Legislative Council

Panel on Environmental Affairs

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Report of the Delegation to Study Overseas Experience in Sewage Treatment

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Volume I : Report

June 2001

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Chapter I Introduction

Background

1.1 Water pollution arising from the disposal of sewage into the coastal and inshore waters of Hong Kong has all along been the subject of major concern of the Legislative Council Panel on Environmental Affairs (the Panel). In 1989, the Environmental Protection Department completed the Sewage Strategy Study which recommended, among other things, the implementation of the four-staged Harbour Area Treatment Scheme (HATS) (formerly known as the Strategic Sewage Disposal Scheme) comprising the collection of sewage from the main urban area using deep tunnels, provision of primary treatment at a centralized sewage treatment plant and disposal of treated effluent into oceanic waters through a deep ocean outfall in south of Hong Kong.

1.2 The Panel has been closely monitoring the progress of HATS since its launch in 1994. From the outset, the Panel has expressed grave concern about the environmental and technical problems associated with the construction of deep tunnels, long-term levels of treatment as well as locations of treatment plant and outfall. HATS Stage I, comprising seven tunnels with a total length of 25 kilometres, has been beset with problems. The unilateral suspension of tunelling works by the contractor in mid-1996 has resulted in the forfeiture of the two original contracts and the re-tendering of three new contracts. The scheduled completion date for HATS Stage I has been deferred from mid-1997 to end of 2001.

1.3 Having regard to the public concern on the delay in HATS Stage I and the continued criticism of the preferred treatment level and of reliance on large treatment plants and discharge arrangements over the years, the Government has finally agreed to appoint a new International Review Panel (IRP) in April 2000 to re-examine subsequent stages of HATS taking into account the experience gained from HATS Stage I. In its report, IRP recommends that Hong Kong shall go for a higher level of wastewater treatment with a short and low dilution outfall, and that Biological Aerated Filters (BAF) treatment shall be provided to all HATS flows. According to IRP, BAF are one of the new, compact and space-saving technologies which have become a popular alternative to traditional sewage treatment systems because of its high-rate treatment characteristics, flexible operation, small footprint and zero-pollution. In determining the technical and economic viability of the options put forward by IRP, the Government has announced in March 2001 that it will undertake trials and studies before drawing conclusions on these options.

Overseas duty visit

1.4 To ascertain the viability of using BAF technology in Hong Kong, the Panel has decided at the meeting on 2 January 2001 that an overseas duty visit be conducted to understand overseas experience in sewage treatment. Given the limited time available, the Panel has decided that the delegation shall visit a number of prominent sewage treatment plants (STPs) using BAF technology in London, Herford, Cologne, Wiesbaden and Paris. Opportunity has also been taken for the delegation to visit a refuse incineration plant in Hamburg, a sewage disinfection technology company in Herford, an automotive technology company in Cologne and a research centre on fuel cell in Aachen to obtain first-hand information on the latest development in other aspects of environmental protection.

1.5 The delegation comprising the following members of the Panel has visited London, Hamburg, Herford, Cologne, Wiesbaden and Paris during the period from 4 to 12 April 2001:

Leader	:	Prof Honourable NG Ching-fai, Panel Chairman
Members	:	Ir Dr Honourable Raymond HO Chung-tai Honourable Tommy CHEUNG Yu-yan Honourable LAU Ping-cheung

At the request of the Administration and with the concurrence of the Panel, Mr HON Chi-keung, Chief Engineer of the Drainage Services Department, has accompanied the delegation to Europe to provide technical advice as and when necessary.

1.6 The itinerary of the overseas duty visit is detailed in Appendix I and a list of persons/organizations visited by the delegation during the tour is given in Appendix II.

The report

1.7 The report of the delegation comes in two volumes, with Volume I on the background, findings, observations and conclusions, and Volume II enclosing reference materials acquired from the visit and documents which the delegation has considered in drawing up its observations. To economize the use of paper, only Volume I is printed for distribution, Volume II is available for reference at the Legislative Council Library, and the list of documents contained in Volume II is given in Appendix III.

Chapter II Wastewater treatment process

2.1 In general, there are three levels of wastewater treatment:

- Primary wastewater treatment
- Secondary wastewater treatment
- Tertiary wastewater treatment

Primary wastewater treatment

2.2 In primary treatment, a portion of the suspended solids (SS) and organic matter is removed from the wastewater. This removal is usually accomplished with physical operations such as screening and sedimentation. Since the physical process will not be effective enough to remove organic matter which remain in suspension, the effluent from primary treatment will normally contain considerable organic matter and will retain a relatively high Biochemical Oxygen Demand [Note1]. An enhancement to the primary process can be effected by adding chemicals such as metal salts for more rapid precipitation of the pollutants in the wastewater.

Secondary wastewater treatment

2.3 Secondary treatment is principally directed towards the removal of biodegradable organics and SS. The process usually entails the use of biological treatment method in order to coagulate and convert the non-settleable colloidal solids into harmless gases that can escape to the atmosphere and into biological cell tissue that can be removed by settling. Conventional secondary treatment refers to a combination of processes customarily used for the removal of polluting constituents and includes biological treatment by suspended growth methods such as activated sludge or lagoon systems, or attached growth method such as and percolating filters or fixed-film reactors.

Tertiary wastewater treatment

2.4 Tertiary treatment is defined as the level of treatment required beyond conventional secondary treatment to remove constituents of concern, including nutrients, toxic compounds and remaining amount of organic matter and SS. For removal of nutrients, which are usually the main areas of concern after secondary treatment, this may be effected by biological, chemical or a combination of processes.

Note[1] Biochemical oxygen demand refers to the amount of oxygen required by micro-organisms in a given period of time to decompose the organic matter in a sample of wastewater.

For example, the nutrient removal processes can be coupled with the conventional secondary treatment by undertaking biological nitrification [Note 2] concurrently with the activated sludge process followed by biological denitrification [Note 3], or adding metal salts to the aeration tank mixed liquor for the precipitation of phosphorus in the final sedimentation tanks.

