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寄件日期: 2026年07月09日星期四 10:24
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主旨: Planning Application No. A/I-TOF/9 - Reply to Departmental Comments
附件: TPB_June2026.pdf; GPRR_TaiO_Pier_rev.pdf; Batches.pdf

類別: Internet Email

Dear Mr Chen,

Please **disregard our previous email** and find attached the finalized, updated responses and documentation regarding Application No. A/I-TOF/9 for the proposed research installation in Tai O.

Following the latest rounds of feedback, we addressed the comments from the different Departments and the public queries.

Thank you very much for your time and continued guidance throughout this process.

Best regards,

Annalisa

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Comments from: Geotechnical Engineering Office, Civil Engineering and Development Department
Contact Person: Mr. T K TSE Tel.: 2762 5384
The Geotechnical Engineering Office has the following comments on the Geotechnical Planning Review Report (GPRR) for the captioned application. 1. Section 3: It is noted that the proposed development includes the placement of a portable cabin on the crest side of an unregistered existing wall. Although the global slope stability has been reviewed in the GPRR, the applicant should include assessment of the wall stability, with consideration of the wall dimensions. Furthermore, the full input and output of the slope stability analyses should be provided in the GPRR. We have now included the full input and output file of slope stability analysis. The wall stability calculations are also included. Please note that as the wall is unregistered, we can only estimate its dimensions based on our observations and measurements on site. 2. Apart from the existing wall, the applicant should discuss whether the proposed development may affect or be affected by other existing man-made features nearby. The cabin will be located underneath the slope feature No. 9SW-C/C 15 and may be affected in case a slope failure occurs at this feature. However, since this feature has been designed and upgraded to meet current slope standards, we believe the risks are minimal. No existing man-made features or registered/unregistered geotechnical features were identified within the zone of influence of the proposed development. 3. It is noted from the Supporting Statement that the proposed portable cabin is for housing the server equipment and is small in nature, which is not intended to be a manned facility. Given the statement in Section 3 of the GPRR that 'the slope stability is evaluated based on the Category 1 (High) "Consequence-to-Life" requirement', please clarify the Consequence-to-Life category of the cabin and update the report text as necessary. We agree that the portable cabin is small in nature and not intended to be a manned facility. We had initially followed the criteria for the registered slope

feature (No. 9SW-C/C 15) above the cabin, which was Category 1 "Consequence-to-Life". We showed that the global slope stability can satisfy the requirements even for this category. We have no objection to if this can be lowered.

4. In connection to para. 2 above, the applicant may consider to relocate the proposed portable cabin to the toe side of the unregistered existing wall. Should the Consequence-to-Life category be defined as Category 3 (as an unmanned facility), the requirement of the wall stability analysis can be waived.
   Unfortunately, relocating the cabin to the toe side would not be suitable for our purposes, since the area at the toe is a beach subject to high tidal excursions, meaning that, in case of a temporary storm surge, the cabin could be exposed to seawater. The sensitive electrical and server equipment could be damaged in this case.

Comments from District Planning Officer/Sai Kung & Islands, Planning Department

Contact Person: Mr. Dicky CHAN Tel.: 2158 6056

Please note our comments below on the captioned application for clarification purpose.

(a) Please elaborate on site selection criteria for suitable location(s) to set up the radar installation within AOI1.
The selection of the radar installation locations within AOI1 (Pearl River Estuary) was guided by the following technical and environmental criteria:

- **Unobstructed Sightlines**: The radar technology requires an open, uninterrupted line of sight to the horizon across the water to ensure accurate data collection and maximum signal propagation. Both selected shorelines offer clear paths mostly free of physical obstruction.
- **Safety and Security (Non-Recreational Isolation)**: To eliminate potential public conflicts, accidental interference, or vandalism, sites with naturally restricted or non-existent public access were prioritized. The rugged, rocky, and steep coastal nature of these locations naturally deters public traffic.

- **Proximity to Existing Infrastructure**: Sites were chosen where they could leverage existing technical facilities or retaining structures to minimize new land footprint, environmental disruption, and visual impact. Radar operation requires power supply, the vicinity to an available power line is a fundamental requirement.
- **Strategic Meteorological Positioning**: Locations directly exposed to incoming coastal weather dynamics were selected to facilitate the earliest possible detection of storm surges and wave phenomena, maximizing the system's value as a hazard early-warning tool.

The design of the HF radar network followed the international best practice used worldwide for the deployment and operation of coastal radars for ocean monitoring. The best practices have been published in several technical and scientific reports, see for example.:

Cook, T., Hazard, L., Otero, M., & Zelenka, B. (2008). Deployment and Maintenance of a High-frequency Radar (HFR) for Ocean Surface Current Mapping: Best Practices.

Mantovani, C., Corgnati, L., Horstmann, J., Rubio, A., Reyes, E., Quentin, C., ... & Griffa, A. (2020). Best practices on high frequency radar deployment and operation for ocean current measurement. Frontiers in Marine Science, 7, 512304.

(b) In view of (a), please elaborate on the suitability of the two locations in Tai O, any interrelationship between these two locations, and the need to have two separate locations for the proposed installation.

Both Tai O sites perfectly meet the site criteria. The Wastewater Treatment Station site features an isolated rocky coastline and an existing technical utility room, while the Tai O Pier site uses an offline, non-public retaining wall structure with a direct, unobstructed horizon line facing toward the Pearl River Estuary.

Indeed, High-Frequency Radar (HFR) networks operate using spatial cross-bearing principles. A single radar station can only measure radial components of sea surface velocities. To continuously map comprehensive, two-dimensional total

velocity fields and wave dynamics across a broad zone like AOI1, a multi-station network configuration is mandatory. Operating both the Wastewater Treatment and Pier stations simultaneously fills the localized observational gaps, expanding high-resolution monitoring coverage seamlessly across the Pearl River Estuary and Hong Kong's Central Waters. Moreover, both stations in Tai O will be overlapped with a station placed in Tuen Mun to cover an area of approximately 600 km^2.

(c) Please elaborate if the proposed installation will have any safety concerns and potential nuisance during construction and operation stages.

 Construction **Stage**:

- **Negligible Noise & Air Pollution**: No heavy machinery will be utilized. Installation involves manual placement of pre-assembled equipment and hand-held tools. There will be minimal concrete usage, no burning, or earth-moving activities that generate dust or environmental runoff.
- **No Ecological Disruption**: All cabling will either follow existing pathways, sit directly on surface rocks/soil, or navigate underneath paved slabs via a highly restricted, temporary shallow trench. No trees or root systems will be cut, trimmed, or felled.

 Operation **Stage**:

- **Acoustic Mitigation**: The only fixed source of noise is the external server AC unit, strictly designed not to exceed **50 dB**, making it acoustically imperceptible against ambient coastal sounds.
- **No electromagnetic pollution**: the HF radar are designed to work with a minimal power not harmful for humans or animals. The equipment that will be installed has been certified by the EU. Moreover, High Frequency (HF) radars do not represent a physical risk for marine mammals like dolphins. Operating primarily above the water's surface to track ocean surface currents, they transmit electromagnetic waves rather than underwater sound waves. Consequently, they do not interfere with marine life's acoustic communication or echolocation. This is important since white dolphins are frequently observed around Lantau Island.
- **Visual Footprint**: The receiving antennas have a very small profile (approx. 3 cm in diameter) and are virtually invisible from land. All antennas will be

coated in a neutral sandy colour to harmonize with the shoreline rock. At the Pier site, the compact server cabin will be fully masked utilizing a camouflage net or painting the cabin to better match the existing natural tree canopy.

(d) According to the supporting statement, please provide the permission proof for the operation the HF-radars emissions issued by the Office of the Communications Authority (OFCA).

Please find attached to the revised application the official permit copy issued by OFCA for your verification

(e) Please concisely provide information on the operational details of the proposed installation, from (i) how the cables support the antennas and server room from power supply; (ii) how the antennas collect data from the sea; (iii) how the collected data is processed by the server room and transmitted to the laboratory; and (iv) how the data will be shared with government departments.

 (i) Power Supply and Cabling: Main electrical power will be fed directly from separate, designated lines co-located seamlessly next to pre-existing utility supply boxes on-site. High-bandwidth coaxial cables (7 mm housed within protective 75 mm corrugated tubes) bundle all data streams together cleanly. These are secured directly to rock faces via minimal cemented strips or integrated along facility boundaries without earthworks.

 (ii) Ocean Data Collection: The active transmitting (TX) antennas emit safe, low-power high-frequency radio waves across the target marine environment. The 12-element passive receiving (RX) antenna arrays capture the backscattered waves reflecting off the moving sea surface, calculating superficial current speeds and wave heights in real time.

 (iii) Processing and Lab Transmission: Raw incoming signals move sequentially through the main cable run into the central computational workstation housed securely within the server rooms (the existing DSD storeroom at the Wastewater plant or the portable cabin at the Pier). Automated onsite software processes the data, which are subsequently sent to the university server using built-in **Data Management Framework** software. The framework allows direct integration into environmental data servers. Data can be transferred and shared via **OPENDAP**, **THREDDS** (Thematic Real-Time Environmental Distributed Data Services), or **OGC Web Services** (such as WMS and WCS).

 (iv) Government Data Sharing: Collected current and wave data will be fully integrated into an open-access, non-profit data-sharing platform. This data will be supplied completely free of charge to key partner departments—including the Hong Kong Observatory (HKO), Civil Engineering and Development Department (CEDD), and Drainage Services Department (DSD)—to refine real-time marine weather forecasting, coastal defence designs, and regional flood mitigation schemes.

(f) Please provide information for the below table for better clarify on the proposed installation. Attached please find 2 site plans for reference.

(g) It is noted that the server cabin height is stated as 2.2m in Appendix G but 2m in the Application form. Please revise.

As formally designated in the cross-section of **Appendix G (Section B-B)**, the structural height of the portable server cabin is **2.2 meters.** The text within the standard Application Form will be promptly revised and corrected to **2.2m** to maintain alignment with the official architectural layout drawings.

Locations	Zoning	Antennas	Sub-Area (A)	Cables	Sub-Area (B)	Server Room	Sub-Area (C)	Total (A+B+C)
Location (a) **Tai O – DSD Imhoff Wastewater Treatment**	"OU(STW)"	10 Antennas (0.25m x 0.25m x 2m) (W x L x H)	0.625m^2	35.15 m x 0.1m in width	3.515 m^2			4.14 m^2
	"CPA"	4 antennas (0.25m x 0.25m x 2m) (W x L x H)	0.25m^2	86.85 m x 0.1m in width	8.685 m^2			8.935 m^2
	Sub-Total		**0.875m^2**	**122m**	**12.2 m^2**			**13.075m^2**
Location (b) **Tai O – Public Pier**	"CPA"	12 Antennas (0.3m x 0.3m x 2.8m) (W x L x H)	1.08m^2	108.05 m x 0.1m in width	10.805 m^2			11.885 m^2
	"GB"	2 antennas (0.3m x 0.3m x 2.8m) (W x L x H)	0.18m^2	52.95 m x 0.1m in width	5.295 m^2	1.2m x 1.2m x 2.2m (W x L x H)	1.44 m^2	6.915 m^2
	Sub-Total		**1.26m^2**	**161m**	**16.1 m^2**		**1.44 m^2**	**18.8 m^2**
Grand Total			***2.135 m^2***	***283m***	***28.3 m^2***		***1.44 m^2***	***31.875m^2***

Comments from Landscape Unit, Urban Design & Landscape Section, Planning Department
Contact Person: Mr. HUI Chun Sing Tel.: 3565 3951
1. Section 5.3.5 of the Supporting Statement mentions that *"the proposed installation area is entirely clear of any tree root systems or overhead canopy coverage."* However, in the same paragraph, the applicant mentions that the cabling will traverse the wooded area behind the Sewage Treatment Plant. The information provided cannot demonstrate that the installation will not cause adverse impacts on the existing trees and distinctive landscape character/resources, i.e., coastal protection area and green belt; The proposed cable routing does not involve any traditional trenching or sub-surface excavation within the natural terrain. Instead, the cables will be entirely enclosed inside a high-durability, flexible conduit and laid on the surface of the ground. Field surveys demonstrate that the corridor behind the existing facility consists predominantly of a thick, natural layer of leaf litter, fallen twigs, and clear organic ground coverage, with no structural living root systems breaching the surface along this specific path. Because the flexible conduit simply rests on top of this superficial organic layer, it exerts minimal mechanical pressure on the underlying soil and eliminates the risk of root severance or bark damage. The flexibility of the conduit allows for real-time adjustments during the physical installation phase, enabling the field team to manually guide the path around any minor surface vegetation, trunks, or natural obstacles without causing any physical impact. Furthermore, this method ensures that no heavy machinery or mechanical excavators will enter the wooded zone, as the entire deployment process will be carried out manually with zero disturbance to the subterranean root systems of the surrounding trees. Upon completion of the installation, the local ground profile and landscape character will remain entirely unaltered, ensuring full compliance with the strict non-intrusive

preservation guidelines required for the area.

2. the dimensions of the power supply and connection mentioned in Figures 11 and 20 are not provided to demonstrate that no adverse landscape impact would be caused.

   To demonstrate that the proposed power supply connection will not cause any adverse visual or landscape impact, we provide the exact dimensions and specifications below:

- **Dimensions:** T he proposed power supply enclosure will be highly compact, with dimensions **not exceeding 500mm (W) x 700mm (H) x 250mm (D)** and will be planned to be attached to the existing facilities.
- **Visual Mitigation:** The enclosure is highly compact and will be finished in an **earth-tone / matte dark green / grey colour** to match the existing utility infrastructure of the nearby facilities.
- **Placement:** It will be installed directly adjacent to existing concrete structures/utilities to ensure it does not create a new visual intrusion or disrupt the natural skyline of the Coastal Protection Area.

Comments from District Planning Officer/Sai Kung & Islands, Planning Department

Contact Person: Mr. Dicky CHAN Tel.: 2158 6056

In view of the above comments from the Landscape Unit, please consider whether a Landscape Proposal should be prepared to properly assess the potential landscape impacts of the proposal.

Comments from Environmental Protection Department
Contact Person: Ms. Tiffany CHEUNG Tel.: 2835 1836

1. Section 5.3.3 and 6.3.3

    a. Please clarify if the concrete basement is existing structure near the Tai O sewage treatment facility / sandy beach. If not, the relevant waste arising should be addressed.

    We clarify that the concrete basement for the antennas is a **new, strictly pre-cast concrete basements**, see details in the next point.

    b. Since concrete basement would be used for antennas supports, please confirm and state that the concrete is pre-cast and directly placed over the rocks, and no concreting works would be involved during construction phase.

    We confirm that the main structural support blocks are pre-cast to eliminate major on-site concrete works. To ensure structural stability against wind loads and properly adhere the pre-cast bases to the uneven natural rock surface, only localized anchoring works will be involved:

- The pre-cast blocks will be secured via mechanical rock-bolts or dowels.
- A **minimal, localized amount of high-strength non-shrink grout/bonding mortar** will be applied strictly beneath the footprint of the pre-cast base for levelling and adhesion purposes.
- **No mass wet concreting works or concrete mixing** will take place near the shoreline.
- To eliminate any risk of runoff into the sea, dry-grouting or ready-to-use pre-mixed mortar bags will be used, and protective bunding (such as plastic sheets/sandbags) will be placed around the immediate work area during application and curing.

2. Section 5.3.4

    a. It is noted that excavation would be involved. Please confirm whether only hand held tools would be used, and supplement key mitigation measures for dust control.

    We confirm that any minor excavation required (e.g., for cable laying)

will be carried out **strictly using hand-held tools**. Heavy machinery will not be used.

b. Please confirm that the project would have no emission, and would not introduce any project ASR during operation phase.

We confirm that the proposed project is fully electrically powered and will have **no gaseous emissions**. Furthermore, as this is an unmanned utility installation, it **will not introduce any project Air Sensitive Receivers (ASRs)** during the operation phase.

3. Section 5.3.5 and 6.3.5

a. Please advise the waste estimation, handling arrangement, reuse/disposal outlet of various waste types (e.g. inert C&D materials, non-inert C&D materials, chemical waste and general refuse from workforce, etc.) and any mitigation measures for the waste management of the proposed works at Section 5 (refers to as "Station: Tai O - Wastewater Treatment Station") and Section 6 (refers to as "Station: Tai O - Pier") respectively.

Due to the pre-fabricated nature of the system, waste generation will be minimal:

- **Inert C&D materials: Zero.** There will be no excavation of natural terrain, hence no generation of inert C&D waste.
- **Non-inert C&D materials & General Refuse:** Minimal packaging materials and general refuse during the installation works. This will be collected daily in garbage bags (Estimated at less than 0.01 m^3) and disposed of at designated **FEHD** refuse collection points.

Based on the detailed construction specifications, the excavation for the under-paved cable routing is minor and localized:

- **Dimensions:** The trench measures 2.43 meters in length, 13.5 centimetres in width, and 23.5 centimetres in depth, yielding a total excavation volume of approximately **0.077** m^3.
- **Handling & Disposal Arrangement:** Since the trench will be backfilled with a sand cushion envelope around the ϕ 75 mm

corrugated tube, topped with soil, and reinstated with concrete to the finished ground level, the net surplus inert C&D material generated for disposal (mainly the broken concrete crust from the initial opening) is negligible, **less than 0.03** m^3 (equivalent to a couple of standard buckets).

- **Disposal Outlet:** This minimal surplus will be sorted on-site, bagged, and transported by the contractor to a designated CEDD public filling facility (e.g., Tuen Mun Area 38 Fill Bank) in accordance with the Trip Ticket System.

- **Chemical Waste: Zero.** No chemical waste will be generated during construction or operation.

b. Please revise the following sentence: "~~The only fixed source of operational noise will be the external AC unit, which is designed not to exceed a level of 50 dB, ensuring minimal acoustic disturbance to the surrounding environment.~~ The planned fixed noise sources (e.g. external AC units, communication equipment, ventilation/cooling fans in server rooms, etc.) will be designed, with necessary noise mitigation measures, to fully comply with the relevant requirements in HKPSG."
As requested, we have updated the Application to include the required commitment.

1. Please highlight all changes in the next submission.
Noted.

Comments from District Planning Officer/Sai Kung & Islands, Planning Department
Contact Person: Mr. Dicky CHAN Tel.: 2158 6056
Please note our further comments below on the captioned application for clarification purpose. (h) Referring to some public comments made on the application, please advise the follows: (i) given the distant coastal locations of the proposed installation, please advise the protective and monitoring measures in case of malfunctioning or damage of the facilities caused by adverse weather and strong storm surges; While every effort will be made to safeguard the field equipment, the installation is designed with a decentralized architecture to minimize financial and operational risk. The most high-value and critical component (the main server) is housed safely indoors/onshore, away from the exposed coastal elements. For the field components, the following protective and monitoring measures are implemented: • **Physical Protection and Lightning Mitigation:** The outdoor antennas and structural mounts are designed to be low-profile and ruggedized to withstand coastal weather. Furthermore, the installation is equipped with a dual lightning protection system to mitigate the risk of electrical surges and damage during extreme weather events. • **Remote Monitoring:** The system uses continuous remote monitoring system. In the event of extreme weather causing a malfunction or physical displacement of an antenna, the technical team will receive an immediate automated alert, allowing for rapid deployment and replacement of the low-cost components as soon as conditions are safe. (ii) please justify if the proposed installation would cause impacts on marine creatures, fishery operations and use of coastal area by nearby residents; The proposed installation is anticipated to have no adverse impact on marine life, local fishery operations, or nearby residents due to the physical nature and safety parameters of the technology used:

- **Electromagnetic Safety and Low Power Output:** The high-frequency (HF) radar system operates at an extremely low power output and emits exclusively non-ionizing radiofrequency radiation. As recognized by the World Health Organization (WHO), this type of energy lacks the power to cause cellular or thermal damage to human or animal health. The emission levels are minimal and safe, operating at parameters comparable to standard everyday technologies such as mobile phone networks.
- **No Acoustic Impact on Marine Mammals (Chinese White Dolphins):** Unlike sonar or other underwater technologies, HF radars operate entirely above the water's surface to track ocean currents and waves. They transmit electromagnetic waves through the air rather than acoustic waves underwater. Consequently, the system does not interfere with the acoustic communication, echolocation, or behaviour of marine mammals, including the Chinese White Dolphin.
- **Spatial and Operational Compatibility:** The physical footprint of the radar equipment does not obstruct marine navigation, local fishery operations, or the general public use of the coastal area by nearby residents.

(iii) as mentioned in the supporting letter from DSD in your submission, please advise whether local consultation has been arranged to collect and address public concerns before the commencement of the works; and

To clarify the procedural timeline, a formal local public consultation has not been initiated at this stage. In line with standard administrative practices for high-technology research infrastructure, it was understood that public or stakeholder consultation would be more appropriately coordinated following the initial land allocation/approval from the relevant authorities. We remain open to provide technical clarifications to local stakeholders through the appropriate government channels if required.

(iv) whether the proposed installation would be further expanded in Tai O in a later stage of the research in addition to the current scale and extent.

There is no plan to expand the physical scale, footprint, or dimension of the current installation in Tai O. The objective of any future phase of this research would be an extension in **time**, not in size. Gathering data over a longer duration will allow capturing seasonal variations, which translates to more

reliable and accurate meteorological forecasts without increasing the physical imprinting of the equipment in the area.

We note that any such future arrangement would proceed through the appropriate planning review channels via the Town Planning Board.

Comments from District Planning Officer/Sai Kung & Islands, Planning Department
Contact Person: Mr. Dicky CHAN Tel.: 2158 6056
Please find the following concerned departmental comments (Batch 5) as at 6.7.2026 of the captioned application No. A/I-TOF/9 for your information and necessary action. (i) It is noted from your detailed plans D, I and J, the heights of the whole antennas (concrete basement, stainless support, wooden support, antenna support and antenna pole) seem to exceed 2m as stated in the application form. Please clarify the correct heights for antennas of two locations. We would like to clarify the heights indicated in Plans D, I, and J, and provide the exact measurements for both locations: • **Tai O Wastewater Treatment Works Location:** At this location, all antennas (both RX and TX), including their respective basements, supports, and poles have a total height of **2.0 meters** from the finished ground level. • **Tai O Pier Location:** The total combined height at this location is **2.8 meters**. This additional height is an engineering requirement driven by localized environmental conditions. Specifically, the structure must be elevated to **withstand extreme tidal fluctuations and storm surges** at the pier, ensuring the sensitive antenna equipment remains safely above the maximum high-water level during adverse weather. Please note that the structural base and supports remain minimal, and the upper section consists solely of lightweight, thin antenna poles with negligible visual bulk or physical footprint.

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DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

email: [redacted]

Application for Permission under Sec. 16 of the Town Planning Ordinance (CAP.131): Temporary Radar Installation for Coastal Monitoring and Data Acquisition (Coastal High Frequency Radar Network) with Ancillary Facility and Associated Excavation and Filling of Land for a period of 3 years

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1 Introduction

The purpose of this Application for Permission under Sec. 16 is to request the temporary use of Hong Kong land in order to deploy a local High Resolution Radars (HFRs) network to cover two of the most interesting spots of the Hong Kong Waters, namely the Central Waters and the exit of the Pearl River Estuary. The new non-profit network will greatly enhance regional ocean monitoring capabilities and the data will be made available on a free basis to a wide range of stakeholders, from the scientific community to all government departments involved in coastal engineering, flood and extreme event mitigation and environmental management, as well as contributing to several future research projects.

High Frequency Radar (HFR) technology refers to land based remote sensing equipment capable of measuring surface currents and waves over distance up to few hundreds of kilometres. Coastal radar technology is now widely recognized as a cost-effective and highly reliable tool to monitor coastal regions for both superficial current and wave climate in real time, overcoming several limitations of more standard oceanographic techniques based on ship-mounted instruments or moorings. The success of this technology is demonstrated by the steadily increasing number of radar stations worldwide. The interest for a real-time areal ocean and coastal monitoring has now gone beyond the boundaries of the scientific community, reaching the interest of the government authorities responsible for protecting the coastal environments and managing the risks associated with natural events and human activities.

The application is part of the activity planned in the framework of the Research Grants Council (RGC) with Reference No. C5032-22EF (`https://www.ugc.edu.hk/eng/rgc/funding_opport/crf/funded%20research/crf22_lay_sum.html#C5032`). In particular, the application regards the allocation from Collaborative Research Fund (CRF) 2022/2023 for Equipment Grant.

Owing to the importance of the coastal radar monitoring network for increasing the coastal resilience against flooding risk, the project has already received support from the Development Bureau (DEVB), as well as other departments (HKO, CEDD and DSD) with interests in coastal processes and coastal defence. Support letters are attached in Section 8.

The need for accurate monitoring of ocean surface currents and wave fields is nowadays recognized not only from the scientific community, but also from public and private sectors. This aspect was decisive in encouraging a joint effort for the expansion of ocean observations and the technological development of new systems suitable for covering ever greater coastal and open ocean areas. It is in this context that the proposed equipment steps in, filling the gap between local (buoys and ships) and long range (low frequency radar) measurements.

In accordance to the provision of law of the Hong Kong SAR government, we submitted and obtained the permit for operation the HF-radars emissions. The permission was issued by the Office of the Communication Authority (OFCA). This parallel process is essential to ensure that all regulatory requirements are met and that the system can operate seamlessly upon approval of the tenancy.

