For discussion
on 22 June 2009

Legislative Council
Panel on Environmental Affairs

Odour management in sewage treatment works of Hong Kong

PURPOSE

This paper presents the odour management measures implemented in sewage treatment works operated by the Drainage Services Department (DSD).

BACKGROUND

2. DSD operates 67 sewage treatment works in the territory, and treats a total daily sewage flow of about 2.8 million cubic metres (Mm^3). Annex 1 shows the list of sewage treatment works operated by DSD and the odour mitigation measures implemented.

3. Sewage smells naturally and under septic condition generates obnoxious hydrogen sulphide gas characterized by its rotten egg smell. In Hong Kong, seawater, with high natural concentration of sulphate, is generally used for toilet flushing. The high sulphate content in sewage is conducive to the emission of hydrogen sulphide.

STATUTORY REQUIREMENTS

4. Construction of new large sewage treatment works or upgrading of existing works (with capacity over 15 000 cubic metres per day (m^3/day) or over 5 000 m^3/day within 200 m of sensitive development such as residential area, educational institute, and health care institute, etc.) are classified as designated projects after the Environmental Impact Assessment Ordinance (EIAO) (Cap. 499) enacted in 1997. Under the EIA process, odour arising from the operational phase of the sewage treatment works would be required to meet a standard of five odour

units (OU[1]) based on an average time of five seconds for odour prediction assessment at the nearest air sensitive receiver[2]. Environmental monitoring and auditing (EM&A) are also required in the Environmental Permits (EPs).

5. Odour arising from all sewage treatment works is under the control of Air Pollution Control Ordinance (APCO) (Cap. 311). For all sewage treatment works, in case the odour emission causes a nuisance, an air pollution abatement notice can be issued under Section 10 of the APCO to require the taking of necessary measures to abate the objectionable odour.

MEASURES TO CONTROL ODOUR IN SEWAGE TREATMENT WORKS

6. DSD adopts three types of proven measures in reducing odour nuisance from the sewage treatment works. These include -

(a) dosing of chemicals, like calcium nitrate, ferric chloride, and other deodourising agents, and injection of oxygen into sewage to control the generation of odour;

(b) covering up of channels, chambers and tanks which are likely to emit odour; and

(c) installing deodourisation units like activated carbon system, chemical scrubbers and biofilters at appropriate locations to clean up the collected foul gases from odour sources in the plants.

7. Depending on the type of treatment operation in a sewage treatment works, and the characteristics of its surrounding and the incoming sewage flow, DSD adopts one or a combinations of the above three types of measures in the sewage treatment works to meet the odour standard.

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[1] OU is defined as the dilution factor that is required for samples of odourous gases to be diluted with clean odour-free air to achieve the detection threshold. Five OU is equivalent to 0.00235 parts per million (ppm) hydrogen sulphide by volume.

[2] The predictive assessment is based on dispersion modeling to reflect the gradual dilution of odour away from the odour source.

8. To ensure that all odour control systems are in proper working condition, DSD monitors closely their performance and provides proper maintenance, like timely replacement of odour absorption media such as activated carbon in the deodourisers.

9. The provision of odour mitigation measures together with good operational practices have been proven to be very effective in controlling odour nuisance from sewage treatment facilities.

10. However, sewage treatment works occasionally experience shock odour load arising from the fluctuating composition of incoming sewage. This may result in short term strong odour emission. The source of such shock load is very difficult to trace. If the sources can be identified, DSD would take appropriate actions to avoid reoccurrence.

ODOUR MONITORING

11. Odour perception is subjective and the measurement in terms of odour unit is a complicated process involving testing by a group of selected and trained people. As hydrogen sulphide gas has a strong correlation with the odour in sewage and can be measured conveniently and accurately by means of analyzers, it is taken by many countries as a substitute indicator. DSD also adopts hydrogen sulphide measurement for odour monitoring in sewage treatment works, in additional to EM&A measurements required under the EIAO.

12. DSD measures hydrogen sulphide levels regularly to monitor the performance of the odour control measures in sewage treatment works. From experience, a level of 0.2 ppm hydrogen sulphide or below measured at the plant is generally considered adequate to protect at the nearest sensitive receiver from nuisance. Operational adjustment, like adding more chemical or increasing the air changing rate of the deodourisers, would be done in the sewage treatment works to tackle any variations in operating environment. DSD would consider upgrading works in case there are or will be major variations which could not be handled by operational adjustments alone.

