淨化海港計劃第二期甲工程團隊
Harbour Area Treatment Scheme Stage 2A Project Team

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	DC/2008/09	保華建築有限公司 Paul Y. Construction Company Limited
	DE/2009/02	安樂工程有限公司 ATAL Engineering Limited
	DC/2009/05	中國建築 – 上海隧道聯營 China State – Shanghai Tunnel Joint Venture
	DC/2009/10	新福港 – 百沃特聯營 Sun Fook Kong – Biwater Joint Venture
	DC/2009/17	中國建築– 安樂聯營 China State – ATAL Joint Venture
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Consultants: AECOM ARUP

IEC: Mott MacDonald

Contractors: ATAL, CHEC, CEC, Gammon, Leader JEC, LNS, Paul Y, SFK, Biwater

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Dec 2015

渠務署
Drainage Services Department

淨化海港計劃
第二期甲

Harbour Area Treatment Scheme Stage 2A
for a *Clean Harbour*

淨化海港計劃背景

Harbour Area Treatment Scheme Background

為了改善維多利亞港水質，淨化海港計劃(前稱「策略性污水排放計劃」)於八十年代後期開始分階段展開，用以收集及處理維港兩岸區域的污水。 這項世界級環保基建項目第一期和第二期甲現已啟用。

To improve the water quality of Victoria Harbour, the Harbour Area Treatment Scheme (HATS), formerly known as Strategic Sewage Disposal Scheme, was launched in late 1980's to be implemented in stages to provide treatment for the sewage collected from the urban areas on both sides of the Harbour. Stage 1 and Stage 2A of this world-class environmental infrastructure project are now in operation.

淨化海港計劃時間表
HATS Timeline

淨化海港計劃第一期及第二期甲

Harbour Area Treatment Scheme Stage 1 & Stage 2A

淨化海港計劃分階段進行，以針對處理維港兩岸發展而帶來的海水污染。淨化海港計劃第一期耗資82億元，工程包括興建昂船洲污水處理廠及23.6公里長的深層隧道，以處理來自九龍、葵青、將軍澳及港島東北部的污水。第一期於1994年動工及2001年啟用，處理75%源自維港兩岸的污水。

第二期甲則處理來自香港島北部和西南部餘下25%的污水。工程包括：

- 改善位於港島北部和西南部8 間基本污水處理廠
- 建造長約21公里的深層污水隧道
- 改善昂船洲污水處理廠及加建消毒設施

第二期甲於2009年動工，並於2015年11月全面啟用，耗資約175億元，與第一期合共每天能處理245萬立方米污水。淨化海港計劃全面啟用，有利維港兩岸地區可持續發展，及讓市民更好享用已淨化的維港。

Harbour Area Treatment Scheme (HATS) is being implemented in stages to combat water pollution caused by urban development around Victoria Harbour. HATS Stage 1 costs $8.2 billion and it comprised the construction of Stonecutters Island Sewage Treatment Works (SCISTW) and 23.6km of deep tunnels for treating sewage collected from Kowloon, Kwai Tsing, Tseung Kwan O and north-eastern Hong Kong Island. It commenced in 1994 and was commissioned in December 2001 providing treatment to 75% of sewage from both sides of the Harbour.

HATS Stage 2A provides treatment to the remaining 25% of sewage from the northern and south-western parts of Hong Kong Island. The works include:-

- Upgrade 8 preliminary treatment works (PTW) in northern and south-western parts of Hong Kong Island
- Construct 21km long of deep sewage tunnels to SCISTW
- Upgrade SCISTW and add disinfection facilities

Stage 2A commenced in 2009 and was commissioned in November 2015. It costs $17.5 billion and together with Stage 1 can treat 2.45 million cubic metres of sewage per day. The full commissioning of HATS helps to enable the sustainable development of the harbour area and also allows the public to better enjoy Victoria Harbour with improved water quality.

