For discussion on
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Legislative Council Panel on Environmental Affairs

Draft Hong Kong Implementation Plan under the Stockholm Convention on Persistent Organic Pollutants

INTRODUCTION

This paper seeks Members' views on the draft Hong Kong Implementation Plan (HKIP) that we need to submit to the Central People's Government (CPG) in April 2006 in relation to the Stockholm Convention on Persistent Organic Pollutants (POPs).

BACKGROUND

2. The Stockholm Convention is a global treaty to protect human health and the environment from POPs, i.e. chemicals that remain intact in the environment for long periods, move long distances in the global environment, accumulate in the fatty tissue of living organisms and are toxic to humans and the wildlife. At present, the Stockholm Convention controls 12 POPs including pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene (HCB), mirex and toxaphene), industrial chemicals (HCB and polychlorinated biphenyls (PCBs)) and unintentionally produced by-products (polychlorinated dibenzo-p-dioxins/polychlorinated dibenzofurans (dioxins/furans). In implementing the Stockholm Convention, governments will take measures to eliminate or reduce the release of POPs into the environment.

3. The Stockholm Convention became effective to the People's Republic of China (PRC) (including the Hong Kong Special Administrative Region (HKSAR)) on 11 November 2004. Under the Convention, the CPG needs to submit a National Implementation Plan, which includes the HKIP, to the Conference of the Parties of the Stockholm Convention in November 2006. We are working on the basis that the HKIP should be submitted to the CPG in April 2006.

Draft Hong Kong Implementation Plan

4. We have conducted a thorough review on current POPs issues in Hong Kong. The overall assessment of the current POPs pollution in Hong Kong's environment is as follows –

(a) On a "per capita" basis, the current (2003) annual dioxin/furan release in Hong Kong was generally similar to that of Asian countries, Canada, the US and Australia, and was the 2nd lowest in air emission.

(b) The level of POPs contamination in the local environment (ambient air, marine water, marine sediment, marine fish and shellfish) was generally comparable to the range reported in most other urban locations in Asia Pacific, Europe, the US and Australia.

(c) Assessment based on available data indicated that overall, there was unlikely to be any ecological risk of toxicological significance associated with exposure of local marine life to the current level of POPs contamination in the marine environment of Hong Kong.

(d) Total daily exposure of local residents to dioxins/furans was estimated to be 0.927 pg TEQ/kg bw/day[1], a value falling at the lower end of the World Health Organization's Tolerable Daily Intake of 1-4 pg TEQ/kg bw/day. Dietary intake was the major route, accounting for 98.2% of total exposure of local residents to dioxins/furans.

(e) Results of human health risk assessment indicated that there was no inhalation nor dietary chronic/carcinogenic risk of toxicological concern associated with a lifetime exposure of Hong Kong residents to current levels of POPs contamination in the local environment and locally consumed foods.

(f) Levels of POPs in local marine biota were found to be well below national and overseas Food Safety Standards/Action Levels of the Mainland, the US and the EC.

[1] picogram Toxicity equivalents per kilogram body weight per day

5. We have also identified action items in order for the HKSAR to comply with the Stockholm Convention. On the strengthening of the institutional and regulatory systems, we intend to introduce the Hazardous Chemicals Control Bill in 2006 to control and regulate the import, export, manufacture and use of non-pesticide hazardous chemicals that impose potentially harmful or adverse effects on human health or the environment, including those that are subject to the Stockholm Convention or the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade[2].

6. The Bill prohibits the import, export, manufacture or use of non-pesticide hazardous chemicals, except in accordance with an activity-based permit. The Environmental Protection Department is responsible for processing applications for the issue and renewal of such permits and related matters. Non-pesticide hazardous chemicals to be controlled under the Bill are listed in two schedules to the Bill, as follows -

(a) <u>Schedule 1 Chemicals</u>

Item	**Chemical**	**CAS Registry Number**
1.	Hexachlorobenzene (HCB)	118-74-1
2.	Polychlorinated biphenyls (PCB)	1336-36-3

[2] The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade aims to promote shared responsibility and cooperative efforts among the contracting parties in the international trade of certain hazardous chemicals and pesticides in order to protect human health and the environment from potential harm. The Convention has introduced a mandatory PIC Procedure to monitor and control the import and export of certain hazardous chemicals and disseminate national importing decisions to the contracting parties. The Convention was adopted at the Diplomatic Conference held in Rotterdam on 10 September 1998. It entered into force on 24 February 2004, on the 90th day of deposition of the 50th instrument of ratification. The Convention has become applicable to the PRC since 20 June 2005. The Convention will not apply to the HKSAR until further notice. The Rotterdam PIC procedure applies to 24 pesticides, 4 severely hazardous pesticide formulations and 11 industrial chemicals.

(b) Schedule 2 Chemicals

Item	Chemical	CAS Registry Number
1.	Asbestos - (a) actinolite; (b) anthophyllite; (c) amosite; (d) crocidolite; and (e) tremolite.	77536-66-4 77536-67-5 12172-73-5 12001-28-4 77536-68-6
2.	Polybrominated biphenyls (PBB) – (a) hexabrominated biphenyl; (b) octabrominated biphenyl; and (c) decabrominated biphenyl.	36355-01-8 27858-07-7 13654-09-6
3.	Polychlorinated terphenyls (PCT)	61788-33-8
4.	Tetraethyl lead	78-00-2
5.	Tetramethyl lead	75-74-1
6.	Tris (2,3 dibromopropyl) phosphate	126-72-7

7. The proposed prohibitions are as follows -

(a) The manufacture of any Schedule 1 chemicals shall be prohibited except for use in laboratory-scale research or as a reference standard, in which case a permit shall be required.

(b) A permit shall be required for the import into Hong Kong, export from Hong Kong or use of any Schedule 1 chemical.

(c) A permit shall be required for the import into Hong Kong, export from Hong Kong, manufacture or use of any Schedule 2 chemical.

Each permitted activity (i.e. import, export, manufacture or use) will be specified in a permit which is valid for 12 months.

8. When non-pesticide hazardous chemicals enter or leave Hong Kong, they also need to be covered by an import/export licence issued under the consignment-based licensing system under the Import and Export Ordinance (Cap 60), in the same way as pesticides which are controlled under the Pesticides Ordinance (Cap 133) (administered by the Agriculture, Fisheries and Conservation Department) and the Import and Export Ordinance (Cap 60). For the purpose of complying with the Stockholm Convention, we need to put in place an effective import/export regulatory system for non-pesticide hazardous chemicals, including those that are in transit. In this regard, the Import and Export (General) Regulations (Cap 60A) will be amended as part of the Bill. Authority will be delegated under the Import and Export Ordinance (Cap 60) to the Director of Environmental Protection and his staff so that they can deal with the issue of licences and imposition of conditions.

9. On the validation and refinement of the POPs inventories, we consider it vital that the inventories are robust and reliable. A number of proposed action items have been identified to address data gaps in source inventories on POPs, environmental levels of POPs, dietary exposure to POPs, and human body burden of POPs.

10. On measures to reduce emission of unintentionally produced POPs, i.e. dioxins/furans, we are pursuing various measures as part of the HKSARG's environmental portfolio in accordance with the established timetable. These measures address emission of dioxin/furans to air, emission of dioxins/furans to the marine environment, and integrated environmental waste management.

11. On public awareness, we have proposed action items to raise the local awareness of POPs-related issues.

12. On regional collaboration with the Mainland, Hong Kong is significantly influenced by the movement of toxic pollutants, POPs in particular, within the Pearl River Delta region via both the atmospheric and water pathways. In this regard, we have proposed action items to strengthen such collaboration.

13. Details are set out in the draft HKIP at the Annex.

PUBLIC CONSULTATION

14. An initial survey conducted by EPD in early 2005 indicates little current trading and/or domestic use of the chemicals covered by the Stockholm Convention in Hong Kong. We held a stakeholder consultation workshop on the preparation of the draft HKIP on 18 November 2005. In gist, the stakeholders appreciated the quality of the work that underpinned the preparation of the draft HKIP, and considered that the Government should focus on (a) improving the routine food surveillance programme and assessing the dietary exposure of the local population to POPs; (b) strengthening regional collaboration with the Mainland on the POPs front; and (c) facilitating capacity building by working with the local academics. We will also consult the Advisory Council on the Environment in March on the draft HKIP. Separately on the Hazardous Chemicals Control Bill, we will be consulting the relevant trade and stakeholders before finalizing the Bill for introduction into the Legislative Council.

Environmental Protection Department
February 2006

1. INTRODUCTION

Persistent organic pollutants (POPs) are organochlorine compounds that persist in the environment, bio-accumulate and bio-magnify through the food chain. Their movement within environmental compartments and long-range transport often result in serious threat to the environment and human population around, and also distant from their original point of release. The United Nations Environment Programme (UNEP) has identified an initial set of 12 POPs to be targeted for global restriction of production/use and, where possible, ultimate elimination under the Stockholm Convention (the Convention). The 12 POPs include pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene (HCB), mirex and toxaphene), industrial chemicals (HCB and polychlorinated biphenyls (PCBs)), and unintentionally produced by-products, i.e., dioxins (polychlorinated dibenzo-*p*-dioxins (PCDDs)) and furans (polychlorinated dibenzofurans (PCDFs)).

The Convention was adopted in Stockholm on May 22, 2001 and entered into force on May 17, 2004. The Convention became effective to the People's Republic of China (PRC), including the Hong Kong Special Administrative Region (HKSAR), on November 11, 2004. According to the work plan, the HKSAR is to develop a Hong Kong Implementation Plan (HKIP) which will form part of the PRC's National Implementation Plan (NIP) to be submitted to the Conference of the Parties of the Stockholm Convention in November 2006.

