For Information
on 24 November 2014

The Legislative Council
Panel on Environmental Affairs

Emergency Sewage Bypass Incident
at Pillar Point Sewage Treatment Works
on 25 August 2014

Follow-up Actions after the Site Visit on 8 September 2014

This paper addresses the follow-up actions raised by the Chairman of the Panel on Environmental Affairs and three other Legislative Council (LegCo) Members during their visit to the Pillar Point Sewage Treatment Works (PPSTW) on 8 September 2014 in respect of the emergency sewage bypass incident (the Incident) at the PPSTW on 25 August 2014.

BACKGROUND

2. An emergency sewage bypass incident at the PPSTW had occurred on 25 August 2014. A total of 95 000 cubic metres (m^3) of sewage was discharged, from around 3:30 p.m. of 25 August 2014 to 2:30 a.m. of 26 August 2014, via the 700m long emergency submarine outfall pipe to the Urmston Road watercourse. As a result of the Incident, the Leisure and Cultural Services Department (LCSD) closed 14 beaches in Tuen Mun and Tsuen Wan starting in the evening of 25 August 2014. LCSD subsequently re-opened the 14 beaches after the water quality monitoring results for 26 August 2014 showed that the beaches were suitable for swimming.

3. To allow a better understanding of the Incident by the LegCo, the Drainage Services Department (DSD) arranged a site visit to the PPSTW for LegCo Members on 8 September 2014. Hon Cyd HO Sau-lan (the then Chairman of the Panel on Environmental Affairs), Hon CHAN Han-pan, Hon WONG Kwok-hing and Hon Michael TIEN Puk-sun joined the site visit.

4. At the site visit, DSD was requested by the LegCo Members to undertake some follow-up actions. The follow-up actions and the Administration's responses are set out below:-

a) Provide the terms of the penalty provisions of the contract for the upgrading of PPSTW and advise whether the contractor will be held liable to the loss of public enjoyment due to the closure of beaches.

The Design-Build-Operate contract form is adopted for the PPSTW upgrading works. The Contract includes the Key Performance Indicators ("KPI") system to assess the performance of the Contractor. The amount of monthly payments to the Contractor for the Operation shall be deducted if the performance of the Contractor cannot meet the parameters set for the KPI. "Unauthorized emergency bypass" is one of the KPIs. In view that the Incident is classified as "Unauthorized emergency bypass", the monthly payment to the Contractor has been deducted to reflect his poor performance in this regard.

Furthermore, legal advice has been sought as to whether the Contractor could be held liable to the loss of public enjoyment due to the closure of beaches. The advice was that under the terms of the Contract, the Contractor could not be held liable in this regard. But as to whether it could be held liable in tort would depend on actual circumstances and also whether particular damages could be substantiated.

b) Advise whether a trial run had been conducted to ensure that the upgraded PPSTW can handle the required treatment capacity of 241 000 cubic metres (m^3) per day.

Before the commencement of the operation stage, tests had been carried out for all the equipment including the four fine screens during the 3-month testing and commissioning. The test results have confirmed that the upgraded PPSTW can handle up to the design treatment capacity of 241 000 m^3 per day.

c) Provide the report of the Task Force to investigate the cause of incident to the Panel in due course and inform the Panel of the findings and the follow-up actions.

The Administration has set up a Task Force led by the Deputy Director of Drainage Services to investigate the Incident. The findings and the follow up actions of the Incident are given in **Annex**.

d) Advise how the communication and coordination among concerned government departments and the publicity arrangements in handling similar

emergency incidents will be improved in the future.

The Environmental Protection Department (EPD) has reviewed the communication and coordination among concerned government departments and the publicity arrangements in handling this incident. According to the current requirements, upon any emergency sewage discharge incident, EPD, LCSD and the Water Supplies Department (WSD) should be informed within one hour of commencement of the discharge. In this incident, the Contractor of the PPSTW informed EPD shortly before the discharge commenced and LCSD about three hours after the discharge through DSD. WSD was not informed.