淨化海港計劃之效益

Benefits of HATS

- 透過適當的污水收集及處理，杜絕污水直接排入維多利亞港及港島西南部水域，令維港水質得以大大改善。

  Stop sewage from directly discharging into Victoria Harbour and southwestern parts of Hong Kong Island by means of proper collection and treatment, hence greatly improving the water quality of the Harbour.

- 改善水質:

  Improve water quality:

  - 增加 13%海水含氧量

    Increase Dissolved Oxygen (DO) by 13%

  - 消除污水中70% 的生化需氧量、80%的懸浮固體及超過99%的大腸桿菌後才排出大海

    Remove 70% of Biochemical Oxygen Demand (BOD), 80% of Suspended Solids (SS) and over 99% of *E.coli* from sewage before discharge

- 在應付海港地區發展的同時，維持理想的海洋環境

  Maintain healthy marine environment whilst meeting future development needs

- 2011年起復辦維港渡海泳

  Resume cross-harbour swimming race since 2011

- 2011年起陸續重開荃灣區泳灘

  Progressively re-open Tsuen Wan beaches since 2011

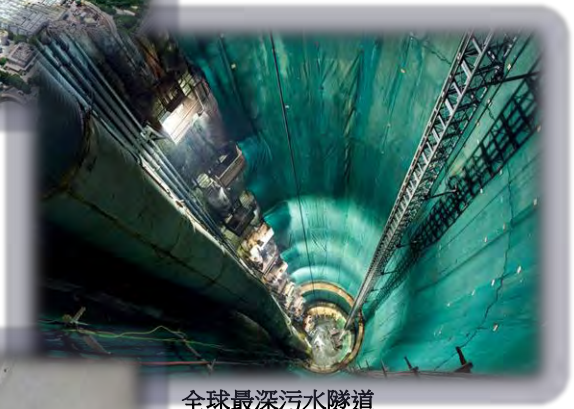
重開荃灣區泳灘
Re-open of Tsuen Wan beaches

復辦維港渡海泳
Resumption of cross-harbour swimming race

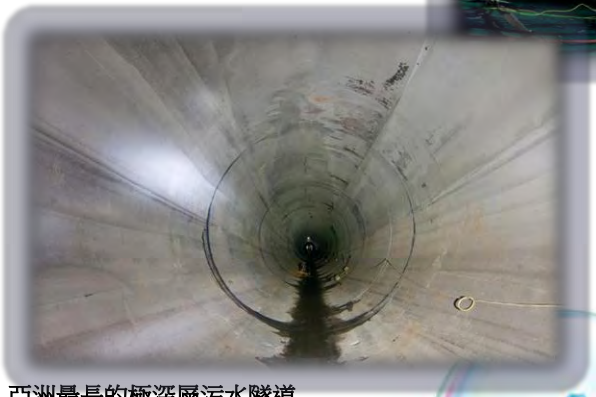
淨化海港計劃之亮點

Highlights of HATS

香港歷來最龐大的環保基建項目
Hong Kong's largest ever environmental infrastructure project



全球最深污水隧道
World's deepest sewage tunnel



亞洲最長的極深層污水隧道
Asia's longest very deep sewage tunnel

世界最大的化學強化一級污水處理廠
World's largest chemically enhanced primary treatment plant

最地盡其用的化學強化一级污水處理廠
Most efficient use of land for providing chemically enhanced primary treatment

全球同類型污水處理廠中最強的泵水系統
World's most powerful sewage pumping system in chemically enhanced primary treatment plant

香港橫跨最多區域的環保基建項目
The environmental infrastructure project spanning the greatest number of districts in Hong Kong

