



## **EEFS Studies and Findings**

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## **Agenda**

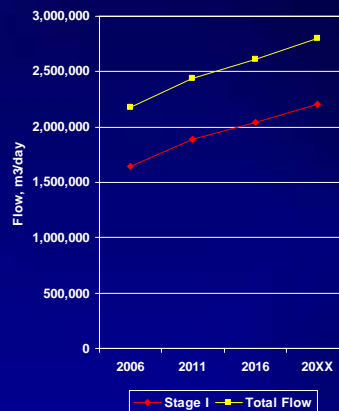
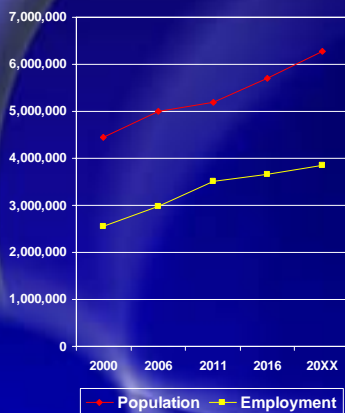
- ◆ **EEFS Background**
- ◆ **Sewage Treatment Works Location & Layouts**
- ◆ **Water Quality Impacts**
- ◆ **Options Evaluations**
- ◆ **Way Forward: Phased Implementation**

## EEFS Brief

- ◆ Focused On IRP Recommendations
- ◆ Develop IRP Options To Next Level Of Detail
- ◆ Assess Environmental, Engineering, Cost And Programme Considerations
- ◆ Conduct Comparisons Between Alternatives
- ◆ Modified To Assess Phased Implementation



## Future Population, Employment, and Flow

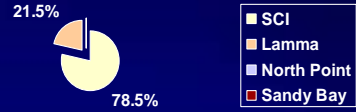


## Relative Flow Distribution

IRP Option A



IRP Option B



IRP Option C



IRP Option D



## Initial Site Screening

- ◆ Consider As Many Sites As Possible
- ◆ Look At Small Sites (0.5 Ha ) To Allow “Building” A Site Out Of Many Small Ones
- ◆ Excluded Various Categories Of Land Use



## Stonecutters Island

- ◆ Location Of Existing Plant
- ◆ Initial Screening Of Several Sites, Including PLA Site and Government Dockyard
- ◆ Short-listed Dockyard And Area Adjacent To Port Rail Terminal
- ◆ Preferred Site Port Rail Terminal



## Lamma Island

- ◆ Previously Investigated For STW Location
- ◆ Disused Quarry On Northeast Side Of Sok Ku Wan
- ◆ Retained This As Preferred Site



## Sandy Bay

- ◆ Looked In Area Adjacent Existing Sewage PTW
- ◆ Only Available Flat Land Is HKU Soccer Pitch
- ◆ Other Available Options Involved Cavern Mined In Hillside
- ◆ Shortlisted Cavern And Plant Buried Beneath Soccer Pitch
- ◆ Preferred Site Is Cavern



## North Point

- ◆ Evaluated Number Of Small Connected Sites Plus Caverns And Victoria Park
- ◆ Shortlist Included Buried Plant At Victoria Park And Braemar Hill Cavern
- ◆ Preferred Site Braemar Hill Cavern