In order to enable timely response actions by all concerned government departments including DSD, EPD, LCSD, WSD, the Agriculture, Fisheries and Conservation Department (AFCD), the respective district offices and district councils in dealing with similar emergency discharge incidents, EPD is working with DSD to establish the protocol to ensure that all possibly relevant departments will be informed within one hour of any similar incidents. DSD's frontline staff of government sewage treatment facilities would notify their management immediately in case of any possible need for emergency discharge of untreated or partially treated sewage, and DSD would keep all concerned government departments and the relevant working group/committee under the respective district council (where applicable) notified of the incident at the earliest opportunity.

In respect of communication with the public, in the event that the environment may be affected by the incident, EPD will act as a coordinating department to inform the public on the latest development of the incident and information on follow-up actions taken, to take samples to assess the impact, as well as to liaise with the relevant departments for initiating any precautionary measures and response actions needed, e.g. temporary closure of bathing beaches managed by LCSD.

Drainage Services Department
November 2014

Annex

The Legislative Council
Panel on Environmental Affairs

Emergency Sewage Bypass Incident
at Pillar Point Sewage Treatment Works
on 25 August 2014

Incident Investigation Findings and Follow-up Actions

PURPOSE

This paper informs Members of the findings of the investigation into the emergency sewage bypass incident of the Pillar Point Sewage Treatment Works (PPSTW) which occurred on 25 August 2014 and the follow-up actions taken by the Administration in respect of the incident.

BACKGROUND

2. The PPSTW, built in 1982, was upgraded from a preliminary sewage treatment plant to a chemically enhanced primary treatment (CEPT) plant with Ultra Violet (UV) disinfection. The design flow was increased from 215,000 m^3/day to 241,000m^3/day under a Design-Build-Operate (DBO) contract of the Drainage Services Department (DSD). The upgrading of the plant was completed in May this year and commencement of the operation phase immediately followed. Under the contract, the contractor is responsible for operating the upgraded PPSTW for a period up to 15 years.

3. The sewage treatment process of the PPSTW comprises coarse screening, fine screening, grit removal, CEPT and UV disinfection. Incoming sewage would first go through coarse screens to remove large particles of a size larger than 25mm and then fine screens to further remove particles of a size between 4mm and 25mm. Grit removal would follow to further remove small and settleable particles. After grit removal, the sewage would then go through the CEPT which is a sedimentation process to remove the remaining solids, suspended particles and other contaminants in the sewage. After the above treatment, the effluent would be disinfected by UV before discharging through a twin 2 km long submarine outfall pipes to the coastal waters (known as the Urmston Road) where water is deep and current is strong to

facilitate rapid dilution and dispersion of the effluent.

4. Under the DBO arrangement, the contractor is responsible for the design, construction and operation of the PPSTW. Upon completion of construction, the contractor would then operate the plant for 10 years and DSD has an option to extend the operation period for a further five years. Payment to the contractor would depend on the volume of sewage treated. There is also a set of Key Performance Indicators (KPIs) for measuring the performance of the contractor. Payment would be deducted should it fail to meet the performance standards given under the KPIs. A consultant is engaged by DSD for administering the DBO contract in regard to the design, build, commissioning and the first year operation of the upgraded PPSTW. After the first year of operation, DSD would take over the contract administration from the consultant.

THE INCIDENT

5. There are altogether four sets of fine screens, namely Fine Screen Nos. 1 to 4, for fine screening. On 25 August 2014, Fine Screen No. 2 of the upgraded PPSTW was under repair while the remaining three fine screens failed progressively within an hour from about 1:11 p.m. all due to the falling apart of the chains for guiding the movement of the rakes of the fine screens. The failed fine screens could not remove the fine particles in the sewage. Such particles then blinded the fine screens and thus sewage could not pass through. The resident site staff of the consultant assessed that the repairing works for the fine screens might take some time. To avoid sewage overflow in the upstream catchment, the PPSTW had to be shut down temporarily for urgent repair. All incoming sewage was hence bypassed and discharged offshore to Urmston Road where current is strong via a designated 700m long emergency submarine outfall, starting from 3:36 p.m., to minimize impact to inshore water quality. The sewage bypass event lasted for a total of about 11 hours and ended at 2:30 a.m. on 26 August 2014. During the period, approximately 95 000m^3 of sewage was discharged.