淨化海港計劃第二期甲污水收集及處理過程
Sewage Collection and Treatment Process of HATS Stage 2A

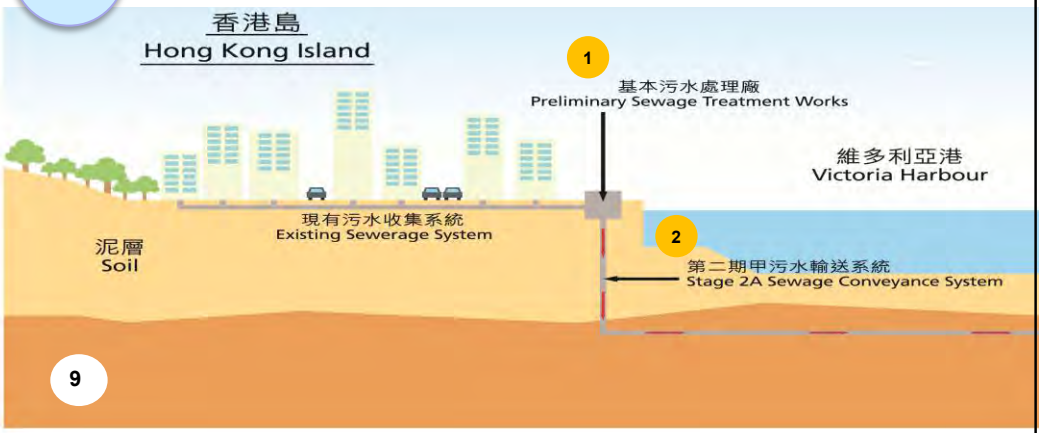
1. 收集及為污水進行基本處理(即隔篩和除砂處理)。
   Sewage is collected and preliminarily treated (by screening and degritting process).

2. 污水經由深層污水隧道輸送至昂船洲污水處理廠。
   Sewage is conveyed to SCISTW via the deep sewage tunnels.

3. 污水於昂船洲污水處理廠進行化學強化一級處理。
   Sewage is treated by chemically enhanced primary treatment (CEPT) at SCISTW.

4. 污水進行消毒程序(去除污水中超過99%大腸桿菌)。
   Sewage undergoes disinfection process (remove over 99% *E. Coli* in sewage).

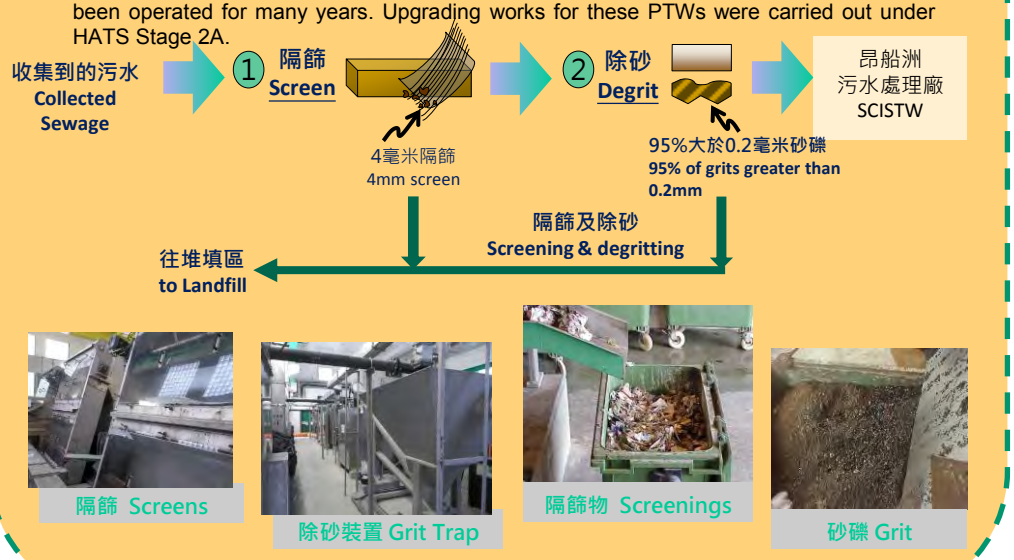
5. 經處理的污水最後排放到維多利亞海港西面。
   Treated effluent is discharged to Western part of Victoria Harbour.

