Application of “Single Site, Multiple Use” in a sewerage project - a breakthrough trial in Kwun Tong Sewage Pumping Station

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ABSTRACT

Hong Kong’s land resources are undoubtedly precious. At the same time, sewerage facilities are of paramount importance to ensure public hygiene and preserve the receiving water quality. Due to the limited land resources, it is inevitable to locate these facilities in close proximity to residential areas. Consequently, objections from neighbouring residents, stemming from the “Not-In-My-Backyard” effect, are frequently received as there are concerns regarding the potential impacts in respect of visual pleasantness and odours. To address this challenge, a breakthrough project, Enhancement Works for Kwun Tong Sewage Pumping Station, was implemented, applying an innovative design strategy, known as the “Single Site, Multiple Use” concept. This project involved constructing a landscaped deck to cover the sewerage facilities, effectively reducing the visual and odour impacts in the surrounding area. Data forecasting and analysis techniques were used to design the capacity of the Balancing Tank. This project not only enhanced the appearance of the otherwise dull sewerage infrastructure, but also improved the quality of life for local residents, as evidenced by the overwhelmingly positive feedback. The successful implementation of this project inspires engineers to build better infrastructure, and provides valuable insights for future sewerage projects aiming to balance the environmental, social, and spatial considerations in compact cities.

KEYWORDS Sewerage facilities; Not-In-My-Backyard; Single Site, Multiple Use; landscaped deck; quality of life
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1. Introduction

1.1. Background of the Harbour Area Treatment Scheme

Over the several decades of rapid development, Victoria Harbour has suffered from the negative impacts of urbanisation. The Government of the Hong Kong Special Administrative Region therefore commenced the construction of the Harbour Area Treatment Scheme (HATS) in 1994, which is the largest environmental infrastructure project aiming to restore the water quality in Victoria Harbour. Sewage collected from Kowloon, Kwai Tsing, Tseung Kwan O, and Hong Kong Island is first preliminarily treated in various local Preliminary Treatment Works (PTWs) and then conveyed to the Stonecutters Island Sewage Treatment Works (SCISTW) through the HATS deep tunnel system for centralised treatment (Environmental Protection Department, 2020). Figure 1 shows the sewage flow model in the HATS.

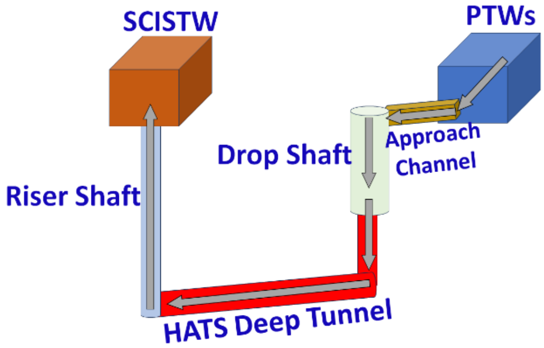


Figure 1. Sewage flow model in the HATS.

1.2. Sewerage strategy in East Kowloon

Sewage from East Kowloon is first conveyed to the Kwun Tong Preliminary Treatment Works (KTPTW) for screening and preliminary treatment (Drainage Services Department, 2024b). However, with future developments such as the Kai Tak Development and housing projects at Anderson Road, the forecast increase in sewage flow is expected to be significant, reaching at least 100,000 m^3 per day. As a result, the HATS system and drop shaft of the KTPTW will no longer be capable of accommodating this surge in sewage intake, particularly during its extreme peak flow periods. In light of such circumstances, the Drainage Services Department (DSD) has undertaken the construction of an underground Balancing Tank (BT) with a storage capacity of 16,000 m^3 (equivalent to 6.5 Olympic-sized swimming pools) on a piece of vacant land adjacent to the existing Kwun Tong Sewage Pumping Station (KTSPS), about 150 metres away from the KTPTW. The purpose of the underground BT is to temporarily store the excess preliminarily treated sewage from the KTPTW during peak hours and pump it into the HATS deep tunnel system via the KTPTW during non-peak hours. This solution not only increases the sewerage capacity but also optimises the utilisation of the existing HATS system. Otherwise, an additional system would need to be built to cater for the increase in sewage flow. By effectively regulating the flow of sewage, the underground balancing facility ensures a more efficient and sustainable sewerage system for East Kowloon (Drainage Services Department, 2020a).