13. Apart from odour monitoring, we also pay special attention to odour concerns reported by the public to the Environmental Protection Department or

DSD. Prompt investigation would be carried out including contacting the complainants and taking odour measurements at the reported locations. Where appropriate, corrective and preventive measures would be carried out to rectify any identified deficiencies. If necessary, DSD would also consider enhancing the odour control measures.

ENHANCED ODOUR MITIGATION MEASURES AT SPECIFIC SEWAGE TREATMENT WORKS

14. Annex 2 shows odour complaint statistics on sewage treatment works operated by DSD in the past five years (2004 to March 2009). There are four plants having higher number of complaint cases in 2004 to 2007. Enhanced odour control measures have been provided to these plants in the past few years and the results are discussed in the following paragraphs.

Odour control at Sha Tin sewage treatment works

15. Sha Tin sewage treatment works stage 3 extension commenced operation in phases in 2005 and is a designated project under the EIAO. Under the EP requirements, the chemical calcium nitrate is dosed at two upstream sewage pumping stations to suppress odour generation. There were a number of odour complaints during stage 3 construction when some installations were being modified. Some short term measures, including relocation of some potential odour sources and provision of biofilters at others which could not be relocated, were quickly implemented in 2005 to address the odour concerns.

16. Other long term deodourisation works were also put in place, in particular a key deodourisation system (biotrickling filter) for the inlet works was completed in August 2008. The system is able to reduce the odour level at the inlet works, one of the major odour sources, by 99%. Since then, the number of odour complaints has dropped significantly.

17. Some odour related improvement works are still on-going. Nine more deodourisers are being installed and all works are anticipated to be completed by mid 2010.

18. An odour monitoring system is in place at this plant. Daily odour patrol at strategic locations of the plant has been conducted since the operation of stage 3 extension in 2005. Odour measurement at strategic locations of the plant is conducted weekly. The average hydrogen sulphide level is found to be less than 0.05 ppm.

19. In addition, an independent odour impact EM&A exercise for the operation of stage 3 extension is being conducted by consultants for more than three years. The finding shows that all the measured hydrogen sulphide concentrations at the nearest sensitive receivers meet the EIA requirements.

Odour control at Siu Ho Wan sewage treatment works

20. The Siu Ho Wan sewage treatment works was upgraded and expanded from a preliminary treatment works to a chemically enhanced primary treatment (CEPT) plant in 2005. It is a designated project under the EIAO and odour mitigation measures have been included in the EP. There were a number of odour complaints in 2006 and action was quickly put in hand to address the issue.

21. Our investigation reveals that due to slower population growth leading to the relatively long traveling time of the small sewage flow to the plant from various sources such as Tung Chung Town Centre (about 6.5 kilometres (km) from the plant) and the Airport (about 8 km from the plant), the septicity of the sewage is relatively high and causes odourous emissions. To address this situation, the following odour mitigation measures were implemented in 2007/2008 -

(a) covering up of sewage intakes to prevent release of odourous gases;

(b) providing additional deodourising unit; and

(c) using ferric chloride, instead of alum, in the treatment process to reduce the production of hydrogen sulphide.

22. The above odour abatement measures have eased the odour problem. Odour measurement at strategic locations of the plant is conducted twice a week. The average hydrogen sulphide level is found to be less than 0.2 ppm. In addition, an independent odour assessment under EM&A was conducted from

July 2008 to January 2009. The preliminary assessment results at the nearest sensitive receiver indicated full compliance with the requirements of the EP.

23. The following additional odour abatement works are also being implemented for completion by end 2009 -

(a) providing additional deodourising facilities in the sludge treatment system;

(b) covering other possible odour sources at the inlet and outlet of sedimentation tanks; and

(c) covering up of channels and chambers of the ultra-violet disinfection facilities which are close to the North Lantau Highway.

Odour control at Stonecutters Island sewage treatment works

24. Stonecutters Island sewage treatment works was completed and put into operation in 1997. The plant is handling daily sewage flow of about 1.4Mm^3 from the Hong Kong Island East and the whole of the Kowloon catchment. While odour mitigation measures had been provided in the design of the plant, there has been an increase in odour complaints since 2005. To address the odour concerns, the following measures were implemented in 2007/2008 -

(a) addition of chemical deodourising spray system at all the sludge cake unloading bays and primary tanks;

(b) provision of biofilters at the vertical discharge chambers of the sedimentation tanks for chemically enhanced primarily treated effluent;

(c) enhancing the air tightness of the existing enclosed sludge containers to prevent release of odour during transportation; and

(d) providing mobile deodourisers during equipment maintenance to control any potential odour emission from the installations.

25. An odour monitoring system is being implemented in Stonecutters Island sewage treatment works which involves daily odour patrol by plant staff. Odour

measurement at strategic locations of the plant is conducted weekly. The average hydrogen sulphide level is found to be less than 0.2 ppm.

