[redacted] Subject: FW: Re HATS

04.11.2004 11:50 AM

Dear Sirs

Here is the paper and appendices that will be delivered on 12 November 2004 to the Symposium on Cross Border Environmental Management and also forms our comments on the HATS Consultation.

We will be pleased to respond in any manner you may choose.

Regards

Peter H.Y.Wong & John Russell

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Final

摘要

題目： 第三種方案：淨化海港計劃＋跨境合作──構建區域整體優質環境

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關鍵詞：

淨化海港計劃、區域性、水體富營養化過程、香港、可持續發展、環境、跨境、污水、污水排放系統、海藻過量、養份、珠三角

內文摘要：

本文曾呈交政府，期望納入爲淨化海港計劃(HATS)其中一個諮詢方案。文章提出第三種「區域性」方案，希望爲香港第二期污水處理及排放計劃帶來更好及可持續的成效。

對污水以高規格處理後本地排放，還是採用低規格於深海排放稀釋這兩種排污方式，坊間的爭論一直持續不休。現在是適當時侯認真考慮第三種、可持續方案：把香港淨化海港計劃結合於珠三角流域跨境污染管理框架之內。

文章認爲，由於珠三角流域污染物水平日高，將使 HATS 2B 針對香港水域海藻、紅潮及水體富營養化過程的措施失去預期效果，因此倡議政府主動投放充裕財政資源，通過跨境有效管治以徹底解決水質問題。

通過推行 1998 年環境影響研究之方案一或方案二（污水初步處理後排放出深海），及重新投放取消 HATS 2B 所節省的十五年滾存資金（港幣 95 億元），珠江豐水期水質惡劣的情況可得到顯著改善。

上述撥款可作兩項用途。其一，建立及參與珠三角流域管理局或委員會；其二，現實可行時，盡早投放資源於指定目標，直接及永久地改善珠三角流域水質。

作者總結指出，香港市民寧願看到多付出的排污費，用作永久及持續解決區內的水質問題（並由此帶來其他得益），而不是投放於現有的方案。

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The THIRD WAY – to make a BETTER WHOLE

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Abstract

This paper has been submitted to be included in the Harbour Area Treatment Scheme (HATS) consultative process. It offers a Third Way for the second stage treatment and disposal of Hong Kong's sewage.

The arguments over whether to treat to a higher standard and discharge locally, or disperse a poorer quality effluent through the greater dilution achieved by a long outfall, have been raging for decades. It is now timely to consider a Third and Sustainable Way: to integrate HATS within a pollution management framework for the Pearl River Delta (PRD) and catchment.

This paper argues that the increasing background levels of nutrients, originating from the PRD catchment, render stage 2B of HATS ineffectual against further algal blooms, red tides, and eutrophication in Hong Kong marine waters. It advocates the initiation and significant financial commitment to a long-term water quality outcome to be achieved through effective cross-border management.

Through the adoption of either Option 1 or 2 of the Environmental Impact Assessment Study September 1998, (dispersion of a poorer quality effluent through a long deep sea outfall) and the redirection of 15 years of recurrent savings, (HK$ 9.0 billion) by not building HATS 2B, the high background levels of the PRD wet season flows can be noticeably reduced.

The above funding would be directed to achieving two objectives. The first, is the establishment and participation in a Regional Pearl River Delta Commission and the second, is to commence as soon as practical, significant targeted investments in water quality measure to directly and permanently improve the water quality in the Pearl River catchments.

The authors conclude that the Hong Kong constituents would rather see their tax monies and increased sewerage charges being directed towards the promise of a long-term and sustainable resolution of water quality issues in the region (with the associated multiple benefits) rather than what is on offer.

1. INTRODUCTION

This paper links two significant initiatives, and in so doing offers a Third ('regional', and hopefully better, sustainable) Way for the second stage treatment and disposal of Hong Kong's sewage.

The first initiative is the proposed capital and recurrent expenditure of HK$19.1 billion and HK$1.18 billion per year, respectively, for the Harbour Area Treatment Scheme (HATS) 2A and 2B which offer high quality treatment with effluent disposal into the Western Buffer Water control Zone (WBWCZ), Hong Kong Harbour.

The second initiative is manifested in a comprehensive briefing document titled, "IMPROVING WATER QUALITY IN THE PEARL RIVER DELTA Opportunities and Challenges ROLE FOR HONG KONG" (Hopkinson & others, 1999) which calls for a significant Hong Kong financial investment in the Pearl River Delta (PRD) and catchment and for Hong Kong to be part of a Regional Pearl River Delta Commission to preside over water quality issues in the region.

The following paper argues the case for linking these two initiatives into a Third Way, which involves the adoption of either Option 1 or 2 of the EIS September 1998, (dispersion of poorer quality effluent through a long sea outfall) in lieu of building HATS 2B (higher standard of effluent and discharging locally) and redirecting 15 years of recurrent savings (HK$9.0 billion) into the second initiative which will return noticeable reductions in high background levels of nutrients, originating from the PRD catchments, during the wet season. It is argued that the existing and predicted high levels of nutrients in the wet season in the Hong Kong Harbour will render HATS 2B ineffective against the reoccurrence of Red Tides, Algal Blooms, and Eutrophication and as a consequence may not be built for generations.

2. BACKGROUND

The argument over whether to treat to a higher standard and discharge locally or disperse a poorer quality effluent through the greater dilution achieved by a long outfall, has been raging for decades; for this reason some background is offered. A brief history of the Strategic

Sewage Disposal Scheme (SSDS) has been outlined by the authors in an earlier paper (Russell and Wong, 1999) with an updated abridged version in appendix 1.

Red tides, algal blooms and eutrophication in Tolo Harbour led the Hong Kong SAR Government's Environmental Protection Department (EPD) to commission consulting engineers, Watson Hawksley, to conduct a comprehensive sewage strategy study for Hong Kong including the New Territories and surrounding marine waters.

The Watson Hawkley 'Sewage Strategy Study' (SSS) October 1989 provided a milestone in the assessment of options, integration of known issues and the presentation of a recommended strategy. (EPD, 1989).

General recommendations for the SSS were the reinforcement of catchment interception schemes, control of agricultural wastes, industrial discharges and improvement of environmental awareness in planning.

