

CHAPTER 7

**Environment and Ecology Bureau
Development Bureau
Drainage Services Department**

**Upgrading and operation of
San Wai Sewage Treatment Works**

**Audit Commission
Hong Kong
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This audit review was carried out under a set of guidelines tabled in the Provisional Legislative Council by the Chairman of the Public Accounts Committee on 11 February 1998. The guidelines were agreed between the Public Accounts Committee and the Director of Audit and accepted by the Government of the Hong Kong Special Administrative Region.

Report No. 82 of the Director of Audit contains 8 Chapters which are available on our website (<https://www.aud.gov.hk>).



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UPGRADING AND OPERATION OF SAN WAI SEWAGE TREATMENT WORKS

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UPGRADING AND OPERATION OF SAN WAI SEWAGE TREATMENT WORKS

Executive Summary

1. The San Wai Sewage Treatment Works (SWSTW) in Yuen Long was commissioned in 1993. It was designed for providing preliminary treatment to serve part of the Yuen Long, Tin Shui Wai and Hung Shui Kiu areas in the Northwest New Territories. In 2015, to cope with the projected increase in sewage flow demand due to planned new developments in the catchment area of SWSTW and to enhance the environmental performance of SWSTW, the capacity and treatment level of SWSTW needed to be upgraded. The Drainage Services Department (DSD) is responsible for the design and construction of the upgrading works, and operation of the upgraded SWSTW. The Environment and Ecology Bureau is responsible for policy matters on environmental protection and for overseeing the operations of DSD on the provision of sewerage and sewage treatment services.

2. DSD adopted a design-build-operate (DBO) arrangement for implementing the upgrading works of SWSTW and operation of the upgraded SWSTW. In April 2016, the Finance Committee of the Legislative Council approved the upgrading works of SWSTW at an approved project estimate (APE) of \$2,572.3 million. In January 2008, DSD awarded a consultancy agreement (Consultancy X) to a consultant (Consultant X) for the investigation, design and construction of the upgrading works of SWSTW. In May 2016, DSD awarded a DBO contract (Contract A) to a contractor (Contractor A) for the design and construction of the upgrading works of SWSTW, and subsequent operation of the upgraded SWSTW. The design and construction of the upgrading works of SWSTW commenced in May 2016 and were substantially completed on 5 March 2021. As of October 2023, \$1,924.7 million (75%) of APE had been incurred. The operation of the upgraded SWSTW commenced on 6 March 2021. Contractor A would operate the plant for 10 years and DSD has an option to extend the operation period for a further 5 years. The total operation payment to Contractor A since commissioning of the upgraded SWSTW and up to October 2023 was about \$163 million. The Audit Commission (Audit) has recently conducted a review to examine DSD's work in managing the upgrading works of SWSTW and operation of the upgraded SWSTW.

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Upgrading works of San Wai Sewage Treatment Works

3. *Scope for improvement in ascertaining conditions of existing drainage system involving interfacing works.* According to Contract A, a complete stormwater drainage system shall be provided for the upgraded SWSTW. Contractor A's original design was to connect the proposed drainage system of the upgraded SWSTW to the external downstream public drainage system via an existing step channel (Channel A). After Contractor A took possession of the site in May 2017, Channel A was found to have been modified and buried below a local access road. As Channel A was found seriously deteriorated and collapsed, in April 2020, Consultant X issued an Employer's Change (EC — later valued at \$5.4 million) to instruct Contractor A to design and construct alternative stormwater drainage pipes and manholes to convey the stormwater flow. In Audit's view, there is scope for improvement in ascertaining conditions of existing drainage system involving interfacing works (paras. 2.6 to 2.8 and 2.10).

4. *Need to critically assess the choice of fill materials.* According to Consultant X, as the upgrading works of SWSTW comprise considerable quantity of backfilling works, the choice of fill materials would have a significant bearing on the potential extension of time due to inclement weather and its effects. As of October 2019, extensions of time of about 90 days had been granted to Contractor A due to inclement weather. In order to minimise risk of further works delay due to inclement weather, Consultant X issued an EC (later valued at \$2.7 million) in October 2019 to instruct Contractor A to adopt a mixed fill material for specific areas. In Audit's view, in implementing works projects involving considerable quantity of backfilling works, there is merit for DSD to critically assess the choice of fill materials (paras. 2.17 to 2.19).

5. *Recurring leakage and ponding problems.* According to Contract A, Contractor A shall be responsible for the rectification of defects in the works at its own cost in construction and operation stages. According to Consultant X, from July 2021 to February 2022, some leakage and ponding problems at various parts of the upgraded SWSTW were found. According to DSD, as of March 2022, Contractor A had rectified such leakage and ponding problems. In September 2022, Consultant X indicated that leakage and ponding problems were found at various parts of the upgraded SWSTW, and requested Contractor A to rectify them under Contract A as soon as possible. According to DSD: (a) these problems were of different nature, extent and locations at the buildings in comparing to those occurred

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before March 2022, and had all been rectified by Contractor A as of mid-March 2024; and (b) it requested Consultant X to conduct an investigation to ascertain the reasons for the recurring leakage and ponding problems at various buildings of the upgraded SWSTW. In Audit's view, DSD needs to take measures to ensure the early completion of the investigation and take further measures as needed to address the matter (paras. 2.22 to 2.25).

6. *Need to ensure that contractors timely submit the full set of required documents for finalisation of contract accounts.* Audit noted that Contractor A only provided the supporting documentation for the final accounts in full in January 2024 (i.e. a delay of about 1 year as compared with the required timeframe under Contract A), which resulted in knock-on delay on the finalisation of accounts of the design and construction portions of Contract A (paras. 2.29 to 2.31).

Monitoring of operation of upgraded San Wai Sewage Treatment Works

7. *Non-compliances with some Key Performance Indicators (KPIs).* According to Contract A, there is a set of 14 KPIs (covering effluent quality requirements, environmental monitoring, and contract administration and reporting) for measuring the performance of Contractor A in operating the upgraded SWSTW. The monthly payment to Contractor A for operation of the upgraded SWSTW is adjusted to reflect the level of performance achieved, which is assessed by calculating the total demerit points based on monitoring results on KPIs in the same reporting month. Since the commissioning of the upgraded SWSTW in March 2021 and up to October 2023, DSD had deducted a total of \$78,822 from operation payments to Contractor A on 11 non-compliances involving 3 KPIs related to contract administration and reporting (i.e. monthly reporting, consistent minor breaches and data integrity). In Audit's view, the payment deductions relating to non-compliances with three KPIs on various occasions indicate scope for improvement in Contractor A's performance (paras. 3.4, 3.5, 3.7 and 3.8).

8. *Inconsistent contract provisions related to demerit point mechanism.* Audit noted that there were inconsistencies between provisions of Contract A related to the demerit point mechanism. For example, while a contract provision provides that the total maximum number of demerit points attributable to the non-compliances with KPIs identified for each reporting month is 5,000 points, another contract

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provision specifies that the maximum number of demerit points for calculating the monthly operation payment adjustment is 4,000 points (para. 3.9).

9. ***Need to timely issue under-performance notices (UPNs) for all under-performance events.*** According to Contract A, in case an under-performance event (i.e. Contractor A fails to comply with any of the general obligations under the contract) is identified, a UPN is issued to Contractor A. For under-performance events happened between March 2021 and October 2023, Audit noted that, as of January 2024, UPNs had not been issued to Contractor A for 16 under-performance events. DSD informed Audit in March 2024 that: (a) UPNs were issued to Contractor A for all these 16 under-performance events in February 2024; and (b) the issue of UPNs would result in assignment of additional demerit points to Contractor A for the related reporting months and potential deduction of \$93,637 from the operation payments made to Contractor A. In Audit's view, DSD needs to take prompt actions to adjust the operation payments to Contractor A (paras. 3.7, 3.12 to 3.14 and 3.16).

10. ***Contamination of effluent samples.*** According to Consultant X and Contractor A, from March 2021 to October 2023, abnormally high 5-day biochemical oxygen demand concentration was found in the effluent samples collected at the upgraded SWSTW in 4 occasions due to contamination of sampling bottles, automatic sampler components and sampling tools. According to DSD, to prevent recurrence of the incidents, follow-up actions had been implemented. In Audit's view, DSD needs to keep under review the effectiveness of the new measures for collecting and handling effluent samples at the upgraded SWSTW (paras. 3.18 and 3.19).

11. ***Need to ensure the timely submission of reporting materials containing the required information.*** According to Contract A, Contractor A is required to submit to the Supervising Officer (responsible for supervising Contractor A's operation of the upgraded SWSTW) reporting materials containing the required information. For the operation plans/reports relating to the period from March 2021 to October 2023, Audit noted that: (a) the operation plans for the second year and third year of operation were submitted late by Contractor A, with delays of 27 and 165 days respectively; and (b) some cases with non-compliance with contract requirements (e.g. total suspended solids concentration in centrate) were omitted in the monthly operation reports by Contractor A (paras. 1.11, 3.25 and 3.26).

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12. ***Scope for making better use of Computerised Maintenance Management System (CMM System) for monitoring maintenance works of facilities.*** According to Contract A, CMM System maintains the inspection and maintenance schedule and maintenance records of the facilities at the upgraded SWSTW. Audit noted that, as of January 2024: (a) there was no readily available information from CMM System showing whether the works orders had been completed as scheduled; and (b) some management reports (e.g. management information on whether preventive maintenance works had been performed as scheduled) could not be generated from CMM System for monitoring purpose (paras. 3.34 and 3.35).

Other related issues

13. ***Scope for enhancing construction site safety.*** According to DSD, during the design and construction phase from May 2016 to March 2021, 5 non-fatal reportable accidents (i.e. accident resulting in an injury with incapacity for more than 3 days) happened at the construction site of Contract A. For some of these reportable accidents, there were late reporting of accidents, and late submission of preliminary accident reports and injury report forms by Contractor A to Consultant X. Apart from these reportable accidents, there were other incidents related to construction site safety during the testing and commissioning stage (e.g. leakage of hazardous gas) (paras. 4.5 and 4.6).

14. ***Scope for enhancing storage and handling of ferric chloride solution.*** According to DSD, ferric chloride solution is used as a coagulant to facilitate the settlement of suspended solids and stored in the storage tanks at the upgraded SWSTW. The Dangerous Goods Ordinance (Cap. 295) and its subsidiary legislation have been amended and came into effect on 31 March 2022 with a grace period of 24 months (i.e. up to 30 March 2024). Under the new legislation, among others, ferric chloride solution (not classified as dangerous goods before the enactment of the new legislation) has been classified as Class 8 dangerous goods and approvals for the storage and use of ferric chloride solution are required to be obtained from the Fire Services Department. Audit noted that, as of January 2024, the application for the storage and use of ferric chloride solution at the upgraded SWSTW had yet to be submitted to the Fire Services Department. In January 2024, DSD issued a letter to Contractor A and stating that it was the obligation of Contractor A to submit, on behalf of DSD, the documentation required for the approvals on the matter, and Contractor A was required to meet various milestones for monitoring the progress of

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implementing measures in meeting the statutory requirements before the expiry of the grace period (paras. 4.9 to 4.11).

15. ***Scope for improving project cost estimation.*** APE of \$2,572.3 million covered the design and construction portions of the upgrading works of SWSTW. However, as of October 2023, the total expenditure under the project vote was \$1,924.7 million (i.e. \$647.6 million (25%) less than APE of \$2,572.3 million). According to DSD, the significant variance was mainly due to lower-than-estimated tender outturn price for Contract A, and the actual adjustment for price fluctuation and contingency sums for unforeseen works lower than their estimated amounts. In Audit's view, in implementing works projects, DSD needs to take measures to ensure that project costs are estimated as accurately as possible (paras. 4.16 to 4.18).

16. ***Need to keep under review DBO contract arrangement.*** The upgrading of SWSTW was DSD's second sewage treatment works project adopting DBO contract arrangement. According to DSD, it was still in the pilot stage in respect of adopting DBO contract arrangement for selected sewage treatment facilities projects, and the actual achievement of cost saving of adopting DBO contract arrangement would be reviewed upon completion of the operation phase of Contract A. In Audit's view, DSD needs to keep under review the DBO contract arrangement of sewage treatment works (paras. 4.21, 4.23 and 4.24).