26. Under the Harbour Area Treatment Scheme stage 2A project, which is subject to EIAO control, long term odour control facilities will be provided. In particular, all the sedimentation tanks will be properly covered. Other potential odour sources such as at the main pumping station, sludge storage tanks and sludge dewatering building will also be contained. A total of seven deodourisers will be installed to treat the foul air collected from the odour sources before release. These additional odour control facilities are scheduled to be completed by 2012.

Odour control at Tai Po sewage treatment works

27. Tai Po sewage treatment works has commenced its operation in 1979 with subsequent expansion in phases in 1982, 1986 and 1995. There were odour complaints received from 2004 to 2007.

28. The development of the stage 5 extension is under EIAO control and all three types of odour control measures mentioned in paragraph 6 above had been incorporated in the design in accordance with the recommendations in the EIA report. These new control measures are also applied to the existing facilities in a coordinated manner. The odour control measures are included under the stage 5 phase 1 extension works which is now under construction and is scheduled for completion in mid 2010. Some of these control measures have been completed as follows and there were no complaints received since 2008 -

(a) covering up of channels, chambers and tanks; and

(b) installing six deodourisation units.

29. In addition, chemical (calcium nitrate) would be dosed at the Tai Yuen sewage pumping station (upstream of Tai Po sewage treatment works) for further odour reduction at the inlet of the Tai Po sewage treatment works by end 2009.

30. An odour impact monitoring programme will be conducted in the first three years, i.e. commences in early 2010, upon commissioning of stage 5 phase 1 works by independent consultants. The odour impact monitoring will be

conducted every three months for the first year of operation for the stage 5 extension to identify if there is any operational abnormality and take prompt rectification action if necessary.

Odour control at Chai Wan sewage treatment works

31. Besides the four plants discussed above, DSD would also consider the need to upgrade the odour control measures at other plants when necessary. An example is the Chai Wan preliminary treatment works. It started operation in 1985 and was upgraded in 1997 under the Harbour Area Treatment Scheme stage 1 works. The potential odour sources from coarse and fine screenings were all kept in-doors and all grit removal facilities were covered properly as part of the upgrading works. Seven deodourisers were constructed to treat the foul air from the screening houses. Measurements of hydrogen sulphide level at the inlet and outlet of the deodourisers are conducted regularly to ensure their satisfactory performance. There is no odour complaint on this plant since 2006 till March 2009.

32. Despite its generally satisfactory performance, DSD is planning some minor enhancements to the odour control system to improve its efficiency and reliability which are scheduled for completion in 2010. This includes providing covers to the input pump sump, covering the coarse and fine screens in the screening house, and improving the ventilation and deodourisation system.

Odour control at other sewage treatment facilities

33. Besides sewage treatment works, our sewerage system also includes sewage pumping stations which are much smaller both in size and odour impact. DSD adopts similar odour management measures in these facilities.

WAY FORWARD

34. DSD puts strong emphasis on mitigating odour nuisance in delivering quality sewage treatment services to the community. The technologies and operational practices adopted are proven and effective to meet the statutory requirement. The management system also allows DSD to identify public concern or operational abnormality as far as odour nuisance is concerned, so that

prompt operational adjustment or enhancement works could be put in place.

35. DSD would continue to monitor the effectiveness of the odour management systems and upgrading them as needed.

ADVICE SOUGHT

36. Members are invited to note the content of this paper for information.

Drainage Services Department
June 2009

Annex 1

Sewage treatment works operated by DSD

Treatment Type	Plant no.	Name of plant	Odour control measures (a) dosing of chemicals or injection of oxygen (b) covering of odour sources (c) installing deodourisation units	Design daily capacity (m^3/day)	Average daily sewage flow (m^3/day)
Preliminary /Screening	1	San Wai preliminary treatment works	(b)	164 000	127 000
Preliminary /Screening	2	Pillar Point preliminary treatment works	(b)	246 000	176 000
Preliminary /Screening	3	North West Kowloon preliminary treatment works	(b) + (c)	406 000	362 000
Preliminary /Screening	4	To Kwa Wan preliminary treatment works	(b) + (c)	288 000	225 000
Preliminary /Screening	5	Kwun Tong preliminary treatment works	(b) + (c)	330 000	286 000
Preliminary /Screening	6	Tseung Kwan O preliminary treatment works	(b) + (c)	154 000	115 000
Preliminary /Screening	7	Kwai Chung preliminary treatment works	(b) + (c)	318 000	205 000
Preliminary /Screening	8	Tsing Yi preliminary treatment works	(b) + (c)	87 900	58 300
Preliminary /Screening	9	Sham Shui Po No. 1 sewage screening plant	(b)	91 000	20 000
Preliminary /Screening	10	Sham Shui Po No. 2 sewage screening plant	(b) + (c)	259 000	262 000
Preliminary /Screening	11	Cheung Sha Wan sewage screening plant	(b) + (c)	115 000	78 000
Preliminary /Screening	12	Central preliminary treatment works	(b) + (c)	110 000	122 000
Preliminary /Screening	13	Wan Chai West preliminary treatment works	(b) + (c)	48 400	26 000
Preliminary /Screening	14	Wan Chai East preliminary treatment works	(b) + (c)	166 000	133 000