The POPs Unit of the Environmental Protection Department (EPD) of the Government of the HKSAR (HKSARG) is responsible for preparing the draft HKIP, working on new legislation to control non-pesticide hazardous chemicals, and coordinating matters relating to the implementation of the Convention in the HKSAR. Preparation of the draft HKIP and an inventory of POPs in Hong Kong are described in Annexes 1 and 2, respectively. Stakeholder consultation is an important process in the preparation of the draft HKIP. Details of a stakeholder consultation workshop convened to seek views from relevant stakeholders on POPs-related issues in Hong Kong are presented in Annex 5.

2. THE HKSAR BASELINE

2.1 The HKSAR Basic Profile

The HKSAR is situated in the Pearl River Delta (PRD) at the south-eastern tip of Mainland China. It has a total area of 1,104 km^2, comprising Hong Kong Island, the Kowloon Peninsula, the New Territories and 262 outlying islands. Hong Kong's climate is sub-tropical.

Hong Kong has one of the finest deep-water ports in the world and is a well established international financial, trading and business hub. It is widely recognized as the world's freest economy (Heritage Foundation's 2005 Index of Economic Freedom) and one of the most competitive economies in the world (ranked 2nd by International Institute for Management Development in its World Competitiveness Yearbook 2005). Over the past few decades, there has been a structural transformation of the Hong Kong economy from manufacturing to service orientation. The local industrial activities have shrunk to a substantial extent in both variety and size as manufacturing enterprises have progressively relocated their production lines to the Mainland. On the other hand, trading and logistics, finance and banking, tourism, and a wide range of business services are becoming more important.

With a population of 6.9 million, Hong Kong is one of the world's most densely populated cities (6,380 persons per km^2 according to the 2004 data of the Census and Statistics Department). Over the years, Hong Kong has developed an efficient wholesale and retail network to cater for the growing consumption needs of a more affluent population.

The dense population coupled with a high level of dynamic economic activities has exerted intense pressure on Hong Kong's environment. This is further compounded by the effects of immense economic growth in the PRD, one of the fastest developing regions in the world. Since the 1980s, the HKSARG has been implementing various plans and programmes to meet the local environmental challenges. Pollution by toxic substances including POPs is a relatively new area of focus in Hong Kong, but one that has received increased attention in recent years. Programmes for monitoring air and water toxic pollutants have been established to assess background pollution and to better safeguard the environment and human health.

2.2 Environmental Policies and Legislative Framework for POPs Control and Management

2.2.1 Legislative Framework on POPs Control

In implementing the Stockholm Convention, Parties will take measures to control/restrict the import, export, domestic production and use of intentionally produced POPs (pesticides and industrial chemicals), to reduce and where possible to ultimately eliminate the production and release of unintentional POPs (dioxins/furans) from anthropogenic sources to the environment, and to impose proper handling and disposal of POPs-containing wastes.

2.2.1.1 Pesticides

The pesticides are controlled under the Pesticides Ordinance (Cap 133) administered by the Agriculture, Fisheries and Conservation Department (AFCD) under the Health, Welfare and Food Bureau (HWFB). The import, manufacture, supply and retail of pesticides in Hong Kong are regulated by a licensing/permit system. In addition, all pesticides entering/leaving Hong Kong are required to be covered by an import/export licence issued under the Import and Export Ordinance (Cap 60) which, however, does not apply to pesticides that are in air transhipment cargoes and pesticides in transit.

2.2.1.2 Hazardous Chemicals

Control of hazardous chemicals is within the ambit of environmental policies administered by the Environmental Protection Department (EPD) under the Environment, Transport and Works

Bureau (ETWB). Legislation and licensing are the major regulatory instruments. A number of environmental ordinances are now in place to deal with the control of air and water pollution and waste handling and disposal. They cover a wide range of chemicals which include hazardous chemicals. However, there is no single piece of environmental legislation dedicated to the control and regulation of the import, export, domestic production and use of hazardous chemicals in Hong Kong. Relevant key environmental legislation includes:

- Air Pollution Control Ordinance (Cap 311)
- Water Pollution Control Ordinance (Cap 358)
- Waste Disposal Ordinance (Cap 354) and Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C)
- Environmental Impact Assessment Ordinance (Cap 499)

2.2.1.2.1 Air Pollution Control Ordinance (APCO)

The APCO (Cap 311) enacted in 1983 is the principal law for managing air quality. The Ordinance provides control over aerial emission of various toxic air pollutants from stationary and mobile sources and enables the promulgation of regulations to establish administrative procedures and work practices for effecting the reduction of pollution to the atmosphere.

Various regulatory schemes which directly or indirectly contribute to the reduction in emission of unintentionally produced POPs to the atmosphere are in place to control pollution from combustion sources. These include:

- Air Pollution Control (Specified Processes) Regulations (Cap 311F)
- Air Pollution Control (Furnaces, Oven and Chimneys) (Installation and Alteration) Regulations (Cap 311A)
- Air Pollution Control (Smoke) Regulations (Cap 311C)
- Air Pollution Control (Open Burning) Regulation (Cap 311O)
- Air Pollution Control (Motor Vehicle Fuel) Regulation (Cap 311L)
- Air Pollution Control (Vehicle Design Standards) (Emission) Regulations (Cap 311J)
- Air Pollution Control (Emission Reduction Devices for Vehicles) Regulation (Cap 311U)

2.2.1.2.2 Water Pollution Control Ordinance (WPCO)

The WPCO (Cap 358) enacted in 1980 is the principal law for managing water quality. The Ordinance provides for the establishment of Water Quality Objectives (WQOs) in relation to the beneficial uses of water bodies and defines Water Control Zones (WCZs) for the entirety of Hong Kong waters within which discharges of effluent are subject to licensing control.

The WQOs set for all WCZs specify that toxic substances in the water should not attain such levels as to produce significant toxic, mutagenic, carcinogenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.

The standards for effluent discharged into the various WCZs are specified in the *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* (TM). The TM prohibits the discharge of toxic substances (including fumigants, pesticides, polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), chlorinated hydrocarbons, flammable or toxic solvents, petroleum oil or tar and calcium carbide) to foul sewers, inland and coastal waters. It also specifies numerical discharge limits for total suspended solids, Biochemical Oxygen Demand (BOD), oil and grease, toxic metals and chemical compounds such as cyanide, phenol, sulphide, total residual chlorine and surfactants.

2.2.1.2.3 Waste Disposal Ordinance (WDO)

The WDO (Cap 354) enacted in 1980 is the principal law for environmentally sound management of waste collection and disposal. The Ordinance provides control over the handling and disposal of livestock waste and chemical waste, the import and export of wastes (including implementation of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal) and the licensing of waste collection services and waste disposal facilities. Its subsidiary legislation, the *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C),* provides for the control, through licensing requirements, of packaging, labeling, storage, collection and disposal (including treatment, reprocessing and recycling) of chemical waste, and the registration of chemical waste producers. Chemical waste is defined under the regulation in a schedule of specific substances and chemicals based on their potential risk to human health and/or pollution to the environment. Disposal of chemical wastes containing PCBs and unintentionally produced POPs is controlled under the WDO.

2.2.1.2.4 Environmental Impact Assessment Ordinance (EIAO)

The EIAO (Cap 499) enacted in 1997 provides a legal instrument for assessing potential environmental impacts of designated projects at the planning stage and for the protection of the environment. The Ordinance contains provisions to avoid, minimize and control adverse impacts to the local environment of designated projects through an environmental permit and environmental monitoring and audit system. The Technical Memorandum for Environmental Impact Assessment Ordinance (EIAO-TM) sets out the technical requirements for the EIA process and the criteria for determining the environmental acceptability of designated projects, stipulating that any adverse environmental effects should be avoided to the maximum practicable extent and minimized to within acceptable levels.

2.2.2 Roles and Responsibilities of Relevant Government Bureaux/Departments

Table 1 summarizes the roles and responsibilities of Government bureaux/departments in protecting the environment and human health against the potential harmful effects of hazardous chemicals including POPs.

Table 1 Roles and Responsibilities of Relevant Bureaux/Departments in the HKSARG in Environmental and Human Health Protection

Bureaux/Departments	Relevant Roles and Responsibilities	Legislative Instruments
Economic Development and Labour Bureau		
Labour Department	• Control the manufacture, process or work involving certain specified hazardous chemicals (such as carcinogenic substances) to protect workers' safety	• Factories and Industrial Undertakings Ordinance (Cap 59) • Occupational Safety and Health Ordinance (Cap 509)
Marine Department	• Prevent, mitigate and repair pollution of and damage to the waters of Hong Kong arising from oil spillage, and from contamination of the sea by hazardous substances discharged from ships	• Merchant Shipping (Prevention and Control of Pollution) Ordinance (Cap 413) • Merchant Shipping (Safety) Ordinance (Cap 369)
Environment, Transport and Works Bureau		
Drainage Services Department	• Provide an effective system for sewage collection, treatment and disposal in an environmentally responsible manner to ensure public safety and health • Maintain a database on effluent/sludge production in sewage treatment works	
Environmental Protection Department	• Impose "downstream" control on air emission, effluent discharge and waste disposal (including chemical waste) of environmental toxic pollutants • Conduct environmental monitoring to assess compliance and provide a basis for the planning of pollution control strategies • Set out technical requirements for the environmental impact assessment (EIA) processes at the planning stage, to avoid, minimize and control potential adverse impacts to the local environment of designated projects	• Air Pollution Control Ordinance (Cap 311) • Water Pollution Control Ordinance (Cap 358) • Waste Disposal Ordinance (Cap 354) • Dumping at Sea Ordinance (Cap 466) • Environmental Impact Assessment Ordinance (Cap 499)
Water Supplies Department	Provide quality water services and ensure public health and safety through routine monitoring of toxic chemicals in drinking water	