Audit recommendations

17. **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:**

Upgrading works of SWSTW

- (a) **in implementing works projects involving works interfacing with existing drainage system, take measures to ascertain the conditions of existing drainage system as comprehensively as possible (para. 2.20(a));**
- (b) **in implementing works projects involving considerable quantity of backfilling works, critically assess the choice of fill materials (para. 2.20(c));**

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- (c) **take measures to ensure the early completion of the investigation relating to the reasons for the recurring leakage and ponding problems at various buildings of the upgraded SWSTW and take further measures as needed to address the matter (para. 2.33(a));**
- (d) **in implementing works projects, strengthen measures to ensure that DSD contractors timely submit the full set of required documents for finalisation of contract accounts (para. 2.33(b)(ii));**

Monitoring of operation of upgraded SWSTW

- (e) **continue to closely monitor the performance of the contractor in operating the upgraded SWSTW (including compliances with KPIs) (para. 3.28(a));**
- (f) **review the contract provisions related to the demerit point mechanism of the upgraded SWSTW contract and take measures to address the matter (para. 3.28(b));**
- (g) **regarding the 16 under-performance events with UPNs issued to Contractor A in February 2024, take prompt actions to adjust the operation payments to Contractor A (para. 3.28(c));**
- (h) **strengthen measures to ensure the timely issuing of UPNs for all under-performance events and adjustment of operation payments to Contractor A as needed (para. 3.28(d));**
- (i) **keep under review the effectiveness of the new measures for collecting and handling effluent samples at the upgraded SWSTW (para. 3.28(f));**
- (j) **strengthen measures to ensure the timely submission of reporting materials containing all required information by the contractor of the upgraded SWSTW (para. 3.28(h));**
- (k) **make better use of CMM System for monitoring maintenance works of facilities at the upgraded SWSTW (para. 3.37(b));**

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Other related issues

- (l) **in implementing works projects:**
 - (i) **make continued efforts to enhance construction site safety (para. 4.13(a)(i));**
 - (ii) **take measures to ensure that DSD contractors timely report all accidents (including submission of related reports) at construction sites in accordance with related requirements (para. 4.13(a)(ii)); and**
 - (iii) **take measures to ensure that project costs are estimated as accurately as possible (para. 4.27(a));**
- (m) **take measures to ensure that the relevant approvals for the storage and use of dangerous goods (particularly ferric chloride solution) at the upgraded SWSTW are timely obtained from the relevant authorities (para. 4.13(b)(ii)); and**
- (n) **keep under review the DBO contract arrangement of sewage treatment works (para. 4.27(b)(ii)).**

Response from the Government

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

PART 1: INTRODUCTION

1.1 This PART describes the background to the audit and outlines the audit objectives and scope.

Background

1.2 The San Wai Sewage Treatment Works (SWSTW) in Yuen Long was commissioned in 1993 with design treatment capacity of 164,000 cubic metres (m³) per day (Note 1). It was designed for providing preliminary treatment (Note 2) to serve part of the Yuen Long, Tin Shui Wai and Hung Shui Kiu areas in the Northwest New Territories (NWNT). The preliminary treatment process removed solids and grits from the sewage inflow before discharging the treated effluent into the northwestern waters via NWNT effluent tunnel and then a submarine outfall at Urmston Road near Tuen Mun.

1.3 The Environmental Protection Department (EPD) is responsible for planning the infrastructure required for collecting and treating sewage and monitoring the marine water quality. In 2015, to cope with the projected increase in sewage flow demand due to planned new developments in the catchment area of SWSTW (Note 3) and to enhance the environmental performance of SWSTW, the capacity and treatment level of SWSTW needed to be upgraded. The Drainage Services Department (DSD) is responsible for the design and construction of the upgrading works, and operation

Note 1: *The quantity of sewage flow to the then SWSTW for treatment was about 130,000 m³ per day in 2015.*

Note 2: *Preliminary treatment includes screening and removal of grits. Solids larger than six millimetres in diameter as well as grits which consists of sand, bone pieces, etc. are removed from the sewage.*

Note 3: *According to the Environment and Ecology Bureau (see Note 4), the design treatment capacity of the then SWSTW (i.e. 164,000 m³ per day) was not sufficient to meet the projected flow derived from the planning data which estimated a population of around 700,000 by 2020 in the catchment area and a further increase by around 100,000 from 2020 onwards in the catchment area of about 1,300 hectares of land for various uses (e.g. residential and commercial developments).*

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of the upgraded SWSTW. The Environment and Ecology Bureau (EEB — Note 4) is responsible for policy matters on environmental protection and for overseeing the operations of DSD and EPD on the provision of sewerage and sewage treatment services.

Upgrading works of SWSTW

1.4 In February 2016, EEB informed the Public Works Subcommittee of the Finance Committee (FC) of the Legislative Council (LegCo) that the upgrading works of SWSTW would be conducted in 2 phases, as follows:

- (a) **Phase 1.** Phase 1 upgrading works of SWSTW would be carried out at a site adjacent to the then-existing SWSTW to minimise interfacing problems (Note 5) with an estimated cost of \$2,572.3 million. The scope of the upgrading works was as follows:
 - (i) upgrading of the sewage treatment level from preliminary treatment to chemically enhanced primary treatment (CEPT — Note 6) with ultraviolet disinfection treatment process;
 - (ii) expansion of the treatment capacity from 164,000 to 200,000 m³ per day; and

Note 4: *In July 2022, EEB was formed to take over the policy responsibility for environmental matters from the then Environment Bureau, which is referred to as EEB in this Audit Report for simplicity.*

Note 5: *According to EEB: (a) the existing service at the then SWSTW would not be affected during the Phase 1 construction of the upgraded SWSTW; and (b) after the commissioning of the upgraded SWSTW under Phase 1, the then SWSTW would be decommissioned and its site would be reserved for future upgrading of SWSTW as necessary.*

Note 6: *Primary treatment includes preliminary treatment process (i.e. screening and removal of grits) and a primary sedimentation process for removal of settleable suspended solids from the sewage. For CEPT, chemicals are added during the primary sedimentation process to enhance the removal of suspended solids.*

- (iii) construction of ancillary works, including an administration building, a maintenance workshop, access roads and landscaping works; and
- (b) **Phase 2.** The next phase of upgrading works of SWSTW would be planned in light of the recommendations in the study for the development of the proposed Hung Shui Kiu new development area.

1.5 In April 2016, FC of LegCo approved Phase 1 upgrading works of SWSTW at an approved project estimate (APE) of \$2,572.3 million. According to DSD, in 2017, Phase 2 upgrading works was consolidated in the plan for providing a new sewage treatment works for Hung Shui Kiu new development area (Note 7).

1.6 DSD adopted a design-build-operate (DBO — Note 8) arrangement for implementing the upgrading works of SWSTW and operation of the upgraded SWSTW (see Photograph 1).

Note 7: *According to DSD: (a) in the early 2010s, upgrading works of SWSTW were planned to be implemented in 2 phases. At that time, the development for the proposed Hung Shui Kiu new development area was under review. The contribution of sewage influent from Hung Shui Kiu new development area, and the planned public trunk sewerage and village sewerage projects was planned to be covered by Phase 2 upgrading works of SWSTW; and (b) in 2017, Phase 2 upgrading works of SWSTW was consolidated in the plan for providing a new sewage treatment works for Hung Shui Kiu new development area.*

Note 8: *DBO is a form of contract procurement whereby the contractor is required to design and construct a proposed facility in accordance with all requirements set forth in the contract by the Government. Upon completion, the contractor will be required under the contract to operate and maintain the completed facility for a specified period of time. The ownership of the facility will remain with the Government throughout the contract duration. Upon expiry of the operation phase specified in the contract, the facility will be handed back to the Government free of any charges in a specified condition.*

Photograph 1

Upgraded SWSTW (April 2022)



Source: DSD records

1.7 In January 2008, DSD awarded a consultancy agreement (Consultancy X) to a consultant (Consultant X) for the investigation, design and construction of the upgrading works of SWSTW, which involved a DBO contract (Contract A — see para. 1.8). Being the Supervising Officer for the DBO contract, Consultant X’s services included supervising the design and construction of the upgrading works, and the first-year operation of the upgraded SWSTW. As of October 2023, consultancy fees of \$13.7 million had been paid to Consultant X (Note 9).

Note 9: *The consultancy fees for planning work (e.g. environmental impact assessment review, reference design, contract documentation and tendering) of \$10.0 million in total were funded under the block allocation Subhead 4100DX of the Capital Works Reserve Fund Head 704 under the control of DSD. The consultancy fees incurred during the construction, commissioning and completion phase (i.e. after Contract A was awarded) of \$3.7 million in total were funded under the project vote of Phase 1 (see para. 1.5).*

1.8 In May 2016, DSD awarded Contract A to a contractor (Contractor A) for the design and construction of the upgrading works of SWSTW, and subsequent operation of the upgraded SWSTW at a contract sum of \$3,142.3 million, which comprised:

- (a) \$2,149.5 million (68%) for the design and construction of the upgrading works (Note 10); and
- (b) \$992.8 million (32%) for the operation stage (covering the contractual operation period of 15 years, viz. the 10 years after completion of the construction works and the option to extend the operation period for a further 5 years — see para. 1.11).

1.9 The design and construction of the upgrading works of SWSTW under Contract A commenced in May 2016 and were substantially completed on 5 March 2021, about 5.3 months (161 days) later than the original completion date of 25 September 2020. According to DSD, extensions of time for the whole period were granted to Contractor A under Contract A due to inclement weather. The operation stage commenced on 6 March 2021.

Project costs

1.10 As of October 2023, the contract expenditure was \$1,766.6 million, and \$1,924.7 million (75%) of APE totalling \$2,572.3 million (see para. 1.5) for the upgrading works of SWSTW had been incurred. Of this \$1,924.7 million:

- (a) \$1,766.6 million (92%) was related to expenditure for the upgrading works of SWSTW under Contract A (see Table 1); and

Note 10: *According to DSD, APE of \$2,572.3 million (see para. 1.5) would cover the design and construction portions while the operation costs for the upgraded SWSTW would be funded under the General Revenue Account.*

Table 1

**Contract expenditure of Contract A
relating to design and construction portions
(October 2023)**

Original contract sum (a)	Contract expenditure (b)	Decrease (c) = (b) - (a)	Decrease in provision for price fluctuation adjustment (d)	Decrease after price fluctuation adjustment (e) = (c) - (d)
(\$ million)				
2,149.5	1,766.6	(382.9) (17.8%)	(216.7) (10.1%) (Note)	(166.2)

Source: DSD records

Note: The original contract sum has already included provision for price fluctuation adjustment.

- (b) the remaining \$158.1 million (8%) comprised resident site staff (RSS) costs (Note 11) of \$135.3 million, consultancy fees of \$3.7 million (see Note 9 to para. 1.7), and other costs of \$19.1 million (Note 12).

Operation of upgraded SWSTW

1.11 The operation of the upgraded SWSTW commenced on 6 March 2021. Contractor A would operate the plant for 10 years and DSD has an option to extend

Note 11: *Consultants are required to employ RSS of different grades (e.g. professional grade and technical grade) for supervising contractors' works. The Government reimburses consultants for the personal emoluments of RSS and pays an on-cost to consultants to cover their costs in managing RSS.*

Note 12: *According to DSD, other costs mainly included costs paid to Consultant X for managing RSS of \$11.3 million and miscellaneous costs for works carried out by other government departments (e.g. excavation permit application and public works laboratory testing services) of \$6.2 million.*

the operation period for a further 5 years. For the first-year operation of the upgraded SWSTW, Consultant X was the Supervising Officer for Contract A and responsible for supervising Contractor A's operation of the upgraded SWSTW, and reporting Contractor A's performance to DSD. After the first-year operation (i.e. since 6 March 2022), DSD has assumed the role of Supervising Officer and fully taken up the work for monitoring (including supervising) Contractor A's operation of the upgraded SWSTW.

1.12 Under Contract A, there is a set of Key Performance Indicators (KPIs) for measuring the performance of Contractor A. The monthly payment to Contractor A for operation of the upgraded SWSTW consists of:

- (a) a fixed fee, which covers maintenance and operation of facilities; and
- (b) a variable fee, which is based on the actual volume of treated effluent.

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.