2 Relevance and Impact

This project is driven by strong commitment to the public benefit, to ensure that the valuable data collected is made available on a non-profit basis to a wide range of stakeholders. Indeed, the network will represent a key resource for both the academic/ scientific community and government departments involved in coastal engineering, flood and extreme event mitigation, and environmental management. The access to the data will be open and free of any charges, promoting a culture of transparency and collaboration that will allow for more informed decision making and innovative solutions.

High-Frequency Radar (HFR) networks have become essential tools for ocean and coastal waters monitoring. What really distinguishes HFR from other ocean monitoring methods is that HFR provide hourly updates of total velocity fields over large areas with high spatial resolution. Indeed, these networks can offer a clear and frequent picture of the ocean weather condition over a wide area. HFR's ability to monitor large areas continuously and real-time is essential to early warning systems for natural hazards such as storms and tsunamis, for improving safety of maritime navigation and for supporting Search and Rescue operation and rapid response in case of marine pollution events.

To fully understand the expected impacts of the Project, it is important to start from the local societal needs and environmental pressures. The local ocean waters and coastal areas represent a perfect example of the future challenges that the Hong Kong community will face to pursue sustainable development and to contrast climate changes. The region is highly vulnerable to extreme weather events, particularly typhoons, which can cause significant damage to coastal infrastructure, affect daily life and pose serious risks to public safety.

Moreover, a real-time data acquisition network, integrated with an early warning system, enables proactive and informed decision-making. Indeed, during typhoons, these systems track wind speeds, wave heights and storm surges, allowing authorities to predict potential flooding, erosion, and infrastructure damages. This real-time information is essential for implementing emergency measures such as evacuations, road closures and strengthening critical infrastructure. It also helps with the long-term planning and design of coastal defences, such as breakwalls and flood barriers, to ensure they can withstand future storms.

One of the most important aspect of the HFRs networks is their long expected lifetime and the possibility of easy extensions. In long term, we expect that the interest on HFRs network will increase and new coastal sites will be covered by the network with the aim to fully cover the HKSAR waters. This will represent a great success in light of the vital importance of coastal lands for the local community.

3 Target Beneficiaries

A comprehensive coastal monitoring system, such as the High-Frequency Radar (HFR) network, provides essential data and insights for a wide range of stakeholders, from local government agencies to the tourism sector.

Several local stakeholders in Hong Kong have already expressed great interest in our project, underlining its relevance and potential impact. Their support not only confirms the importance of our initiative, but also demonstrate an openness to meaningful collaborations. These expressions of interest are documented in the support letters, included in Section 8. These letters serve as a proof of the alignment between the goal of our project and the needs of the local community, and they provide a strong foundation for building partnerships and securing further engagement.

In particular, the Hong Kong Observatory (HKO) will use our data for refining their weather forecasting and monitoring, ensuring accurate and timely information for public safety. The Civil Engineering and Development Department (CEDD) will employ our data for coastal works design. Moreover, CEDD also monitors the sea through the use of buoys, thus an integration between the two measuring systems will help with the maintenance and management of coastal protection measures. In addition, the Drainage Services Department (DSD) will use our data to address flooding issues, enabling them to implement effective drainage and flood prevention strategies. To conclude, our data plays a vital role in supporting these government agencies in their respective missions.

Indeed, HFR data can greatly assist local governments in developing more informed coastal management policies, urban planning and even improving emergency response systems. Real-time data of surface currents, waves and other oceanographic conditions enable local authorities to make more informed decisions on the sustainability and resilience of their coastal zones: this information facilitates the development of sustainable strategies and resource allocation policies.

In the maritime industry, the use of HFR could bring several benefits. For example, shipping companies may optimize vessels routes: this not only lowers operating costs, but also reduces the environmental impact of shipping activities by reducing fuel consumption and travel time. Port authorities could manage operations more efficiently with real-time information, scheduling of ship arrivals and departures according to wave conditions, reducing waiting times and optimising the use of port facilities. Finally, fisheries may use oceanographic data to locate areas rich in nutrients and fish populations, and target the fishing operations to increase catch, while minimising the environmental impact.

In general, the whole coastal communities will benefit significantly from the data provided by the network, experiencing improved safety, economic stability, and an enhanced quality of life. The safety will be enhanced by providing early warnings and real-time monitoring of oceanographic conditions, allowing for timely alerts and evacuations in the event of natural disasters. By having access to accurate and up-to-date information, residents can take proactive measures to protect lives and property. In this way, coastal communities will also experience a better economic stability, optimising the resources and preserving high-valued infrastructures a-priori.

4 Area of Interest

The selection of the specific radar positions across the designated AOIs was guided by the following requirements:

- Unobstructed Sightlines: The radar technology requires an open, uninterrupted line of sight to the horizon across the water to ensure accurate data collection and maximum signal propagation. Both selected shorelines offer clear paths mostly free of physical obstruction.

- Safety and Security (Non-Recreational Isolation): To eliminate potential public conflicts, accidental interference, or vandalism, sites with naturally restricted or non-existent public access were prioritized. The rugged, rocky, and steep coastal nature of these locations naturally deters public traffic.

- Proximity to Existing Infrastructure: Sites were chosen where they could leverage existing technical facilities or retaining structures to minimize new land footprint, environmental disruption, and visual impact. Radar operation requires power supply, the vicinity to an available power line is a fundamental requirement.

- Strategic Meteorological Positioning: Locations directly exposed to incoming coastal weather dynamics were selected to facilitate the earliest possible detection of storm surges and wave phenomena, maximizing the system's value as a hazard early-warning tool.

The design of the HF radar network followed the international best practice used worldwide for the deployment and operation of coastal radars for ocean monitoring. The best practices have been published in several technical and scientific reports, see for example.:

- Cook, T., Hazard, L., Otero, M., & Zelenka, B. (2008). Deployment and Maintenance of a High-frequency Radar (HFR) for Ocean Surface Current Mapping: Best Practices.

- Mantovani, C., Corgnati, L., Horstmann, J., Rubio, A., Reyes, E., Quentin, C., ... & Griffa, A. (2020). Best practices on high frequency radar deployment and operation for ocean current measurement. Frontiers in Marine Science, 7, 512304.

The Areas of Interest (AOIs), proposed in the present application, are shown in figure 1.

AOI1 covers the Pearl River Estuary: this region had been already deeply studied since its dynamic is one of the most important drivers for the circulations in the Hong Kong SAR waters. AOI2 focuses on the core of the HKSAR waters, the Central Waters.

The Central Water is already a focus of sea waves and water levels monitoring. Several pointwise measuring stations are installed in the Hong Kong Waters and have been collecting data for several years. The instruments are managed by different institutions, namely the Hong Kong Observatory, the Hydrographic Office of Marine

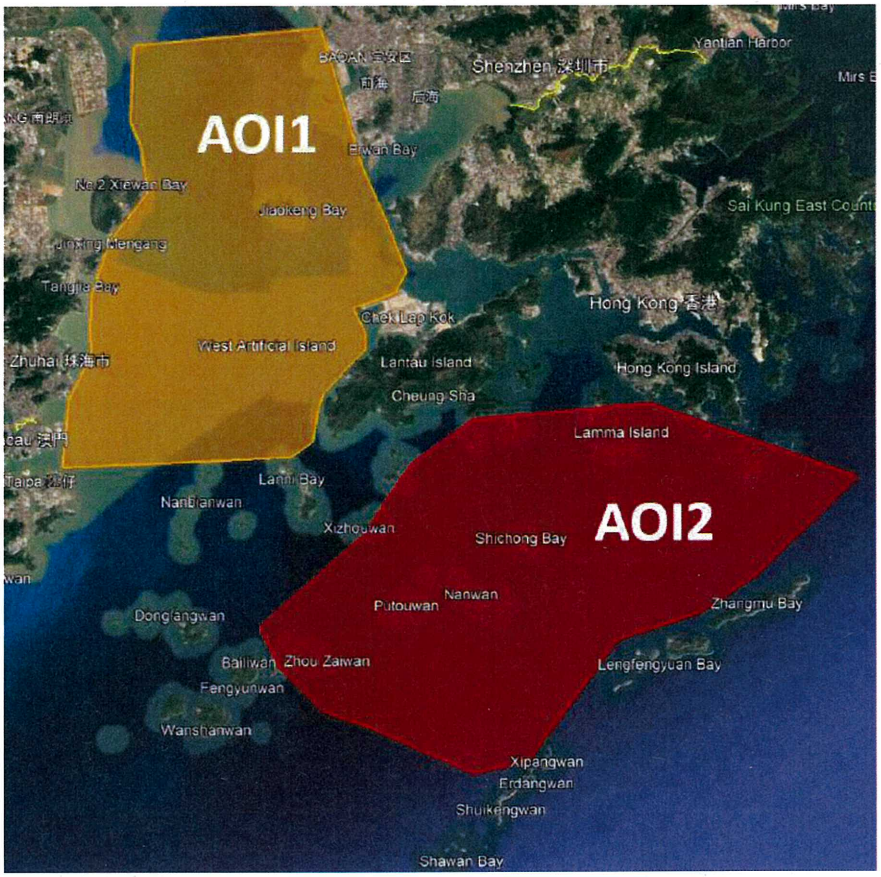

Figure 1: AOIs considered in the present project. Pearl River Estuary (AOI1 in orange) and Hong Kong Central Waters (AOI2 in red).

Department, the Airport Authority and the Drainage Services Department. The data are available online from the website of the Hong Kong Observatory.

Moreover, the Port Works Division of the Civil Engineering and Development Department have been maintaining a long term wave monitoring programme since 1994. Two monitoring stations have been set up in the Central Waters (harbour near Kau Yi Chau and at the West Lamma Channel) and in the future the number of mooring stations is planned to be increased based on the need to increase the monitoring capabilities for the coastal management of Hong Kong. Therefore, the present proposal is in line with the long term strategy of ocean monitoring and the HFRs, once operating, will contribute to increase the knowledge of the main coastal processes and will represent a powerful tool for future planning of coastal defences and extreme events preparedness actions.

All sites perfectly meet the site criteria. Indeed, High-Frequency Radar (HFR) networks operate using spatial cross-bearing principles. A single radar station can only measure radial components of sea surface velocities. To continuously map comprehensive, two-dimensional total velocity fields and wave dynamics across a broad zone, a multi-station network configuration is mandatory. Operating all the stations simultaneously fills the localized observational gaps, expanding high-resolution monitoring coverage seamlessly across the Pearl River Estuary and Hong Kong's Central Waters.

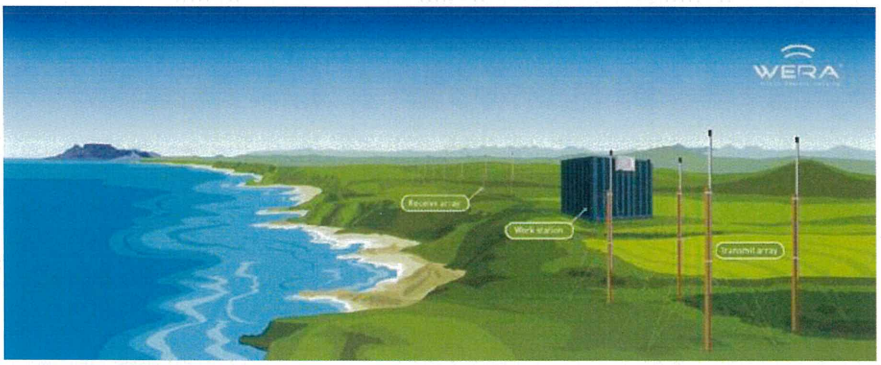

Figure 2: Sketch of WERA Ocean Remote Sensing System.

Figure 2 provides a detailed sketch of a typical coastal monitoring system configuration, illustrating the essential layout for modern oceanographic observation. Strategically situated along the coastline, the 'Receive array' and 'Transmit array' antennas are arranged in a calibrated grid pattern to optimise the capture of high-frequency signals across the marine environment. These arrays are interconnected via high-bandwidth cable links and connected to a fully equipped workstation that serves as the operational nerve centre for data acquisition, processing and analysis. This integrated setup is representative of a state-of-the-art ocean remote sensing net-

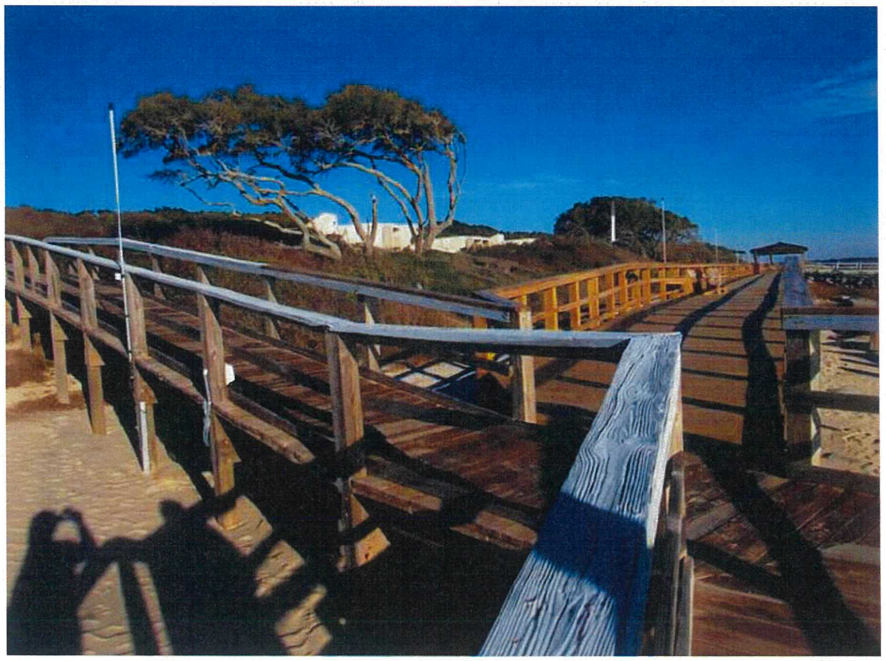

Figure 3: Antenna Array integrated along a boardwalk in Georgia, USA.

work designed to monitor parameters such as surface currents and wave dynamics.

The system combines advanced antenna technology with computational infrastructure to enhance our understanding and stewardship of coastal zones.

Various installations of the Ocean Remote Sensing System are operational worldwide, with some examples illustrated in the images in this section.

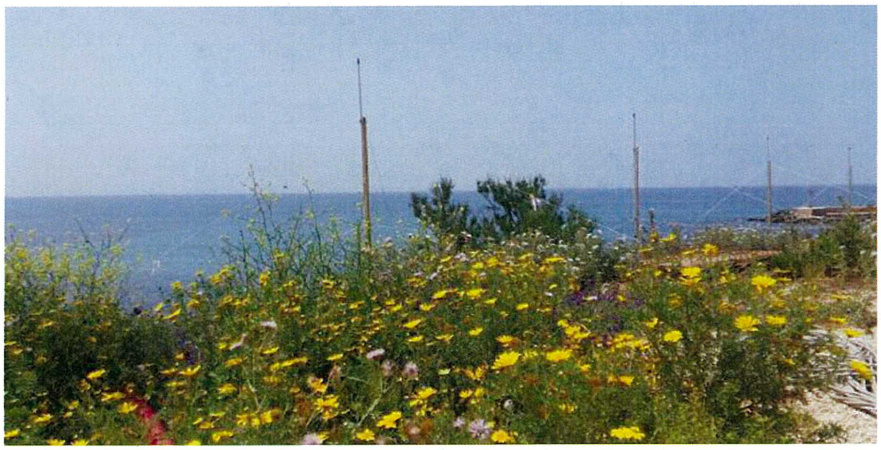

Figure 4: Antenna Array surrounded by nature in Capo Granitola, Sicily, Italy.

Figure 3 captures an antenna array positioned on a wooden boardwalk along the coast of Georgia, integrated into a public space frequently visited by tourists. The design reflects careful consideration of both functionality and aesthetics, allowing the structure to fulfill its purpose without disrupting the natural or recreational use of the area. In figure 4, the antenna array is situated within the scenic landscape of

Figure 5: Antenna Array along a public beach in Liverpool Bay, UK.

Capo Garinola, nestled among vibrant wildflowers and Mediterranean vegetation. This setting demonstrates that the presence of the antennas do not hinder ecological restoration of the site, while also highlights how such installations can maintain a low visual profile and blend harmoniously with their surroundings.

Lastly, figures 5 and 6 showcase antenna arrays deployed along public beaches. Both cases reveal how these structures are engineered to withstand saltwater exposure, high winds, and public interaction, demonstrating their adaptability to coastal environments.

These images underscore the remarkable versatility and widespread applicability of modern antenna arrays, confirming their role as unobtrusive yet robust components in diverse environmental settings, from urban waterfronts to natural habitats.

Figure 6: Antenna Array along a public beach in South Florida, USA.

Figure 7: Example of a small portable cabin, used as local server room.

The following sections provide a comprehensive overview of the individual monitoring stations and their constituent components. In general, each station is composed of a standardized yet flexible configuration designed for robust performance in varied environmental conditions. A typical setup includes an array of 12 receive antennas (denoted as RX), arranged to optimize signal reception and spatial resolution, along with either 2 or 4 transmitting antennas (TX), with the exact number determined by site-specific requirements such as coverage area and target resolution.

In addition to the antenna arrays, each station features a dedicated server room housed within a compact, portable cabin (see Figure 7), which provides a secure and controlled environment for the computational and networking equipment es-

sential for real-time data processing and system operation. This cabin is designed to withstand outdoor conditions while ensuring thermal stability and physical security. A designated power supply point, often supported by backup systems such as uninterrupted power supplies (UPS), ensures continuous operation and reliability even in remote or off-grid locations. Together, these elements form an integrated, self-sufficient station capable of sustained high-performance monitoring.

5 Station: Tai O - Wastewater Treatment Station

5.1 Overview of the site layout

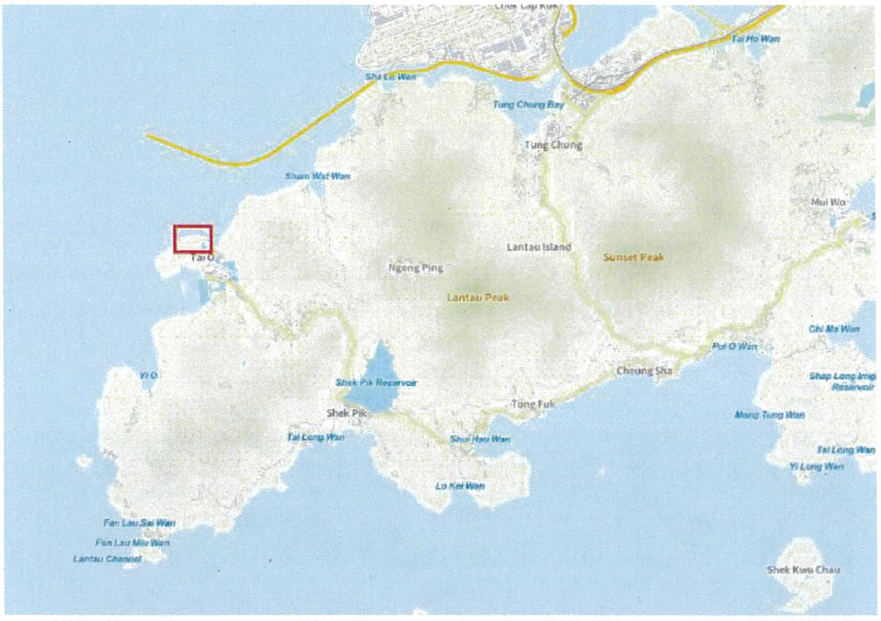

Figure 8: Approximate position of the Tai O - Wastewater Treatment Station site in respect to Lantau Island (red squared box).

The Imhoff wastewater treatment station in Tai O is a facility designed to manage and treat wastewater in the area. The wastewater treatment station is operated and maintained by the Drainage Services Department (DSD) of the Hong Kong Government.

Figure 8 indicates the approximate position of the site in respect to Lantau Island, whereas figure 9 shows an areal close up of the site.

An in situ survey was conducted in order to determine the GPS positions of the different components of the network within the study area. This survey involved the direct measurement of coordinates on the ground, ensuring precise and reliable data

Figure 9: Areal view of Tai O - Wastewater Treatment Station site.

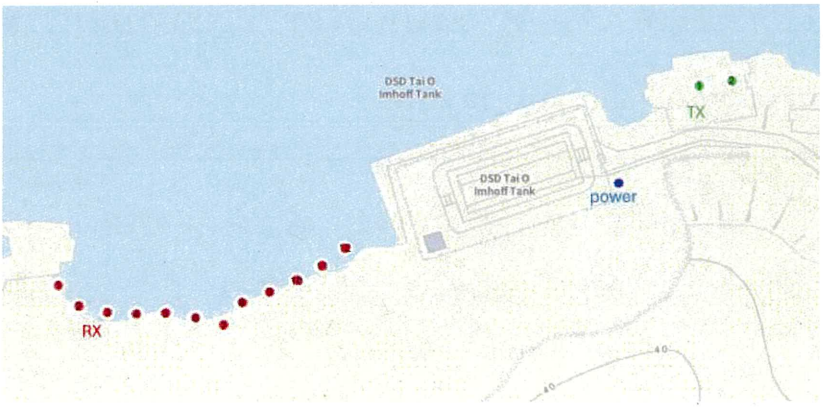

Figure 10: GPS positions reported on the geospatial information service provided by the Hong Kong Special Administrative Region (HKSAR) Government (GeoInfo Map).

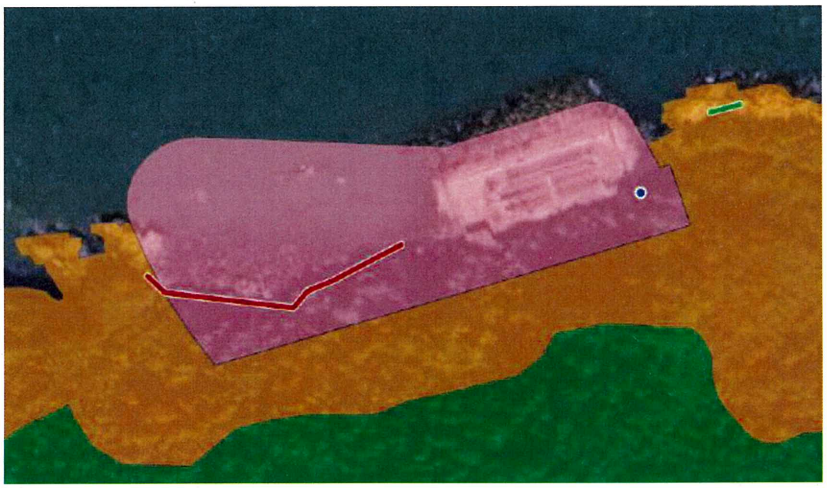

Figure 11: Outline Zoning Plan. Pink: Other Specified Uses; Orange: Coastal Protection Area; Green: green belt. The red and green line represents the Rx and Tx positions, respectively. The power connection is marked by the blue dot.

collection. A sketch of the GPS position is provided in figure 10 and the coordinates, in HK1980 reference, are listed in table 1. The antennas are positioned at a safe distance from the High Water Mark Line.

Another information needed is the Outline Zoning Plan. The purpose of an Outline Zoning Plan is to provide a comprehensive framework for guiding and regulating the development and use of land. The Outline Zoning Plan is provided by the Town Planning Board (`https://www.ozp.tpb.gov.hk/`) and it is shown in figure 11. The transmitting antennas falls in the so called *Coastal Protection Area*. However, the network is primarily located within the area designated as *Other Specified Uses*. Specifically, the Imhoff Wastewater Treatment facility is managed by the Drainage Services Department. We have already contacted DSD, and they agreed to host the server and electronics inside the technical room of the Plant, see email in section 8.

		Lon	Lat
RX	1	803497.79	813602.63
	2	803502.22	813598.47
	3	803508.28	813595.33
	4	803514.15	813596.35
	5	803519.08	813597.10
	6	803524.87	813595.41
	7	803529.64	813596.42
	8	803534.03	813598.71
	9	803538.72	813600.94
	10	803543.88	813602.89
	11	803548.72	813604.67
	12	803555.29	813608.05
TX	1	803618.82	813640.21
	2	803624.82	813641.12
	power	803603.67	813622.06
	server room	803569.13	813610.98

Table 1: Tai O - Wastewater Treatment Station - HK1980 GPS coordinates of the antennas, power supply and server room.

5.2 Current state of the area

The site surrounding the Tai O Wastewater Treatment Facility provides an ideal environment in which operate an antenna array securely and without interruption. The terrain is characterised by a natural, rocky coastline, as shown in figure 12.

The area is distinctly non-recreational; the rugged, inaccessible shoreline naturally discourages public access, thereby eliminating potential conflicts and minimising the risk of vandalism or accidental interference. Furthermore, although vegetation is present, it naturally recedes from the rocky coast, ensuring a permanent, unobstructed line of sight for radio frequencies. The area currently shows signs of neglect, with accumulations of tidal debris and a lack of active landscaping (bottom right panel of figure 12).

