8th IWA-ASPIRE Conference and Exhibition

Wastewater Management: Pollutant Removal from Wastewater

Reviving the Fragrant Harbour: What are the Challenges?

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渠務署
Drainage Services Department

Fragrant Victoria Harbour – Symbol of Hong Kong

Pollution Problems at Victoria Harbour

本港海水染汚
程度日見嚴重
中大研究員郭王曉瑚促當局注視

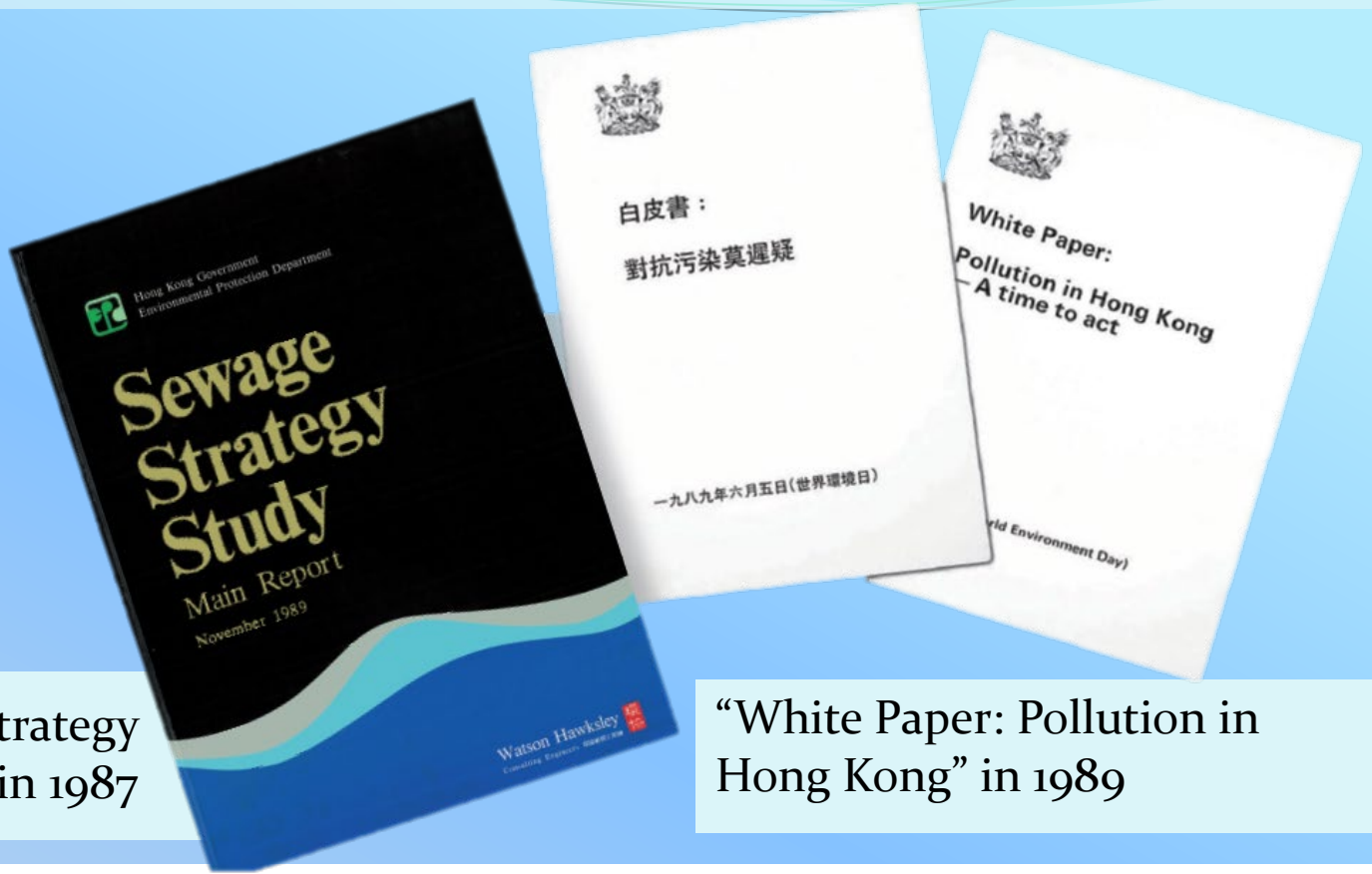
【本報訊】中大海洋研究所研究員郭王曉瑚指出：本港海水染汚程度，日見嚴重，有些地區海水發現會有膿菌，希望當局及早預防，免人類及海產受害。