1.13 According to DSD, from March 2021 to October 2023, the average volume of sewage treated by the upgraded SWSTW was about 142,000 m³ per day (i.e. about 71% of the design treatment capacity of 200,000 m³ per day). In 2022-23, the payment to Contractor A for operation of the upgraded SWSTW was about \$60 million. The total operation payment to Contractor A since commissioning of the upgraded SWSTW (i.e. 6 March 2021) and up to October 2023 was about \$163 million.

Responsible divisions of DSD

1.14 The Harbour Area Treatment Scheme Division under DSD's Sewage Services Branch was responsible for monitoring the design and construction of the upgrading works of SWSTW, and the first-year operation of the upgraded SWSTW. After the first-year operation (i.e. since 6 March 2022), the Sewage Treatment Division 1 under DSD's Electrical and Mechanical Branch has taken over the monitoring of the operation of the upgraded SWSTW. An extract of DSD's organisation chart as at 31 October 2023 is at Appendix A. As of October 2023,

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10 staff in the Sewage Treatment Division 1, among other duties, were involved in monitoring the operation of the upgraded SWSTW (Note 13).

Audit review

1.15 In November 2023, the Audit Commission (Audit) commenced a review to examine DSD's work in managing the upgrading works of SWSTW and operation of the upgraded SWSTW. The audit review has focused on the following areas:

- (a) upgrading works of SWSTW (PART 2);
- (b) monitoring of operation of upgraded SWSTW (PART 3); and
- (c) other related issues (PART 4).

Audit has found room for improvement in the above areas and has made a number of recommendations to address the issues.

Acknowledgement

1.16 Audit would like to acknowledge with gratitude the full cooperation of the staff of DSD during the course of the audit review.

Note 13: *According to DSD, the 10 staff were also involved in monitoring the operation of other sewage treatment works and flood control facilities in NWNT, Sham Tseng and Tuen Mun Region. The related staff expenditure incurred solely for monitoring the operation of the upgraded SWSTW for 2022-23 was about \$2.3 million.*

PART 2: UPGRADING WORKS OF SAN WAI SEWAGE TREATMENT WORKS

2.1 This PART examines DSD's work in managing the upgrading works of SWSTW, focusing on:

- (a) design and construction of upgrading works (paras. 2.4 to 2.21); and
- (b) other contract management issues (paras. 2.22 to 2.34).

Contract A

2.2 In May 2016, DSD awarded Contract A to Contractor A for the upgrading works of SWSTW and the operation of the upgraded SWSTW at a contract sum of \$3,142.3 million, comprising \$2,149.5 million for the design and construction portions and \$992.8 million for the operation stage (Note 14).

2.3 The design and construction works of Contract A commenced in May 2016 and were substantially completed on 5 March 2021 (see para. 1.9). Consultant X (under Consultancy X) was the Supervising Officer responsible for supervising the design and construction of the upgrading works under Contract A. The operation stage (i.e. 10 years plus an optional extension of 5 years) commenced on 6 March 2021. Consultant X was responsible for supervising the first-year operation of the upgraded SWSTW and the role of Supervising Officer was handed over to DSD in March 2022.

Note 14: *Contract A sets out, among others, the Employer's Requirements which specify the requirements for design, construction and operation of the upgraded SWSTW. Under Contract A, Contractor A would be reimbursed for the design and construction portions by reference to the Schedule of Prices and the Schedule of Milestones, and operation payments on a monthly basis for the operation and maintenance of the upgraded SWSTW during the operation stage, subject to price fluctuation adjustment.*

Design and construction of upgrading works

2.4 Under Contract A, Contractor A was required to design and construct the upgrading works of SWSTW in accordance with the contract requirements. Contractor A was required to submit design submissions (Note 15) to Consultant X (Note 16) for comment and consent. Consultant X would seek advice from DSD on major aspects (e.g. process design and deviations from the contract requirements) before granting consent to Contractor A's design submissions (Note 17).

Contract expenditure of Contract A

2.5 As of October 2023, the contract expenditure was \$1,766.6 million (see Table 2), representing 82.2% of the original contract sum of design and construction portions of Contract A (i.e. \$2,149.5 million).

Note 15: *According to DSD, an independent design checker of Contractor A had checked and certified that Contractor A's design complied with the relevant contract requirements.*

Note 16: *Being the Supervising Officer, Consultant X would ensure that Contractor A and the independent design checker of Contractor A discharged their duties satisfactorily and the designs were in compliance with Contract A.*

Note 17: *After Consultant X's granting of approval-in-principle to Contractor A's preliminary design (such as design standards, criteria and parameters), Contractor A submitted the detailed design to Consultant X for approval.*

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Table 2

**Contract expenditure of Contract A
relating to design and construction portions
(October 2023)**

Particulars	Amount (\$ million)
Contract works completed	1,608.3
Payment for contract price fluctuation (Note)	158.3
Total	1,766.6

Source: DSD records

Note: A provision for price fluctuation adjustment of \$375.0 million was included in the original contract sum.

Scope for improvement in ascertaining conditions of existing drainage system involving interfacing works

2.6 According to Contract A, a complete stormwater drainage system shall be provided for the upgraded SWSTW. The original drainage design by Contractor A was to connect the proposed drainage system of the upgraded SWSTW to the external downstream public drainage system (i.e. a box culvert on Ha Tsuen Road) via an existing step channel (Channel A) and drainage pipe.

2.7 According to Consultant X:

- (a) the original design was completed mainly based on the as-built records as of November 2016. After Contractor A took possession of the site in May 2017, Channel A was found to have been modified and buried below a local access road; and
- (b) Channel A was found during rainstorms to have limited flow capacity and it was unsuccessful to unblock it in August 2017. As the whole covered section of Channel A was found seriously deteriorated and collapsed, and its condition was beyond repair, an alternative design of the drainage

Upgrading works of San Wai Sewage Treatment Works

connection between the upgraded SWSTW site and the downstream stormwater box culvert was necessary for completion of the works.

2.8 In the event, in April 2020, Consultant X issued an Employer's Change (EC — Note 18) (EC A, later valued at \$5.4 million — Note 19) to instruct Contractor A to design and construct alternative stormwater drainage pipes and manholes to convey the stormwater flow (i.e. the flow within the upgraded SWSTW site and the flow from the upstream) to pass through the upgraded SWSTW and discharge to the external downstream public drainage system.

2.9 According to DSD:

- (a) it was not desirable that the original design was mainly based on the as-built records;
- (b) for existing drainage/sewerage systems where the new works would interface with, more detailed investigation should be conducted during the design stage; and
- (c) inspection on the underground drainage system (e.g. by using closed-circuit television) should have been carried out to assure the existing conditions.

2.10 In Audit's view, in implementing works projects involving works interfacing with existing drainage system, DSD needs to take measures to ascertain the conditions of existing drainage system as comprehensively as possible with a view to avoiding design changes after commencement of works.

Note 18: *According to Contract A, the Supervising Officer (see para. 1.11) may order an EC to change the works (including a change in the Employer's Requirements which makes necessary the alteration or modification of the design, quality or quantity of works) any time before the date of Final Operation Certificate (see Note 25 to para. 2.22).*

Note 19: *According to Consultant X, EC A would not cause delay to the work progress and would not incur any cost other than the direct cost.*

Scope for improvement in local consultation process

2.11 Under Contract A, Contractor A was required to design and construct an alternative permanent access road (Road A) connecting a main road (Road B) to an existing access road (Road C). Timely commissioning of Road A was a pre-requisite to the closure of a section of Road C which formed part of the site and was essential to the upgrading works of SWSTW.

2.12 After commencement of Contract A, several consultations had been made with a rural committee of that area between May and November 2017 in relation to the design and construction of Road A stipulated in Contract A. The rural committee raised concerns on traffic congestion problem along Road B caused by Road A, as the design did not include a corresponding widening of Road B for provision of a dedicated right-turn lane or pocket. According to the rural committee:

- (a) traffic volume of Road B had increased significantly with lots of container vehicles travelling in both traffic directions; and
- (b) vehicles on the westbound lane of Road B would need to wait for a long time for a safe opportunity to turn right into Road A, and therefore would cause the traffic to tail back to the preceding junction of Road B and a connecting road and cause congestion in both traffic directions.

2.13 In view of the above concerns, joint site inspections were conducted by DSD, the Transport Department and Consultant X between August and September 2017, and all parties concurred that:

- (a) right-turn vehicles would often need to wait on the westbound lane of Road B for a long time because of the busy traffic on the eastbound lane, which obstructed the westbound traffic; and
- (b) the widening of Road B to provide a dedicated right-turn lane or pocket could effectively enhance the performance of junction between Road A and Road B.

Upgrading works of San Wai Sewage Treatment Works

According to DSD, the rural committee's concerns were addressed after the joint site inspections, and Road A was commissioned in November 2017 (which was essential to the upgrading works of SWSTW — see para. 2.11).

2.14 In October 2019, Consultant X issued EC B (later valued at \$6.0 million — Note 20) to instruct Contractor A to carry out road widening works on Road B to provide an additional traffic lane for a dedicated right-turn pocket at the junction of Road A and Road B (Note 21). The road widening works on Road B was substantially completed in December 2020.

2.15 In Audit's view, in implementing works projects involving road works, DSD needs to take measures to improve local consultation process with a view to early ascertaining and addressing the concerns of relevant stakeholders.

Need to critically assess the choice of fill materials

2.16 The upgrading works of SWSTW comprise considerable quantity of backfilling works. Contract A specifies that general fill material (Note 22) shall be adopted for area of fill unless otherwise stated in the Contract.

Note 20: *According to Consultant X, EC B would not cause delay to the work progress and would not incur any cost other than the direct cost.*

Note 21: *According to DSD, during November 2017 to October 2019, Consultant X and Contractor A were liaising with relevant government bureaux/departments and working on the detailed design on provision of an additional traffic lane for a dedicated right-turn pocket at the junction of Road A and Road B (including the lighting design, temporary traffic arrangement, etc.).*

Note 22: *According to the General Specification for Civil Engineering Works, fill material shall consist of naturally occurring or processed material, or inert construction and demolition material, which at the time of disposition is capable of being compacted to form stable areas of fill. Different types of fill material shall have the particle size distributions within various ranges. For general fill material, its particle size would be of 200 millimetres.*

Upgrading works of San Wai Sewage Treatment Works

2.17 According to Consultant X:

- (a) using general fill materials for backfilling enables use of fill materials from a wide range of sources. However, general fill materials are generally sensitive to inclement weather which poses risks of extension of time; and
- (b) as the upgrading works of SWSTW comprise considerable quantity of backfilling works, the choice of fill materials would have a significant bearing on the potential extension of time due to inclement weather and its effects.

2.18 As of October 2019, extensions of time of about 90 days had been granted to Contractor A due to inclement weather. In order to minimise risk of further works delay due to inclement weather, Consultant X issued EC C (later valued at \$2.7 million — Note 23) in October 2019 to instruct Contractor A to adopt a mixed fill material (with coarse granular material and fine fill material in an appropriate proportion) for areas of fill where shallower than 2 metres below the earthworks final surface (Note 24).

2.19 In Audit's view, in implementing works projects involving considerable quantity of backfilling works, there is merit for DSD to critically assess the choice of fill materials, taking into account all relevant factors (e.g. risk of extension of time due to inclement weather).

Audit recommendations

2.20 **Audit has *recommended* that the Director of Drainage Services should:**

Note 23: *According to Consultant X, EC C would not cause delay to the work progress and would not incur any cost other than the direct cost.*

Note 24: *According to DSD, the backfilling works using the mixed fill materials under EC C were carried out in the wet seasons of 2019 and 2020. It was estimated that, during the period, inclement-weather delay of backfilling works of 59 days was avoided.*

Upgrading works of San Wai Sewage Treatment Works

- (a) in implementing works projects involving works interfacing with existing drainage system, take measures to ascertain the conditions of existing drainage system as comprehensively as possible with a view to avoiding design changes after commencement of works;
- (b) in implementing works projects involving road works, take measures to improve local consultation process with a view to early ascertaining and addressing the concerns of relevant stakeholders; and
- (c) in implementing works projects involving considerable quantity of backfilling works, critically assess the choice of fill materials, taking into account all relevant factors (e.g. risk of extension of time due to inclement weather).