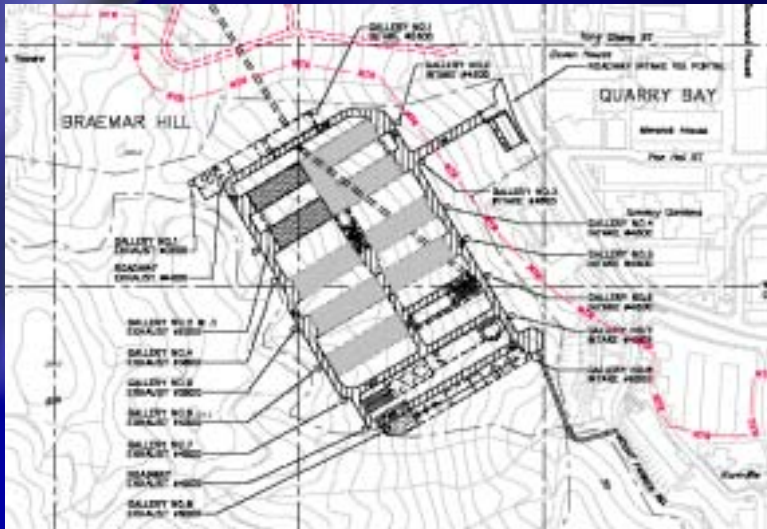
## Cavern Construction



## View of Sandy Bay Hillside



## North Point



## View of North Point Hillside



## Construction Costs (HK\$Billion)

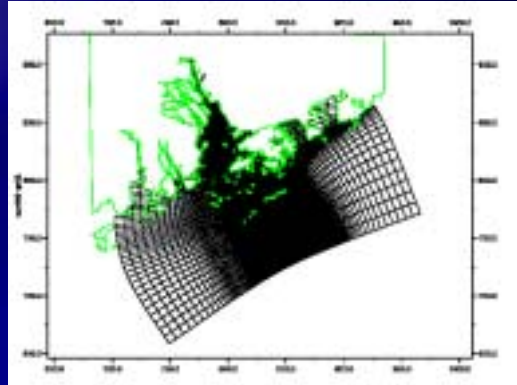
Option	Treatment Level	EEFS		HKISMP Review	Total
		STW	Tunnels & Outfalls	PTW Upgrading	
A	Nitrification	12.45	3.78	0.89	17.12
	Denitrification	14.42			19.09
B	Nitrification	11.87	4.71		17.47
	Denitrification	13.63			19.23
C	Nitrification	13.27	3.54		17.7
	Denitrification	15.12			19.55
D	Nitrification	14.21	3.22		18.32
	Denitrification	16.01			20.12

## Recurrent Costs (HK\$Billion)

Option	Treatment Level	New STWs, tunnels & outfalls	Stage 1 system	PTW operations	Sludge disposal	Total
A	Nitrification	0.748	0.254	0.094	0.132	1.228
	Denitrification	1.002			0.146	1.496
B	Nitrification	0.752			0.132	1.232
	Denitrification	1.006			0.146	1.500
C	Nitrification	0.823			0.132	1.303
	Denitrification	1.076			0.146	1.570
D	Nitrification	0.927			0.132	1.407
	Denitrification	1.180			0.146	1.674

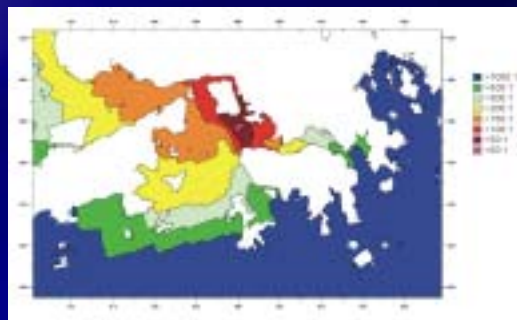
## Water Quality Assessment Approaches

- ◆ Enhanced 3D Models
  - ◆ Large Spatial Extent
  - ◆ Multiple Sources
  - ◆ Supports Far Field Analysis
- ◆ Science Assessment
- ◆ Near Field Analysis



## Circulation

- ◆ Harbour Very Energetic
- ◆ Residual Currents Much Greater Than STW Flows
- ◆ Flows Always Have A Significant Westward Or Southern Component
- ◆ Contributes To Relatively Cleaner Eastern Waters



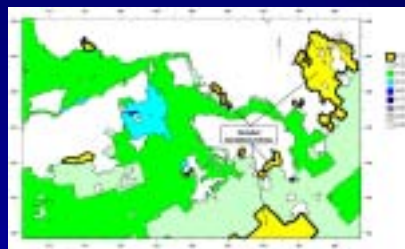
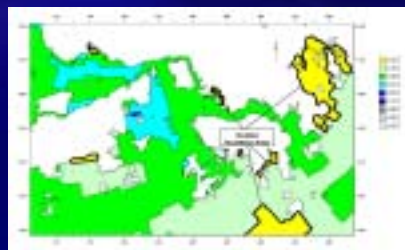
## Key Water Quality Parameters

- ◆ E. Coli
- ◆ Dissolved Oxygen
- ◆ Nutrients
  - ◆ Nitrogen
  - ◆ Phosphorus
- ◆ Unionized Ammonia