2.5 Until more recently, the predominant conventional secondary treatment options for sewage treatment has been the suspended growth activated sludge process. This requires final settlement and relatively large areas of land. However, in many parts of the world, increasing population has placed a premium on land use which requires the use of innovative technology to provide appropriate treatment in the space available. BAF have become a viable process for secondary sewage treatment on account of their high-rate treatment characteristics, flexible operation to cater for seasonal load variations, small footprint and zero-pollution.

2.6 BAF have been introduced in Europe during the late 1980s. Generically speaking, they contain a bed of granular or structured media in water. Process air is introduced at the base of the reactor via diffuser nozzles while sewage water is passed through the media. Certain biospecies in the sewage water will first form a "biofilm" which will attract pollutants whereby biological degradation under aerated condition takes place rather efficiently. The selected support medium normally has very large surface area to allow attachment of a high concentration of biomass — typically four times more than those found in conventional suspended growth systems, resulting in a much smaller volume requirement for the reactor. As the process combines biological degradation with filtration, a solid removal stage is no longer required thus further contributing towards the compactness of the technology. Moreover, BAF have been developed to include nitrification and denitrification in addition to BOD removal. Given that treatment and biomass separation are achieved in a single reactor, the process has the advantage of small land area requirement. The reactors are also compact enough to be totally enclosed inside a building or below ground for odour and noise control. Nowadays, BAF have been adopted in large full-scale STPs for a considerable range of applications from treatment of raw sewage, settled sewage, primary effluent to secondary effluent.

2.7 To ascertain the effectiveness of BAF as opposed to the conventional secondary treatment options, the delegation has also visited a number of STPs using the conventional activated sludge process in wastewater treatment.

Note[2] Nitrification refers to the process of converting the ammonia in wastewater into soluble nitrites or nitrates by biological actions of bacteria.

Note[3] Denitrification refers to the process of removing nitrogen or nitrogen compounds, including nitrite and nitrate nitrogen, from wastewater by biological actions of bacteria to convert the nitrogen compounds into nitrogen gas.

Chapter III Findings

London - Crossness STP

3.1 The plant is situated on the south bank of the River Thames. It treats an average daily flow of about 600 000 cubic metres (m^3) sewage from 1.6 million people equivalent in six boroughs in South London. The sewage is first screened before being pumped to the plant. The treatment process consists of grit removal, primary settling and secondary treatment by the activated sludge process using surface aeration. The sewage sludge is digested in the primary digestion tanks before displacing into the open secondary digestion tanks for storage prior to incineration. Gas produced by the sludge digestion plant is used to generate electrical power for use of the plant.

3.2 The focus of the plant is however on sludge incineration. Following the decision in 1990 to ban the disposal of sewage sludge to sea by 1998, incineration has been adopted since 1999 as the alternative to handle the enormous amount of sewage sludge produced. In the year 1999/2000, more than 37 800 tonnes of sludge were incinerated. Sludge incineration takes place in a fluidized bed incinerator to allow complete combustion of the sewage sludge. Flue gas leaving the waste heat boiler is dedusted using bag filter and scrubbed to remove pollutants, including dioxin, mercury and sulphur dioxide. The electrical power generated from incineration is either used in the incineration complex or exported for use at other facilities. The inert ash produced is sent to landfill.

Belt-press hall of Crossness sludge powered generator

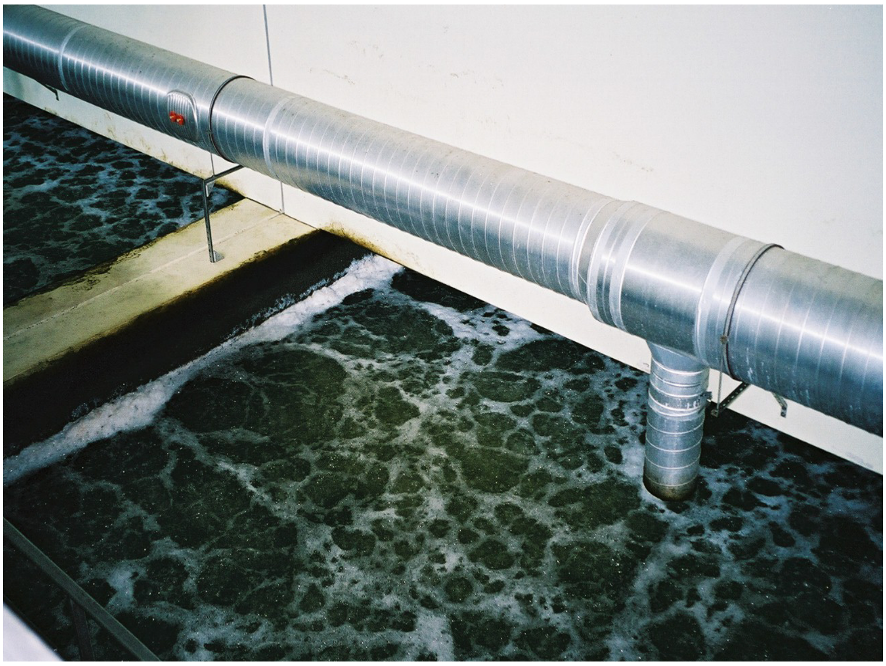
London - Mogden STP

3.3 The plant has a footprint of 40 hectares (ha) and is one of the largest STP in the United Kingdom. It treats an daily average of 450 000 m^3 and 810 000 m^3 sewage for dry-weather and wet-weather flows respectively from 1.8 million population equivalent in West London. It was built in 1933 and has been upgraded and expanded in 1936, 1962 and 1990. The treatment process consists of screening, grit removal, primary settling and secondary treatment by the activated sludge process. The sewage sludge produced which amounts to 22 000 m^3/week is digested and dewatered prior to off-site incineration. The 55 000 m^3/day of gas produced by the sludge digestion plant is used to generate electrical power for use of the plant.