Response from the Government

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

Other contract management issues

Recurring leakage and ponding problems

2.22 According to Contract A, Contractor A shall be responsible for the rectification of defects in the works in construction and operation stages until the issue of the Final Operation Certificate (Note 25). Any work of repair or rectification or make good any defect shall be carried out by Contractor A at its own cost if the necessity for such work shall, in the Supervising Officer's opinion, be due to the design or use of plant, materials or workmanship not in accordance with the contract.

Note 25: *According to Contract A, following the expiry of the operation period (see para. 1.11), the Supervising Officer shall issue the Final Operation Certificate stating the date on which Contractor A has achieved completion of the operation in accordance with the Contract.*

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2.23 From July 2021 (i.e. soon after the substantial completion of design and construction portions under Contract A in March 2021) to February 2022, some leakage and ponding problems at various parts of the upgraded SWSTW were found. According to Consultant X:

- (a) some civil defect items (including water leakage into buildings) required repeated rectification works, affecting the normal operation and potentially causing safety hazards; and
- (b) while some rectification works had been made by Contractor A, the recurring leakage and ponding problems indicated that the remedial works did not solve all the problems. Contractor A was therefore advised to accord high priority to permanently rectify such defects (such as persistent ponding and algae growth on green roofs of various buildings).

According to DSD, as of March 2022, Contractor A had rectified the above leakage and ponding problems.

2.24 At a progress meeting among DSD, Consultant X and Contractor A in September 2022, Consultant X indicated that leakage and ponding problems were found at various locations of various buildings of the upgraded SWSTW, and requested Contractor A to rectify them under Contract A (see para. 2.22) as soon as possible. In response to Audit's enquiries, between January and March 2024, DSD informed Audit that:

- (a) the leakage and ponding problems mentioned by Consultant X at the progress meeting in September 2022 were defects occurred after March 2022. These problems were of different nature, extent and locations at the buildings in comparing to those occurred before March 2022 (see para. 2.23);
- (b) Contractor A was responsible for the maintenance and rectification of the defects in the works in construction and operation stage at its own cost until the issue of the Final Operation Certificate (see para. 2.22). As of mid-March 2024, all the leakage and ponding problems had been rectified by Contractor A; and

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- (c) in March 2024, it requested Consultant X to conduct an investigation to ascertain the reasons for the recurring leakage and ponding problems at various buildings of the upgraded SWSTW.

2.25 In Audit's view, DSD needs to take measures to ensure the early completion of the investigation relating to the reasons for the recurring leakage and ponding problems at various buildings of the upgraded SWSTW and take further measures as needed to address the matter.

Need to ensure that consultants and contractors complete their obligations in a timely manner

2.26 In September 2023, DSD informed Consultant X that:

- (a) DSD considered it unsatisfactory and expressed concern on the slow progress in completing certain outstanding obligations of the design and construction phase by Consultant X (Note 26) and Contractor A (Note 27), including:
- (i) valuation and revaluation of about 20 ECs;
 - (ii) approval on a number of submissions (e.g. manuals) prepared by Contractor A; and
 - (iii) outstanding fieldworks (e.g. installation of rainwater harvesting system, works to disconnect the flow from the then SWSTW to junction chamber and reinstatement works of site area);

Note 26: *Poor rating was given in achievement of objectives and targets aspect in Consultant X's performance report from July to September 2023 to reflect the poor performance in deadline control on the committed programme with Contractor A.*

Note 27: *Poor ratings were given in relevant aspects (e.g. adequacy of planning of work, attention to submission of accounts/valuation, and quality and promptness of design submission) in Contractor A's performance reports from December 2021 to August 2023 to reflect the slow progress in completing outstanding obligations.*

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- (b) based on Consultant X's programme set in 2022, the above outstanding obligations were targeted to be completed by March 2023 (i.e. 2 years after the substantial completion of construction works in March 2021). However, the time target was not met despite repeated reminders (via phone calls, meetings and emails) by DSD. Furthermore, there was no committed programme by Consultant X thereafter on completing these outstanding obligations; and
- (c) DSD had grave concern on Contractor A's capability and determination to complete its outstanding obligations.

Furthermore, in November 2023, DSD wrote to Consultant X to express concern again on the slow progress of contract finalisation.

2.27 In January and February 2024, DSD informed Audit that:

- (a) the installation of rainwater harvesting system and works to disconnect the flow from the then SWSTW to junction chamber (see para. 2.26(a)(iii)) were completed in November 2023; and
- (b) all other outstanding obligations were completed in February 2024.

2.28 In Audit's view, in implementing works projects, DSD needs to strengthen measures to ensure that its consultants and contractors complete their obligations in a timely manner.

Need to ensure that contractors timely submit the full set of required documents for finalisation of contract accounts

2.29 According to Contract A:

- (a) Contractor A shall submit a statement of final accounts in respect of the design and construction portions and supporting documentation within

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90 days after the date of issue of the Defects Correction Certificate (Note 28); and

- (b) Consultant X shall issue a final payment certificate within 90 days after receipt of the final accounts in respect of the design and construction portions and of all information required for its verification.

2.30 Audit noted that the Defects Correction Certificate of Contract A was issued on 6 October 2022. As such, according to Contract A, Contractor A should submit the statement of final accounts together with supporting documentation by 4 January 2023 (see para. 2.29(a)). However, Contractor A only provided the supporting documentation for the final accounts in full in January 2024 (i.e. a delay of about 1 year).

2.31 According to DSD:

- (a) the accounts of the design and construction portions of Contract A were originally targeted to be finalised within 2 years (i.e. by March 2023) from the substantial completion of construction works in March 2021;
- (b) however, as of November 2023, Consultant X failed to manage Contractor A to complete a number of outstanding obligations as scheduled (see paras. 2.26 to 2.28) and to provide the supporting documentation for the final accounts in full (see para. 2.30). These resulted in knock-on delay on the finalisation of accounts of the design and construction portions of Contract A; and

Note 28: *Under Contract A, the Supervising Officer shall have power to order during the Defects Correction Period Contractor A to repair, rectify or make good any defect, imperfection or other fault in the construction works or any section. Contractor A shall carry out such work at its own cost within the Defects Correction Period (which commenced after substantial completion of Contract A) or as soon as practicable thereafter. Such rectification works shall be carried out within the one-year Defects Correction Period. Upon expiry of the Defects Correction Period and when all the design and construction works have been completed to the satisfaction of the Supervising Officer, the Defects Correction Certificate shall be issued to Contractor A which stated the date on which Contractor A has completed its obligation in respect of defects correction.*

- (c) Consultant X issued the final payment certificate to finalise the accounts of the design and construction portions of Contract A in March 2024.

2.32 In Audit's view, in implementing works projects, DSD needs to strengthen measures to ensure that its contractors timely submit the full set of required documents for finalisation of contract accounts.

Audit recommendations

2.33 **Audit has *recommended* that the Director of Drainage Services should:**

- (a) **take measures to ensure the early completion of the investigation relating to the reasons for the recurring leakage and ponding problems at various buildings of the upgraded SWSTW and take further measures as needed to address the matter; and**
- (b) **in implementing works projects:**
 - (i) **strengthen measures to ensure that DSD consultants and contractors complete their obligations in a timely manner; and**
 - (ii) **strengthen measures to ensure that DSD contractors timely submit the full set of required documents for finalisation of contract accounts.**

Response from the Government

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

PART 3: MONITORING OF OPERATION OF UPGRADED SAN WAI SEWAGE TREATMENT WORKS

3.1 This PART examines DSD's work in monitoring the operation of the upgraded SWSTW, focusing on:

- (a) monitoring of contractor's performance (paras. 3.4 to 3.29); and
- (b) monitoring of operation and maintenance of facilities (paras. 3.30 to 3.38).

Sewage treatment process and operation of upgraded SWSTW

3.2 The sewage treatment process of the upgraded SWSTW comprises fine screening, grit removal (Note 29), CEPT (Note 30) and ultraviolet disinfection. After going through the treatment process, the effluent will be discharged via NWNT effluent tunnel and submarine outfall at Urmston Road near Tuen Mun into the northwestern waters where water is deep and current is strong to facilitate rapid dilution and dispersion of the effluent.

Note 29: *According to DSD, finer matters and grit particles in the sewage would be removed under fine screening and grit removal respectively.*

Note 30: *According to Contractor A, coagulant (i.e. ferric chloride) and flocculant (i.e. polymer) are added to facilitate the settlement of suspended solids.*

3.3 Under the Water Pollution Control Ordinance (Cap. 358), EPD has issued to DSD a licence for the discharge of effluent from the upgraded SWSTW (Note 31). According to Contract A, the objectives for the operation of the upgraded SWSTW include the following:

- (a) to achieve full compliance with the conditions (e.g. effluent quality) stipulated in the discharge licence issued by EPD; and
- (b) to operate and maintain the upgraded SWSTW to upkeep the facilities in the optimum conditions in order to maximise the service life of the facilities.

Monitoring of contractor's performance

3.4 According to Contract A, there is a set of 14 KPIs for measuring the performance of Contractor A in operating the upgraded SWSTW, as follows:

- (a) 8 KPIs on effluent quality requirements (i.e. concentration of total suspended solids (TSS), 5-day biochemical oxygen demand (BOD) (Note 32) and *Escherichia coli* (*E. coli*) — Note 33), which are related to the discharge standards stipulated in the discharge licence issued by EPD;

Note 31: *According to the Water Pollution Control Ordinance, in application of the Ordinance to the Government, if it appears to the Director of Environmental Protection that any discharge is being, or has been, made in contravention of the Ordinance by any person in the course of carrying out his duties in the service of the Government, the Director will report the matter to the Chief Secretary for Administration if the contravention is not forthwith terminated to the Director's satisfaction. On receipt of the Director of Environmental Protection's report, the Chief Secretary for Administration will inquire into the circumstances and, if the inquiry shows that a contravention is continuing or likely to recur, the Chief Secretary for Administration will ensure that the best practicable steps are taken to terminate the contravention or avoid the recurrence.*

Note 32: *5-day BOD is a measure of the amount of oxygen consumed by microorganisms in the process of decomposing organic matter in 5 days. A high value of the parameter indicates that a water body has been polluted by a large quantity of organic matter.*

Note 33: *Of the 8 KPIs, 3 KPIs are related to TSS, 3 KPIs are related to 5-day BOD and 2 KPIs are related to E. coli.*

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- (b) 2 KPIs on environmental monitoring (i.e. odour and unauthorised emergency bypass); and
- (c) 4 KPIs on contract administration and reporting (i.e. monthly reporting, data integrity, incident reporting and consistent minor breaches).

3.5 According to Contract A, the monthly payment to Contractor A for operation of the upgraded SWSTW consists of a fixed fee (which covers maintenance and operation of the facilities) and a variable fee (i.e. depending on the actual volume of treated effluent). The monthly operation payment to Contractor A is adjusted to reflect the level of performance achieved, which is assessed by calculating the total demerit points based on monitoring results on KPIs in the same reporting month (from the 27th of a month to the 26th of the next month). Demerit points are assigned to non-compliances with KPIs identified in each reporting month and the number of demerit points assigned to each KPI is capped in each reporting month.

3.6 According to Contract A, in case of continued failure to meet KPIs and/or comply with the requirements of the contract, the Supervising Officer will inform Contractor A in writing and Contractor A should take immediate actions to rectify the non-compliances. According to DSD, the Supervising Officer evaluates the performance of Contractor A and reflects the results in the quarterly performance reports of Contractor A. Besides, the Supervising Officer's staff conduct site inspections at the upgraded SWSTW on a regular basis.

