Appendix 3B
Part 1: Calculation of Odour Emission Rate (Unmitigated Scenario)

Odour sources to be open: inlet works, grit chambers, equalisation tank, SBR, sludge thickeners, sludge digesters.
Odour Sources to be covered: screenings and grits storage area, return liquor pumping station.

Sewage Characteristics:

Temp	=	30 ^{O}C	or	86.00 F
ORP (mV)	=	50 mV	(for septic sewage)	
A (m^3)	=	0.5 x surface area of tank		
V (air change per hour)	=	5		
Cf	=	0.52 for 5 Air Change Per Hour (ACPH)		

DF (OUm^{-3}) = $1.6 \times (T/10)^{4.9} \times (ORP + 200)^{-0.59}$

E (OUs^{-1}) = $DF \times A \times (V/3600) \times Cf$

Source ID				DF (OUm^{-3})	E (OUs^{-3})	E ($OUm^{-2}s^{-1}$)
S1	**Inlet Works**					
	L (m)	=	7.4			
	W (m)	=	1.5			
	No. of duty units	=	1 (+ 1 standby)			
	Area (m^2)	=	11.0	2335.49	9.30	0.8434
S2	**Grit Chambers**					
	Diameter (m)	=	2.1			
	No. of duty units	=	1 (+ 1 standby)			
	Area (m^2)	=	3.6	2335.49	3.00	0.8434
S3	**Equalization Tanks**					
	L (m)	=	15.7			
	W (m)	=	13.0			
	No. of duty units	=	1			
	Area (m^2)	=	204.1	2335.49	172.13	0.8434
S4 to S7, S7a	**SBR A to E**					
	L (m)	=	15.5			
	W (m)	=	7.0			
	No. of units	=	5			
	Area (m^2)	=	542.5	2335.49	457.53	0.8434
S8	**Sludge Thickener**					
	Diameter (m)	=	5.0			
	No. of duty units	=	1 (+ 1 standby)			
	Area (m^2)	=	19.6	2335.49	16.55	0.8434
S9	**Sludge Digester**					
	L (m)	=	8.6			
	W (m)	=	6.6			
	No. of duty units	=	1 (+ 1 standby)			
	Area (m^2)	=	56.8	2335.49	47.87	0.8434

Source ID				DF (OUm^{-3})	E (OUs^{-3})	E ($OUm^{-2}s^{-1}$)
S10	**Vent of Deodourisation Unit**					
	For screenings and grit storage area:					
	L (m)	=	12.5			
	W (m)	=	8.5			
	No. of duty units	=	1			
	Area (m^2)	=	106.3			
	A (m^3)	=	53.1			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	265.6	2335.49	89.61	
	Return Liquor Pumping Station					
	L (m)	=	4.70			
	W (m)	=	3.0			
	No. of duty units	=	1			
	Area (m^2)	=	14.1			
	A (m^3)	=	7.1			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	35.3	2335.49	11.89	
	For Emission from Deodourisation Units:					
Inlet	Total E (OUs^{-1})	=			101.50	
	DF (OUm^{-3})	=			2335.49	
	H2S conc. (ppm)	=			1.17	
Outlet	Total E (OUs^{-1})	=			0.51	
(assume 99.5%	DF (OUm^{-3})	=			11.68	
removal efficienc	H2S conc. (ppm)	=			0.0058	
	Total air flow rate (m3/hr)	=			300.9	
	Dia of pipe (m)	=			0.30	
	Pipe area (m2)	=			0.07	
	Exit velocity (m/s)	=			1.18	

P1	**Peng Chau Sewage Pumping Station**					
	(Provided by DSD)					
Inlet	H_2S conc. (ppm)	=			5.00	
	DF (OUm^{-3})	=			10000	
Outlet	H2S conc. (ppm)	=			0.025	
(99.5% removal	DF (OUm^{-3})	=			50	
efficiency)	Vent pipe dimensions (m)			=	0.6 x 0.6	
	Vent pipe area (m^2)			=	0.36	
	Air flow rate (m^3/h)			=	1505	
	Total Outlet E (OUs^{-1})			=	20.90	
	Exit velocity (m/s)			=	1.16	
	Exit height (m)			=	3.00	

Appendix 3B
Part 2: Calculation of Odour Emission Rate (Mitigated Scenario)

Odour sources to be covered: inlet works, grit chambers, equalisation tank, SBR, sludge thickeners, sludge digesters, screenings and grits storage area, return liquor pumping station.

