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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

Contents

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 7.

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

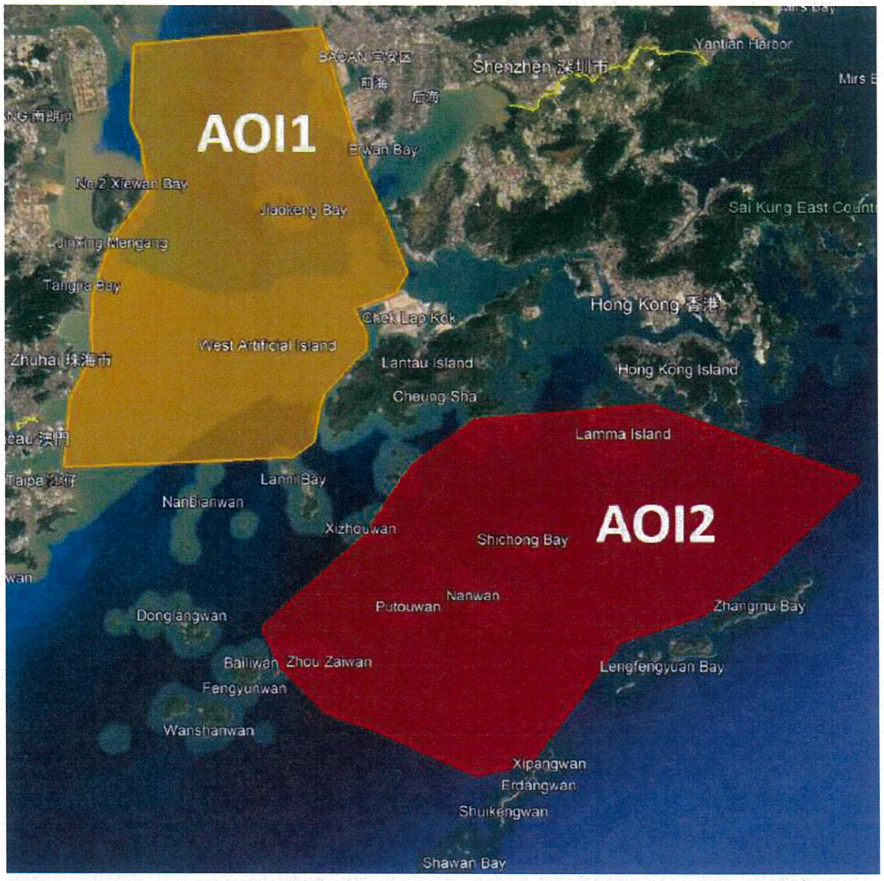

Figure 1: AOIs considered in the present project. Pearl River Estuary (AOI1 in orange) and Hong Kong Central Waters (AOI2 in red).

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 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.

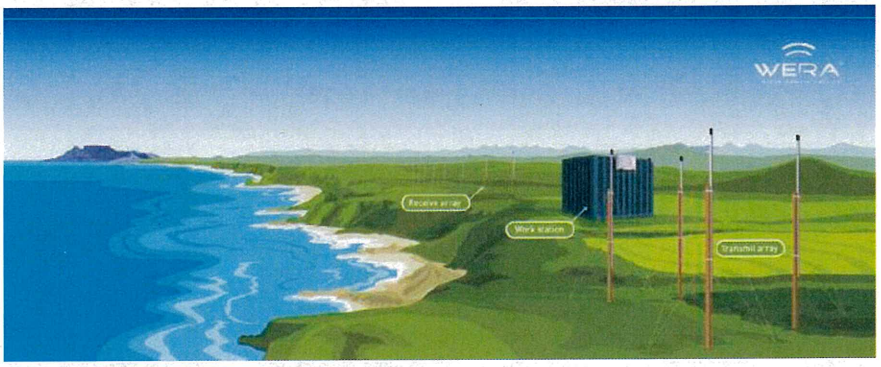

Figure 2: Sketch of WERA Ocean Remote Sensing System.