Non-compliances with some KPIs

3.7 Since the commissioning of the upgraded SWSTW in March 2021 and up to October 2023, DSD had deducted a total of \$78,822 from operation payments to Contractor A (see Table 3) on 11 non-compliances involving 3 KPIs related to contract administration and reporting, as follows:

- (a) ***Monthly reporting.*** According to Contract A, demerit points will be assigned to Contractor A for delay in submitting monthly reports (Note 34)

Note 34: *According to Contract A, monthly reports include operation report, and environmental monitoring and audit report.*

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more than 10 days (or 15 days since October 2021 — Note 35) after the end of the reporting month. Audit noted that, from March 2021 to October 2023, there were 5 non-compliances involving late submission of monthly reports by Contractor A, ranging from 1 to 62 days, resulting in a total payment deduction of \$34,012;

- (b) ***Consistent minor breaches.*** According to Contract A, Contractor A is required to comply with the general requirements stipulated in the contract (e.g. site cleanliness, provision of safety measures during works, and equipment availability and serviceability). The Supervising Officer will issue an under-performance notice (UPN — which is only applicable to the KPI on consistent minor breaches) if Contractor A fails to comply with any of the general obligations under the contract (i.e. under-performance events). Demerit points will be assigned to Contractor A in accordance with the number of under-performance points assigned (i.e. based on UPNs affirmed) in a reporting month (Note 36). Audit noted that, from March 2021 to October 2023, 23 UPNs had been issued to Contractor A (Note 37), resulting in a total payment deduction of \$27,889; and
- (c) ***Data integrity.*** According to Contract A, demerit points will be assigned to Contractor A for material inconsistencies (Note 38) in the data reported associated with the data supporting KPIs. Audit noted that, from

Note 35: *According to DSD, in October 2021, it was approved by Consultant X (with the consent of DSD) that the monthly reporting deadline has been changed from 10 to 15 days after the end of the reporting month.*

Note 36: *According to Contract A, for a non-repeated under-performance event (i.e. a single incident), each UPN will count as 20 under-performance points. For a repeated under-performance event (i.e. a repeated failure to comply with the same obligation within a rolling two-month period), each UPN will count as 40 under-performance points. Demerit points will be assigned to Contractor A (i.e. will result in payment deduction) if under-performance points reach 61 or above in a reporting month.*

Note 37: *According to DSD, of the 23 UPNs issued to Contractor A, a UPN issued in June 2022 was subsequently rescinded in July 2022 and 2 UPNs issued in May and October 2023 were subsequently affirmed in January 2024.*

Note 38: *According to Contract A, material inconsistency refers to: (a) a gross error in a reported result for a parameter set out in the discharge licence; (b) reporting a result referred to in the discharge licence where the work, measurement or sample was not done or taken; or (c) a materially false entry.*

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March 2021 to October 2023, there were 14 material inconsistencies identified in the monthly operation reports (including the number and results of the influent and effluent samples taken by Contractor A), resulting in a total payment deduction of \$16,921.

According to DSD, the above 11 non-compliances involved 3 KPIs related to contract administration and reporting, which did not result in non-compliance with any KPIs on monitoring of effluent quality.

Table 3

Non-compliances with KPIs resulting in payment deduction (March 2021 to October 2023)

No.	KPI	Month of non-compliance	Payment deducted (\$)
1	Monthly reporting	April 2021	4,183
		May 2021	7,478
		June 2021	7,688
		July 2021	7,662
		September 2021	7,001
			34,012 (43%)
2	Consistent minor breaches	August 2021	7,763
		November 2021	6,623
		May 2022	6,689
		June 2022	6,814
			27,889 (35%)
3	Data integrity	April 2021	12,548
		April 2022	4,373
			16,921 (22%)
Total			78,822 (100%)

Source: DSD records

3.8 In Audit's view, the payment deductions relating to non-compliances with three KPIs related to contract administration and reporting on various occasions (see para. 3.7) indicate scope for improvement in Contractor A's performance. DSD needs to continue to closely monitor the performance of the contractor in operating the upgraded SWSTW (including compliances with KPIs).

Inconsistent contract provisions related to demerit point mechanism

3.9 Audit noted that there were inconsistencies between provisions of Contract A related to the demerit point mechanism, as follows:

- (a) while a contract provision provides that, of the total number of 10,000 demerit points allocated to all 14 KPIs, the total maximum number of demerit points attributable to the non-compliances with KPIs identified for each reporting month is 5,000 points (i.e. 50% of the monthly operation payment would be subject to service level adjustment), another contract provision specifies that the maximum number of demerit points for calculating the monthly operation payment adjustment is 4,000 points (i.e. a maximum adjustment of 40% of the monthly operation payment); and
- (b) while a contract provision provides that Contractor A should submit monthly operation reports within 7 days after the end of the reporting month, another contract provision specifies that demerit points would be assigned to Contractor A for delay in submitting monthly reports more than 10 days (or 15 days since October 2021 — see Note 35 to para. 3.7(a)) after the end of the reporting month (i.e. resulting in monthly operation payment adjustment).

3.10 In March 2024, DSD informed Audit that:

- (a) it was the practice of DSD that only a maximum of 4,000 demerit points would be counted for adjusting the monthly operation payment (i.e. capped at 40%);
- (b) notwithstanding that late submission of monthly reports on 8 to 10 days (or 15 days since October 2021) after the end of the reporting month would not give rise to demerit points, it would be taken into account in drafting the contractor's performance reports on a case-by-case basis; and
- (c) notwithstanding that the contract provisions related to the demerit point mechanism of the upgraded SWSTW might give rise to inconsistent interpretation, the relevant contract provisions had so far been operable.

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3.11 In Audit's view, DSD needs to review the contract provisions related to the demerit point mechanism of the upgraded SWSTW contract and take measures to address the matter.

Need to timely issue/affirm UPNs for all under-performance events

3.12 According to Contract A, in case an under-performance event is identified, a UPN is issued to Contractor A (see para. 3.7(b)). Contractor A should immediately investigate the matter and take relevant improvement actions to prevent recurrence of the event (Note 39). In case Contractor A does not agree that the under-performance event described in the UPN has arisen, it should provide detailed justification regarding the disagreement within one week of receipt of the UPN. The Supervising Officer should either affirm or rescind the UPN within one week upon receipt of Contractor A's report.

3.13 *UPNs not issued for some under-performance events.* Audit noted that, as of January 2024, UPNs had not been issued to Contractor A for some under-performance events happened between March 2021 and October 2023, as follows:

- (a) 1 case with improper procedures in cleaning the automatic sampler components by Contractor A in April 2021 (see para. 3.18(b)(i));
- (b) 1 case with incorrect setting of the wiper system of the ultraviolet disinfection system by Contractor A in July 2021 (Note 40);
- (c) 6 cases happened in June and July 2021, January 2022 and January 2023 with TSS concentration in centrate not meeting the requirement stipulated in Contract A (see Note 54 to para. 3.22(a)); and

Note 39: *According to Contract A, Contractor A should rectify and take improvement actions within two weeks of the issue of the UPN or within a reasonable time agreed with the Supervising Officer.*

Note 40: *Audit noted that a similar incident happened in September 2023. In the event, a UPN was issued to Contractor A in October 2023 and affirmed (accounted for 20 under-performance points) by the Supervising Officer in January 2024 (see Note 43 to para. 3.15(b)).*

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- (d) 8 (i.e. 4 grits and 4 screenings) cases happened in March to June, August and September 2021 with the monthly average dry solid content (i.e. grits or screenings) not meeting the requirement stipulated in Contract A (see Note 57 to para. 3.22(b)).

3.14 In response to Audit's enquiry about the 16 under-performance events identified by Audit as mentioned in paragraph 3.13 (i.e. 1 + 1 + 6 + 8), DSD informed Audit in March 2024 that:

- (a) UPNs were issued to Contractor A for all these 16 under-performance events in February 2024. The issue of UPNs would result in assignment of additional demerit points to Contractor A for the related reporting months and potential deduction of \$93,637 from the operation payments made to Contractor A (Note 41) (i.e. about 0.06% of the total operation payment to Contractor A since commissioning of the upgraded SWSTW); and
- (b) despite the above under-performance events, the effluent quality had all along been in compliance with the contract requirements and the discharge licence since the commissioning of the upgraded SWSTW in March 2021.

Note 41: *The additional demerit points would lead to potential deduction of operation payments for 5 reporting months (i.e. ended April, May and July to September 2021), ranging from some \$7,000 to \$51,000 for each reporting month.*

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3.15 *Late issuing/affirming of UPNs for some under-performance events.* For under-performance events happened between March 2021 and October 2023, Audit noted that:

- (a) there were late issuing of 2 UPNs by the Supervising Officer for 2 under-performance events happened in April and August 2023 (being 8.7 and 5.5 months after their respective happening days) (Note 42); and
- (b) there were late affirming of 2 UPNs (issued in May and October 2023) by the Supervising Officer (with delay of 7.5 and 1.6 months respectively) (Note 43).

Audit noted that for all under-performance events related to the KPI on consistent minor breaches involving operation payment deduction (see para. 3.7(b)), operation payments were deducted in the reporting months that the under-performance events happened. For the above 4 cases with late issuing/affirming of UPNs, while the assignment of demerit points and adjustment of operation payments to Contractor A of 2 UPNs were made in the reporting month in which the under-performance events happened (i.e. followed DSD's practice), the assignment of demerit points and adjustment of operation payments to Contractor A of the other 2 UPNs were made in the month of issuing/affirming the UPNs.

Note 42: *The two under-performance events were, as follows: (a) 1 case in April 2023 related to contamination of automatic sampler components and a UPN was issued to Contractor A in December 2023 (see Note 48 to para. 3.18(b)(ii)); and (b) 1 case in August 2023 related to delay in submission of operation plan for the third year of operation and a UPN was issued to Contractor A in January 2024 (see Note 60 to para. 3.26(a)).*

Note 43: *The late affirming of 2 UPNs (counting from 1 week after receiving Contractor A's report on disagreement with UPNs — see para. 3.12) related to the following under-performance events: (a) 1 case in April 2023 related to contamination of sampling tools and a UPN was issued to Contractor A in May 2023. Disagreement was raised by Contractor A in May 2023 and the UPN was affirmed by the Supervising Officer in January 2024 (i.e. 7.5-month delay) (see Note 49 to para. 3.18(c)); and (b) 1 case in September 2023 related to incorrect setting of the wiper system of the ultraviolet disinfection system by Contractor A and a UPN was issued to Contractor A in October 2023. Disagreement was raised by Contractor A in November 2023 and the UPN was affirmed by the Supervising Officer in January 2024 (i.e. 1.6-month delay).*

- 3.16 In Audit's view, DSD needs to:
- (a) regarding the 16 under-performance events with UPNs issued to Contractor A in February 2024 (see paras. 3.13 and 3.14), take prompt actions to adjust the operation payments to Contractor A;
 - (b) strengthen measures to ensure the timely issuing/affirming of UPNs for all under-performance events and adjustment of operation payments to Contractor A as needed; and
 - (c) regarding the cases identified by Audit with demerit points assigned and operation payments to Contractor A adjusted in the reporting months of issuing/affirming UPNs (see para. 3.15), adjust the assignment of demerit points and operation payments as needed in the reporting months when the under-performance events happened.

Contamination of effluent samples

3.17 According to Contract A, the sampling and testing of effluent samples collected (i.e. including the concentration of TSS, 5-day BOD and *E. coli* — see para. 3.4(a)) would be conducted by an independent accredited laboratory (Note 44) employed by Contractor A in accordance with the sampling frequencies specified in the contract (Note 45).