The long term solution for the harbour area;

> "....concluded that the final environmental standards can most reliably and most economically be achieved by combining a degree of land based sewage treatment with the natural self-purifying abilities of the ocean. The strategic conclusions are that this would be best accomplished by the collection of harbour area flows westward, treating and then discharging southwards through a long outfall into the major ocean currents off the Lema Channel. It is stressed the marine disposal of certain types of water borne wastes is to be considered unacceptable. These will therefore be removed prior to discharge and only the biodegradable, harmless or inert residual disposed to the ocean." And,
> "....In the long term, when controls are effective, the process can revert to a single sedimentation but the chemical facilities will still provide an effective backup and means of reducing pathogens in the remote chance that the principal oceanic outfall should be ever out of commission." (ibid)

The proposed implementation programme showed completion of the Kowloon System by 1994 and the Ocean Outfall System by 1997. An artist's impression of the recommended long term sewage disposal scheme is reproduced in appendix 2, showing the tunnel network beneath the sea and long outfall to the oceanic waters off the Lema Channel, South China Sea. (ibid)

The SSS related the level and type of sewage treatment to the assimilative capacity of the receiving waters. The receiving waters were categorised into four water types: Oceanic Waters, Offshore Waters, Inshore Waters and Enclosed Waters with the degree of treatment (and cost) progressively increasing with each type. The Oceanic Waters were described as "...located to the south east and south of Hong Kong and never drawn into the estuary, providing a massive body of water..." i.e. the Lema Channel, where it was proposed the long deep sea outfall would discharge, where as, the Inshore Waters are "...generally delineated as waters within the 5 fathom mark and the shore. It is concluded that full biological treatment would be needed..." i.e. the location of the HATS 2B outfall.

It is of great relevance to note that with the full commissioning of the SSDS the Hong Kong Harbour would be 'cleaned-up' except for the regular occurrence of algal blooms and red tides in the wet season until such time the high background seasonal nutrient load was significantly reduced.

Subsequent substantive reports, environmental impact assessment studies, public hearings, involvement of an International Review Panel (IRP) confirmed a marginally modified SSDS, and on the 22nd October 1998, the Advisory Council for the Environment (ACE) selected the long deep sea outfall, to the Lema Channel, with disinfection following Chemically Enhanced Primary Treatment (CEPT) with the proviso: to with-hold CEPT when the raw sewage was 'domestic', with minimal industrial pollution. As a follow up to this meeting the EPD undertook to provide requested information which was outside the Environmental Impact Assessment Study which included the water pollution status in the Pearl River Delta and Deep Bay.

In January 2000 the SSDS Environmental Impact Assessment recommended the EIA Option 1 which is a slight variation on the SSDS. Option 1 proposed disinfection at Lamma Quarry and for the Stage 2 ocean outfall to consist of a deep tunnel about 7.5 km long connecting Lamma Island and the Lamma Island channel with the flexibility to upgrade treatment or extend the outfall in the future.

In November 2000 the IRP published its Review of the Strategic Sewage Disposal Scheme and stated that,

> **"The IRP is of the opinion that the discharge and dilution of the CEPT effluent into the waters south of Lamma Island or in the Lema Channel is neither a viable nor sustainable option."** and **"The IRP is aware that these statements rejecting the four EIA options and our subsequent recommendations represent a major departure from the recommendations of the EIA and from the Hong Kong's Government's position Paper on the SSDS of May, 2000.)"**.(EPD, 2000)

The IRP consequently recommended biological nutrient removal with local effluent disposal which laid the basis for HATS 2A and 2B.

It is of great relevance also to note that with the full commissioning of HATS 2A and 2B the Hong Kong Harbour would be 'cleaned-up' except for the regular occurrence of algal blooms and red tides in the wet season until such time the high background seasonal nutrient load was significantly reduced.

A detailed discussion of the IRP's reasons for reversing their former position is given in appendix 1, needless to say that the IRP made the following comments relating to the pollution from the Pearl River Delta.

> "It is important to note that the **current water quality objectives of the DO used in Hong Kong ... is the lowest in the world**....It is further noted that a single, low standard of DO is being applied for all BU's in Hong Kong, except for marine fish culture." (ibid, p.B-3)

However, in a further paragraph the IRP wrote on the need for regional control of the high background levels of nutrients from the PRD,

> "Although the SSDS aims at dealing with sewage disposal problems in Victoria Harbour and the surrounding waters, Hong Kong's marine water quality cannot be maintained at a sustainable level without considering the enormous pollution loading discharging from the Pearl River. It is well known that the hydrography in Hong Kong's western and southern waters is profoundly affected by the Pearl River outflow, especially in the wet season (Morton & Wu, 1975). In the EIA report, the influence of the Pearl River outflow on the water quality of southern waters is clearly exemplified by the high background level of nutrients. To curb the overall pollution loading entering coastal waters of Hong Kong, regional efforts and controls are absolutely essential."(ibid, p.)

Further, in a response to the 'public expressions' the IRP proposed four components for future cooperation within the Pearl River watershed. The fourth is quoted here;

> "(iv) Guangdong Province needs a large investment for engineering works for pollution control. It will be very helpful if Hong Kong can find ways of loaning or contributing financial resources." (ibid, p.34)

3. IMPACT OF THE PEARL RIVER DELTA ON HONG KONG MARINE WATERS

All the reports cited in this paper comment in one way or another on the significant adverse effects the Pearl River has on Hong Kong's marine waters, especially in the wet season. And, if it were not for this high level of background pollution arriving from the PRD in the wet season the Hong Kong SAR Government would have a choice of effluent disposal options where there is adequate residual assimilative capacity.

3.1 Regional Hydrodynamics of the Pearl River

The regional hydrodynamics of the Pearl River is significantly influenced by the following phenomena;

1. The buoyancies differences between the 'freshwater' in the Pearl River and saline waters in the sea with resultant gradients.
2. Seasonal effects of rainfall. (Dry and wet seasons)
3. Movement of Oceanic Currents.

The above phenomena interact to produce predictable seasonal water body movements which provide a vector for the PRD pollutants.

In the dry season the low rainfall is reflected in the low Pearl River Flows. As the Pearl River enters the coastal waters the more buoyant freshwater remains on the surface causing a stratification of predominantly a freshwater layer on top of seawater; there is limited mixing through a gradient. The Oceanic waters, "...originating from the Sea of Japan and East China Sea flows southward passed Hong Kong." (EPD, 1995b) and interacts with the low flow volumes in the Pearl River having very little impact on Hong Kong marine water east of Lantau Island.

In the wet season the high rainfall across the catchment causes large discharges of water in the Pearl River. These large discharges into the coastal waters cause significant buoyancy stratification and flows into all Hong Kong marine waters, due in part, to the "warmer waters of the Hainan current from the tropics heading northwards." (ibid. p.11-15)

3.2 Regional Pollution Load and the Pearl River

The regional pollution load is constantly generated but is discharged into the Pearl River as a constant and seasonal load.

In the dry season the municipal drains, municipal and industrial treatment plants and untreated wastewater discharge their effluent (that is not reused or recycled) into the Pearl River for discharge into the estuary.

In the wet season the heavy rainfall flushes the catchments of pollutants which have accumulated in the dry season (predominantly agricultural and urban runoff) into the high flowing Pearl River for discharge into the estuary. The combined pollution load is much larger due to the added agricultural and urban pollution loads.

It is the oxygen demand of this un-stabilized pollution which strips the dissolved oxygen from the Pearl River and saline coastal waters. This is the reason why low levels of DO are monitored in the Hong Kong Harbour, Southern and Oceanic waters in the wet season.

