

UPGRADING AND OPERATION OF PILLAR POINT SEWAGE TREATMENT WORKS

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1. The Pillar Point Sewage Treatment Works (PPSTW) in Tuen Mun was built in 1982. It was designed for providing preliminary treatment of sewage from the Tuen Mun district before discharging to the marine waters at the Urmston Road channel to the south west of Tuen Mun. It also provides septic waste reception and treatment facilities to handle septic waste delivered to it. In 2001, to cater for the increase in population and planned new developments in Tuen Mun district and to improve the quality of the effluent discharged from PPSTW, the Environmental Protection Department (EPD) considered that there was a need to upgrade the capacity and treatment level of PPSTW. The Drainage Services Department (DSD) is responsible for the design and construction of the upgrading works and operation of the upgraded PPSTW. The Environment Bureau is responsible for policy matters on environmental protection and for overseeing the operation of DSD and EPD on the provision of sewerage and sewage treatment services.

2. DSD adopted a design-build-operate (DBO) arrangement for implementing the upgrading and operation of PPSTW, and it was DSD's first pilot use of DBO arrangement for a sewage treatment project. In July 2009, the Finance Committee (FC) of the Legislative Council approved the upgrading works of PPSTW at an approved project estimate (APE) of \$1,360.9 million. In July 2010, FC approved an increase in APE by \$559.6 million to \$1,920.5 million. In June 2005, DSD awarded a consultancy agreement (Consultancy X) to a consultant (Consultant X) for the upgrading works. In July 2010, DSD awarded a DBO contract (Contract A) to a contractor (Contractor A) for the design and construction of the upgrading works of PPSTW and operation and maintenance of the upgraded PPSTW. The design and construction of the upgrading works of PPSTW commenced in July 2010 and were substantially completed on 17 May 2014. As of October 2020, the total project expenditure was \$1,858.9 million. The operation of the upgraded PPSTW commenced on 18 May 2014. Contractor A would operate the plant for 10 years and DSD has an option to extend the operation period for a further five years. The total operation payment to Contractor A since commissioning of the upgraded PPSTW and up to 31 March 2020 was about

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\$412 million. The Audit Commission (Audit) has recently conducted a review of the upgrading and operation of PPSTW.

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3. ***Early deterioration of concrete protective coating.*** According to Contract A, all concrete structures that may be in contact with sewage shall be protected by liquid applied membrane system, which shall give a minimum of 10-year protection to the concrete. According to DSD, a polyurea-based coating was adopted by Contractor A to the concrete surfaces of the newly constructed structures. However, since December 2013, deterioration of the protective coating had been found by Consultant X. In March 2015, about 15% of the membrane was found peeling off. In July 2016, significant portions of the membrane were found peeling off from some structures (e.g. coarse screen channels and manholes) which became exposed and corroded. According to DSD: (a) Contractor A had carried out small-scale trial tests to identify more durable protective coatings than the polyurea-based coating used. As of February 2021, two types of coatings had been used for repairing the peeled-off concrete coating and the works were completed in March 2020; and (b) in November 2020, DSD appointed a local university to carry out an investigation on the failure of concrete protective coating to identify the root cause of the matter (expected to be completed by November 2021). In Audit's view, DSD needs to continue to monitor the performance of the new types of protective coatings and complete the investigation as early as practicable (paras. 2.7 to 2.10).

4. ***Automatic cleaning system of ultraviolet (UV) disinfection facilities not fully functioning.*** After chemically enhanced primary treatment (CEPT) process at the upgraded PPSTW, sewage is fed into the UV disinfection facilities for disinfection by the UV lamps. The UV lamps were fitted with a mechanical/chemical cleaning system to reduce fouling of the lamps, thereby maximising the disinfection performance. According to Consultant X, in April 2014 (i.e. one month before the commissioning of upgraded PPSTW in May 2014), it found that the automatic cleaning system of the UV disinfection facilities could not perform well in keeping the sleeves of the UV lamps clean, thus causing high *Escherichia coli* (*E. coli*) counts in the treated effluent. According to Contractor A, one of the factors leading to the failure of the automatic cleaning system was the formation of ferric sulphide on the sleeves of the UV lamps during CEPT process, which affected the functioning of hydraulic cylinders of the system. Contractor A set up a cleaning team in July 2014 to clean the UV sleeves manually in order to

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restore the performance of the UV disinfection system until a permanent solution was in place, and replacement of hydraulic cylinders were carried out from July to October 2014 as immediate mitigation. In Audit's view, DSD needs to keep under review the operation of the automatic cleaning system and explore further measures for enhancing its effectiveness (paras. 2.11 to 2.13 and 2.16).