6. As a result of the sewage bypass incident, the Leisure and Cultural Services Department (LCSD) temporarily closed 14 beaches in Tuen Mun and Tsuen Wan in the evening of 25 August 2014. The Environmental Protection Department (EPD) collected water samples at the 14 beaches on 26 August 2014 to assess the impact on water quality. The laboratory analysis on these water samples available on 27 August 2014 confirmed that the levels of *E. coli* in all 14 beaches on 26 August 2014 were suitable for swimming, with 13 beaches rated as Grade 2 (Fair) and one beach rated as Grade 1 (Good). As a result, LCSD reopened the closed beaches on 27 August 2014.

7. Immediately following the incident, a Task Force led by the Deputy Director of Drainage Services was set up to investigate the incident. Further to initial reports received in early September 2014, the contractor and consultant respectively submitted detailed investigation reports in October 2014. The Task Force had studied in detail the substance and arguments of these two reports, examined thoroughly relevant information including records on design, workmanship and operation, and also drew operation experience from DSD's other similar sewage treatment facilities, and concluded on the causes and liabilities of the incident.

RESULTS OF INVESTIGATION INTO EMERGENCY SEWAGE BYPASS INCIDENT

Direct Causes leading to the Bypass Incident

8. Fine screens are commonly used in sewage treatment plants in Hong Kong. The fine screens of the PPSTW were manufactured by a supplier in Austria and delivered to the site as a complete set for installation. Out of the four fine screens installed, one serves as a standby unit and the other three duty units. The rakes of each fine screen run on two guiding chains respectively located at the two sides of each screen. Each chain is attached to two sprockets – one at the top and the other at the bottom of the screen. The sprocket at the top of the screen is in turn connected to a motor and a chain tensioning device which respectively turns the sprocket and keeps the tension in the guiding chain at an appropriate level. When the sprockets rotate, the chains bring the connecting rakes to remove the particles caught by the bar screens. The chain consists of a series of rollers, link plates and pins and they are all held together by connecting clips at the sides of the chains.

9. An electronic overload protection mechanism is also installed at each fine screen to protect it from damage due to overloading. When stubborn particles are caught by the bars of the fine screens, a larger force would automatically be generated in the chains to drive the rakes for removal of these particles. In case these stubborn particles could not be removed by this larger force, or when the driving force of the fine screen exceeds the normal working level, the chains will move forward and backward a few times to try to loosen these jammed particles. If the jammed particles could still not be removed, the electronic overload protection mechanism will cut off the power supply immediately to protect the fine screen and its components from damage due to overloading. The jammed materials would then be removed manually.

10. The PPSTW, including the four sets of fine screens and all other equipment, had successfully passed the 3-month testing and commissioning, with all the teething problems duly resolved, before entering the operation phase on 18 May 2014.

11. The investigation revealed that upon commencement of the operation phase, the contractor had on his own accord changed the protection level setting of the electronic overload protection mechanism to over 50% above the normal setting. Although this abnormally high setting did not immediately cause structural damage to the fine screens, the chains would however have to withstand a larger than normal tension force whenever there was a need to remove stubborn particles caught by the screens. This larger force would be transferred through the chains to the chain tensioning device causing it to move slightly. Although such movement might be very small, it was already enough to slacken the chains. The slackening of the chains would in turn result in either "gear slipping" or easier trapping of debris between the chains and the sprockets. In both cases, a lateral squeezing out force would be generated (as compared to the normal tension force which runs along the chains) which dislodged the connecting clips and eventually led to the falling apart of the chains.