Figure 12: Station Tai O Wastewater Treatment Current State. Top left: view from the last Rx toward the Wastewater Plant Station; Top right: view toward the Rx position from the Wastewater Plant Station; Bottom left: Tx positions (Wastewater Plant Station on the back); Bottom right: accumulation of garbage due to flooding.

5.3 Installation details

5.3.1 Plan view

A detailed plan view of the project area is provided in Appendix A. This drawing shows the layout of the 12 passive receiving (RX) antenna array, positioned on the west side of the Tai O Wastewater Treatment Facility, and the 2 passive transmitting (Tx) antennas, which will be installed on a flat rock outcrop to the east. A rendering of the antennas is provided in figure 13.

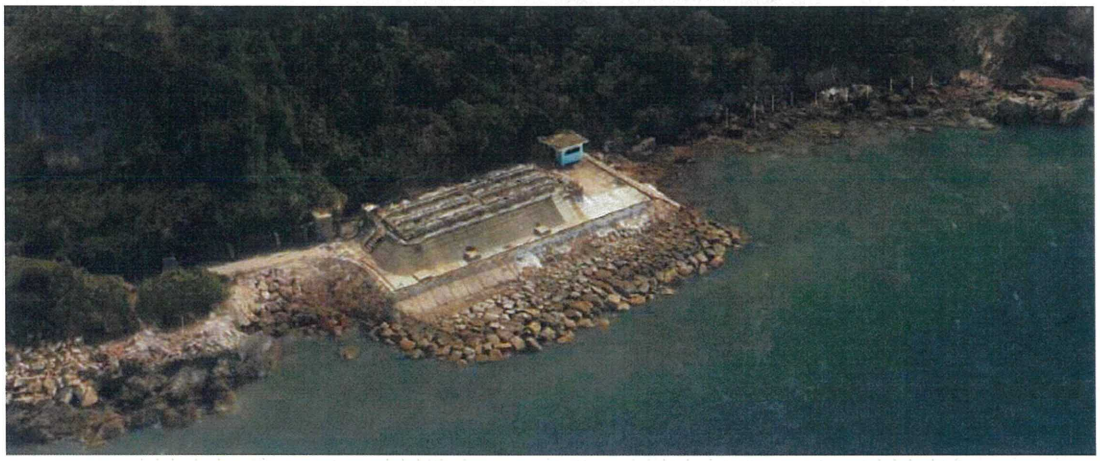

Figure 13: Rendering showing the antennas on the rocky coastline.

The server equipment will be housed within an existing technical room (figure 14), owned by the Drainage Services Department (DSD). This represents a positive reuse of built infrastructure, requiring no new land consumption or additional visual footprint. We are also prepared to install appropriate fire extinguishers within the server room to ensure full compliance with fire safety regulations.

Figure 14: DSD technical room.

Furthermore, to demonstrate that the proposed power supply connection will not cause adverse visual or landscape impact, the exact dimensions and specifications are detailed below:

- Dimensions: The proposed power supply enclosure will be highly compact, with dimensions not exceeding 500 mm (W) × 700 mm (H) × 250 mm (D).

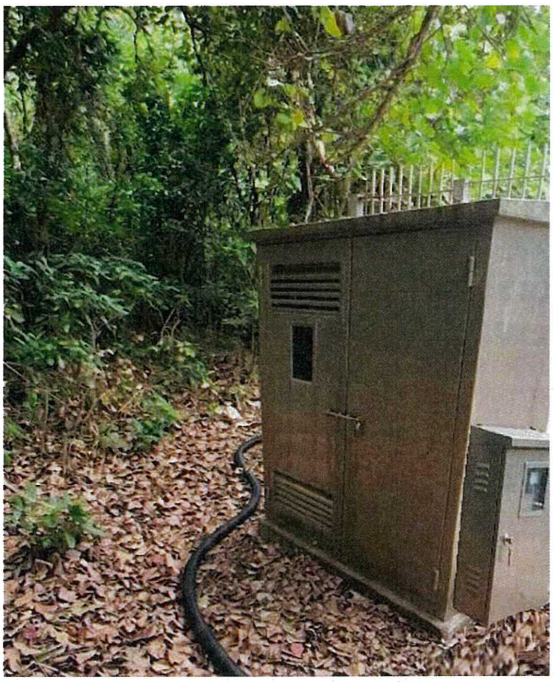

Figure 15: Rendering showing the compact power supply box integrated on the side of the existing utility cabinet, outside DSD gate. The connection cable will be enclosed in weather-proof flexible conduit running along the ground to eliminate the need for trenching, thereby ensuring zero impact on the surrounding soil and vegetation.

- Visual Mitigation: The enclosure features a low-profile design and will be finished in a grey color to seamlessly match the existing utility infrastructure of the nearby facilities.

- Placement: It will be installed directly adjacent to existing utilities. This strategic positioning ensures it does not create a new visual intrusion or disrupt the natural landscape.

A rendering of the new power supply is shown in Figure 15.

5.3.2 Cross sections

The plan view (provided in Appendix A at positions C-6 and C-7) shows the location of Section A-A. The detailed cross-section is presented in Appendix B. This cross-section clarifies the proposed installation geometry with a focus on one RX antenna and illustrates its minimal impact above the natural topography. Section B-B (in squared G-4 and G-5 Appendix A) is reported in Appendix C and it illustrates the cross-section detail of one TX antenna. Both profile views confirm the antennas low-profile design and their negligible visual impact on the surrounding landscape, effectively preserving the area character.

5.3.3 Antennas supports

In Appendix D are shown the antennas constructive details. In particular, the both RX and TX antenna poles are fixed to a wooden. The wooden pole is then inserted on a stainless steel support on a concrete basement placed over the rocks, without any operation of filling or excavation of land, as required in the CPA zone, in accordance with the temporary use of the land.

5.3.4 Cable routing

The cable connection layout is also reported in the plan view, and the types of installation are detailed in Appendix K and L. In Appendix A, in blue are indicated all the cable sections placed above the ground with installation detail as in the blue cables in Appendix K and L: in red (see position F-5 in Appendix A) is indicated the under-paved section with an installation scheme reported in red in Appendix K and L.

The cabling infrastructure interconnects the twelve-element receiving (Rx) array and the two-element transmitting (Tx) array, terminating at the central server room, which is interfaced with the primary power supply. The cable routing for the Rx array is secured across the rock formations, continues along the landward side perimeter of the Wastewater Treatment facility, traverses the pedestrian walkway, and extends to the coastal Tx antenna locations, as explicitly detailed in the referenced plan view (Appendix A). Installation will be non-intrusive: all cabling will be affixed to rock surfaces or laid on the soil without excavation. No earthworks, including cutting, filling, or land removal, will be undertaken.

As shown in the rendering in Figure 15, the proposed cable routing does not involve any traditional trenching or sub-surface excavation within the natural terrain. Instead, the cables will be entirely enclosed inside a high-durability, flexible conduit and laid on the surface of the ground, as simulated in the render.

Field surveys demonstrate that the corridor behind the existing facility consists predominantly of a thick, natural layer of leaf litter, fallen twigs, and clear organic ground coverage, with no structural living root systems breaching the surface along this specific path. Because the flexible conduit simply rests on top of this superficial organic layer, it exerts minimal mechanical pressure on the underlying soil and eliminates the risk of root severance or bark damage.

The flexibility of the conduit allows for real-time adjustments during the physical installation phase, enabling the field team to manually guide the path around any minor surface vegetation, trunks, or natural obstacles without causing any physical impact. Furthermore, this method ensures that no heavy machinery or mechanical excavators will enter the wooded zone, as the entire deployment process will be carried out manually with zero disturbance to the subterranean root systems of the surrounding trees. Upon completion of the installation, the local ground profile and landscape character will remain entirely unaltered, ensuring full compliance with the strict non-intrusive preservation guidelines required for the area.

As the connection to the transmitter (TX) antennas will require the installation of a conduit pathway beneath the existing surface walkways (marked in red line in position F-5 of Appendix A), an *Excavation Permit* and all other related documents will be requested following the approval of this document. A shallow trench shall

be excavated crossing the pathway route. The trench for the under-paved pathway cable routing (indicated as a red line in Appendix A at position F-5) shall be:

- 2.43 meters long,
- excavated to a depth of 23.5 centimeters, and
- a total width of 13.5 centimeters.

Centrally laid within this sand envelope is a ϕ 75 mm (7.5 cm) corrugated tube housing the internal ϕ 7 mm coaxial cables, which must be fully covered by an additional layer of sand on both the sides and the top for proper cushioning. Finally, the remaining upper section of the trench shall be backfilled with soil and covered by concrete up to the finished ground level. All excavation shall be performed with care to avoid damaging the edge of the existing concrete slab. We are fully committed to maintaining the structural integrity and surface condition of the existing pathway throughout the entire duration of the temporary permit. Furthermore, upon the conclusion of the permit period and the subsequent decommissioning and removal of all installation components, we will undertake a thorough reinstatement of the pathway to its original, pre-existing condition, ensuring no lasting impact on its function or appearance.

5.3.5 Noise and Land Impact assessment

A thorough preliminary site assessment confirmed that the proposed installation area is entirely clear of any tree root systems or overhead canopy coverage. This placement ensures that the installation will have zero impact on the existing wooded area, thereby completely eliminating the need for any tree felling, trimming, or removal. This approach underscores our commitment to preserving the natural landscape and maintaining the existing ecosystem. Furthermore, to minimize any potential disruption to the soil structure and the sub-terrain environment, the cabling that traverses the wooded area behind the Sewage Treatment Plant will not require any trenching or excavation. Instead, the cables will be carefully and securely laid directly on the ground surface. This methodology is not only feasible but is specifically chosen because the area is designated as a non-public transit zone, meaning there is no risk of interference with pedestrian or vehicular traffic. Consequently, the entire installation process is designed to be non-invasive, protecting both the arboreal and the ground-level habitats from any adverse effects. The planned fixed noise sources (e.g. external AC units, communication equipment, ventilation/cooling fans in server rooms, etc.) will be designed, with necessary noise mitigation measures, to fully comply with the relevant requirements in HKPSG. All receiving antennas have been positioned specifically to manage their visual presence. Their only potential line of sight is from the sea, and their extremely small diameter (approximately 3 cm) renders them virtually imperceptible at any meaningful distance from the coast. Furthermore, the transmitting antennas will be strategically placed on an inaccessible rock, where they will be effectively screened by existing vegetation. This vegetation will remain entirely intact, as it does not interfere with operations, allowing it to continue providing natural visual screening.

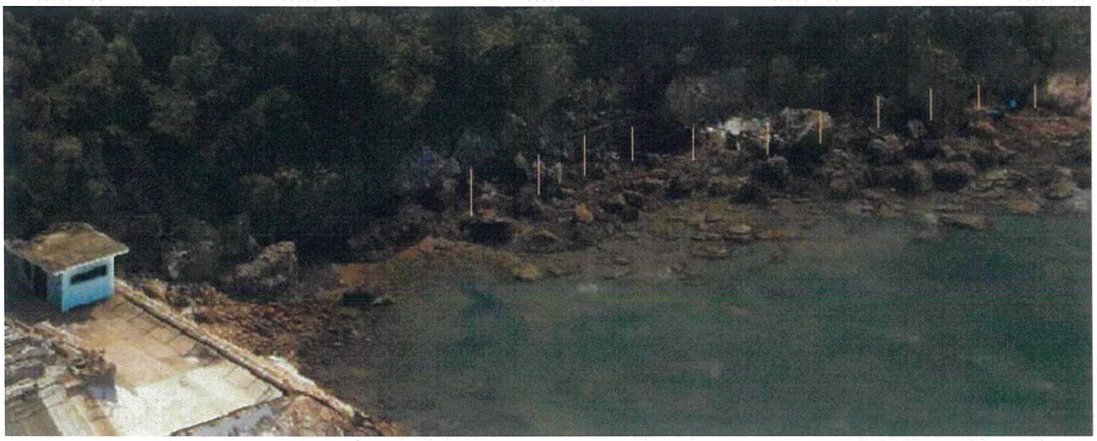

Figure 16: Rendering close up of the receiving antennas.

Moreover, the antennas will be painted by a sandy colour coat in order to further minimize their impact on the landscape.

As the provided rendering illustrate (figures 13 and 16), the proposed installation will be assimilated into the landscape with no material change to its character. Given this minimal impact, we are confident that no significant landscape or visual concerns will be raised.

During the construction phase, environmental impacts will be rigorously minimized. Noise pollution will be negligible, as the installation requires no heavy machinery. The primary activities, such as the placement of pre-assembled equipment and cabling, are manual and low-impact. Similarly, air and environmental pollution will be absent; there will be no burning, concrete pouring, or earth moving that might generates dust or runoff. All works will be conducted using hand held tools and existing pathways to avoid disturbing the surrounding habitat, ensuring that both auditory and ecological disruptions are kept to an absolute minimum.

6 Station: Tai O - Pier

6.1 Overview of the site layout

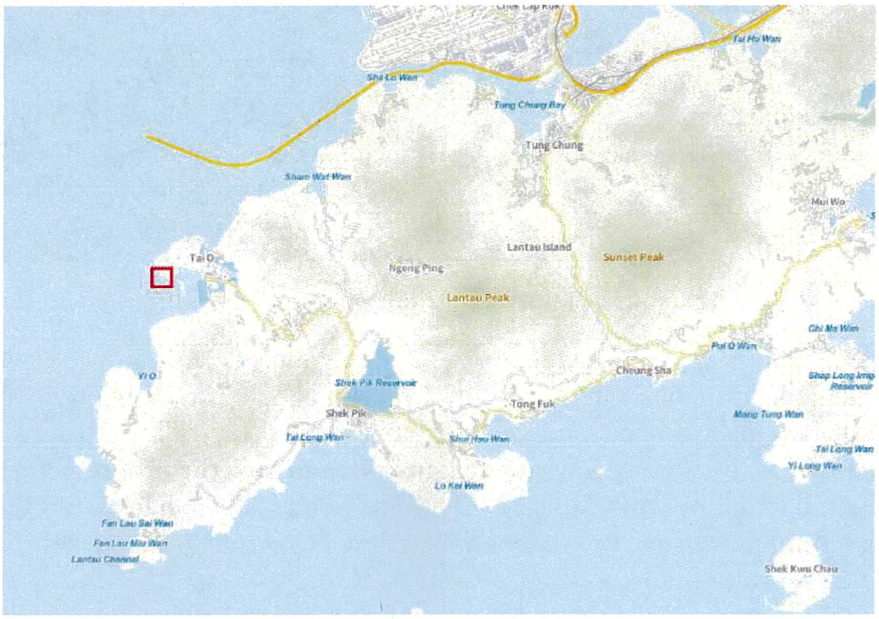

Figure 17: Approximate position of the Tai O - Pier site in respect to Lantau Island (red squared box).

The Tai O Pier is a significant feature of the Tai O fishing village on Lantau Island. The Tai O Pier has been a crucial part of the local community for many years, serving as a hub for transportation and trade. It has facilitated the movement of people and goods, connecting Tai O to other parts of Hong Kong and the mainland.

The area of coastline behind Tai O Old Pier is not open to the public, with no designated entry points or infrastructure for public use. This isolation, coupled with unobstructed sightline extending across the water towards Zhuhai, makes it an ideal location for offshore radar measurement installations. The absence of physical

Figure 18: Areal view of Tai O - Pier site.

obstructions in front of the antennas, such as buildings or islands, ensures clear

Figure 19: GPS positions reported on the geospatial information service provided by the Hong Kong Special Administrative Region (HKSAR) Government (GeoInfo Map).

Figure 20: Outline Zoning Plan. Pink: Other Specified Uses; Orange: Coastal Protection Area; Green: green belt. The red and green line represents the Rx and Tx positions, respectively. The server room is marked by the orange dot, whereas the blue one indicates the power connection.

signal propagation and accurate data collection, while its seclusion minimizes the risk of public disturbance. Figure 17 indicates the approximate position of the site in respect to Lantau Island, whereas figure 18 shows an areal close up of the site.

An in situ survey was conducted in order to determine the GPS positiosn of the different components of the network within the study area. This survey involved the direct measurement of coordinates on the ground, ensuring precise and reliable data collection. A sketch of the GPS position is provided in figure 19 and the coordinates, in HK1980 reference, are listed in table 2. The antennas are positioned at a safe distance from the High Water Mark Line, ensuring compliance with coastal regulatory guidelines. Another information needed is the Outline Zoning Plan. The purpose of an Outline Zoning Plan is to provide a comprehensive framework for guiding and regulating the development and use of land. The Outline Zoning Plan is provided by the Town Planning Board (`https://www.ozp.tpb.gov.hk/`) and it is shown in figure 20. The receiving antennas are placed in the *Coastal Protection Area*, whereas all the other components of the network are within the *Green Belt* area.

		Lon	Lat
RX	1	802854.60	812850.66
	2	802853.18	812856.16
	3	802852.47	812861.76
	4	802850.66	812867.05
	5	802847.61	812871.89
	6	802845.10	812877.08
	7	802842.84	812882.50
	8	802839.60	812887.08
	9	802836.90	812891.89
	10	802833.36	812896.14
	11	802829.44	812899.90
	12	802824.20	812901.73
TX	1	802896.15	812758.63
	2	802898.65	812753.16
	power	802901.82	812735.32
	server room	802895.06	812764.17

Table 2: Tai O - Pier - HK1980 GPS coordinates of the antennas, power supply and server room.

6.2 Current state of the area

Situated near the Tai O Old Pier, the site offers an optimal environment for the secure and uninterrupted operation of an antenna array. This application covers two distinct beach areas, see figure 21: the first is a sandy beach clearly visible from the Old Pier, while the second is a rocky beach hidden by the natural curvature of the coastline and therefore obscured from the Pier.

Figure 21: Station Tai O Pier: view of the proposed area from the pier.

The area endures a uniquely harsh maritime environment and it is considered non-recreational. Indeed, the shoreline does not have public access. This eliminates potential conflicts and minimises the risk of vandalism or accidental interference. Its exposition makes the area vulnerable to waves and storms that, even in normal

conditions due to tides, drive the accumulation of debris along the entire seashore (see bottom panel of figure 22).

This exposure is of paramount importance for the effective deployment of our radar network. The unobstructed, open sightline to the horizon is ideal for maximizing radar coverage and accuracy. Furthermore, the position as the first point impacted by storms allows for the earliest possible detection of approaching meteorological phenomena, making it an strategically optimal location for environmental monitoring and hazard early-warning systems.

Figure 22: Station Tai O Pier Current State. Panel 1: Rx positions, from last Rx, toward Tai O Old Pier (hardly visible on right side in the background); Panel 2 and 3: accumulation of garbage on the beach due to tidal run up.

6.3 Installation details

6.3.1 Plan view

A detailed plan view of the site is provided in Appendix E, illustrating the proposed layout of the antenna infrastructure. The 12-element passive receiving (RX) array is situated on the rocky beach, distanced from the Old Pier to minimize visual intrusion. The two passive transmitting (Tx) antennas are to be installed atop the containment wall adjacent to the nearer sandy beach, recognizable in figure 21. A rendering of the Rx antennas is provided in figure 23.

Figure 23: Rendering showing the antennas on the rocky coastline.

As shown in the rendering in figure 24, the portable cabin designated for use as a server room will be positioned atop the retaining wall adjacent to the beach. Its placement will be carefully planned to prevent disruption to the existing canopy and preserve the natural landscape. The impact of the small portable cabin on the landscape will be minimized using a camouflage net. This installation will be supported by a geotechnical study, which will be included as part of the project documentation (see the attached Geotechnical Planning Review Report). Note that the ground surface consists solely of a superficial layer of dead leaves and fallen woody debris, which does not conceal or interfere with any root systems beneath.

The new electrical supply point will be co-located immediately adjacent to an existing one (figure 25), minimizing the need for new above-ground space and further concentrating services.

Furthermore, to demonstrate that the proposed power supply connection will not cause adverse visual or landscape impact, the exact dimensions and specifications are detailed below:

- Dimensions: The proposed power supply enclosure will be highly compact, with dimensions not exceeding 500 mm (W) × 700 mm (H) × 250 mm (D).
- Visual Mitigation: The enclosure features a low-profile design and will be finished in a sandy color to seamlessly match the existing utility infrastructure of the nearby facilities.
- Placement: It will be installed directly adjacent to existing structures. This strategic positioning ensures it does not create a new visual intrusion or disrupt the natural landscape.

Figure 24: Left panel: Current state of the retaining wall and surrounding landscape. Right panel: AI-generated rendering illustrating the placement of the server cabin above the wall, designed to preserve existing canopy trees.

Figure 25: Existing supply points attached to the wall at the boundary of the beach.

6.3.2 Cross sections

In the plan view (positions B-3 and B-4), the Section A-A is marked and this section can be found in Appendix F. This cross-section clarifies the proposed installation geometry with a focus on one RX antenna and illustrates its minimal impact above the natural topography. The profile view confirms that the antenna low-profile design and its negligible visual impact on the surrounding landscape, effectively preserving the area character. Section B-B (in squared F-5 and F-6 Appendix E) is reported in Appendix G and it illustrates the cross-section of the small portable cabin positioned atop the containment wall adjacent to the sandy beach. Its compact design ensures it does not disrupt the existing canopy or surrounding vegetation. In fact, we have intentionally incorporated the natural vegetation, along with a camouflage net as previously mentioned, to effectively mask the cabin and minimize its visual presence within the landscape. Section C-C (in squared G-5 and G-6 Appendix E) is reported in Appendix H. This cross-section shows the installation detail of one TX antenna and illustrates its minimal impact atop of the containment wall, adjacent the sandy beach.

6.3.3 Antennas supports

In Appendix I and Appendix J are shown the receiving and transmitting antennas constructive details, respectively. In particular, the RX antenna pole is fixed to a wooden pole. The wooden pole is then inserted in a stainless steel support attached to a concrete block placed on the gravelled beach to provide a sufficient stability to the antenna base. The gravel will be rearranged so that, once the permit expires, the beach can be restored to its original configuration (see figure 22), in accordance with the temporary use of the land. The height of the support is determined by the tidal range to which this beach is exposed, about 2 meters. The Tx antenna pole is fixed to a wooden pole. The wooden pole is then inserted in a stainless steel support attached to a concrete block placed on the top of the wall at the edge of the sandy beach.

6.3.4 Cable routing

The cable connection layout is also reported in the plan view, and the types of installation are detailed in Appendix K and L with a colour code consistent with the plan view. The cable routing infrastructure is designed for both efficiency and minimal environmental impact. All individual connections and power line are integrated into a unified cable pathway, ensuring a protected, organized, and visually unobtrusive installation that respects the surrounding landscape. A single, cable will connect all twelve antennas in a sequential order before being routed along the beach edge. This main cable will enter the portable cabin, located between the Rx and Tx antenna arrays. Primary power will be supplied to the cabin to operate the server for the data collection and an AC unit. For the temporary nature of the installation, the cables will be securely laid on the rocks using small cemented strips, which will be entirely removed upon the conclusion of operational activities.

6.3.5 Noise and Land Impact assessment

A preliminary site assessment was conducted to evaluate the proposed installation area. This evaluation confirmed that the designated site is clear of any tree root systems, eliminating the risk of disturbing underground biological structures. Even though some groups of trees are located within the area designated for the installation, these trees do not obstruct or interfere with the operational performance of the antennas. As a result, no tree felling, trimming, or removal will be required. This strategic placement ensures the installation will have no adverse impact on the wooded environment and underscores our commitment to preserving the natural landscape and maintaining the integrity of the existing ecosystem. The planned fixed noise sources (e.g. external AC units, communication equipment, ventilation/cooling fans in server rooms, etc.) will be designed, with necessary noise mitigation measures, to fully comply with the relevant requirements in HKPSG. We are also prepared to install appropriate fire extinguishers within the server room to ensure full compliance with fire safety regulations. All receiving antennas have been positioned in such a way that their only potential line of sight is from the sea, and their extremely small diameter (approximately 3 cm) renders them virtually imperceptible at any meaningful distance from the coast. Note that the antennas will be painted by a sandy colour coat in order to minimize the impact on the landscape. During the construction phase, environmental impacts will be rigorously minimized. Noise pollution will be negligible, as the installation requires no heavy machinery. The primary activities, such as the placement of pre-assembled equipment and cabling, are manual and low-impact. Similarly, air and environmental pollution will be absent; there will be no burning, concrete pouring, or earth moving that might generates dust or runoff. All works will be conducted using hand held tools and existing pathways to avoid disturbing the surrounding habitat, ensuring that both auditory and ecological disruptions are kept to an absolute minimum.

7 Environmental, Safety, and Nuisance Assessment

7.1 Construction Stage

Given the small footprint and the non-invasive nature of High-Frequency Radar (HFR) installations, potential nuisances and safety concerns during the construction phase are minimal and highly controllable:

- Negligible Noise and Air Pollution: No heavy machinery will be utilized. Installation involves manual placement of pre-assembled equipment and hand-held tools. There will be minimal concrete usage, no burning, or earth-moving activities that generate dust or environmental runoff.
- No Ecological Disruption: All cabling will either follow existing pathways, sit directly on surface rocks/soil, or navigate underneath paved slabs via a highly restricted, temporary shallow trench. No trees or root systems will be cut, trimmed, or felled.
- Minimized On-Site Concrete Works and Runoff Control: The main structural support blocks are pre-cast to eliminate major on-site concrete works. To ensure structural stability against wind loads and properly adhere the pre-cast bases to the uneven natural rock surface, only localized anchoring works will be involved:
  - The pre-cast blocks will be secured via mechanical rock-bolts or dowels.
  - A minimal, localized amount of high-strength non-shrink grout/bonding mortar will be applied strictly beneath the footprint of the pre-cast base for levelling and adhesion purposes.
  - No mass wet concreting works or concrete mixing will take place near the shoreline.
  - To eliminate any risk of runoff into the sea, dry-grouting or ready-to-use pre-mixed mortar bags will be used, and protective bunding (such as plastic sheets/sandbags) will be placed around the immediate work area during application and curing.
- Minimal Waste Generation: Due to the pre-fabricated nature of the system, waste generation during the installation phase will be minimal and strictly managed:

  Inert C&D Materials: There will be no excavation of natural terrain, hence no generation of inert C&D waste.