Sewage Characteristics:

Temp	=	30 ^{O}C	or	86.00 F
ORP (mV)	=	50 mV	(for septic sewage)	
A (m^3)	=	0.50 x surface area of tank		
V (air change per hour)	=	5		
Cf	=	0.52 for 5 Air Change Per Hour (ACPH)		

DF (OUm^{-3}) = $1.6 \times (T/10)^{4.9} \times (ORP + 200)^{-0.59}$

E (OUs^{-1}) = DF x A x (V/3600) x Cf

Source ID			DF (OUm^{-3})	E (OUs^{-3})	E ($OUm^{-2}s^{-1}$)
SM1	**Vent of Deodourisation Unit**				
	For inlet works:				
	L (m)	= 7.4			
	W (m)	= 1.5			
	No. of duty units	= 1 (+ 1 standby)			
	Area (m^2)	= 11.0			
	A (m^3)	= 5.5			
	V (ACPH)	= 5.0			
	Air flow rate (m3/hr)	= 27.6	2335.49	9.30	
	For Grit Chambers:				
	Diameter (m)	= 2.1			
	No. of duty units	= 1 (+ 1 standby)			
	Total Area (m^2)	= 3.6			
	A (m^3)	= 1.8			
	V (ACPH)	= 5.0			
	Air flow rate (m3/hr)	= 8.9	2335.49	3.00	
	For equalisation tank:				
	L (m)	= 15.7			
	W (m)	= 13.0			
	No. of duty units	= 1			
	Area (m^2)	= 204.1			
	A (m^3)	= 102			
	V (ACPH)	= 5			
	Air flow rate (m3/hr)	= 510.3	2335.49	172.13	
	For SBR:				
	L (m)	= 15.5			
	W (m)	= 7.0			
	No. of duty units	= 5 (one of which is for future expansion)			
	Total Area (m^2)	= 542.5			
	A (m^3)	= 271			
	V (ACPH)	= 5			
	Air flow rate (m3/hr)	= 1356.3	2335.49	457.53	
	For sludge thickeners:				
	Diameter (m)	= 5.0			
	No. of duty units	= 1.0 (+ 1 standby)			
	Total Area (m^2)	= 19.6			
	A (m^3)	= 10			
	V (ACPH)	= 5			
	Air flow rate (m3/hr)	= 49.1	2335.49	16.55	
	For sludge digesters:				
	L (m)	= 8.6			
	W (m)	= 6.6			
	No. of duty units	= 1 (+ 1 standby)			
	Area (m^2)	= 56.8			
	A (m^3)	= 28			
	V (ACPH)	= 5			
	Air flow rate (m3/hr)	= 141.9	2335.49	47.87	

Source ID				DF (OUm^{-3})	E (OUs^{-3})	E ($OUm^{-2}s^{-1}$)
	For screenings and grit storage area:					
	L (m)	=	12.5			
	W (m)	=	8.5			
	No. of duty units	=	1			
	Area (m^2)	=	106.3			
	A (m^3)	=	53			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	265.6	2335.49	89.61	
	Return Liquor Pumping Station					
	L (m)	=	4.70			
	W (m)	=	3.0			
	No. of duty units	=	1			
	Area (m^2)	=	14.1			
	A (m^3)	=	7.1			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	35.3	2335.49	11.89	
	For Emission from Deodourisation Units:					
Inlet	Total E (OUs^{-1})	=			807.88	
	DF (OUm^{-3})	=			2335.49	
	H2S conc. (ppm)	=			1.17	
Outlet	Total E (OUs^{-1})	=			4.04	
(assume 99.5%	DF (OUm^{-3})	=			11.68	
removal efficiency)	H2S conc. (ppm)	=			0.0058	
	Total air flow rate (m3/hr)	=			2394.80	
	Dia of pipe (m)	=			0.40	
	Pipe area (m2)	=			0.13	
	Exit velocity (m/s)	=			5.30	

P1	**Peng Chau Sewage Pumping Station**				
	(Provided by DSD)				
Inlet	H_2S conc. (ppm)	=			5.00
	DF (OUm^{-3})	=			10000.00
Outlet	H2S conc. (ppm)	=			0.025
(99.5% removal	DF (OUm^{-3})	=			50.00
efficiency)	Vent pipe dimensions (m)		=	0.6 x 0.6	
	Vent pipe area (m^2)		=		0.36
	Air flow rate (m^3/h)		=		1505.00
	Total Outlet E (OUs^{-1})		=		20.90
	Exit velocity (m/s)		=		1.16
	Exit height (m)		=		3.00

Appendix 3B
Part 3: Calculation of Odour Emission Rate (Unmitigated Scenario) (when Drying Bed is Used)

Odour sources to be open: sludge drying Bed.
Odour sources to be covered: inlet works, grit chambers, equalisation tank, SBR, sludge thickeners, sludge digesters, screenings and grits storage area, return liquor pumping station.