Herford STP

3.4 The need for Herford STP arose when the existing facility was no longer able to meet the new requirements in respect of elimination of nitrogen or phosphorous nutrients. In order to comply with the new requirements, a new conventional plant with a tank capacity of at least six times greater than that of the existing one would have to be built. This would involve the purchase of some 10 ha of land which amounted to more than DM55 million. As such a proposal was considered not acceptable, an alternative STP of high performance and small footprint had to be worked out. Reference had been made to the use of BAF for wastewater treatment in France. It was found that a STP using BAF would only take up 15% of the land area required by an equivalent conventional treatment plant. As a result, Herford became the first municipality in Germany to adopt BAF in the public water-recycling services. The construction of the Herford STP commenced in 1994 and it only took four years for the works to complete, a much shorter time when compared with that of a conventional plant. In view of the proximity of the plant to residential area, all process stages of sewage treatment and sludge pretreatment were installed in one completely enclosed two-level building complex with a total floor area of 0.74 ha.

3.5 The plant is designed to treat an average daily flow of 33 000 m^3 sewage with a maximum hourly inlet of 2 200 m^3 and 4 400 m^3 for dry weather and wet weather respectively from 250 000 population equivalent. The design capacity has taken into account the high proportion of sewage from the industrial sector. The sewage is first screened and de-gritted before being pumped to the plant. The treatment process consists of a chemically enhanced primary treatment (CEPT) process with lamella settling and two stages of BAF for carbon and phosphorous removal, denitrification and nitrification. Ultraviolet (UV) lamps are also used for disinfection of part of the treated waste water for re-circulation in the treatment process. Sewage sludge is thickened before pumping to the old side of the plant and fed into the septic treatment plant where the sludge is allowed to rot fully before being partly used as agricultural compost.



Top view of the upward flow of BAF

Cologne - Stammheim STP

3.6 The plant has a capacity to treat sewage from 1.5 million population equivalent. It has been recently upgraded in 1992 to include a BAF process in addition to the conventional activated sludge process. The BAF process, which assists in nitrification and phosphorus removal, is used to improve the quality of effluent from the activated sludge process and to cater for seasonal load variations. Sewage sludge is thickened and digested in five enclosed egg-shaped digestors before pumping to the centrifuge unit for dewatering. Owing to the lack of sufficient land to operate an incineration plant, the dried sludge is taken to a brown coal power plant and used as a supplementary fuel for generating electricity.

Sludge digestors

Wiesbaden STP

3.7 This plant has just commenced operation in April 2001. It has a footprint of 1.5 ha and is located at the perimeter of a residential area. It treats an average daily flow of about 80 000 m^3 sewage from 156 000 people equivalent. The treatment process consists of grit removal, primary settling and BAF for nitrification and denitrification. Sewage sludge is thickened and dewatered before removal for off-site incineration.

BAF at work

Paris - Colombes STP

3.8 The Colombes STP was originally stemmed as an extension of the Acheres STP. The proposal was ruled out mainly because of strong local objection. Therefore, a new STP had to be built and the Colombes site was identified as a suitable site for this purpose. The proposed STP would need to cater for the seasonal effect on the self-cleaning capacity of the Seine River, the place where treated effluent is disposed of, particularly in summer when the flow can be as low as 60 m^3/second when compared with the discharges of 25 m^3/second of the Acheres STP. Moreover, the limited area of four ha of the site and its proximity to a densely populated area rendered it not possible to build a conventional STP which would require 20 ha of land to allow sufficient open space for final settlement. As such, BAF were adopted in the design of the Colombes STP. In addition, two sludge incinerators and flue gas scrubbers were also incorporated in the concealed building for absolute environmental protection with no sludge, smoke or odour to inconvenience residents. The construction works of the plant started in 1994 and completed in 1998.

3.9 This plant has a footprint of three ha. It treats an daily average of 240 000 m^3 and 1 200 000 m^3 sewage for dry-weather and wet-weather flows respectively from one million population equivalent. It incorporates a modified form of CEPT using microsand and lamella settling for SS and phosphorus removal. Three separate stages of BAF are applied for carbon removal, nitrification and denitrification. The biofilters can be operated in parallel or in series depending on the seasonal variation in the quantity of the influent flow. Completely enclosed for odour and noise control, the plant also performs full sludge treatment with incineration. Flue gas is dedusted, scrubbed, filtered and catalytically treated to remove sulphur oxides and nitrogen oxides.

Sludge incinerator

Paris - Archeres STP

3.10 The plant was first built in 1933 and has undergone four phases of expansion in 1940, 1966, 1972 and 1978. Being the largest STP in Europe using the conventional activated sludge process, it has a capacity of 1.94 million m^3/day with an additional 390 000 m^3/day in standby. In 1999, a physiochemical process using flocculant and coagulant with lamella settling has been included to perform primary treatment on the excess flow during rainfall (mixed sewage and storm water) for SS and BOD removal. It is claimed that the process can also be used to perform tertiary treatment after the conventional activated sludge process to treat the dry weather flow for SS, BOD and phosphorus removal. Sewage sludge is thickened and thermally conditioned.

A lamella plate at work

Paris - Dammarie-les-lys STP

3.11 The plant was completed in 1993. It has a footprint of 1.2 ha and treats an average daily flow of 24 000 m^3 from 120 000 population equivalent. It incorporates a CEPT process with lamella settling for phosphorus removal and a stage of BAF for carbon removal, denitrification and nitrification. Part of the facilities can be transformed for stormwater storage. Sewage sludge is thickened and dried by centrifugal dewatering followed by lime sanitization for agricultural reuse. Chemical scrubbing is used for odour treatment.

Grit removal facilities

3.12 Based on available information, a comparison table on some of the STPs visited is at Appendix IV.

Wedeco AG Water Technology

3.13 Noting the growing trend from chemical disinfection to physical biotechnology, the delegation has visited the Wedeco AG Water Technology where members received a briefing on the differences between the use of UV and chlorine/membrane filtration in the disinfection of wastewater. While appreciating that UV has the advantages of no by-products nor residual; no effect of odour; no re-growth of viruses, bacteria and parasites; no corrosion; no hazardous chemicals; no resistance as with chlorine and antibiotics; and no concentration nor sludge, the delegation remains concerned about the safety aspect of UV, particularly on the need for safety measures to protect the operatives working in the STPs.