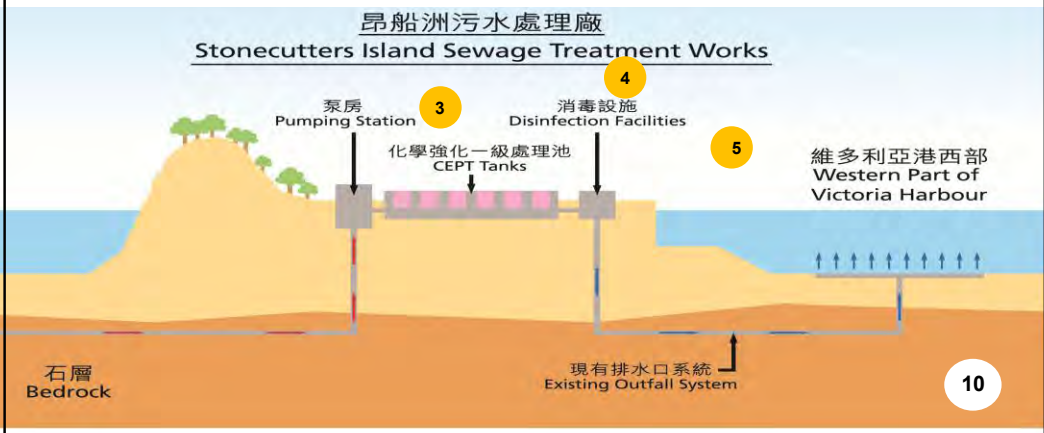


基本污水處理廠改善工程
Upgrading Works at Preliminary Treatment Works

第二期甲的污水集水區位於港島北部及西南部，集水區內的污水會先被輸送到8間沿海的基本污水處理廠進行處理。這些使用多年的廠房，已在淨化海港計劃第二期甲下完成改善工程。

HATS Stage 2A collects sewage from catchments located at the northern and southwestern parts of Hong Kong Island. The sewage within these catchment areas will be first conveyed to the 8 PTWs along the coast for preliminary treatment. These plants have been operated for many years. Upgrading works for these PTWs were carried out under HATS Stage 2A.



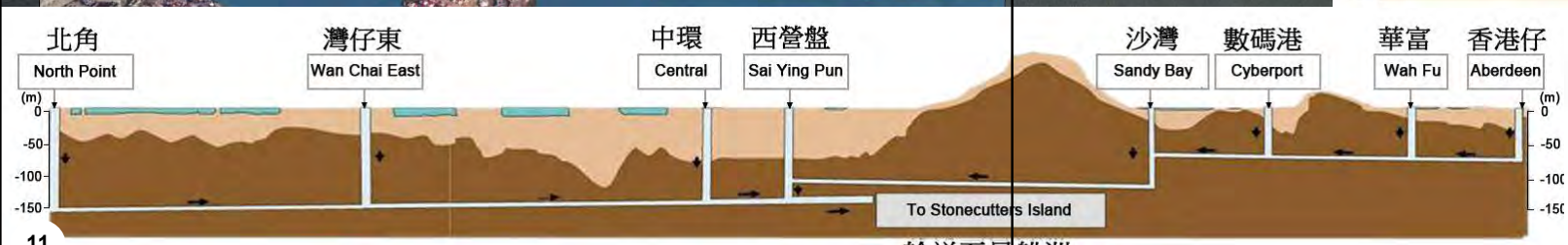


淨化海港計劃第二期甲污水輸送系統

Sewage Conveyance System (SCS) of HATS Stage 2A

淨化海港計劃第二期甲的污水輸送系統由相連的污水隧道網絡及豎井組成。豎井用以收集來自基本污水處理廠的污水。收集所得的污水會經由全長約21公里的深層污水隧道，輸送至昂船洲污水處理廠。污水隧道之深度介乎海平面以下70米至163米之間。

The SCS of HATS Stage 2A comprises a network of interconnected sewage tunnels and vertical shafts. The vertical shafts collect sewage from the PTWs. The sewage then via a total of 21km long of deep tunnels, with depths varying from 70m to 163m below sea level, is conveyed to the SCISTW.