Bureaux/Department	Relevant Roles and Responsibilities	Legislative Instruments
Financial Services and Treasury Bureau		
Census and Statistics Department	• Maintain a database of vital statistics to facilitate research, planning and decision–making within the Government and in the community	
Health, Welfare and Food Bureau		
Agriculture, Fisheries and Conservation Department	• Control the manufacture, import, supply, storage, and retail sale of pesticides in Hong Kong • Administer the import and export licensing control system of pesticides in Hong Kong	• Pesticides Ordinance (Cap 133) • Import and Export Ordinance (Cap 60)
Department of Health	• Execute health care policies and statutory functions and safeguard the health of the community through promotive, preventive, curative and rehabilitative services	
Food and Environmental Hygiene Department	• Ensure food safety through food surveillance and certification, conduct dietary risk assessment and risk communication and advice on food safety standards	• Public Health and Municipal Services Ordinance (Cap 132)
Government Laboratory	• Provide laboratory analytical services to Government departments on samples of various matrices to meet client departments' respective responsibilities for environmental protection, public health and safety	
Security Bureau		
Customs and Excise Department	• Control the import and export of commodities and certain prohibited articles by air, land, and sea.	• Import and Export Ordinance (Cap 60)
Fire Services Department	• Control the manufacture, labelling, packaging, storage, transport (on land and at sea) and use of dangerous goods (including corrosive, flammable and poisonous substances, etc)	• Dangerous Goods Ordinance (Cap 295)

2.2.3 Obligations under Other Related Environmental Conventions Applicable to the HKSAR

2.2.3.1 The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

The Basel Convention aims to protect the environment and human health from the harmful effects of hazardous waste. The Convention defines the global means to: (a) minimize hazardous waste at source; (b) strictly control the transboundary movement of hazardous waste; and (c) ensure that the hazardous wastes are disposed of in an environmentally sound manner. The Convention requires that a prior informed consent system be put in place to control and monitor the transboundary movement of hazardous waste among the Parties to the Convention.

The Convention was adopted by the Conference of Plenipotentiaries in Basel in 1989 and entered into force in May 1992. The PRC ratified the Convention in December 1991. The Convention has become applicable to the HKSAR through extension of the PRC's ratification.

The State Environmental Protection Administration (SEPA) is the National Focal Point of the PRC for the Convention and EPD is the designated Competent Authority of the HKSAR for implementing the Convention in Hong Kong. Transboundary movement of hazardous waste as specified in the 7th Schedule to the WDO is subject to import/export control provided for in that Ordinance. EPD has established an information exchange network with both local and oversea control authorities to monitor waste shipment activities and to collect intelligence of dubious waste shipment for joint enforcement action to effectively combat illegal shipment of hazardous waste in the region.

2.2.3.2 The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade

The Rotterdam Convention aims to promote shared responsibility and cooperative efforts among the contracting parties in the international trade of certain hazardous chemicals and pesticides in order to protect human health and the environment from potential harm. The Convention has introduced a mandatory prior informed consent procedure (PIC procedure) to monitor and control the import and export of certain hazardous chemicals and disseminate national importing decisions to the contracting parties. The Rotterdam PIC procedure applies to 24 pesticides, 6 severely hazardous pesticide formulations and 11 industrial chemicals.

The Convention was adopted at the Diplomatic Conference held in Rotterdam on September 10, 1998 and entered into force on February 24, 2004. The Convention became applicable to the PRC (not including the HKSAR) on June 20, 2005. The HKSAR would seek extension of the PRC's ratification after enactment of new legislation to effect control of the trade, domestic production, use and/or release of hazardous chemicals covered by the Convention. For implementing the Convention in Hong Kong, AFCD will be responsible for the control of PIC pesticides, while EPD will be responsible for the control of PIC industrial chemicals.

2.3 Overview of the Current POPs Issue in the HKSAR

2.3.1 Source Inventories of POPs

2.3.1.1 Trade, Production and Use of Intentional POPs

2.3.1.1.1 Pesticides

Nine pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, HCB, mirex and toxaphene) had been identified as intentionally produced POPs by the Convention, targeted for global elimination or restricted production and use. In Hong Kong, these pesticides were either not registered or had their registration status cancelled for many years due to toxicological or environmental concern.

Aldrin	Chlordane	DDT	Dieldrin	Endrin	Heptachlor	HCB	Mirex	Toxaphene
1988*	1991*	1988*	1988*	NR	NR	NR	1997*	1984*

* : The year prohibited from all use and trade activity unless under a pesticide permit granted in exceptional circumstances

NR: Not registered

Table 2 presents the local source characterization and quantification of the nine POPs pesticides. There was no import, export, production nor use and no stockpiling of any of these pesticides in Hong Kong for the past 5 years (2000–2004). Trans-shipment of DDT was reported for the years 2000–2003 but not for 2004, while trans-shipment of mirex was recorded for 2004 only.

Table 2 Source Characterization and Quantification of POPs Pesticides in Hong Kong for the Period 2000 – 2004

Chemical	Import (t/a)	Export (t/a)	Production (t/a)	Use (t/a)	Stockpile (kg)	Transhipment (kg)				
					2000-2004	2000	2001	2002	2003	2004
Aldrin	0	0	0	0	0	0	0	0	0	0
Chlordane	0	0	0	0	0	0	0	0	0	0
DDT	0	0	0	0	0	112,600	274,228	153,118	123,440	0
Dieldrin	0	0	0	0	0	0	0	0	0	0
Endrin	0	0	0	0	0	0	0	0	0	0
Heptachlor	0	0	0	0	0	0	0	0	0	0
HCB	0	0	0	0	0	0	0	0	0	0
Mirex	0	0	0	0	0	0	0	0	0	125
Toxaphene	0	0	0	0	0	0	0	0	0	0

2.3.1.1.2 Industrial Chemicals

Stockpiles of PCBs contained in PCB-products manufactured from past industrial activities exist. Results of a PCB-equipment survey conducted by EPD in 2001/02 indicated that there were no PCB-containing transformers in the local industries and the quantity of PCB-capacitors dropped significantly from an initial number of 830 in 1994/95 to 303 in 2001/02. Most of these capacitors were small ones. As shown in Table 3, in 2004, the number of PCB-capacitors further dropped to 191, of which 104 were no longer in use and expected to be disposed of anytime. The total quantity of PCBs in use/stockpile was estimated to be 422 kg. Phased out PCB-containing equipment is classified as a chemical waste, the disposal of which is under the control of the WDO. The PCB-fluid removed from equipment is incinerated at the Chemical Waste Treatment Centre (CWTC).

Table 3 Domestic Use of PCBs in Hong Kong for Year 2004

Product	Major Business	PCB-Form	No. of Units	Unit Volume (L)	PCB-Content (%)	Total PCB Use / Stockpile (kg)
High voltage transformer	Power plants Power stations Railway / Mass Transit Railway		0			0
High voltage capacitor	Old buildings Factories	Dielectric fluid	191	Variable	100	422 *

* The PCB content of individual capacity unit was calculated based on its unit volume, assuming a capacitor of size (60×30×15) cm would contain 1.4 kg of 100% PCB fluid

It was noted that PCBs might also be present in minute quantities in some consumer products such as small old electrical appliances/parts, electronics, impact papers, adhesives, sealants, plastic materials and paints. The 2003 Census and Statistic figures showed local trading activities of these consumer products. However, in the absence of information on the product content of PCBs, no estimate of total PCBs in semi-closed and open application could be made. The relative contribution from this category was likely to be insignificant.

No information was available on the domestic use of HCB as an industrial chemical in Hong Kong.

2.3.1.2 Release of Unintentional POPs as by-Products

2.3.1.2.1 Dioxins and Furans

Dioxins (PCDDs) and furans (PCDFs) are unintentional by-products of industrial and combustion processes. The annual dioxin/furan emission and release inventory in Hong Kong for the year 2003 was compiled based on the framework presented in the "UNEP Standardized

Toolkit for Identification and Quantification of Dioxin and Furan Releases”[1] and an overall summary is presented in Table 4.

Table 4 Summary of Annual Dioxin/Furan (PCDD/PCDF) Emission Inventory in Hong Kong for Year 2003

Cat.	Source Categories	Annual Release (g TEQ/a)					Total-All Routes (g TEQ/a)
		Air	Water	Land	Products	Residues	
1	Waste Incineration	0.01	0.00	0.00	0.00	0.06	0.07
2	Ferrous and Non-Ferrous Metal Production	0.27	0.00	0.00	0.00	7.70	7.97
3	Power Generation and Heating/Cooking	1.55	0.00	0.00	0.00	3.69	5.24
4	Production of Mineral Products	0.01	0.00	0.00	0.00	0.07	0.08
5	Transport *	0.12	0.00	0.00	0.00	0.00	0.12
6	Uncontrolled Combustion Processes	0.31	0.00	0.05	0.00	0.21	0.57
7	Production of Chemicals, Consumer Goods	0.00	0.00	0.00	ND	0.00	0.00
8	Miscellaneous	0.35	0.00	0.00	0.00	0.06	0.41
9	Disposal/Landfill	0.00	0.86	0.00	0.06	4.90	5.81
1-9	**Total [a] – All Categories**	2.61	0.86	0.05	0.06	16.70	20.27

* : Bunker fuel sale not included in the annual dioxin emission estimate 2003; The sale of bunker fuel to international ocean-going vessels is not considered representative of local fuel consumption

[a] : Values may not add up to “total” due to rounding

ND = No Data

In 2003, there was an annual release of 20.3 g TEQ dioxins/furans to the environment via all vectors. Relative contributions of different categories are shown in Figure 1. The top 3 contributing categories of dioxin/furan emission were “Ferrous and Non-Ferrous Metal Production” (39.3%), “Disposal/Landfill” (28.7%) and “Power Generation and Heating/Cooking” (25.9%). Together, they represented 93.9% of the total. A “zero” emission value was assigned to Cat. 7 “Production of Chemicals, Consumer Goods” due to a general lack of local data on the contamination level of dioxins/furans in consumer goods.

On a vector basis (Figure 2), the major route of release was “residues”, responsible for 82.4% of the total, followed by “air” (12.9%) and “water” (4.2%). The “land” and “products” together contributed to only 0.5% of the total annual release. It was observed that for the “land” and “products” vectors, a “blank” release value was assigned to many classes of potential emission sources due to a general lack of data on emission factors.