Sewage Characteristics:

Temp	=	30 ^{O}C	or	86.00 F
ORP (mV)	=	50 mV	(for septic sewage)	
A (m^3)	=	0.50 x surface area of tank		
V (air change per hour)	=	5		
Cf	=	0.52 for 5 Air Change Per Hour (ACPH)		

DF (OUm^{-3}) = $1.6 \times (T/10)^{4.9} \times (ORP + 200)^{-0.59}$
E (OUs^{-1}) = $DF \times A \times (V/3600) \times Cf$

Source ID				DF (OUm^{-3})	E (OUs^{-3})	E ($OUm^{-2}s^{-1}$)
SM1	**Vent of Deodourisation Unit**					
	For inlet works:					
	L (m)	=	7.4			
	W (m)	=	1.5			
	No. of duty units	=	1	(+ 1 standby)		
	Area (m^2)	=	11.0			
	A (m^3)	=	5.5			
	V (ACPH)	=	5.0			
	Air flow rate (m3/hr)	=	27.6		2335.49	9.30
	For Grit Chambers:					
	Diameter (m)	=	2.1			
	No. of duty units	=	1	(+ 1 standby)		
	Total Area (m^2)	=	3.6			
	A (m^3)	=	1.8			
	V (ACPH)	=	5.0			
	Air flow rate (m3/hr)	=	8.9		2335.49	3.00
	For equalisation tank:					
	L (m)	=	15.7			
	W (m)	=	13.0			
	No. of duty units	=	1			
	Area (m^2)	=	204.1			
	A (m^3)	=	102			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	510.3		2335.49	172.13
	For SBR:					
	L (m)	=	15.5			
	W (m)	=	7.0			
	No. of duty units	=	5	(one of which is for future expansion)		
	Total Area (m^2)	=	542.5			
	A (m^3)	=	271			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	1356.3		2335.49	457.53
	For sludge thickeners:					
	Diameter (m)	=	5.0			
	No. of duty units	=	1.0	(+ 1 standby)		
	Total Area (m^2)	=	19.6			
	A (m^3)	=	10			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	49.1		2335.49	16.55
	For sludge digesters:					
	L (m)	=	8.6			
	W (m)	=	6.6			
	No. of duty units	=	1	(+ 1 standby)		
	Area (m^2)	=	56.8			
	A (m^3)	=	28			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	141.9		2335.49	47.87

Source ID				DF (OUm^{-3})	E (OUs^{-3})	E ($OUm^{-2}s^{-1}$)
	For screenings and grit storage area:					
	L (m)	=	12.5			
	W (m)	=	8.5			
	No. of duty units	=	1			
	Area (m^2)	=	106.3			
	A (m^3)	=	53			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	265.6	2335.49	89.61	
	Return Liquor Pumping Station					
	L (m)	=	4.70			
	W (m)	=	3.0			
	No. of duty units	=	1			
	Area (m^2)	=	14.1			
	A (m^3)	=	7.1			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	35.3	2335.49	11.89	
	For Emission from Deodourisation Units:					
Inlet	Total E (OUs^{-1})	=			807.88	
	DF (OUm^{-3})	=			2335.49	
	H2S conc. (ppm)	=			1.17	
Outlet	Total E (OUs^{-1})	=			4.04	
(assume 99.5%	DF (OUm^{-3})	=			11.68	
removal efficiency)	H2S conc. (ppm)	=			0.0058	
	Total air flow rate (m3/hr)	=			2394.80	
	Dia of pipe (m)	=			0.40	
	Pipe area (m2)	=			0.13	
	Exit velocity (m/s)	=			5.30	
S2	**Drying Bed**					
	L (m)	=	18.00			
	W (m)	=	10.0			
	No. of duty units	=	2			
	Area (m^2)	=	360.0	2335.49	303.61	0.8434

P1	**Peng Chau Sewage Pumping Station**					
	(Provided by DSD)					
Inlet	H_2S conc. (ppm)	=			5.00	
	DF (OUm^{-3})	=			10000.00	
Outlet	H2S conc. (ppm)	=			0.025	
(99.5% removal	DF (OUm^{-3})	=			50.00	
efficiency)	Vent pipe dimensions (m)			=	0.6 x 0.6	
	Vent pipe area (m^2)			=	0.36	
	Air flow rate (m^3/h)			=	1505.00	
	Total Outlet E (OUs^{-1})			=	20.90	
	Exit velocity (m/s)			=	1.16	
	Exit height (m)			=	3.00	

Appendix 3B
Part 4: Calculation of Odour Emission Rate (Mitigated Scenario) (when Drying Bed is Used)

Odour sources to be covered: inlet works, grit chambers, equalisation tank, SBR, sludge thickeners, sludge digesters, sludge drying bed, screenings and grits storage area, return liquor pumping station.