輸送至昂船洲

污水隧道的等效直徑介乎**600**毫米至**3,000**毫米之間。

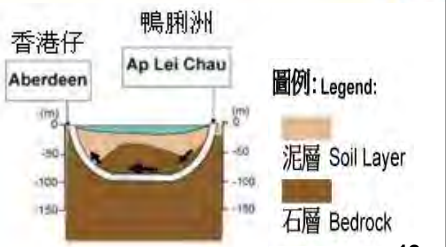
Tunnels are of sizes ranging from 600mm to 3,000mm equivalent diameter.

採納不同的隧道興建方法

污水輸送系統中直徑較大的隧道，都是採用鑽爆方法配合高壓灌漿技術而興建。這種方法可以使隧道挖掘面有更多工作空間，以便更靈活地安裝臨時支撐及進行挖掘前灌漿的工作。而挖掘隧道所產生的石料，更可再用於建築業的石料製品上。至於直徑較小，由鴨脷洲至香港仔的一段隧道，則採用定向鑽挖方法來建造。

Use of Different Tunnel Construction Methods

Drill-and-blast method with high pressure grouting technique was adopted for construction of the larger tunnel under the SCS. This method allows more working space for temporary support installation and pre-excavation grouting works. In addition, the excavated rock could be reused as construction materials. The smaller tunnel from Ap Lei Chau to Aberdeen was constructed by horizontal directional drilling.



隧道建造
Tunnel Construction

隧道鑽挖工程

隧道鑽挖工程以循環施工方式進行。首先，在隧道挖掘面的前方鑽探孔，用以勘察地質狀況。再按地質情況及地下水入水量而進行高壓灌漿，然後進行鑽爆。在爆破後，去除鬆石及移走碎石，再安裝臨時支撐。

Tunnel Excavation Works

Tunnel excavation works were carried out in cycles. Firstly, probe holes were drilled at the tunnel excavation face to ascertain the ground conditions. High pressure grouting was then applied according to the actual ground conditions and ground water inflow rate. Afterwards, blasting was carried out. After blasting, scaling, mucking out and installation of temporary support followed.

灌漿
Grouting

鑽炮孔
Drilling Blast Holes

安裝爆炸品
Charging Explosives

移走碎石
Mucking Out

安裝臨時支撐
Installation of
Temporary Support

隧道永久襯砌建造工程

隧道貫通後，隧道內管會鋪上混凝土襯砌，以形成輸送污水的管道。

Construction of Tunnel Permanent Lining

After tunnel breakthrough, tunnels were lined with concrete to form a conduit for sewage conveyance.

預製的鋼模板
Prefabricated
Steel Shutter
Formwork

雙管隧道
Twin Tunnels

伸縮式模板
Telescopic
Formwork

單管隧道
Single Tunnel

豎井建造
Shaft Construction

反井鑽挖方法

挖掘豎井時，除採用了鑽爆方法外，部分傾卸豎井採用了「反井鑽挖方法」建造。讓鑽挖所產生的碎石先掉到隧道內，然後運走，大大減低工程對附近環境及市民的影響。

Raise Boring Method

In construction of the shafts, apart from drill-and-blast method, raise boring method was also adopted in some drop shafts. The excavated materials were allowed to drop into the tunnels for mucking out, minimizing the disturbance to the surroundings and the public.

