Appendix 3.10 Calculation of Odour Emission Source at EPP, FWPF and SPS

Proposed Effluent Polishing Plant

Design of Deodorization System

DO 1 (Inlet Works + Primary Treatment)

Location	Nos.	Air Phase Height (m)	Total Odour Emission Area (m2)	Air Phase Volume (m3)	Aeration Rate (m3/hr) (if any)	Air Exchange Rate (Air Changes / hr)	SOER (ou/m2/s)	Unmitigated Odour Emission Rate (ou/s)	Flow Rate (m3/hr)	Total Flow Rate (m3/s)	Velocity (m/s)	Number of Exhaust Point (nos.)	Height of the Deodorizer Exhaust Point (mAG)	Diameter of the Deodorizer Exhaust Point (m)	Removal Efficiency (%)	Mitigated Odour Emission Rate (ou/s)	Temperature at exhaust point (C)
Inlet Works																	
Inlet Well	1	4	121	485		3	3.26	394.96	1,454								
Coarse Screen Channel	4	4	166	665		3	3.51	583.20	1,994								
Distribution Channel (screen - wet well)	1	4.5	92	415		3	3.26	300.92	1,246								
Wet Well	2	4.5	185	831		3	3.26	601.85	2,492								
Distribution Channel (wet well - fine screen)	1	2	157	314		3	3.26	511.57	942								
Fine Screen Channel	4	2.5	185	462		3	3.51	648.00	1,385								
Distribution Channels (fine screen - grit trap) A	1	2.5	98	245		3	3.26	319.73	736								
Distribution Channels (fine screen - grit trap) B	1	2.5	87	216		3	3.26	282.12	649								
Distribution Channels (fine screen - grit trap) C	1	2.5	170	425		3	3.26	554.83	1,276								
Grit Trap Influent Channels	3	2.5	71	177		3	3.26	230.21	530								
Grit Trap	3	2.5	243	607		3	3.26	791.09	1,820								
Grit Trap effluent Channels	3	2.5	100	249		3	3.26	325.00	748								
Distribution Channel (grit trap to Distribution chamber) wide	1	2.5	81	202		3	3.26	263.31	606								
Distribution Channel (grit trap to Distribution chamber) narrow	1	2.5	32	81		3	3.26	105.32	242	25.23	7.50	1	33	2.07	97%	668	Ambient
Coarse Screening Skip Area	1	3	93	280		12	3.51	328.05	3,365								
Screening and Grit Skip Area	1	3	323	969		12	3.51	1134.00	11,631								
Conveyors	6	0.3	42	12		3	3.51	145.80	37								
Equalization Tank	1	3.5	1,236	4,325		3	3.26	4028.61	12,976								
Distribution Chamber	1	1.5	136	203		3	3.26	441.98	610								
Primary Treatment																	
Inlet Channel	1	4	110	438		3	3.26	357.35	1,315								
Scum Tank	2	1	17	17		3	4.03	69.75	52								
Influent Distribution Channel	1	4	202	808		3	3.26	658.27	2,423								
Scum "Y" Channel	2	1.5	37	55		3	1.54	56.86	166								
Skimmer Tank Area	2	2	295	591		3	4.03	1190.40	1,772								
Primary Sedimentation Tank Area	2	3	1,163	3,489		3	4.03	4687.20	10,468								
Primary Sedimentation Tank Inspection Area	1	3	729	2,188		12	4.03	2938.80	26,252								
PST Effluent Channel	1	6	202	1,212		3	1.54	310.96	3,635								
							sub-total	**22,260**	**90,821**								

DO 2 (Sludge + Sidestream)

Location	No. of Units (Duty)	Air Phase Height (m)	Total Odour Emission Area (m2)	Air Phase Volume (m3)	Aeration Rate (m3/hr) (if any)	Air Exchange Rate (Air Changes / hr)	SOER (ou/m2/s)	Unmitigated Odour Emission Rate (ou/s)	Flow Rate (m3/hr)	Total Flow Rate (m3/s)	Velocity (m/s)	Number of Exhaust Point (nos.)	Height of the Deodorizer Exhaust Point (mAG)	Diameter of the Deodorizer Exhaust Point (m)	Removal Efficiency (%)	Mitigated Odour Emission Rate (ou/s)	Temperature at exhaust point (C)
Thickening & Dewatering House																	
Sludge Blend Tanks	2	1.5	69	104		3	3.98	275.54	312								
Thickening Centrifuges	2	1	18	18		3	3.98	73.48	55								
Thickened Sludge Holding Tanks	2	1	307	307		3	3.98	1221.55	921								
Centrate Buffer Tanks	2	1	65	65		3	3.98	257.17	194								
Digested sludge holding tank	2	1.5	335	503		6	3.98	1333.61	3,016								
Dewatering Centrifuges	2	1	18	18		3	3.98	73.48	55								
Dryer Centrifuges	1	1	9	9		3	3.98	36.74	28								
Dryer	1	1	46	46		3	3.98	183.69	138								
Sludge Silo (Dewatering)	3	1	61	61		3	0.43	26.05	182	5.94	7.5	1	33	1.00	97%	222	Ambient
Dried Sludge Silo (Drying)	4	1	69	69		3	0.43	29.77	208								
Sludge Skip Room	1	3	318	954		12	3.51	1115.78	11,444								
Conveyors	6	0.3	91	27		3	3.51	320.76	82								
Side Stream																	
Anammox Process Tanks	1	1.81	790	1,433		3	2.73	2157.17	4,298								
Thickened Sludge Tank Wet Well	1	2	18	36		3	3.98	70.85	107								
Sludge Mixing Tank Wet Well	1	2	18	36		3	3.98	70.85	107								
Anammox Sludge Storage Tank	1	2	39	78		3	3.98	154.94	234								
							sub-total	**7,401**	**21,380**								

Appendix 3.10 Calculation of Odour Emission Source at EPP, FWPF and SPS

Proposed Effluent Polishing Plant

Design of Deodorization System

DO 3 (Bioreactor)