  Non-Inert C&D Materials and General Refuse: Minimal packaging materials and general refuse will be generated during the installation works. This will be collected daily in garbage bags and disposed of at designated FEHD refuse collection points.

  Chemical Waste: No chemical waste will be generated during either the construction or operational phases.

7.2 Operation Stage

During the operational phase, the system is designed to run unmanned and automatically, posing no risk or nuisance to the surrounding environment or public:

- Acoustic Mitigation: The only fixed source of noise is the external server AC unit, strictly designed not to exceed 50 dB, making it acoustically imperceptible against ambient coastal sounds.

- No electromagnetic pollution: the HF radar are designed to work with a minimal power not harmful for humans or animals. The equipment that will be installed has been certified by the EU. Moreover, High Frequency (HF) radars do not represent a physical risk for marine mammals like dolphins. Operating primarily above the water's surface to track ocean surface currents, they transmit electromagnetic waves rather than underwater sound waves. Consequently, they do not interfere with marine life's acoustic communication or echolocation. This is important since white dolphins are frequently observed around Lantau Island

- Visual Footprint: The receiving antennas have a very small profile (approx. 3 cm in diameter) and are virtually invisible from land. All antennas will be coated in a neutral sandy colour to harmonize with the shoreline rock. At the Pier site, the compact server cabin will be fully masked utilizing a camouflage net or painting the cabin to better match the existing natural tree canopy .

8 Support Letters

政府總部
發展局
工務科
香港添馬添美道 2 號
政府總部西翼

Works Branch
Development Bureau
Government Secretariat
West Wing, Central Government Offices,
2 Tim Mei Avenue, Tamar, Hong Kong

本局網址 Our Website: http://www.devb.gov.hk/
本局檔號 Our Ref.: DEVB(W) 216/27/32 Pt.1
來函檔號 Your Ref.:

電話 Tel No.: 3509 8278
傳真 Fax No.: 2521 8387
電郵 E-mail: psw@devb.gov.hk

By E-mail: [redacted]

25 April 2025

Dr Alessandro STOCCHINO
Associate Professor
Department of Civil and Environmental Engineering
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong

Dear Dr Stocchino,

Support Letter for the Research Project
"Hong Kong Coastal HF-Radar Network"

I am pleased to offer support to your research project "Hong Kong Coastal HF-Radar Network" funded by the Research Grants Council Collaborative Research Fund 2022/23 (Project Reference No. C5032-22EF).

The Government has been actively driving the application of technologies in enhancing the resilience capability in coping with climate change and extreme weather. The project aims to design and deploy a High Frequency Radar network covering the Hong Kong SAR waters, and to establish a data-sharing platform of currents and waves data collected, which would have great potential to enhance real-time monitoring of coastal dynamics as well as formulate coastal wave forecasting and early alert system.

I wish you every success in your research.

Yours sincerely,

(Ricky C K LAU)
Permanent Secretary for Development (Works)

香港天文台
HONG KONG OBSERVATORY

Our Ref : HKOG 1/50/41 Pt.8

11 March 2025

(By email: [redacted]

Professor Alessandro Stocchino
Department of Civil and Environmental Engineering
The Hong Kong Polytechnic University
Hung Hom, Kowloon
Hong Kong

Dear Prof Stocchino,

RGC Ref No. C5032-22G: Hong Kong Coastal HF-Radar Network

Reference is made to your email of 8 March 2025 regarding the captioned Collaborative Research Fund project.

The Hong Kong Observatory (HKO) takes note of the enormous potential the project that could bring to our operations with an increased coverage of sea surface monitoring in the local and neighbouring waters of Hong Kong after its implementation. The Observatory is pleased to support the captioned project. We will provide essential meteorological data and climatological statistics as appropriate, and share with the project team HKO's experience in the development, implementation and maintenance of a similar network in the eastern part of Hong Kong.

You are welcome to contact Mr David Hui (Tel: 2926 8433; Fax: 2311 9448; Email: dhui@hko.gov.hk) for data acquisition and experience sharing as necessary in the future.

Yours sincerely,

(Dr P W Chan)
Director of the Hong Kong Observatory

科學創新・服務用心 *Innovate with Science・Serve with Heart*

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hk.observatory

香港天文台
HONG KONG OBSERVATORY

Our Ref : HKOG 1/50/41 Pt.8
Your Ref :

11 July 2022

(By email: [redacted]

Professor Alessandro Stocchino
Department of Civil and Environmental Engineering,
The Hong Kong Polytechnic University,
Hung Hom, Kowloon,
Hong Kong.

Dear Prof. Stocchino,

RGC Ref No. C5032-22G: Hong Kong Coastal HF-Radar Network

I refer to your email of 23 June 2022 to our Mr ST Chan regarding the captioned Collaborative Research Fund project proposal.

The Hong Kong Observatory (HKO) takes note of the enormous potential the project that could bring to our operations with the increased coverage of sea surface monitoring in the local and neighbouring waters of Hong Kong via the proposed radar networks. The Observatory is pleased to support the proposed project. We will provide essential meteorological data and climatological statistics as appropriate, and share with the project team HKO's experience in the development, implementation and maintenance of a similar network in the eastern part of Hong Kong.

You are welcome to contact Mr David Hui at 2926 8433 (phone); 2311 9448 (fax) or dhui@hko.gov.hk (email) for data acquisition and experience sharing as necessary in the future.

We sincerely hope that you will be successful in the application.

Yours sincerely,

(Queenie C.C. Lam)
for Director of the Hong Kong Observatory

科學創新，服務用心 *Innovate with Science · Serve with Heart*

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土木工程拓展署
Civil Engineering and Development Department

土木工程處
Civil Engineering Office

Web site 網址 : http://www.cedd.gov.hk
E-mail 電子郵件: alankytang@cedd.gov.hk
Telephone 電話 : (852) 2762 5630
Facsimile 傳真 : (852) 2714 2054
Our reference 本署檔號: ( ) in PW-04-0065-5
Your reference 來函檔號:

香港九龍公主道 101 號
土木工程拓展署大樓
Civil Engineering and Development Building,
101 Princess Margaret Road,
Kowloon, Hong Kong

30 June 2022

Dr. Alessandro STOCCHINO
Department of Civil and Environmental Engineering
The Hong Kong Polytechnic University
Kowloon, Hong Kong

By Post

Dear Dr. STOCCHINO,

Support to Application for Collaborative Research Fund 2022/23
"Hong Kong Coastal HF-Radar Network"

We are pleased to offer our support to the above proposal ("the Project") to be submitted to the Research Grants Council.

The geographical position of Hong Kong makes it susceptible to adverse weather-related threats such as tropical cyclones, rainstorms, storm surges and overtopping waves. In particular, some coastal low-lying and windy locations are vulnerable to sea water inundation caused by extreme storm surges and overtopping waves, and have the facilities situated near the seaside damaged as a result. In relation to more frequent and intense extreme weather events, the Civil Engineering and Development Department (CEDD) would adopt a pragmatic multi-layered enhancement measure, in which early alert system would be included to enhance the level of preparedness of the community to cope with the potential coastal risks. CEDD has launched a trial scheme on real-time wave monitoring by Acoustic Doppler Current Profilers (ADCPs) in the Hong Kong waters since 2021 with a view to collecting real-time wave data, which could serve for calibration of wave impact under extreme weather.

We understand that the objectives of the Project are to design and deploy a coastal High-Frequency Radar (HFR) network in Hong Kong waters, and to prepare a data sharing platform of current and wave field. We believe that the Project, including the development of technology on coastal monitoring as well as the set-up of data sharing platform, could create synergy with our ADCP trial scheme on wave and current monitoring, and give valuable input in formulation of future coastal wave forecasting and early alert system. Furthermore, the higher spatial resolution of monitoring by HFR network under the Project compared with using ADCPs has a potential to extend the observing capacity on the Hong Kong waters. In view of the above, we are pleased to offer our support to the Project.

We wish you all the success in your application and look forward to hearing from you soon.

Yours sincerely,

(Alan K Y TANG)
Chief Engineer/Port Works
Civil Engineering Office
Civil Engineering and Development Department

Internal
SE/D, E/D1, E/P4D – thro' L/N

卓越工程 建設香港 We Engineer Hong Kong's Development

香港特別行政區政府 The Government of the Hong Kong Special Administrative Region
渠務署署長 **Drainage Services Department**
香港灣仔告士打道 5 號稅務大樓 43 樓 43/F, Revenue Tower, 5 Gloucester Road, Wan Chai, Hong Kong
電話 Tel: (852) 2594 7001 傳真 Fax: (852) 2827 9477 電子傳真 e-Fax: (852) 3103 0001 電郵 E-mail: alicepang@dsd.gov.hk

來函檔號 Your Ref:
本署檔號 Our Ref: ( ) DSD T 1/20/15 Pt.5

12 July 2022

Dr. STOCCHINO Alessandro
Department of Civil and Environmental Engineering,
The Hong Kong Polytechnic University,
Hung Hom, Kowloon, Hong Kong

Dr. STOCCHINO,

Application for the Collaborative Research Fund for 2022/23
Hong Kong Coastal High-Frequency Radar Network

Letter of Support

We are pleased to tender our non-financial support to your application for the Collaborative Research Fund (CRF) 2022/23 concerning the research study titled "Hong Kong Coastal High-Frequency Radar Network".

We are glad to learn that your research aims at deploying and operating a coastal High-Frequency Radar (HFR) network in selected sites of the Hong Kong SAR coastal water. By collecting real time data such as HFR currents and waves information, the project would develop a short time forecasting model on wave runup, wave setup and wave overtopping, with the use of machine learning and data mining algorithms.

We expect that the proposed coastal HFR network and short time forecasting model will provide us with useful information for flood risk assessment in coastal urban areas. We hope that the research findings will be beneficial to enhance flood prevention and mitigation and our services to the public.

... / 2

我們的抱負是提供世界級的污水和雨水處理排放服務，以促進香港的可持續發展。
Our VISION is to provide world-class wastewater and stormwater drainage services enabling the sustainable development of Hong Kong.
ISO 9001, 14001 & 45001 Certified

- 2 -

We wish you success in your application and look forward to your sharing with us the result of the research study. If you need further assistance, please feel free to contact our Senior Engineer / Research & Development, Ms. Selina FONG, at 2300 1150.

Yours sincerely,

(Alice PANG)
Director of Drainage Services

9 OFCA Permitting

通訊事務管理局
COMMUNICATIONS AUTHORITY

通訊事務管理局
COMMUNICATIONS AUTHORITY
人口許可證
IMPORT PERMIT

此表格需經繳費並由通訊事務管理局辦公室人員填妥下列第5及6段後，才成為一張有效的人口許可證。
This form will only become a valid Import Permit upon payment and completion of parts 5 and 6 below by the Office of the Communications Authority.

1. 人口商 Importer	2. 人口來源 Imported from
商號 Name: The Hong Kong Polytechnic University Department of Civil and Environmental Engineering	商號 Name: Helzel Messtechnik GmbH
地址 Address: [redacted]	地址 Address: Carl-Benz-Str. 9, 24568 Kaltenkirchen, Germany
電話 Telephone: [redacted]	入口日期 Import date: 09/08/2025
商業登記證號碼: -- Business Registration Certificate No.	貨運方式 Transport mode: Vessel
電郵地址 E-mail: [redacted]	

3. 入口無線電設備的詳細資料 Full description of the radio equipment to be imported:

數量 Quantity	設備類型 Equipment type	廠名/牌子 Make/Brand	型號 Model	機身編號 Serial number	價值 Value
	Please see next page				

* 如以上位置不夠，請往下頁填寫其他設備的資料。If the space above is insufficient, please go to the next page.

4. 人口商聲明 Importer's Declaration (請在方格內加上✓號以接受聲明 Please check✓the box to accept the declaration)

☑ 我謹此聲明在本表格內所填報的資料全部正確無誤，並聲明入口的無線電設備將會是在本表格第3段所列的設備。
I hereby declare that the information given in this form is true and correct and the radio equipment imported shall be as those described in part 3 above.

申請人姓名 Applicant's Full Name: Alessandro Stocchino
(英文請用正楷) (In English BLOCK LETTERS)

日期 Date: 06/08/2025

公事用，不用填寫 FOR OFFICIAL USE ONLY

5. 繳費 Payment

收據號碼 Receipt No: W78735

費用 Fee paid: $ 150

入口許可證號碼 Import Permit No: 314/2025

批准日期/時間 Date/Time Approved: -4 AUG 2025 0938

6. 批准 Approval

根據電訊條例(香港法例第106章)第9條，現批准上述人口商進口在第3段所開列的無線電設備。
In accordance with Section 9 of the Telecommunications Ordinance (CAP 106), permission is hereby given to the above named importer to import the radio equipment as described in part 3 above.

部門印鑒 Departmental Chop

通訊事務管理局
For the Communications Authority
(Leung Hoi Yan 代行)

通訊事務管理局辦公室
香港灣仔皇后大道東213號胡忠大廈26樓
電話 2961 6671 傳真 3155 0936

Office of the Communications Authority
26/F., Wu Chung House, 213 Queen's Road East, Wan Chai, Hong Kong
Telephone: 2961 6671 Fax: 3155 0936

續上頁第3段 Continue from section 3 of previous page:

3. 入口無線電設備的詳細資料 **Full description of the radio equipment to be imported :**

數量 Quantity	設備類型 Equipment type	廠名/牌子 Make/Brand	型號 Model	機身編號 Serial number	價值 Value
1	High Frequency Oceanographic Radar, WERA IV, 12-channels	Helzel Messtechnik GmbH	1x Frequency Control Rack 1x Power Amplifier Rack 1x PC 1x GPS-SYNC 4x Tx Antenna coils (V2.0) 5Wdg 4x Aluminum antenna poles (Tx), 1.5m	FCR-2347-162 PAR-2445-125 3267576v007 GPS-SYNC-2509-24 N/A N/A	HKD 1,088,000
1	High Frequency Oceanographic Radar, WERA IV, 12-channels	Helzel Messtechnik GmbH	1x Frequency Control Rack 1x Power Amplifier Rack 1x PC 1x GPS-SYNC 4x Tx Antenna coils (V2.0) 5Wdg 4x Aluminum antenna poles (Tx), 1.5m	FCR-2444-168 PAR-2506-129 3267576v006 GPS-SYNC-2509-29 N/A N/A	HKD 1,088,000
1	High Frequency Oceanographic Radar, WERA IV, 12-channels	Helzel Messtechnik GmbH	1x Frequency Control Rack 1x Power Amplifier Rack 1x PC 1x GPS-SYNC 4x Tx Antenna coils (V2.0) 5Wdg 4x Aluminum antenna poles (Tx), 1.5m	FCR-2434-165 PAR-2345-122 3267576v005 GPS-SYNC-2509-25 N/A N/A	HKD 1,088,000
1	High Frequency Oceanographic Radar, WERA IV, 12-channels	Helzel Messtechnik GmbH	1x Frequency Control Rack 1x Power Amplifier Rack 1x PC 1x GPS-SYNC 4x Tx Antenna coils (V2.0) 5Wdg	FCR-2439-166 PAR-2445-126 3267576v003 GPS-SYNC-2509-26 N/A	HKD 1,088,000

			4x Aluminum antenna poles (Tx), 1.5m	N/A	
1	High Frequency Oceanographic Radar, WERA IV, 12-channels	Helzel Messtechnik GmbH	1x Frequency Control Rack	FCR-2439-167	HKD 1,088,000
			1x Power Amplifier Rack	PAR-2447-127	
			1x PC	3267576v002	
			1x GPS-SYNC	GPS-SYNC-2509-27	
			4x Tx Antenna coils (V2.0) 5Wdg	N/A	
			4x Aluminum antenna poles (Tx), 1.5m	N/A	
1	High Frequency Oceanographic Radar, WERA IV, 12-channels	Helzel Messtechnik GmbH	1x Frequency Control Rack	FCR-2444-169	HKD 1,088,000
			1x Power Amplifier Rack	PAR-2447-128	
			1x PC	3267576v004	
			1x GPS-SYNC	GPS-SYNC-2509-28	
			4x Tx Antenna coils (V2.0) 5Wdg	N/A	
			4x Aluminum antenna poles (Tx), 1.5m	N/A	

OFFICE OF THE COMMUNICATIONS AUTHORITY
OFCA

香港特別行政區政府收據

THE GOVERNMENT OF
THE HONG KONG SPECIAL ADMINISTRATIVE REGION MISCELLANEOUS RECEIPT

U 178225

茲收到 Received from	有關下列事項 in respect of	交來金額 the sum of dollars (in words)	現金 Cash / 支票號碼 Cheque No.
The Hong Kong Polytechnic University Department of Civil and Environmental Engineering	Import Permit# 314/2008	One Hundred and Fifty Only	港幣 $ 150.00

日期： 04-08 20 08

機關首長 for *Head of Department*
代行 ( )

機關名稱 *Name of Department*

Try. 44 (Rev. 99)

許可證編號 Permit No.：**T00940(Amended)**

通訊事務管理局
COMMUNICATIONS AUTHORITY

根據《電訊條例》(第 106 章)
第 7E 條發出的許可證
PERMIT ISSUED UNDER SECTION 7E OF THE TELECOMMUNICATIONS ORDINANCE (CAP. 106)

發證日期 Date of Issue：**01 August 2025**

類型 Type：**High Frequency Radar Network Trial in Hong Kong Areas**

現根據《電訊條例》(第 106 章)第 7E 條及在符合以下條件的規限下，批准：
In accordance with section 7E of the Telecommunications Ordinance (Cap. 106) and subject to the conditions below, permission is granted to:

The Hong Kong Polytechnic University
Department of Civil and Environmental Engineering

(下稱「獲授予人」)及為此獲他授權的人在下列指定期間管有、設置、維持和使用附表(下稱「該附表」)指明的發射及接收電台(下稱「該電台」)，作無線電通訊用途。
(hereinafter called "the Grantee") and persons authorized by him on that behalf, to possess, establish, maintain and use transmitting and receiving station(s) (hereinafter called "the Station") as specified in the schedule (hereinafter called "the Schedule") for radiocommunications during the period of

05 August 2025 to 04 February 2026 (both dates inclusive)

一般條件
GENERAL CONDITIONS

1. 本許可證不得轉讓。
   This permit is not transferable.
2. 本許可證不可續期。
   This permit is non-renewable.

3. 獲授予人須—

The Grantee shall –

(a) 以不對其他電訊設施造成干擾的方式，維持及操作該電台；

maintain and operate the Station in such a manner as not to cause interference with any other means of telecommunications;

(b) 遵從管理局為避免任何該等干擾而作出的指示；及

comply with any direction given by the Authority for the purpose of avoiding any such interference; and

(c) 在接獲管理局的書面通知時，將管理局認為正干擾或相當可能干擾其他電訊設施的運作的該電台的任何部分拆離或移走。

on receipt of a notice in writing from the Authority, disconnect or remove any part of the Station, which, in the opinion of the Authority, is interfering, or is likely to interfere with the working of any other means of telecommunications.

4. 該電台只能於附表指明的「地點~~/及只以移動方式~~」*使用，並且只能採用附表指明的發射頻率、類別及特性，以及就正使用的類別及特性而言，只能採用附表指明的功率及天線特性。

The Station shall be used only [at the location ~~/ and at mobile only~~]* with emissions at the frequency/frequencies and of the class and characteristics respectively specified in the schedule hereto; and with such power and aerial characteristics as are specified in the schedule hereto; in relation to the class and characteristics of the emission in use.

5. 該電台不得發送令人厭惡、淫褻或不雅的訊息。

No message which is offensive, obscene or indecent shall be transmitted from the station.

6. 該電台及本許可證須在任何合理時間供管理局妥為授權的人員檢查。

The Station, this Permit shall be available for inspection at all reasonable times by duly authorized officers of the Authority.

7. 如在系統的任何部分使用任何工具、器具或材料，或將任何電流連接至或施用於該系統的任何部分，以致對任何其他電訊設施的運作造成干擾，或相當可能會造成干擾，則獲授予人不得在該系統的任何部分使用該等工具、器具或材料，或將任何電流連接至或施用於該系統的任何部分。

The Grantee shall not use any instrument, apparatus or material on, or connect or apply any electrical currents to, any part of the system if the same interferes, or is likely to interfere, with the working of any other means of telecommunications.

8. 天線的安裝及維持須符合良好工程標準，以免對鄰近的人或財產造成不可接受的危險。

An aerial shall be installed and maintained to good engineering standard so as not to pose unacceptable risks to persons or property in the vicinity.

*並非強制性，如不適用的話可以刪除

*Optional and can be deleted as appropriate

附 表

THE SCHEDULE

Table 1: Station Locations

電台位置 Station Location	備註 Remark
(1) Lung Kwu Tan RX: 1 809908.44 827515.78; 2 809907.41 827521.19; 3 809906.43 827526.64; 4 809905.47 827532.00; 5 809904.43 827537.38; 6 809903.43 827542.82; 7 809902.42 827548.24; 8 809901.39 827553.64; 9 809900.42 827559.09; 10 809899.45 827564.45; 11 809898.41 827569.84; 12 809897.41 827575.27 TX: 1 809918.90 827392.40; 2 809920.67 827392.73; 3 809917.81 827398.27; 4 809919.58 827398.60 power 809920.50 827504.19 server room 809916.60 827445.75 (2) Tai O – Wastewater Treatment Station RX: 1 803499.04 813603.10; 2 803502.94 813599.16; 3 803508.28 813598.03; 4 803513.71 813597.69; 5 803519.23 813597.85; 6 803524.66 813596.95; 7 803529.99 813595.57; 8 803533.33 813599.78; 9 803538.46 813601.70; 10 803543.51 813603.92; 11 803548.32 813606.63; 12 803552.57 813609.96 TX: 1 803618.82 813640.21; 2 803624.82 813641.12 power 803603.67 813622.06 server room 803569.13 813610.98	System operated very close to the sea shoreline. The receive antennas consist of a linear phased array of 12 vertical monopoles with a consecutive separation of 5.5m. The transmit antennas consist of either a rectangular array of 4 vertical monopoles in a 6m x 1.8m rectangle configuration, or a left-right pair of monopoles separated by 6m distance. Each monopole consists of a vertical 1.5m long pole. Coverage of 120° towards the sea. The system automatically minimizes interference to other users on the same frequency band by scanning the allowed band before transmission and operating with reduced bandwidth over a free, unused gap

電台位置 Station Location	備註 Remark
(3) Tai O – Pier RX: 1 (802854.60, 812850.66); 2 (802853.18, 812856.16); 3 (802852.47, 812861.76); 4 (802850.66, 812867.05); 5 (802847.61, 812871.89); 6 (802845.10, 812877.08); 7 (802842.84, 812882.50); 8 (802839.60, 812887.08); 9 (802836.90, 812891.89); 10 (802833.36, 812896.14); 11 (802829.44, 812899.90); 12 (802824.20, 812901.73) TX: 1 (802896.15, 812758.63); 2 (802898.65, 812753.16) power (802901.82, 812735.32) server room (802895.06, 812764.17) (4) House of Prayer – Cheung Chau RX: 1 (822163.37, 807458.64); 2 (822158.09, 807457.18); 3 (822152.74, 807455.75); 4 (822147.44, 807454.49); 5 (822142.02, 807453.37); 6 (822136.54, 807452.71); 7 (822131.05, 807453.55); 8 (822125.67, 807452.89); 9 (822120.18, 807452.14); 10 (822114.71, 807451.42); 11 (822109.58, 807449.53); 12 (822104.47, 807447.52) TX: 1 (822036.82, 807426.09); 2 (822030.42, 807422.98) power (822029.85, 807442.14) server room (822023.41, 807436.77)	System operated very close to the sea shoreline. The receive antennas consist of a linear phased array of 12 vertical monopoles with a consecutive separation of 5.5m. The transmit antennas consist of either a rectangular array of 4 vertical monopoles in a 6m x 1.8m rectangle configuration, or a left-right pair of monopoles separated by 6m distance. Each monopole consists of a vertical 1.5m long pole. Coverage of 120° towards the sea. The system automatically minimizes interference to other users on the same frequency band by scanning the allowed band before transmission and operating with reduced bandwidth over a free, unused gap

電台位置 Station Location	備註 Remark
(5) Lamma Island – Lo So Shing Beach RX: 1 830559.85 807423.36; 2 830554.78 807425.46; 3 830549.72 807427.68; 4 830544.66 807429.79; 5 830539.60 807432.00; 6 830534.59 807434.11; 7 830529.47 807436.21; 8 830524.38 807438.41; 9 830519.35 807440.54; 10 830514.29 807442.71; 11 830509.23 807444.86; 12 830504.16 807446.96 TX: 1 830444.47 807485.63; 2 830439.43 807488.96 power 830685.01 807241.50 server room 830658.11 807390.18 (6) Chung Hum Kok Battery RX: 1 838540.70 807980.58; 2 838535.23 807981.13; 3 838529.77 807981.79; 4 838524.30 807982.35; 5 838518.83 807983.01; 6 838513.36 807983.56; 7 838507.90 807984.23; 8 838502.45 807984.80; 9 838496.96 807985.44; 10 838491.52 807986.00; 11 838486.03 807986.66; 12 838480.56 807987.21 TX: 1 838437.26 807992.52; 2 838431.30 807993.19 power 838448.29 808020.86 server room 838462.03 808014.57	System operated very close to the sea shoreline. The receive antennas consist of a linear phased array of 12 vertical monopoles with a consecutive separation of 5.5m. The transmit antennas consist of either a rectangular array of 4 vertical monopoles in a 6m x 1.8m rectangle configuration, or a left-right pair of monopoles separated by 6m distance. Each monopole consists of a vertical 1.5m long pole. Coverage of 120° towards the sea. The system automatically minimizes interference to other users on the same frequency band by scanning the allowed band before transmission and operating with reduced bandwidth over a free, unused gap

Table 2: Station Particular(s)

設備詳情 Station particulars					
設備詳情 **Equipment Particulars**	頻率 **Frequency (MHz)**	發射類別 **Class of Emission**	極化 **Polarization**	天線增益 **Antenna Gain (dBi)**	最大有效輻射功率 **Maximum Effective Radiated Power (in Watts)**
Brand: Helzel Messtechnik GmbH Model: WERA IV, 12-channels (Station locations: (1), (2) (3), (4) (5) and (6))	Receive: 24.45 – 24.60 MHz Transmit: 24.45 – 24.60 MHz	150KF0N	Vertical	-1.22	13.8

Other Conditions:

1. The technical and operational characteristics of the Stations shall conform to the prevailing version of ITU-R Recommendation M.1874-1.