Similarly, it is the TIN, predominately from agriculture, which provides the high levels of nutrients which again are monitored in the Hong Kong Harbour, Southern and Oceanic Waters.

4. ALGAL BLOOMS, 'TRIGGER' LEVELS and BENEFICIAL USE

4.1 Algal blooms.
Algae (phytoplankton) are one of the simplest forms of plant life. Blue-Green algae were thought to be present on the earth in excess of 1 billion years ago. Phytoplankton grows in the presence of sunlight and is food for more complex marine life. An excess of nutrients, especially nitrogen and phosphorous, in the right ratio and hydrodynamic conditions will cause a bloom of algae in a water body which could result in harmful red tides and even eutrophication. (All the dissolved oxygen in the water column is consumed by the bloom leaving the oxygen dependent marine life to die.)

4.2 'Trigger' Levels.
The term 'trigger' level has been used by the IRP to describe a combination of levels of nitrogen and phosphorous that have been found to cause algal blooms. The level is described as the average, in mg/L, over the depth. However, these values can vary significantly depending on the hydrodynamic conditions of the water body. E.g. A shallow land-locked water body like Tolo Harbour is more conducive to algal blooms, red tides with subsequent possible eutrophication because the water movement is restricted and water temperatures are elevated. Hence, such a location requires more stringent criteria compared to oceanic waters where there are massive flows of water that circulate to depth moderating the surface temperatures and reducing the exposure time of algae to sunlight.

The IRP (ibid, p.B-5) in disagreeing with the EIA Study report statement, "...that nutrient removal is not required in the southern and oceanic waters..." adopted a 'trigger' level of around 0.1mg-N/L and 0.02mg-P/L for Hong Kong coastal waters. (EPD, 1988; Hodgkiss & Ho, 1997) and stated,

> "In southern waters, typical annual depth average TIN and TP is 0.15mg-TIN/L and 0.02mgTP/L respectively (Vol. 2, p. A2.9-16), and is therefore at the verge of eutrophication. Any further discharge of nutrient will increase the chance of algal blooms."

Unfortunately, in support of their claim the IRP did not cite any references of the sighting of algal blooms in oceanic waters as different from coastal waters.

4.3 Beneficial Use.
Different areas of coastal waters in Hong Kong are designated for different "Beneficial Uses' (BU) and different water quality standards are required for supporting the designated functions of different BU's. (ibid, p.B-1). However, the selection of the Beneficial Use type for the Western Buffer Water Control Zone and the Southern Waters Control Zone and Oceanic waters appear to bear no correlation as to whether algal blooms will occur or not. I.e. The water body in the WBWCZ has been degraded over the years by local and PRD pollution particularly in the wet season. As a consequence the Beneficial Use has been set at BU5 with associated water quality criteria of (annual average) 0.4mgTIN-/L and 0.04mgPO4-P/L which exceed by a factor of two the IRP's stated 'Trigger' level.

5. HARBOUR AREA TREATMENT SCHEME (HATS STAGE 2)

The above scheme is described in two stages. HATS Stage 1 is the replacement title for the SSDS Stage 1. (Sewage collection from Chai Wan, the north-side of Victoria Harbour and Tsing Yi for delivery to the Stonecutters Island Wastewater Treatment Plant with effluent discharge via an interim outfall into the WBWCZ. HATS Stage 2, the replacement for the SSDS Stage 2, is proposed to be built in two parts: HATS 2A and HATS 2B.

The SSDS Stage 1, 2, 3 and 4 was planned to collect Hong Kong's sewage, treat all of the sewage at Stonecutters Island using Chemically Enhanced Primary Treatment (CEPT), disinfect, and then dispose the effluent off the Lema Channel in the South China Sea. However, this proposal would not prevent the formation of algal blooms and red tides in the Western Buffer Water Control Zone, until such times that the high background levels of nutrient, originating from the Pearl River Delta in the wet season, could be significantly reduced.

HATS Stage 2A is effectively the completion of the SSDS with the exception that the effluent is permanently disposed in the vicinity of the existing interim outfall from Stonecutter Island exacerbating the nutrient loads. This proposal too, will also not prevent the formation of algal blooms and red tides in the Western Buffer Water Control Zone until such time that the high background levels of nutrient originating from the Pearl River Delta in the wet season can be significantly reduced. HATS 2B is a proposed biological nutrient removal plant to be commissioned at some time in the distant future when the Pearl River Delta nutrient loads are permanently reduced to a level where they no longer initiate algal blooms in the Western Buffer Water Control Zone.

Both proposals are dependent on the success of the Mainland's pollution clean up of the PRD catchment before there can be some respite from algal blooms and red tides in Hong Kong marine waters. If the clean up takes 10 years then HATS 2B will be commissioned and the constituents of Hong Kong would be committed to a very expensive treatment plant for ever. Or, an effective clean up might never happen in which case HATS 2B would never be built.

6. COMPARISON OF COSTS BETWEEN the SSDS and HATS 2A and 2B

The comparative capital and recurrent cost of the SSDS and HATS 2A and 2B are show in the following table.

Table 1 Comparison of Costs (EPD, 2004)

	Capital Cost (HK$ billion)	Recurrent Cost (HK$ billion / year)
Stage 2A	8.4	0.44
Stage 2B	11.1	0.72
Total	**19.5**	**1.16**
SSDS	**15.8**	**0.56**

It is clear from Table 1 above that HATS 2B (the biological nutrient removal process advocated for the Hong Kong Harbour) is a very expensive solution (capital cost HK$ 11.1 billion and recurrent cost HK$ 0.72 billion per year, respectively) for preventing algal blooms and red tides in the Hong Kong Harbour. However, it cannot be effectively installed until the high background nutrient levels, from the Pearl River in the wet season, are significantly reduced.

It is to be carefully noted that since HATS 2A is less expensive than the SSDS there is a strong economic disincentive to participate in a regional approach to clean up the pollution in the PRD because the sooner the nutrient levels are brought down below the 'trigger' level a sizable financial commitment has to be made to the very expensive HATS 2B to prevent the Hong Kong high TIN effluent causing algal blooms and red tides. The disincentive could mean the Hong Kong Harbour would be plagued with algal blooms and red tides for possible generations.

Alternatively, the Third Way accelerates the clean up, provides early enjoyment of a 'fragrant harbour' and the multiple benefits of the water quality improving not only throughout the Hong Kong marine waters but the entire PRD and catchment.

Table 2 Comparison of Greenhouse Emission Costs (ibid)

	Energy Cost (HK billion / year
Stage 2A	0.10
Stage 2B	0.35
Total	**0.45**
SSDS	**0.19**

The comparison of Greenhouse Emission Costs (energy costs in HK$ billions per year) in Table 2 clearly shows the SSDS uses HK$ 0.26 billion per year less of energy and so is by far the more sustainable into the future since there is significantly less CO_2 being released into the atmosphere to generate electricity power..