[1] UNEP, 2003. UNEP Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, UNEP Chemicals, May 2003.

Figure 1 – Contribution of Various Emission Source Categories to Annual Dioxin/Furan Emission

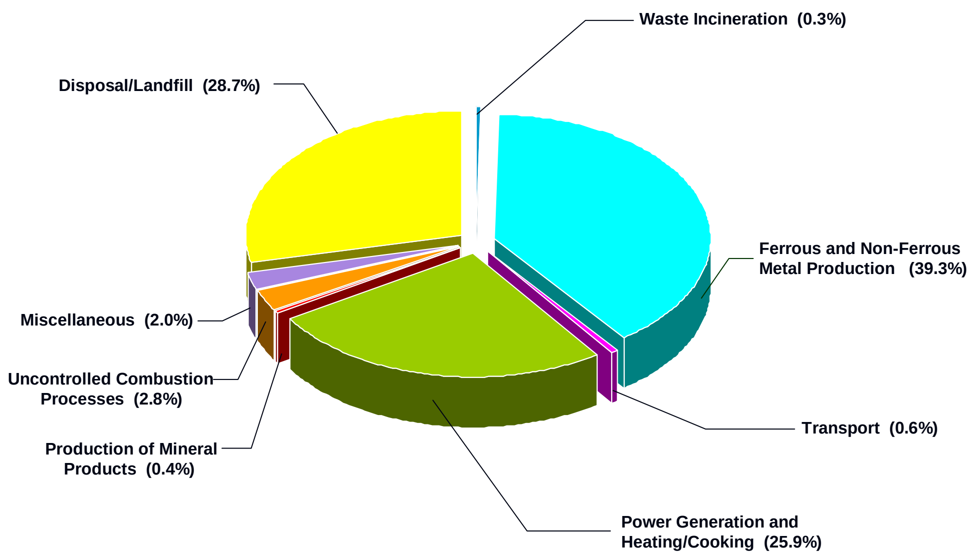
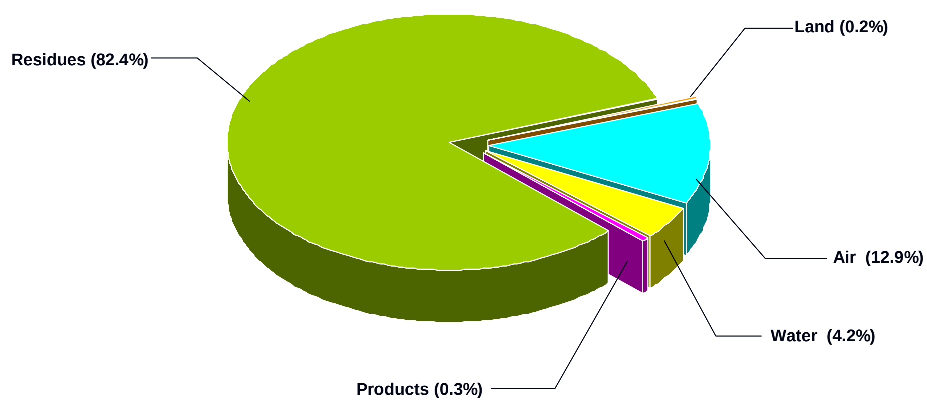


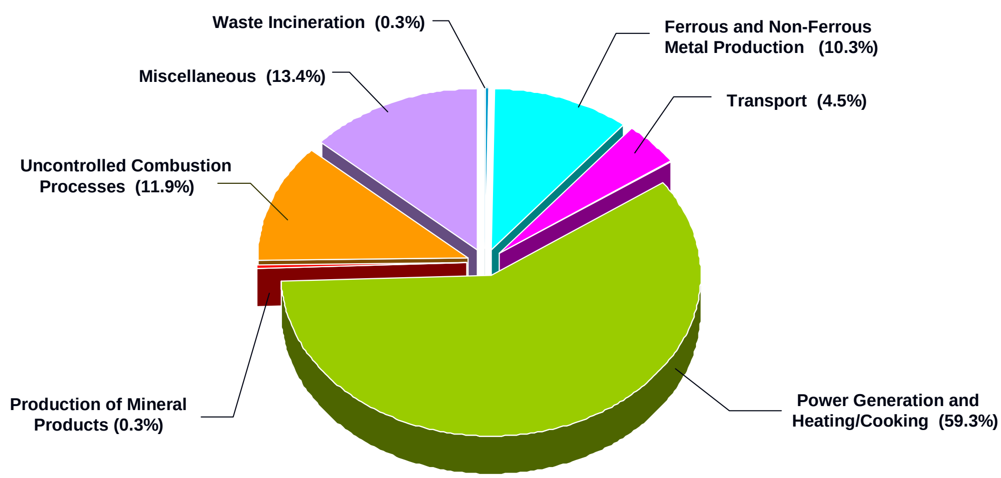
Figure 2 – Percentage of Dioxin/Furan Emission on a Vector Basis



Release of Dioxins/Furans to Air

The 2003 annual dioxin/furan release to the atmosphere was 2.61 g TEQ. The relative contributions of different source categories to air emission are presented in Figure 3. A further breakdown of the nine categories into individual classes of emission sources revealed that the top 4 contributing classes of local processes were: (a) "coal fired power boilers plants" (45.3%) in the "Power Generation and Heating/Cooking" category (59.3%), (b) "crematoria" (13.4%), sole contributor in the "Miscellaneous" category (13.4%), (c) "aluminium production (secondary)" (10.3%), sole contributor in the "Ferrous and Non-Ferrous Metal Production" category (10.3%), and (d) "accidental fires - houses, factories and vehicles" (9.6%) in the "Uncontrolled Combustion Processes" category (11.9%). These four classes of processes together accounted for 78.6% of the total annual air emission while the remaining 18 classes were responsible for the remaining 21.4%.

Figure 3 – Contribution of Different Source Categories to Annual Dioxin/Furan Emission to Air



Contributions from the "coal fired power boilers plants" and "crematoria" were well characterized and the emissions were calculated based on locally developed emission factors (EFs). Estimates of local dioxin/furan emission from the "aluminium production (secondary)" and "accidental fires" activities were made by adopting the generic EFs published in the UNEP Standardized Toolkit (2003). Since the annual local aluminium production (secondary) activity reported also appeared on the high end compared with those reported in Asian and European countries, the annual dioxin/furan emission from this class of industrial activities would be likely to be over-estimated. While the contribution from “accidental fires” could hardly be controlled, efforts to establish a more representative local annual activity and emission level from the “aluminium production (secondary)” process would help to better understand and assess the performance of the industry and its contribution to local air dioxin/furan release.

Release of Dioxins/Furans to Water

The 2003 annual dioxin/furan release to the local marine environment was 0.86 g TEQ, contributed solely by the “Disposal/Landfill” category. Within this category, the two major contributing classes of emission sources were “sewage with no sludge removal” (92.4%) and “sewage with sludge removal” (7.0%), together accounting for 99.4% of the total release, while the landfill leachate contributed to only a minor 0.6%. Given the limited local data available and considering the large quantities of annual sewage production in Hong Kong, further analysis of sewage discharges at source would help to better estimate their contribution to annual dioxin/furan release.

Stormwater discharge was recognized as a potential non-point water release source to “open water dumping”. However, in the absence of local information on the annual stormwater volume and the level of dioxin/furan contamination, its contribution to total water dioxin/furan release could not be estimated. Sediment dredging and dumping of contaminated mud in controlled disposal pits would be another potential source of POPs release to “open water”.

Release of Dioxins/Furans to Land

For release “to land”, the only category with an EF available was “Uncontrolled Combustion Processes”. Burning of biomass in forest/grassland fires contributed to the total annual release of 0.05 g TEQ dioxins/furans to land. There was a general lack of local information on other potential sources of dioxin/furan release to land.

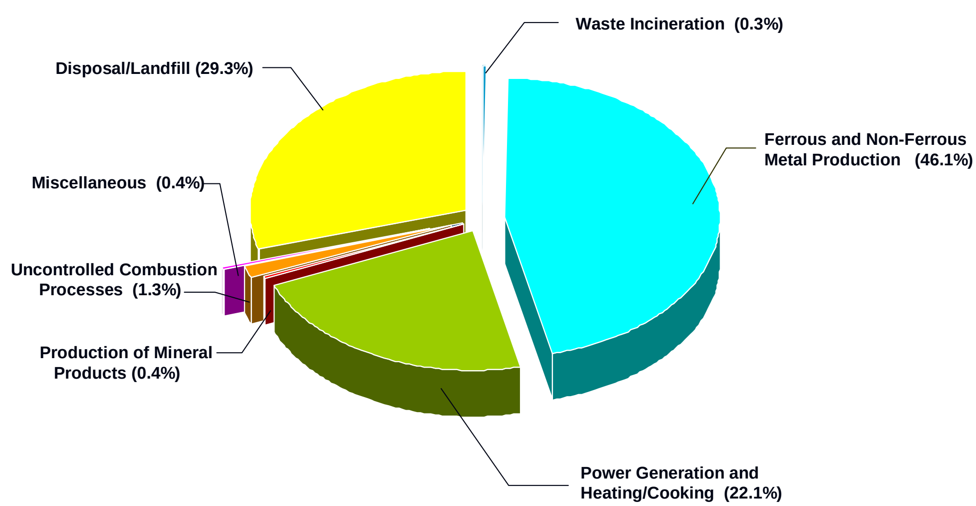
Release of Dioxins/Furans in Products

The 2003 annual dioxin/furan release “in products” was 0.06 g TEQ, from the “Disposal/Landfill” category. Within this category, the sole contributing class of emission sources was “composting of livestock wastes”. Release from composting of livestock wastes was estimated using an UNEP generic EF for composting of garden and kitchen wastes as surrogate. A local EF specific to livestock waste would need to be determined for a better estimate of contribution from this class of emission source. The compost was used as product for landscaping and horticulture work. There was a general lack of local information on other potential sources of dioxin/furan release in products.