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-

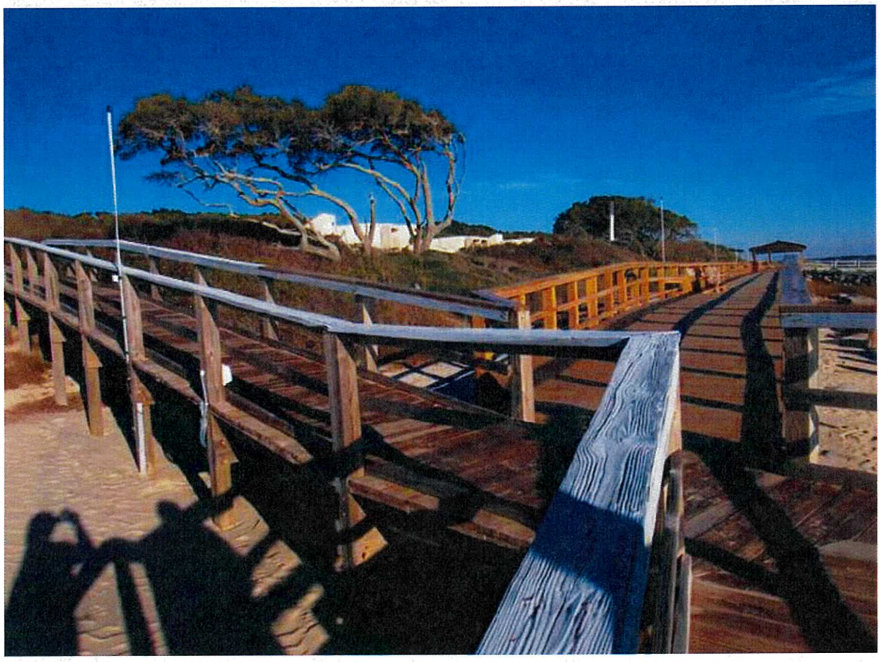

Figure 3: Antenna Array integrated along a boardwalk in Georgia, USA.

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

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

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 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.

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

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 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 essential 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 uninterruptible 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

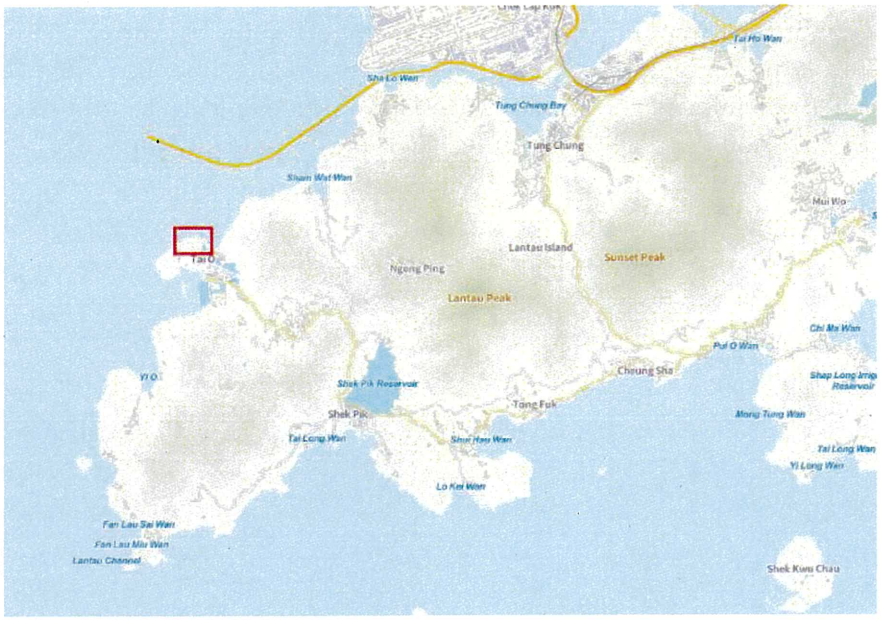

Figure 8: Approximate position of the Tai O - Wastewater Treatment Station site in respect to Lantau Island (red squared box).

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.

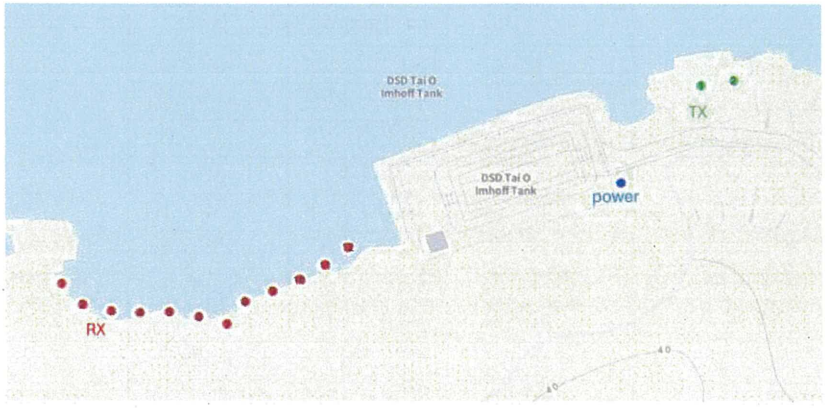

Figure 10: GPS positions reported on the geospatial information service provided by the Hong Kong Special Administrative Region (HKSAR) Government (GeoInfo Map).