1.3. Characteristics of Kwun Tong District

With an area of 1,128 hectares and approximately 669,000 residents in 2022, Kwun Tong District stands as one of the most densely populated areas in Hong Kong. This situation is expected to continue due to the future developments mentioned in the previous paragraph (Census and Statistics Department, 2023).

However, the high population density will pose challenges for infrastructure projects, particularly those involving sewerage facilities. The proposed sewerage facilities in the local area inevitably face opposition from residents, leading to the "Not-In-My-Backyard (NIMBY)" effect. As a result, these projects necessitate unique designs as well as extensive public consultations and engagement activities in order to gain public support.

1.4. Case study on the application of 'Single Site, Multiple Use' in a drainage project in Hong Kong

The initiative of "Single Site, Multiple Use" (SSMU) was first introduced in the Chief Executive's 2018 Policy Address for public works projects. Originally, its main objective was to provide public car parking spaces in suitable "Government, Institution or Community" facilities and Public Open Space (POS) projects (Lam Cheng, 2018). SSMU has gained in popularity in recent years in Hong Kong primarily due to the scarcity of land resources. SSMU has evolved to optimise the utilisation of under-utilised sites by incorporating mixed residential, commercial, educational, and welfare uses. This approach not only facilitates the development of modernised facilities but also contributes to the increased supply of various types of housing, such as housing for the elderly, youth hostels, and transitional housing, among others (Lam Cheng, 2019).

Before the SSMU concept was introduced in 2018, the DSD had already successfully applied a similar concept in various stormwater facilities, including Sheung Wan Stormwater Pumping Station (SWSmPS), Tai Hang Tung Storage Scheme (THTSS), and Happy Valley Underground Stormwater Storage Scheme (HVUSSS).

SWSmPS was commissioned in 2009 by the DSD with the aim of alleviating the flooding problem in Sheung Wan (Drainage Services Department, 2020b). The project mainly comprises an underground storage tank of 9,000 m^3 and a single-storey pump house with two levels of basement. On top of the underground storage tank, a 5,700 m^2 open space comprising a waterfront promenade, a plaza, and a pet garden was developed with around 110 trees and over 20,000 shrubs planted.

THTSS, completed in 2004, stands as the first large-scale underground stormwater storage scheme in Hong Kong, featuring an underground storage tank with a capacity of 100,000 m^3, accompanied by a pumping station. The primary objective of THTSS is to intercept stormwater from the nearby natural hillsides and temporarily store it in the underground tank located beneath the Tai Hang Tung Recreation Ground. This innovative approach effectively addresses the flooding issue in Mong Kok by significantly reducing the discharge of surface runoff into the downstream drainage system during heavy rainstorms while providing rugby and football pitches for public enjoyment (Drainage Services Department, 2020c).

The DSD commenced the construction of HVUSSS in 2012, which comprises a 60,000 m^3 underground stormwater storage tank underneath the Happy Valley Recreation Ground, a box culvert, and a stormwater pump house. The objective of the project is to temporarily store a portion of stormwater collected from the upstream catchment during heavy rainstorms. The storage tank was constructed underneath the existing sports pitches in the Happy Valley Recreation Ground (Luk, 2012).

In recent years, the application of SSMU has gained in popularity in regard to both public and private projects in Hong Kong. However, its use in sewerage projects is rare due to public concerns about the unpleasant odours associated with such facilities. This paper will explore the implementation of SSMU in the Enhancement Works for the KTSPS sewerage project, demonstrating how these facilities can effectively integrate with the local community while promoting sustainability. The study aims to inspire Hong Kong engineers to develop better infrastructure and provide insights for future sewerage projects that consider the environmental, social, and spatial factors in densely populated urban areas. It encourages the importance of exploring potential innovative combinations of sewerage facilities with office, residential, or other uses, rather than leisure uses, to foster more integrated and sustainable urban environments.