Release of Dioxins/Furans in Residues

The 2003 annual dioxin/furan release "in residues" was 16.7 g TEQ. The relative contributions of different source categories to emission in residues are presented in Figure 4. A further breakdown of the nine categories into sub-categories and individual classes of release sources revealed that the top three contributing sub-categories/classes of local processes were: (a) "aluminium production (secondary)" (46.1%), the sole contributor in the "Ferrous and Non-Ferrous Metal Production" category (46.1%), (b) "disposal of sludge from sewage treatment works" (29.3%), the sole contributor in the "Disposal/Landfill" category (29.3%), and (c) "coal fired power boilers plants" (22.1%), the sole contributor in the "Power Generation and Heating/Cooking" category (22.1%). These three classes of processes together accounted for 97.5% of the total annual dioxin/furan release in residues.

Figure 4 – Contribution of Different Source Categories to Annual Dioxin/Furan Emission to Residues



Estimates of annual dioxin/furan release from the "aluminium production (secondary)", "sludge disposal" and "coal fired power boiler plants" activities were made by adopting the generic EFs published in the UNEP Standardized Toolkit (2003). In view of their significant relative contribution to the residue dioxin/furan release profile, the use of specific, local EFs would help to better estimate their annual emissions. Since all sludge produced from sewage treatment works was currently disposed of in landfills, the landfills would act as an environmental sink for release of dioxins/furans in residues. A small proportion of the boiler ash (residues) produced in coal fired power plants would be reused in concrete batching or in non-structural concrete such as paving blocks and road base site formation/reclamation, while the majority of it would be disposed of on-site in designated ash lagoons acting as another environmental sink for the release of dioxins/furans in residues. The percentage reuse of local boiler ash in “products” would warrant further investigation.

2.3.1.2.2 Hexachlorobenzene

There was comparatively little information on the release of HCB as an unintentionally produced POP from combustion and/or as an intermediate during industrial processes in Hong Kong. HCB is used as a raw material for the production of many agricultural chemicals such as pentachlorophenol (PCP), quintozene (PCNB), chlorthal-dimethyl (TCTP), chlorothalonil and picloram, and remains as an impurity in these products. Apart from PCP, all other four agricultural chemicals are registered pesticides in Hong Kong. Records of their trading for the period 2000-2004 revealed that PCNB and chlorothalonil had been imported for local use. In the absence of information on the actual percentage of HCB as impurity in any of these pesticides, the potential annual release of HCB as an unintentional by-product to the local environment due to their domestic applications could not be estimated. However, the relative contribution was likely to be insignificant.

2.3.1.2.3 Polychlorinated Biphenyls

Similar to HCB, there was comparatively little local information on the release of PCBs as unintentionally produced POPs. PCBs are known to be produced as unintentional combustion by-products of incineration and combustion processes. The current UNEP Toolkit does not give EFs for PCBs. Local information on the release of PCBs from known emission sources is scanty. Some measured emission data were available from a number of incinerators, crematoria and power plants to permit local EFs to be derived and annual releases of dioxin-like PCBs to be estimated for these processes. Results indicated that the measured total annual air emission of dioxin-like PCBs was very low (less than 0.1 g TEQ).

2.3.1.3 Contaminated Sites

Three local dioxin-contaminated historical activity sites were identified and documented by EPD during 2000-2004. The Choy Lee Shipyard site (located at Penny’s Bay in Lantau Island) was the major contaminated site, contributing to 98.6% of the estimated total dioxin stockpile due to historical improper open burning of waste materials on-site. Decontamination of the Choy Lee Shipyard site and incineration of all dioxin-residue recovered from the contaminated soil at the Chemical Waste Treatment Centre (CWTC) was completed in March 2005. The other two minor contaminated sites were phased-out incineration plants at Kwai Chung, the New Territories and Kennedy Town, Hong Kong Island. Together, they were responsible for only 1.4% of the estimated total dioxin stockpile. There were no known existing sites contaminated by PCBs or POPs pesticides in Hong Kong. As noted above, the landfills and the confined contaminated mud disposal facility at East Sha Chau would represent potential sinks of POPs, not posing immediate threats to the environment or human health.

2.3.2 Environmental Levels of POPs

2.3.2.1 Contamination Levels of POPs in Environmental Media

The major sources of information that contributed to the inventory on environmental levels of POPs in Hong Kong include: reports of EPD's routine monitoring programmes, Government-funded consultancy studies and studies conducted by local academia. A summary of POPs analyzed and reported in environmental media (ambient air, surface water, surface sediment and soil, and vegetation) for 2000-2004 is presented in Table 5.

Table 5 Mean Levels of POPs Contamination in the Environment of Hong Kong for 2002 – 2004 [a]

Chemical	Ambient Air [b] (ng/m^3)	Surface Water (ng/L)	Surface Sediment (µg/kg dw)		Surface Soil [c] (µg/kg dw)	Vegetation (µg/kg dw)	
		Marine Water [c]	Marine Sediment [c]	River Sediment		Ground Vegetation	Tree Bark
Aldrin	0	0	**4.70** (1.30 – 9.2)				
Chlordane		0	**4.20** (<0.01 – <10.0)				
DDT	**0.05** (0 – 0.10)	0	**6.81** (0.30 – 33.1)	**4.96** (2.82 – 8.63)	**0.52** (<0.004 – 6.00)		
Dieldrin	0	0	**5.19** (2.40 – 11.0)				
Endrin	0	0	**3.86** (<0.01 – <10.0)		**0.01** (<0.004 – 0.10)		
Heptachlor	**0.03** (0 – 0.09)	0	**4.48** (<0.01 – <10.0)				
HCB	**0.16** (0.05 – 0.23)	0	**5.98** (0.05 – 23.8)		**0.01** (<0.001 – 0.30)		
Mirex		0	0				
Toxaphene		0	0				
PCBs	**0.48** (0.01 – 1.81)	0	**24.1** (0.63 – 330)	**193** (43.0 – 461)	**0.10** (<0.004 – 0.16)		
Dioxins / Furans*	**0.06** (0.04 – 0.35)	**5.21** (0.0005 – 24.4)	**9.10** (2.28 – 38.7)		**5.33** (0.35 – 32.8)	**2.13** (0.29 – 14.1)	**1.47** (0.49 – 3.57)

* : Unit of dioxins/furans in ambient air = pg I-TEQ/m^3; in surface water = pg I-TEQ/L; in surface sediment/surface soil/vegetation = ng I-TEQ/kg dw

a : Results are expressed as mean (minimum, maximum) values

b : "0" indicates values were < DL; DL of pesticides in ambient air = 0.02 ng/m^3; If mixed values of >DL and <DL were recorded in a sample pool, mean value was calculated by assuming "0" for samples <DL

c : "0" indicates values were < DL; DL of DDT, all other pesticides and PCB in marine water = 15, 10 and 100 ng/L, respectively; DL of mirex and toxaphene in marine sediment = 10 µg/kg dw; If mixed values of >DL and <DL were recorded in a sample pool, mean value was calculated by assuming "0.5DL" for sample <DL

The mean environmental levels of POPs were weighted arithmetic sample means calculated based on samples analyzed and reported in individual studies.

2.3.2.1.1 Ambient Air

Ambient levels of total PCBs and dioxins/furans (PCDD/Fs) have been routinely monitored at two general urban locations (Tsuen Wan and Central & Western) in Hong Kong since mid-1997. In addition, dioxin data collected from a year-long dioxin-monitoring project (2000-2004) that targeted suspected local emission source at Tsing Yi (where CWTC is located) and from an *ad hoc* study conducted at Tai Mo Shan (2000-2001) were included in the calculation of the mean ambient air dioxin/furan concentration. The average local ambient air concentrations of PCBs and dioxins/furans measured for 2000-2004 were 0.48 ng/m^3 and 0.06 pg I-TEQ/m^3, respectively.

Data of local ambient air POPs pesticides were limited. The ambient air levels of aldrin, DDT, dieldrin, endrin, heptachlor and HCB reported were *ad hoc* measurements taken in a single sampling event at the Tai Mo Shan Station, a rural site at the highest point (~957 m above sea level) in Hong Kong. Relatively low levels of DDT (0.05 ng/m^3), heptachlor (0.03 ng/m^3) and HCB (0.16 ng/m^3) in the ambient air were detected.

2.3.2.1.2 Surface Water

Data on marine water POPs were mainly generated by a major consultancy study on toxic substances pollution in Hong Kong commissioned by EPD (1999-2003). The 2004 EPD in-house toxic substance monitoring programme and a number of studies conducted by local academia also contributed to the inventory, especially on the marine water levels of DDT, PCBs and dioxins/furans. None of the nine POPs pesticides was detected at any of the sampling sites, and the level of PCBs was also reported to be below detection limit in 180 water samples analyzed from 38 sites located throughout Hong Kong. Dioxins/furans appeared ubiquitously throughout the region, with highest values found in the Inner Deep Bay and Victoria Harbour. The mean marine water concentration of dioxins/furans reported for 2000-2004 was 5.21 pg I-TEQ/L.

There were no data available on the level of POPs in inland waters of Hong Kong.

2.3.2.1.3 Surface Sediment

Contamination of local marine sediment by toxic chemical pollutants has been relatively well documented. The POPs marine sediment inventory was compiled based primarily on data generated from a major consultancy study on local toxic substances pollution reported in 2003, EPD's routine and *ad hoc* marine monitoring programmes of 2003/2004, and study reports published by local academia. With the exception of mirex and toxaphene, all other POPs pesticides were detected in the marine sediment sampled at over 20 locations throughout Hong Kong. The mean sediment pesticide concentrations ranged <DL – 6.81 µg/kg dw, and DDT (6.81 µg/kg dw), HCB (5.98 µg/kg dw) and dieldrin (5.19 µg/kg dw) were found to be the major POPs pesticide contaminants. PCBs and dioxins/furans were widely distributed, with sediment levels ranging 0.63 – 330 µg/kg dw and 2.28 – 38.7 ng I-TEQ/kg dw for PCBs and dioxins/furans, respectively.

