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BUILDING HARMONY, HONG KONG WETLAND PARK

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Summary

The Hong Kong Wetland Park is on a 64 hectare site on the north-eastern edge of Tin Shui Wai (TSW), New Territories, Hong Kong. The Park is envisaged as a prime example of harmony with nature, environmental practice and sustainable development; unique to Hong Kong; seeking to provide equally for the very varied and potentially conflicting functions of conservation, tourism, education and recreation. The site was originally perceived as purely a conservation and ecological mitigation initiative between the urban areas and the Inner Deep Bay RAMSAR site and Mai Po Marshes to the North-east which was required as one of the conditions of the Town Planning Board approval to the development of the TSW Reserve Zone as the major second development phase of the TSW. However, the Visitor and Tourism Study for Hong Kong, commissioned by the Hong Kong Tourism Board, recommended that new tourist attractions and facilities should be developed to sustain the long-term growth of the tourism industry. The idea for the Wetland Park arose from this vision, building upon the existing ecological mitigation plans to create a major tourism, educational and community facility based around the ecological themes of wetland conservation. Thus, the task to harmonize the man-made and the natural begins.

1. Building Harmony

Water is a key element in wetlands that sustains and maintains life. It can be in many forms whether it is still, dynamic, misty, raining etc. It springs life and re-news the land. Light, works hand in hand with water brings warmth, comfort, birth and nutrition to many life forms. Air is an easily neglected element; which cannot be seen but surrounds us. No creature can survive without it. The approach in the design of the Wetland Park buildings and landscape recognizes and springs from the importance of these elements.

Figure 1 Southern entrance of Phase 1 building with granite from Police Headquarter's wall as paving; Gabion wall with oyster shells from Lau Fan Shan oyster farm

The development is comprised of two phases. Phase 1 has been completed at the end of year 2000 as a small scale exhibition gallery and garden serving as an environmental and sustainable demonstration for the things to come and further elaborated in the Phase 2 development. These include the handling of the

building envelope and the adoption of screens and louvers to maximize energy efficiency; the use of natural materials including timber, stone and oyster shells; reliance on natural ventilation and lighting wherever possible; a trial geothermal heat pump air-conditioning; and the extensive use of native wetland plant species, not commonly available in the Hong Kong nursery trade. The Phase 1 building is being conserved and converted into a Ticket Office when the Phase 2 Visitor Center opens in early 2006.

The Visitor Centre is expected to draw a large number of visitors and is purposely sited close to the entrance of the site and the urban area. Thereafter a series of display gardens, exhibition ponds and recreated habitats lead progressively to the Satellite Building Discovery Centre, and beyond via a series of fixed and floating boardwalks to the bird hides and more remote outer habitat areas, closer to the RAMSAR site, where visitor number are expected to be much lower. The Visitor Centre is purposely hidden within the landscape to maintain the overall environmental outlook of the development such that, when viewed from the urban area, the Visitor Centre would be seen as a green hill. The level of built form and intensity of usage diminishes as one moves further into the site, away from the urban development and towards the RAMSAR site, and the recreated natural habitats gradually predominate.