1.5. Provision of public spaces in Kwun Tong

To echo the strategic directions of the "Hong Kong 2030+: Towards a Planning Vision and Strategy Transcending 2030" (Hong Kong 2030+), which aims to enhance the overall liveability of our compact high-density city and raise the quantity and quality of open spaces, an iconic and innovative landscaped deck (the Deck), named Cha Kwo Ling Promenade, has been constructed over the BT and the existing KTSPS, thereby providing an open space of about 11,000 m^2 for public enjoyment. The objectives of this pioneering project are, on one hand, to enhance the sewerage capacity and optimise the utilisation of the current HATS system and, on the other hand, to provide a public space for the community while minimising both odour and visual impacts on nearby residents.

1.6. Case study on the application of "Single Site, Multiple Use" worldwide

Similar projects in other regions are examined, with China recognised as a global leader in the application of the SSMU concept. A notable example is the Honghu Park Water Purification Plant, which was completed in 2021. This innovative project is designed to treat and purify approximately 18 million cubic metres of domestic sewage annually, effectively addressing the increased sewage challenges that have arisen from the urban renewal and development in the Qingshui River-Sungang area. In response to various claims from the local government and community stakeholders, a park for public leisure use has been constructed on top of the fully buried water treatment facility. This park includes the restoration of approximately 3.24 hectares of surface landscape, the construction of deodourising vent shaft pagodas, pavilions, gazebos, and corridors, and the installation of rain shelters with seating. Due to its creative design, significant media attention has been attracted to Honghu Park, leading to numerous press visits for photography and reporting (NODE Architecture & Urbanism, 2022).

Another similar application of SSMU in a sewerage project is the Pantai 2 Sewage Treatment Plant (P2STP) in Kuala Lumpur. This state-of-the-art facility has been constructed to provide sewage treatment with a capacity of 320,000 cubic metres per day, serving a population of 1.423 million. The Pantai catchment area encompasses 6,700 hectares in the central and southwestern regions of Kuala Lumpur. Despite its many benefits, the project encountered significant challenges, including concerns from surrounding residents and various site and technical difficulties, which required careful planning and innovative solutions to address effectively. In addition to its essential sewage treatment functions, the project includes a 12-hectare public park-Pantai Eco Park-which significantly improves the local environment by incorporating picturesque waterways and lush greenery. This park features a variety of recreational amenities, such as jogging tracks, playgrounds, and sports courts for futsal, tennis, sepak takraw, volleyball, and badminton, as well as a community centre, cafeteria, surau, and covered parking facilities (Construction Plus Asia, 2018).

2. Methodology

2.1. Planning of the sewerage facilities

2.1.1. Estimation of the sewerage flow

Under Agreement No. CE 47/2013 (DS) "Upgrading of Kwun Tong Preliminary Treatment Works - Investigation, Design and Construction" (Drainage Services Department, 2024a), the flow projection was based on the 2011-based Territorial Population and Employment Data Matrix (TPEDM) compiled by the Planning Department and the additional estimated flow from the proposed developments within the KTPTW catchment as at the time of design in 2014. The design average dry weather flow (ADWF) was estimated to be 445,891 m^3/day, with a projected peak wet weather flow (PWWF) and peak dry weather flow (PDWF) of 13.13 m^3/s and 9.02 m^3/s, respectively.

For this project, the sewerage flow projection of the KTPTW has been further reviewed using the latest planning data, including the enhanced 2011-based TPEDM, provided by the Planning Department on 20 April 2016, as well as the updated population data for New Development Projects (NDPs) within the KTPTW catchment, provided by the Environmental Protection Department (EPD) (abbreviated as "updated population data for NDPs") on 12 May 2016. The projection was conducted following the Guidelines for Estimating Sewage Flows (GESF) (Environmental Protection Department, 2005). The estimation of the ADWF was based on the following formulas:

$$\text{Projected ADWF} = N \times UFF \times P_{CIF}, \quad (1)$$

$$\text{Design ADWF} = \text{Projected ADWF} \times 1.02, \quad (2)$$

where:

N = Number of population in accordance with the enhanced 2011-based TPEDM and the updated population data of NDPs

UFF = Unit flow factors for domestic / commercial / industrial flows as shown in Tables T-1, T-2, and T-3 of GESF

PCIF = 1.10 for East Kowloon as shown in Table T-4 of GESF

1.02 = 2% uncertainty allowance

Under CE 47/2013 (DS), a 10% uncertainty allowance was assumed for the design of the ADWF. Given that the flow projection for this project is based on the latest population data for NDPs, the uncertainty has been reduced, leading to a design ADWF uncertainty allowance of 2% instead of the previous 10%.