## Dissolved Oxygen

Scenario	Criteria		
	>2 mg/l	>4 mg/l	>5 mg/l
Baseline	19	11	58
No Action	28 (9)	41 (30)	59 (1)
<b>Option A</b>			
Nitrification	19 (0)	11 (0)	58 (0)
Denitrification	19 (0)	11 (0)	58 (0)
<b>Option B</b>			
Nitrification	19 (0)	11 (0)	58 (0)
Denitrification	19 (0)	11 (0)	58 (0)
<b>Option C</b>			
Nitrification	19 (0)	11 (0)	58 (0)
Denitrification	19 (0)	11 (0)	58 (0)
<b>Option D</b>			
Nitrification	19 (0)	11 (0)	58 (0)
Denitrification	19 (0)	11 (0)	58 (0)

Baseline



Option A Nitrification

## Nutrient Control Strategies

- ◆ N & P By Themselves Not The Concern – It Is Their Impact In Stimulating Algae
- ◆ In Waters Impacted By The Discharge:
  - ◆ Nutrients And Dynamic Factors Such As Mixing, Light Penetration, Etc Act To Limit Growth
  - ◆ Phosphorus Is The Potentially Limiting Nutrient In Wet Season.
  - ◆ Nutrient Levels And Algae Are Low In The Dry Season, And Are Expected To Stay So.
  - ◆ Under Conditions Assumed For EEFS Analyses, N Removal Of Marginal Value.
  - ◆ Continued Monitoring Warranted To Confirm Findings, Detect Changes

Class/Analyte	Undiluted Effluent	Diluted Effluent	Background Concentration	Predicted Concentration	Criteria	% From HATS Discharge
<b>Metals</b>						
Arsenic, µg/L	0.88	0.02	1.48	1.50	20.00	2%
Chromium, total, µg/L	8.45	0.22	0.55	0.77	50.00	29%
Copper, µg/L	9.98	0.26	2.25	2.51	5.00	10%
Mercury, µg/L	3.48	0.09	0.06	0.15	0.21	60%
Nickel, µg/L	22.30	0.59	1.02	1.61	5.00	37%
Zinc, µg/L	11.80	0.31	3.54	3.85	20.00	8%
<b>Other Inorganics</b>						
Unionised Ammonia 1 hour (NH <sub>3</sub> ) µg/L	268.76 <sup>4</sup>	7.90	6.33 <sup>8</sup>	14.23	233.00	56%
Unionised Ammonia 4 day (NH <sub>3</sub> ) µg/L	127.98 <sup>5</sup>	3.37	6.33 <sup>8</sup>	9.70	35.00	35%
Unionised Ammonia average (NH <sub>3</sub> -N, µg/L	NA <sup>7</sup>	NA <sup>7</sup>	NA <sup>7</sup>	5.20 <sup>7</sup>	21.00	NA
Sulphide, µg/L	53.00	1.39	48.00	49.39	20.00	3%
Total Residual Chlorine, mg/L	NA <sup>8</sup>	NA <sup>8</sup>	NA <sup>8</sup>	NA <sup>8</sup>	0.013	NA
<b>Organic Class</b>						
Anionic surfactants (as MBAS), µg/L	380.00	10.00	400.00	410.00	30.00	2%
Phenol, µg/L	30.00	0.79	0.00	0.79	5.00	100%

## Evaluation Process

- ◆ Intended To Present Strengths And Weaknesses Of Options In Understandable Format
- ◆ Mostly Qualitative Rankings Between Options
- ◆ Uses Criteria Developed Through Stakeholder Interviews
- ◆ 24 Separate Evaluation Criteria, Grouped According To 6 Broad Topics