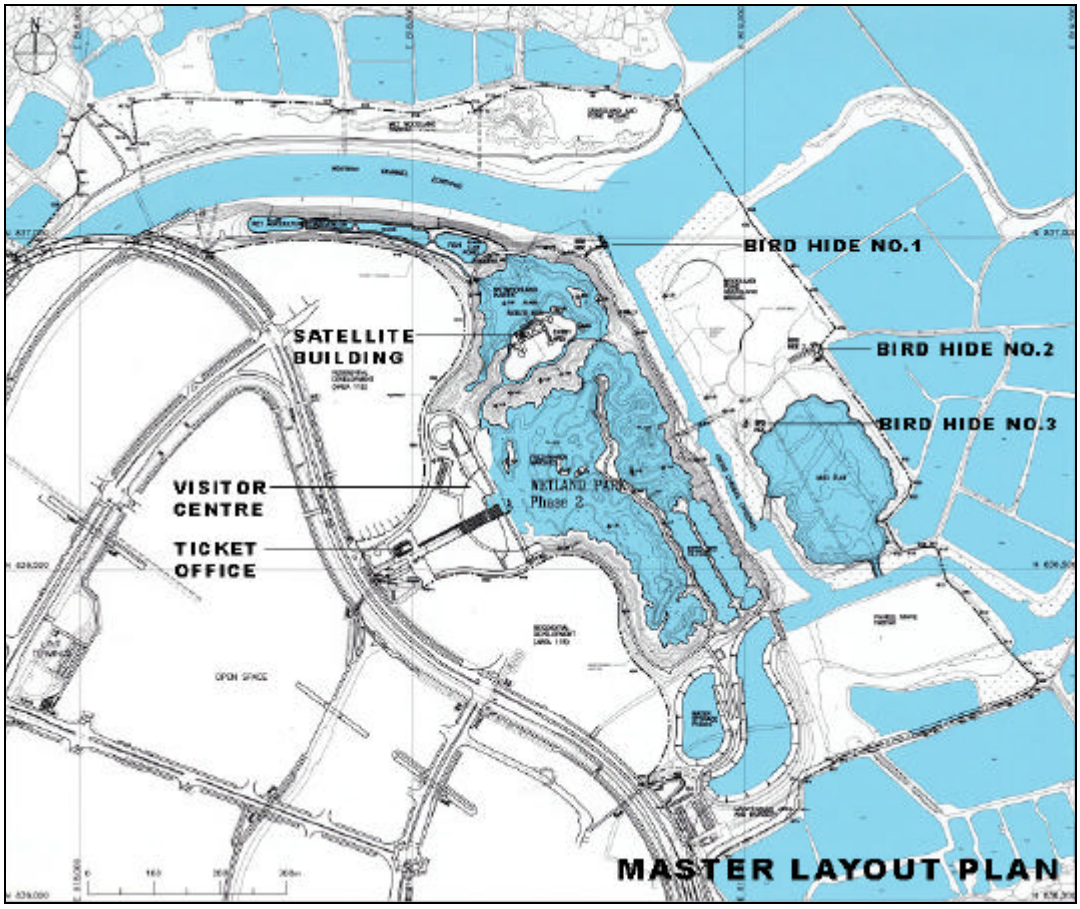

Figure 2 Master layout Plan

1.1 Visitor Centre

At the entrance plaza, the sound of water falling from an entrance water feature opposite the Ticket Office rejuvenates and welcomes visitors coming by car, coach or on foot from TSW town. The Phase 1 centre will be retained by converting its interiors and toilet layout and transforming it into a Ticket Office. Its original sustainable concepts will be maintained. Leaving the Ticket office, visitors can enjoy the view of an accessible green hill which hides the Visitor Centre below. The landscaped roof, as well as immediately announcing the environmental credentials of the scheme, is also instrumental in maximizing the energy efficiency of the building – the form of roof construction works with the careful orientation of the building to minimize solar gain. In addition, visitors may stroll up the gently sloping lawns of the roof to where a spectacular panorama of the surrounding wetland habitats will unfold before them. A water feature in a form of a square pond close to the Ticket Office begins the journey into the Visitor Centre building. The square pond feeds into a narrow stream course in the middle of the processional route. A glazed canopy and recycled Chinese brick wall on the west of the processional route link up the Ticket office and the Atrium of the Visitor Centre building mitigating the effects of solar gain on buildings.