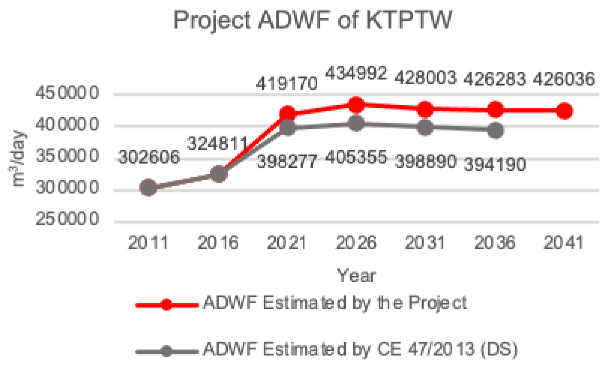


Figure 2. Projected ADWF of the KTPTW.

Figure 2 shows a comparison of the projected ADWF between Agreement No. CE 47/2013 (DS) and the project. By incorporating the enhanced 2011-based TPEDM data and the updated population data for NDPs, a similar trend in the projected ADWF was observed compared to the estimation under CE 47/2013 (DS). It was anticipated that the peak values would occur in 2026 of 434,992 m^3/day, followed by a slight decrease from 2026 to 2041. With a 2% uncertainty allowance included, the design ADWF was assumed to be 443,692 m^3/day.

In addition to the population, along with industrial and commercial activities, the projected PWWF and PDWF of the KTPTW also considered the flows discharging from dry weather flow interceptors (DWFIs) inside the KTPTW catchment and the cruise vessels docked at the Kai Tak Cruise Terminal, using the following formula.

PWWF/ PDWF = Design ADWF x P + Peak Discharge from DWFIs and Cruise Vessels in 2026

where:

P = Peaking factors for wet weather flows and dry weather flows according to Table T-5 and Appendix VIII of GESF

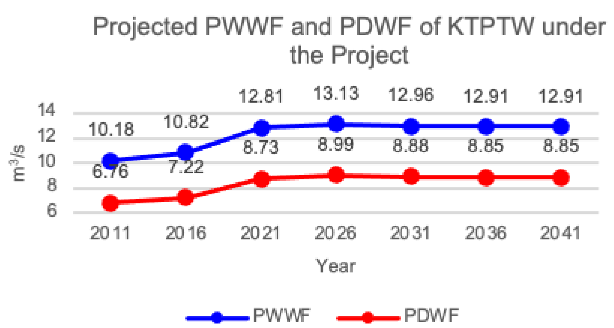


Figure 3. Projected PWWF and PDWF of the KTPTW under the project.

Figure 3 illustrates the projected PWWF and PDWF of the KTPTW under the project. The projected PWWF and PDWF of the KTPTW are expected to reach their peaks in 2026. Thereafter, the forecast flows remain fairly constant, with a slight drop. The new projected PWWF is maintained at 13.13 m^3/s, which is aligned with the estimation adopted under CE 47/2013 (DS). Hence, the projected sewerage flows under CE 47/2013 (DS) with the estimated PWWF and PDWF of 13.13 m^3/s and 9.02 m^3/s, respectively, were still deemed valid and were adopted for the design works of the project.

2.1.2. Odour control and monitoring

Odours can be emitted at different stages of the treatment process and hydrogen sulphide (H_2S) is a common odourous gas generated from sewerage facilities. H_2S primarily originates from the decomposition of organic matter, such as sewerage, under anaerobic conditions. Bacteria break down organic compounds without oxygen, leading to the production of H_2S. Additionally, H_2S can be released during the handling and treatment of sludge, as sulphur compounds present in the sludge can convert to H_2S under specific circumstances (Rasmussen, 1974). The effective management and control of H_2S generation are therefore crucial for mitigating the odour issues in sewerage treatment facilities.