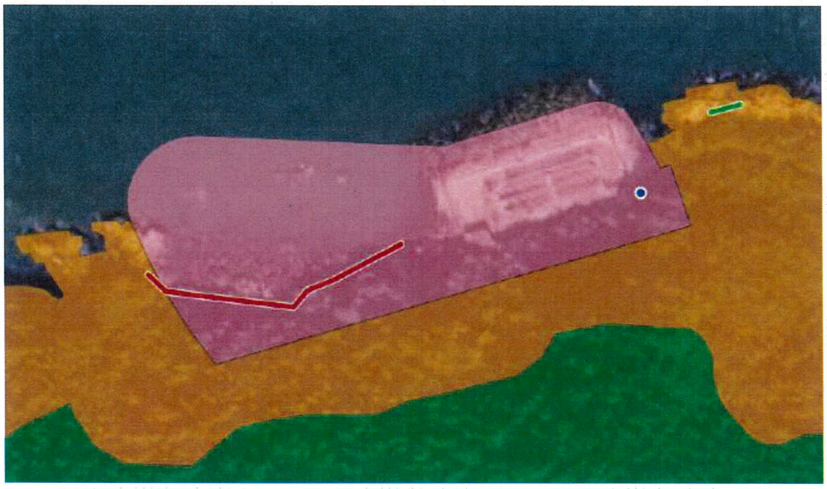

Figure 11: Outline Zoning Plan. Pink: Other Specified Uses; Orange: Coastal Protection Area; Green: green belt. The red and green line represents the Rx and Tx positions, respectively. The power connection is marked by the blue dot.

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 7.

		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).