7. PROJECTED FEES AND CHARGES OF HATS 2A and 2B

The projected fees and charges associated with the recommended HATS preferred Option are;

> "An average household in Hong Kong is paying around $11 per month based on a sewage rate at $1.20 per cubic metre of water consumed (with the first 12 cubic metres free in each billing cycle). At the same charging rate, the sewage charge of an average household is estimated to increase to $14 and $21 per month upon operation of Stage 2A and 2B respectively. Whilst the increases are high in percentage terms, the level of charges would still be a relative small part of the overall living expenses for the majority of households in the territory. They are also low when compared with the sewage charges in other cities of comparable per capita GDP." (EDP, 2004)

8. THE REGIONAL DIMENSION

The second initiative was a call for "...region-wide watershed management..." in a briefing paper titled, "IMPROVING WATER QUALITY IN THE PEARL RIVER DELTA – OPPORTUNITIES AND CHALLENGES – A ROLE FOR HONG KONG". This extensive paper of 21 pages cited 66 references and puts the case for a Regional Pearl River Delta Watershed Commission. (Hopkinson & others, 1999).

Hong Kong's current marine water quality issues can not be totally resolved by any 'local' means since the cause of algal blooms and red tides is a 'regional' pollution problem. The sheer magnitude of the 'background' levels of TIN and low dissolved DO levels emanating from the Pearl River Delta in the wet season dominates the presence of any treated effluent discharged. E.g. Water quality modelling studies in the southern and oceanic waters for the wet season showed the levels of DO and TIN not to be noticeably changed by the discharge of treated effluent because the background levels originating from the PRD were so dominant. (Appendix3). The IRP in their concern for marine life wrote;

> "It is important to note that the **current water quality objectives of DO used in Hong Kong** (depth average of >4mg/L and bottom 2m >2mg/L, 90% of the time) **is the lowest in the world** …It is further noticed that a single, low standard of DO is being applied for all BU's in Hong Kong, except for marine fish culture."(EDP, 2000)

> "To curb the overall pollution loading entering coastal waters of Hong Kong, regional efforts and controls are absolutely essential." (ibid, p. B-5)

> "Guandgong Province needs a large investment for engineering works for pollution control. It will be very helpful if Hong Kong can find ways of loaning or contributing financial resources." (ibid, p. 34))

The briefing paper stated that Guangdong issued a 'Green Water Building Plan' in 1997 and is doing what it can, however;

> "The PRD is one of the fastest growing regions in the world, due in part, to relocation there of Hong Kong's manufacturing industries. The surge in population and development has heightened the demand for clean, plentiful water. But the surge in development and population has simultaneously caused a severe deteriation in water quality due to pollution from industry, agriculture and municipal wastewater. Unfortunately, neither China's nor Hong Kong's existing environmental laws adequately control these sources of pollution. Moreover, both China and Hong Kong are woefully short of adequate wastewater treatment plants and of comprehensive watershed management." (Hopkinson & others, 1999).

It is clear that a regional approach to 'whole of catchment management' can produce multiple benefits across the whole Pearl River Delta including the Hong Kong marine waters. Such benefits include improved drinking water, economic savings on agricultural chemicals, healthy lands, healthy rivers, and healthy marine waters, support for biodiversity etc and healthy people.

It would be a rude shock for the constituents of Hong Kong if HATS 2A was paid for and algal blooms and red tides persisted in the Harbours, especially if they realised they had foregone the opportunity of a long-term sustainable resolution of the water quality issues in the region.

9. DISCUSSION

9.1 Background

The background is about the arguments and counter arguments for two ways to treat Hong Kong's sewage waste: either the SSDS (long outfall) or the HATS 2A and 2B (biological nutrient removal and harbour outfall).

What is offered in this paper is a THIRD WAY with a Regional Dimension.

9.2 Implications of the International Review Panel's change of recommendation.

The IRP were obviously very concerned about the low levels of DO and high nutrient background nutrient levels in the southern and oceanic waters, in the wet season. The prospect of adding further loads, no matter how small a percentage, was sufficient for them to reverse their previous recommendation for a deep sea outfall in favour of biological nutrient removal with harbour disposal of effluent. This decision, to safeguard the southern and oceanic waters has two major flow on effects.

The first effect will be that the water quality in the Hong Kong Harbour will be noticeably lesser than for the SSDS (long outfall) if only HATS 2A is built (harbour outfall). The second and worst effect is that if HATS 2A and eventually 2B is built, Hong Kong will be committed to a very expensive treatment process for ever, having expended the funds without addressing the cause and solution of the problem which the IRP so ably identified and articulated.

9.3 Impact of Pearl River Delta.

It is clear from the references in this paper that the pollution, in terms of low dissolved oxygen and high background levels of nutrients, severely limits the capability of either the SSDS or HATS 2A and 2B to clean up the Hong Kong Harbour and marine waters.

9.4 Algal Blooms and 'Trigger' Levels

High levels of nutrients from the PRD in the wet season are the major contributor to algal blooms and red tides. The 'trigger' levels for algal blooms depend on a number of coincident factors and there is a propensity for blooms to occur in contained shallow coastal waters where the nutrients are at the appropriate concentration and ratio. For similar concentrations and ratio of nutrients the occurrence of blooms in oceanic waters is far less likely.

9.5 HATS Consultative Document (ETWB, 2004)

The Consultative Document for the Harbour Area Treatment Scheme Stage 2 is well presented and well written, however, it has neglected to include some important information issues some of which are listed below:

- The acknowledgement of the dominance and deleterious effects that the Pearl River has on the water quality in Hong Kong's Harbour and marine waters during the wet season.
- An explanation of how the above, impacts the proposed HATS Stage 2 Option A recommendation.
- A clear explanation to the public showing how algal blooms in the Harbour will persist for as long as the PRD remains severely polluted.
- An explanation as to why HATS 2B (biological nutrient removal) will not be built until high background levels of nutrient, coming in with Pearl River water in the wet season are significantly reduced.
- A clear explanation of 'Trigger' levels.
- An indication of the new fees and charges for each household.

9.6 HATS Supplementary Technical Notes (ibid)
The Supplementary Technical Notes are brief and in so doing are misleading by omission. Again there is no mention of the influence of the Pearl River on the water quality in the Hong Kong Harbour. (This is a major omission.) The examples of the water quality modelling outputs used to demonstrate the acceptability of options against established water quality criteria, used in the most part, 'Annual Average' values which take into account no seasonal variability and so does not demonstrate the efficacy of what is proposed.

9.7 Comparison of costs and funding the Third Way
A comparison of costs in Table 1 shows the difference in projected annual recurrent costs between the SSDS and HATS 2A and 2B to be HK$ 0.6 billion per year which is HK$ 9.0 billion over a period of 15 years. (The source of funding for the Third Way.)

The difference in capital cost is HK$ 2.7 billion in the SSDS's favour. The difference in energy emission costs is HK$ 0.26 billion per year and so the SSDS is more sustainable.