To address the considerable challenge of constructing the BT facility in the densely populated Kwun Tong District of Hong Kong, a comprehensive three-tier odour management system has been implemented within the KTSPS. This system has been specifically designed to mitigate the impact of H_2S emissions on the surrounding area.

Firstly, the BT and odour-emitting equipment are securely covered, and the sewage received at the pumping station undergoes chemical dosing with calcium nitrate to effectively reduce odour emissions.

Secondly, the odourous gas emitted from sewage is treated with de-odourising (DO) units, which comprise bio-trickling filters, activated carbon systems, and a ventilation system to further eliminate any remaining odours.

Lastly, an additional layer of protection is provided by installing an activated carbon filter at the air ventilation outlet. This ensures that any emitted gases are effectively filtered before being released into the atmosphere. The ventilation system is strategically located at the edge of the Deck, facing Victoria Harbour and the Kwun Tong Bypass, facilitating the effective dispersion of gases.

By implementing a three-tier odour management system, the project efficiently eliminates the potential odour impact on the surrounding environment. The efficiency of the DO system can be determined using the following formula and will be discussed in Section 3.

$$H_2S \text{ removal efficiency } (\%) = [1 - (H_2S \text{ concentration at outlet}) / (H_2S \text{ concentration at inlet})] \times 100\%, \quad (3)$$

2.2. Design of the building

2.2.1. Foundation scheme

The Deck and the BT share a common foundation system utilising Large-Diameter Bored Piles (LDBPs). This choice is primarily driven by the challenging ground conditions, characterised by approximately 7 metres of fill material overlaying 15 metres of marine deposits. The low bearing capacity of this soil profile renders traditional footing or raft foundations inadequate for supporting the loads imposed by the BT and the Deck. Additionally, the marine deposits have a tendency to settle more rapidly than the piles, which can induce negative skin friction and further diminish the bearing capacity of any foundation system relying on skin friction for support. In this context, LDBPs emerge as the optimal solution due to their larger bearing capacity, which not only enhances the structural stability but also allows for a reduction in the number of piles required. This results in a cost-effective design capable of accommodating the loads from both the Deck and the BT while minimising the construction complexity and potential settlement issues.

2.2.2. Superstructure scheme

The building features a beam-column frame structure that enhances both the functionality and aesthetic appeal. This design enables open floor layouts without continuous shear walls, creating flexible interior spaces suitable for various activities. Additionally, it streamlines the construction process by utilising Design for Manufacture and Assembly (DfMA), which reduces the need for formwork and shortens the construction time, which is especially advantageous in urban settings where timely project completion is essential. The structure also promotes material efficiency, requiring fewer concrete materials while maintaining the load-bearing capacity, thus lowering the costs and minimising the environmental impact. Furthermore, it allows for striking architectural designs and spacious interiors, enhancing the overall appeal of the Deck for both visitors and residents.

To ensure its structural stability, the BT incorporates a basement wall system designed to counteract the lateral forces exerted by the surrounding soil. These basement walls effectively absorb and withstand the lateral earth pressure, maintaining the integrity of the structure above and allowing it to safely bear its own weight without the risk of movement. Figure 4 shows the vertical load path of the Deck and BT to the LDBP.