反井鑽挖機
Raise Boring Machine

大型鑽頭
Reamer

工程挑戰
Engineering Challenges

高壓灌漿技術

由於隧道深達海平面以下160多米，建造隧道期間所面對的地下水壓高達16倍大氣壓力。要有效控制地下水的滲入，讓鑽挖工程得以順利進行是工程面對的重大挑戰。工程團隊曾經於建造維港海床下的一段隧道時，遇到極大量的地下水滲入，在一個只有50毫米直徑的鑽孔噴射出來的地下水，竟然高達每分鐘約1,200公升。有見及此，工程團隊運用了高壓灌漿技術，在鑽爆挖掘前進行高壓灌漿，將石層的縫隙填滿以減少地下水滲入隧道，同時亦可避免因地下水流失而引致土地沉降。最終鑽孔的入水量大幅降至每分鐘約1.5公升，隧道爆破亦得以順利進行。

High Pressure Grouting Technique

As the deepest tunnel section is at more than 160m below sea level, the underground water pressure can build up to 16 times of the atmospheric pressure. One of the major challenges of this project is to effectively control the ingress of underground water such that excavation of the tunnel could be smoothly carried out. During the construction of a section of tunnel underneath Victoria Harbour, the project team encountered an excessive amount of groundwater inflow, with an inflow rate of about 1,200L/min in a 50mm diameter drill hole.

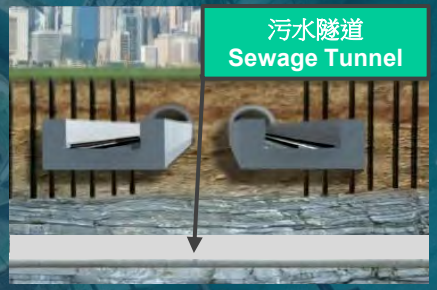
In order to cope with this challenge, the project team applied the technique of high pressure grouting. Before excavation, high pressure grouting was applied to seal up the joints in the rock so as to reduce the inflow of underground water into the tunnel. It could also avoid excessive ground settlement due to groundwater draw down. With this technique, the rate of groundwater inflow was largely reduced to 1.5L/min and thus the blasting works could be carried out smoothly.

在港鐵管道及行車隧道下爆破

由於部份深層污水隧道位處港鐵管道及行車隧道以下，工程團隊除了與港鐵及有關政府部門保持緊密聯絡外，亦在港鐵管道內安裝精密監測儀器，確保爆破工程不會對列車服務帶來不必要的影響。

Blasting Underneath MTR and Road Tunnels

As part of the tunnels are located underneath the existing MTR and road tunnels, the project team maintained close communication with MTR and related government departments. In addition, comprehensive monitoring devices and instruments were installed inside the MTR tunnels to ensure the blasting works would not affect the train services.



港鐵隧道監測儀器
MTR Tunnel Monitoring Equipment

昂船洲污水處理廠

Stonecutters Island Sewage Treatment Works

昂船洲污水處理廠是世界最大的化學強化一級污水處理廠 ，該廠的污水處理量達每日245萬立方米，相等於約1,000個標準游泳池的容量。

SCISTW is the World's largest chemically enhanced primary treatment plant. Its treatment capacity is 2.45 million cubic metres per day, equivalent to the volume of about 1,000 standard swimming pools.

新主泵房

New Main Sewage Pumping Station (MPS2)

污水到達昂船洲污水處理廠後，主泵房的污水泵會把污水從深層污水隧道抽到地面作處理。新主泵房是全球最大的地下污水泵房之一，它採用圓形設計，直徑55米、深40米。

When sewage arrives at SCISTW, it is lifted from the deep tunnels to the surface via MPS2, which is one of the World's largest underground sewage pumping stations. The MPS2 is circular in shape, with an internal diameter of 55m and depth of 40m.

新主泵房內安裝了8台大型污水泵，每台泵每秒能輸送4立方米污水。 8台泵只需約1分鐘便能填滿一個標準游泳池。

8 sets of mega size sewage pumps have been installed inside MPS2. Each pump has a capacity of 4m^3/s. The combined design capacity of the 8 pumps can fill up a standard swimming pool in about 1 minute.