5. *Need to ensure compliance with contract requirements relating to materials for equipment/facilities.* Contract A specified the requirements for the material used in fine screens. In November 2014, it was found that the materials of chain in the fine screens at the upgraded PPSTW included one grade of stainless steel which was at variance with the grade specified under the contract requirements and there was a durability issue as the main difference between the two grades was corrosion resistance. In the event, all the chains were replaced by Contractor A at its sole cost in August 2015. In March 2021, DSD informed Audit that additional measures for ensuring the contractor's compliance with contract requirements relating to materials for equipment/facilities had been taken by DSD in the upgrading works project of the San Wai Sewage Treatment Works (which was under a DBO contract awarded in May 2016 (after the award of Contract A) and commenced operation in March 2021). In Audit's view, DSD needs to keep under review the effectiveness of such measures (paras. 2.17 to 2.20 and 4.4).

6. *Need to ensure timely completion of defects correction.* According to Contract A, Contractor A should carry out the outstanding works and the relevant works to repair, rectify or make good any defect, imperfection or other fault in the construction works at its own cost within the one-year defects correction period which commenced after the substantial completion of construction works in May 2014 (i.e. defects correction period expired in May 2015). Audit noted that Contractor A completed its obligation in respect of defects correction in November 2015 (i.e. 6 months after the expiry of the defects correction period) (paras. 2.28 and 2.29).

7. *Need to ensure timely finalisation of contract accounts.* According to Financial Circular No. 7/2017, for a DBO contract, accounts of the design and build portions of the contract should be finalised as soon as possible and in any event not later than three years after the completion of the design and build portions. Audit noted that the account of Contract A in respect of the design and build portions was finalised in November 2017 (i.e. 3.5 years after the substantial completion of the upgrading works of PPSTW in May 2014), exceeding the 3-year time limit specified in the Financial Circular (paras. 2.32 and 2.33).

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8. *Non-compliances with some Key Performance Indicators (KPIs).* According to Contract A, there are 13 KPIs (covering effluent quality, environmental monitoring, and administration and reporting) for measuring the performance of Contractor A in operating the upgraded PPSTW. The monthly operation payment to Contractor A is adjusted to reflect the level of performance achieved, which is assessed based on monitoring results on KPIs in the reporting month. Since commissioning of the upgraded PPSTW in May 2014 and up to October 2020, DSD had deducted a total of \$565,920 from payment to Contractor A on 8 occasions involving non-compliances with 5 of the 13 KPIs. The non-compliance involving the highest amount (\$460,980) of payment deduction (accounting for 81% of the total of \$565,920) was related to an unauthorised emergency bypass incident in August 2014. The incident lasted for about 11 hours with about 95,000 cubic metres untreated sewage discharged and, as a result, 14 beaches were closed for about two days. According to DSD: (a) the direct cause leading to the bypass incident was mechanical failure of all the four fine screens; (b) the main contributing factors included inadequate experience of Contractor A's operation staff and lack of adequate awareness of risks by Contractor A; and (c) follow-up actions had been implemented to prevent recurrence of the incident. In Audit's view, the payment deductions relating to non-compliances with five KPIs on various occasions indicate scope for improvement in Contractor A's performance (paras. 3.4, 3.5, 3.8, 3.9 and 3.11).

9. *Scope for improving demerit point mechanism.* According to Contract A, demerit points are assigned for non-compliances with KPIs, which provide the basis for payment deduction from Contractor A. Audit noted that: (a) the total payment deduction for non-compliances with KPIs is capped at 32% of the monthly operation payment under Contract A. For the DBO contract of the San Wai Sewage Treatment Works awarded in May 2016 (after the award of Contract A), the maximum payment deduction is 40% (i.e. 8 percentage points higher); and (b) for unauthorised emergency bypass, deduction can only be made for one event in each month at the maximum under Contract A (without taking into account the gravity of the event). For the San Wai Sewage Treatment Works contract, the assignment of demerit points to unauthorised emergency bypass in a month is linked to the duration of the bypass. In March 2021, DSD informed Audit that it aimed to start reviewing the demerit point mechanism of Contract A in mid-2022 (when reviewing

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the further five-year extension of Contract A from May 2024 to May 2029 — see para. 2). In Audit’s view, DSD needs to conduct the review as scheduled and complete it timely (paras. 3.12 to 3.15).