王女士表示稱：目前

海水汚染日益嚴重
將軍澳列爲汚染區
魚類大量死亡海灘已不能游泳

Ta Kung Pao 1982
1982年《大公報》

Sewage Strategy for Hong Kong



The Sewage Strategy Study in 1987

"White Paper: Pollution in Hong Kong" in 1989

Strategic Sewage Disposal Scheme in 1990s

SSDS 4-stages conceptual implementation – Mega Environmental Infrastructure Project

- An Integrated Deep Sewage Tunnel System;
- Centralised Treatment at Stonecutters Island;
- A Long Ocean Outfall into South China Sea

Known as Harbour Area Treatment Scheme (HATS) at later stage

4 Big Challenges for Implementation

1. Centralisation VS Decentralisation;
2. Level of Treatment;
3. Feasibility of Deep Tunnel;
4. Political Issue of 1997 – handover of HK to PRC

Centralisation VS Decentralisation

Evaluation by computer and physical models

- The most cost-effective option - centralized sewage treatment at the Stonecutters Island;

Other considerations:

- Risk Management;
- Precious land resources in urban area;
- Proximity to residents; and
- Environmental impacts

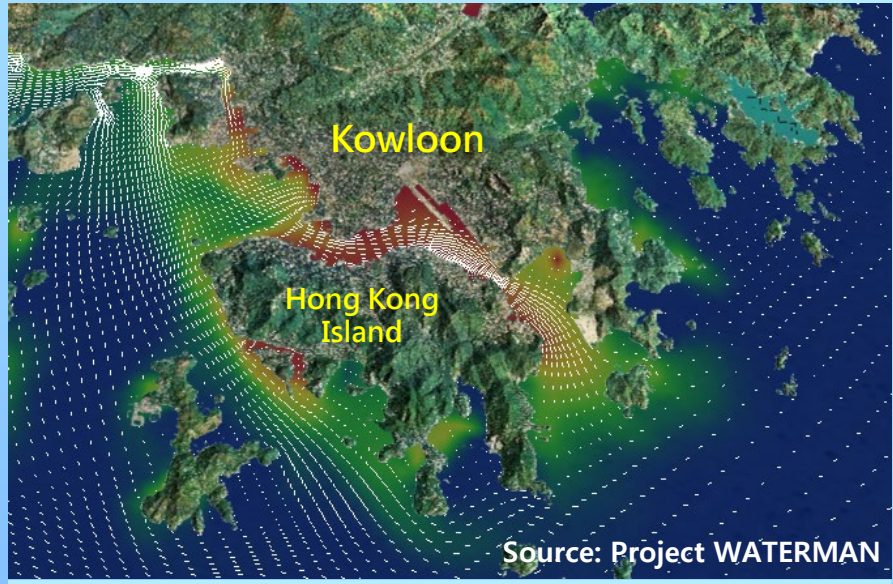
Stonecutters Island Sewage Treatment Works

Level of Treatment

Only Chemically Enhanced Primary Treatment (CEPT) was adopted for HATS Stage 1 and 2A,

- Vast self-purificaiton capacity at the western part of the Victoria Harbour (Submarine Outfall);
- Lower capital and recurrent cost; and
- Available footprint at Stonecutters Island;