Local information on POPs in river sediments was sketchy. One study of the inland water systems in Hong Kong was conducted by the local academia and the available data were reported in this inventory. Fifteen river sediment samples were taken at sediment sites along the three main local rivers (Shing Mun River, Tai Po River and Lam Tsuen River in the New Territories) and analyzed for DDT and PCBs. The mean level of DDT contamination was 4.96 µg/kg dw, while that of PCB contamination was 193 µg/kg dw.

2.3.2.1.4 Surface Soil

The soil POPs pesticide inventory was compiled based on an *ad hoc* territory-wide background monitoring of surface soil in Hong Kong jointly conducted by the Nanjing Institute of Soil Sciences, Chinese Academy of Sciences and the Croucher Institute for Environmental Sciences, Hong Kong Baptist University. Rural surface soil samples were collected from 46 locations across the region, mostly woodland and grassland, and analyzed for DDT, endrin, HCB and PCBs. Contamination levels of POPs pesticides in the soil were generally very low, with mean values ranging from 0.01 (endrin and HCB) to 0.52 µg/kg dw (DDT). The mean soil PCB concentration was 0.1 µg/kg dw which was 241 times and 1,930 times lower than those reported for marine and river sediments, respectively. Dioxins/furans were measured in an EPD-commissioned consultancy monitoring project in 2001/2002 that targeted potential local dioxin emission sources. Forty soil samples were taken at five locations near landfills, CWTC or livestock waste composting sites. Soil concentrations of dioxins/furans ranging 0.35 – 32.8 ng I-TEQ/kg dw were reported.

2.3.2.1.5 Vegetation

Levels of dioxins/furans in ground vegetation and tree barks were measured in an EPD-commissioned consultancy monitoring project in 2001/2002 that targeted suspected local dioxin emission sources. Forty samples of ground vegetation and 10 samples of tree barks were taken at five locations near landfills, CWTC or livestock waste composting sites. The mean levels of dioxins/furans in ground vegetation and tree barks at potential local dioxin emission sources were 2.13 and 1.47 ng I-TEQ/kg dw, respectively. No data on POPs pesticides in local vegetation were available.

2.3.2.2 Contamination Levels of POPs in Aquatic Biota

A summary of POPs analyzed and reported in representative freshwater and marine biota (fish, shellfish, water bird eggs and marine mammals) is presented in Table 6. The mean tissue levels of POPs were weighted arithmetic genus means calculated based on tissue samples analyzed and reported in individual studies.

Table 6 Mean Levels of POPs Contamination in Aquatic Biota of Hong Kong for 2002 – 2004 [a]

Chemical	Freshwater Fish [b] (µg/kg ww)	Marine Fish [b] (µg/kg ww)	Marine Shellfish [b] (µg/kg ww)	Water Bird Eggs (µg/kg ww)	Marine Mammals (µg/kg ww)
Aldrin	0	**28.9** (0.08 – <100)	0		
Chlordane		**3.80** (0.39 – 16.4)	**1.12** (0.11 – 5.02)	**156** (31.0 – 280)	
DDT	**6.78** (3.32 – 10.9)	**27.6** (0.83 – 99.0)	**7.73** (0.16 – 28.6)	**900** (600 – 1,200)	**32,763**
Dieldrin	0	**2.18** (<0.08 – 15.8)	**0.21** (<0.01 – 0.40)		
Endrin	0	**28.1** (0.14 – <100)	**5.86** (<0.01 – 25.2)		
Heptachlor	0	**25.3** (0.18 – <100)	**5.99** (<0.01 – 25.1)		
HCB		**5.8** (<0.20 – 18.1)	**0.80** (0.13 – 3.43)		
Mirex		0	0		**178** (70.5 – 286)
Toxaphene		**1.33** (0.25 – 2.36)	0		**32.0** (19.7 – 44.2)
PCBs	**57.8**	**22.6** (<2.00 – 153)	**13.8** (<1.00 – 55.0)	**595** (230 – 960)	**8,190**
Dioxins / Furans*		**0.33** (0.09 – 0.57)	**0.53** (0.21 – 0.85)		

* : Unit of dioxins/furans = ng I-TEQ/kg ww

a : Results are expressed as mean (minimum, maximum) values

b : "0" indicates values were <DL; DL of pesticides in freshwater fish = 0.10 µg/kg ww; DL of aldrin/mirex and toxaphene in marine fish/shellfish = 100 and 0.2 µg/kg ww, respectively; If mixed values of >DL and < DL were recorded in a sample pool, mean value was calculated by assuming "0.5DL" for sample <DL

2.3.2.2.1 Freshwater Fish

There was a general paucity of information on POPs in freshwater biota. Studies reported by local academia contributed to all the data compiled in this section of the inventory. Four freshwater fishes from a few (1-3) sampling sites were analyzed. DDT was the only POPs pesticide detected, with tissue concentration ranging 3.32 – 10.9 µg/kg ww. PCBs were measured in only one fish species from two locations and mean tissue level of 57.8 µg/kg ww was reported.

2.3.2.2.2 Marine Fish and Shellfish

Compared with freshwater fish, more information on POPs in local marine fish and shellfish were available. Data were retrieved primarily from two toxic substances consultancy studies reported in 2003, the 2003 EPD *ad hoc* baseline survey on trace toxics in Hong Kong marine biota, and the 2004 CEDD Environmental Monitoring and Audit for Contaminated Mud Pit IV at East Sha Chau. Studies by local academia also contributed significantly to the data pool. Most POPs pesticides were detected in a variety of marine fish and shellfish sampled at multiple sites throughout Hong Kong. DDT, endrin and heptachlor were found to be the major POPs pesticide contaminants of both marine fish and shellfish, while aldrin was prominent only in the marine fish.

The mean concentrations of PCBs in local marine fish and shellfish were 22.6 and 13.8 μg/kg ww, respectively. Dioxins/furans were detected in all fish and shellfish genera examined. The mean level of dioxin/furan contamination was 0.33 ng I-TEQ/kg ww in marine fish and 0.53 ng I-TEQ/kg ww in marine shellfish. With the exception of dioxins/furans, the level of POPs contamination was found to be generally higher in marine fish than in marine shellfish.

2.3.2.2.3 Water Bird Eggs

One local study of body burden of POPs in local water birds measured the level of chlordane, DDT and PCBs in the eggs of two species of water birds sampled at two locations in the New Territories. Relatively high levels of all three POPs were detected, with average genus concentrations of 156 μg, 900 μg and 595 μg per kg ww for chlordane, DDT and PCBs, respectively.

2.3.2.2.4 Marine Mammals

Levels of POPs in two local marine mammals, the Indo-Pacific humpback dolphin (*Sousa chinensis*) and finless porpoise (*Neophocaena phocaenoides*), were measured in two studies of stranded cetaceans (1995-2000 and 2000-2001) published in the open literature. Blubber tissue samples were collected from stranded animals found in Hong Kong and analyzed for DDT, mirex, toxaphene and PCBs. High mean blubber concentrations of DDT (32.8 mg/kg ww) and PCBs (8.19 mg/kg ww) were reported.

2.3.3 Dietary Exposure to POPs

Human exposure to POPs through dietary intake was estimated based on measurements of contamination levels of POPs in various foods and information on daily diets of the local population.

In 2000, the Food and Environmental Hygiene Department (FEHD) conducted a food consumption survey in local secondary school students to obtain consumption data on individual food items using a food frequency questionnaire. Using data from the survey, a dietary exposure study to dioxins of secondary school students was carried out in 2002. Dietary exposure to dioxins for an average secondary school student was estimated to be 0.85 pg WHO-TEQ/kg bw/day, while that for high consumers was 2.07 pg WHO-TEQ/kg bw/day. Both levels fell within the Tolerable Daily Intake Limit (1-4 pg TEQ/kg bw/day) established by WHO in 1998, suggesting that secondary school students in Hong Kong were unlikely to experience toxicological effects of dioxins. FEHD commissioned another study on dietary exposure to DDT in secondary school students in 2005 and the results are expected to be available in early 2006.

Contamination levels of POPs in locally consumed foods are monitored year-round by FEHD under a routine food surveillance programme. Food items (mainly imports from the Mainland and other countries) are sampled regularly from local market stalls, supermarkets, fresh provision shops, food wholesalers and at the points of entry into Hong Kong. Analysis of the levels of toxic chemical contamination is carried out by the Hong Kong Government Laboratory (GL). Table 7 presents summaries of contamination levels of POPs in eight main locally consumed food groups and estimates of daily dietary exposure of Hong Kong residents to POPs for the year 2003.