Location	No. of Units (Duty)	Air Phase Height (m)	Total Odour Emission Area (m2)	Air Phase Volume (m3)	Aeration Rate (m3/hr) (if any)	Air Exchange Rate (Air Changes / hr)	SOER (ou/m2/s)	Unmitigated Odour Emission Rate (ou/s)	Flow Rate (m3/hr)	Total Flow Rate (m3/s)	Velocity (m/s)	Number of Exhaust Point (nos.)	Height of the Deodorizer Exhaust Point (mAG)	Diameter of the Deodorizer Exhaust Point (m)	Removal Efficiency (%)	Mitigated Odour Emission Rate (ou/s)	Temperature at exhaust point (C)
Bioreactor																	
Outlet Channel (PST to Fine Screen)	1	1	48	48		3	1.65	79.96	145								
Fine Screen Chamber	4	2	277	554		3	3.51	972.00	1,662								
Fine Screen Effluent Channel A	2	1.5	88	132		3	1.65	144.69	395								
Fine Screen Effluent Channel B	1	1.5	115	173		3	1.65	190.38	519								
Fine Screen Effluent Channel C	1	1.5	169	253		3	1.65	278.72	760	29.52	7.5	1	33	2.24	97%	217	Ambient
Pre- Anoxic Tank	3	2	945	1,890		3	1.65	1559.25	5,670								
Aerobic Tank	3	2	1,192	2,384	89,723	3	1.65	1967.05	89,723								
Post- Anoxic Tank	3	2	276	552		3	1.65	455.78	1,657								
Bioreactor Effluent Channel A	2	2	502	1,004		3	1.65	828.55	3,013								
Bioreactor Effluent Channel B	1	2	457	914		3	1.65	753.92	2,742								
							sub-total	**7,230**	**106,286**								

DO 4 (Membrane Bioreactor Building)

Location	No. of Units (Duty)	Air Phase Height (m)	Total Odour Emission Area (m2)	Air Phase Volume (m3)	Aeration Rate (m3/hr) (if any)	Air Exchange Rate (Air Changes / hr)	SOER (ou/m2/s)	Unmitigated Odour Emission Rate (ou/s)	Flow Rate (m3/hr)	Total Flow Rate (m3/s)	Velocity (m/s)	Number of Exhaust Point (nos.)	Height of the Deodorizer Exhaust Point (mAG)	Diameter of the Deodorizer Exhaust Point (m)	Removal Efficiency (%)	Mitigated Odour Emission Rate (ou/s)	Temperature at exhaust point (C)
MBR Building																	
Inlet Channel	1	1	291	291		3	1.65	479.77	872	27.29	7.5	1	33	2.15	97%	123	Ambient
Membrane Tank	10	1	1,717	1,717	95,908	3	1.65	2832.92	95,908								
Deoxygenation zone	1	1	485	485		3	1.65	799.62	1,454								
							sub-total	**4,112**	**98,234**								

DO 5 (Food Waste)

Location	No. of Units (Duty)	Air Phase Height (m)	Total Odour Emission Area (m2)	Air Phase Volume (m3)	Aeration Rate (m3/hr) (if any)	Air Exchange Rate (Air Changes / hr)	SOER (ou/m2/s)	Unmitigated Odour Emission Rate (ou/s)	Flow Rate (m3/hr)	Total Flow Rate (m3/s)	Velocity (m/s)	Number of Exhaust Point (nos.)	Height of the Deodorizer Exhaust Point (mAG)	Diameter of the Deodorizer Exhaust Point (m)	Removal Efficiency (%)	Mitigated Odour Emission Rate (ou/s)	Temperature at exhaust point (C)
Food Waste Reception																	
Food Waste Bunker	2	5.00	238.43	1192.15		3	3.98	948.95	3,576								
Food Waste Dilution Tank	1	1.00	27.69	27.69		3	3.98	110.22	83	1.05	7.5	1	33	0.42	97%	36	Ambient
Digester																	
Sludge Buffer Tank	1	1.00	36.92	36.92		3	3.98	146.95	111								
							sub-total	**1,206**	**3,770**								

Remarks:

[1] SOER Reference: Shek Wu Hui effluent polishing plant https://www.epd.gov.hk/eia/register/report/eiareport/eia_2132013/eia/pdf/appendix/appendix_3-8.pdf. The SOER from SWHEPP was adopted because SWHEPP receives similar nature of sewage without seawater flushing, adopts the same sewage treatment process of proposed EPP. Among Hong Kong's sewage treatment works with the above similar nature of sewage and treatment process, SWHEPP is of the nearest order of capacity compared to proposed EPP.
[2] The odour removal efficiency for deodourization units is referenced from Scottish Executive Environment Group Code of Practice on Assessment and Control of Odour Nuisance from Waste Water Treatment Works which is appended in this Appendix.
[3] The adopted SOER for Food Waste Reception Building is referenced from SOER from sludge in Shek Wu Hui EPP with sludge digestion process. Compared to the SOER adopted for food waste (3.68 OU/m2/s) for North Lantau RTS Building Area in the approved Organic Waste Treatment Facilities Phase 1 (OWTF-P1) EIA Report (AEIAR-149/2010), and its subsequent Environmental Review Report for Variation of Environmental Permit (VEP-488/2015), SWHEPP's sludge SOER of 3.98 OU/m2/s is higher and more conservative. It is therefore adopted in this assessment.
[4] Detailed calculations of SOER of Annamox, referenced from Appendix 3.7 of YLSEPP EIA Report (AEIA-237/2022), are shown in last page of Appendix 3.10.
[5] Dimensions of odour emission area, air phase volume, air exchange rate and exhaust parameters are based on engineering design.

Appendix 3.10 Calculation of Odour Emission Source at EPP, FWPF and SPS

Proposed Effluent Polishing Plant

Exhaust Design

Deodouriser	Description	Source Type	Exhaust Location		Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity (m/s)
			X	Y				
EPP_DO1	Exhaust point (Inlet Works + PST)	POINTCAP	825097.11	839152.71	2.07	33.00	Ambient	7.5
EPP_DO2	Exhaust point (Sludge + Side Stream)	POINTCAP	824745.29	839062.78	1.00	33.00	Ambient	7.5
EPP_DO3	Exhaust point (BR)	POINTCAP	824955.70	839226.23	2.24	33.00	Ambient	7.5
EPP_DO4	Exhaust point (MBR Building)	POINTCAP	825023.18	839112.82	2.15	33.00	Ambient	7.5
EPP_DO5	Exhaust point (Food Waste)	POINTCAP	824665.88	839101.06	0.42	33.00	Ambient	7.5

Remark:
1. The exhaust parameters are provided by engineer.