12. Records showed that upon commencement of the operation phase, this kind of fine screen failures first occurred at Fine Screen No. 3 on 12 August 2014. The damaged chains were replaced and operation resumed on 21 August 2014. On the same day, Fine Screen No. 2 failed with chains falling apart but the contractor did not carry out the repair works immediately. Hence, on 25 August 2014 (the date of the incident), there were only three fine screens in operation in the PPSTW with no standby unit for emergency use. Although three fine screens should still have been adequate to cater for the flow, the problem of movement in the chain tensioning devices and slackening chains might have already occurred in Fine Screen Nos. 1 and 4. At 1:11 p.m. of 25 August 2014, chain slackening of Fine Screen No. 4 had resulted in either a small "gear slipping" or easier trapping of harder debris between the chains and the sprockets. This dislodged the connecting clips of the chains of Fine Screen No. 4 and as a result the chains fell apart causing its failure, thus leaving only two fine screens in operation. For the two remaining fine screens, Fine Screen No. 1 which also had the similar chain slackening problem also failed at 1:57p.m. due to dislodging of the connecting clips. By this time, all the flow was directed to the only fine screen which was still in operation, i.e. Fine Screen No. 3. Although Fine Screen No. 3 had only had its chains replaced around two weeks before the incident, it however was unable to withstand all the flow and the associated impact. This impact was mainly from the high debris content in the sewage leading to the trapping of debris in the gap between the sprockets and the chains which in turn generated a lateral

squeezing out force dislodging the connecting clips. This caused the chains to fall apart resulting in the failure of Fine Screen No.3 shortly afterwards at around 2:07 p.m. By that time, all fine screens had failed. As sewage could no longer pass through the fine screens, the PPSTW had to be shut down.

Main Contributing Factors behind the Direct Causes

Inadequate experience of contractor's operation staff

13. Making reference to the operation experience of DSD's other similar sewage treatment facilities, the Task Force considers that it is of paramount importance to maintain the protection level setting of the electronic overload protection mechanism at a normal level and to carry out regular inspection on it to ensure its proper operation. An experienced plant manager or management of the plant should enhance communication with the front-line operation staff and, after taking due consideration of the sewage characteristics in the catchment area and in consultation with the fine screen supplier, make appropriate adjustments to the above setting to ensure its proper operation. In view of the above, the Task Force considers that experienced operation staff would not unduly set the protection level setting of the electronic overload protection mechanism above the normal level. They should also have noticed the slight movement of the chain tensioning device and hence should have made necessary adjustment to it to ensure that the tension of the chains be kept at a normal level. The operation staff of the PPSTW obviously did not possess adequate experience to allow them to take the above prudent maintenance measures thus leading to the incident.

Lack of adequate awareness of risks by the contractor

14. Before the incident, there were already two accounts of fine screen failure which occurred in August 2014. The first case of fine screen failure (at Fine Screen No. 3) occurred on 12 August 2014, while the second case (at Fine Screen No. 2) occurred on 21 August 2014. The contractor had failed to realize that this was an early sign of possible total failure of the fine screens and hence did not conduct a proper investigation into it. Had they had adequate awareness of risks, they would have realized that setting the protection level of the electronic overload protection mechanism to well above its normal setting would have an adverse impact on the chain tensioning device and led to its movement. They should then be able to carry out timely follow up and repair.

15. Furthermore, the contractor did not promptly replace the chains of Fine Screen No. 2 which was out of order due to chain failure on 21 August 2014. Had

they repaired this fine screen promptly, one standby fine screen would have been available on the day of the incident. Together with Fine Screen No. 3 which had just been repaired, there would then be two sets of fine screens in good serviceable conditions, and the progressive failure of all the fine screens might have been prevented.

Responsibilities of Parties Concerned

The Contractor

16. Pursuant to the relevant provisions of the contract, all levels of operating staff engaged by the contractor should have adequate experience to operate the plant. Accordingly, the Task Force considers that the contractor should bear contractual responsibility for the bypass incident caused by inadequate experience of their front-line operation staff and lack of adequate awareness of risks of their management staff, and be responsible for the costs of replacing all the failed chains, reinforcing works on the chain tensioning devices and for the implementation of all necessary measures for improving the operation of the PPSTW.

17. In addition, DSD had deducted about $500,000 from the payment to the contractor for its unsatisfactory performance under the incident in accordance with the contract under the KPI "Unauthorized emergency bypass".

18. Furthermore, DSD had sought legal advice on whether the contractor could be held liable for loss of public enjoyment due to the closure of beaches. The legal advice obtained is that the contractor could not be held liable for loss of public enjoyment under the contract. But as to whether it could be held liable in tort would depend on actual circumstances and also whether particular damages could be substantiated.