Table 7 Estimates of Dietary Exposure to POPs Contamination in Foods of Hong Kong for Year 2003

	Cereals	Vegetables	Fruits	Dairy Products	Eggs	Seafoods	Meats	Poultry	Daily Consumption / Exposure
Food Consumption (g/capita/day) [a]	445.7	340.3	186.3	66.3	22.2	122.5	33.3	26.3	1,242.9
Contamination Level (µg/kg food) *									
Aldrin	0	0	0	0			0		
Chlordane	0	0	0	0		0	0	0	
DDT	0.85	0	0.14	1.00		10.5	0	0	
Dieldrin	0	0	0	0			0		
Endrin		0	0						
Heptachlor	0	0	0	0		0	0	0	
HCB	0.15	0	0	0		0	0	0	
Mirex		0	0						
PCBs			0	0		4.07	0	0	
Dioxins/Furans (pg TEQ/g food)	0.015			0.100	0.137	0.285	0.001	0.131	
Estimated Daily Exposure (ng/kg bw/day) [b]									
Aldrin	0	0	0	0			0		**0**
Chlordane	0	0	0	0		0	0	0	**0**
DDT	6.31	0	0.43	1.11		21.4	0	0	**29.3**
Dieldrin	0	0	0	0			0		**0**
Endrin		0	0						**0**
Heptachlor	0	0	0	0		0	0	0	**0**
HCB	1.11	0	0	0		0	0	0	**1.11**
Mirex		0	0						**0**
PCBs			0	0		8.31	0	0	**8.31**
Dioxins/Furans (pg TEQ/kg bw/day)	0.110			0.111	0.051	0.582	0.001	0.057	**0.91**

* : "0" indicates values were < DL; DL of pesticides and PCB = 0.005 mg/kg; DL of dioxins/furans = 0.02/0.05/0.10 ng/kg for individual congeners

[a] : Due to the lack of local data, food consumption patterns of Far East Countries (including China) published by WHO (2003 in "GEMS/Food Regional Diets") were adopted for estimation of daily dietary exposure

[b] : Estimate was based on an average adult body weight of 60 kg

With the exception of DDT and HCB, POPs pesticides were not detected in most food groups. DDT was found in four of the eight main food groups (cereals, fruits, dairy products and seafoods) while HCB was detected in cereals only. PCBs were not detected in fruits, dairy products, meats or poultry, but found in seafood items at a mean concentration of 4.07 µg/kg food. Measurable levels of dioxins/furans were found in cereals, dairy products, eggs, seafoods, meats and poultry, with mean dioxin/furan levels ranging from 0.001 (meats) to 0.285 (seafoods) pg TEQ/g food. Dioxins/furans were not measured in vegetable and fruit items sampled in 2003.

As comprehensive local food consumption data at the population level was currently not available, the food consumption patterns of Far East countries (including China) published by WHO in 2003[2] were adopted for a rough estimation of human exposure to POPs through the dietary intake pathway. Dietary exposure of Hong Kong residents to DDT, HCB, PCBs and dioxins/furans was estimated to be 29.3 ng, 1.11 ng, 8.31 ng and 0.91 pg-TEQ per kg bw per day, respectively. The major food groups contributing to POPs exposure were cereals, seafoods and dairy products.

While acknowledging that there is a general lack of local food consumption data on the population level, FEHD has initiated a population-based food consumption survey and the results are expected to be available around 2008. Based on results of the survey, a more accurate assessment of dietary exposure of local residents to POPs will be performed at the population level.

2.3.4 Human Body Burden of POPs

POPs in the environment can enter the food chain, bio-accumulate and bio-magnify as they move up the trophic levels and ultimately end up in the human body. It is expected that POPs will continue to accumulate in the body fat and their average concentrations will increase with age. Levels of POPs in human blood/serum and breast milk can serve as good indicators of their body burden.

2.3.4.1 <u>Human Breast Milk</u>

Local data on levels of POPs in breast milk of lactating mothers were reported in two studies of Hong Kong residents, including a study conducted by local academia as part of the 3rd Round WHO/EURO Exposure Study 2002-03[3]. Table 8 presents a summary of POPs contamination in breast milk of lactating mothers in Hong Kong for 2000-2003. In total, 115 local lactating mothers (aged 22-46, during their weeks 3-5 postpartum) participated in the milk sampling for analysis of DDT and PCBs and 316 local lactating mothers (aged 18-42, during their weeks 2-6 postpartum) contributed milk samples for analysis of dioxin-like PCBs and dioxins/furans. The mean human breast milk concentrations of DDT and indicator PCBs were 2.68 and 0.04 μg/g lipid wt, respectively, and those of dioxin-like PCBs and dioxins/furans were 4.67 and 8.25 pg TEQ/g lipid wt, respectively.

[2] WHO, 2003. Global Environment Monitoring System - Food Contamination Monitoring and Assessment Programme (GEMS/Food).
[3] Hedley, A.J., Wong, T.W., Nelson, E.A.S. and Hui, C.L.L., 2004. Human Dioxin Levels in Hong Kong – A Pilot Study. ECF Grant No. 8/2000, Final Report.

Table 8 Mean Levels of POPs Contamination in Breast Milk of Hong Kong Mothers for Period 2000 - 2002

Chemical	Human Breast Milk Concentration (μg/g lipid wt.)	
	No. of Participants	Mean (Min, Max)
DDT	115	**2.68** (0.66 - 5.61)
PCBs	115	**0.04** (0.01 - 0.07)
Dioxin-like PCBs (pg TEQ/g lipid wt.)	316	**4.67** (2.80 - 6.58)
Dioxins / Furans (pg TEQ/g lipid wt.)	316	**8.25** (5.80 - 10.1)

2.4 Analysis of POPs Inventory Data Gaps

2.4.1 Source Inventories on POPs

2.4.1.1 Trade, Production and Use of Intentional POPs

The POPs inventory on domestic use of industrial chemicals was incomplete. The inventory did not include estimates of PCBs in use/stockpile in consumer products (e.g. small old electrical appliances/parts, electronics, impact papers, adhesives, sealants, plastic materials and paints) due to a lack of information on their product content of PCBs. In view of the minute quantities of PCBs likely be present, the relative contribution from this category to PCBs in use/stockpile is judged to be insignificant. Although there is no existing information on the quantities of HCB used as an industrial chemical in Hong Kong, an initial survey conducted by EPD in early 2005 indicates little current trading and/or domestic usage of the chemical.

2.4.1.2 Release of Unintentional POPs as by-Products

As the inventory was compiled based on existing information, there were incomplete documentation of local industrial/commercial/urban activities and/or limited analytical data on the level of POPs contamination in some classes of emission sources. Efforts to establish more representative local EFs and/or annual activities would help to better assess the performance of the local emission sources and their relative contributions to the local dioxin/furan emission profile. This would be particularly relevant to emission sources identified as potential major contributors, for example, the "*aluminium production (secondary)*" (for its emission "to air" and "in residues"), the "*sewage discharges*" and "*sludge disposal from sewage treatment works*" (for its emission "to water" and "in residues"), and the "*coal fired power boiler plants*" (for its emission "in residues" and "in products").

Stormwater discharge was recognized as a potential non-point source of dioxin/furan release "to water" in the "Open water dumping" category. Collating an inventory of annual stormwater volume and its level of dioxin/furan contamination would be an expensive and challenging task and could only be achieved through careful planning and mobilization of adequate resources.

It was observed that for the "to land" and "in products" vectors, a "blank" release value was assigned to many classes of potential emission sources due to a general lack of data on local activities and/or EFs (local or generic). This was judged to be responsible, at least in part, for their apparent low contributions to total annual dioxin/furan release.

There was comparatively little information on the release of HCB as an unintentionally produced POP from combustion and/or as an intermediate during industrial processes in Hong Kong. Trade records showed that two agricultural chemicals known to contain HCB as impurity had been imported for local use in the past five years. Although contribution of local usage of these pesticides to the annual HCB release profile could not be readily quantified, its role was likely to be insignificant.

The current UNEP Toolkit does not give EFs for PCBs. Only a few locally measured emission data of PCBs were available and the results indicated that the measured total annual air emission of dioxin-like PCBs was very low (less than 0.1 g TEQ). Compilation of the local dioxin-like PCB emission profile would await further emission data from all other potential sources.

2.4.1.3 Contaminated Sites

The landfills and the confined contaminated mud disposal facility at East Sha Chau would represent local potential sinks of POPs, posing no immediate threats to the environment or human health but should continue to be kept under surveillance through environmental monitoring and auditing.

2.4.2 Environmental Levels of POPs

2.4.2.1 Contamination Levels of POPs in Environmental Media

The database on baseline monitoring of POPs contamination levels in environmental media was incomplete. Not all 12 Convention POPs were routinely monitored in the ambient air, water and sediment. Local data on POPs in river sediments, surface soil and vegetation were particularly sketchy.

2.4.2.2 Contamination Levels of POPs in Aquatic Biota

The contamination level of POPs (DDT and PCBs in particular) in local marine fish and shellfish had been well studied, with the exception of perhaps dioxins/furans for which data of only a few genera were available. However, there was a general paucity of information on POPs in local freshwater biota. This could be accounted for, at least in part, by the fact that most of Hong Kong's major inland rivers had been channelized and there appeared to be a general lack of freshwater biota, especially in the downstream segments. Only limited data of body burden of POPs in local water birds and marine mammals were available.

2.4.3 Dietary Exposure to POPs

The database on routine surveillance of POPs contamination levels in locally consumed foods was incomplete. Not all 12 Convention POPs were adequately analyzed in all main locally consumed food groups (food items of animal origin in particular). There was a general lack of food consumption data on the population level. Estimates of daily dietary exposure of local residents to POPs for the year 2003 were mostly derived based on generic regional food consumption patters (WHO GEMS/Food Regional Diets 2003) not specific to Hong Kong. To better understand the local situation and to assess the overall dietary exposure of the local population to POPs, there would be a need to include analysis of all 12 Convention POPs in the routine food surveillance programme and to conduct a food consumption survey to determine the food consumption patterns of the local residents. To address this issue, a population-based local food consumption survey has recently been commissioned by FEHD.

2.4.4 Human Body Burden of POPs

Local data on the contamination level of selected POPs (DDT, PCBs, dioxin-like PCBs and dioxins/furans) in breast milk of lactating mothers were reported in two studies of Hong Kong residents. Data of other POPs pesticides in human breast milk were not available. No information on the level of POPs in blood/serum of local residents existed. Contamination levels of POPs in human breast milk and in blood/serum can both serve as good indicators of their body burden. To better assess the body burden of POPs contamination in the Hong Kong population, it would be beneficial to measure all 12 Convention POPs in both the breast milk and plasma/serum of local residents.

