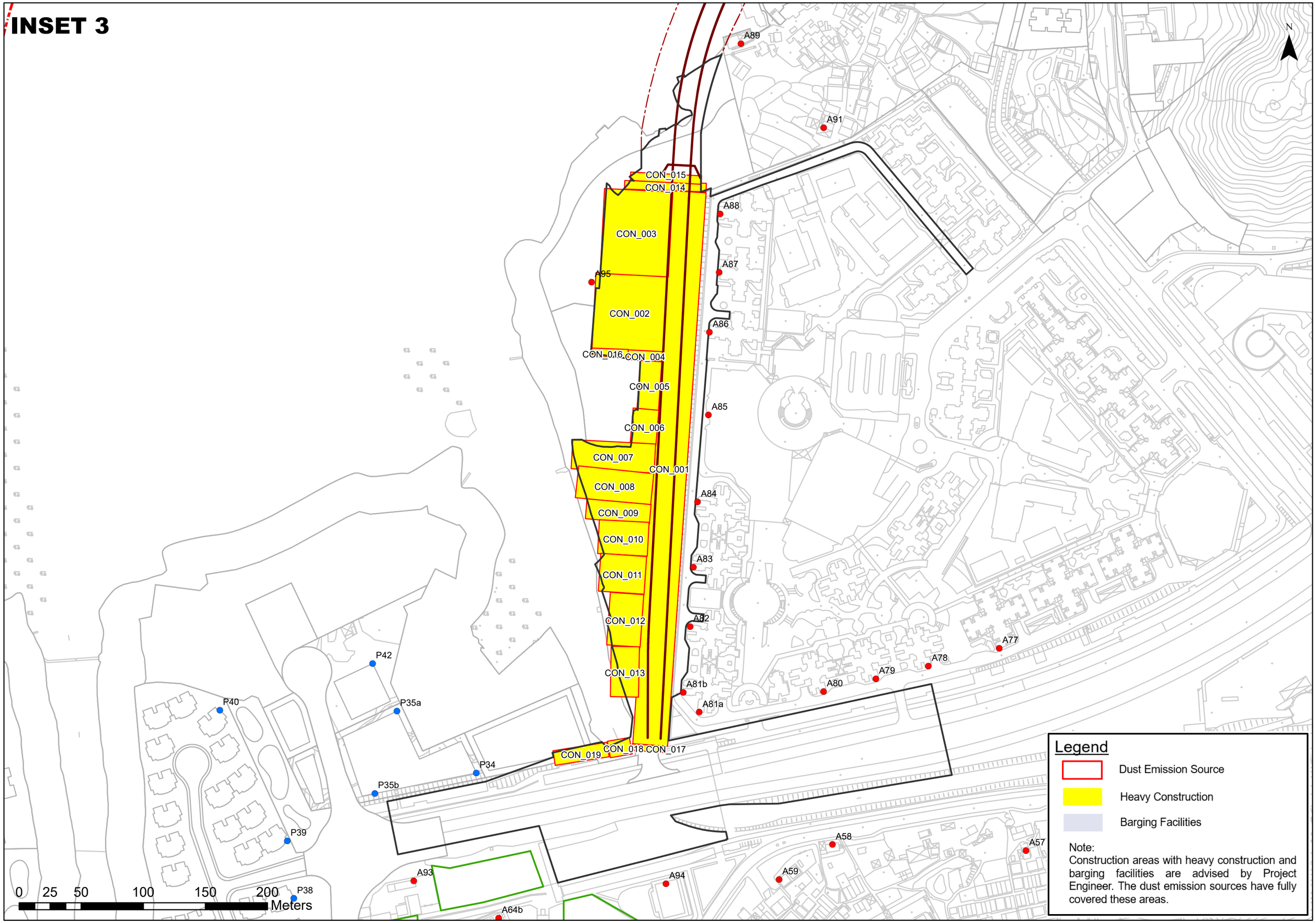

INSET 1
INSET 2
INSET 3
N
0 75 150 300 450 600
Meters
Legend
Dust Emission Source
Heavy Construction
Barging Facilities
Note:
Construction areas with heavy construction and barging facilities are advised by Project Engineer. The dust emission sources have fully covered these areas.

INSET 1


N
P12
P13
P14
P15
P16
P17
P19
P20
P21a
P21b
P22
P23
P25
A03
A04
A05
A06
TE1_001
TE1_002
TE1_003
TE1_004
TE1_005
TE1_006
TE1_007
TE1_008
TE1_009
TE1_010
TE1_011
TE1_012
TE1_013
TE1_014
TE1_015
TE1_016
TE1_017
TE1_018
TE1_019
TE1_020
TE2_001
TE2_002
0 25 50 100 150 200
Meters
Legend
Dust Emission Source
Heavy Construction
Barging Facilities
Note:
Construction areas with heavy construction and barging facilities are advised by Project Engineer. The dust emission sources have fully covered these areas.


INSET 2
BP_BDE
BP_LUPE
Unloading Points
BP_BDW
BP_LUPW
Barges
BP_BDE
BP_BDW
Barging Facilities
BP_SP
Stockpiles
A11c
A11b
A11a
P27
P26
N
A09
A17
A18
A19
A20a
A20b
A23
A24
A21
A22
A25b
A25a
A25c
A25d
A34
A33
A37
A36b
A38
A32
A35b
A36a
EAP_001
EAP_002
EAP_003
A39b
A31
A39a
A30b
EAP_004
0 25 50 100 150 200
Meters
Legend
Dust Emission Source
Heavy Construction
Barging Facilities
Note:
Construction areas with heavy construction and barging facilities are advised by Project Engineer. The dust emission sources have fully covered these areas.

INSET 3


N
A89
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CON_015
CON_014
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CON_003
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A95
CON_002
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CON_016
CON_004
CON_005
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CON_006
CON_007
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CON_008
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CON_009
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CON_011
CON_012
A82
A77
A78
A79
A80
A81b
A81a
CON_013
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P40
P35a
CON_019
CON_018
CON_017
P34
P35b
P39
A58
A57
A93
A94
A59
P38
A64b
0 25 50 100 150 200
Meters
Legend
Dust Emission Source
Heavy Construction
Barging Facilities
Note:
Construction areas with heavy construction and barging facilities are advised by Project Engineer. The dust emission sources have fully covered these areas.