The Third Way is less expensive than HATS 2A and 2B and offers multiple benefits to both Hong Kong and Guangdong Province in variety of ways. E.g. improved drinking water, improved DO in all marine waters, reduced nutrient load, etc. An economic case could be made for all these environmental externalities.

9.8 The Regional Dimension
Hong Kong's current marine water quality issues can not be totally resolved by any 'local' means since the cause of algal blooms and red tides is a 'regional' pollution problem.

In the hierarchy of sustainability, Global, Regional and Local actions, regional actions transcend borders to provide mutual benefits in the sustainability stakes.

The authors conclude that the Hong Kong constituents would rather see their tax monies and increased sewerage charges being directed towards the promise of a long-term and sustainable resolution of water quality issues in the region (with the associated multiple benefits) rather than what is on offer.

10. PREDICTING REDUCTIONS IN THE PEARL RIVER POLLUTION LEVELS

The Pearl River Estuary is a large settling basin and digester for suspended solids and dissolved biochemical oxygen demand carried by the Pearl River.

10.1 Existing Pollution
The briefing paper (Hopkinson and others, 1997) stated the following;

> "This national water quality crisis is particularly acute in the Pearl River Delta of Guangdong Province...The enormity of the Pearl River means that its waters, and its pollutants, strongly influence Hong Kong's marine waters, particularly those to the west and northwest, and in Deep Bay." (ibid, p.2)
> and,
> "Only about nine percent of this domestic wastewater and sewage receive treatment before discharge-over 80 percent of industrial wastewater receive treatment...Legislation mandates the treatment of industrial wastewater, but no such legislation exists for domestic wastewater....most sewage in the PRD is simply discharged with minimal treatment." (ibid, p.4).
> Further,
> "Farming can cause copious agricultural runoff if proper management techniques are not in use-which they are not in Guangdong....Back modelling data suggests that agricultural runoff bearing excess fertilizer supplies most of the Total Inorganic Nitrogen in the Pearl River." (ibid, p.7)

10.2 Predicting Reductions in Pollution.
The amount of dissolved oxygen (at saturation) for an **unpolluted** Pearl River in the wet season has been calculated to be 1.95 million tonnes and the Biochemical Oxygen Demand for the Pearl River, also in the wet season, **without** any treatment at all has been estimated to be 1.02 million tonnes. Refer appendix 4.

The BOD removed by treatment is estimated to be 0.25 million tonnes with the remaining BOD being 0.77 million tonnes. I.e. the BOD removed from treatment is about one quarter. Refer appendix 4

Hence it would appear the present untreated BOD in the Pearl River has lowered the dissolved oxygen level from around 7.0 mg/L to an average depth value of around 4.0 mg/L. and for < 2metres around 2.0 mg/L. It is postulated that if the current untreated BOD of 0.77 million tonnes was reduced by two thirds (0.51 million tonnes) through treatment the depth average dissolved oxygen, on a linear extrapolation, would increase from 4 mg/L to 6.0 mg/L with a corresponding increase for < 2metres to 3.0 mg/L.

10.3 Targeting Reductions Pollution

To achieve the above nearly all the municipal and industrial wastewater would need to be treated to at least effluent quality class C with significant reductions in agricultural and urban BOD loads. The municipal BOD loads and improving agricultural practices would be the primary target.

11. LINKING THE TWO INITIATIVES – THE THIRD WAY – A HYPERTHETICAL

The Hong Kong SAR Government has decided as an outcome of its HATS consultative process to address the chronic problems of algal blooms in its harbours and low dissolved oxygen in its marine waters by working collaboratively and supportively with the Guangdong Provincial Authorities to address and progressively rectify the sources of pollution in the PRD, especially during the wet season.

To fund the above the HKSAR Government should allocate a total sum of HK$ 9.0 billion over 15 years finishing in 2020. (This amount being savings in recurrent spending over 15 years through the adoption of Option 1 or 2 of the EIA Study (long outfalls) in lieu of constructing and operating HATS 2A and 2B at some time in the future.)

The funding would be directed to;

1. The forming, with the Guangdong Provincial Authorities, a 'Regional Pearl River Delta Commission', suitably funded and with legal powers to administer and control water quality improvement throughout the catchment and delta.
2. Invest in significant, targeted programs and projects which will directly and permanently improve the water quality in the PRD. E.g. Support Best Management Practice (BMP), strong Incentive Programs in agriculture and Target Investments in municipal and industrial sewage treatment plants.

With concerted combined action as outlined in this paper, it will take about 5 years for the Hong Kong SAR Government and the Guangdong Provincial Authorities to halt the disturbing wet season trends in decreasing DO and increasing TIN.

By 2020 with all municipal and industrial wastewater treatment plants producing at least effluent quality C, together with best management practice fully established in the agricultural areas, it could be expected that the dissolved oxygen levels could be significantly raised to a depth average value approaching 6.0 mg/L and for < 2 metres 3.5 mg/L in the Southern and Oceanic waters and for the present level of TIN to be at least halved. These trends would continue for a number of years and plateau around 2035 if all parties remained vigilant.

The above indicative outcomes could be expected given the experience and remarkable success Hong Kong has had with the management of its industrial wastes and the successes in Australia where dairy effluent discharge to drains was more than halved in ten years due to BMP and incentive schemes following extensive blue-green algal blooms in major rivers and streams.

12. CONCLUSION

It is time for the Hong Kong SAR Government to;

1. Form, with the Guangdong Province a 'Regional Pearl River Delta Commission', suitably funded, with legal powers to administer and control water quality improvement throughout the catchment and delta and,
2. Commence, as soon as it is prudent, significant targeted investments in water quality measures in the catchment and delta to directly and permanently improve the water quality in the Pearl River.

13. APPENDIX

1. Brief history of the SSDS and milestones to the present day.
2. Artist's impression of the SSDS.
3. Water quality modelling results.
4. Calculations for Prediction Reductions.

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15. ACKNOWLEDGEMENTS

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APPENDIX 1 BRIEF HISTORY OF THE SSDS AND MILESTONES TO THE PRESENT DAY

Historically, the argument over whether to treat to a higher standard and discharge locally or disperse a poorer quality effluent through the greater dilution achieved by a long outfall, has been raging for decades; for this reason some background is offered. A brief history of the Strategic Sewage Disposal Scheme (SSDS) has been outlined by the authors in an earlier paper (Russell and Wong, 1999).

Red tides, algal blooms and eutrophication in Tolo Harbour led the Hong Kong Government's Environmental Protection Department (EPD) to commission consulting engineers, Watson Hawksley, to conduct a comprehensive sewage strategy study for Hong Kong including the New Territories and surrounding marine waters.

The Watson Hawkley 'Sewage Strategy Study' (SSS) October 1989 provided a milestone in the assessment of options, integration of known issues and the presentation of a recommended strategy. (EPD, 1989). The study addressed two key issues namely;

1. What water quality objectives should be set for Hong Kong's coastal waters and
2. How can these objectives be achieved?