Note 44: *According to Contract A, the Supervising Officer should have the right to: (a) take additional samples for independent testing by its staff; or (b) instruct that additional sampling and testing to be carried out by a second independent accredited laboratory to be appointed by Contractor A.*

Note 45: *According to Contract A: (a) for TSS and 5-day BOD, 24-hour composite samples (i.e. samples collected with the use of automatic samplers throughout 24 hours in order to obtain an average daily value) would be collected by the accredited laboratory at a frequency of three times per week; and (b) for *E. coli*, grab samples (i.e. samples collected at a particular time and location) would be collected by the accredited laboratory on a daily basis.*

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3.18 According to Consultant X and Contractor A, from March 2021 to October 2023, abnormally high 5-day BOD concentration was found in the effluent samples collected at the upgraded SWSTW in some occasions, as follows:

- (a) ***Contamination of sampling bottles.*** In August 2021, due to contamination of the sampling bottles used by the accredited laboratory, the effluent samples collected in three days of August 2021 (i.e. 5, 12 and 17 August) for testing 5-day BOD were contaminated. To prevent recurrence of the incident, follow-up actions had been implemented, including establishing an additional bottle cleaning procedure with the accredited laboratory to prevent contamination and closely monitoring the sampling activities and effluent test results by the Supervising Officer (Note 46);

- (b) ***Contamination of automatic sampler components.*** There were two occasions involving contamination of automatic sampler components, as follows:
 - (i) in April 2021, due to the improper procedures of Contractor A in cleaning the automatic sampler components by using household bleach, bleaching action increased the bioactivity of the samples. The effluent samples collected on 1 April 2021 for testing 5-day BOD were thus contaminated. To prevent recurrence of the incident, follow-up actions had been implemented, including using potable water to clean the automatic sampler components (Note 47); and

 - (ii) in April 2023, due to contamination of the stainless steel guide for the automatic sampler (i.e. accumulation of biofilm with high concentration of organic matter), the effluent samples collected on 6 April 2023 for testing 5-day BOD were contaminated. To prevent recurrence of the incident, follow-up actions had been implemented, including using water jet to flush the guide by the staff of

Note 46: *According to DSD, as the incidents were regarded as under-performance events (see para. 3.7(b)), three UPNs, which accounted for a total of 100 under-performance points, had been issued to Contractor A.*

Note 47: *According to DSD, as of January 2024, UPN had not been issued for the incident.*

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Contractor A every day to prevent biofilm accumulation (Note 48);
and

- (c) ***Contamination of sampling tools.*** In April 2023, due to inappropriate cleaning practice in handling the mixing bucket used for collecting composite samples by the on-site sampling technician of the accredited laboratory, the effluent samples collected on 18 April 2023 for testing 5-day BOD were contaminated. To prevent recurrence of the incident, follow-up actions had been implemented by the accredited laboratory, including provision of refreshment training to sampling technicians, issuing a revised and clear sampling procedure focusing on the cleaning of sampling tools and using new mixing bucket exclusively for effluent samples to prevent contamination (Note 49).

3.19 In Audit's view, DSD needs to keep under review the effectiveness of the new measures for collecting and handling effluent samples at the upgraded SWSTW and devise further measures as needed for avoiding contamination of effluent samples.

Need to ensure compliance with the contract requirements relating to solid handling and dewatering process

3.20 According to Consultant X and Contractor A:

- (a) grit slurry settled from the grit removal process and screenings collected from the fine screening process are conveyed to the solids handling building for dewatering before disposal; and

Note 48: *According to DSD, as the incident was regarded as an under-performance event (see para. 3.7(b)), a UPN (accounted for 20 under-performance points) was issued to Contractor A by the Supervising Officer in December 2023 and affirmed by the Supervising Officer in January 2024.*

Note 49: *According to DSD, as the incident was regarded as an under-performance event (see para. 3.7(b)), a UPN (accounted for 40 under-performance points) was issued to Contractor A by the Supervising Officer in May 2023 and affirmed by the Supervising Officer in January 2024.*

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- (b) primary sludge generated from the CEPT process is dewatered into sludge cake in the centrifuges (Note 50) at the sludge dewatering building before disposal. Centrate generated from the sludge dewatering process is collected and conveyed to the inlet of the preliminary treatment works for treatment.

All solids arising from the dewatering process (including grits, screenings and primary sludge) is then disposed of at the sludge treatment facilities in Tuen Mun or other designated disposal areas (e.g. the West New Territories Landfill).

3.21 According to Contract A:

- (a) centrate generated from the sludge dewatering process should have a maximum TSS concentration of 1,000 milligrams per litre (mg/l) (Note 51); and
- (b) all solids arising from the dewatering process (including grits, screenings and primary sludge) should achieve a minimum of 32% dry solid content and an average of 34% dry solid content before disposal (Note 52).

3.22 Audit noted that, according to the test results from the accredited laboratory for the period from March 2021 to October 2023 (Note 53):

Note 50: *According to Consultant X, there are 3 centrifuges (2 duty and 1 standby) in the sludge dewatering building for dewatering wet sludge into sludge cake. Polymer is used as flocculant to assist the sludge dewatering process.*

Note 51: *According to Contract A, 24-hour composite centrate samples should be collected for TSS concentration testing at a frequency of three times per week.*

Note 52: *According to Contract A, for each type of solid waste to be deposited of, one skip load will be sampled daily for the measurement of the dry solid content. The average dry solid content is computed on a monthly basis.*

Note 53: *According to Contractor A, laboratory test results for TSS concentration in centrate were not reported to DSD from 6 March to 26 June 2021.*

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- (a) there were 10 cases with TSS concentration in centrate not meeting the requirement stipulated in Contract A (i.e. maximum of 1,000 mg/l), ranging from 1,013 to 1,453 mg/l. According to DSD, the reasons for these 10 non-compliance cases (Note 54) were as follows:
- (i) for 1 case in January 2022 (see Note 54) and 2 cases in May 2022 (Note 55), inadequate polymer concentration for centrifuge sludge treatment was noted, leading to deterioration of centrate quality;
 - (ii) for 1 case in September 2021 (see Note 54) and 1 case in August 2022 (Note 56), there were failures in the centrate automatic sampler; and
 - (iii) for the remaining 5 cases in June 2021, July 2021 and January 2023 (see Note 54), they were related to the blockage of sampling hose for centrate automatic sampler; and
- (b) there were 9 (i.e. 4 grits and 5 screenings) cases with the monthly average dry solid content not meeting the requirement stipulated in Contract A (i.e. 34% dryness), ranging from 33% to 33.5% (Note 57). According to DSD, the reasons for these 9 non-compliance cases were due to improper operation setting of the screw compactor for screening and timer setting of the screw conveyor for grit handling in the initial operation stage.

Note 54: *According to DSD, as of January 2024, of the 10 non-compliance cases: (a) UPNs had not been issued for 6 cases happened in June and July 2021, January 2022 and January 2023; and (b) for 1 case in September 2021, it involved the trial use of sampling method as instructed by Consultant X and thus not regarded as an under-performance event with no UPN issued to Contractor A.*

Note 55: *According to DSD, for the 2 cases in May 2022, two UPNs, which accounted for a total of 60 under-performance points, had been issued to Contractor A.*

Note 56: *According to DSD, for the case in August 2022, a UPN, which accounted for 20 under-performance points, had been issued to Contractor A.*

Note 57: *According to DSD, for a screenings case in October 2021, a UPN, which accounted for 20 under-performance points, had been issued to Contractor A. However, as of January 2024, UPNs had not been issued for 8 other cases (i.e. 4 grits and 4 screenings cases) happened in March to June, August and September 2021.*

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3.23 In March 2024, DSD informed Audit that:

- (a) regarding the cases with TSS concentration in centrate not meeting the requirement stipulated in Contract A, enhanced measures had been implemented by Contractor A, including optimisation of the dosing setting of polymer dosing pump and increasing the inspection and cleansing frequency for the centrate automatic sampler and sampling hose. There had been no similar case since January 2023 after the implementation of the enhanced measures; and
- (b) regarding the cases with the monthly average dry solid content not meeting the requirement stipulated in Contract A, enhanced measures had been implemented by Contractor A, including optimisation of the operation setting of the screw compactor for screening and the timer setting of the screw conveyor for grit handling. There had been no similar case since October 2021 after the implementation of the enhanced measures.

3.24 In Audit's view, DSD needs to keep under review the effectiveness of the enhanced measures relating to solid handling and dewatering process at the upgraded SWSTW with a view to ensuring compliance with contract requirements.

Need to ensure the timely submission of reporting materials containing the required information

3.25 According to Contract A, Contractor A is required to submit to the Supervising Officer reporting materials containing the required information, as follows:

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- (a) an updated operation plan (Note 58) of the upgraded SWSTW on an annual basis (Note 59). It should be submitted in early August every year; and
- (b) monthly operation reports with information including the quality of grits, screenings and sludge disposed of, safety records, records of non-compliance or under-performance events, records of maintenance and overhauling works carried out.

3.26 For the operation plans/reports relating to the period from March 2021 to October 2023, Audit noted that:

- (a) ***Delay in submission of operation plans.*** The operation plans for the second year (i.e. March 2022 to March 2023) and third year (i.e. March 2023 to March 2024) of operation were submitted late by Contractor A, with delays of 27 and 165 days respectively (Note 60); and
- (b) ***Omission in monthly operation reports.*** Some cases with non-compliance with contract requirements were omitted in the monthly operation reports by Contractor A, as follows:
 - (i) of the 10 cases with TSS concentration in centrate not meeting the requirement stipulated in Contract A (see para. 3.22(a)), only

Note 58: *According to Contract A, the annual operation plan should set out the policies and procedures for the systematic management approach to occupational health and safety, rehabilitation, environmental protections, operation and maintenance activities associated with the operation of the upgraded SWSTW.*

Note 59: *According to Contract A, the initial operation plan should be submitted by Contractor A at least 270 days before the anticipated commencement of the commissioning tests. According to Contract A and DSD, the plan should be updated on an annual basis thereafter and submitted in early August every year.*

Note 60: *According to DSD, a UPN, which accounted for 20 under-performance points, was issued to Contractor A in January 2024 for the delay in submission of operation plan for the third year of operation. However, according to DSD, as the delay in submission of operation plan for the second year of operation was not material and not regarded as an under-performance event, UPN would not be issued to Contractor A in this regard.*

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9 cases were reported in the monthly operation reports (i.e. 1 case was omitted); and

- (ii) of the 9 (i.e. 4 grits and 5 screenings) cases with the monthly average dry solid content not meeting the requirement stipulated in Contract A (see para. 3.22(b)), only 4 (i.e. 2 grits and 2 screenings) cases were reported in the monthly operation reports (i.e. 5 (2 grits and 3 screenings) cases were omitted).

3.27 In Audit's view, DSD needs to strengthen measures to ensure the timely submission of reporting materials containing all required information (e.g. non-compliances with contract requirements) by the contractor of the upgraded SWSTW.

Audit recommendations

3.28 **Audit has recommended that the Director of Drainage Services should:**

- (a) **continue to closely monitor the performance of the contractor in operating the upgraded SWSTW (including compliances with KPIs);**
- (b) **review the contract provisions related to the demerit point mechanism of the upgraded SWSTW contract and take measures to address the matter;**
- (c) **regarding the 16 under-performance events with UPNs issued to Contractor A in February 2024, take prompt actions to adjust the operation payments to Contractor A;**
- (d) **strengthen measures to ensure the timely issuing/affirming of UPNs for all under-performance events and adjustment of operation payments to Contractor A as needed;**
- (e) **regarding the cases identified by Audit with demerit points assigned and operation payments to Contractor A adjusted in the reporting months of issuing/affirming UPNs, adjust the assignment of demerit**

points and operation payments as needed in the reporting months when the under-performance events happened;

- (f) keep under review the effectiveness of the new measures for collecting and handling effluent samples at the upgraded SWSTW and devise further measures as needed for avoiding contamination of effluent samples;**
- (g) keep under review the effectiveness of the enhanced measures relating to solid handling and dewatering process at the upgraded SWSTW with a view to ensuring compliance with contract requirements; and**
- (h) strengthen measures to ensure the timely submission of reporting materials containing all required information (e.g. non-compliances with contract requirements) by the contractor of the upgraded SWSTW.**

Response from the Government

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

Monitoring of operation and maintenance of facilities

Some equipment required frequent corrective maintenance

3.30 According to Contract A:

- (a) Contractor A should uphold the conditions of facilities of the upgraded SWSTW and carry out routine inspection and maintenance (i.e. preventive maintenance) for the facilities to avoid inducing undue wear and tear to the equipment; and**
- (b) upon identification of any defect, Contractor A should carry out corrective maintenance to rectify and make good the defect without undue delay or imposing unacceptable hazard to the operators, workers, staff or visitors at the upgraded SWSTW.**

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3.31 According to DSD, there were 7,059 preventive maintenance tasks (involving 840 equipment items) and 1,475 corrective maintenance tasks (involving 479 equipment items) carried out between March 2021 and October 2023. Audit noted that, of the 479 equipment items with corrective maintenance works carried out, 14 items (i.e. 3% of 479) (with more than 10 corrective maintenance tasks recorded for each item) constituted a total of 236 corrective maintenance tasks (i.e. 16% of 1,475 corrective maintenance tasks). In particular, 34 and 17 corrective maintenance tasks had been carried out for 2 horizontal centrifugal pumps (Note 61), and 17 to 20 corrective maintenance tasks had been carried out for 3 centrifuges (see Note 50 to para. 3.20(b)).