## Summary Overview

No.	Criterion	Option 5a	Option 5b	Option 5c	Option 5d
1	Water Quality (harmful algal blooms)	1 <sup>st</sup> =	1 <sup>st</sup> =	1 <sup>st</sup> =	1 <sup>st</sup> =
2	Marine Ecology	1 <sup>st</sup> =	4 <sup>th</sup>	1 <sup>st</sup> =	1 <sup>st</sup> =
3	Fisheries	1 <sup>st</sup> =	4 <sup>th</sup>	1 <sup>st</sup> =	1 <sup>st</sup> =
4	Public Health	1 <sup>st</sup> =	1 <sup>st</sup> =	1 <sup>st</sup> =	1 <sup>st</sup> =
5	Hazard to the Public	1 <sup>st</sup> =	1 <sup>st</sup> =	3 <sup>rd</sup>	4 <sup>th</sup>
6	Air Quality	1 <sup>st</sup> =	1 <sup>st</sup> =	3 <sup>rd</sup>	4 <sup>th</sup>
7	Noise	1 <sup>st</sup> =	1 <sup>st</sup> =	3 <sup>rd</sup>	4 <sup>th</sup>
8	Terrestrial Ecology	1 <sup>st</sup> =	1 <sup>st</sup> =	3 <sup>rd</sup>	4 <sup>th</sup>
9	Landscape and Visual	1 <sup>st</sup>	4 <sup>th</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>
10	Waste Management Implications	2 <sup>nd</sup>	1 <sup>st</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
11	HATS System Resiliency	4 <sup>th</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	1 <sup>st</sup>
12	Tunnel/ Outfall Construction Risk	3 <sup>rd</sup>	4 <sup>th</sup>	2 <sup>nd</sup>	1 <sup>st</sup>
13	Sewage Treatment Works Construction Risk	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
14	Operational Risk	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
15	Ability to Cope with Change	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
16	Community Facilities Impact	1 <sup>st</sup> =	1 <sup>st</sup> =	1 <sup>st</sup> =	1 <sup>st</sup> =
17	Road Traffic	2 <sup>nd</sup>	1 <sup>st</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
18	Marine Traffic	1 <sup>st</sup> =	3 <sup>rd</sup>	1 <sup>st</sup> =	4 <sup>th</sup>
19	Potential Public Concern	1 <sup>st</sup>	2 <sup>nd</sup> =	2 <sup>nd</sup> =	4 <sup>th</sup>
20	Job Creation	1 <sup>st</sup> =	1 <sup>st</sup> =	1 <sup>st</sup> =	1 <sup>st</sup> =
21	Total Lifecycle Cost	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
22	Utilisation of Surface Land Resource	1 <sup>st</sup> =	4 <sup>th</sup>	1 <sup>st</sup> =	1 <sup>st</sup> =
23	Land Zoning	1 <sup>st</sup> =	1 <sup>st</sup> =	1 <sup>st</sup> =	1 <sup>st</sup> =
24	Land Status	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>

Green is first ranked. Red is last ranked

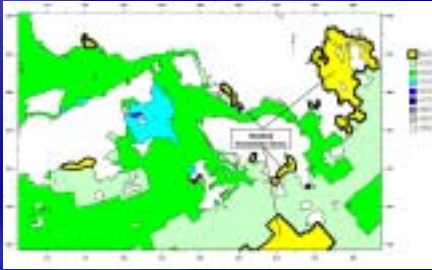
## Phased Implementation

- ◆ **Assessed Marginal Costs**
  - ◆ Tunnels And Ptw's – 25 % Of Costs
  - ◆ Expanded CEPT – 17 % Of Costs
  - ◆ Biological Treatment – 58 % Of Costs
- ◆ **What Are Marginal Improvements From CEPT Over Time ?**
- ◆ **What Are Engineering Implications ?**
- ◆ **Is Phasing Rational ?**

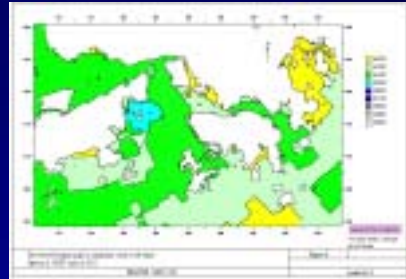
## Water Quality Analyses

- ◆ **Disinfection Absolutely Necessary**
- ◆ **Impacts Mainly On Dissolved Oxygen And Unionized Ammonia**
- ◆ **Exceedances Of Criteria Relatively Limited In Area And Duration Well Into The Future**