The SSS, however, was not limited to "engineering solutions" and placed emphasis on long term planning of strategic solutions. The study in discussing 'The Need for a Strategy' stated,

> "A solution is therefore called for which will protect the sea's resources, solve existing pollution problems and yet respond to, and be sufficiently robust to accommodate, the rapid development programmes which are so characteristic of Hong Kong. Thus a flexible sewage strategy rather than a fixed sewage disposal Master Plan is required."

General recommendations for the SSS were the reinforcement of catchment interception schemes, control of agricultural wastes, industrial discharges and improvement of environmental awareness in planning. The recommendations were structured,

> "...so that measures could be taken immediately to gain maximum environmental benefit while retaining full flexibility for future action."...."Future Implementation – which requires decisions which can only be taken in the light of finding from ongoing planning studies."

The long term solution for the harbour area ,

> "....concluded that the final environmental standards can most reliably and most economically be achieved by combining a degree of land based sewage treatment with the natural self-purifying abilities of the ocean. The strategic conclusions are that this would be best accomplished by the collection of harbour area flows westward, treating and then discharging southwards through a long outfall into the major ocean currents off the Lema Channel. It is stressed the marine disposal of certain types of water borne wastes it to be considered unacceptable. These will therefore be removed prior to discharge and only the biodegradable, harmless or inert residual disposed to the ocean."

And,

> "....In the long term, when controls are effective, the process can revert to a single sedimentation but the chemical facilities will still provide an effective backup and means of reducing pathogens in the remote chance that the principal oceanic outfall should be ever out of commission."

The proposed implementation programme showed completion of the Kowloon System by 1994 and the Ocean Outfall System by 1997.

The SSS related the level and type of sewage treatment to the assimilative capacity of the receiving waters. The receiving waters were categorised into four water types: Oceanic Waters, Offshore Waters, Inshore Waters and Enclosed Waters with the degree of treatment (and cost) progressively increasing with each type. The Oceanic Waters was described as "..located to the south east and south of Hong Kong and never drawn into the estuary, providing a massive body of water..." i.e. the Lema Channel, where it was proposed the long deep sea outfall would discharge, where as, the Inshore Waters are "...generally delineated as waters within the 5 fathom mark and the shore. It is concluded that full biological treatment would be needed..." i.e. the location of the HATS 2B outfall.

In June 1991 consultants AB2H completed site investigations and engineering studies for stage 1 of the Strategic Sewage Disposal Scheme (SSDS). (DSD,1991) These studies were commissioned by the Drainage Services Department (DSD). Laboratory analyses and pilot plan trials were conducted in the selection of the optimum process for the partial removal of an estimated 5 tonnes of total toxic metals (TTM) which found its way into Victoria Harbour each day. Completion date for stage 1 was projected at mid 1996.

No public Environmental Impact Statement was undertaken for this project and it was not until 1993 that the SSDS was seriously open to public scrutiny. The prospect of creating the largest lime-dosing 'white elephant' in the world set Friends of the Earth and others on the course of questioning all aspects of the SSDS. Subsequent hearings and the establishment of an International Review Panel (IRP) abandoned lime dosing for Chemically Enhanced Primary Treatment (CEPT) for Stage 1 at Stonecutters Island with an undertaking of further studies to establish water quality objectives and the optimum for of secondary/tertiary treatment to meet these objectives.

In April 1995 the 'Review of the Strategic Sewage Disposal Scheme, Stage 2 Options, Main Report' was completed. (EPD,1995) The purpose of this review was to advise the EPD on the candidate Stage 2 Options and not to reach a conclusion on which was best. This work included significantly refined water quality modelling and was conducted in an atmosphere of increased public awareness in environmental matters and business interest of possible changes in mechanism for sewage cost recovery. The review acknowledged that the operation and maintenance costs, which varied substantially with the options, would be incurred after the transfer of sovereignty over Hong Kong. On the 30th June 1997 sovereignty over Hong Kong was transferred to the Peoples Republic of China with Hong Kong assuming the status of a Special Administrative Region. (SAR)

September 1998 saw the first Environmental Impact Assessment Study (EIAS) issued to the public by the EDP for this project. (EDP,1998a) This document set out a "Briefing Document on Optimum Evaluation and Comparison" for the SSDS. The document did not attempt to set or recommend Water Quality Objectives (WQO) but adopt a set of marine water quality criteria, derived from local and international experience, to provide a basis for comparison of sewage treatment and disposal options in deciding environmentally acceptable options; the definition and application of 'mixing zones' allowed for the environmental assimilative capacity of the water body as a whole, even where there would be a high degree of treatment it is expected the WQO's will not be achieved. Both Lema Channel scenarios 4a and 4b met all the criteria for CEPT. (Scenario 4b is Scenario 4a with disinfection.)

On the 22nd October 1998, the Advisory Council for the Environment (ACE) selected the long deep sea outfall, to the Lema Channel, with disinfection following Chemically Enhanced Primary Treatment (CEPT) with the proviso: to with-hold CEPT when the raw sewage was 'domestic', with minimal industrial pollution. This is similar to the Stage 1 recommendation in the SSDS outlined earlier in this paper. As a follow up to this meeting the EPD undertook to provide requested information which was outside the Environmental Impact Assessment Study which included the water pollution status in the Pearl River Delta and Deep Bay.

In January 2000 the SSDS Environmental Impact Assessment recommended the EIA Option 1 which is a slight variation on the 'original' SSDS. Option 1 proposed disinfection at Lamma Quarry and for the Stage 2 ocean outfall to consist of a deep tunnel about 7.5 km long connecting Lamma Island and the Lamma Island channel with the flexibility to upgrade treatment or extend the outfall in the future.

In November 2000 the IRP published its Review of the Strategic Sewage Disposal Scheme and stated that;

> **"The IRP is of the opinion that the discharge and dilution of the CEPT effluent into the waters south of Lamma Island or in the Lema Channel is neither a viable nor sustainable option."** and **"The IRP is aware that these statements rejecting the four EIA options and our subsequent recommendations represent a major departure from the recommendations of the EIA and from the Hong Kong's Government's position Paper on the SSDS of May, 2000.)"**.(EPD,2000)

In the authors opinion, the principal specific comment made by the IRP for rejecting the four EIA options was that of the risk of the carrying capacity being exceeded in the waters south of Lamma Island or in the Lema Channel. The IRP was particularly concerned for the future survival of marine life in an environment where there was and high background levels of nutrients eminating from the Pearl River Delta catchment in the wet season and low levels of dissolved oxygen.