Biological treatment to be further considered in HATS Stage 2B



High Velocity of Ocean Current at Victoria Harbour

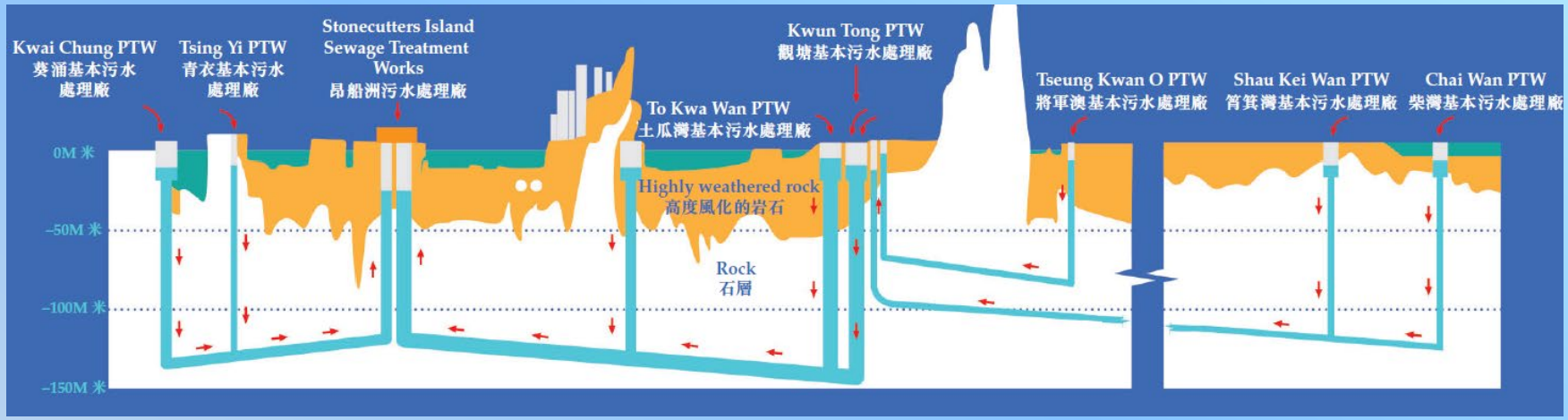
Sewage Conveyance System

Adoption of the deep tunnel approach (min. 30m rock cover):

Pros – Minimise the disruption to traffic during construction;

– Prevent clashing with utilities, existing foundation and MTRC rail tunnel; and

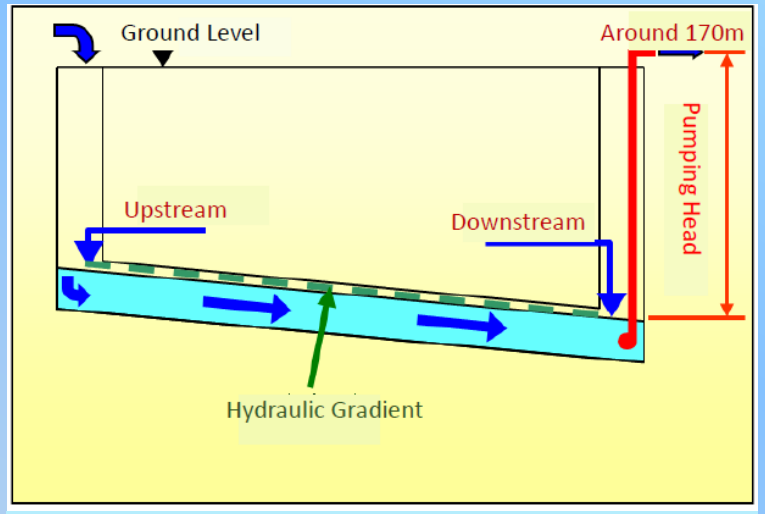
– No constraints to future development



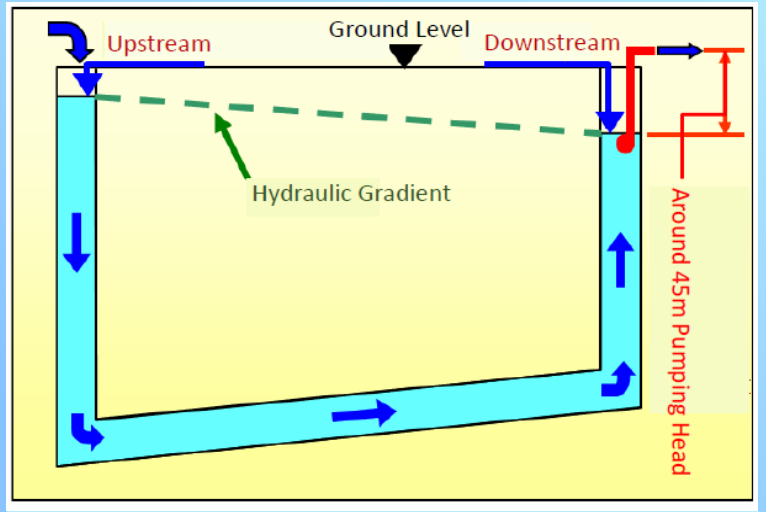
Sewage Conveyance System

Problems to be solved for deep tunnel:

1. Energy cost – Use of inverted siphon design;
   – Save up to 40% energy in pumping



Ordinary Gravity Sewer Design

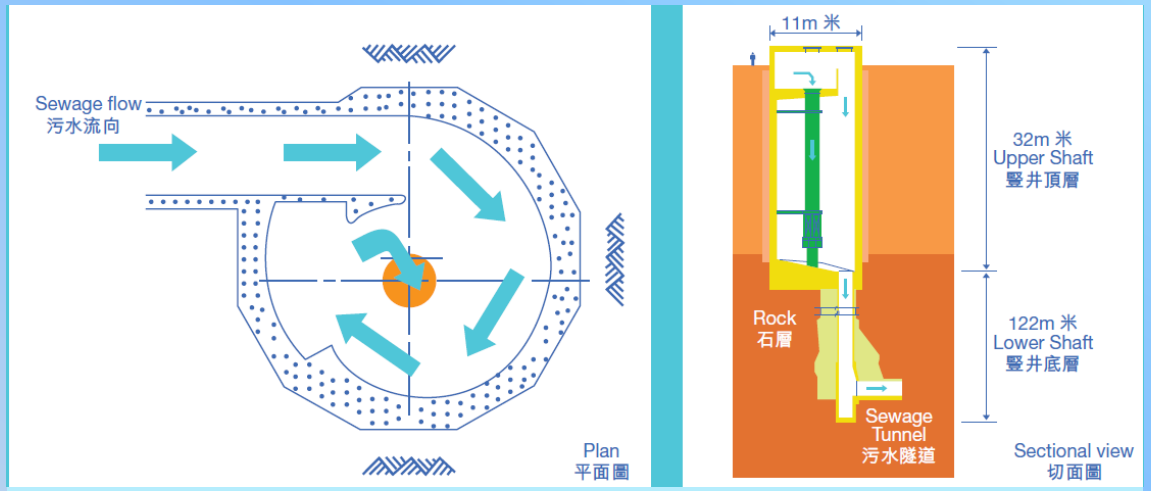


Inverted Siphon Design

Sewage Conveyance System

Problems to be solved for deep tunnel:

2. Air entrainment and air lock formation –
   - Special designed vortex inlet;
   - Minimum gradient of tunnel: 1 in 500 Gradient



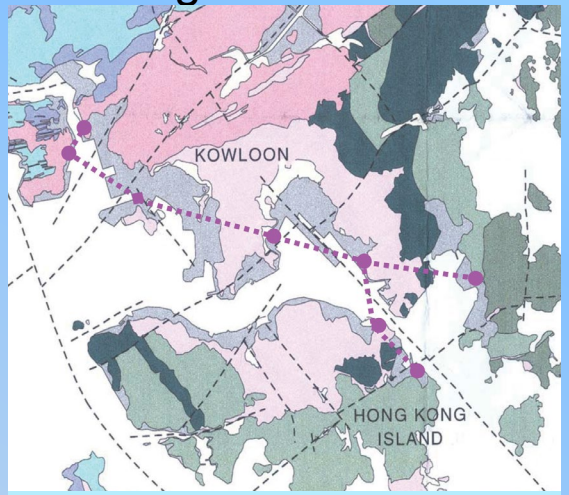
Vortex Inlet

Interior of the upper drop shaft

Sewage Conveyance System

Problems to be solved for deep tunnel:

3. Construction difficulties and settlement problem
   - Difficult geological condition, passing major fault zones;
   - Large amount of water ingress under high pressure



Geological Map

High Water Ingress During Tunnel Excavation

Sewage Conveyance System

Problems to be solved for deep tunnel:

3. Construction difficulties and settlement problem
   - Adoption of pre-excavation grouting with modification of TBMs;
   - Manual excavation with sufficient ground supports during major fault zones

Pre-excavation Grouting & Manual Excavation

Tunnel Breakthrough

Political Challenges

- Handover of Hong Kong to PRC in July 1997
- Conspiracy Theory:
  - Drain down the reserve of colonial government;
  - Committed contractual payments/claims may become liability to future HKSAR government
- Target to complete HATS Stage 1 by 1997
- Concerns raised on the proposal of Long ocean outfall at Lema Channel that infringes on the Mainland waters
  - Interim outfall at the western part of Victoria Harbour