3.32 In March 2024, DSD informed Audit that:

- (a) regarding the 2 horizontal centrifugal pumps, all corrective maintenance tasks were carried out in 2021 and 2022, and were mainly due to malfunction of the sensors of the pumps. The plant performance was not affected; and
- (b) regarding the 3 centrifuges, most of the corrective maintenance tasks were related to minor incidents (including fault of sensors, motor noise, fan malfunction and loosen inspection door) and had been rectified by Contractor A within 1 to 2 days. The plant performance was not affected.

3.33 In Audit's view, DSD needs to keep under review the conditions of equipment at the upgraded SWSTW, particularly those equipment with frequent corrective maintenance, with a view to ensuring the smooth operation of the sewage treatment process.

Scope for making better use of Computerised Maintenance Management System for monitoring maintenance works of facilities

3.34 According to Contract A:

Note 61: *According to Consultant X, there are 4 horizontal centrifugal pumps (i.e. 2 duty and 2 standby inlet pumps) for lifting water from the ultraviolet disinfection system to the re-use water system.*

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- (a) in order to maximise the service life of the facilities, it is necessary to devise a comprehensive inspection and maintenance schedule over the life of the asset. Contractor A should carry out routine inspection and maintenance (i.e. preventive maintenance) for the facilities (see para. 3.30(a)) according to the frequencies (ranging from daily to annually) specified in the inspection and maintenance schedule as a minimum; and
- (b) the Computerised Maintenance Management System (CMM System) maintains the inspection and maintenance schedule and maintenance records of the facilities at the upgraded SWSTW. It should keep track of the status of works orders, trigger preventive maintenance works orders based on the defined frequency criterion, collect statistics in the database for analytical use and be able to produce management reports.

3.35 Audit noted that, as of January 2024:

- (a) there was no readily available information from CMM System showing whether the works orders had been completed as scheduled (i.e. the planned/actual start/completion dates of the maintenance works); and
- (b) some management reports could not be generated from CMM System for monitoring purpose. For example, management information on whether preventive maintenance works had been performed in accordance with the frequencies specified in the inspection and maintenance schedule.

3.36 In Audit's view, DSD needs to make better use of CMM System for monitoring maintenance works of facilities at the upgraded SWSTW (e.g. generating related management reports regularly).

Audit recommendations

3.37 **Audit has *recommended* that the Director of Drainage Services should:**

- (a) **keep under review the conditions of equipment at the upgraded SWSTW, particularly those equipment with frequent corrective**

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maintenance, with a view to ensuring the smooth operation of the sewage treatment process; and

- (b) make better use of CMM System for monitoring maintenance works of facilities at the upgraded SWSTW (e.g. generating related management reports regularly).**

Response from the Government

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

PART 4: OTHER RELATED ISSUES

4.1 This PART examines other issues related to the upgrading and operation of SWSTW, focusing on:

- (a) work safety (paras. 4.2 to 4.14); and
- (b) other project management issues (paras. 4.15 to 4.28).

Work safety

4.2 According to Contract A, Contractor A should:

- (a) throughout the progress of the works (including the design, construction works and operation), take full responsibility for the adequate stability and safety of all works and services connected with the execution of works on the site, and have full regard for the safety and health of all persons on or in the vicinity of the site; and
- (b) keep the site and the works in an orderly state appropriate to the avoidance of danger to all persons.

4.3 According to the Construction Site Safety Manual issued by the Development Bureau (DEVB), contractors are required to:

- (a) verbally report dangerous occurrences and accidents involving death, serious injury, serious damage or with worker admitted to the hospital to the Engineer's site staff immediately, followed by preliminary accident report within 24 hours; and
- (b) promptly report all reportable accidents (i.e. accident resulting in death, serious injury and injury with incapacity for more than 3 days) to the Engineer's Representative. The contractor shall complete an injury report form within 7 days from the date of an accident.

Other related issues

4.4 Furthermore, according to DEVB Technical Circular (Works) No. 1/2020 and its superseded version No. 26/2000 “Score Card for Assessment of Site Safety Performance”, Score Card system (being a quantitative tool to assess the safety performance of contractors in a consistent approach) was implemented for assessing the contractor’s site safety performance (including the timeliness in reporting accidents at construction sites) in quarterly performance reports for public works contracts.

Scope for enhancing construction site safety

4.5 *Non-fatal reportable accidents.* According to DSD, during the design and construction phase from May 2016 to March 2021, 5 non-fatal reportable accidents (i.e. accident resulting in an injury with incapacity for more than 3 days) happened at the construction site of Contract A between September 2017 and October 2020, involving sick leave ranging from 123 to 607 days. Regarding the reporting of these reportable accidents by Contractor A (Note 62), according to DSD, there were:

- (a) late reporting of 3 reportable accidents by Contractor A to Consultant X (all involving workers admitted to the hospital), with delay of 1, 2 and 112 days respectively (see para. 4.3(a));
- (b) late submission of preliminary accident reports by Contractor A to Consultant X for 2 reportable accidents, with delay of 1 and 111 days respectively (see para. 4.3(a)); and
- (c) late submission of injury report forms by Contractor A to Consultant X for 3 reportable accidents, with delay of 1, 5 and 105 days respectively (see para. 4.3(b)).

Note 62: *According to DSD, the follow-up actions on these reportable accidents included taking improvement measures to enhance site safety and/or giving poor ratings to site accident record aspects in Contractor A’s performance reports for the related periods.*

4.6 ***Other incidents related to construction site safety.*** Apart from the accidents mentioned in paragraph 4.5, Audit noted that the following incidents related to site safety happened at the construction site of Contract A during the testing and commissioning stage (Note 63):

- (a) ***Sudden discharge of water into foulwater drainage system during testing and commissioning stage.*** Sudden discharge of water (during testing and commissioning) into the site-wide foulwater drainage system occurred twice, as follows:
- (i) on 15 August 2020, it was found that water was unexpectedly flowing into an ultraviolet disinfection channel while workers were inside the channel. The workers managed to vacate from the channel immediately; and
 - (ii) a similar incident recurred 3 days later (i.e. on 18 August 2020) in which water was unexpectedly flowing into another ultraviolet disinfection channel while workers were inside the channel. No one was injured as the inflow was immediately stopped by closing the drainage valves.

According to Consultant X, the occurrence and recurrence of such incidents were totally unacceptable and the consequences could be very serious. A warning letter was issued by Consultant X to Contractor A in respect of unsafe work environment caused by the instances of sudden discharge of water; and

- (b) ***Leakage of hazardous gas.*** Leakage of hydrogen sulphide (one of the most common hazardous gases found in drainage worksites) occurred 2 times in the centrifuge area inside the sludge dewatering building of the upgraded SWSTW, as follows:
- (i) on 24 August 2020, Consultant X's inspection team reported that a strong odour was smelt at the building. The hydrogen sulphide level

Note 63: *According to DSD, poor ratings were given to related aspects under site safety in Contractor A's performance report for the related period.*

Other related issues

exceeded the first alarm level (1 parts per million (ppm) — Note 64) of the hazardous gas detection alarm system. However, no alarm was triggered to alert the workers in the area; and

- (ii) on 27 August 2020 (i.e. 3 days after the above leakage), Consultant X's inspection team reported that a very strong odour was smelt at the building. The hydrogen sulphide level was up to dangerous level (11.6 ppm) without any alarm or signal to alert the workers.

According to Contractor A, the reason why no alarm was triggered in both occasions was because the gas detection alarm system was still undergoing testing during that period and it was only completed on 2 September 2020. A warning letter was issued by Consultant X to Contractor A in respect of instances of leakage of hydrogen sulphide.

4.7 In Audit's view, in implementing works projects, DSD needs to:

- (a) make continued efforts to enhance construction site safety with a view to safeguarding safety of all operations and all persons on sites; and
- (b) take measures to ensure that its contractors timely report all accidents (including submission of related reports) at construction sites in accordance with related requirements.

Scope for enhancing storage and handling of ferric chloride solution

4.8 According to Contract A, Contractor A is required to:

Note 64: *Hydrogen sulphide is a deadly gas with a distinctive "rotten egg" odour that can be detected at very low concentrations. At concentrations above 100 ppm, hydrogen sulphide has a paralysing effect on the sense of smell. Even at lower concentrations, hydrogen sulphide can affect the olfactory nerve and workers cannot detect the changes in concentrations. An airborne concentration of hydrogen sulphide above 100 ppm is immediately dangerous to life or health and concentrations over 1,000 ppm could cause immediate collapse.*

- (a) ensure that all operations should be conducted in compliance with the provisions of relevant statutory requirements (Note 65), contract provisions and its safety plan (Note 66) for the operation with a view to eliminating the risks to persons, property and equipment; and
- (b) obtain all the required approvals from the relevant authorities, including the Fire Services Department (FSD) for all fire safety and fire services aspects at the upgraded SWSTW (e.g. the approvals for all dangerous goods stores).

4.9 According to DSD, ferric chloride solution is used as a coagulant to facilitate the settlement of suspended solids in the CEPT process. Ferric chloride solution is delivered and stored in four coagulant storage tanks with shelter and dosed to the CEPT coagulation tank by coagulant dosing pumps at the upgraded SWSTW.

4.10 To align the regulatory system for dangerous goods with international standards and to enhance the safety of the manufacture, conveyance, storage and use of dangerous goods, the Dangerous Goods Ordinance (Cap. 295) and its subsidiary legislation have been amended and came into effect on 31 March 2022 with a grace period of 24 months (i.e. up to 30 March 2024) for the trades and the public to adapt to the new legislation. Under the new legislation, among others, ferric chloride solution (not classified as dangerous goods before the enactment of the new legislation) has been classified as Class 8 dangerous goods (Note 67) and approvals for the storage and use of ferric chloride solution are required to be obtained from FSD.

Note 65: *According to Contract A, Contractor A should conform with any additions, amendments or new enactment, regulations, bye-laws or rules made during the contractual period. It should also be responsible for any penalties, fines and liabilities for every kind of breach of such enactment, regulations, bye-laws or rules.*

Note 66: *According to Contract A, the safety plan should set out details of the safety management system that Contractor A has implemented at the upgraded SWSTW with details such as safety policy, safety rules and regulations, job hazard analysis, personal protective equipment, accident/incident investigation, etc.*

Note 67: *According to FSD, Class 8 dangerous goods refers to corrosive substances which, by chemical action, will cause irreversible damage to the skin, or, in the case of leakage, will materially damage, or even destroy other goods.*

Other related issues

4.11 Audit noted that:

- (a) ***Improper storage and handling of ferric chloride solution.*** From March 2021 to October 2023, there were 9 instances of ferric chloride solution leakage found in the coagulant storage tanks and dosing pumps. Besides, in May 2021, a worker suffered from minor eye injury caused by splashing of ferric chloride solution during regular maintenance of ferric chloride pipework in the chemical building (Note 68). To prevent recurrence of the incidents, follow-up actions had been implemented, including placing of drip tray and tightening the joints of valves, installing drain cover to prevent splashing, mandating additional personal protective equipment requirements for similar works and providing training to operators; and
- (b) ***Approvals for storage and use of ferric chloride solution not yet obtained.*** While the grace period for the adoption of new legislation in relation to dangerous goods was up to 30 March 2024 (see para. 4.10), as of January 2024, the application for the storage and use of ferric chloride solution at the upgraded SWSTW had yet to be submitted to FSD. In January 2024, DSD issued a letter to Contractor A and stating that:
- (i) it was the obligation of Contractor A to submit, on behalf of DSD, the documentation required for the approvals for the storage and use of ferric chloride solution granted under the Dangerous Goods Ordinance, irrespective of whether an instruction had been given by the Supervising Officer (i.e. DSD); and
- (ii) with a view to better monitoring the progress of implementing measures in meeting the statutory requirements before the expiry of the grace period, Contractor A was required to meet various milestones, including submission of siting plan of dangerous goods store and formal application to FSD for the approvals for the storage and use of dangerous goods, consultation with FSD for applicable transitional arrangement and submission of outlined plan to DSD.

Note 68: *According to Contractor A, it is a non-reportable accident as the injured worker was entitled to 2-day sick leave only.*

- 4.12 In Audit's view, DSD needs to take measures to:
- (a) enhance the occupational safety in the storage and handling of dangerous goods (e.g. ferric chloride solution) by the contractor at the upgraded SWSTW; and
 - (b) ensure that the relevant approvals for the storage and use of dangerous goods (particularly ferric chloride solution) at the upgraded SWSTW are timely obtained from the relevant authorities.