Conversion of 1-hour Average to 5-second Average Concentration

Deodouriser	Emission Rate (OU/s)	Stability Class	Conversion Multiplier	Emission Rate with 5-second Peak Factor (OU/s)	Reference
EPP_DO1	668	A, B, C, D, E, F	2.3	1535.95	- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales. - Katestone Scientific 1995, The Evaluation of Peak-to-Mean Ratios for Odour Assessments, volumes I and II, Katestone Scientific Pty Ltd, Brisbane. - Katestone Scientific 1998, Peak-to-Mean Concentration Ratios for Odour Assessments, Katestone Scientific Pty Ltd, Brisbane.
EPP_DO2	222	A, B, C, D, E, F	2.3	510.70	
EPP_DO3	217	A, B, C, D, E, F	2.3	498.89	
EPP_DO4	123	A, B, C, D, E, F	2.3	283.75	
EPP_DO5	36	A, B, C, D, E, F	2.3	83.22	

Emission Source Listing in AERMOD

Source ID	Type	X	Y	Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity(m/s)	Emission Rate with 5-second Peak Factor (OU/s)
EPP_DO1	POINTCAP	825097.11	839152.71	2.07	33.00	Ambient	7.5	1535.95
EPP_DO2	POINTCAP	824745.29	839062.78	1.00	33.00	Ambient	7.5	510.70
EPP_DO3	POINTCAP	824955.70	839226.23	2.24	33.00	Ambient	7.5	498.89
EPP_DO4	POINTCAP	825023.18	839112.82	2.15	33.00	Ambient	7.5	283.75
EPP_DO5	POINTCAP	824665.88	839101.06	0.42	33.00	Ambient	7.5	83.22

Appendix 3.10 Calculation of Odour Emission Source at EPP, FWPF and SPS

Proposed Food Waste Pre-treatment Facility

Pollutant Concentration to Odour Concentration

Pollutant	Odour threshold k (ppm) [1][2]	Molar Mass M (g/mol)	Volume of Gas V_T (m^3/mol) [3]	At Temperature T (Celcius)	Odour threshold in Mass Concentration k_C (mg/m^3)
NH_3	0.037	17.0305	24.4513	25	0.0258
H_2S	0.00047	34.0810	24.4513	25	0.0007

Remark:

[1] Reference from Ammonia Fact Sheet, AERISA

[2] Reference from Hydrogen Sulphide Fact Sheet, AERISA

[3] Volume of Gas at Standard Temperature and Pressure is 22.4 m^3/mol. By Ideal Gas Law, $V_T = 22.4 / 273 * (273 + T)$, where T is the temperature in Celcius

[4] $k_C = k * M / V$

Summary of Monitoring Data from Food Waste Pre-treatment Facility of the Food Waste / Sludge Anaerobic Co-Digestion Tai Po Pilot Plant

Data Summary	H_2S Concentration at Inlet (ppm)	H_2S Concentration at Outlet (ppm)	NH_3 Concentration at Inlet (ppm)	NH_3 Concentration at Outlet (ppm)
Min	0.0631723	0.0100155	0.5221730	0.0689271
Max	0.5737897	0.0897909	4.4088579	1.6821527
Average	0.1954407	0.0366411	1.8604502	0.3091344

Remark:

Hourly monitoring data was recorded from Jan 2020 to Jan 2023.

Other Operation Details:

Design flow rate of DO system (m^3/hr):	12000
Processing capacity (tpd):	50

Odour Emission Rate of Each Exhaust Point in Food Waste Pre-treatment Facility

Pollutant	Emission Concentraion C_x (ppb) [1]	Molar Mass M (g/mol)	Volume of Gas V_T (m^3/mol) [2]	At Temperature T (Celcius)	Mass concentration C (mg/m^3)[3]	Equivalent Odour Concentration C_{OU} (OU/m^3) [4]	Flow Rate Q (m^3/s) [1]	Odour Emission Rate E_{OU} (OU/s) [5]
NH_3	1682.1527	17.0305	24.4513	25	1.1716	45.4636	3.3333	151.5453
H_2S	89.7909	34.0810	24.4513	25	0.1252	191.0445	3.3333	636.8150

Remark:

[1] Reference from Monitoring Data from Food Waste Pre-treatment Facility of the Food Waste / Sludge Anaerobic Co-Digestion Tai Po Pilot Plant. The maximum concentration is adopted.

[2] Volume of Gas at Standard Temperature and Pressure is 22.4 m^3/mol. By Ideal Gas Law, $V_T = 22.4 / 273 * (273 + T)$, where T is the temperature in Celcius

[3] $C = C_X /1000 * M / V_T$

[4] $C_{OU} = C / k_C$

[5] $E_{OU} = C_{OU} * Q$

[6] Continuous monitoring of actual H_2S and NH_3 concentrations after commissioning is required.

Appendix 3.10 Calculation of Odour Emission Source at EPP, FWPF and SPS

Proposed Food Waste Pre-treatment Facility

Exhaust Design

Deodouriser	Description	Source Type	Exhaust Location		Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity (m/s)
			X	Y				
FWPF1a	Exhaust point	POINT	824662.37	839134.79	0.80	10.00	Ambient	6.6
FWPF1b	Exhaust point	POINT	824662.37	839134.79	0.80	10.00	Ambient	6.6
FWPF2a	Exhaust point	POINT	824580.35	839099.98	0.80	10.00	Ambient	6.6
FWPF2b	Exhaust point	POINT	824580.35	839099.98	0.80	10.00	Ambient	6.6

Remark:
1. Two units of food waste pre-treatment facility (50 tpd each) of the Food Waste / Sludge Anaerobic Co-Digestion Tai Po Pilot Plant is employed to account for the proposed capacity of 100 tpd.
2. The exhaust parameters are provided by engineer.