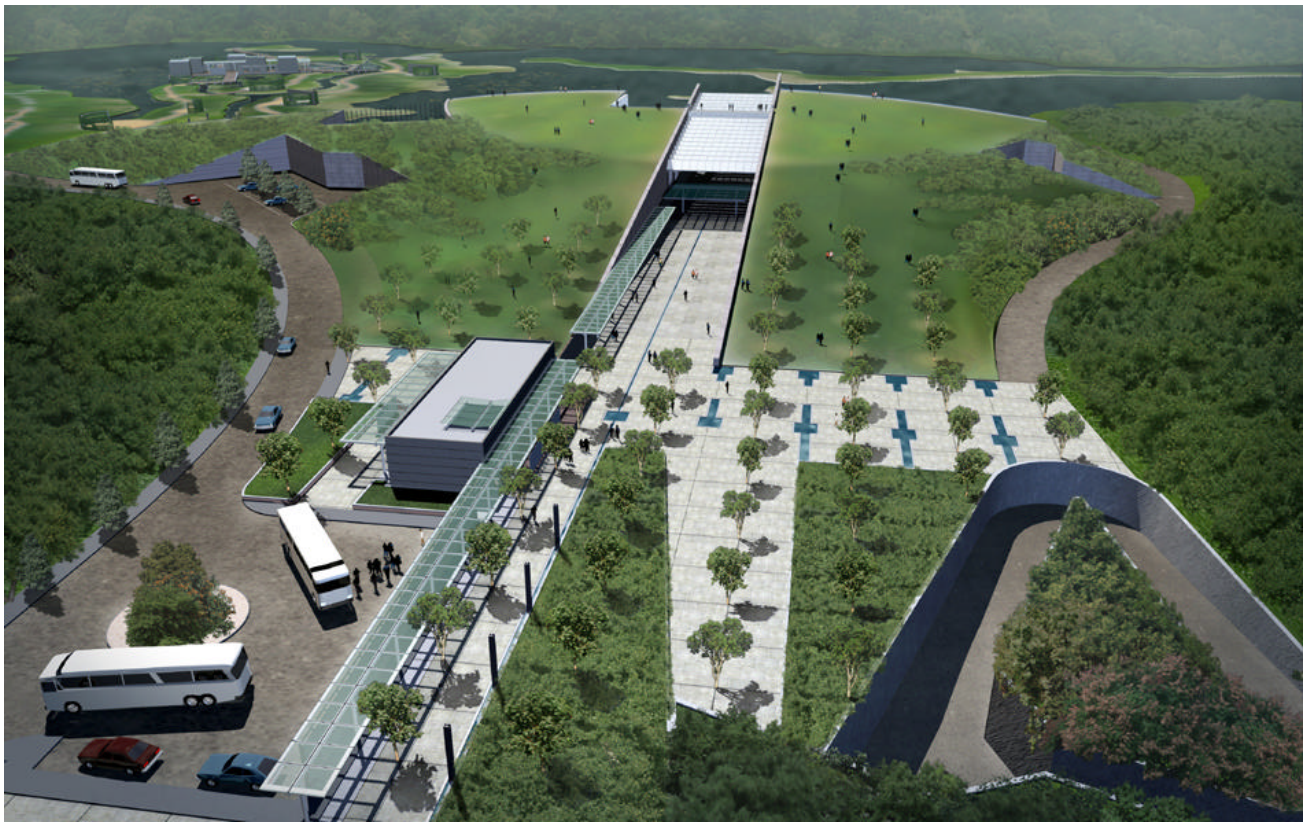

Figure 3 Entrance plaza, with a stream course leading into the Visitor Centre, which is hidden underneath the leisurely lawn roof

Sustainability extends throughout the detailing of the building. Skylights are utilized to maximize natural lighting, particularly to the Atrium, through which a stream course flows connecting to the wetlands beyond, but also in some of the gallery areas and toilets. Timber louvers are extensively employed to provide shading, particularly to the glass curtain wall façade overlooking the main lakes, where they also act as sound and visual barriers to minimize disturbance to the large numbers of water birds that are already beginning to colonize the wetland water bodies. The Visitor Centre building requires to house extensive wetland related exhibition galleries over two storeys with a building gross floor area of approximately 10,000 square meters. Circulation ramps are adopted throughout the galleries to cater for disabled people and minimize the need for mechanical lifts.