The disinfection facilities in Herford STP

Rugenberger Damm Waste Incineration Plant

3.14 The delegation has also taken the opportunity to visit the Rugenberger Damm Waste Incineration Plant in Hamburg which adopts the latest technology in waste incineration. Members are generally impressed by the compactness and low emission performance of the plant, particularly in respect of dioxin emission. They also note that apart from energy, residues resulting from incineration are recycled and processed for further use within the plant as far as practicable. The delegation therefore holds the view that refuse incineration may be viable in Hong Kong if the latest technology is employed. Some operational details of the plant is at Appendix V.

The Rugenberger Damm Waste Incineration Plant

Chapter IV Observations

Land requirement

4.1 The delegation notes that the adoption of BAF technology in the STPs visited is either attributed to the non-availability of sufficient land as in the case of Herford STP or the infeasibility of further expansion of existing conventional plants as in the case of Colombes STP. Members consider that these two cases can provide useful reference for Hong Kong which is facing the same problem of shortage in land supply for sewage treatment. The latter case is of particular relevance to Hong Kong in considering the merits of centralization/decentralization of treatment process in the Stonecutters Island. While agreeing that a centralized system with all treatment modules housed in a single large treatment plant is more cost effective, some members express concern about the higher risk of breakdown, particularly of the pumping plant. In view of the small land requirement of treatment plants using BAF, members are generally in favour of a partially distributed system with three treatment plants at the Stonecutters Island, Lamma Island and Tseung Kwan O. This will not only provide room for further expansion to treat possible increases in sewage beyond 2021 but also flexibility of reserving more land for the provision of a sludge incineration facility for HATS.

Effluent quality

4.2 Members are impressed by the high quality of treated effluent using BAF which not only meets but in some areas surpasses the stringent statutory requirements. BAF also have the advantage of producing less sludge than the conventional activated sludge process. They however note that while BAF can be designed to treat different influent flow and to meet different standards in respect of effluent quality, some interviewed plant managers and consulting engineers have recommended pilot tests prior to dimensioning, design and construction of BAF in Hong Kong in view of the distinct nature of sewage in Hong Kong, which contains a high saline quantity as a result of the use of seawater for flushing. Water quality analysis to assess the assimilation capacity of the receiving water bodies shall also be conducted to determine whether processes such as nitrification/denitrification or disinfection are required if the treated effluent is to be discharged to the inner Victoria Harbour.

Sewage sludge

4.3 The delegation notes that at present, there are three main options for disposal of sewage sludge viz recycling to land as an agricultural fertilizer, landfill and incineration. However, the first two options are less preferred by most of the STPs concerned having regard to the serious impact on the existing road network arising from tank movements to landfill and the lack of available farmland within easy reach of STP for sludge disposal. Incineration, either done on site or off site, is therefore the most commonly adopted option. For those STPs which have on-site incineration facilities, the incinerators have to be equipped with flue gas treatment process to meet the stringent emission control imposed by the European Union in respect of harmful substances, including dioxins, sulphur oxides and nitrogen oxides.

4.4 Members also note that contrary to Hong Kong, the people in Europe generally accepts that incineration is a more environmental friendly way in the treatment of waste, including sewage sludge and municipal waste. During a meeting with the Environmental Panel of the Parliament of Hamburg, the delegation has been informed that the decision to adopt incineration in Hamburg has been made after extensive public consultation and repeated debates. Even the Green Party and the green groups have accepted that incineration is a better alternative over landfill which is a dubious practice from the ecological point of view.

Meeting with the Environmental Panel of the Parliament of Hamburg

Sewage charge

4.5 It is noted that people in the cities which the delegation has visited are more environmentally conscious of the need for sewage treatment and are willing to bear the cost incurs. Members also note that while the sewage charges of $5.8/m^3 in Paris and $15.66/m^3 in Cologne and Wiesbaden are higher than that of $1.2 in Hong Kong, the water consumption levels in these overseas cities are much lower than that in Hong Kong. As sewage charge is calculated according to the volume of effluent discharged, the higher the water consumption level, the higher the treatment cost and hence the higher the sewage charge. To reduce the treatment cost in Hong Kong, members consider that education should be stepped up to promote public awareness on the need to save water.

Privatization

4.6 The delegation notes that the water industry in the United Kingdom has undergone a process of privatization in 1989, during which 10 private water and sewerage companies and 29 private water only companies were created in England and Wales. These companies are licensed for 25 years and the licence conditions are performance-based. Members note that privatization has the advantages of fostering a customer-oriented service ethos and a transparent performance; providing major capital investment and medium-term incentive-based regime; as well as reducing staffing. They generally consider that privatization may also apply to sewage treatment in Hong Kong with a view to reducing the treatment cost.

Chapter V Conclusion

5.1 The delegation concurs in principle with IRP that that Hong Kong should go for a higher level of treatment for sewage from an environmental point of view, and that BAF technology is viable for Hong Kong on account of its compactness, small land requirement, high-rate treatment characteristics and flexible operation. However, pilot tests are strongly recommended prior to dimensioning, design and construction of BAF in Hong Kong in view of the distinct nature of sewage in Hong Kong, including the high salinity content as a result of the use of seawater for flushing. Water quality analysis shall also be conducted to assess the assimilation capacity of the receiving water bodies with a view to determining whether processes such as denitrification and disinfection are really required. While acknowledging that BAF units can be stacked up or built underground, the delegation holds the view that housing all the modules in a single large treatment plant will increase the risk of breakdown, particularly in respect of pumping. In view of the small land requirement of treatment plants using BAF, members consider that decentralization rather than centralization of treatment process in Stonecutters Island is more preferable to allow flexibility for further expansion to treat possible increases in sewage beyond 2021. In considering the merits of various tendering options for the treatment plants, the Government should have regard to factors such as financial viability, technical and contractual risks and operational efficiency. It should also explore the feasibility of privatizing the operation of the treatment plants to achieve further savings.