Conversion of 1-hour Average to 5-second Average Concentration

Deodouriser	Emission Rate (OU/s)	Stability Class	Conversion Multiplier	Emission Rate with 5-second Peak Factor (OU/s)	Reference
FWPF1a	637	A, B, C, D, E, F	2.3	1464.67	- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales. - Katestone Scientific 1995, The Evaluation of Peak-to-Mean Ratios for Odour Assessments, volumes I and II, Katestone Scientific Pty Ltd, Brisbane. - Katestone Scientific 1998, Peak-to-Mean Concentration Ratios for Odour Assessments, Katestone Scientific Pty Ltd, Brisbane.
FWPF1b	152	A, B, C, D, E, F	2.3	348.55	
FWPF2a	637	A, B, C, D, E, F	2.3	1464.67	
FWPF2b	152	A, B, C, D, E, F	2.3	348.55	

Emission Source Listing in AERMOD

Source ID	Type	X	Y	Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity(m/s)	Emission Rate with 5-second Peak Factor (OU/s)
FWPF1a	POINT	824662.37	839134.79	0.80	10.00	Ambient	6.63	1464.67
FWPF1b	POINT	824662.37	839134.79	0.80	10.00	Ambient	6.63	348.55
FWPF2a	POINT	824580.35	839099.98	0.80	10.00	Ambient	6.63	1464.67
FWPF2b	POINT	824580.35	839099.98	0.80	10.00	Ambient	6.63	348.55

Proposed Sewage Pumping Station (OU.1.2, OU.3.2, OU.5.7)

Design of Sewage Pumping Station

Location	Total Odour Emission Area (m^2) [1]	SOER ($ou/m^2 \cdot s$)	Unmitigated Odour Emission Rate (ou/s)	Removal Efficiency (%)	Mitigated Odour Emission Rate (ou/s)
SPS at OU.5.7	954.00	3.26	3110.04	95	155.502
SPS at OU.3.2	563.50	3.26	1837.01	95	91.8505
SPS at OU.1.2	322.50	3.26	1051.35	95	52.5675

Remark:

1. The area of wet well is provided by design engineer.
2. SOER of the inlet well / wet well of the Proposed EPP is adopted to represent the raw sewage.

Exhaust Design

Deodouriser	Description	Source Type	Exhaust Location		Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity (m/s)
			X	Y				
SPS1	Exhaust point of SPS at Site OU.5.7	POINTHOR	825509.39	839378.40	2.00	4.35	Ambient	5.0
SPS2	Exhaust point of SPS at Site OU.3.2	POINTHOR	826578.39	840033.99	2.00	4.35	Ambient	5.0
SPS3	Exhaust point of SPS at Site OU.1.2	POINTHOR	825472.87	841653.66	2.00	4.35	Ambient	5.0

Remark:

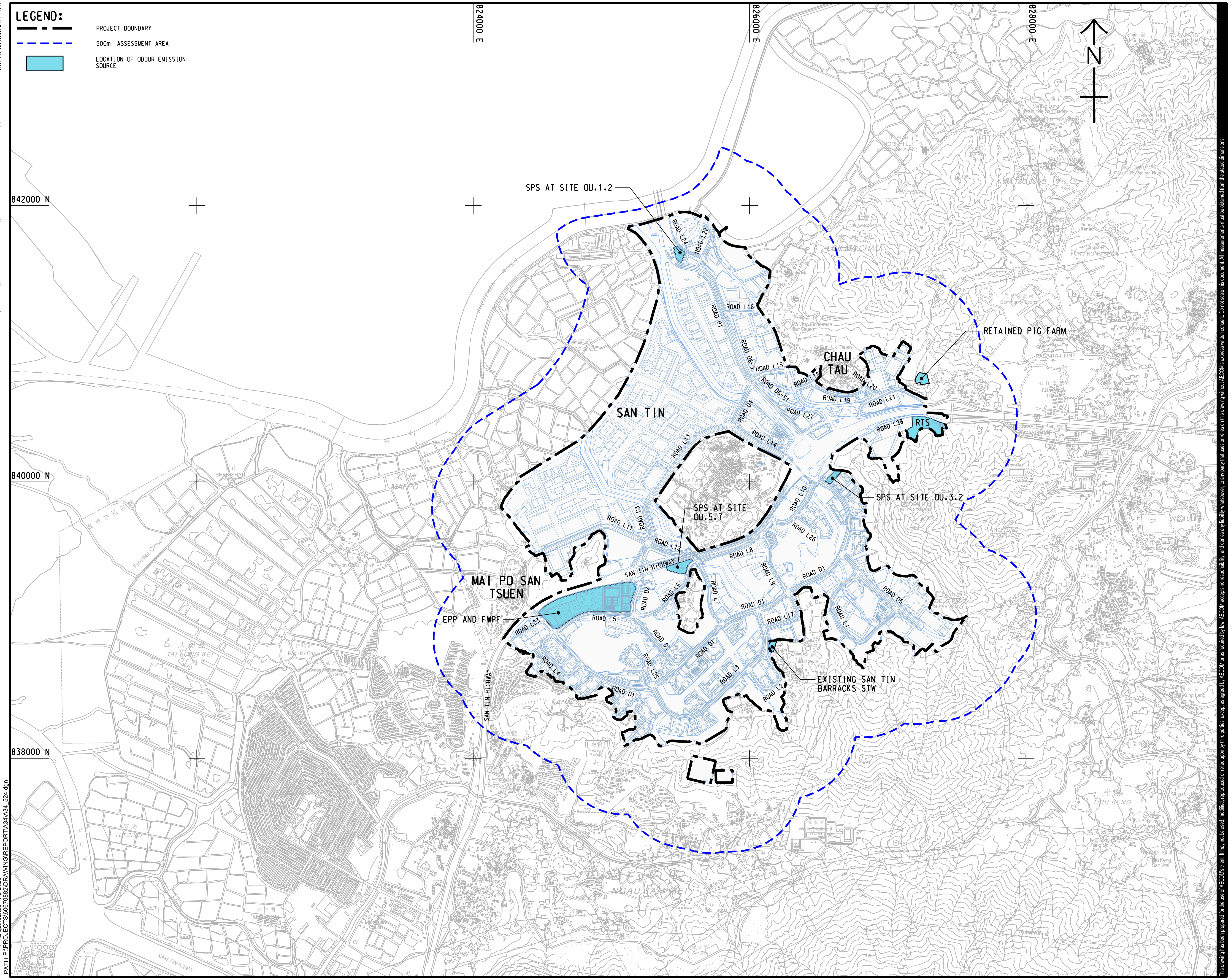
1. The exhaust parameters are provided by engineer.