2. The Stations shall not cause harmful interference to, or claim protection from, stations operating in the fixed services.

3. The Stations shall operate in accordance with Resolution 612 (Rev.WRC-12).

4. The Grantee and all persons operating the Stations shall at all times observe and comply with the relevant provisions of the Constitution and Convention of the ITU and the Radio Regulations annexed thereto, which have been from time to time or at any time been acceded to or applied to Hong Kong, except to the extent the Authority may in writing expressly exempt the permit from such compliance.

5. The Grantee shall submit a report of the trial to the Office of the Communications Authority ("OFCA") within three months upon completion of the trial. OFCA reserves the right to publish the report submitted by the Grantee.

6. The trial is to be conducted on a non-commercial basis and shall not be promoted commercially or advertised. Any announcement or publicity by the Grantee or its agents about the trial should be subject to prior approval of the Authority.

7. The frequencies used in the trial shall be shared with other users specified by the Authority from time to time.

8. Use of the Station may be terminated upon notice by the Authority at any time.

9. The Grantee shall ensure that:

    a. the antennas and their supporting framework used in the Station shall be capable of sustaining the wind loads specified in the "Code of Practice on Wind Effects in Hong Kong", and that the stability of the supporting building is not affected by the antennas and their supporting framework used in the Station;

    b. the antennas and their supporting framework shall not be erected at a level which contravenes height limit provisions of the Hong Kong Airport (Control of Obstructions) Ordinance (Cap. 301); and

    c. the installation and use of the radio equipment for the trial shall comply with all relevant ordinances, statutory instruments and codes of practice including but not limited to the "Code of Practice for the Protection of Workers and Members of Public Against Non-Ionising Radiation Hazards from Radio Transmitting Equipment".

10. The Grantee shall tolerate interference from other telecommunications service lawfully carried on or other telecommunications apparatus lawfully operated.

11. The Authority's approval of the trial should not bind the Authority whatsoever in respect of the approval for the future use of the Station under trial and assignment of frequencies to the Grantee.

通訊事務管理局
(梁凱欣　代行)
(Leung Hoi Yan)
For and on behalf of the Communications Authority

許可證編號 Permit No.：**T01049**

通訊事務管理局
COMMUNICATIONS AUTHORITY

根據《電訊條例》(第 106 章)
第 7E 條發出的許可證
PERMIT ISSUED UNDER SECTION 7E OF THE TELECOMMUNICATIONS ORDINANCE (CAP. 106)

發證日期 Date of Issue：**28 January 2026**

類型 Type：**High Frequency Radar Network Trial in Hong Kong Areas**

現根據《電訊條例》(第 106 章)第 7E 條及在符合以下條件的規限下，批准：
In accordance with section 7E of the Telecommunications Ordinance (Cap. 106) and subject to the conditions below, permission is granted to:

The Hong Kong Polytechnic University
Department of Civil and Environmental Engineering

(下稱「獲授予人」)及為此獲他授權的人在下列指定期間管有、設置、維持和使用附表(下稱「該附表」)指明的發射及接收電台(下稱「該電台」)，作無線電通訊用途。
(hereinafter called "the Grantee") and persons authorized by him on that behalf, to possess, establish, maintain and use transmitting and receiving station(s) (hereinafter called "the Station") as specified in the schedule (hereinafter called "the Schedule") for radiocommunications during the period of

4 February 2026 to 3 August 2026 (both dates inclusive)

一般條件
GENERAL CONDITIONS

1. 本許可證不得轉讓。
   This permit is not transferable.
2. 本許可證不可續期。
   This permit is non-renewable.

3. 獲授予人須—

The Grantee shall –

(a) 以不對其他電訊設施造成干擾的方式，維持及操作該電台；

maintain and operate the Station in such a manner as not to cause interference with any other means of telecommunications;

(b) 遵從管理局為避免任何該等干擾而作出的指示；及

comply with any direction given by the Authority for the purpose of avoiding any such interference; and

(c) 在接獲管理局的書面通知時，將管理局認為正干擾或相當可能干擾其他電訊設施的運作的該電台的任何部分拆離或移走。

on receipt of a notice in writing from the Authority, disconnect or remove any part of the Station, which, in the opinion of the Authority, is interfering, or is likely to interfere with the working of any other means of telecommunications.

4. 該電台只能於附表指明的「地點~~/及只以移動方式~~」*使用，並且只能採用附表指明的發射頻率、類別及特性，以及就正使用的類別及特性而言，只能採用附表指明的功率及天線特性。

The Station shall be used only [at the location ~~/ and at mobile only~~]* with emissions at the frequency/frequencies and of the class and characteristics respectively specified in the schedule hereto; and with such power and aerial characteristics as are specified in the schedule hereto; in relation to the class and characteristics of the emission in use.

5. 該電台不得發送令人厭惡、淫褻或不雅的訊息。

No message which is offensive, obscene or indecent shall be transmitted from the station.

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The Station, this Permit shall be available for inspection at all reasonable times by duly authorized officers of the Authority.

7. 如在系統的任何部分使用任何工具、器具或材料，或將任何電流連接至或施用於該系統的任何部分，以致對任何其他電訊設施的運作造成干擾，或相當可能會造成干擾，則獲授予人不得在該系統的任何部分使用該等工具、器具或材料，或將任何電流連接至或施用於該系統的任何部分。

The Grantee shall not use any instrument, apparatus or material on, or connect or apply any electrical currents to, any part of the system if the same interferes, or is likely to interfere, with the working of any other means of telecommunications.

8. 天線的安裝及維持須符合良好工程標準，以免對鄰近的人或財產造成不可接受的危險。

An aerial shall be installed and maintained to good engineering standard so as not to pose unacceptable risks to persons or property in the vicinity.

*並非強制性，如不適用的話可以刪除

*Optional and can be deleted as appropriate

附表

THE SCHEDULE

Table 1: Station Locations

電台位置 Station Location	備註 Remark
(1) Lung Kwu Tan TX: 1 – HK1980 (E) 809919, HK1980 (N) 827392 TX: 2 – HK1980 (E) 809921, HK1980 (N) 827393 TX: 3 – HK1980 (E) 809918, HK1980 (N) 827398 TX: 4 – HK1980 (E) 809920, HK1980 (N) 827399 (2) Tai O – Wastewater Treatment Station TX: 1 – HK1980 (E) 803619, HK1980 (N) 813640 TX: 2 – HK1980 (E) 803625, HK1980 (N) 813641 (3) Tai O – Pier TX: 1 – HK1980 (E) 802896, HK1980 (N) 812759 TX: 2 – HK1980 (E) 802899, HK1980 (N) 812753 (4) House of Prayer – Cheung Chau TX: 1 – HK1980 (E) 822037, HK1980 (N) 807426 TX: 2 – HK1980 (E) 822030, HK1980 (N) 807423	The system operates very close to the sea shoreline. Each receive antenna consists of a linear phased array of 12 vertical monopoles with a consecutive separation of 5.5 m. Each transmit antenna consists of either a rectangular array of 4 vertical monopoles in a 6m x 1.8m rectangle configuration, or a left-right pair of monopoles separated by 6m. Each monopole consists of a vertical 1.5 m long pole. Coverage of 120° towards the sea. The system automatically minimises interference to other users on the same frequency band by scanning the allowed band before transmission and operating with reduced bandwidth over a free and unused gap.

(5) Lamma Island – Lo So Shing Beach

		HK1980 (E)	HK1980 (N)
TX	1	830444	807486
	2	830439	807489

(6) Chung Hum Kok Battery

		HK1980 (E)	HK1980 (N)
TX	1	838437	807993
	2	838431	807993

The system operates very close to the sea shoreline.

Each receive antenna consists of a linear phased array of 12 vertical monopoles with a consecutive separation of 5.5 m.

Each transmit antenna consists of either a rectangular array of 4 vertical monopoles in a 6m x 1.8m rectangle configuration, or a left-right pair of monopoles separated by 6m.

Each monopole consists of a vertical 1.5 m long pole.

Coverage of 120° towards the sea.

The system automatically minimises interference to other users on the same frequency band by scanning the allowed band before transmission and operating with reduced bandwidth over a free and unused gap.

Table 2: Station Particular(s)

設備詳情 Station Particulars					
設備詳情 Equipment Particulars	**頻率 Frequency (MHz)**	**發射 類別 Class of Emission**	**極化 Polarization**	**天線 增益 Antenna Gain (dBi)**	**最大 有效輻射功率 Maximum Effective Radiated Power (in Watts)**
Brand: Helzel Messtechnik GmbH Model: WERA IV, 12-channels (Station locations: (1), (2), (3), (4) (5) and (6))	Receive: 24.45 – 24.60 MHz Transmit: 24.45 – 24.60 MHz	150KF0N	Vertical	-1.22	13.8

Other Conditions:

1. The technical and operational characteristics of the Stations shall conform to the prevailing version of ITU-R Recommendation M.1874-1.

2. The Stations shall not cause harmful interference to, or claim protection from, stations operating in the fixed services.

3. The Stations shall operate in accordance with Resolution 612 (Rev.WRC-12).

4. The Grantee and all persons operating the Stations shall at all times observe and comply with the relevant provisions of the Constitution and Convention of the ITU and the Radio Regulations annexed thereto, which have been from time to time or at any time been acceded to or applied to Hong Kong, except to the extent the Authority may in writing expressly exempt the permit from such compliance.

5. The Grantee shall submit a report of the trial to the Office of the Communications Authority ("OFCA") within three months upon completion of the trial. OFCA reserves the right to publish the report submitted by the Grantee.

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8. Use of the Station may be terminated upon notice by the Authority at any time.

9. The Grantee shall ensure that:

    a. the antennas and their supporting framework used in the Station shall be capable of sustaining the wind loads specified in the "Code of Practice on Wind Effects in Hong Kong", and that the stability of the supporting building is not affected by the antennas and their supporting framework used in the Station;

    b. the antennas and their supporting framework shall not be erected at a level which contravenes height limit provisions of the Hong Kong Airport (Control of Obstructions) Ordinance (Cap. 301); and

    c. the installation and use of the radio equipment for the trial shall comply with all relevant ordinances, statutory instruments and codes of practice including but not limited to the "Code of Practice for the Protection of Workers and Members of Public Against Non-Ionising Radiation Hazards from Radio Transmitting Equipment".

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11. The Authority's approval of the trial should not bind the Authority whatsoever in respect of the approval for the future use of the Station under trial and assignment of frequencies to the Grantee.

通訊事務管理局
(梁凱欣　代行)
(Leung Hoi Yan)
For and on behalf of the Communications Authority

Outlook

Re: [Internet]Re: [Internet]Re: [Internet] Re: [Internet] Re: [Internet] seeking research support

From Tsz Chiu LAM <tclam03@dsd.gov.hk>
Date Tue 25/03/2025 11:47
To STOCCHINO, alessandro [CEE] [redacted]
Cc Albert Ka Fai TSE <akftse@dsd.gov.hk>; DE LEO, Annalisa [CEE] [redacted] bchchan@dsd.gov.hk <bchchan@dsd.gov.hk>; cmlee@dsd.gov.hk <cmlee@dsd.gov.hk>; Shing Hei YU <shyu03@dsd.gov.hk>; Yujing QIU <yqiu@dsd.gov.hk>

1 attachment (1 MB)
Option 1 & 2.pdf;

CAUTION: External email. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Dear Professor Stocchino,

I refer to your below email concerning your proposal to host a server of the radar systems inside the Imhoff plant at Tai O. While we support your proposal, we have the following comments.

As we understand from your proposal, the radar system will comprise antennas and a hardware server. While the antennas will be installed outside the Imhof Tank site along the rocky costal line, the server is proposed to be installed within the Tai O Imhof tank site, with two options available (i.e. Option 1 and option 2) as outlined in the attached slides (p. 5 and p. 6). The installation will require access to the plant for a few days and the maintenance will require access to the plant of 1 day once every 12-18 months. Regarding the anticipated years of operation of the system, we note that you are discussing with Lands Department and the initial discussions indicated to commence a 5 years temporary use of the land, with the possibility to extend it for more years.

Given the small size of the proposed server and the site is along the seaside subject to possible storm during typhoon, utilizing the existing store room to house the server (i.e. Option 2) is advisable . Reversely, if additional container is chosen (i.e .Option 1), it must be securely fixed to address safety issue during severe weather condition or typhoons. Please note that for any option, DSD will not be responsible for any damages of the system.

Please arrange a public consultation to collect and address public opinions/comments from the stakeholder (e.g. Tai O village) before the commencement of the works. You might wish to seek assistance from liaison officer of Islands District Office, Home Affairs Department (HAD), Mr. Wong Chi Wing, Nathan (Tel: 2852 3740), in facilitating you to conduct the public consultation.

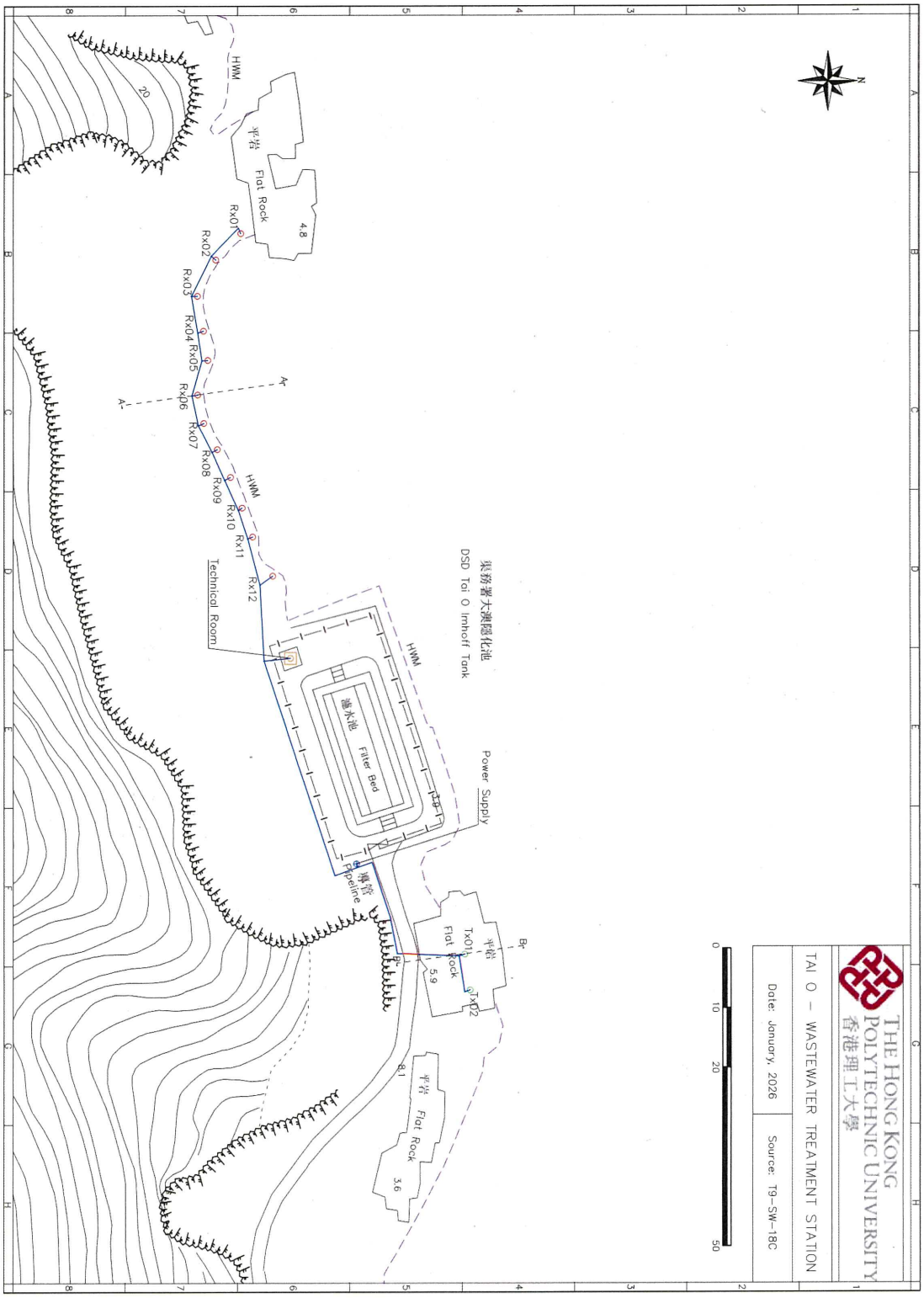
Please kindly note our comments from management and maintenance viewpoints:

1. The proposed sever shall be placed in a manner that it would not obstruct the existing safety and working access necessary for use by DSD's in house staff to carry out operation and maintenance works;
2. The proposed sever shall equip with a separate electricity power line (i.e. there no need for DSD to provide power to support the system in all time). Also, the electricity power line to be equipped shall not interrupt the existing power supplying to sewage treatment facilities;
3. Please install a AC unit, if there need to keep temperature and humidity under control. There is no any A/C system in existence inside the storm room;
4. Please apply the necessary permits to obtain certificate from DSD, namely, the Site Work Authorisation Certificate (SWAC), prior to installation and periodical maintenance;
5. Please note DSD will not be responsible for any damage and security of your proposed system.
6.

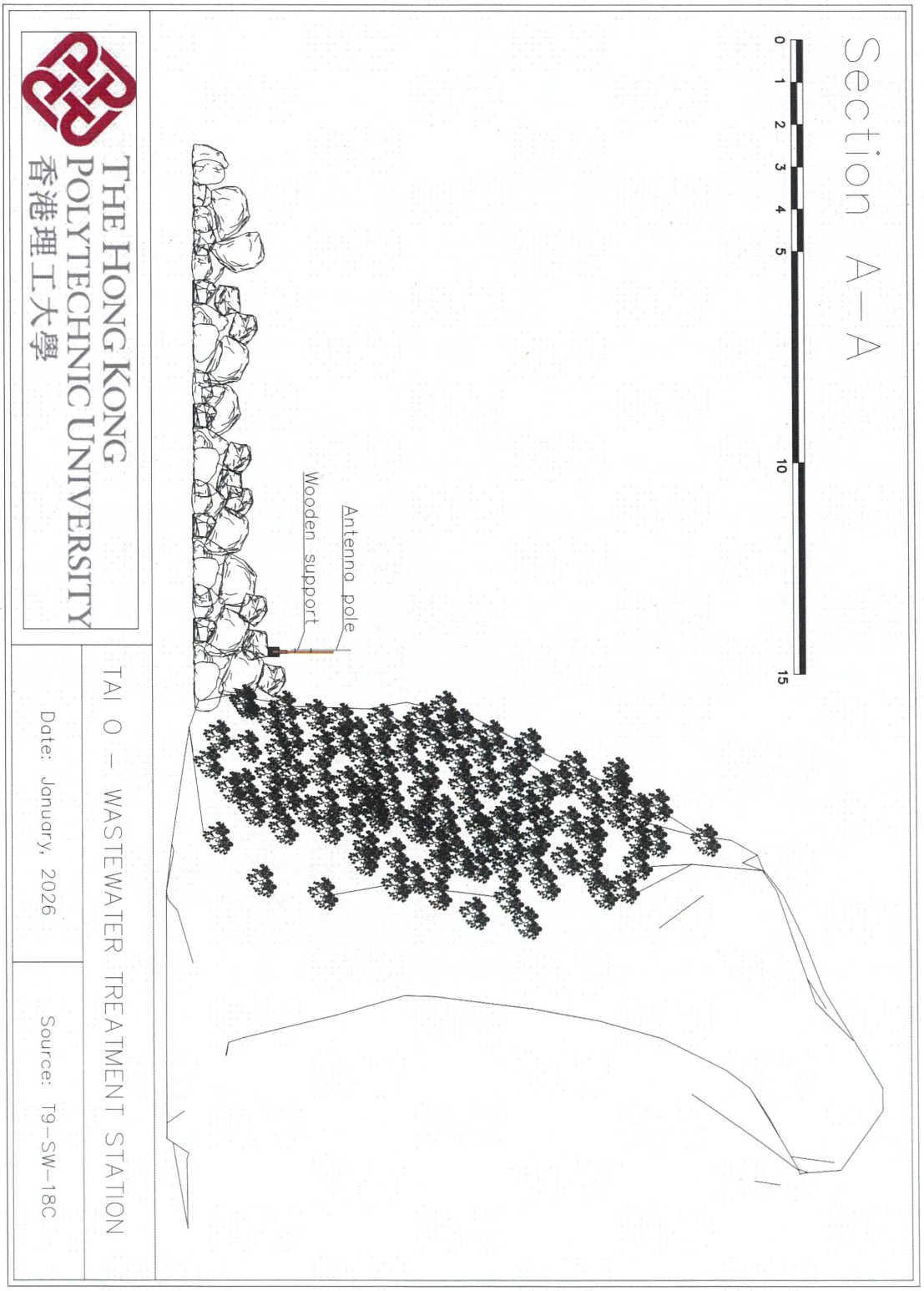
Please note our comment from project planning viewpoints.
1. There is potential upgrading works for the Tai O Sewage Treatment Plant (i.e. the Imhoff plant site) which is currently under design stage. If any upgrading works are to to be carried out during the operation period of your system if future, please address any potential interface issues that may arise. Subject to on-site coordination, you might be requested to relocate the equipment and/or power line at your own cost if any conflict with the upgrading works needed to be addressed.