Proposed Long Ocean Outfall

Harbour Area Treatment Scheme (HATS) Stage 1

Commissioned in Dec 2001

Treatment Capacity:
1,700,000 m³/day
Service Population
3,500,000

Construction Cost: Around **8.2 Billion**
Objective: Collects **75% of sewage** from both sides of the Victoria Harbour and conveys them to SCISTW for chemically enhanced primary treatment

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Drainage Services Department

The Way Forward of Remaining Stages

- Significant improvement of water quality in Victoria Harbour
- Commissioned an International Review Panel (IRP) to review the scheme
- Extensive public consultations, EIA study
- Reached consensus – remaining stage of scheme revised to Stage 2A (Collect remaining sewage from northern and south western part of Victoria Harbour) and 2B (Upgrade to biological treatment)

HKSAR Govt Commenced the 5 Months Public Consultation in June 2004

Harbour Area Treatment Scheme (HATS) Stage 2A

Commissioned in Dec 2015

Treatment Capacity:
2,450,000 m³/day
Service Population
5,700,000

Construction Cost: Around **17.5 Billion**
Objective: Collects the remaining 25% of sewage from both sides of the Victoria Harbour and conveys them to SCISTW for chemically enhanced primary treatment and disinfection

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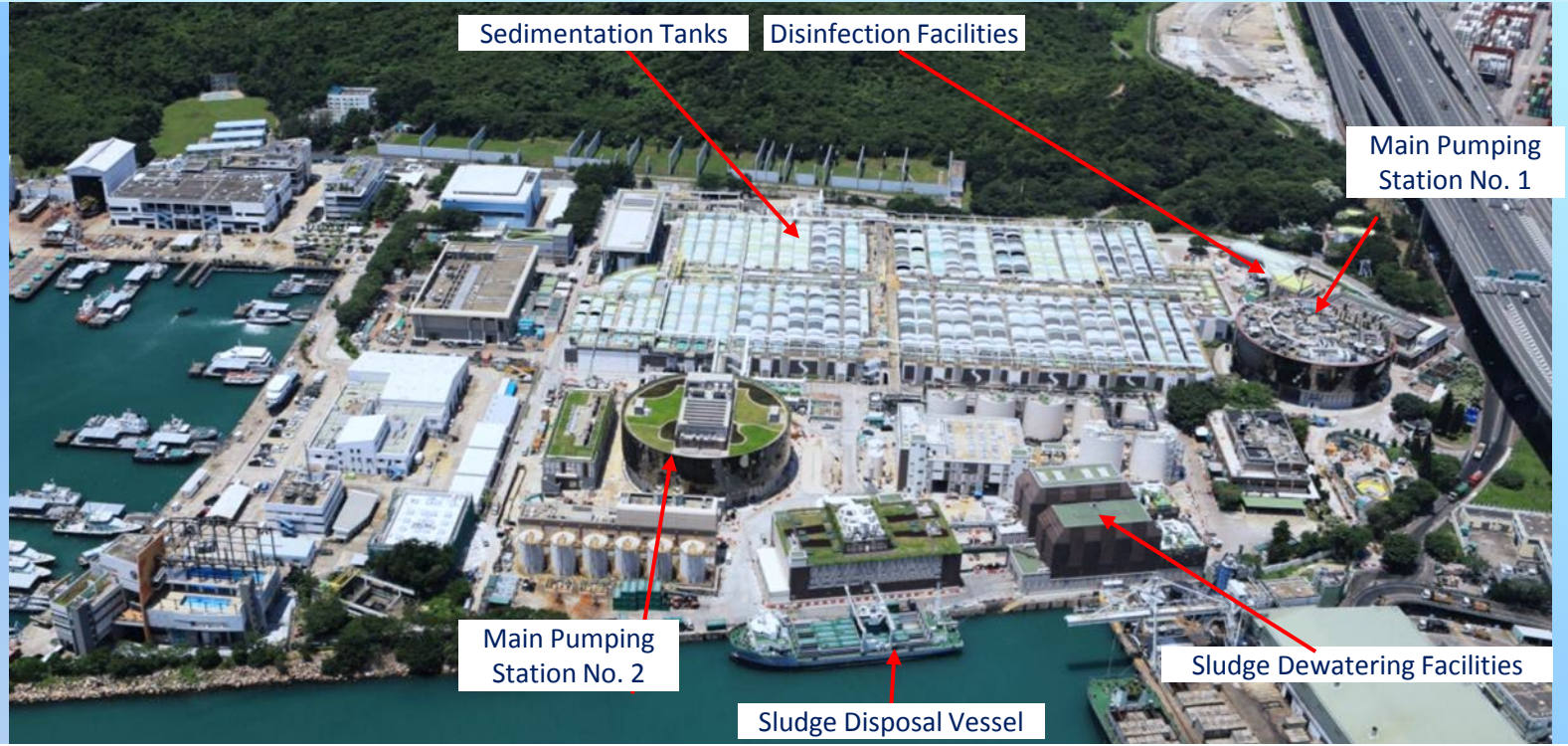
Drainage Services Department