Conversion of 1-hour Average to 5-second Average Concentration

Deodouriser	Emission Rate (OU/s)	Stability Class	Conversion Multiplier	Emission Rate with 5-second Peak Factor (OU/s)	Reference
SPS1	156	A, B, C, D, E, F	2.3	357.65	- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales. - Katestone Scientific 1995, The Evaluation of Peak-to-Mean Ratios for Odour Assessments, volumes I and II, Katestone Scientific Pty Ltd, Brisbane. - Katestone Scientific 1998, Peak-to-Mean Concentration Ratios for Odour Assessments, Katestone Scientific Pty Ltd, Brisbane.
SPS2	92	A, B, C, D, E, F	2.3	211.26	
SPS3	53	A, B, C, D, E, F	2.3	120.91	

Emission Source Listing in AERMOD

Source ID	Type	X	Y	Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity(m/s)	Emission Rate with 5-second Peak Factor (OU/s)
SPS1	POINTHOR	825509.39	839378.40	2.00	4.35	Ambient	5.00	357.65
SPS2	POINTHOR	826578.39	840033.99	2.00	4.35	Ambient	5.00	211.26
SPS3	POINTHOR	825472.87	841653.66	2.00	4.35	Ambient	5.00	120.91



AECOM

PROJECT

FIRST PHASE DEVELOPMENT OF THE NEW TERRITORIES NORTH – SAN TIN / LOK MA CHAU DEVELOPMENT NODE – INVESTIGATION

CLIENT

土木工程拓展署
CEDD Civil Engineering and Development Department

規劃署
Planning Department

CONSULTANT

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SUB-CONSULTANTS

ISSUE/REVISION

I/R	DATE	DESCRIPTION	CHK.

STATUS

SCALE: A3 1 : 25000

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60670882

AGREEMENT NO.: CE 20/2021

SHEET TITLE

LOCATION OF ODOUR EMISSION SOURCES (OVERVIEW)

SHEET NUMBER

60670882/A34/Appendix 3.10

ISO A1 594mm x 841mm

Approved:

Checked:

Designer:

Project Management Initials:

Plot File by: haiquan.zhao11/9/2023
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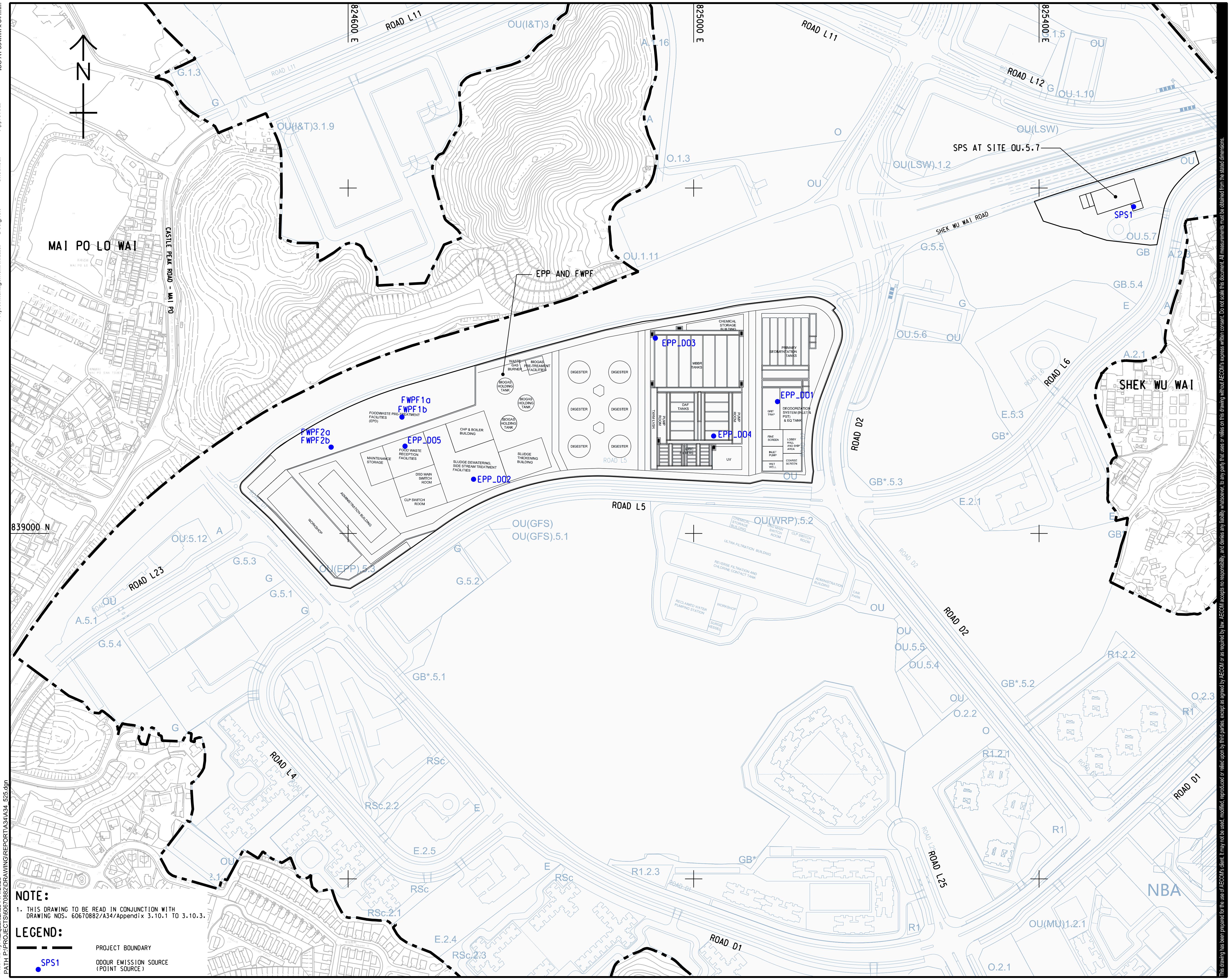

NOTE:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH DRAWING NOS. 60670882/A34/Appendix 3.10.1 TO 3.10.3.