The transition from internal gallery space to external demonstrations in the recreated wetland landscape is almost seamless, continuing the educational message of environmental concern and stewardship. As the visitor exits the building, a source of a rushing mountain stream, cascading over boulders down from the roof of the Visitor Centre will be found, in the first of a series of recreated habitat displays. The stream can be followed downhill through all stages of its natural life cycle until it slowly winds through the delta and empties into a freshwater pond close to the Satellite Building Discovery Centre.

Figure 4 Atrium with skylight giving natural lighting, Chinese recycled brick wall on the west which extends from the Ticket office and the stream course in the middle of the Atrium which leads to the wetland beyond; Detail of external timber louvers in front of the curtain wall of Visitor Centre

1.1.1 Sustainable Teachings

Sustainable buildings must convey their design approach and detailing to the next generation, in order to encourage people to become sustainable minded. Deriving from the exceptional potential of the wetland park, educational interpretive programmes are being developed for use both by school parties and other visitors with the following specific objectives:

- To raise awareness and increase understanding of the major benefits and values of wetlands
- To increase knowledge of nature's vitality and diversity
- To encourage action and lifestyle adjustments to a more sustainable approach
- To provide leisure and recreation facilities for all visitors

1.1.2 Construction Materials and Methods

Great care has been taken throughout the construction process from site formation to piling to superstructure works to minimize any potentially adverse ecological impacts. As far as possible, all excavated materials are to be reused on site, whereas the use of hoardings, formwork and other temporary works will be carefully controlled. Natural clay materials are to be used to waterproof lakes and ponds.

For the Site Formation work, approximately 5000 tonnes of grade 200 recycled crushed concrete was used, with a further 1000 tonnes incorporated in the Piling Contract. For the Superstructure work, a total of 4900 tonnes of grade 200 and 4400 tonnes of 40mm size crushed concrete was used as sub-base, hardcore and fill materials for the Visitor Centre and external works.

Jacking machines and hydraulic hammers are used in the driven steel H-piles Contract to mitigate noise and air pollution the Foundation works.

The Wetland Park Visitor Centre is the first building in Hong Kong displaying extensive use of concrete incorporating recycled aggregates from crushed concrete in concrete works, among many environmental objectives consistent with the theme of the project. All the concrete in the sub-structure works, retaining walls, outer zone buildings and external works contains 20% recycled aggregates. The quantities of 20mm size recycled aggregates obtained from the recycling plant at nearby Tuen Mun Area 38 is about 5600 tonnes.

PFA is used as partial cement replacement for all concrete in watertight construction. Concrete mix containing PFA has been specified in the Visitor Centre lawn roof construction in order to reduce shrinkage and thermal cracking. Thus, other than the waterproofing membrane, the concrete structure acts as a second defence barrier.

To avoid any contamination to the existing lakes and water bodies during construction, a double sheet pile barrier was installed to segregate the Visitor Centre from the water, which has been removed at the end of the contract. In addition, a clay bund has been installed to protect the Satellite Building Discovery Centre area particularly during the excavation of its footings. A portable coffer dam system was used to allow construction of the boardwalks to proceed with the minimum environmental disruption, avoiding the need to drain any of the lakes whilst avoiding any incidence of pollution. Clay bunds have been laid at the ends of an existing tidal channel to segregate the construction of a floating boardwalk from the channel to avoid contamination.

1.1.3 Geothermal Heat Pump Air-conditioning System

Environmental principles also feature strongly in the building services installation design for the project, resulting in extremely high energy efficiency and minimal maintenance cycle costs. In particular, the Visitor Centre of the Wetland Park will be the first major project in Hong Kong to utilize a highly energy efficient geothermal cooling system in its air-conditioning installation. This system utilizes the relatively constant and stable ground temperatures occurring just a few meters below the surface, together with the substantial area of land available for heat dissipation within the site boundary, and consists of 468 sets of polyethylene pipes, laid in 50 meter deep boreholes and embedded in cement for greater conductivity. Boreholes are placed 4 meters apart to maximize heat dissipation capacity and sufficiently deep underground to avoid any adverse impact on the soft landscape. A variable speed pumping system divides the total flow into 4 pump sets, so that pumping energy can be varied according to the required A/C loading and valves can be shut off to stop the flow when not required. The pipe work design minimizes the amount of trenching required but also provides sufficient back-up capacity so that, if any part of the system needs to be shut down for rectification works, this will only affect a maximum of 8.4% of the total A/C loading.