Stonecutters Island Sewage Treatment Works

A Highly Land- and Energy-Efficient System

Footprint: 10.6 ha | Treatment Capacity: 2.45 Million m^3/day | Population served: 5.7 million



Sludge Delivery by Marine Vessels to Incineration for Energy

Special Features of Clean Harbour 1 & 2:

- Hong Kong's First Diesel – Electric Cargo Vessel;
- Minimizes environmental nuisance during transportation;
- Journey time from SCISTW to T· Park shortened from 5 hours to 3 hours;
- Use of on-shore power supply, no emissions when berthed;

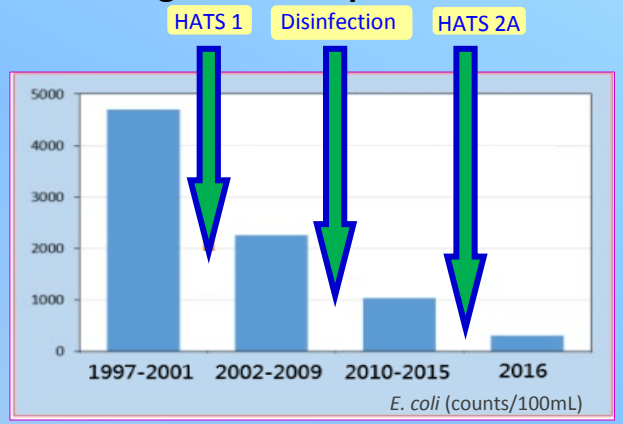
Environmental Benefits*

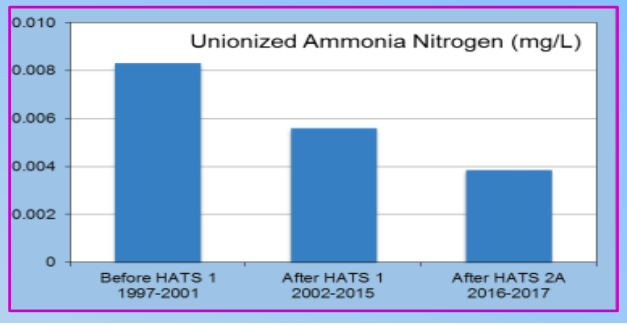
- Reduces 130,000 kg CO_2 emission per year ;
- Equivalent to the CO_2 absorption of 5,800 trees per year

* Compared with ordinary Diesel Vessel

Efficacy of Harbour Area Treatment Scheme (HATS)

- Increasing Dissolved Oxygen concentration
- Decreasing *E. coli* and pollutant level





Cross-Harbour Race

- 1978 - Suspended
- 2011 - Resumed in eastern Victoria Harbour
- 2017 - Revived the central Victoria Harbour route

Re-open 7 nos. of beaches in Tsuen Wan

Recognition of HATS Project - Awards

The 15th Tien-yow Jeme Civil Engineering Prize (詹天佑獎)(2018)
- Municipal Engineering Category

Global Water Awards (2016)
Distinction, Wastewater Project of the Year

Edmund Hambly Medal,
Institution of Civil Engineers, U.K. (2018)

Highlights of the Project

The Largest

Hong Kong's largest ever environmental infrastructure

**Total budget at HK$25.8 billion

The Deepest

World's deepest sewage tunnel

**The deepest tunnel section is at 163m under sea level, equivalent to the height of a commercial building at about 50 storeys (Jardine House)