LEGEND:

— · — (line symbol)	PROJECT BOUNDARY
● SPS1	ODOUR EMISSION SOURCE (POINT SOURCE)

AECOM

PROJECT

FIRST PHASE DEVELOPMENT OF THE NEW TERRITORIES NORTH – SAN TIN / LOK MA CHAU DEVELOPMENT NODE – INVESTIGATION

CLIENT

土木工程拓展署 Civil Engineering and Development Department

規劃署 Planning Department

CONSULTANT

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SUB-CONSULTANTS

ISSUE/REVISION

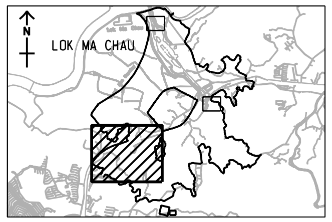
I/R	DATE	DESCRIPTION	CHK.

STATUS

SCALE: A3 1 : 4000

DIMENSION UNIT: METRES

KEY PLAN A3 1 : 150000



PROJECT NO.: 60670882

AGREEMENT NO.: CE 20/2021

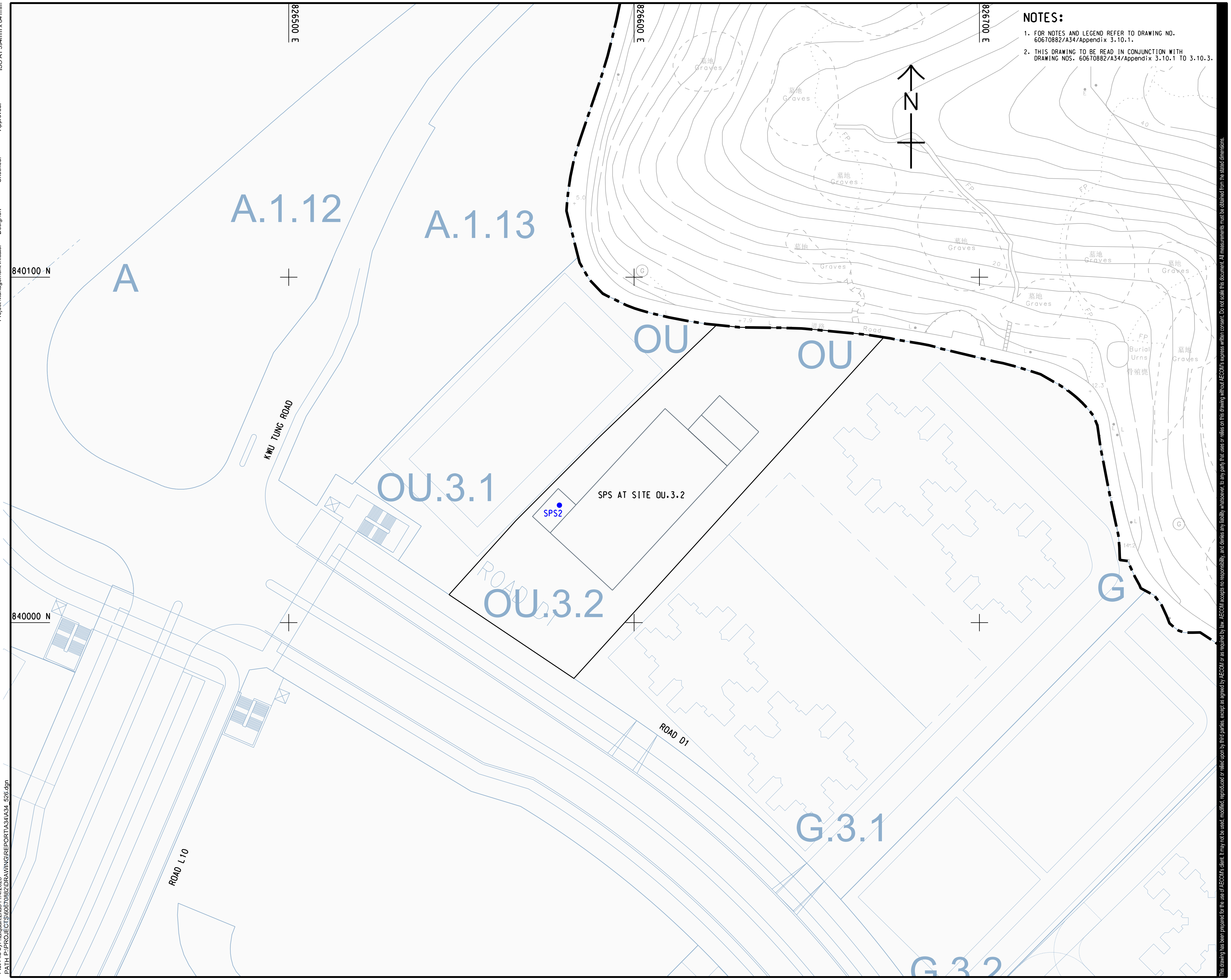
SHEET TITLE

LOCATION OF ODOUR EMISSION SOURCES (PROPOSED EPP, FWPF AND SPS)

SHEEET 1 OF 3

SHEET NUMBER

60670882/A34/Appendix 3.10.1



NOTES:

1. FOR NOTES AND LEGEND REFER TO DRAWING NO. 60670882/A34/Appendix 3.10.1.
2. THIS DRAWING TO BE READ IN CONJUNCTION WITH DRAWING NOS. 60670882/A34/Appendix 3.10.1 TO 3.10.3.

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PROJECT 項目

FIRST PHASE DEVELOPMENT OF THE NEW TERRITORIES NORTH – SAN TIN / LOK MA CHAU DEVELOPMENT NODE – INVESTIGATION

CLIENT 業主

CEDD 土木工程拓展署 Civil Engineering and Development Department

規劃署 Planning Department

CONSULTANT 工程顧問公司

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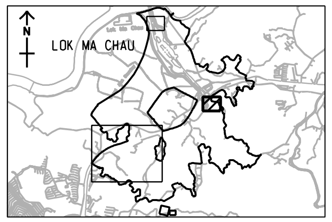
I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 復核

STATUS 階段

SCALE 比例 A3 1 : 1000

DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖 A3 1 : 150000



PROJECT NO. 項目編號 60670882

AGREEMENT NO. 協議編號 CE 20/2021

SHEET TITLE 圖紙名稱

LOCATION OF ODOUR EMISSION SOURCES (PROPOSED EPP, FWPF AND SPS)

SHEEET 2 OF 3

SHEET NUMBER 圖紙編號

60670882/A34/Appendix 3.10.2

Plot File by: haiquan.zhao11/4/2023
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NOTES:

1. FOR NOTES AND LEGEND REFER TO DRAWING NO. 60670882/A34/Appendix 3.10.1.
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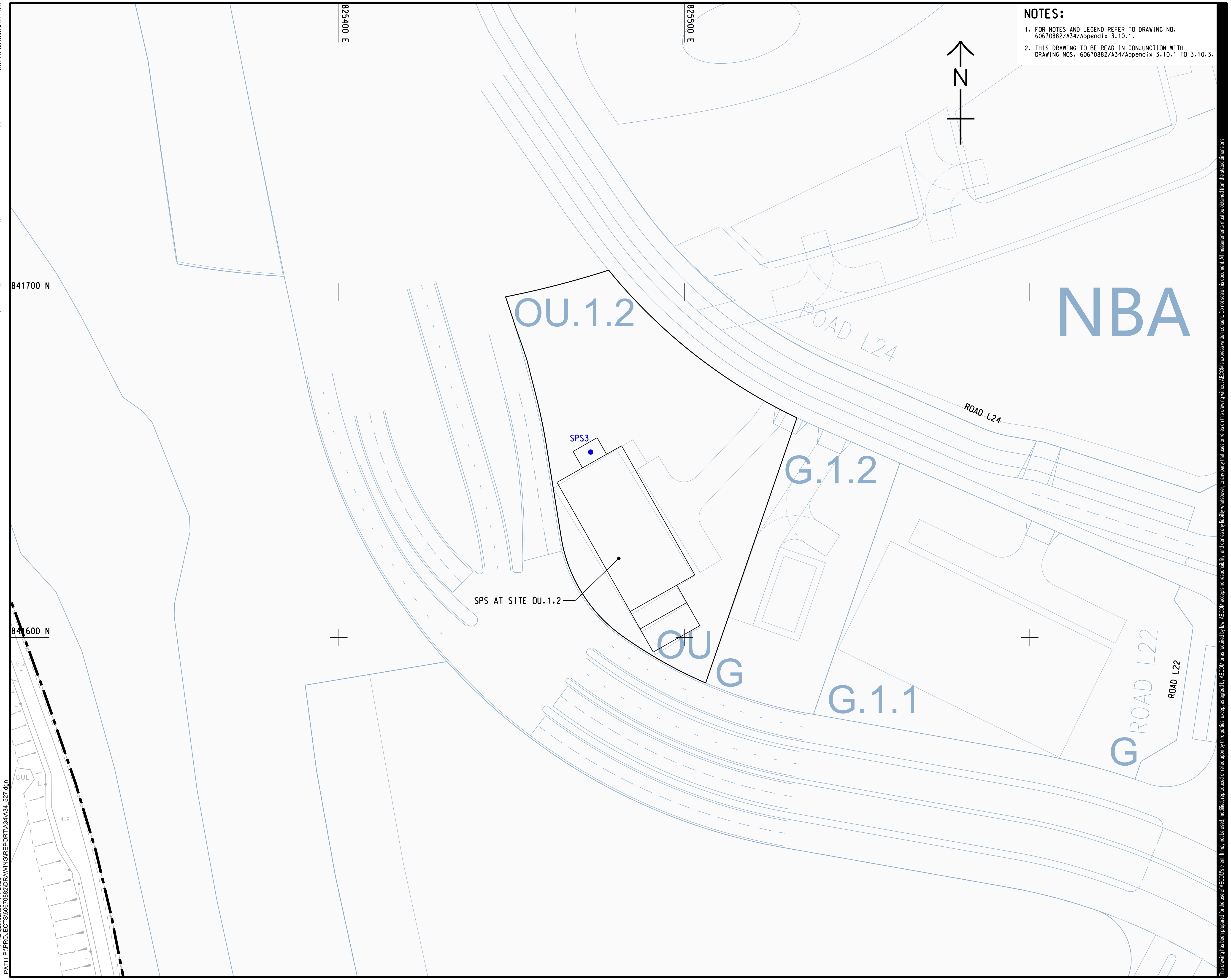

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PROJECT 項目

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STATUS

SCALE A3 1 : 1000

DIMENSION UNIT METRES

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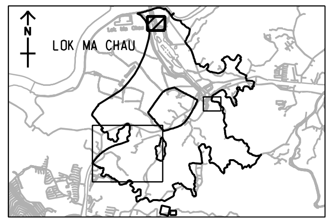

PROJECT NO. 60670882

AGREEMENT NO. CE 20/2021

SHEET TITLE

LOCATION OF ODOUR EMISSION SOURCES (PROPOSED EPP, FWPF AND SPS)

SHEEET 3 OF 3

SHEET NUMBER

60670882/A34/Appendix 3.10.3

Scottish Executive Environment Group

Code of Practice on Assessment and Control of Odour Nuisance from Waste Water Treatment Works

April 2005
Paper 2005/9

- The design of tanks and covers should minimise the need for regular access for maintenance and inspection as confined space entry systems will be required
- The vent volumes need to be adequate to ensure no odour escape and also to account for air quality inside the cover (occupational exposure, corrosion and explosion hazard).
- Ventilation rates will depend upon the exact process operations but for tanks the design flows are typically 0.5 – 12 air changes per hour based upon the empty tank volume or 120% of the maximum filling rate. In the case of thickener tanks, the volume may increase to 200% of the maximum fill rate
- The design will take account of the fill and empty rate, maximum rate of change in headspace, likely gaps and leakage, evolution rate of flammables to maintain <25% LEL for methane (10% is good design)
- Allowance should be made for emergency ventilation of the tanks
- One problem with tank covers is that they cannot be easily inspected therefore tend to be poorly maintained.

Additionally, guidance on the design of waste water treatment plants in BS EN 12255 advises designers to :-

- Locate sources requiring abatement close together to optimise abatement options and minimise costs
- Consider explosion risk, corrosion, access and health and safety.

14.2 Odour Abatement Equipment

The air which is exhausted from enclosures usually requires abatement to avoid odour nuisance. It is possible to establish performance criteria to reflect what constitutes best practicable means (bpm) in relation to abatement equipment. This can be specified as follows:-

> *Any odour abatement equipment installed on contained emissions (ventilation air from the process building) should have an odour removal efficiency of not less than 95%*[2]*. Determination of the destruction efficiency should be by dynamic olfactometry based upon manual extractive sampling undertaken simultaneously at the inlet and outlet of the odour control equipment. At least three samples should be taken from both the inlet and outlet.*

There is a wide range of odour abatement equipment that can be used to treat emissions of contained air from WWTW. There are many factors which will affect the choice of equipment including required odour removal efficiency, flow rate and inlet odour concentration, type of chemical species in the odour, variability in flow and load, space requirements and infrastructure (power, drainage etc.). The range of technologies available is detailed in the Environment Agency H4 Guidance Note on odour.