10. ***High E. coli concentration found in some effluent samples of DSD’s surprise checks.*** According to DSD, it has developed a surprise checking mechanism for better monitoring of Contractor A’s performance, and its surprise checks serve as quality assurance and aim to provide additional checking on effluent quality at different time slots. DSD conducted surprise checks for *E. coli* concentration in effluent of PPSTW on 161 days from April 2019 to October 2020. It considered that there were 23 (14%) days with high *E. coli* concentration (i.e. exceeding 300,000 counts per 100 millilitres) in effluent and requested Contractor A to investigate the reasons. Audit noted that: (a) for the 23 days, the time taken for completion of the investigations by Contractor A (counting from DSD’s surprise checking dates) ranged from 9 days to about 20 months (averaging about 3.5 months). In particular, for 3 days, the investigation results were only available after one year; and (b) while there was an established practice for the surprise checking mechanism, DSD had not promulgated guidelines in this regard (paras. 3.16 to 3.18).

11. ***Scope for enhancing occupational safety at PPSTW.*** According to Contract A, Contractor A is required to ensure that all operations are conducted in such a manner so as to eliminate the risks to persons, property and equipment. Audit noted the following instances involving occupational safety at PPSTW: (a) a fatal accident occurred in October 2014, with a worker of Contractor A suspected to have fallen into a terminal manhole and his body was found one month later. The Labour Department (LD) prosecuted Contractor A for violation of the Occupational Safety and Health Ordinance (Cap. 509) for the fatal accident and Contractor A was convicted and fined a total of \$145,000 in September 2015. However, Audit noted that DSD had not taken adequate and timely follow-up actions on Contractor A with regard to the fatal accident. It was only in March 2021 that DSD sent a written request to LD asking for information on the cause of the accident and issued an under-performance notice to Contractor A for poor provision of safety measures during work; (b) two incidents involving injuries occurred in October 2015 and April 2018 respectively. DSD had issued under-performance notices to Contractor A for the two incidents; and (c) there were unauthorised entries of workers of Contractor A into confined space without proper certificates in September 2017, January 2018 and September 2020 respectively. DSD had issued warning letters to Contractor A for the incidents (paras. 3.20 to 3.22 and 3.24).

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12. *Scope for enhancing the monitoring of preventive maintenance.* Contractor A is required under Contract A to maintain a Computerised Maintenance Management System (CMM System) to facilitate management of corrective and preventive maintenance of PPSTW, and carry out preventive maintenance according to the schedules as specified in the contract as a minimum. According to CMM System records, there were 16,952 preventive maintenance tasks (involving 432 equipment items) completed during the period of some 5.5 years from January 2015 to October 2020. Audit selected 20 equipment items for which preventive maintenance was carried out once during the period, and noted that their maintenance frequency fell short of the required minimum frequency of once every six months or every year under Contract A. According to DSD: (a) Contractor A had fine-tuned the preventive maintenance schedules to meet the operational needs of the plant; and (b) some maintenance records were not included in CMM System and were maintained in manual records. Audit noted that there was no readily available information on the revisions made to the preventive maintenance schedules in Contract A (paras. 3.30, 3.34 to 3.38).

13. *Need to ensure the timely completion of maintenance tasks and compile regular management information on maintenance.* According to CMM System records, there were 7,572 maintenance tasks (7,313 for preventive maintenance and 259 for corrective maintenance) completed between January 2019 and October 2020. Audit noted that: (a) there was delay in completion for 2,108 (29%) of the 7,313 preventive maintenance tasks, ranging from 1 day to 1 year (averaging 12 days) after target completion dates. For the 259 corrective maintenance tasks, there was delay in completion for one task for about 5 months; and (b) DSD had not regularly compiled management information (e.g. highlights or summaries) on maintenance carried out at PPSTW (para. 3.40).

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14. After the award of the first DBO contract (i.e. Contract A) in July 2010, two more DBO contracts were awarded by DSD for other sewage treatment works in June 2013 and May 2016 respectively. According to DSD, the experience gained during the implementation of Contract A would be a valuable reference for future contract arrangement of projects of sewage treatment works (paras. 4.4 and 4.5).