In disagreeing with the EIA report which claimed the levels DO at the outfall were acceptable the IPR wrote,

> "It is important to note that the **current water quality objectives of the DO used in Hong Kong** (depth average of >4mg/L and bottom 2m > 2mg/L, 90% of time) **is the lowest in the world**....It is further noted that a single, low standard of DO is being applied for all BU's in Hong Kong, except for marine fish culture." (ibid, p. B-3) (This is the strongest argument yet for the Hong Kong Government to seek a regional solution to the pollution of the Pearl River Delta. To be discussed further in this paper. Authors note)

In refuting the EIA claim that "...nutrient removal is not required...since the TIN will only increase a small percentage with respect to the background (from 0.14 to 0.17mg/L)..."(ibid, p.B-5) the IRP wrote,

> "(a) Several studies have shown that the trigger level for algal blooms and red tides in the Hong Kong coastal waters is around 0.1mgN/L and 0.02mg-P/L(EPD, 1988, Hodgkiss & Ho, 1997). In southern waters, typical annual depth average TIN and TP is 0.15mg-TIN/L and 0.02mg TP/L respectively (Vol. 2, p. A2.9-16), and is therefore at the verge of eutrophication. Any further discharge

of nutrient will increase the chance of algal blooms.

"(b) Further increase in nutrient loading from the catchment from the Pearl River is possible in the future. This possible increase, together with the SSDS discharge, will pose a significant threat to the marine ecology system in the southern waters."(Ibid, p. B-5)

However, in a further paragraph the IRP wrote on the need for regional control of the high background levels of nutrients from the PRD,

"Although the SSDS aims at dealing with sewage disposal problems in Victoria Harbour and the surrounding waters, Hong Kong's marine water quality cannot be maintained at a sustainable level without considering the enormous pollution loading discharging from the Pearl River. It is well known that the hydrography in Hong Kong's western and southern waters is profoundly effected by the Pearl River outflow, especially in the wet season (Morton & Wu, 1975). In the EIA report, the influence of the Pearl River outflow on the water quality of southern waters is clearly exemplified by the high background level of nutrients. To curb the overall pollution loading entering coastal waters of Hong Kong, regional efforts and controls are absolutely essential."(ibid, p.B-5)

Further, in a response to the 'public expressions' the IRP proposed four components for future cooperation within the Pearl River watershed.

"(i) Exchange and discussion on the strategic plans for water pollution control in the Pearl River Delta and Hong Kong. Mutual understanding and coordination can be obtained by this activity.

(ii) Effective control of industry pollution in the Pearl River Delta through the efforts made by the partnership of Hong Kong businessmen and Guangdong Environmental Protection Bureau. Many small and medium scale enterprises in Guangdong Province are owned by Hong Kong enterprises.

(iii) For control of nitrogen and phosphorous pollution in both Pearl River Delta and Hong Harbour. Kong waters, non-point source control is very important for both sides.

(iv) Guangdong Province needs a large investment for engineering works for pollution control. It will be very helpful if Hong Kong can find ways of loaning or contributing financial resources." (ibid, p. 34)

(It is a pity the IRP's brief did not explicitly include a regional solution. Authors' note.)

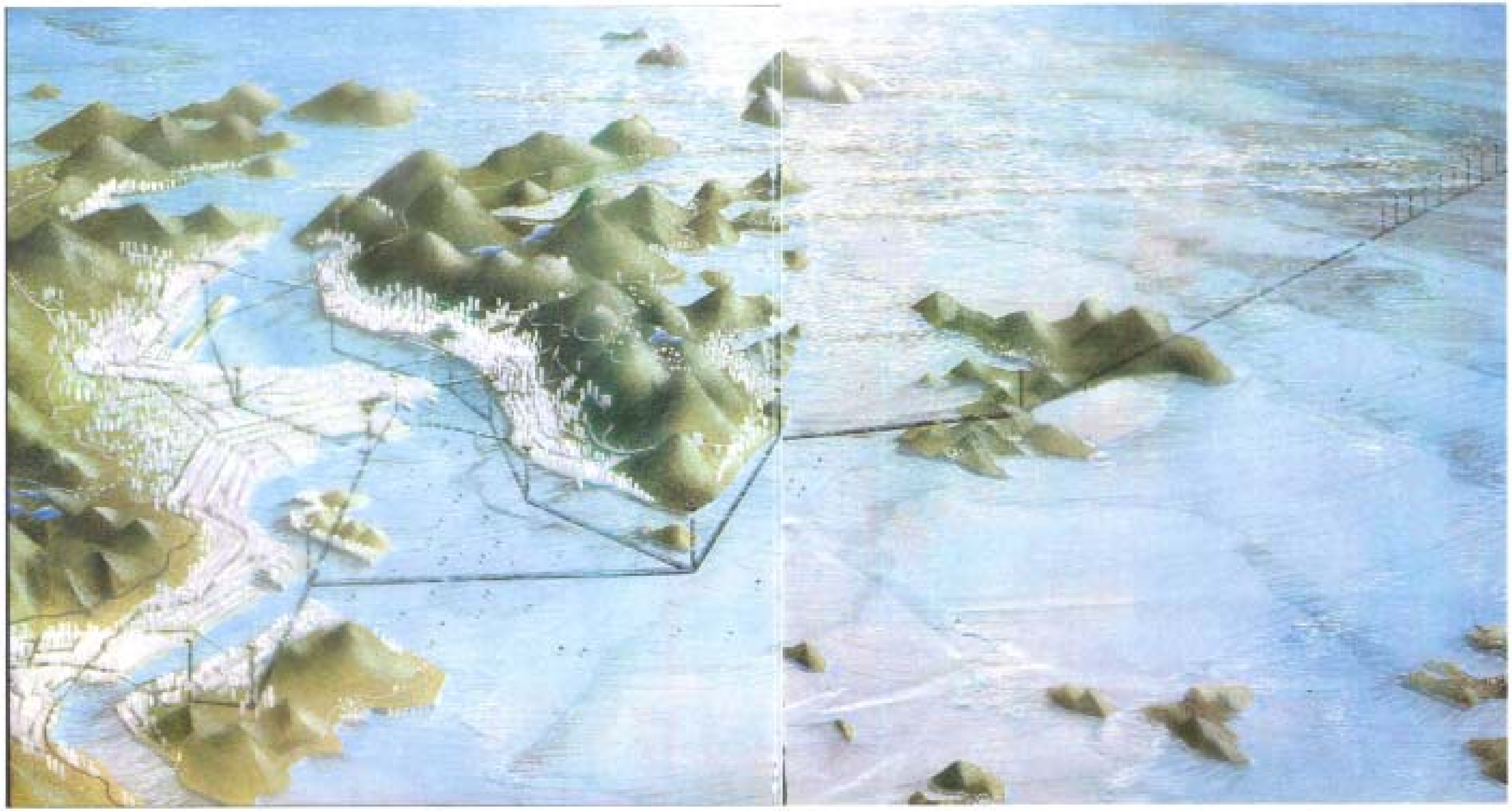
SUCCESS OF WASTE MINIMIZATION AND CLEANER PRODUCTION

The SSS October 1989 (EDP, 1998) recommendations included,

"legislation to control the quality of industrial wastes and to connect all sewage to the 'proper collection system." and
"enforcement of controls over what enters the environment, particularly from industry, restaurants, landfill sites and livestock farms."