[2] Where the inlet odour concentrations are very low and the 95% destruction efficiency is difficult to demonstrate due to measurement reproducibility and equipment efficiency at low concentrations, the final discharge to air should contain less than 500 odour units/m^3.

It is important when evaluating the most appropriate control technology to consider both total cost (capital and operating) and environmental impact (such as energy use, chemical use and secondary pollutant generation). Often operating costs are closely linked with environmental impact (that is costs for energy, raw materials etc.) and wherever possible the most environmentally sustainable technique should be selected.

As odour abatement plant capacity is usually tightly specified (little spare capacity), the assumption is that all other measures are being correctly used – covers, doors, chemicals replenished etc. This therefore becomes a key management issue that should be included in the Odour Management Plan.

The site layout may permit a centralised plant or due to locational constraints it may be necessary to use more than one system for example on the inlet works and the sludge process. It may be economical to provide a number of smaller biofilters for individual sources but if the selected technology is wet scrubbing it may be more cost effective to provide a single system. In some cases it may be appropriate to divide the odour streams and use different technology based upon the load and characteristics of each system.

Table 2 below summarises the main types of abatement equipment and the odour abatement efficacy that may be achieved.

SYSTEM	CAPITAL	CONSUMABLES	EFFECTIVENESS
Biofilters	Moderate	Need space, fan energy, media replacement 3 – 5 years	High >95% - not able to rapidly adjust to changes in flow or load
Bioscrubbers	Moderate	Fan energy, effluent needs oxygenation	High >95% - can handle higher H_2S loads than biofilters
Activated sludge plant	Low additional	Needs fully aerobic sludge	90 – 95% for H_2S and NH_3 ; may be ideal as a polishing stage
Wet scrubbers	High	Fan energy, pump energy, dosing chemicals and effluent disposal – high energy user	Single stage <80% but multiple stage - >98%
Dry scrubbing (carbon or impregnated media)	High	Media replacement is a high cost with strong odours, suffer with moisture loading	> 95% ; Widely used for passive sources. Need several seconds residence for treatment
Catalytic iron oxidation	Moderate	Low operating cost	Specific for H_2S – good for low flow high load
Thermal oxidation	High	Fan energy and support fuel	>98% ; good for dryer vents and VOC loads
Ozone	Moderate	Replacement of source and energy for fan and ozone generator	>90% on low concentrations – good for building vents
Counteractants and masking	Low	Replenishment of chemicals	Not an abatement method – may be suitable for short-term use

TABLE 2– ODOUR ABATEMENT

Experience in operation of peat and heather type biofilters has shown that they do not perform well when the flow or odour load from the process is variable although other media (shell-type material) appears to perform better for these applications. There has been a considerable amount

of biofilter and bioscrubber equipment installed at WWTW. The units range in size from 75 – 435,000m^3/hr but are typically 1600 – 3000m^3/hr. The suppliers tend to offer 95-98% odour removal, 95-99.9% H_2S removal and 300 ou$_E$/m^3 in exhaust gases.

The industry approach is that emission sources which exhibit strong odour peaks are best treated in wet scrubbers or carbon systems as some bio systems have been overloaded previously. It is increasingly common to have scrubbers on the sludge processing operations (often 3 or 4-stage scrubbers are used).

Quantification of NH_3 Emission From Sidestream Anammox Process

The NH_3 emission from the sidestream anammox process is calculated as 13.4 ppm in total according to *Appendix A of Dynamic of nitric oxide and nitrous oxide emission during full-scale reject water treatment (Kampschreur, et. al, 2008)* (12 ppm from the nitritation reactor and 1.4 ppm from the anammox reactor, therefore a total of 13.4 ppm emission).

The ammonia and Total Kjeldahl Nitrogen (TKN) loading of the quoted process is also similar to STLMC EPP design. Therefore, the NH_3 gaseous emission from the quoted paper is considered representative of the STLMC EPP NH_3 gaseous emission and adopted in this calculation of NH_3 emission for STLMC EPP's anammox process.

Converting 13.4 ppm gas phase NH_3 to OU, by using 0.037 ppm NH_3 = 1 OU/m^3 (Odour threshold of NH_3 is 0.037 ppm, reference from *Iowa State University Extension (May 2004). "The Science of Smell Part 1: Odor perception and physiological response" (PDF). PM 1963a*)

The OU concentration of gas phase NH_3 = 13.4 ppm NH_3 / (0.037 ppm $NH_3/(OU/m^3)$) = 362 OU/m^3. This is corresponding to the WWTP studied by the reference paper which treated 773 m^3 of influent per day.

The dewatering centrate flow for STLMC EPP is estimated to be 1,525 m^3 per day so the OU concentration can be prorated as 362 / 773 x 1525 = 714 OU/m^3.

The odour extraction air flow rate of the anammox process in STLMC EPP's design is 4,298 m^3/hr, or (4,298 m^3/hr / (3600s/hr) = 1.19 m^3/s while the total surface area of the sidestream treatment facility is 790 m^2.

Hence, the Specific Odour Emission Rate (SOER) of sidestream treatment in the proposed STLMC EPP due to NH_3 emission = 714 OU/m^3 x 1.19m^3/s /790 m^2 = 1.08 $OU/m^2 \cdot s$.

The total SOER adopted for sidestream treatment = 1.65 (SOER value referenced from bioreactor of Shek Wu Hui STW) +1.08 (due to NH_3 gas emission) = 2.73 $OU/m^2 \cdot s$.

Reference:

Kampschreur, M. J.; van der Star, W.R.L.; Wielders, H.A.; Mulder, J.W.; Jetten, M.S.M.; van Loosdrecht, M.C.M. 2008. Dynamic of nitric oxide and nitrous oxide emission during full-scale reject water treatment. Water Research 42 (2008), p812 – 826

Iowa State University Extension (May 2004). "The Science of Smell Part 1: Odor perception and physiological response" (PDF). PM 1963a)