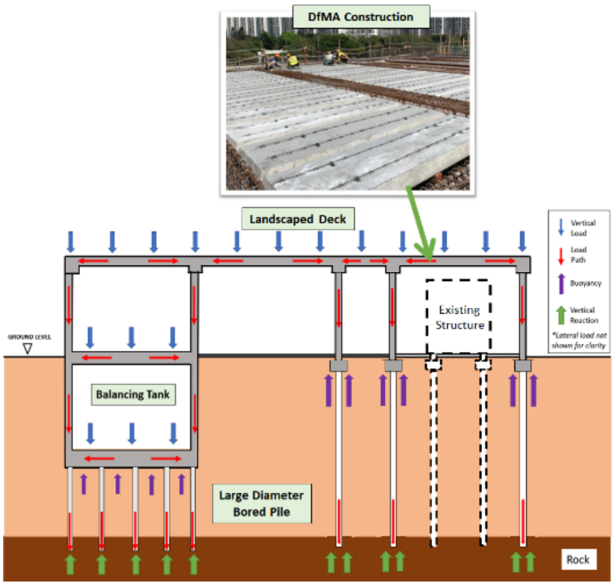


Figure 4. Typical section of the BT and the Deck and the vertical load path.

2.2.3. Gathering of public opinions

It was anticipated that the community, particularly the local residents, may have concerns over creating a public space on top of sewerage facilities. Engaging the key stakeholders and the public was critical to the success of the project. In July 2019, a user survey was carried out to collect nearby residents' preferences on the usage of public space. The results showed that "interactive water feature" and "amenity lawn" were most welcomed by the nearby residents. Subsequently, the DSD further engaged the public in the design development process. The opinions of various stakeholders such as children, parents, the elderly, District Council members, and professional groups including educational psychologists, social workers, and occupational therapists, were collected through focus group workshops, design workshops, and trial play sessions. With the collaborative effort, a Water Play Area and a Forest Hunt themed multi-play equipment with 8 metres high slides were designed on the Deck, aiming to provide a large variety of play experiences. Figure 5 shows the aerial view of the building.

Figure 5. Public engagement activities and aerial view of the Deck.

2.2.4. Park design theme

The site, located adjacent to Tsui Ping River and the Kwun Tong Promenade, offers worthy opportunities for children to engage with nature in an urban setting. "Playful Nature" is a design attempt to deliberately integrate play with the living landscape, and promote a full-body engagement with the environment instead of leaving nature as a mere backdrop to children's activities. The natural elements of Air, Sun, Sky, Ground, and Water are infused into the different play settings, offering play opportunities throughout the entire playscape, rather than in confined play areas as normally seen in traditional playgrounds.

2.2.5. Material selection for park facilities

The Deck is designed with a focus on functionality, safety, and environmental consciousness to promote sustainability. All the equipment in the park is carefully selected to be easy to maintain and environmentally friendly. For instance, stainless steel is used for the slides instead of plastic, offering enhanced durability and playground safety. This not only reduces the need for frequent repairs but also enhances the safety of the Deck's visitors. In addition, the Deck uses sustainable bamboo for its flooring as a replacement for the traditional hardwood, showcasing its commitment to sustainability while offering a visually appealing surface. Furthermore, given that the Deck is situated 10 metres above the ground, glass balustrades and stainless steel handrails have been installed to ensure the safety of visitors without obstructing the views of Victoria Harbour. These protective features are designed to prevent falls from the elevated areas of the Deck, providing a secure and enjoyable experience for all users. The combination of easy maintenance, durable materials, and sustainable choices enhances its functionality, safety, and eco-friendliness. Further sustainable design features and its efficiency will be discussed in Section 3.

3. Result and discussion

3.1. Capacity of the Balancing Tank

Under CE 47/2013 (DS), the sewage treatment capacity of the KTPTW was upgraded from 10.93 m^3/s to 13.13 m^3/s to accommodate the forecast flow. Despite this upgrade, the forecast mid-day and evening flow peaks exceed the drop shaft capacity of the KTPTW. Therefore, the design of the BT was to capture the excess sewage and prevent any overflow of preliminarily treated sewage into Victoria Harbour under normal dry weather operations.