Regards,
George Lam
E/RD2, BCM, DSD
Tel.: 2594 6037

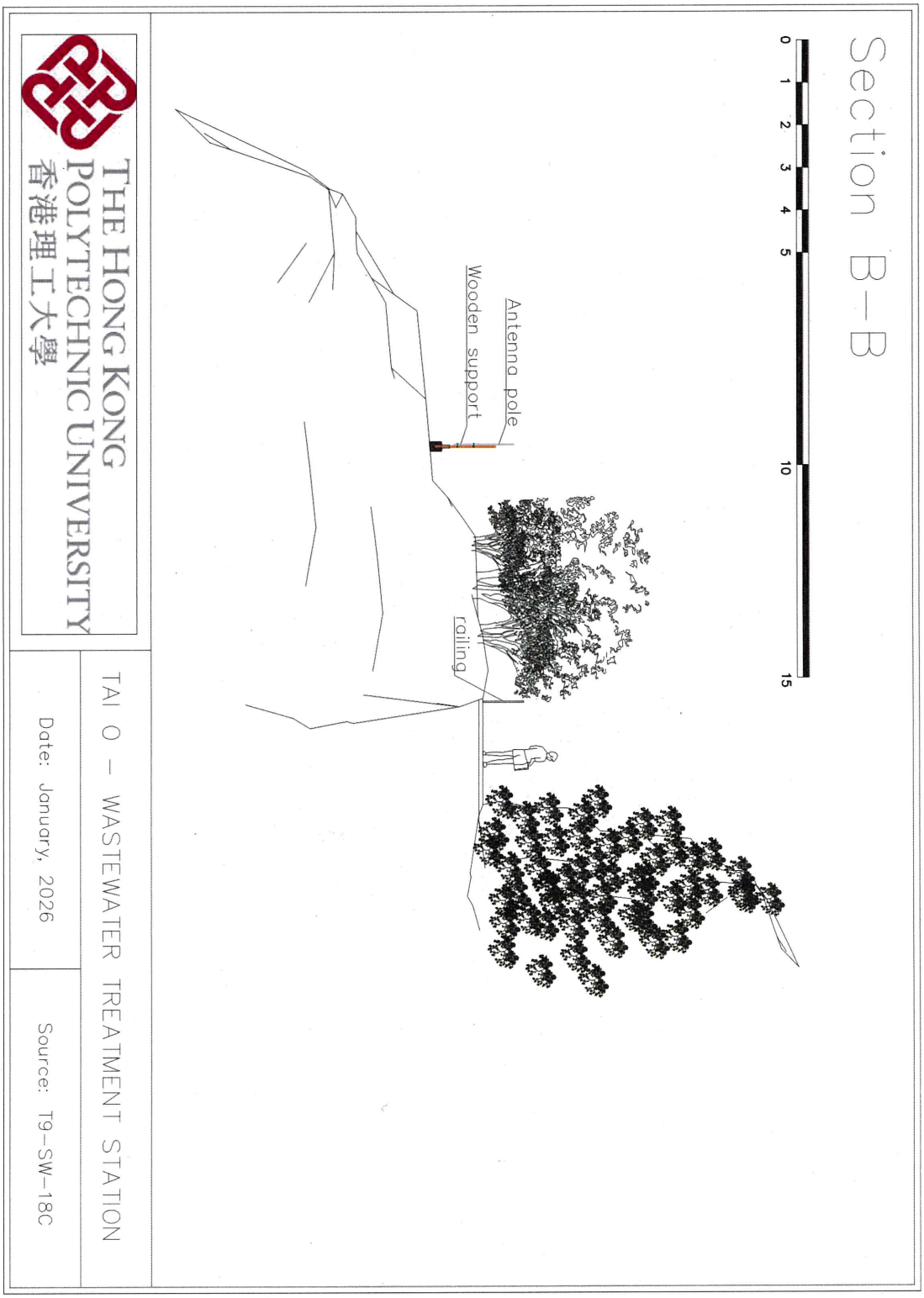
A Tai O - Wastewater Treatment Station - Detailed Plan View



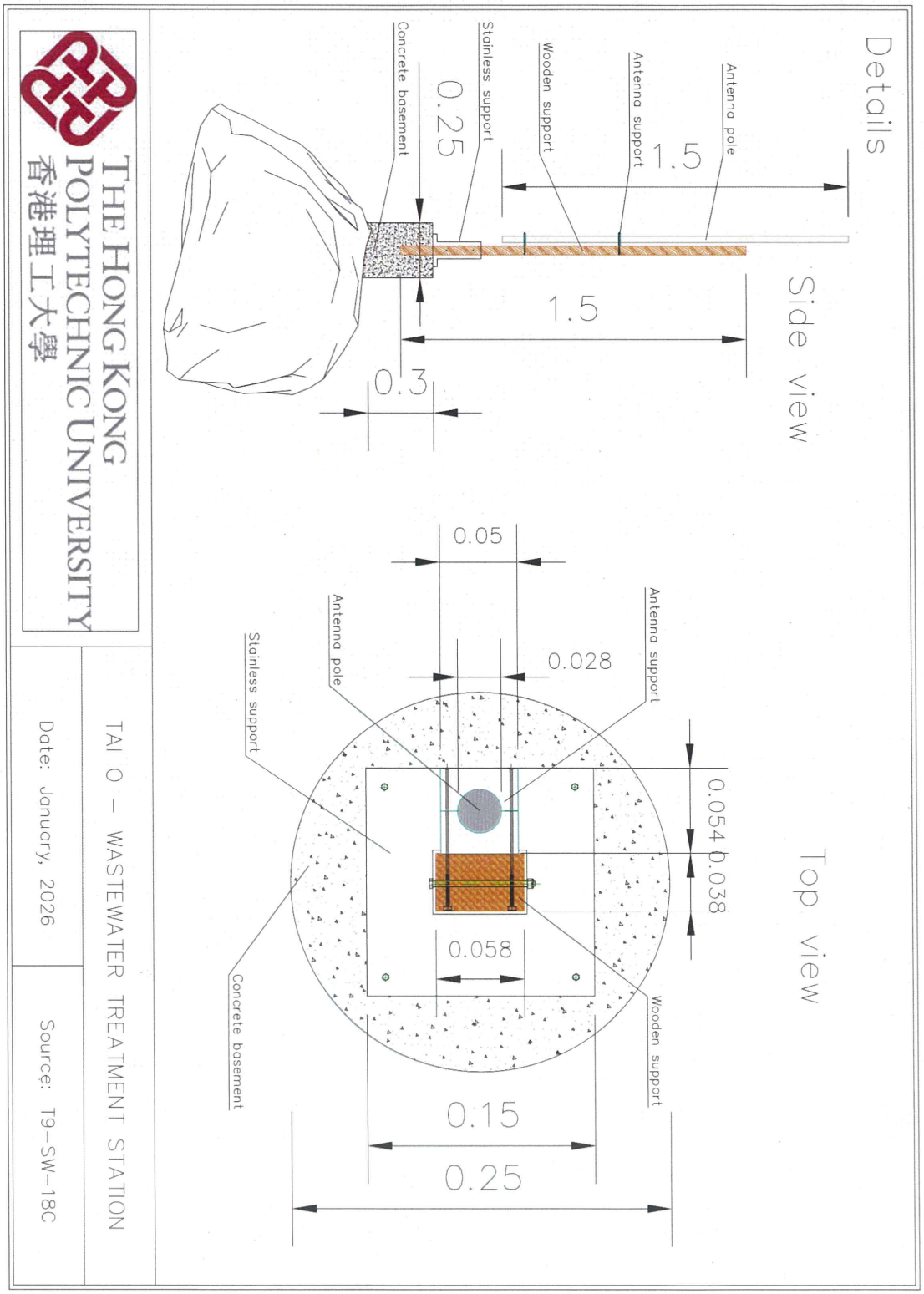
B Tai O - Wastewater Treatment Station - Section AA



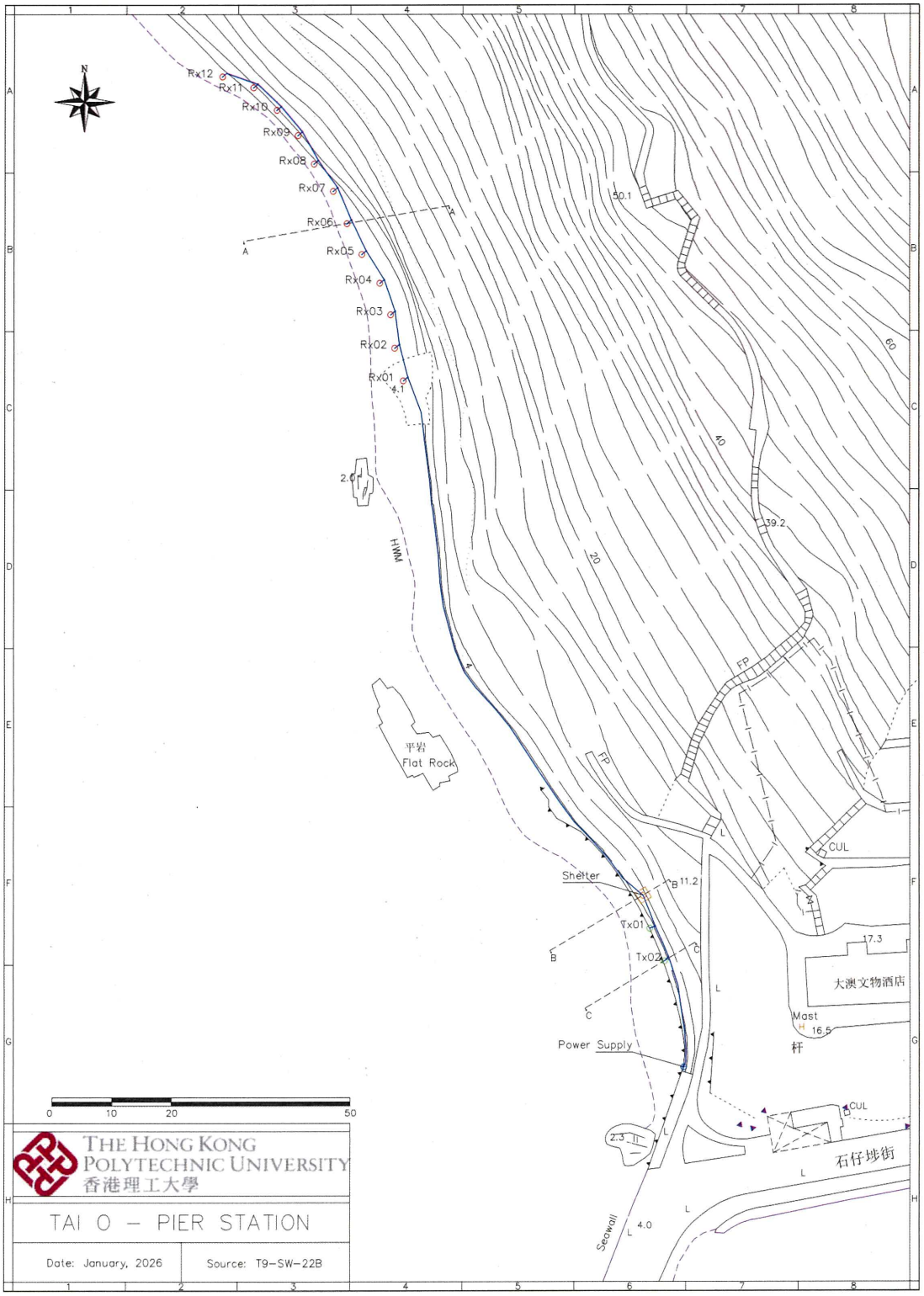
C Tai O - Wastewater Treatment Station - Section BB



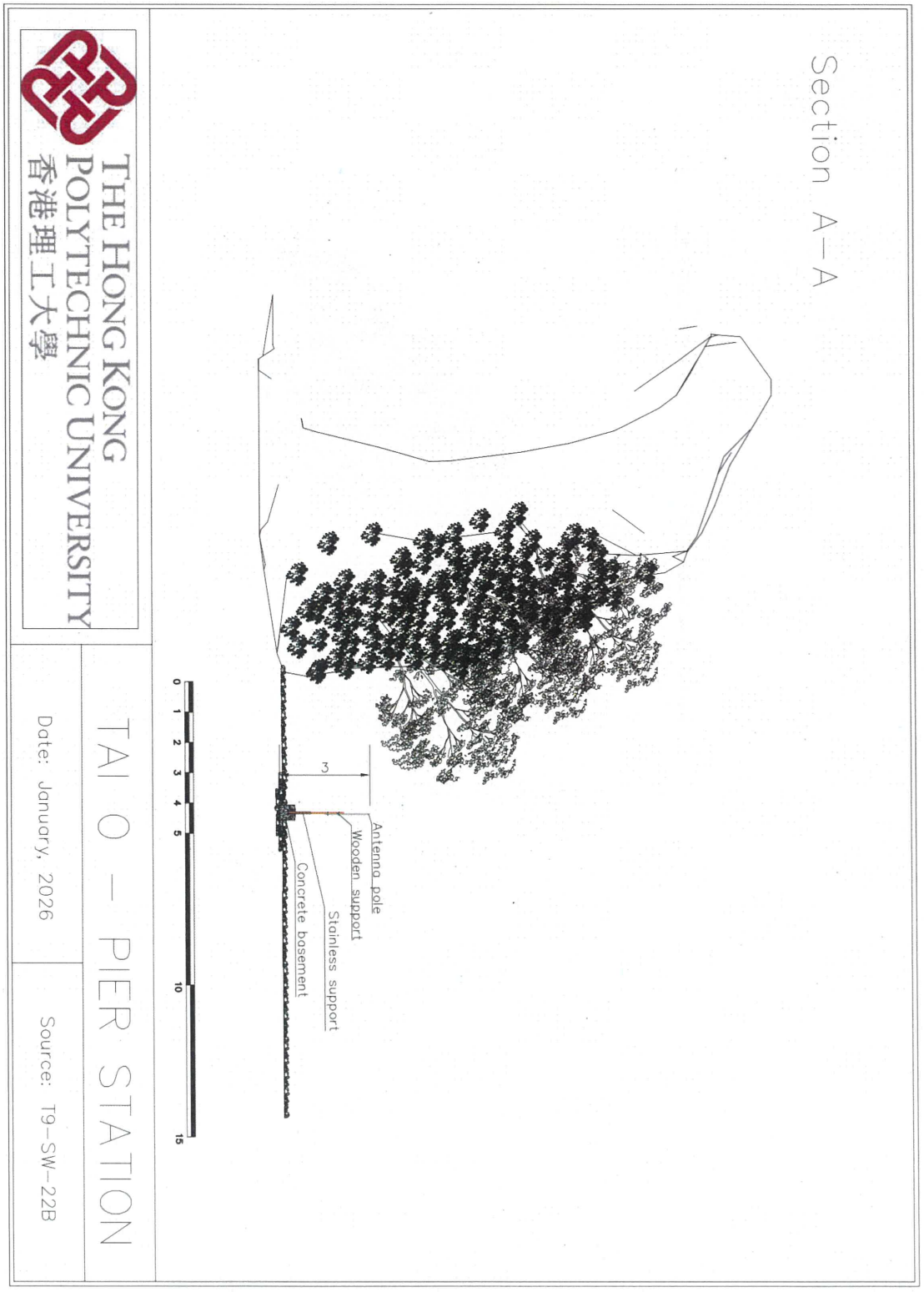
D Tai O - Wastewater Treatment Station - Antennas Details



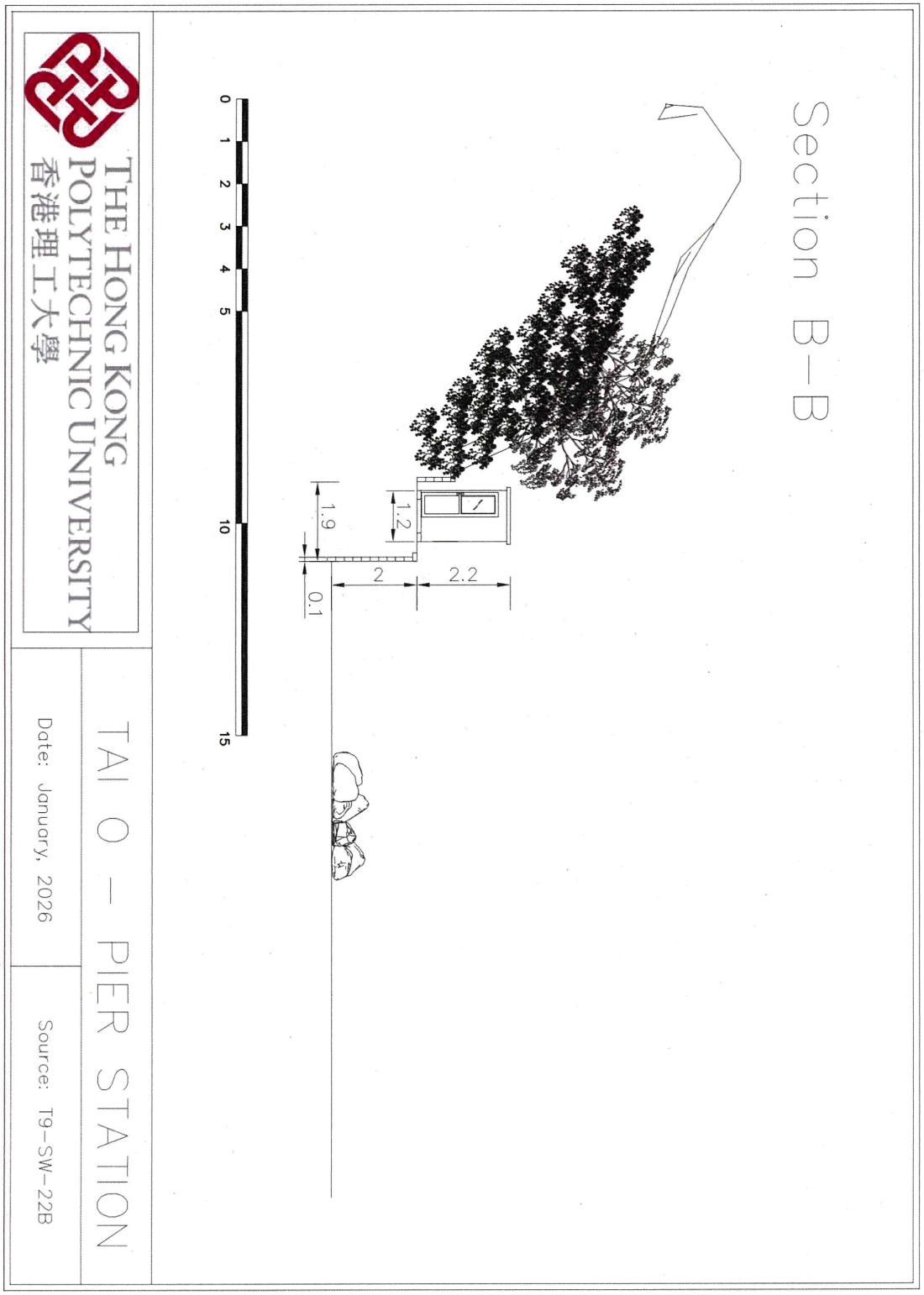
E Tai O - Pier Station - Detailed Plan View