Treatment Type	Plant no.	Name of plant	Odour control measures (a) dosing of chemicals or injection of oxygen (b) covering of odour sources (c) installing deodourisation units	Design daily capacity (m^3/day)	Average daily sewage flow (m^3/day)
Preliminary /Screening	15	North Point preliminary treatment works	(b) + (c)	118 000	84 000
Preliminary /Screening	16	Aberdeen preliminary treatment works	(b) + (c)	54 700	69 000
Preliminary /Screening	17	Ap Lei Chau preliminary treatment works	(b) + (c)	34 600	31 000
Preliminary /Screening	18	Wah Fu preliminary treatment works	(b)	15 700	8 000
Preliminary /Screening	19	Sandy Bay preliminary treatment works	(b) + (c)	8 900	4 400
Preliminary /Screening	20	Shek O preliminary treatment works	(b) + (c)	1 100	984
Preliminary /Screening	21	Chai Wan preliminary treatment works	(b) + (c)	65 600	55 000
Preliminary /Screening	22	Shau Kei Wan preliminary treatment works	(b) + (c)	54 000	72 000
Primary	23	Cheung Chau sewage treatment works	(b) + (c)	4 000	11 000
Primary	24	Tai O imhoff tank	(b)	1 220	1 170
CEPT	25	Sham Tseng sewage treatment works	(b) + (c)	17 000	5 700
CEPT	26	Stonecutters Island sewage treatment works *(Note 1)*	(b) + (c)	1 725 000	1 384 000
CEPT	27	Cyberport sewage treatment works *(Note 2)*	(b) + (c)	11 000	4 000
CEPT	28	Siu Ho Wan sewage treatment works *(Note 2)*	(a) + (b) +(c)	180 000	45 000
Major secondary	29	Shek Wu Hui sewage treatment works *(Note 2)*	(b) + (c)	93 000	83 000
Major secondary	30	Yuen Long sewage treatment works	(b)	70 000	15 000

Treatment Type	Plant no.	Name of plant	Odour control measures (a) dosing of chemicals or injection of oxygen (b) covering of odour sources (c) installing deodourisation units	Design daily capacity (m^3/day)	Average daily sewage flow (m^3/day)
Major secondary	31	Tai Po sewage treatment works *(Note 2)*	(b) + (c)	88 000	95 000
Major secondary	32	Sha Tin sewage treatment works *(Note 2)*	(a) + (b) + (c)	340 000	251 000
Major secondary	33	Sai Kung sewage treatment works	(b)	8 000	8 800
Major secondary	34	Stanley sewage treatment works	(b)	11 600	8 200
Minor secondary	35	Sha Tau Kok sewage treatment works	(b)	1 660	854
Minor secondary	36	Kwu Tung Market sewage treatment plant	(b)	257	51
Minor secondary	37	Lo Wu Police Headquarters sewage treatment plant	(b)	120	62
Minor secondary	38	Lok Ma Chau Control Point sewage treatment plant	(b) + (c)	498	99
Minor secondary	39	Lok Ma Chau Police Operation Base sewage treatment plant	(b)	26	8
Minor secondary	40	Man Kam To Control Point sewage treatment plant	(b)	155	109
Minor secondary	41	Man Kam To Food Control Point sewage treatment plant	(b)	20	8
Minor secondary	42	Kam Tin Market sewage treatment plant	(b)	75	57
Minor secondary	43	Siu Lam Hospital sewage treatment plant	(b)	68	36
Minor secondary	44	Siu Lam Psychiatric Centre sewage treatment plant	(b)	188	162
Minor secondary	45	Tai Lam Chung Marine Police Headquarters sewage treatment plant	(b)	17	62