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15. ***Need to keep under review the cost-effectiveness of adopting DBO contract arrangement.*** In July 2010, FC approved an increase of the APE by \$559.6 million (41%) to \$1,920.5 million for meeting the required expenditure of the upgrading works. The justifications for the cost increase provided by the Environment Bureau included: (a) additional capital cost of \$403.1 million was required for developing a sewage treatment plant design that fulfilled specified performance requirements and for achieving higher cost-effectiveness in subsequent operations; and (b) it was expected that the estimated annual recurrent expenditure arising from the upgrading works for the operation stage would be decreased by \$30 million and overall savings of \$450 million would be yielded over the 15-year life cycle (see para. 2) of the upgraded PPSTW. As of January 2021, the upgraded PPSTW had been operated for about 6.5 years. According to DSD, the actual operation expenditure in general reflected that the estimated annual saving of \$30 million had been achieved. In Audit's view, DSD needs to keep under review the savings achieved in operating the upgraded PPSTW (paras. 4.8 and 4.9).

16. ***Need to timely conduct post-completion review.*** According to the Project Administration Handbook for Civil Engineering Works, a post-completion review: (a) is a useful project management tool; (b) is generally not warranted for consultancy agreements and works contracts of a project which has a total cost less than \$500 million; and (c) should be carried out within a reasonable period, say six months, after the substantial completion of a consultancy agreement or a works contract. Audit noted that the design and construction portions of Contract A were already substantially completed in May 2014 and the total contract expenditure (\$1,774.7 million) was much higher than \$500 million. However, as of January 2021 (more than six years thereafter), DSD had not conducted a post-completion review for the design and construction portions of Contract A (paras. 4.10 and 4.11).

17. ***Scope for making better use of Knowledge Management Portal in sharing experience gained.*** According to DSD, the experience gained during the implementation of Contract A would be a valuable reference for future procurement of sewage treatment works projects and should be properly included in the Knowledge Management Portal of DSD. Audit noted that, regarding the information for DBO contracts, as of January 2021: (a) the Portal only contained a PowerPoint presentation on DBO contract procurement dated November 2016 (i.e. more than 4 years ago); and (b) DSD's experience gained in monitoring the operation of the upgraded PPSTW was not posted onto the Portal (para. 4.14).

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Audit recommendations

18. Audit recommendations are made in the respective sections of this Audit Report. Only the key ones are highlighted in this Executive Summary. Audit has *recommended* that the Director of Drainage Services should:

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- (a) continue to monitor the performance of the new types of protective coatings for repairing the peeled-off concrete coating at PPSTW and complete the investigation on the failure of the concrete protective coating at PPSTW as early as practicable (para. 2.21(a));
- (b) keep under review the operation of the automatic cleaning system of UV disinfection facilities at PPSTW and explore further measures for enhancing its effectiveness (para. 2.21(b)(i));
- (c) keep under review the effectiveness of the additional measures implemented at other sewage treatment works for ensuring the contractor's compliance with contract requirements relating to materials for equipment/facilities (para. 2.21(c));
- (d) take measures to ensure the timely completion of defects correction by the contractor of a works project and the timely finalisation of accounts of the design and build portions of a DBO contract (para. 2.35(c) and (d));

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- (e) continue to closely monitor the performance of the contractor in operating PPSTW including compliances with KPIs, and review the demerit point mechanism of the contract as scheduled and complete it timely (para. 3.27(a) and (b));
- (f) take timely actions to investigate the reasons for high *E. coli* concentration in effluent found by DSD's surprise checks at PPSTW and address the issues identified (para. 3.27(c));

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- (g) formalise the existing practice and promulgate guidelines on DSD's surprise checks conducted on effluent quality of PPSTW (para. 3.27(d));
- (h) take adequate and timely follow-up actions on incidents relating to occupational safety at PPSTW and make continued efforts to enhance the occupational safety at PPSTW (para. 3.27(f) and (g));
- (i) enhance the documentation of the revisions made to the preventive maintenance schedules in the PPSTW contract (para. 3.45(b)(i));
- (j) strengthen measures to ensure that the maintenance for equipment and facilities at PPSTW is timely completed, and regularly compile management information on maintenance carried out at PPSTW for monitoring purpose (para. 3.45(c) and (e));

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- (k) keep under review the savings achieved in operating the upgraded PPSTW under the DBO contract arrangement (para. 4.16(a));
- (l) conduct a post-completion review for the design and construction portions of Contract A (para. 4.16(b)); and
- (m) make better use of the Knowledge Management Portal in sharing experience gained from DBO contract arrangement (para. 4.16(c)).

Response from the Government

19. The Director of Drainage Services agrees with the audit recommendations.