Action by the EDP on these and the commissioning of the Chemical Waste Treatment Centre (CWTC) in 1993 resulted in the removal of over 90% of the total toxic metals (TTM's) in the raw sewage. (it should also be remembered that the spontaneous migration of many small Hong Kong 'dirty' businesses to Mainland China at that time contributed considerably to the TTM removal from the raw sewage flow.) It should be noted that by the year 2010 there should be approximately 95% reduction in TTM's. This will bring the waste to 'domestic' standard and so suitable for the long deep sea outfall.

The principles for waste minimization and cleaner production were applied in a substantive report, "Support to Industry on Environmental Matters, April 1993", commissioned by the Industry Department of Hong Kong Government. (Industry Department, 1993). This report offers a 'blueprint' for the support and so modernisation of industry enabling the environmental cost to be fully costed such that "Compliance and wealth generation are not, however, mutually exclusive." The EPD must be given every credit for the successful removal of recent and future TTM's from Hong Kong's marine waters. (It is important to remember that about 35000 tonnes of TTM's still lie in the sludges (benthic layer!) of Victoria Harbour.



APPENDIX 2 ARTISTS IMPRESSION OF THE STRATEGIC SEWAGE DISPOSAL SCHEME (SSDS) - HONG KONG HARBOUR

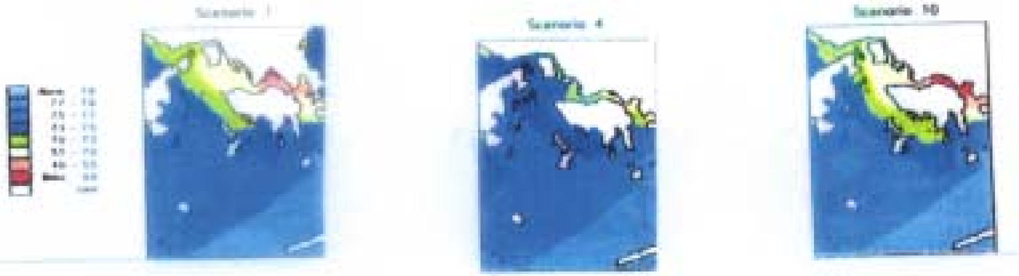
APPENDIX 3 WATER QUALITY MODELLING RESULTS

A COMPARISON [EPD, (1998a)]

LOCATION OF OUTFALLS

COMPARISON OF DISSOLVED OXYGEN

DRY



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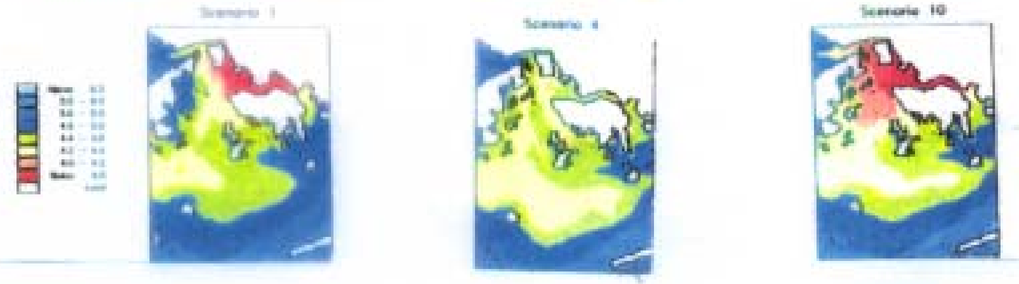
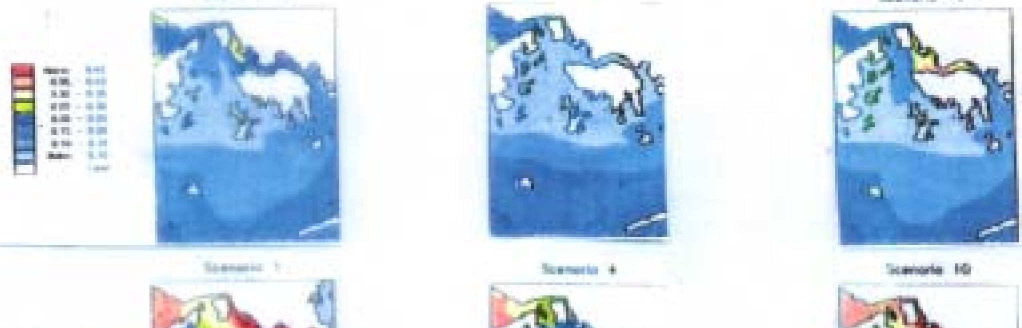


COMPARISON OF TOTAL INORGANIC NITROGEN

DRY



WET

APPENDIX 4 CALCULATIONS FOR PREDICTED IMPROVEMENTS IN WATER QUALITY IN THE SOUTHERN AND OCEANIC WATERS

Pearl River Oxygen in the Wet Season (6 months)

Pearl River annual Flow 333.8 billion m^3
Assume a dry: wet season flow 1:5.
Assume a wet season over 6 months.
Wet season discharge 278.2 billion m^3
The calculated amount of Oxygen at saturation ($7mgO_2/L$) in wet season is 1.95 million tonnes.

Estimated Biochemical Oxygen Demand (BOD) from all sources of Wastewater in the Pearl River Catchment for 1997.

Source of Wastewater	Pearl River Wastewater (80%/90% of Guangdong*) (Tonnes-x10000)		BOD Load Rate (mg/L) 6 months	BOD (Tonnes-x10000) 6 months	Removed BOD % 6 months	Removed BOD (Tonnes-x10000) 6 months	Remaining BOD (Tonnes-x10000) 6 months
	12months	6 months					
Municipal	234759	117380	400[E]	46.9	5[EE]	2.4	44.5
Industrial	112928	56464	800[E]	45.2	50[EE]	22.6	22.6
Total	347687	173844		92.1		25.0	67.1
Runoff (15%)[E] (Agriculture 10% and Urban 5%)		26077	400[E]	10.3	nil	nil	10.3
Total		2.58		102.4		25.0	77.4

* Guangdong Wastewater Total 4.19 billion tonnes per year. (Hopkinson & others, 1999)
Pearl River Wastewater estimated @ 80% total for Municipal Wastewater and 90% total for Industrial.
E Estimate
EE Estimate based on (Hopkinson and others, 1997)

Southern and Oceanic waters Dissolved Oxygen Content

Dry Season. Dissolved Oxygen appears unaffected. Depth average around 7.0 mg/L.
Wet Season Dissolved Oxygen affected. Depth average around 4.0 mg/L and for < 2m around 2.0 mg/L. **EPD** monitoring data. (EPD, 2004, p. B-4)