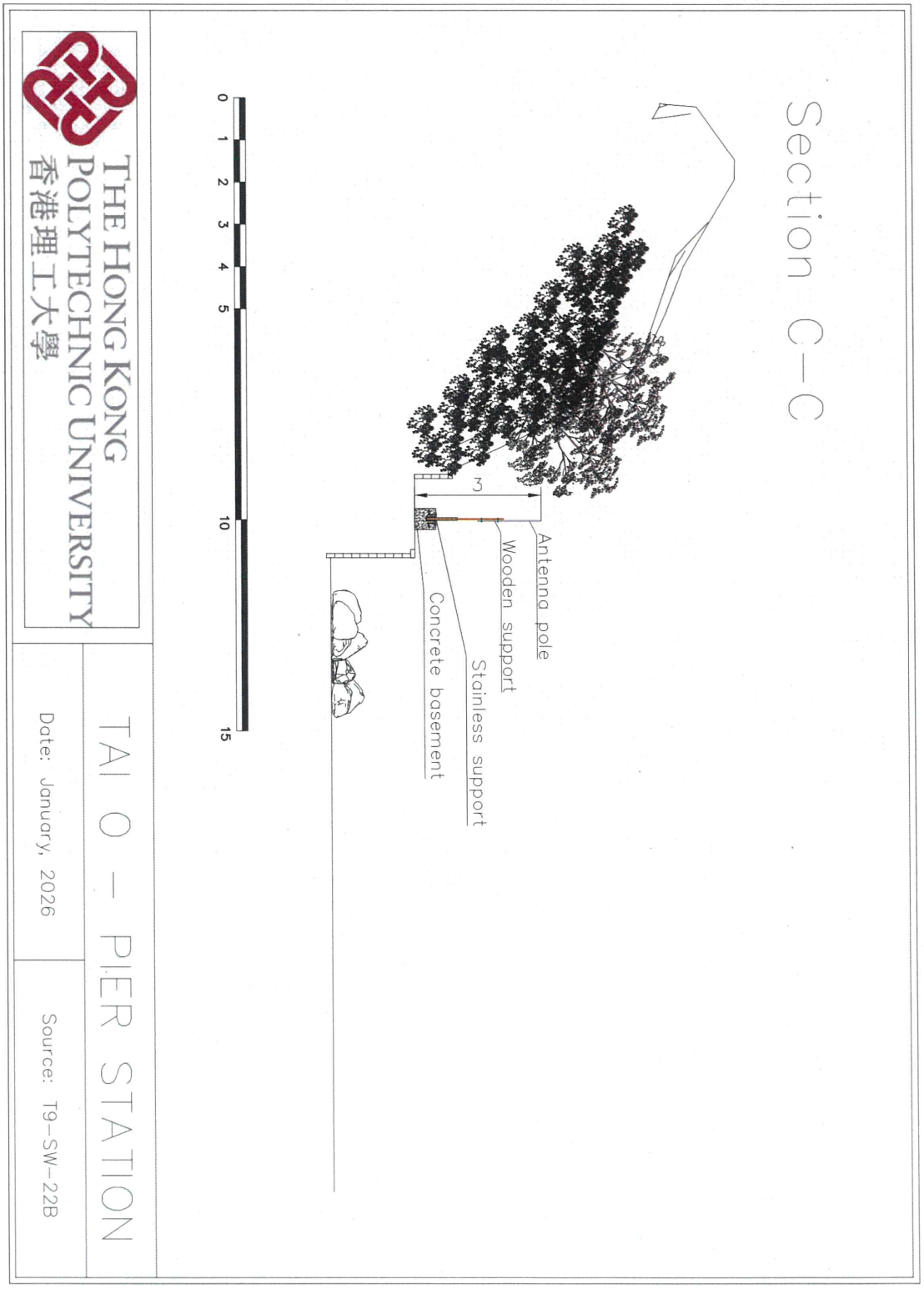
F Tai O - Pier Station - Section AA



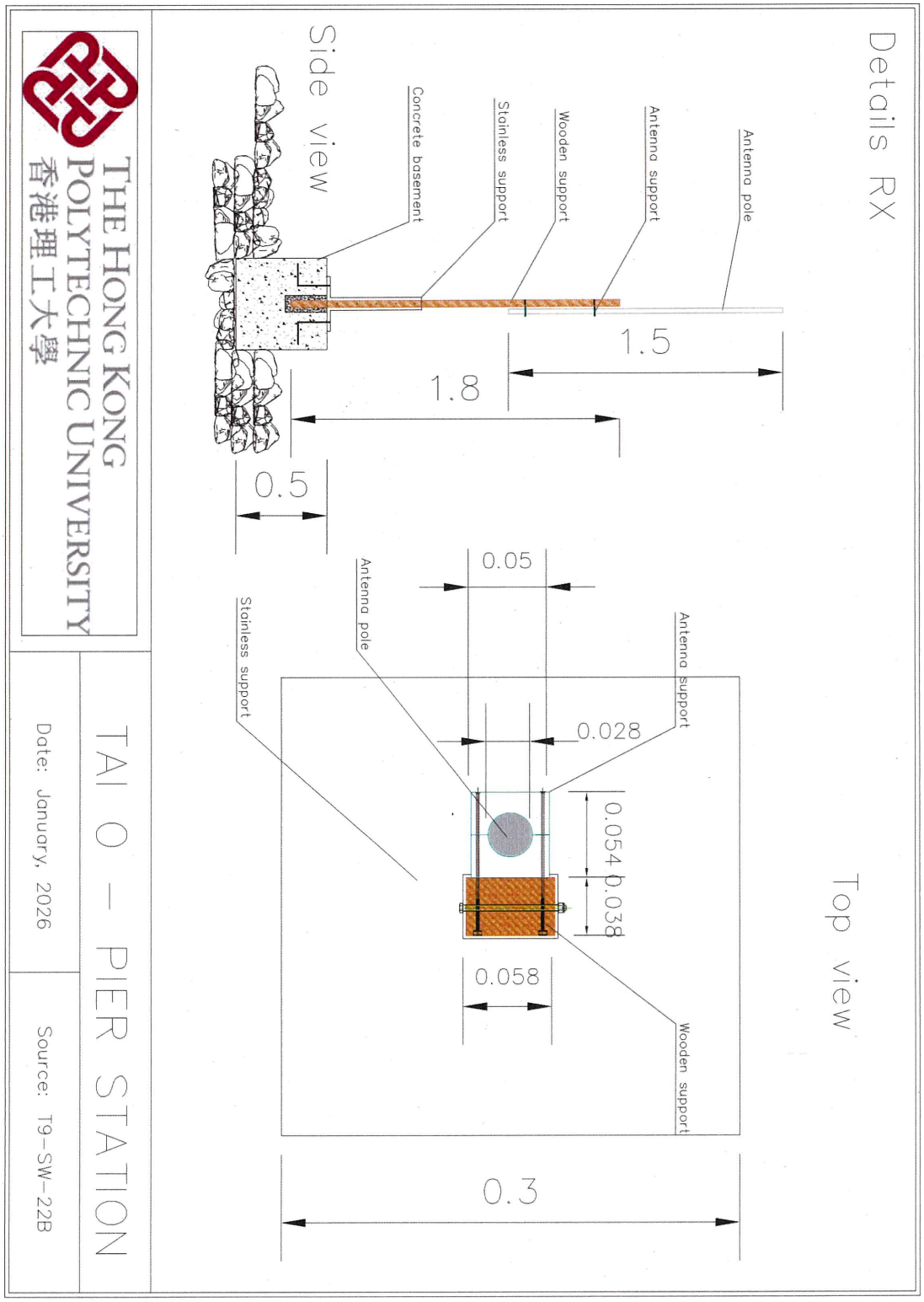
G Tai O - Pier Station - Section BB



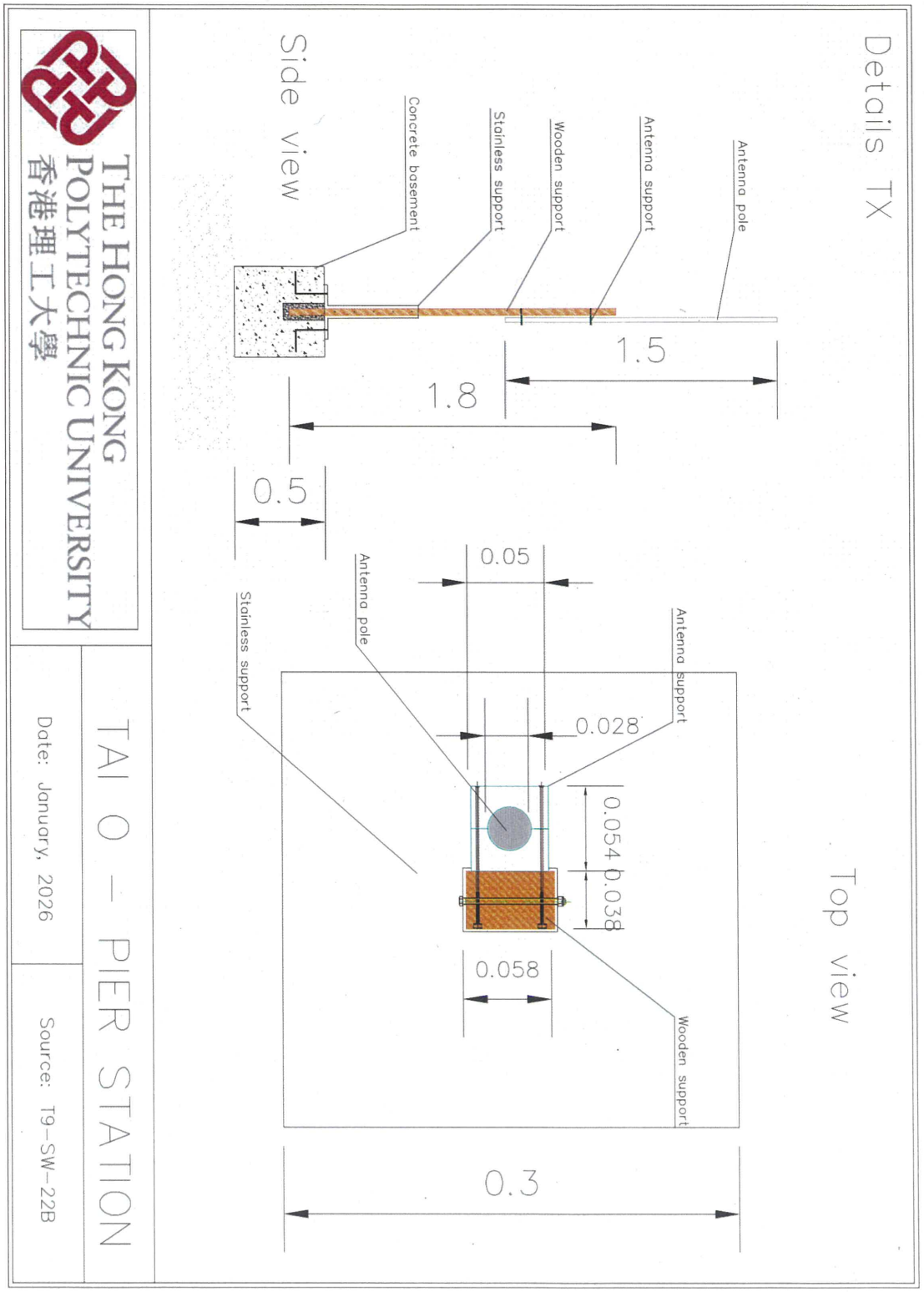
H Tai O - Pier Station - Section CC



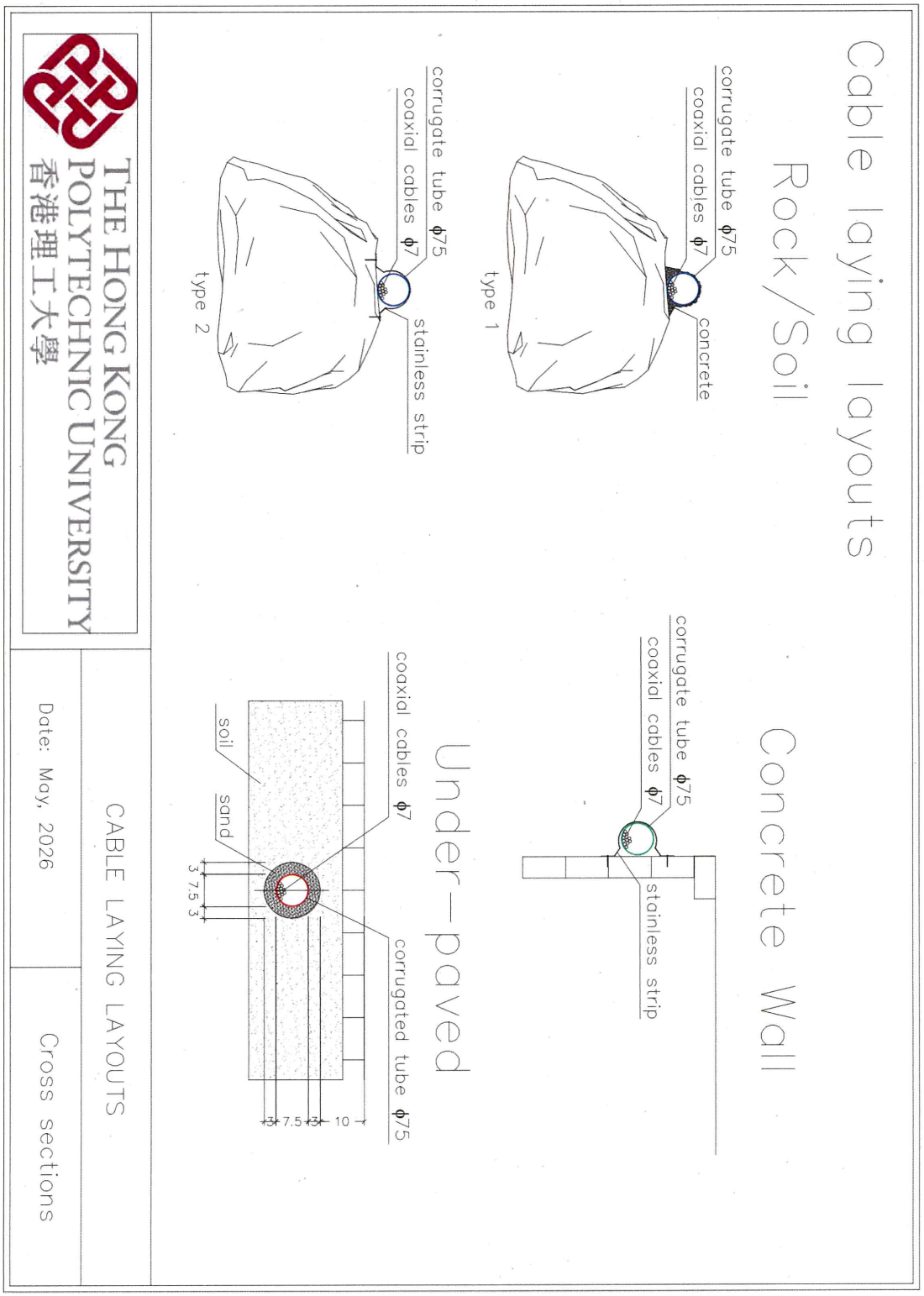
I Tai O - Pier Station - RX Details



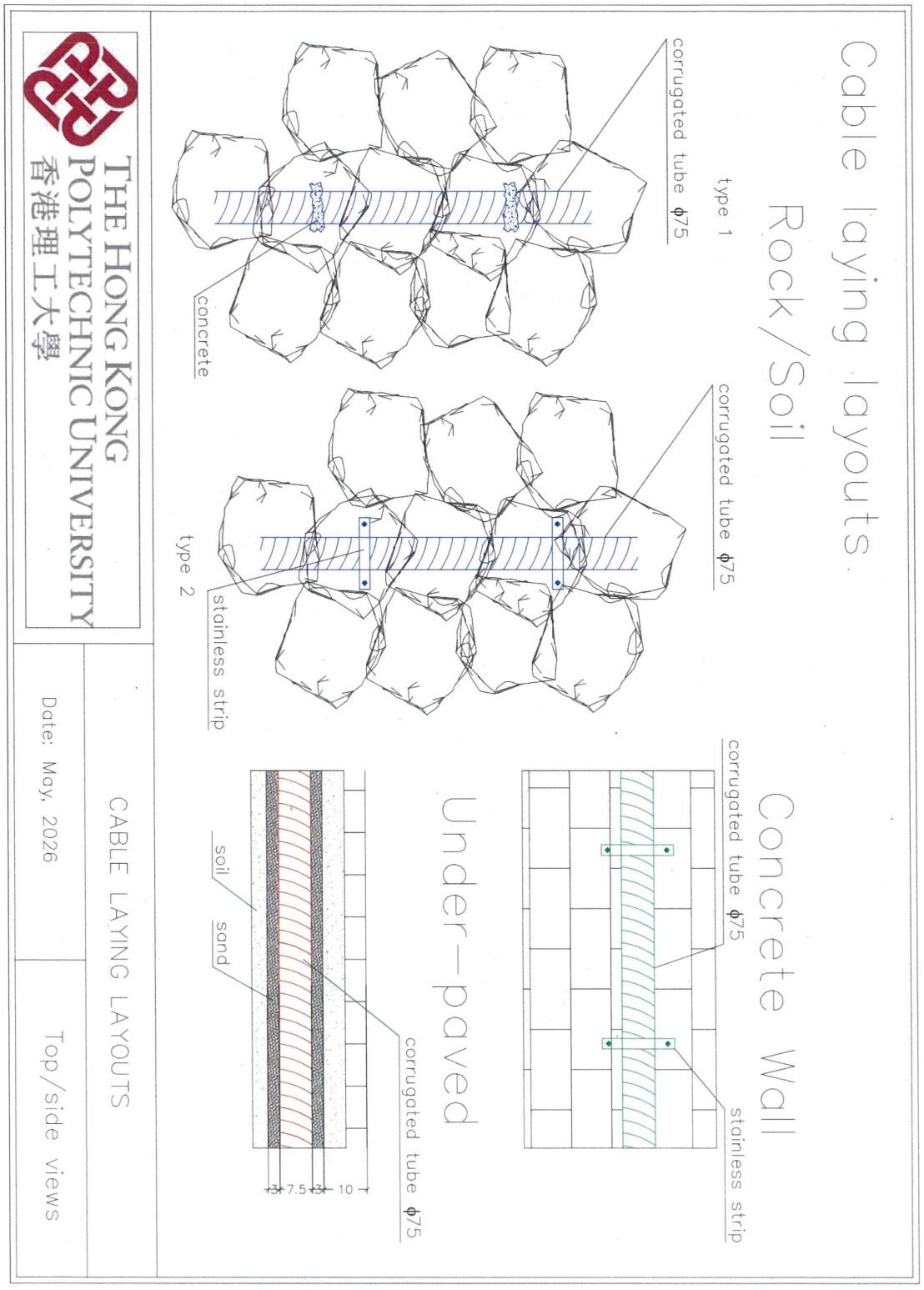
J Tai O - Pier Station - TX Details



K Cable details - Section 1



L Cable details - Section 2



Geotechnical Planning Review Report (GPRR) for Small technical room in Tai O Pier within the RGC project No. C5032-22EF - Hong Kong Coastal HF-Radar Network

1. Introduction

This document contains the geotechnical planning review for placing a small technical room atop the coastal defence wall adjacent to the Old Pier in Tai O. This installation will serve as server room to control and collect data from the new Radar network that will be deployed across Hong Kong waters to enhance the region's coastal resilience to flooding.

This report has been prepared to seek approval from the Town Planning Board under section 16 of the Town Planning Ordinance (cap. 131).

This report contains the following as listed.

(a) an outline of the topography and geology of the site;
(b) a general description of the proposed works and discussion of how the existing geotechnical features (such as slopes and retaining walls) and adjacent foundations will affect or be affected by such works.

2. Outline of the topography and geology of the site

The Tai O Pier is a significant feature of the Tai O fishing village on Lantau Island. The Tai O Pier has been a crucial part of the local community for many years, serving as a hub for transportation and trade. It has facilitated the movement of people and goods, connecting Tai O to other parts of Hong Kong and the mainland. The area of coastline behind Tai O Old Pier is not open to the public, with no designated entry points or infrastructure for public use.
The site is characterized by a gently sloping beach that reaches the base of the containment wall. This 2-meter-high vertical structure is built of squared rock; its schematic representation, along with the proposed installation, is shown in *Figure 1*.

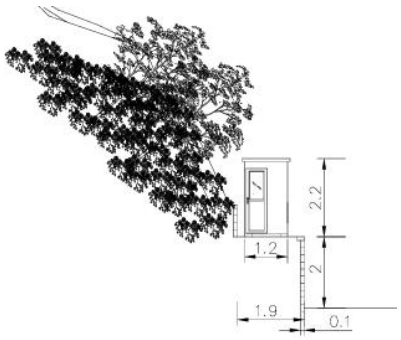


Figure 1 Schematic representation of the containment wall

The location site is shown in *Figure 2*.

Figure 2 Site layout

The ground investigation information belongs to previous works (LGL, 2001) and the results are summarized in *Table 1*.

Table 1 Nearby borehole information

Borehole ID	Depth range	Soil type
DH/14/1	16.85 to 15.85 meters	Fill
	15.85 to 12.95 meters	Colluvium
	12.95 to 12.75 meters	Colluvium
	12.75 to 10.55 meters	CDT
	10.55 to 5.95 meters	CDT/HDT
	5.95 to 5.83 meters	HDT/MDT
	5.83 to 4.25 meters	CDT/HDT
	4.25 to 4.10 meters	MDT
	4.10 to -3.15 meters	CDT/HDT
	-3.15 to -3.58 meters	MDT
TP/14/1	10.14 to 9.44 meters	Colluvium
	9.44 to 6.54 meters	CDT

The soil parameters employed for analysis and design are based on Halcrow, 2004. The unit weight γ, the effective cohesion c' and the effective angle of friction φ' for each type of soil in the area are listed in *Table 2*.

Table 2 Soil strength parameters

Soil Type	γ (kN/m^3)	c' (kPa)	φ' (degrees)
Fill	17	0	28

Colluvium	18	6	28
CDT	19	6	35

The design groundwater table is assumed at the toe of the slope according to previous monitoring records (the highest monitored groundwater level: +2.23 mPD).

The slope ground profile was established using the 2020 LiDAR data and field observations (https://sdportal.cedd.gov.hk/#/en/lidar).

3. Proposed works

Within the framework of the RGC Project, the primary objective is to deploy a network of low-impact pole-mounted antennas at strategic locations throughout Hong Kong

The data gathered by this network is critical for ongoing hydrological studies and, crucially, for enhancing emergency response protocols during flood events. The system is intended to provide vital real-time information that can support early warning systems, thereby improving public safety and resilience.

The small technical cabin, which is the subject of this geotechnical assessment, is an essential component of this network. Its fundamental purpose is to house on-site server equipment dedicated to the continuous collection, processing, and storage of the radar data transmitted by the antennas.

Based on a comprehensive site evaluation, the optimal location for this cabin has been identified atop the existing beach containment wall, without any foundation works given the temporary nature of the project. Consequently, a detailed assessment of the wall's structural integrity and overall stability is a prerequisite for the safe and feasible installation of this critical infrastructure.

The components are as follows:

- Portable cabin
- Server rack
- AC unit

The embedment depth of the masonry wall is assumed as 0.5 m and its thickness is about 0.1 m. The surcharge load is around 4 kPa with a footprint of the portable cabin of 1.2 m by 1.2 m.

The slope stability is evaluated based on the Category 1 (High) ‘Consequence-to-Life’ requirement.

The geological model was constructed based on the nearby boreholes and information from Section A-A of the feature No. 9SW-C/C 15 (Halcrow, 2004).

In *Table 3* a summary of the stability analysis is provided.

Table 3 Summary of stability analysis with and without surcharge load

Case	Critical FOS (Morgenstern-Price Method)		Acceptable
	Calculated	Required	
Without surcharge load	1.51	1.40	Yes
With surcharge load	1.46	1.40	Yes

Figure 3 and *Figure 4* present the results of the stability analysis for both the unloaded condition and the condition with the cabin surcharge load applied.

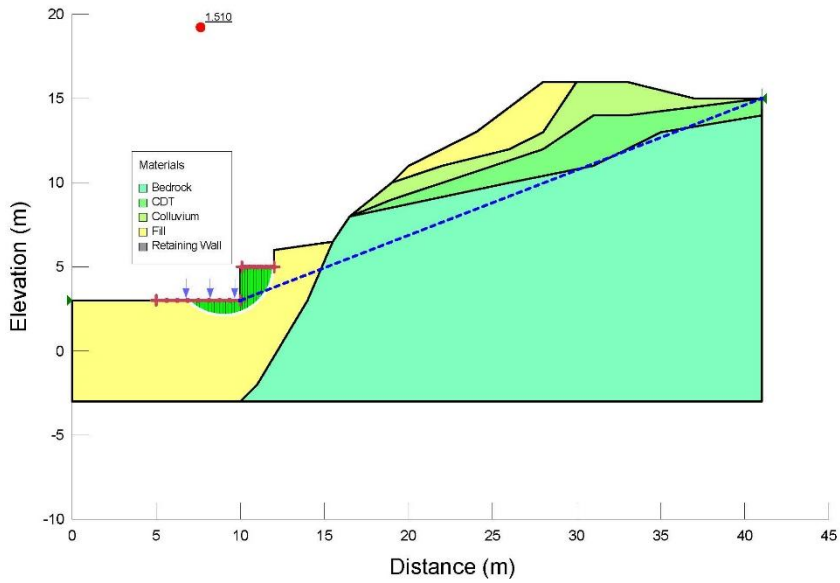


Figure 3 Slope stability analysis without surcharge load

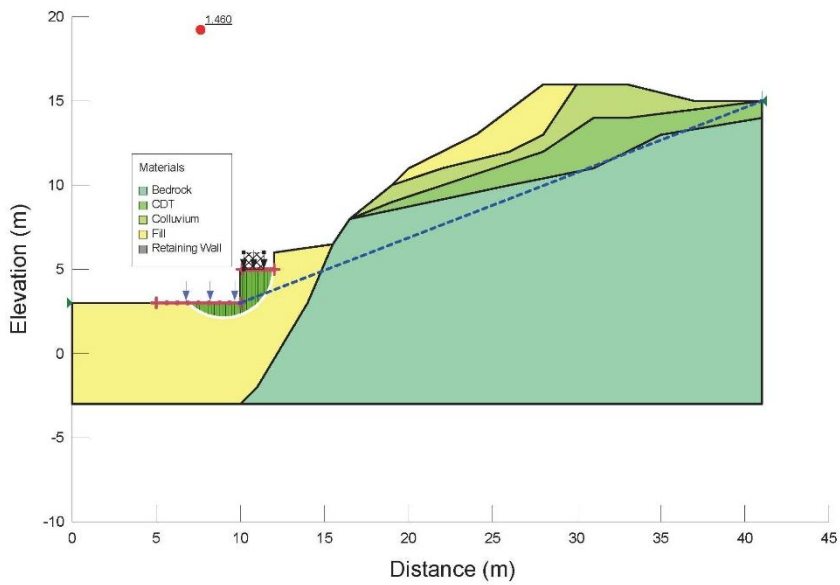


Figure 4 Slope stability analysis with surcharge load

4. Impact on adjacent premises/ geotechnical features

As the existing registered retaining walls and slope might be affected by the positioning of the

portable cabin, consideration shall be taken in the design of the proposed works.

Given the temporary nature of the proposed installation and the intrinsic characteristics of the structure, a lightweight, prefabricated outdoor cabin requiring no foundational excavation, its impact on adjacent structures is considered negligible. This assessment is based on the structure minimal weight and surface-mounted placement. The cabin will be positioned atop the existing wall as a fixed surface load.

Consequently, groundwater control measures are deemed unnecessary for this project, as no excavation or ground penetration works will be conducted.

5. Conclusion

Based on the available geotechnical information, the following conclusions and recommendations are drawn:

(a) The proposed installation as presented is considered as a geotechnical feasible scheme.
(b) No groundwater control scheme shall be considered in design.
(c) Stability of all slopes (man-made and natural terrains) and retaining walls within or in vicinity to the lot resulted not to be affected by the presence of the portable cabin.

Based on the current assessment, the proposed development is considered geotechnically feasible.

References

De la Varga, M., Schaaf, A., & Wellmann, F. (2019). GemPy 1.0: open-source stochastic geological modelling and inversion. *Geoscientific Model Development*, 12(1), 1-32.

LGL (2001). Ground investigation fieldwork report. *Works Order No. GE 2001/08/GI/14 Feature No. 9SW-C/C15. Contract No. GE/2001/08*.

Halcrow China Ltd (2004). Feature No. 9SW-C/C 15 Tai O police station, Tai O, Lantau. *CED Contract No. GE/2002/17*.

Retaining Wall Stability Analysis

Assumptions

(1) The retaining wall is simplified as a rectangular gravity wall with 1.7 m width and 2.3 m height, with the embedment depth of 0.5 m and concrete unit weight of 24 kN/m^3. The wall width is estimated by based on site observations and estimates. The retaining wall geometry is shown in Table 1;

(2) The retained Fill is horizontal behind the wall based on the 2020 LiDAR data and field observations;

(3) The static groundwater table of +2.2 mPD for wall stability analysis is adopted based on the highest monitored groundwater level of +2.23 mPD (Halcrow, 2004);

(4) The Fill parameters are selected based on the nearby slope feature No. 9SW-C/C 15 ground investigation works (Halcrow, 2004), as shown in Table 1;

(5) The uniform surcharge load is around 4 kPa;

(6) The earth pressure is estimated using Rankine's theory, as shown in Fig. 1.

Table 1. Soil strength parameters

Soil Type	γ (kN/m^3)	c' (kPa)	ϕ' (degrees)
Fill	17	0	28

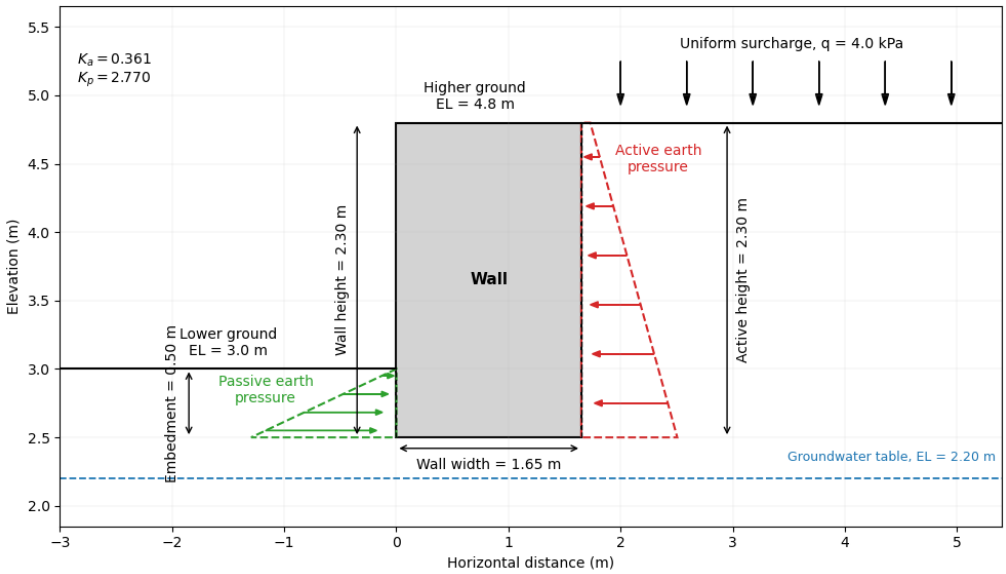


Figure 1. Retaining wall geometry and earth pressure.

Ultimate Limit State (ULS) Approach

The Hong Kong Geoguide 1 (GEO, 2020) adopts partial factors of material parameters and actions for ultimate limit state retaining wall design. The factors used below are shown in Table 2.