Audit recommendations

- 4.13 **Audit has *recommended* that the Director of Drainage Services should:**
- (a) **in implementing works projects:**
 - (i) **make continued efforts to enhance construction site safety with a view to safeguarding safety of all operations and all persons on sites; and**
 - (ii) **take measures to ensure that DSD contractors timely report all accidents (including submission of related reports) at construction sites in accordance with related requirements; and**
 - (b) **take measures to:**
 - (i) **enhance the occupational safety in the storage and handling of dangerous goods (e.g. ferric chloride solution) by the contractor at the upgraded SWSTW; and**
 - (ii) **ensure that the relevant approvals for the storage and use of dangerous goods (particularly ferric chloride solution) at the upgraded SWSTW are timely obtained from the relevant authorities.**

Response from the Government

4.14 The Director of Drainage Services agrees with the audit recommendations. He has said that DSD submitted to FSD the application for the approvals for the storage and use of dangerous goods at the upgraded SWSTW on 22 February 2024.

Other project management issues

Scope for improving project cost estimation

4.15 According to the Project Administration Handbook for Civil Engineering Works issued by the Civil Engineering and Development Department:

- (a) project engineers are responsible for keeping the works within the approved scope and estimate. They must ensure that estimates are carefully prepared and given the same attention to detail as other aspect of project preparation; and
- (b) any estimate must be as accurate as possible as it affects the management of public funds and it has a direct effect on fund allocation.

4.16 APE of \$2,572.3 million covered the design and construction portions of the upgrading works of SWSTW (see para. 1.5). However, as of October 2023, the total expenditure under the project vote was \$1,924.7 million (i.e. \$647.6 million (25%) less than APE of \$2,572.3 million).

4.17 According to DSD, at the time of preparing Contract A for tender, it prepared the project cost estimate in accordance with the relevant technical circulars, and the cost estimate was considered reasonable. The significant variance between the estimated and actual project cost was mainly due to the following reasons:

- (a) lower-than-estimated tender outturn price for the upgrading works contract (i.e. Contract A);
- (b) actual adjustment for price fluctuation lower than the estimated amount; and

- (c) actual contingency sums for unforeseen works lower than the estimated amount.

4.18 In Audit's view, in implementing works projects, DSD needs to take measures to ensure that project costs are estimated as accurately as possible.

Need to keep under review the results of the trial use of new systems/technologies

4.19 Audit noted that the upgrading works of SWSTW had introduced and adopted certain new systems/technologies for trial, as follows:

- (a) in July 2019, Consultant X issued EC D (later valued at \$5.5 million) instructing Contractor A to integrate CMM System as specified in Contract A with Building Information Modelling (BIM — Note 69) and smart technology for the implementation of the upgraded SWSTW for trial. According to DSD, the integration would benefit it to evaluate the BIM usage and performance in operation and maintenance stage, as well as to gain knowledge for development of a more efficient way to manage and operate sewage treatment facilities. Under EC D, Contractor A needs to perform a 3-year trial (starting from the commencement of the operation stage (i.e. March 2021)) and submit a report to DSD after the trial for evaluation on the performance of such integration (i.e. by March 2024);

Note 69: *In December 2017, DEVB promulgated DEVB Technical Circular (Works) No. 7/2017 on "Adoption of Building Information Modelling for Capital Works Projects in Hong Kong". According to the Technical Circular, works departments are recommended to optimise the use of BIM technology and to critically review the asset management strategy in order to leverage the technology to enter into the digital built environment.*

Other related issues

- (b) in August 2021, Consultant X issued EC E (later valued at \$3.8 million) instructing Contractor A to procure, install and operate a new Plant Smart System (Note 70) for the CEPT and ultraviolet disinfection facilities as trial run/pilot scheme. In June 2022, Contractor A submitted an evaluation report to DSD which stated that a number of benefits and positive results had been achieved with the use of the new system; and
- (c) in March 2023, Consultant X issued EC F (later valued at \$3.8 million) instructing Contractor A to design, provide and carry out a trial operation of a rainwater harvesting system (see para. 2.26(a)(iii)) (Note 71) for 24 months for irrigating the green roof systems of the administration building and workshop of the upgraded SWSTW. Under EC F, Contractor A needs to submit a report to DSD after the 24-month trial operation for evaluation on the performance of such system (i.e. by March 2025).

4.20 In Audit's view, DSD needs to keep under review the results of the trial use of the new systems/technologies at the upgraded SWSTW with a view to drawing on the experience gained in implementing future sewage treatment works projects.

Need to keep under review DBO contract arrangement

4.21 The upgrading of SWSTW was DSD's second sewage treatment works project adopting DBO contract arrangement after the project for the upgrading of Pillar Point Sewage Treatment Works (PPSTW) (Note 72). According to DSD, it

Note 70: *According to Contractor A, the new Plant Smart System was installed to facilitate the operating of the CEPT and ultraviolet disinfection facilities. It could improve the management of plant operation performance by providing real time monitoring and alert of operation performance, enhancing data visualisation (e.g. energy consumption, chemical dosage rate, etc.) and improving transparency in compliance reporting.*

Note 71: *According to DSD, the rainwater harvesting system with water treatment and disinfection allowed rainwater from the roofs of administration building and workshop to be stored, purified and reused for irrigating the green roof systems, in order to reduce the use of freshwater for irrigation.*

Note 72: *A DBO contract for the upgrading of PPSTW was awarded in July 2010, and the upgraded sewage treatment works commenced operation in May 2014.*

brought in DBO arrangement for procuring sewage treatment facilities in view of the following potential merits:

- (a) encouraging the introduction of overseas innovative technologies, experience and management techniques;
- (b) larger scope for optimisation resulting in lower life-cycle cost;
- (c) minimisation in government staff resources; and
- (d) clearer accountability of responsibilities among design, construction and operation phases as only one party is responsible for the whole DBO process.

4.22 According to DSD, a DBO contract arrangement was adopted in the upgrading of SWSTW to allow the contractor flexibility in planning the works schedule in the design and construction stages, and to achieve reasonable construction and operation costs of the upgraded SWSTW.

4.23 In January 2024, DSD informed Audit that:

- (a) consolidating the experience gained so far from the upgrading of PPSTW and SWSTW, it was still in the pilot stage in respect of adopting DBO contract arrangement for selected sewage treatment facilities projects (Note 73); and
- (b) it would review the actual achievement of cost saving of adopting DBO contract arrangement upon completion of the operation phase of Contract A.

4.24 In Audit's view, DSD needs to keep under review the DBO contract arrangement of sewage treatment works (e.g. achievement of intended benefits) with

Note 73: *According to DSD, there are 2 new sewage treatment facilities projects currently under planning and design which may adopt DBO contract arrangement.*

Other related issues

a view to paving the way forward for adopting such contract arrangement for future sewage treatment facilities projects.

Need to keep under review the demand of sewage treatment at the upgraded SWSTW

4.25 According to DSD, the design treatment capacity of SWSTW has been increased from 164,000 to 200,000 m³ per day after the upgrading works. Audit noted that, from March 2021 to October 2023, the volume of sewage treated by the upgraded SWSTW ranged from 50,498 to 254,856 m³ per day (averaging about 142,000 m³ per day — i.e. about 71% of the design treatment capacity) (see para. 1.13). The volume of sewage treated by the upgraded SWSTW was approaching its design treatment capacity for some days, as follows:

- (a) there were 9 days (3, 4 and 2 days in 2021, 2022 and 2023 respectively) with treated sewage discharged from the upgraded SWSTW over the design treatment capacity of 200,000 m³ per day, ranging from 202,113 to 254,856 m³. The maximum daily volumes of treated sewage discharged were 254,856, 217,820 and 253,099 m³ in 2021, 2022 and 2023 respectively; and
- (b) there were 24 days (7, 12 and 5 days in 2021, 2022 and 2023 respectively) with treated sewage discharged from the upgraded SWSTW at 90% to 100% of the design treatment capacity (i.e. between 180,000 and 200,000 m³).

4.26 According to DSD, in 2017, Phase 2 upgrading works of SWSTW was consolidated in the plan for providing a new sewage treatment works for Hung Shui Kiu new development area (see para. 1.5). In Audit's view, DSD needs to keep under review the demand of sewage treatment at the upgraded SWSTW with a view to early considering the need for taking further measures to address the demand.

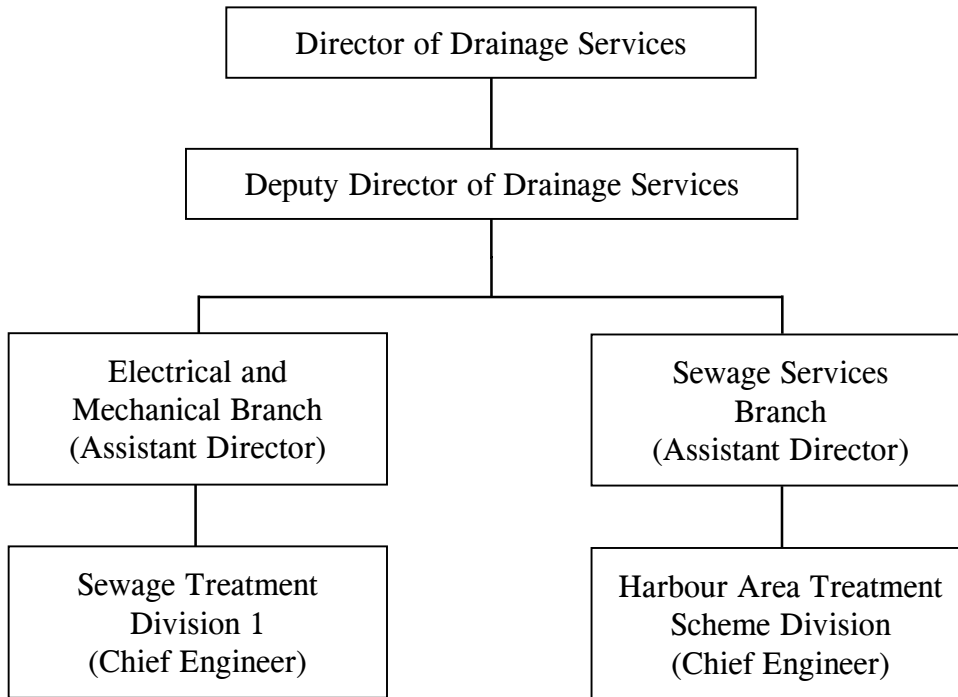
Audit recommendations

- 4.27 **Audit has recommended that the Director of Drainage Services should:**
- (a) **in implementing works projects, take measures to ensure that project costs are estimated as accurately as possible; and**
 - (b) **keep under review:**
 - (i) **the results of the trial use of the new systems/technologies at the upgraded SWSTW with a view to drawing on the experience gained in implementing future sewage treatment works projects;**
 - (ii) **the DBO contract arrangement of sewage treatment works (e.g. achievement of intended benefits) with a view to paving the way forward for adopting such contract arrangement for future sewage treatment facilities projects; and**
 - (iii) **the demand of sewage treatment at the upgraded SWSTW with a view to early considering the need for taking further measures to address the demand.**

Response from the Government

- 4.28 The Director of Drainage Services agrees with the audit recommendations.

**Drainage Services Department:
Organisation chart (extract)
(31 October 2023)**



Source: DSD records

Acronyms and abbreviations

APE	Approved project estimate
Audit	Audit Commission
BIM	Building Information Modelling
BOD	Biochemical oxygen demand
CEPT	Chemically enhanced primary treatment
CMM System	Computerised Maintenance Management System
DBO	Design-build-operate
DEVB	Development Bureau
DSD	Drainage Services Department
<i>E. coli</i>	<i>Escherichia coli</i>
EC	Employer's Change
EEB	Environment and Ecology Bureau
EPD	Environmental Protection Department
FC	Finance Committee
FSD	Fire Services Department
KPIs	Key Performance Indicators
LegCo	Legislative Council
m ³	Cubic metres
mg/l	Milligrams per litre
NWNT	Northwest New Territories
ppm	Parts per million
PPSTW	Pillar Point Sewage Treatment Works
RSS	Resident site staff
SWSTW	San Wai Sewage Treatment Works
TSS	Total suspended solids
UPN	Under-performance notice