沉澱池

Sedimentation Tanks

當污水被輸送回地面後，會於沉澱池以三氯化鐵進行化學強化一級污水處理。昂船洲污水處理廠應用了節省空間的雙層沉澱池設計以減少用地。該廠房雖只佔地10公頃（約半個維多利亞公園的大小)，卻可為570萬人提供服務 。

The sewage entering the system will be pumped to the sedimentation tanks at which ferric chloride would be added for chemically enhanced primary treatment. SCISTW adopts a space-saving, double-tray sedimentation tanks design to reduce its footprint. The total footprint of SCISTW is only 10 ha (about half of the size of Victoria Park) but can serve up to 5.7 million people.

污泥脫水設施
Sludge Dewatering Facilities

來自沉澱池的污泥會被送往污泥脫水設施進行處理
The sludge drawn from the sedimentation tanks will undergo sludge dewatering process

污泥儲存缸 Sludge Storage Tanks

未經處理的污泥會存放於儲存缸內暫存，再輸送到污泥脫水大樓。
Sludge is temporarily stored in tanks and conveyed to the Sludge Dewatering Building.

污泥脫水大樓 Sludge Dewatering Building

大樓設有14部離心機，以每分鐘2,700轉高速(約3倍家用洗衣機轉速) 去除污泥中的水份。
Water is removed from raw sludge by 14 nos. of high performance centrifuges which spin at 2,700 revolution per minute (approx. 3 times spin speed of a domestic spin drier).

污泥塊筒倉 Sludge Cake Silos Buildings

經處理後的污泥暫存於筒倉，再由水路運走。
The dewatered sludge stored in the Sludge Cake Silos is disposed of by marine vessels.

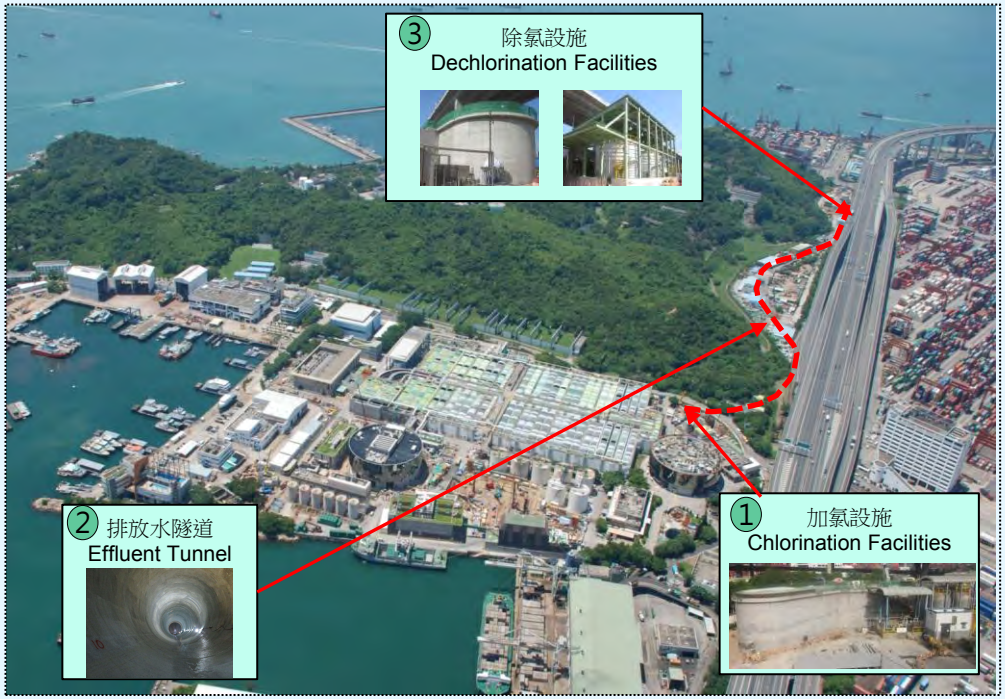
淨港一號及淨港二號
Clean Harbour 1 & Clean Harbour 2

負責運送昂船洲污水處理廠的污泥至屯門的污泥處理設施。
They are responsible for delivering dewatered sludge from SCISTW to the Sludge Treatment Facility in Tuen Mun.