Table 2. Minimum partial load and material factors for use in design against ULSs

Type		Partial factor
Load	Dead load due to weight of the retaining wall	1.0
	Dead load due to weight of soil, rock and water	1.0
	Surcharge	1.5
Material	Unit weight	1.0
	Base friction angle	1.2
	Drained shear strength	1.2

(1) Factored strength and surcharge:

The factored friction angle is obtained by factoring $\tan\phi'$:

$$\tan\phi'_f = \frac{\tan\phi'}{\gamma_m} = \frac{\tan 28°}{1.2} = 0.443$$

$$\phi'_f = 23.9°$$

The factored surcharge is: $q_f = \gamma_f q = 1.5 \times 4 = 6.0$ kPa

The ULS active and passive earth pressure coefficients are:

$$K_{a,f} = \tan^2\left(45° - \frac{\phi'_f}{2}\right) = 0.423$$

$$K_{p,f} = \tan^2\left(45° + \frac{\phi'_f}{2}\right) = 2.362$$

(2) ULS active and passive thrusts:

Wall height: $H_{wall} = 2.3$ m

Active height on the retained side: $H_a = 2.3$ m

Passive embedment height on the lower ground side: $H_p = 0.5$ m

ULS active thrust due to soil self-weight: $P_{a,soil,f} = \frac{1}{2}K_{a.f}\gamma_{soil}H_a^2 = 19.037$ kN/m

ULS active thrust due to surcharge: $P_{a,q,f} = K_{a,f}qH_a = 5.843$ kN/m

Total ULS active thrust: $P_{a,f} = P_{a,soil,f} + P_{a,q,f} = 24.880$ kN/m

The ULS passive thrust: $P_{p,soil,f} = \frac{1}{2}K_{p,f}\gamma_{soil}H_p^2 = 5.019$ kN/m

(3) ULS sliding check:

The angle of base shearing resistance is assumed as the lower bound of "rough concrete" case recommend in Geoguide 1 (GEO, 2020), which is $0.9\phi'$

The factored base friction angle is obtained by factoring $\tan(0.9\phi')$:

$$\tan\delta'_f = \frac{\tan(0.9\phi')}{\gamma_m} = \frac{\tan(0.9 \times 28°)}{1.2} = 0.392$$

$$\delta'_f = 21.4°$$

Wall self-weight: $W_{wall} = \gamma_c B H_{wall} = 93.84$ kN/m

The design sliding action is: $D_f = P_{a,f} = 24.880 \ \ \mathrm{kN/m}$

The ULS sliding resistance is: $R_f = \tan(\delta_f') \times W_{wall} + P_{p,soil,f} = 40.735 \ \ \mathrm{kN/m}$

The ULS sliding utilization is: $U_{sliding} = \frac{D_f}{R_f} = 0.61 < 1.0$

The ULS sliding check is satisfied.

(4) ULS overturning check:

The ULS overturning moment is:

$$M_{O,f} = P_{a,soil,f} \times H_a/3 + P_{a,q,f} \times H_a/2 = 21.314 \ \ \mathrm{kN.m/m}$$

The resisting moment from wall self-weight: $M_{R1,f} = W_{wall} \times 0.5B =$

$75.141 \ \ \mathrm{kN.m/m}$

The resisting moment from passive thrust: $M_{R2,f} = P_{p,soil,f} \times H_p/3 = 0.837 \ \ \mathrm{kN.m/m}$

The total stabilizing moment is: $M_{R,f} = M_{R1,f} + M_{R2,f} = 75.978 \ \ \mathrm{kN.m/m}$

The ULS overturning utilization is: $U_{overturning} = \frac{M_{O,f}}{M_{R,f}} = 0.28 < 1.0$

The ULS overturning moment check is satisfied.

The ULS eccentricity is: $e_f = 0.5B - (M_{R,f} - M_{O,f})/W_{wall} \approx 0.218 \ \ \mathrm{m}$

Eccentricity check: $|e_f| \leq B/6 = 0.283 \ \ \mathrm{m}$; Tension will not develop in the soil.

The base remains in compression under the ULS loading.

(5) ULS bearing capacity check:

The effective width is: $B_f' = B - 2e_f \approx 1.264 \ \ \mathrm{m}$

The ULS applied bearing pressure is: $q_{applied,f} = W_{wall}/B_f' \approx 74.266 \ \ \mathrm{kPa}$

The ultimate bearing capacity with $c' = 0$ is: $q_{ult} = q_0 N_q i_q + 0.5\gamma B' N_\gamma i_\gamma$

Using the factored friction angle $\phi_f' = 23.9°$, the bearing capacity factors are:

$$N_{q,f} = e^{\pi \tan \phi_f'} \tan^2\left(45° + \frac{\phi_f'}{2}\right) = 9.502$$

$$N_{\gamma,f} = 2(N_{q,f} + 1)\tan \phi_f' = 9.307$$

The net horizontal design load for bearing inclination factors is:

$$H_{net,f} = P_{a,f} - P_{p,soil,f} = 19.861 \ \ \mathrm{kN/m}$$

The net vertical design load for bearing inclination factors is:

$$V_{net,f} = W_{wall} = 93.84 \ \ \mathrm{kN/m}$$

For s strip footing with $c' = 0$, the inclination factors are taken as:

$$i_{q,f} = \left(1 - \frac{H_{net,f}}{V_{net,f}}\right)^2 = 0.611$$

$$i_{\gamma,f} = \left(1 - \frac{H_{net,f}}{V_{net,f}}\right)^3 = 0.478$$

The embedment depth: $D_f = 0.5 \ \ \mathrm{m}$

The groundwater table is withing one range of wall width, therefore:

$$\gamma' = \frac{(EL_{wall_base} - EL_{GWT}) \times \gamma + [B - (EL_{wall_base} - EL_{GWT})] \times (\gamma - \gamma_w)}{B}$$

The overburden pressure at the base level is: $q_0 = \gamma D_f = 8.5$ kPa

The ULS bearing capacity is: $q_{ult,f} = q_0 N_{q,f} i_{q,f} + 0.5\gamma' B'_f N_{\gamma,f} i_{\gamma,f} = 75.897$ kPa

The ULS bearing utilization is: $U_{bearing} = \frac{q_{applied,f}}{q_{ult,f}} = 0.98 < 1.0$

The ULS bearing capacity check is satisfied.

Summary

ULS approach check:

Check	Value	Requirement	Result
Sliding utilization	0.61	≤ 1.0	OK
Overturning utilization	0.28	≤ 1.0	OK
Eccentricity	0.218 m	≤ $B/6$ = 0.283 m	OK
Bearing utilization	0.98	≤ 1.0	OK

Following the Geoguide 1 design philosophy, the relevant actions and material parameters are factored directly, and the design action is compared with the corresponding design resistance. Under this approach, the retaining wall satisfies the sliding and overturning stability checks. The ULS bearing utilization is approximately 1.0. The eccentricity also remains within the middle third of the base, and the minimum bearing pressure remains positive. Therefore, the wall satisfies the ULS bearing capacity requirement.

References

GEO (2020). *Guide to Retaining Wall Design (Geoguide 1) (Second Edition)*. Geotechnical Engineering Office, Civil Engineering and Development Department, HKSAR Government.

Halcrow China Ltd (2004). Feature No. 9SW-C/C 15 Tai O police station, Tai O, Lantau. *CED Contract No. GE/2002/17*.

Slope Stability (2)

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File Information

File Version: 11.05
Product Version: 23.1.2.11
Revision Number: 42
Date: 04/01/2026
Time: 04:50:27 PM
File Name: With_loading111.gsz
Directory: C:\Users\Administrator\Desktop\20260401\
Last Solved Date: 2026/04/01
Last Solved Time: 16:50:26

Project Settings

Unit System: International System of Units (SI)

Analysis Settings

Slope Stability (2)

Kind: SLOPE/W
Analysis Type: Morgenstern-Price
Settings
- Side Function
  - Intercolumn force function option: Half-Sine
- PWP Conditions from: Piezometric Surfaces
- Apply Phreatic Correction: Yes
- Use Staged Rapid Drawdown: No
- Unit Weight of Water: 9.807 kN/m³

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 m
  - Minimum Slip Surface Volume: 1 m³
  - Number of Columns: 30
- Factor of Safety Convergence Settings
  - Maximum Number of Iterations: 100
  - Tolerable difference in F of S: 0.001
- Under-Relaxation Criteria
  - Initial Rate: 1
  - Minimum Rate: 0.1
  - Rate Reduction Factor: 0.65
  - Reduction Frequency (iterations): 50
- Solution Settings

Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Fill

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 17 kN/m³
Effective Cohesion: 0 kPa
Effective Friction Angle: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

Colluvium

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Effective Cohesion: 6 kPa
Effective Friction Angle: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

CDT

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Effective Cohesion: 6 kPa
Effective Friction Angle: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

Bedrock

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Effective Cohesion: 40 kPa
Effective Friction Angle: 10 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

Retaining Wall

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 24 kN/m³
Effective Cohesion: 500 kPa
Effective Friction Angle: 89 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (5, 3) m

Left-Zone Right Coordinate: (10, 3) m
Left-Zone Increment: 8
Right Type: Range
Right-Zone Left Coordinate: (10.1, 5) m
Right-Zone Right Coordinate: (12, 5) m
Right-Zone Increment: 8
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 3) m
Right Coordinate: (41, 15) m

Piezometric Surfaces

Piezometric Surface 1

Coordinates

	X	Y
Coordinate 1	10 m	3 m
Coordinate 2	41 m	15 m

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 4 kN/m³
Direction: Vertical

Coordinates

	X	Y
	10.2 m	5 m
	10.2 m	6 m
	11.4 m	6 m

Geometry

Name: 2D Geometry

Settings

View: 2D
Element Thickness: 1.2 m

Points

	X	Y
Point 1	10.000401 m	5 m
Point 2	16 m	5 m
Point 3	10.000401 m	3 m
Point 4	16.5 m	8 m
Point 5	16 m	2 m
Point 6	17 m	-2 m
Point 7	18 m	-8 m

Point 8	19 m	10 m
Point 9	22 m	11 m
Point 10	26 m	12 m
Point 11	28 m	13 m
Point 12	30 m	16 m
Point 13	33 m	16 m
Point 14	37 m	15 m
Point 15	41 m	15 m
Point 16	33 m	14 m
Point 17	31 m	14 m
Point 18	28 m	12 m
Point 19	19 m	9 m
Point 20	20 m	-8 m
Point 21	22 m	-8 m
Point 22	26 m	10 m
Point 23	31 m	11 m
Point 24	35 m	13 m
Point 25	41 m	14 m
Point 26	41 m	-8 m
Point 27	20 m	11 m
Point 28	24 m	13 m
Point 29	28 m	16 m
Point 30	10.100401 m	5 m
Point 31	10.100401 m	3 m
Point 32	10.100401 m	2.5 m
Point 33	10.000267 m	2.5 m
Point 34	0 m	-8 m
Point 35	0 m	3 m
Point 36	12 m	5 m
Point 37	12 m	6 m
Point 38	15.5 m	6.5 m

Regions

	Material	Points	Area
Region 1	Bedrock	21,26,25,24,23,22,4,2,5,6,7,20	459.25 m^2
Region 2	Fill	8,27,28,29,12,11,10,9	17 m^2
Region 3	Retaining Wall	30,1,3,33,32,31	0.25003 m^2
Region 4	Fill	34,35,3,33,32,31,30,36,37,38,4,2,5,6,7	204.62 m^2
Region 5	Colluvium	8,9,10,11,12,13,14,15,16,17,18,19,4	25.25 m^2
Region 6	CDT	23,24,25,15,16,17,18,19,4,22	31.75 m^2

Slip Results

Slip Surfaces Analysed: 20 of 405 converged

Current Slip Surface

Slip Surface: 180
Factor of Safety: 1.460
Volume: 5.9083281 m^3
Weight: 102.19181 kN
Resisting Moment: 172.47679 kN·m
Activating Moment: 118.15698 kN·m

Resisting Force: 47.829736 kN
Activating Force: 32.76554 kN
Slip Rank: 1 of 405 slip surfaces
Exit: (12, 5) m
Entry: (6.875, 3) m
Radius: 3.0117139 m
Center: (8.9916578, 5.1424707) m

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Column Base Material
Column 1	11.896712 m	4.518847 m	-6.6921468 kPa	2.8277952 kPa	1.5035654 kPa	0 kPa	0 kPa	Fill
Column 2	11.690135 m	3.825978 m	-1.4647051 kPa	10.223339 kPa	5.4358457 kPa	0 kPa	0 kPa	Fill
Column 3	11.493423 m	3.474167 m	0.88643549 kPa	14.82439 kPa	7.4109421 kPa	0 kPa	0 kPa	Fill
Column 4	11.314286 m	3.229976 m	2.3777117 kPa	20.941087 kPa	9.8703217 kPa	0 kPa	0 kPa	Fill
Column 5	11.142857 m	3.038252 m	3.4469409 kPa	23.96851 kPa	10.911512 kPa	0 kPa	0 kPa	Fill
Column 6	10.971429 m	2.875760 m	4.2668526 kPa	26.756028 kPa	11.957707 kPa	0 kPa	0 kPa	Fill
Column 7	10.800000 m	2.736474 m	4.8888463 kPa	29.440206 kPa	13.05419 kPa	0 kPa	0 kPa	Fill
Column 8	10.628571 m	2.616505 m	5.3460771 kPa	32.110633 kPa	14.230967 kPa	0 kPa	0 kPa	Fill
Column 9	10.457143 m	2.513185 m	5.6613166 kPa	34.828122 kPa	15.508266 kPa	0 kPa	0 kPa	Fill
Column 10	10.285714 m	2.424599 m	5.850883 kPa	37.632823 kPa	16.898757 kPa	0 kPa	0 kPa	Fill
Column 11	10.150201 m	2.363030 m	5.9285974 kPa	36.519948 kPa	16.26571 kPa	0 kPa	0 kPa	Fill
Column 12	10.050401 m	2.323494 m	5.936312 kPa	53.514434 kPa	25.297736 kPa	0 kPa	0 kPa	Fill
Column 13	10.000334 m	2.304691 m	6.8201627 kPa	10.396203 kPa	1.9014144 kPa	0 kPa	0 kPa	Fill
Column 14	10.000134 m	2.304620 m	6.8201004 kPa	8.8438363 kPa	1.0760394 kPa	0 kPa	0 kPa	Fill
Column 15	9.913194 m	2.276659 m	0 kPa	9.6919587 kPa	5.1533059 kPa	0 kPa	0 kPa	Fill
Column 16	9.739583 m	2.226481 m	0 kPa	11.488014 kPa	6.1082855 kPa	0 kPa	0 kPa	Fill
Column 17	9.565972 m	2.187346 m	0 kPa	13.251989 kPa	7.0462073 kPa	0 kPa	0 kPa	Fill
Column 18	9.392361 m	2.158817 m	0 kPa	14.956042 kPa	7.9522686 kPa	0 kPa	0 kPa	Fill
Column 19	9.218750 m	2.140593 m	0 kPa	16.560309 kPa	8.8052726 kPa	0 kPa	0 kPa	Fill
Column 20	9.045139 m	2.132483 m	0 kPa	18.012649 kPa	9.5774953 kPa	0 kPa	0 kPa	Fill
Column 21	8.871528 m	2.134408 m	0 kPa	19.249434 kPa	10.235106 kPa	0 kPa	0 kPa	Fill
Column 22	8.697917 m	2.146385 m	0 kPa	20.197816 kPa	10.739369 kPa	0 kPa	0 kPa	Fill

Column 23	8.524306 m	2.168537 m	0 kPa	20.779791 kPa	11.048811 kPa	0 kPa	0 kPa	Fill
Column 24	8.350694 m	2.201094 m	0 kPa	20.91815 kPa	11.122378 kPa	0 kPa	0 kPa	Fill
Column 25	8.177083 m	2.244409 m	0 kPa	20.543915 kPa	10.923393 kPa	0 kPa	0 kPa	Fill
Column 26	8.003472 m	2.298975 m	0 kPa	19.604349 kPa	10.423817 kPa	0 kPa	0 kPa	Fill
Column 27	7.829861 m	2.365459 m	0 kPa	18.070017 kPa	9.6079987 kPa	0 kPa	0 kPa	Fill
Column 28	7.656250 m	2.444745 m	0 kPa	15.939066 kPa	8.4749519 kPa	0 kPa	0 kPa	Fill
Column 29	7.482639 m	2.538010 m	0 kPa	13.236877 kPa	7.0381722 kPa	0 kPa	0 kPa	Fill
Column 30	7.309028 m	2.646831 m	0 kPa	10.009679 kPa	5.3222407 kPa	0 kPa	0 kPa	Fill
Column 31	7.135417 m	2.773372 m	0 kPa	6.3111603 kPa	3.3557034 kPa	0 kPa	0 kPa	Fill
Column 32	6.961806 m	2.920693 m	0 kPa	2.1806878 kPa	1.1594923 kPa	0 kPa	0 kPa	Fill

Slope Stability

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File Information

File Version: 11.05
Product Version: 23.1.2.11
Revision Number: 42
Date: 04/01/2026
Time: 04:50:27 PM
File Name: With_loading111.gsz
Directory: C:\Users\Administrator\Desktop\20260401\
Last Solved Date: 2026/04/01
Last Solved Time: 16:50:26

Project Settings

Unit System: International System of Units (SI)

Analysis Settings

Slope Stability

Kind: SLOPE/W
Analysis Type: Morgenstern-Price
Settings
- Side Function
  - Intercolumn force function option: Half-Sine
- PWP Conditions from: Piezometric Surfaces
- Apply Phreatic Correction: Yes
- Use Staged Rapid Drawdown: No
- Unit Weight of Water: 9.807 kN/m³

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 m
  - Minimum Slip Surface Volume: 1 m³
  - Number of Columns: 30
- Factor of Safety Convergence Settings
  - Maximum Number of Iterations: 100
  - Tolerable difference in F of S: 0.001
- Under-Relaxation Criteria
  - Initial Rate: 1
  - Minimum Rate: 0.1
  - Rate Reduction Factor: 0.65
  - Reduction Frequency (iterations): 50
- Solution Settings

Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Fill

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 17 kN/m³
Effective Cohesion: 0 kPa
Effective Friction Angle: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

Colluvium

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Effective Cohesion: 6 kPa
Effective Friction Angle: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

CDT

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Effective Cohesion: 6 kPa
Effective Friction Angle: 35 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

Bedrock

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Effective Cohesion: 40 kPa
Effective Friction Angle: 10 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

Retaining Wall

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 24 kN/m³
Effective Cohesion: 500 kPa
Effective Friction Angle: 89 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Surface: 1

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (5, 3) m

Left-Zone Right Coordinate: (10, 3) m
Left-Zone Increment: 8
Right Type: Range
Right-Zone Left Coordinate: (10.1, 5) m
Right-Zone Right Coordinate: (12, 5) m
Right-Zone Increment: 8
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 3) m
Right Coordinate: (41, 15) m

Piezometric Surfaces

Piezometric Surface 1

Coordinates

	X	Y
Coordinate 1	10 m	3 m
Coordinate 2	41 m	15 m

Geometry

Name: 2D Geometry

Settings

View: 2D
Element Thickness: 1.2 m

Points

	X	Y
Point 1	10.000401 m	5 m
Point 2	16 m	5 m
Point 3	10.000401 m	3 m
Point 4	16.5 m	8 m
Point 5	16 m	2 m
Point 6	17 m	-2 m
Point 7	18 m	-8 m
Point 8	19 m	10 m
Point 9	22 m	11 m
Point 10	26 m	12 m
Point 11	28 m	13 m
Point 12	30 m	16 m
Point 13	33 m	16 m
Point 14	37 m	15 m
Point 15	41 m	15 m
Point 16	33 m	14 m
Point 17	31 m	14 m
Point 18	28 m	12 m
Point 19	19 m	9 m
Point 20	20 m	-8 m

Point 21	22 m	-8 m
Point 22	26 m	10 m
Point 23	31 m	11 m
Point 24	35 m	13 m
Point 25	41 m	14 m
Point 26	41 m	-8 m
Point 27	20 m	11 m
Point 28	24 m	13 m
Point 29	28 m	16 m
Point 30	10.100401 m	5 m
Point 31	10.100401 m	3 m
Point 32	10.100401 m	2.5 m
Point 33	10.000267 m	2.5 m
Point 34	0 m	-8 m
Point 35	0 m	3 m
Point 36	12 m	5 m
Point 37	12 m	6 m
Point 38	15.5 m	6.5 m

Regions

	Material	Points	Area
Region 1	Bedrock	21,26,25,24,23,22,4,2,5,6,7,20	459.25 m^2
Region 2	Fill	8,27,28,29,12,11,10,9	17 m^2
Region 3	Retaining Wall	30,1,3,33,32,31	0.25003 m^2
Region 4	Fill	34,35,3,33,32,31,30,36,37,38,4,2,5,6,7	204.62 m^2
Region 5	Colluvium	8,9,10,11,12,13,14,15,16,17,18,19,4	25.25 m^2
Region 6	CDT	23,24,25,15,16,17,18,19,4,22	31.75 m^2

Slip Results

Slip Surfaces Analysed: 18 of 405 converged

Current Slip Surface

Slip Surface: 180
Factor of Safety: 1.510
Volume: 5.9086539 m^3
Weight: 102.19735 kN
Resisting Moment: 165.27553 kN·m
Activating Moment: 109.48579 kN·m
Resisting Force: 45.900215 kN
Activating Force: 30.405609 kN
Slip Rank: 1 of 405 slip surfaces
Exit: (12, 5) m
Entry: (6.875, 3) m
Radius: 3.0117139 m
Center: (8.9916578, 5.1424707) m

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Column Base Material
Column 1	11.896712 m	4.518847 m	-6.6921468 kPa	2.880926 kPa	1.5318155 kPa	0 kPa	0 kPa	Fill

Column 2	11.690135 m	3.825978 m	-1.4647051 kPa	10.333085 kPa	5.4941986 kPa	0 kPa	0 kPa	Fill
Column 3	11.504266 m	3.488790 m	0.79751296 kPa	14.714483 kPa	7.3997844 kPa	0 kPa	0 kPa	Fill
Column 4	11.339105 m	3.260322 m	2.2008307 kPa	18.03951 kPa	8.4215752 kPa	0 kPa	0 kPa	Fill
Column 5	11.173945 m	3.070355 m	3.2757671 kPa	20.902151 kPa	9.3721144 kPa	0 kPa	0 kPa	Fill
Column 6	11.008784 m	2.908810 m	4.1083039 kPa	23.513098 kPa	10.317712 kPa	0 kPa	0 kPa	Fill
Column 7	10.843624 m	2.769778 m	4.7488166 kPa	25.999819 kPa	11.299359 kPa	0 kPa	0 kPa	Fill
Column 8	10.678463 m	2.649447 m	5.2298359 kPa	28.446695 kPa	12.344623 kPa	0 kPa	0 kPa	Fill
Column 9	10.513302 m	2.545192 m	5.5737425 kPa	30.911978 kPa	13.472579 kPa	0 kPa	0 kPa	Fill
Column 10	10.348142 m	2.455127 m	5.796616 kPa	33.435619 kPa	14.695919 kPa	0 kPa	0 kPa	Fill
Column 11	10.182981 m	2.377858 m	5.9103596 kPa	36.04279 kPa	16.021698 kPa	0 kPa	0 kPa	Fill
Column 12	10.050401 m	2.323494 m	5.936312 kPa	53.563939 kPa	25.324058 kPa	0 kPa	0 kPa	Fill
Column 13	10.000334 m	2.304691 m	6.8201627 kPa	10.423502 kPa	1.9159292 kPa	0 kPa	0 kPa	Fill
Column 14	10.000134 m	2.304620 m	6.8201004 kPa	8.8708491 kPa	1.0904024 kPa	0 kPa	0 kPa	Fill
Column 15	9.913194 m	2.276659 m	0 kPa	9.7201124 kPa	5.1682754 kPa	0 kPa	0 kPa	Fill
Column 16	9.739583 m	2.226481 m	0 kPa	11.498356 kPa	6.1137846 kPa	0 kPa	0 kPa	Fill
Column 17	9.565972 m	2.187346 m	0 kPa	13.242358 kPa	7.0410869 kPa	0 kPa	0 kPa	Fill
Column 18	9.392361 m	2.158817 m	0 kPa	14.924701 kPa	7.9356043 kPa	0 kPa	0 kPa	Fill
Column 19	9.218750 m	2.140593 m	0 kPa	16.506023 kPa	8.776408 kPa	0 kPa	0 kPa	Fill
Column 20	9.045139 m	2.132483 m	0 kPa	17.934791 kPa	9.5360976 kPa	0 kPa	0 kPa	Fill
Column 21	8.871528 m	2.134408 m	0 kPa	19.148108 kPa	10.18123 kPa	0 kPa	0 kPa	Fill
Column 22	8.697917 m	2.146385 m	0 kPa	20.073977 kPa	10.673523 kPa	0 kPa	0 kPa	Fill
Column 23	8.524306 m	2.168537 m	0 kPa	20.635366 kPa	10.972019 kPa	0 kPa	0 kPa	Fill
Column 24	8.350694 m	2.201094 m	0 kPa	20.756137 kPa	11.036234 kPa	0 kPa	0 kPa	Fill
Column 25	8.177083 m	2.244409 m	0 kPa	20.368462 kPa	10.830104 kPa	0 kPa	0 kPa	Fill
Column 26	8.003472 m	2.298975 m	0 kPa	19.42081 kPa	10.326228 kPa	0 kPa	0 kPa	Fill
Column 27	7.829861 m	2.365459 m	0 kPa	17.884989 kPa	9.5096174 kPa	0 kPa	0 kPa	Fill
Column 28	7.656250 m	2.444745 m	0 kPa	15.760442 kPa	8.3799754 kPa	0 kPa	0 kPa	Fill
Column 29	7.482639 m	2.538010 m	0 kPa	13.073966 kPa	6.9515508 kPa	0 kPa	0 kPa	Fill

Column 30	7.309028 m	2.646831 m	0 kPa	9.8735216 kPa	5.2498445 kPa	0 kPa	0 kPa	Fill
Column 31	7.135417 m	2.773372 m	0 kPa	6.2152777 kPa	3.3047218 kPa	0 kPa	0 kPa	Fill
Column 32	6.961806 m	2.920693 m	0 kPa	2.1428189 kPa	1.139357 kPa	0 kPa	0 kPa	Fill