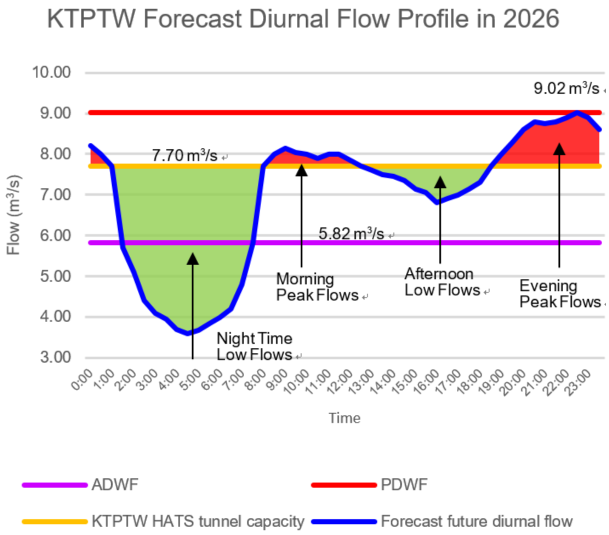
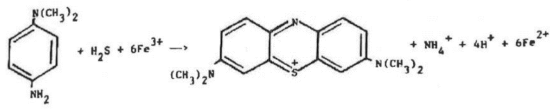


Figure 6. KTPTW Forecast Diurnal Flow Profile in 2026.

Figure 6 illustrates the forecast KTPTW dry weather diurnal flow profile for 2026. The flow pattern exhibits a double-peaked trend, exceeding the drop shaft capacity of the KTPTW during both peaks. The forecast evening peak dry weather flow, occurring from approximately 6:30pm to 12:30am, significantly surpasses the tunnel's capacity. The peak overflow rate is projected to reach as high as 1.32 m^3/s at around 10:30pm. The red areas in the figure represent the estimated excess sewage volume of approximately 16,000 m^3 during this period. However, the tunnel has sufficient spare capacity during the night-time hours, as shown in the green areas. Flows during the period from approximately 12:30am to 8:30am in the morning, spanning around 8 hours, remain below the tunnel's capacity. This presents an opportunity to utilise this time to pump the stored volume back into the KTPTW HATS tunnel, fully emptying the BT in preparation for the peak flows of the following day. Based on this analysis, it has been concluded that a BT size of 16,000 m^3 would effectively prevent dry weather diurnal overflows at the KTPTW.

3.2. Operation of de-odourising units

The KTSPS has implemented effective odour control measures using two-stage DO units, comprising two bio-trickling tanks as the first stage and three activated carbon filters as the second stage. The chemical formula shows the removal of H_2S in a bio-trickling tank (Lodge, 1988).



Germs + Odour + Nutrients → Products

The bio-trickling tanks employ microorganisms to absorb H_2S and reduce the concentration of odours, while the activated carbon filters capture any remaining H_2S and odorous compounds. Regular maintenance is carried out to ensure optimal performance, including the provision of water and nutrients to the bio-trickling tanks.

To further enhance the effectiveness of the DO units, the activated carbon filters play a vital role in adsorbing odorous compounds due to their high porosity and large surface area, which exhibit exceptional adsorption capabilities for a wide range of organic and inorganic molecules. The activated carbon media consist of two types: potassium hydroxide impregnated activated carbon and virgin activated carbon.

Table 1 below shows the Site Acceptance Test (SAT) report prepared by the laboratory accredited by The Hong Kong Laboratory Accreditation Scheme (HOKLAS) for the DO units during operation.

Table 1. Efficiency of H_2S removal for DO units.

Sampling location	Concentration of H_2S - before treatment	Concentration of H_2S - after treatment	H_2S removal efficiency
1st biofilter	27 ppm - - (1)	1.3 ppm	95.2%
2nd biofilter	24 ppm	0.5 ppm	97.9%
1st carbon filter	2.0 ppm	0.020 ppm - -(2)	99.0%
2nd carbon filter	0.47 ppm	<0.002 ppm	99.6%
3rd carbon filter	2.20 ppm	0.020 ppm	99.1%
Overall H_2S removal efficiency (worst scenario) = [(2)-(1)/(1)] * 100%			99.9% > 99.8%

The above results demonstrate that the DO units are highly effective. These units exhibit remarkable performance, achieving an odour removal rate of 99.9%, surpassing the environmental permit requirement of 99.5% (Environmental Protection Department, 2016) and the contract specification requirement of 99.8%. The use of DO units not only meets the regulatory standards but also achieves rigorous odour control, leading to improved air quality and a more pleasant community environment. The three-tier odour management system is definitely a vital element for the project's success and leads to SSMU facilities being welcomed by the public.