## Minimum Dissolved Oxygen

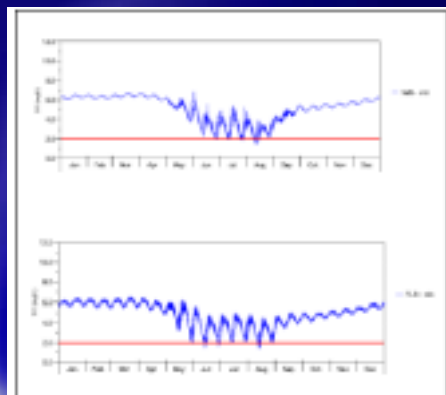


Option A Nitrification

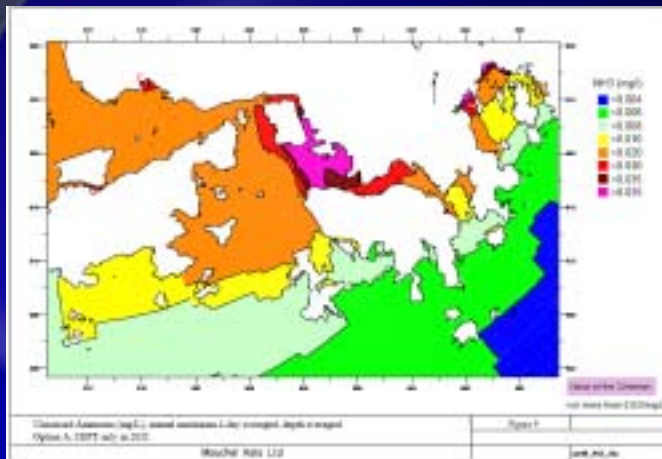


CEPT "2021" at SCI

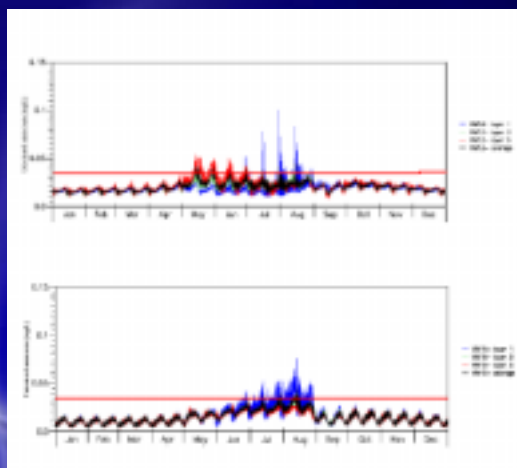
## Frequency of DO below 2 mg/l



## 4 Day average unionized ammonia



## Frequency of Unionized Ammonia above Criteria



## Disinfection

- ◆ CEPT Argues For Chlorination Rather Than UV Disinfection
- ◆ Maximum Allowable Residual Chlorine in Effluent is 0.44 mg/l : Dechlorination is Necessary.
- ◆ CBP levels (0.006 mg/l) estimated to be well below relevant aquatic toxicity standards

## Conclusions With Respect To Water Quality

- ◆ Exceedances Of Criteria Projected
- ◆ Tend To Be Small In Relative Scale
- ◆ If Growth Not As Predicted, Impacts Less Than Projected
- ◆ Underlying Modeling Is Conservative
- ◆ Reasonable To Proceed With Phased Implementation

## Engineering Layout



## Cost Implications

	Construction Cost (Billion HKD)	Recurrent Cost (Billion HKD)
Stage 1	8.2	0.32
Stage 2a	8.4	0.44
Stage 2b	11.1	0.72
Stage 2 Total	19.5	1.16

## Programme Considerations

- ◆ At SCI:
  - ◆ Permanent Disinfection In Place Late 2011
  - ◆ Temporary Disinfection By Late 2008
  - ◆ HKI Tunnels Completed By Mid 2013
- ◆ Stage 2b When Needed
  - ◆ EIA, Land Matters Addressed Immediately
  - ◆ Approximately 3 Years To Tender/Design
  - ◆ Approximately 4 Years To Construct

## Web Sites:

- ◆ <http://www.cleanharbour.gov.hk/english/pc.html>
  - ◆ Links To Main HATS Studies
- ◆ [http://www.cleanharbour.gov.hk/english/phase\\_index.html](http://www.cleanharbour.gov.hk/english/phase_index.html)
  - ◆ Links To Studies On Phased Implementation