Not only does the geothermal system avoid the discharge of waste heat into the atmosphere, with consequent adverse impacts on global warming, or into the surrounding habitats with potentially negative effects ecologically, it also saves substantial amounts of energy for cooling the building by utilizing a much lower ground condensing temperature, which can be as low as 28C in summer, compared to 35C for a

conventional A/C system. The geothermal installation is estimated to result in a 25% energy saving overall, compared to a conventional cooling tower approach.

The system also has visual and architectural benefits, as all heat dissipation equipment is buried underground, thereby leaving a clean building façade and grass roof unencumbered by ducting, fans, condensers and the like. This is particularly important visually in the appearance of the green roof from the entry plaza and also the building façade viewed from the satellite building area or across the main lake.

Other environmental features of the building services installations include carbon dioxide sensors to regulate fresh air in accordance with visitor occupancy, and computer controlled lighting systems with sensors to control illumination levels and timers to close down lighting selectively, as and when it is not required.

1.2 Satellite Building Discovery Centre

The satellite building functions as an outdoor classroom and is surrounded by interpretive zones where visitors can pond-dip to investigate the life forms commonly found in water bodies; learn how the Wetland Park is managed and the water levels manipulated by simple mechanical devices; and discover a wide range of wetland agricultural practices that have been an important way of life historically for the people of Hong Kong and China.

The Satellite Building has been designed with a similar sustainable approach to the Ticket Office. In addition it relies entirely on natural ventilation by means of high ceiling and high level windows for dissipation of heat. Solar gain is also minimized by careful use of sustainable timber louvers. The flat roof has been designed to collect rain water for flushing purposes.

Figure 5 Western entrance of Satellite Building Discovery Centre connected with timber boardwalk extending over Exhibition pond; Southern entrance of Bird Hide 1 with timber boardwalk in the foreground

1.3 Bird Hides

There are three Bird Hides located at different areas of the site, each offering distinctive views to the nearby wetland areas. One overlooks the Deep Bay RAMSAR area; a second overlooks the neighboring fish ponds and another overlooking a vast tidal mud flat area.

These outlying bird hides are designed with skylights and double-skin sustainable timber louvers to maximize natural ventilation. User comfort is further enhanced by solar panel powered oscillating fans. Beyond the Satellite Building, timber boardwalks lead out across the lakes into the ‘outer zone’ of increasingly natural landscape and lower key development, characterized by timber bird hides, boardwalks and nature trails.

2. Implemented environmental and sustainable concepts

Integrated with the natural setting of a 64 hectare park, the structures of the buildings are purposely designed with landscape roof, timber cladding and multiple layers of shades. The Visitor Centre has three major Galleries, Resource Centre, Office, Café, Shop, Play area and Toilets. In the external area, the Satellite Building and three Bird Hides. All of which have their unique functions conveying wetland messages. There are also 10 major green concepts embedded in the development as summarized in the following aspects.

2.1 Low Overall Thermal Transfer Value (OTTV)

Green Roof and orientation of the building allow the Visitor Centre envelope to achieve energy efficiency performance of approximately OTTV 16W/m^2.