排放水隧道及消毒設施
Effluent Tunnel & Disinfection Facilities

污水經過沉澱後會加入消毒用的漂水(次氯酸鈉)，然後進入新建的排放水隧道進行消毒處理，以消滅污水中超過99%大腸桿菌。經消毒後的污水會進行除氯程序，加入亞硫酸氫鈉，以消除污水中的餘氯，才排放到昂船洲西南面水域。

After the CEPT process, bleach (sodium hypochlorite) is added to the effluent for disinfection. The effluent undergoes disinfection process in the new effluent tunnel to reduce over 99% of *E. Coli*. The effluent then undergoes a dechlorination process by adding sodium bi-sulphite to neutralize the residual chlorine before discharging to the Southwest part of Stonecutters Island.



氣味控制

Odour Control

淨化海港計劃除了處理污水外，亦提升氣味控制的設備。所有可能產生氣味的設施（包括泵房、污泥脫水大樓、污泥塊儲存倉、沉澱池等）會被覆蓋以防止氣味擴散。導致氣味的氣體會經管道被抽到除味設施進行除味程序，然後排出。

Other than sewage treatment, odour treatment facilities were installed under HATS to enhance the odour control. All potentially odorous facilities at SCISTW, including the pumping stations, sludge dewatering buildings, sludge cake silos, sedimentation tanks, etc. are enclosed to ensure the odour is enclosed inside the facilities. The odorous gas inside the enclosures is extracted and ducted to designated deodourization facilities to undergo treatment before discharge.

「淨化海港計劃」第二期甲 - 便覽 HATS Stage 2A – Facts at a glance	
預計服務人口(一期及二期甲合計): Projected population to be served (Stage 1 & Stage 2A combined):	570萬 5.7 million
污水處理量(一期及二期甲合計): Treatment Capacity (Stage 1 & Stage 2A combined):	每日245萬立方米污水 2.45 million cubic metres of sewage per day
核准預算: Approved Project Estimate:	175億港元 HK$17.5 billion
施工期: Construction Period:	2009年7月至2015年1月 July 2009 to January 2015
測試及試行運作期: Testing and Commissioning Period:	2015年2月至11月 February to November 2015
基本污水處理廠: Preliminary Treatment Works:	8個經全面改善的基本污水處理廠位於北角、灣仔東、中環、沙灣、數碼港、華富、香港仔及鴨脷洲 Upgrading of eight existing PTWs located at North Point, Wan Chai East, Central, Sandy Bay, Cyberport, Wah Fu, Aberdeen & Ap Lei Chau
昂船洲新主泵房2的抽水量: Pumping Capacity of SCISTW MPS2	每秒32立方米 32 cubic metres per second
豎井/隧道: Shafts/ Tunnels:	7個傾卸豎井，深度介乎84米至170米之間，直徑介乎5米至12米之間 隧道全長21公里，深度介乎海平面以下70米至163米之間，直徑介乎0.6米至3米之間 7 drop shafts up to 84m - 170m deep, diameters 5m - 12m 21km long tunnels with depths varying from 70m to 163m below sea level, diameters 0.6m - 3m
昂船洲污水處理廠 (一期及二期甲合計): Stonecutters Island STW (Stage 1 & Stage 2A combined):	46個雙層沉澱池 14個絮凝池 14台離心機 (每日可處理28,800立方米未脫水污泥，最高脫水率達38%) 46 double-tray sedimentation tanks 14 flocculation tanks 14 centrifuges (total capacity: 28,800m³/day of raw sludge at maximum 38% dryness) 化學品 – 三氯化鐵及聚合物 Chemical dosing - ferric chloride and polymer
挖掘出來的泥石總量: Total Material excavated:	972,600 立方米 972,600 cubic metres
所用的混凝土總量: Total Concrete used:	448,700 立方米 448,700 cubic metres