To effectively manage and control odour in the long term, a comprehensive monitoring system has been put in place. Ten monitoring points have been strategically positioned, before and after the treatment process of the DO units. This allows for the accurate measurement and evaluation of the odour concentration levels throughout the entire process to ensure compliance with the environmental permit requirements. Figure 7 displays the elevation view of the DO units.

Figure 7. Bio-trickling tanks (left) and activated carbon filters (right).

3.3. Sustainable design of the Deck

To promote sustainability and minimise the environmental impact, the Deck has implemented various measures in its design, including the introduction of a rainwater harvesting system, which collects rainwater and undergoes filtration and sterilisation processes to ensure its safety for irrigation and flushing purposes. By utilising this system, the recycled rainwater reduces wastewater and can save up to 860 m^3 of fresh water and flushing supplies.

Additionally, renewable energy facilities have been strategically positioned around the Deck. Solar panels have been installed to enhance the energy efficiency and reduce carbon emissions. These panels are expected to generate approximately 80 kWh of electricity per day, resulting in a reduction of 56 kg of CO_2 emissions. Furthermore, the plant house incorporates three large skylights, allowing ample natural daylight to illuminate the interior space. To further optimise the energy consumption, the mechanical equipment within the plant house, such as the ventilation and DO systems, is connected to an automatic system with a variable speed control. This enables the operating levels of these systems to be adjusted based on the actual conditions, thereby reducing their energy consumption.

To enhance the sustainability within the community, the Deck incorporates a greening ratio of around 30%, and expansive green terraced buffers have been constructed along the perimeter of the site. These buffers serve as resting places for birds and insects, while providing a visual separation between the Deck and the bustling roads adjacent to the site. The landscape design encompasses approximately 60 plant species, with half of them being native to support biodiversity. The selection of these plant species was carried out meticulously, taking into consideration their seasonal beauty, suitability for the play space theme, and ability to thrive in waterfront conditions.

3.4. Feedback from the public

Since its opening in August 2023, the park has become highly popular among citizens due to its unique and innovative design. The facilities have been widely praised, resulting in high usage rates, particularly in the Water Play Area and Forest Hunt area which are often crowded on holidays. Over 10 media press have visited the Deck to film and interview the project team. The extensive media coverage has further attracted both adults and children to visit the Deck.

Moreover, the Deck has become a popular spot for hosting large-scale events. On 26 August 2023, the Harbourfront Office of the Development Bureau, and the Drainage Services Department jointly organised the "CoolPlay 3-4-5" event at the Cha Kwo Ling Promenade, featuring emerging sports, booth games, and orienteering checkpoints. Thousands of citizens participated in the events. In December 2023, the Hong Kong Playground Association and "Hong Kong Streetathon" co-organised the "Street Horse Playground Run and Festivity" event, which included a one-kilometre run and orienteering activities on the park's scenic platforms, attracting numerous citizens.

This pilot project has successfully blended the sewage pumping station into the surrounding environment, thus transforming the public's perception of sewerage facilities and breaking away from the negative stereotypes associated with such infrastructure.

4. Conclusion

Facing the challenges brought about by climate change, the DSD not only maintains its consistent strategy of enhancing the flood resilience of drainage systems and improving the operation of sewerage facilities, but also actively promotes and implements the concept of "blue-green infrastructure". The DSD incorporates greenery and sustainable development principles into its facilities, aiming to enhance the sustainability of drainage works, reduce their carbon footprint, and achieve the goal of sustainable development.

Enhancement works for the KTSPS successfully demonstrated the effective blending of NIMBY infrastructure into the community, creating a mutually beneficial situation for all the parties involved. By utilising the available land, the project has not only enhanced the resilience and durability of the sewerage conveyance system but also provided a valuable public space for the community to embrace and enjoy as well as promoting the importance of sustainability.

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Notes on contributors

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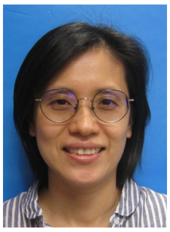

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