5.2 Given the lack of agricultural land and landfill for disposal of sewage sludge in Hong Kong, the delegation considers that incineration may be a possible way out given its popular usage in Europe. With the advancement in technology, flue gas generated from incineration can be treated not only to remove harmful substances such as dioxin and nitrogen oxides but also odour. In considering the feasibility of sludge incineration in Hong Kong, the Government should also explore how best the by-products such as energy and ash generated from incineration can be utilized. It may need to review the overall energy policy taking into account the imminent expiry of the franchise of Hong Kong Electric Company Limited and CLP Power Limited with a view to integrating the green energy generated from incineration.

5.3 As sewage treatment is costly, the delegation considers the best way to contain the treatment cost is to reduce pollution at source. To this end, members consider that education shall be stepped up to promote public awareness on environmental protection and the need to save water.

Chapter VI Acknowledgements

6.1 The delegation wishes to thank the Economic and Trade Offices of the Hong Kong Government in London and Brussels which have kindly assisted the delegation during their visits to London, Hamburg, Cologne and Paris. The delegation is deeply grateful to all persons and organizations, both in Hong Kong and overseas, for providing valuable information for the study. The delegation would also like to thank the staff of the Legislative Council Secretariat for their assistance in undertaking the study.

Legislative Council Secretariat
June 2001

Appendix I

LegCo Panel on Environmental Affairs

Itinerary for the Overseas Duty Visit
4 to 12 April 2001

4 Apr (Wed)	11.55 pm	departed for London
5 Apr (Thu)	5:45 am	arrived at London
	Morning	guided tour of the Crossness STP by Mr Brian PHELPS, Incineration Manager
	2:15 pm - 2:45 pm	presentation on SAFe Process - Biological Aerated Filter at the Mogden STP by Mr Alan SMITH
	2:45 pm - 4:00 pm	guided tour of the Mogden STP by Ms Shelly May
	6:30 pm	official dinner with the Economic and Trade Office in London
6 Apr (Fri)	12:40 pm	arrived at Hamburg from London
	2:30 pm - 4:00 pm	guided tour of the Rugenberger Damm Waste Incineration Plant by Ms Doris MENKE
	5:00 pm - 6:30 pm	meeting with Mrs Renate VOGEL, Chairwoman of the Environmental Panel of the Parliament of Hamburg, and representatives
	7:00 pm	official dinner with members of the Environmental Panel of the Parliament of Hamburg

7 Apr (Sat)	10:00 am	arrived at Herford by coach
	10:30 am - 11:45 am	guided tour of the Wedeco AG, a leading manufacturer in environmental technology, by Dr Helmut BENZ, Managing Director Asia
	12:00 noon	official lunch with the Wedeco AG
	2:00 pm	guided tour of the Herford STP by Mr Gerhard ALTEMEIER, Technical Director
	6:30 pm	arrived at Cologne by coach
8 Apr (Sun)	9:00 am - 12:00 noon	meeting with Mr Volker SCHNEIDER of the Bosch Company to receive briefing on the latest diesel automotive technology and state-of-the-art diesel
	12:30 pm - 2:30 pm	official lunch with the Bosch Company
	7:00 pm	official dinner with Mr Jorg HENNERKES, Deputy Minister for Transport in the Ministry of Economics, Energy and Transport of North Rhine Westphalia, and other representatives

9 Apr (Mon)	8:30 am - 10:00 am	guided tour of the Cologne-Stammheim STP by Mr Otto SCHAAF
	11:00 am - 12:00 noon	received a briefing on the latest development of fuel cell at the Ford Research Centre at Aachen by Mr Heninz KROSCH, Manager
	3:00 pm	guided tour of the Wiesbaden STP by Mr Bernd HOLZMANN
	0:30 am	arrived at Paris from Frankfurt
10 Apr (Mon)	9:30 am - 12:00 noon	guided tour of the Colombes STP by Mr Jean-Marie BRUN, Public Relations Director
	12:30 pm	official lunch with Mr Jean-Marie BRUN and other representatives
	2:30 pm - 4:30 pm	guided tour of the Acheres STP by Mr Jean-Marie BRUN
	8:30 pm	official dinner with Mr Francois LAMOISE, Director of the Division of the International Affairs in the Economic and International Affairs Department and Mr Jean-Marie BRUN
11 Apr (Tue)	9:00 am - 11:00 am	guided tour of the Dammarie-les-lys STP by Mr Jean-Marie BRUN
	2:05 pm	departed for Hong Kong

STP - Sewage Treatment Plant

Appendix II

List of persons/organizations visited by the delegation during the tour

Thursday, 5 April 2001

London

Department of Trade and Industry and Environment, Transport and the Regions

Ms Janet JENNINGS
Deputy Director
Joint Environmental Markets Unit

Crossness STP

Mr Brian PHELPS
Incineration Manager

Mr David TODD

Mr Mike FORDHAM

Mogden STP

Ms Shelly MAY

Thames Water International

Mr Jim MCGIVERN
Managing Director
International Business Development

Mr Allard M. NOOY
Regional Director
South China, Hong Kong, Taiwan

Mr Andy HARE
Client Relations Manager

Mr Alan SMITH
Innovation and Communication Manager

Hong Kong Economic and Trade Office

Mr FONG Ngai
Assistant Director-General

Mr Edmond HUNG
Investment Relations Officer

Trade Partners UK

Mr Alan MURRAY
Director
Asia Pacific

Hong Kong Trade Development Council

Mr Owen CHI
Director Europe

Environmental Services Association

Mr Dirk HAZELL
Chief Executive

Friday, 6 April 2001

Hamburg

Economic Development Corporation, North Rhine-Westphalia

Mr Willy STAHL
Director of China/South East Asia Division

Rugenbergen Damm Waste Incineration Plant

Ms Doris MENKE
Leiterin Überwachung

Babcock Borsig Power Environment GmbH

Mr Andreas SOEDER
Senior Sales Manager
Marketing & Business Development

Institute of Asian Affairs

Dr Margot SCHUELLER
Senior Research Fellow

Environmental Panel of the Parliament of Hamburg

Mrs Renate VOGEL
Chairwoman

Mr ENGELS
Mr BUGLER
Mr SCHERUELL
Mr SCHAEFFNER
Mr BUNBAUM
Members

Mr Frank FECHNER
Press spokesman

German Asia-Pacific Business Association

Dr Thomas STURM
Regional Manager

Saturday, 7 April 2001

Herford

Wedeco AG Water Technology

Dr Helmut BENZ
Managing Director Asia

Dr Andreas KOLCH
Vice President
Research & Development

Mr Michael BECKEMEYER
Sales Engineer
Far East

Herford STP

Mr Gerhard ALTEMEIER

Hydro Ingenieure GmbH

Mr Klaus ALT
General Manager

UCL Engineering Limited

Ms Tansy LAW
Director

Sunday, 8 April 2001

Cologne

Robert Bosch GmbH

Mr Andreas UNTERBERG
Diesel Fuel-Injection Technology
Application and Sales

Mr Volker SCHNEIDER
Diesel fuel Injection Equipment
Application and Sales Engineering