2.2 Geothermal Heat Pump Hybrid Air-conditioning System

With the sizeable land of the park, a Geothermal Heat Pump Hybrid Air-conditioning system is adopted at the Visitor Centre. It saves up to 25% of energy over conventional cooling tower. Approximately 468 numbers 32mm diameter flow and return high-density polyethylene (HDPE) pipes are inserted into the ground at 50m depth embedded in bentonite clay and cement grouting for heat exchange with the constant underground temperature giving approximately 390 tonnes of air-conditioning. The lake water has also been utilized for a back up Aqua loop system by means of heat dissipation at a water feature and storage pond with the capacity of delivering a total of 144 tones of air-conditioning. This eliminates visible and noisy heat dissipation air-conditioning equipment, reduces external louvers and precludes direct heat injection to the environment which is found to be favorable and suitable to the wetland park setting.

2.3 Natural Lighting and Ventilation

Natural lighting by means of skylights at Atrium (north light) and external toilets. External artificial lighting is minimized to reduce power consumption. Natural ventilation is implemented by means of high level windows at the Satellite Building, double layer of louvers and vented skylights at External Toilets for energy saving. Light bulbs and mechanical ventilation system at external toilets are triggered by photo sensitive sensors and wind sensors respectively to save energy. Solar panels, delivering a maximum of 200W of power, drive oscillating fans at Bird Hides.

2.4 Ramp Access

Circulation ramps are built throughout G/F and 1/F galleries at the Visitor Centre to cater for disabled visitors and minimize the use of mechanical lifts.

2.5 Minimized Water Consumption

Low capacity, 6-liter water closets are used to reduce water consumption at all toilets. Satellite Building has been designed to collect rainwater for flushing. Recycling of the lake water for a water feature saves water consumption. Automatic irrigation is provided to aid soft landscape establishment and maintenance but only used at night time to reduce evaporation and consumption.

2.6 Re-cycled Brick Wall and Fenders

Re-cycled Chinese brick from demolished traditional Chinese village houses collected by Antiques and Monuments Office, has been used as a brick wall on the south aspect of the Visitor Centre & Ticket Office to mitigate the effects of solar gain to the building. Timber fenders collected from Victoria harbour ferry piers have been re-used in the freshwater marshes to serve as resting posts for wildlife.

2.7 Shading by Timber Screens

Sustainable timber from identified renewable sources is used throughout the whole project as vertical and horizontal louvers to provide shades for buildings and external landscape works.

2.8 Recycled Aggregates and PFA

A total of 15,300 tonnes of recycled aggregates has been used as sub-base, hardcore and fill materials in the development together with 5600 tonnes of recycled coarse aggregates in the structural concrete. The majority of the recycled aggregates are from a nearby recycling plant. The total amount of structural concrete used containing recycled aggregates or PFA as partial cement replacement amounts to about 75% of the total concrete volume.

2.9 Re-use of Existing Materials

Existing materials at the Phase 1 site, including aluminium wetland habitat sculptures, recycled granite paving from the Hong Kong Police Headquarter's wall, recycled Chinese bricks from demolition of old Chinese Village houses and re-used oyster shells from nearby Lau Fan Shan oyster farm would be reused in the Phase 2 works. The existing Phase 1 Visitor Center would be converted into a new Ticket Office. All existing trees and many other plants from the Phase 1 site will be retained or transplanted within the Phase 2 site.

2.10 Soft Landscape Species

Predominantly native plant species which require less maintenance and water consumption are used for landscaping work.

3. Conclusion

On opening in early 2006, the Hong Kong Wetland Park will represent a showcase of sustainability and environmental consciousness in building harmony with nature, in terms of architectural, structural, building services and landscape design. It will satisfy its potentially conflicting objectives in order to provide a world class tourist attraction and also a major conservation, educational and recreational resource.

For any building to be truly sustainable, it relies not only on the design approach but also on the future use and management of the facility. With the education value provided by this wetland development, visitors can enjoy the park and begin to learn to be stewards, not just of this project but also of their overall environment. The Wetland Park will demonstrate the need for a sustainable lifestyle to cherish our given resources, thereby ensuring the true meaning of sustainable development can be passed on to all visitors.

Figure 6 Northern part of the site with the Visitor Centre facing the lake, linked by series of timber boardwalk to the Satellite Building in the foreground and to Outer zones