Treatment Type	Plant no.	Name of plant	Odour control measures (a) dosing of chemicals or injection of oxygen (b) covering of odour sources (c) installing deodourisation units	Design daily capacity (m^3/day)	Average daily sewage flow (m^3/day)
Minor secondary	46	Tai Lam Correctional Institution sewage treatment plant	(b)	762	442
Minor secondary	47	Yuen Tun sewage treatment plant	(b) +(c)	173	79
Minor secondary	48	Shuen Wan pre-treatment works	(b)	103	278
Minor secondary	49	Clear Water Bay Second Beach sewage treatment plant	(b) + (c)	140	119
Minor secondary	50	Razor Hill sewage treatment plant	(b)	35	25
Minor secondary	51	Pik Uk Staff Quarters sewage treatment plant	(b) + (c)	210	107
Minor secondary	52	Pik Uk Prison sewage treatment plant	(b) + (c)	300	250
Minor secondary	53	Pik Uk Correctional Institution sewage treatment plant	(b) + (c)	200	166
Minor secondary	54	Cape Collinson Correctional Institution sewage treatment plant	(b) + (c)	158	92
Minor secondary	55	Mui Wo sewage treatment works	(b)	1 190	1 487
Minor Secondary	56	Ma Po Ping sewage treatment plant	(b)	600	434
Minor secondary	57	Sha Tsui Detention Centre sewage treatment plant	(b)	183	156
Minor secondary	58	Shek Pik rotating biological contactor plant	(b)	790	686
Minor secondary	59	Hei Ling Chau Annex sewage treatment plant	(b)	100	42
Minor secondary	60	Hei Ling Chau Lai Sun sewage treatment plant	(b)	761	436

Treatment Type	Plant no.	Name of plant	Odour control measures (a) dosing of chemicals or injection of oxygen (b) covering of odour sources (c) installing deodourisation units	Design daily capacity (m^3/day)	Average daily sewage flow (m^3/day)
Minor secondary	61	Hei Ling Chau oxidation ditch plant	(b)	900	197
Minor secondary	62	Hei Ling Chau rotating biological contactor plant	(b)	177	83
Minor secondary	63	Hung Shing Ye Beach sewage treatment plant	(b)	170	38
Minor secondary	64	Peng Chau sewage treatment plant *(Note 2)*	(b) + (c)	1 580	368
Minor secondary	65	Chi Ma Wan Correctional Institution sewage treatment plant	(b)	350	176
Minor secondary	66	Chi Sun Correctional Institution sewage treatment plant	(b) + (c)	210	136
Tertiary	67	Ngong Ping sewage treatment works *(Note 2)*	(b) + (c)	2 000	313

Treatment type	Number of plants
Preliminary /Screening	22
Primary	2
CEPT	4
Major secondary	6
Minor secondary	32
Tertiary	1
Total	67

Notes

1. Under the Stonecutters Island sewage treatment works, there are two EPs covering the advance disinfection system and HATS stage 2A of the works.
2. Works with an EP.

Annex 2

Odour complaints statistics on sewage treatment works (between 1/1/2004 and 31/3/2009)

Plant no.	Name of plant	2004	2005	2006	2007	2008	2009 (Jan to Mar)
32	Sha Tin sewage treatment works	9	5	12	12	3	1
28	Siu Ho Wan sewage treatment works	0	2	8	5	1	0
26	Stonecutters Island sewage treatment works	1	4	3	3	3	1
31	Tai Po sewage treatment works	8	1	5	5	0	0
21	Chai Wan preliminary treatment works	0	1	0	0	0	0
23	Cheung Chau sewage treatment works	0	2	1	1	1	0
27	Cyberport sewage treatment works	1	1	1	1	1	0
12	Central preliminary treatment works	0	0	1	0	0	0
6	Tseung Kwan O preliminary treatment works	2	0	0	0	1	0
29	Shek Wu Hui sewage treatment works	0	1	0	0	0	0
10	Sham Shui Po No. 2 sewage screening plant	0	0	0	3	1	0
11	Cheung Sha Wan sewage screening plant	0	0	0	1	0	0
4	To Kwa Wan preliminary treatment works	1	0	0	1	0	0
14	Wanchai East preliminary treatment works	1	0	0	0	2	0
20	Shek O preliminary treatment works	1	0	0	0	0	0
33	Sai Kung sewage treatment works	0	0	0	0	2	0
15	North Point preliminary treatment works	1	0	0	2	0	0
5	Kwun Tong preliminary treatment works	1	0	0	0	1	0
	Total	**26**	**17**	**31**	**34**	**16**	**2**

Notes

1. The odour complaints statistics were received from individuals or representatives/district councilors representing the affected public.
2. No complaint was received in the other 49 sewage treatment works in the specified period.