Mr Dinggui GAO
Diesel Fuel-Injection Technology
Sales and Application Engineering

Ministry of Economics, Energy and Transport, North Rhine-Westphalia

Mr Jorg HENNERKES
Deputy Minister for Transport

Economic Development Corporation, North Rhine-Westphalia

Dr Otmar BECKER
Project Manager

RAG Trading Asia Pacific Pte Ltd

Ms Silvia SIMON
Chief Representative

Babcock Borsig Power

Mr Klaus-Dieter STURM
Vice President
Sales and Marketing

Monday, 9 April 2001

Cologne

Stammheim STP

Mr Otto SCHAAF
Leiter Amt für Stadtentwässerung

Mr Ralf BRÖCKER
Amt für Stadtentwässerung

Aachen

Ford Forschungszentrum Aachen GmbH

Mr Heninz KROSCH
Manager
Alternative Powertrains and FFA Operations

Wiesbaden

Weisbaden STP

Mr Bernd HOLZMANN

J.F. Knauer Industrie-Elektronik

Mr Jochen KNAUER
Managing Director

Tuesday, 10 April 2001

Paris

French Trade Commission
Consulate General of France in Hong Kong

Ms Helene PLICH
Commercial Attache for Industrial Goods

Department of the Economic and International Affairs, Ministry of Public Works, Transportation and Housing

Mr Francois LAMOISE
Director of the Division of International Affairs

Mrs Emmanuelle FOURNIER
In charge of Eastern Europe and Central Asia

Vivendi Water

Mr Jean-Marie BRUN
Director
International Executive Delegate

Ms Jenny GLEIZES
Commercial Attache
Asia Pacific

Mr TIAN Phan Bai
Project Engineer
Vivendi Water

Wednesday, 11 April 2001

Paris

Directorate of Economic and International Affairs

Ms Gaétane TRACZ
Office of Exportation

Dammarie-les-lys STP

Mr Jean Louis MERLET
Director Técnico

Appendix III

List of reference materials acquired from the visit and documents which the delegation has considered in drawing up its observations

1. Metcalf & Eddy on Wastewater Engineering - Treatment Disposal Reuse
2. Fact sheets on Crossness Sewage Treatment Plant
3. Information on Crossness Sewage Treatment Plant
4. Explanatory Note on Biological Aerated Filter
5. Article on Biological Aerated Filter
6. Operating experiences with Biological Aerated Filer at Silchester Treatment Plant
7. Fact sheets on Mogden Sewage Treatment Plant
8. Information on Mogen Sewage Treatment Plant
9. Overview of privatization and regulatory regime and performances in United Kingdom
10. Notes for guided tour of Herford Sewage Treatment Plant
11. Information on Herford Sewage Treatment Plant
12. Adapting plants to the strict control of reject.
    A case study: the Herford Sewage Treatment Plant
13. CD Rom on Stammheim Sewage Treatment Plant
14. Schematic diagram of Stammheim Sewage Treatment Plant
15. The 1999-2001 Year Book of the German Association for wastewater
16. Information on Colombes Sewage Treatment Plant
17. Information on Colombes Sewage Treatment Plant
18. Publication on Colombes Sewage Treatment Plant
19. Information on Dammarie-les-lys Sewage Treatment Plant

20. Fact sheet on treatment of residual waters

21. Fact sheet on treatment of sewage and storm water

22. Fact sheet on sludge incineration

23. Fact sheet on fluidized-bed incineration of sewage sludge

24. Fact sheet on flameless sludge combustion

25. Fact sheet on odour treatment

26. Information on Rugenberger Damm Waste Incineration Plant

27. Information on wastewater disinfection with ultraviolet light

	Crossness STP	Herford STP	Cologne - Stammheim STP
Date of commencement of construction of plant	1994	1994	1987 (for the BAF process)
Date of completion of plant	1998	1998	1992
Capital cost	£65 million	99.5 million DM (VAT excluded)	
- Architecture	--	--	--
- civil works	--	41.9 million DM	172 million DM
- electrical and mechanical installation, including bio-filters if applicable	--	57.6 million DM	175 million DM
- sludge incineration facilities if applicable	--	--	--
Recurrent cost			
- operating cost	£2.1 million/annum	2.4 million DM/annum	] 24 million DM/annum
- maintenance cost	£0.7 million/annum	1.9 million DM/annum	]
- sludge disposal	--	--	10 million DM/annum
Footprint	4 896 m^2	7 400 m^2	Not available
Capacity	168 tonnes/day	33 000 m^3/day	Not available
Population equivalent	1.6 million	250 000	1.5 million
Sewage charges (separate from potable water charges)	£0.22/m^3	Not available	2.40 DM/m^3 (waste water) plus 2.15 DM/m^2 (covered surface)
Waste water treatment process line (please state the types of primary, secondary and tertiary treatment adopted as well as the media being used in the process)	bar screening, grit removal, primary sedimentation, secondary treatment by activated, sludge using surface aeration	● Pre-treatment (screening and grit removal) ● Chemical primary treatment with lamellar settling (suspended solids and phosphorus removal) ● Biological treatment using 2 stages of biofiltration for carbon removal, nitrification and denitrification	● Pre-treatment (screening and sand removal) ● Aeration with nitrification and denitrification followed by biofiltration for nitrification, denitrification and phosphorus removal