The Consultant

19. Under the consultancy agreement, the consultant is required to review and approve the design and materials submissions of the contractor and ensure that they comply with the contractual and statutory requirements. In addition, they are also responsible for supervising and monitoring the performance of the contractor during the construction stage to ensure that the contractor completed the works and the necessary testing and commissioning in accordance with the contract. They are also responsible for administering the contract during the first year of operation after which the contract administration would be taken over by DSD. DSD has reviewed the

performance of the consultant regarding these aspects and considers that their performance in reviewing and approving the contractor's design and supervising the construction works was satisfactory.

20. However, as mentioned above, there were already two accounts of fine screen failure in August 2014 before the incident. The consultant was obviously not proactive and vigilant enough in respect of supervising the contractor to properly follow up operation related incidents. The resident site staff of the consultant should have been more proactively directing the contractor to promptly repair the failed fine screens and find out the root causes of the failures for prompt follow-up actions before the incident. On the day of the incident, they should have supervised and directed the contractor to carry out contingency measures in a more timely manner. In this regard, DSD had urged the consultant to enhance the training of their resident site staff in order to improve their vigilance and responsiveness to emergency situations so as to improve the quality of their supervision of the operation of the PPSTW.

21. DSD has also in accordance with the established management and appraisal mechanisms duly reflected the performance of the contractor and consultant under the incident in their respective performance reports.

FOLLOW-UP ACTIONS

Immediate Measures

22. Following the incident, DSD immediately implemented a series of measures to ensure no further possibility of sewage bypass due to fine screen failure, including:-

i) Setting up a "Joint Operation Review Committee" comprising representatives of DSD, the consultant and the contractor to conduct joint meetings for reviewing the performance of daily operation of the plant with reference to the operation and maintenance (O&M) manual, and sharing the experience of plant operation so that timely follow-up actions could be taken to address problems encountered.

ii) Stepping up the inspection of the fine screens from once per day to three times per day and ensuring that the setting of the electronic overload protection mechanism is maintained at a normal level.

iii) Replacing the chains of all four fine screens.

iv) Reinforcing the connecting clips of the chains and the chain tensioning devices according to the advice of the fine screens supplier.

23. The fine screens have since the incident been operating satisfactorily and there has been no further sewage bypass incident.

Follow-up Measures

24. The contractor and consultant have gained experience from the incident and have implemented the following follow-up measures:

By the Contractor

i) An independent consultant has been engaged to conduct a "Hazard and operability study" to identify potential critical components the failure of which could cause serious impacts on the plant operation. Following the study, improvement measures have been proposed for implementation to enhance plant reliability, including:-

a) Temporarily remove one of the fine screens to allow free passage of sewage flow downstream for subsequent treatment processes in the unlikely event of failure of all the fine screens. In addition, provide one fine screen that could be removed quickly as a medium term measure for allowing incoming flow to bypass the fine screens and enter into the grit removal chambers while emergency repair is conducted.

b) Investigate and consider constructing an additional bypass channel as a long term measure for improving the handling of flow under emergency situations as necessary.

c) Provide standby inlet pumps and sludge pump motors to minimize the operation risk of the PPSTW due to failure of key parts.

ii) An experienced overseas O&M expert has been engaged to give an overall review of the operation organization structure, training needs, emergency response plans, and competency, experience and performance of the Operation Team of the contractor. Improvement measures would be recommended to strengthen the organization structure and training programme, and to enhance the technical skills of the Operation Team of the contractor.

By the Consultant

iii) Review the operation reliability and safety of the plant and oversee the proper implementation of the resulting recommendations.

iv) Ensure proper plant operation by the contractor through deployment of more resources for closer monitoring.

v) Through training, raise the vigilance and response capability of the consultants' resident site staff in order to enhance their effectiveness in supervising the operation of the plant by the contractor.

25. We are confident that through the implementation of the above measures, similar bypass incidents would be avoided in the future.

26. In addition, following the incident, we had immediately carried out thorough inspection of all DSD facilities which use the same kind of fine screens. The inspection revealed that the fine screens of these facilities are all working satisfactorily.

Drainage Services Department
November 2014