The Longest

Asia's longest very deep sewage tunnel

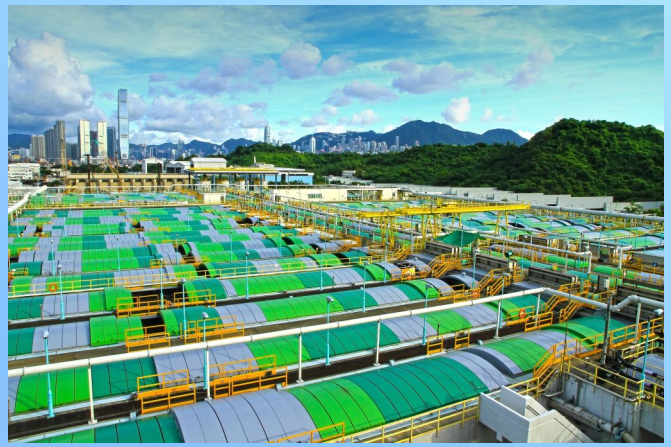
**Total length of deep sewage tunnel is 44.6km, even longer than a full marathon (42km)

Highlights of the Project

The Largest

One of the World's largest
chemically enhanced primary treatment works

**Treatment capacity of Stonecutters Island Sewage Treatment Works is 900 million m^3 per year, or 2.45 million m^3 per day (the latter equivalent to the volume of about 1,000 standard swimming pools)



The Most Efficient

Most efficient use of land for providing
chemically enhanced primary treatment

**The footprint of Stonecutters Island Sewage Treatment Works is only 10 ha (about half the size of Victoria Park) but serves up to 5.7 million people

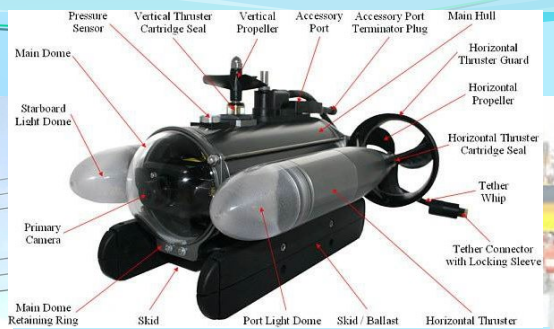
The Most Powerful

World's most powerful sewage pumping system in chemically enhanced primary treatment works

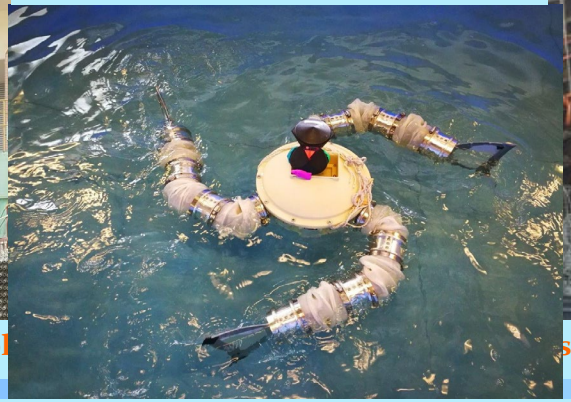
**Max. capacity of 63.2 m^3/s, i.e. a standard swimming pool of water can be pumped out in 40 seconds

Challenges Ahead – Inspection and Maintenance Difficulties

- Any major inspection/maintenance may require temporary sewage bypass at a number of upstream PTWs
  - associated adverse environmental impacts;
- Replacement of the two large penstocks (4.4m (height) x 2.6m (width) each) at MPS1 was carried out;
- Three 2-weeks bypass (early 2018, end 2018 and early 2019) of 7 nos. of Stage 1 PTWs were made; and
- Exploration new robotics technology for inspection of deep tunnel



Remotely Operated Vehicle (ROV)



New Type of Underwater Robotics Technology by Hong Kong Polytechnic University

Challenges Ahead – System Management of HATS

- Optimization of plant operation:
  - Chemicals optimization for disinfection;
  - Odour enhancement measures;
  - Energy saving in pumping;
  - Cope with new demands and development;
  - Management of upstream catchment (inflow and infiltration);
- Knowledge management; and
- Training and development of engineers

Stonecutters Island Sewage Treatment Works

A Clean Harbour for Hong Kong