Influent vs effluent in terms of	Crossness STP Influent	Crossness STP Effluent	Crossness STP Statutory Requirements	Herford STP Influent	Herford STP Effluent	Herford STP Statutory Requirements	Cologne - Stammheim STP Influent	Cologne - Stammheim STP Effluent	Cologne - Stammheim STP Statutory Requirements
- Suspended solids	300 mg/l	10 mg/l	--	703 mg/l	20 mg/l	--	--	--	--
- Biochemical oxygen demand	200 mg/l	6 mg/l	25 mg/l	924 mg/l	15 mg/l	15 mg/l	330 mg/l	‹3 mg/l	15 mg/l
- total kjeldahl nitrogen	--	--	--	126 mg/l	--	--	63 mg/l	2.9 mg/l	--
- ammoniacal nitrogen	25 mg/l	4 mg/l	16 mg/l	--	3 mg/l	10 mg/l	37 mg/l	1.1 mg/l	10 mg/l]
- nitrite-nitrogen	--	--	--	--	--	--	--	‹0.05 mg/l	--] 18
- nitrate-nitrogen	--	--	--	--	--	--	--	6.1 mg/l	--]mg/l
- phosphorus	--	--	--	18 mg/l	0.8 mg/l	1 mg/l	8 mg/l	0.29 mg/l	1mg/l
- chemical Oxyen Demand	--	--	--	2,153 mg/l	65 mg/l	75 mg/l	--	--	--
- total nitrogen anorganic	--	--	--	--	15 mg/l	18 mg/l	--	--	--
- total nitrogen	--	--	--	--	--	--	--	--	--

	Crossness STP			**Herford**			**Cologne-Stammheim STP**		
Sludge treatment process line				• Thickening of primary sludge before pumping into septic tanks of the old sewage plant			• Thickening of primary sludge in 5 egg-shape containers • Dewatering by centrifugation (down to 35% of original volume)		
	Before treatment	After treatment	Statutory requirements	Before treatment	After treatment	Statutory requirements	Before treatment	After treatment	Statutory requirements
Content of fumes generated by sludge incineration									
- carbon dioxide	not available	--							
- dust (mg/Nm^3)	not available	10			no incineration			off-site incineration	
- chlorine compounds (mg/Nm^3)	not available	10							
- sulphur oxides (mg/Nm^3)	not available	200							
- nitrogen oxides (mg/Nm^3)	not available	400							
- mercury (mg/Nm^3)	not available	0.05							
- cadmium (mg/Nm^3)	not available	0.05							
- total organics (mg/Nm^3)	not available	20							
- dioxins (mg/Nm^3)	not available	0.1							
- carbon monoxide	not available	100							
Odour treatment process line (please state the types of scrubbing adopted and the capacity)	N/A			Odour treatment by chemical scrubbing			N/A		

VAT: Value Added Tax

N/A: not applicable

1 DM = 3.6 HKD

1 FRF = 1.07 HKD

1 GBP (£) = 11.31 HKD

	Wiesbaden STP	Colombes STP	Acheres STP	Dammarie-les-lys STP
Date of commencement of construction of plant	1999	1994	1997 (for the physiochemical process only)	1990
Date of completion of plant	2001	1998	1999	1993
Capital cost - Architecture - civil works - electrical and mechanical installation, including bio-filters if applicable - sludge incineration facilities if applicable	 19 million DM 24.1 million DM on design	 1 million FRF (VAT excluded) 885 million FRF (VAT excluded)]] 1,309 million FRF (VAT excluded)]	 -- 220 million FRF (VAT excluded) 245 million FRF (VAT excluded) --	 -- 64 million FRF (VAT excluded) 96 million FRF (VAT excluded) --
Recurrent cost - operating cost - maintenance cost - sludge disposal	15 million DM/annum -- -- --	 -- --	 -- -- --	-- -- --
Footprint	15 000 m^2	30 000 m^2	9 600 m^2	12 000 m^2
Capacity	80 000 m^3/day	240 000 m^3/day (dry flow) to 1 200 000 m^3/day (wet flow)	1.94 million m^3/day An additional 390 000 m^3/day in standby	24 000 m^3/day
Population equivalent	156 000	1 million	N/A	120 000
Sewage charges (separate from potable water charges)	4.15 DM	5.4 FRF/m^3 in Paris region, including sewer maintenance and sewage treatment	5.4 FRF/m^3 in Paris region, including sewer maintenance and sewage treatment	5.4 FRF/m^3 in Paris region, including sewer maintenance and sewage treatment
Waste water treatment process line (please state the types of primary, secondary and tertiary treatment adopted as well as the media being used in the process)	4 screens, 2 grit chambers with grease chamber, 2 primary settling tanks, storage tank 12 predenitrification filters, 12 nitrification tanks, 8 secondary denitrification and suspended filters	● Pre-treatment (screening, sand/grease removal) ● Physical chemical primary treatment with lamellar settling (suspended solids and phosphorus removal) ● Biological treatment using 3 stages of biofiltration operating in parallel or in series depending on the flow, for carbon removal, nitrification, and denitrification	Chemical addition (flocculant and coagulant), rapid mixing, and lamella settling	● Pre-treatment ● Excess stormwater storage ● Chemically enhanced lamellar settling with phosphorus removal ● Biofiltration for carbon removal, nitrification and denitrification

Influent vs effluent in terms of	Wiesbaden STP Influent	Wiesbaden STP Effluent	Wiesbaden STP Statutory Requirements	Colombes STP Influent	Colombes STP Effluent	Colombes STP Statutory Requirements Sewage quality during dry weather flow (24 hr composite sample, 95% of the time)
- Suspended solids	10.9 t/d	‹8 mg/l	--	250 mg/l	20 mg/l	35 mg/l or removal higher than 90%
- Biochemical oxygen demand	9.4 t/d	10 mg/l	15 mg/l	220 mg/l	25 mg/l	25 mg/l or removal higher than 80%
- total kjeldahl nitrogen	1.7 t/d	10 mg/l	--	45 mg/l	7 mg/l	--
- ammoniacal nitrogen	1.2 t/d	1 mg/l	10 mg/l	30 mg/l	--	--
- nitrite-nitrogen	--	‹1 mg/l	--	--	--	--
- nitrate-nitrogen	--	7 mg/l	--	--	--	--
- phosphorus	0.25 t/d	0.8 mg/l	1 mg/l	6 mg/l	1 mg/l	1 mg/l or removal higher than 80%
- chemical Oxyen Demand	18.8 t/d	50 mg/l	75 mg/l	--	--	--
- total nitrogen anorganic	--	--	18 mg/l	--	--	--
- total nitrogen	--	--	--	Not available	10	10 or removal higher than 70%