Sewage Characteristics:

Temp	=	30 ^{O}C	or	86.00 F
ORP (mV)	=	50 mV	(for septic sewage)	
A (m^3)	=	0.50 x surface area of tank		
V (air change per hour)	=	5		
Cf	=	0.52 for 5 Air Change Per Hour (ACPH)		
	=	0.26 for 10 Air Change Per Hour (ACPH)		

DF (OUm^{-3}) = $1.6 \times (T/10)^{4.9} \times (ORP + 200)^{-0.59}$

E (OUs^{-1}) = $DF \times A \times (V/3600) \times Cf$

Source ID				DF (OUm^{-3})	E (OUs^{-3})	E ($OUm^{-2}s^{-1}$)
SM1	**Vent of Deodourisation Unit**					
	For inlet works:					
	L (m)	=	7.4			
	W (m)	=	1.5			
	No. of duty units	=	1	(+ 1 standby)		
	Area (m^2)	=	11.0			
	A (m^3)	=	5.5			
	V (ACPH)	=	5.0			
	Air flow rate (m3/hr)	=	27.6		2335.49	9.30
	For Grit Chambers:					
	Diameter (m)	=	2.1			
	No. of duty units	=	1	(+ 1 standby)		
	Total Area (m^2)	=	3.6			
	A (m^3)	=	1.8			
	V (ACPH)	=	5.0			
	Air flow rate (m3/hr)	=	8.9		2335.49	3.00
	For equalisation tank:					
	L (m)	=	15.7			
	W (m)	=	13.0			
	No. of duty units	=	1			
	Area (m^2)	=	204.1			
	A (m^3)	=	102			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	510.3		2335.49	172.13
	For SBR:					
	L (m)	=	15.5			
	W (m)	=	7.0			
	No. of duty units	=	5	(one of which is for future expansion)		
	Total Area (m^2)	=	542.5			
	A (m^3)	=	271			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	1356.3		2335.49	457.53
	For sludge thickeners:					
	Diameter (m)	=	5.0			
	No. of duty units	=	1.0	(+ 1 standby)		
	Total Area (m^2)	=	19.6			
	A (m^3)	=	10			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	49.1		2335.49	16.55
	For sludge digesters:					
	L (m)	=	8.6			
	W (m)	=	6.6			
	No. of duty units	=	1	(+ 1 standby)		
	Area (m^2)	=	56.8			
	A (m^3)	=	28			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	141.9		2335.49	47.87

Source ID				DF (OUm^{-3})	E (OUs^{-3})	E ($OUm^{-2}s^{-1}$)
	For screenings and grit storage area:					
	L (m)	=	12.5			
	W (m)	=	8.5			
	No. of duty units	=	1			
	Area (m^2)	=	106.3			
	A (m^3)	=	53			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	265.6	2335.49	89.61	
	Return Liquor Pumping Station					
	L (m)	=	4.70			
	W (m)	=	3.0			
	No. of duty units	=	1			
	Area (m^2)	=	14.1			
	A (m^3)	=	7.1			
	V (ACPH)	=	5			
	Air flow rate (m3/hr)	=	35.3	2335.49	11.89	
	Drying Bed					
	L (m)	=	18.00			
	W (m)	=	10.0			
	No. of duty units	=	2			
	Area (m^2)	=	360.0			
	A (m^3)	=	180			
	V (ACPH)	=	10	(recommended by the engineer to ensure sludge drying efficiency)		
	Air flow rate (m3/hr)	=	1800.0	2335.49	303.61	
	For Emission from Deodourisation Units:					
Inlet	Total E (OUs^{-1})	=			1111.50	
	DF (OUm^{-3})	=			2335.49	
	H2S conc. (ppm)	=			1.17	
Outlet	Total E (OUs^{-1})	=			5.56	
(assume 99.5%	DF (OUm^{-3})	=			11.68	
removal efficiency)	H2S conc. (ppm)	=			0.0058	
	Total air flow rate (m3/hr)	=			4194.80	
	Dia of pipe (m)	=			0.40	
	Pipe area (m2)	=			0.13	
	Exit velocity (m/s)	=			9.28	

P1	**Peng Chau Sewage Pumping Station**				
	(Provided by DSD)				
Inlet	H_2S conc. (ppm)	=			5.00
	DF (OUm^{-3})	=			10000.00
Outlet	H2S conc. (ppm)	=			0.025
(99.5% removal	DF (OUm^{-3})	=			50.00
efficiency)	Vent pipe dimensions (m)		=	0.6 x 0.6	
	Vent pipe area (m^2)		=		0.36
	Air flow rate (m^3/h)		=		1505.00
	Total Outlet E (OUs^{-1})		=		20.90
	Exit velocity (m/s)		=		1.16
	Exit height (m)		=		3.00