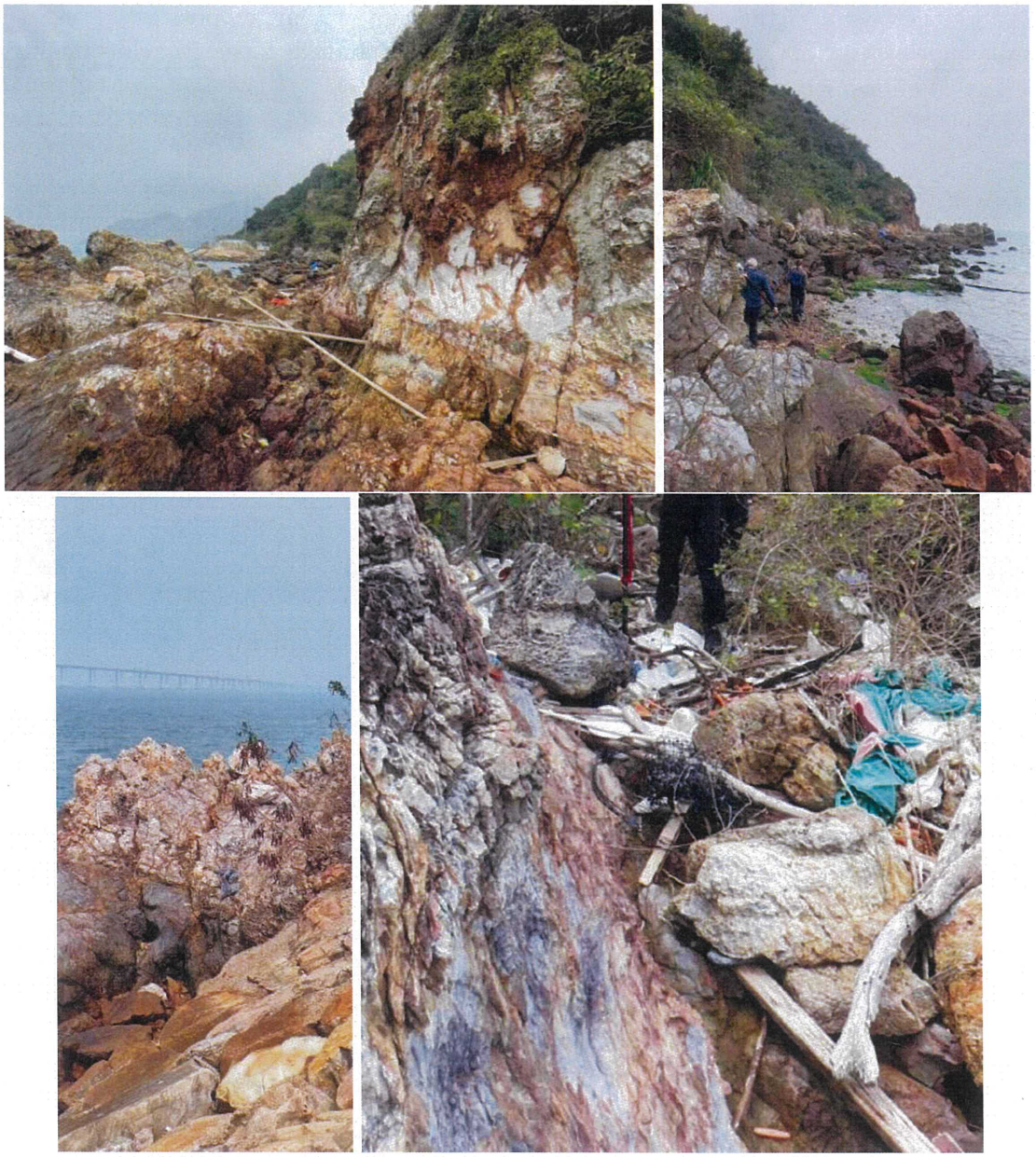

Figure 12: Station Tai O Wastewater Treatment Current State. Top left: view from the last Rx toward the Wastewater Plant Station: Top right: view toward the Rx position from the Wastewater Plant Station; Bottom left: Tx positions (Wastewater Plant Station on the back); Bottom right: accumulation of garbage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

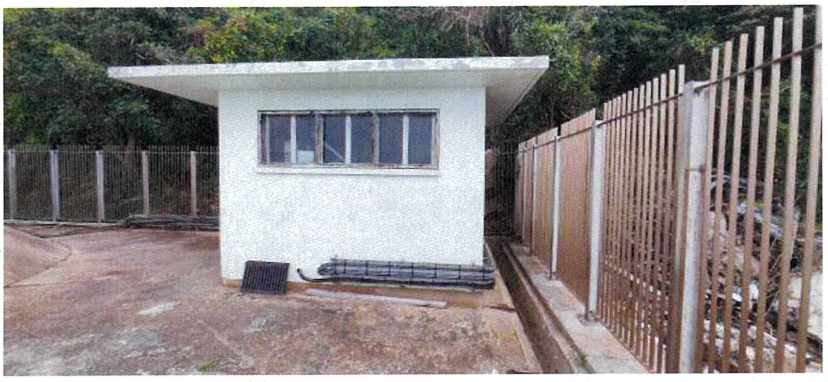

Figure 14: DSD technical room.

Furthermore, the new electrical supply connection point will be co-located directly adjacent to an existing one (figure 15). This strategic placement minimizes the requirement for new above-ground space.

Figure 15: Power box close to the Facility gate.

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 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

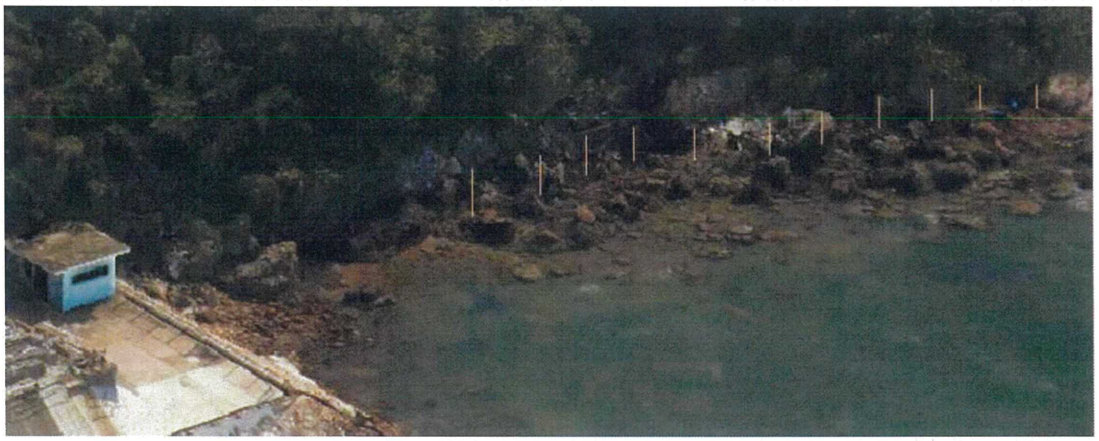

Figure 16: Rendering close up of the receiving antennas.

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 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.

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.

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.

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

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.

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 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. 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 Support Letters

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Works Branch
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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
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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 [redacted] for data acquisition and experience sharing as necessary in the future.

Yours sincerely,

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

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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 [redacted] 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

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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

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

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 [redacted]

Yours sincerely,

(Alice PANG)
Director of Drainage Services

Outlook

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

From Tsz Chiu LAM [redacted]
Date Tue 25/03/2025 11:47
To STOCCHINO, alessandro [CEE] [redacted]
Cc Albert Ka Fai TSE [redacted] DE LEO, Annalisa [CEE] [redacted]
[redacted] Shing Hei YU [redacted] Yujing QIU [redacted]

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.: [redacted]