Influent vs effluent in terms of	Acheres STP Influent *rainfall*	 *dry weather*	Acheres STP Effluent *rainfall*	 *dry weather*	Acheres STP Statutory Requirements *rainfall*	 *dry weather*	Dammarie-les-lys STP Influent	Dammarie-les-lys STP Effluent	Dammarie-les-lys STP Statutory Requirements 2hr sample	 24 hr sample
- Suspended solids	250 - 300 mg/l	30 mg/l	80% removal	60% removal or less than 12mg/l	--	30 mg/l	210 mg/l	5 mg/l	30 mg/l	30 mg/l
- Biochemical oxygen demand	250 mg/l	20-25 mg/l	80% removal	20 mg/l	--	20 mg/l	167 mg/l	6 mg/l	30 mg/l	25 mg/l
- total kjeldahl nitrogen	N/A	N/A	N/A	N/A	--	--	Not available	6 mg/l	15 mg/l	10 mg/l
- ammoniacal nitrogen	N/A	N/A	N/A	N/A	--	--	--	--	--	--
- nitrite-nitrogen	N/A	N/A	N/A	N/A	--	--	--	--	--	--
- nitrate-nitrogen	N/A	N/A	N/A	N/A	--	--	--	--	--	--
- phosphorus	N/A	5	N/A	60% removal or less than 2mg/l	--	60% removal or less than 2mg/l	15 mg/l	2 mg/l	80% removal	80% removal
- chemical Oxyen Demand	--	--	--	--	--	--	--	--	--	--
- total nitrogen anorganic	--	--	--	--	--	--	--	--	--	--
- total nitrogen	--	--	--	--	--	--	34	11	20	15

	Wiesbaden STP			Colombes STP			Acheres STP			Dammarie-les-lys STP		
Sludge treatment process line	● Thickening of primary sludge ● Dewatering			● Thickening by flotation of sludge from biofilters ● Total sludge dewatering by centrifugation (down to 1/10 of original volume) ● Incineration with grease. As a standby: sanitization, stabilization, and agricultural reuse Incineration includes heat recovery and fume treatment by dedusting, scrubbing, filtering, and catalytic treatment to meet the highest European standards, resulting in removal of sulphur oxides and nitrogen oxides			As part of Archeres STP sludge treatment line			● Thickening of primary sludge (4 to 10 times) ● Floatation of biological sludge ● Dewatering by centrifugation ● Lime sanitization for agricultural reuse		
Content of fumes generated by sludge incineration	Before treatment	After treatment	Statutory requirements	Before treatment	After treatment	Statutory requirements	Before treatment	After treatment	Statutory requirements	Before treatment	After treatment	Statutory requirements
- carbon dioxide				Not available	40	50						
- dust (mg/Nm^3)				Not available	5	5						
- chlorine compounds (mg/Nm^3)		off-site incineration		Not available	5	10		N/A			no incineration	
- sulphur oxides (mg/Nm^3)				Not available	20	40						
- nitrogen oxides (mg/Nm^3)				Not available	70	70						
- mercury (mg/Nm^3)				Not available	0.05	0.2						
- cadmium (mg/Nm^3)				Not available	0.05	0.2						
- total organics (mg/Nm^3)				Not available	Not detectable	10						
- dioxins (mg/Nm^3)				Not available	0.1	0.1						
Odour treatment process line (please state the types of scrubbing adopted and the capacity)	timber. Air capacity: 45 000 m^3/hr			Odor treatment (600 000 Nm^3/hr) by chemical scrubbing (acid, sodium hypochlorite, sodium hydroxide, thiosulphatc)			N/A			Chemical scrubbing using an acid scrubber, a base oxidizing scrubber, and a base oxidizing scrubber. Capacity: 74 000 Nm^3/hr		

VAT: Value Added Tax

N/A: not applicable

1 DM = 3.6 HKD

1 FRF = 1.07 HKD

1 GBP (£) = 11.31 HKD

	Rugenberger Damm Waste Incineration Plant	
Date of commencement of construction of plant	1996	
Date of completion of plant	1999	
Capital cost - civil works - electrical and mechanical installation - engineering, licensing, etc	 60 million DM 110 million DM 30 million DM	
Recurrent cost - operational and maintenance costs	 25 million DM/annum	
Footprint	--	
Capacity	320 000 tonnes/annum	
Population equivalent	approx. 1 million	
Refuse charges	approx. 100 DM/tonne	
Incineration process line	2 units	
Content of fumes	<u>Emission</u>	Statutory <u>requirements</u>
- Carbon dioxide	approx 12%	--
- Dust	0.4 mg/m^3	3 mg/m^3
- Chlorine compounds	0.1 mg/m^3	3 mg/m^3
- Sulphur oxides	2.4 mg/m^3	15 mg/m^3
- Nitrogen oxides	82 mg/m^3	100 mg/m^3
- Mercury	0.0005 mg/m^3	0.02 mg/m^3
- Cadmium	0.0006 mg/m^3	0.002 mg/m^3
- total organics	0.5 mg/m^3	8 mg/m^3
- dioxins	0.0023 mg/m^3	0.05 mg/m^3
Odour treatment process line (please state the types of scrubbing adopted and the capacity)	No odour treatment is required. The air in the waste bunker is used as primary air for combustion.	
Operation problems encountered and how these were resolved	No serious problems have been encountered due to good planning at the start-up stage. Last year, time availability already surpassed 90%.	
Disposal of by-products from incineration	Less than 1% of the waste input (by weight) has to be disposed of. All other by-products generated from incineration such as flue gas, slag, gypsum, hydrochloric acid and boiler fly ash can be reused.	