2.5 Environmental and Human Health Risk Assessment of POPs

2.5.1 Comparison with Other Countries/Regions

2.5.1.1 Annual Release of Dioxins/Furans

In 2003, the estimated annual release of dioxins/furans to the environment of Hong Kong via all vectors was 20.3 g TEQ. A comparison of the local annual dioxin/furan emission with that of Asian countries, Canada, the US and Australia on a “per capital” basis was made. Among the five Asian countries participated in the Asian UNEP toolkit project, Hong Kong’s total annual dioxin/furan release per capita was similar to that of Jordon, Lebanon, the Philippines and Vietnam, but significantly lower than that of Brunei. On a vector basis, Hong Kong’s annual air dioxin/furan emission per capita was ranked the 2nd lowest, at least 1 or 2 orders of magnitude lower than that of Australia, Canada, the US, Japan and all Asian countries except Vietnam. The local annual water and residues dioxin/furan releases per capita were generally comparable to the range reported in most countries under comparison.

2.5.1.2 Contamination Levels of POPs in Environmental Media and Marine Biota

The contamination levels of POPs in local environmental media (ambient air, marine water, marine sediment and marine fish and shellfish) were found to be generally comparable to the range reported in other urban locations around the world.

2.5.1.2.1 Ambient Air

Overall, ambient air dioxin concentration of 0.06 pg I-TEQ/m^3 measured in Hong Kong for the period 2000-04 was comparable with the range reported in most other urban locations in Europe, the US and Australia, and fell at the lower end of that reported for Japan and Korea.

2.5.1.2.2 Marine Water and Sediment

Mean concentration of 5.21 pg I-TEQ/L dioxins/furans was measured in the marine water of Hong Kong for the period 2000-04. Few marine water dioxin/furan data from elsewhere in the world were available for comparison. Extremely low mean values (0.24-0.40 pg TEQ/L) were reported in public waters of Japan for 1998-2000. All other 10 Convention POPs were found to be below detection limit in the local marine water.

Comparison of the levels of marine sediment POPs contamination in Hong Kong and other countries/regions was made based on best available data. Overall, the levels of POPs in local marine surface sediment were comparable with those reported in other locations around the world. Of the POPs pesticides compared, local sediment DDT contamination appeared to be lower than that in the California coast while dieldrin contamination was slightly higher than the levels found in Tampa Bay (the US), Pearl River Estuary (of the Mainland), Argentina and Columbia. For sediment PCB and dioxin/furan contamination, mean local levels fell at the lower end of the range reported in New York Harbour (PCBs and dioxins/furans), Californian and Dutch coast (PCBs), and New Zealand and Swedish coast (dioxins/furans).

2.5.1.2.3 Marine Fish and Shellfish

Similarly, levels of POPs contamination in marine fish and shellfish of Hong Kong were compared with those reported by other countries/regions. The levels of POPs in local marine fish and shellfish were generally comparable with those reported in other locations around the world. HCB in local marine fish appeared to be higher than the extremely low range reported in all other locations. Fish DDT level in Hong Kong was similar to the level found in the Mediterranean, the Japanese Sea and the Mainland coast, but slightly higher than the range reported in South East Asia locations. DDT level in local shellfish was comparable to the level recorded in Japan, Singapore, Korea and some South East Asia countries, and at the lower end of the range recorded for the Mainland and Vietnam. The mean concentrations of PCBs in both marine fish and shellfish of Hong Kong were similar to those found in Japan, Singapore, Korea and Australia and at the lower end of the range reported in the Mediterranean. The dioxin/furan level in marine fish was at par with that detected in the European coast, Baltic Sea, San Francisco Bay and Tokyo Bay, and at the lower end of the range reported in Southern Norway, North Sea and New York Harbour.

2.5.1.2.4 Contamination Levels of POPs in Human Breast Milk

The mean breast milk concentration of DDT in Hong Kong mothers was 2.68 µg/g lipid wt which was the highest level reported in the 16 countries participated in the exercise, and that of indicator PCBs was 0.04 µg/g lipid wt which ranked the 8th lowest among 26 participating countries worldwide. The mean human breast milk concentrations of dioxin-like PCBs and dioxins/furans were 4.67 and 8.25 pg TEQ/g lipid wt, respectively, which ranked 10th and 13th lowest, respectively, among the 26 countries/regions that participated in the 3rd Round WHO/EURO Exposure Study.

2.5.2 Ecological Risk Assessment

Assessment based on available data indicated that overall, there was unlikely to be any ecological risk of toxicological significance associated with exposure of local marine life to the current level of POPs contamination in the marine environment of Hong Kong.

2.5.2.1 Risk Assessment of POPs to Pelagic Organisms

A two-tiered approach to ecological risk assessment of POPs to local pelagic organisms (excluding cetaceans) at the population level was adopted. Tier 1 calculated the Hazard Quotients (HQ) of POPs by comparing their concentrations detected in local marine water with relevant chronic toxicity values. POPs with a HQ >1 were identified as chemicals of potential toxicological concern subject to further, in-depth Tier 2 Probabilistic Risk Assessment (PRA) using the procedures outlined in Solomon and Takacs (2002)[4].

With the exception of DDT, the calculated HQs for all other POPs were <1, indicating no risk of toxicological significance to local pelagic organisms (not including cetaceans). DDT was subject to further evaluation by the Tier 2 PRA. The PRA results indicated that the lower 5th centile of estimated chronic toxicity distribution was not exceeded by the upper 5th centile of exposure distribution, suggesting there was no significant ecological risk of DDT exposure to local pelagic organisms (not including cetaceans).

Ecological risk assessment of POPs (chlordane, DDT, dieldrin, heptachlor, HCB, toxaphene and PCBs) to local cetaceans had previously been conducted in two consultancy studies[5,6], adopting an individual-based approach and methodology based on the Guidelines for Ecological Risk Assessment (USEPA, 1998) and using toxicity values derived from terrestrial mammalian studies as surrogates. Assessment results indicated that there was no unacceptable risk of toxicological significance associated with exposure of local dolphins to the current levels of POPs contamination of the marine environment.

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4 Solomon, K.R., & Takacs, P., 2002. Probabilistic risk assessment using species sensitivity distributions. In: *L. Posthuma, T. Traas and G. W. Suter* (*Eds*.), *Species Sensitivity Distributions in Ecotoxicology* (pp. 285-313). Boca Raton, FL, USA: CRC Press

5 EPD, 2003. A study of Toxic Substances Pollution in Hong Kong, Agreement No. CE 22/99.

6 CEDD, 2005. Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau (2000-2005), Agreement No. CE64/99.

2.5.2.2 Risk Assessment of POPs to Benthic Organisms

The ecological risk to local benthic organisms from potential exposure to POPs through direct contact with marine sediment was also assessed. Local sediment concentrations of POPs were evaluated against the published international Sediment Quality Criteria/Guidelines. Mean contamination levels of POPs in the marine sediment of Hong Kong generally fell at the lower end of the range of screening concentrations published in the Sediment Quality Criteria/Guidelines of USEPA, Canada and Australia/New Zealand, suggesting there would be little risk of toxicological significance of POPs exposure to local benthic organisms.

2.5.3 Health Risk Assessment

Results of the health risk assessment indicated there was no unacceptable risk of toxicological significance associated with inhalation and dietary exposure of the Hong Kong population to the current level of POPs contamination in the local environment and food items.

2.5.3.1 Estimate of Daily Total Exposure to Dioxins/Furans

The measured mean ambient air concentration of dioxins/furans in Hong Kong (2003) was 0.06 pg I-TEQ/m^3. Assuming a respiratory rate of 20/min and a tidal volume of 600 ml, the daily intake of dioxins/furans by local residents via the inhalation route was estimated to be 0.017 pg TEQ/kg bw/day (calculated based on body weight of 60 kg for an average adult). The estimate of dietary exposure of the local population to dioxins/furans (2003) was 0.91 pg TEQ/kg bw/day. Therefore, total daily exposure of local residents to dioxins/furans was estimated to be 0.927 pg TEQ/kg bw/day (assuming negligible intake via the drinking water route). This value fell at the lower end of the range (1-4 pg TEQ/kg bw/day) of Tolerable Daily Intake of dioxins/furans set by WHO (1998). Dietary exposure was the major route, accounting for 98.2% of total exposure to dioxins/furans, while inhalation exposure accounted for only 1.8%. The finding was in good agreement with internationally reported data.

2.5.3.2 Human Non-Carcinogenic Risk Assessment on POPs

The potential for non-carcinogenic health effects associated with exposure to POPs contamination of the local ambient air and locally consumed food items was evaluated by calculating the Hazard Quotient (HQ) which was defined as the ratio of the estimated lifetime average daily dose (LADD) of POPs from dietary (Table 7) and inhalation (Table 5) pathways to the Reference Dose (RfD) (USEPA) or Acceptable Daily Intake (ADI) (WHO). Exposure levels below the RfD or ADI would be considered unlikely to elicit adverse health effects. The calculated HQs of all 12 Convention POPs were well below unity, indicating there was no non-carcinogenic risk of toxicological significance associated with a lifetime exposure of local residents to current levels of POPs contamination in the local ambient air and locally consumed foods.

2.5.3.3 Human Carcinogenic Risk Assessment on POPs

2.5.3.3.1 Inhalation Carcinogenic Risk Assessment

Japan has established an ambient air quality standard of 0.6 pg TEQ/m^3 for the sum of dioxins/furans and dioxin-like PCBs. The concentration guidelines for dioxins in ambient air set by various government agencies elsewhere in the world range from 0.02 to 40 pg I-TEQ/m^3. The HKSARG has not set ambient air quality standard for dioxins/furans. The mean dioxin/furan concentration of 0.06 pg I-TEQ/m^3 measured in local ambient air (2003) fell at the lower end of the range published in overseas national guidelines and significantly lower than that of Japan.

Inhalation cancer risk of POPs to the local residents was estimated based on the measured ambient air POPs concentrations (for 2000-04) and using unit risk factors published in the USEPA Scorecard and IRIS database. Excess lifetime cancer risk in the range of 1×10^{-4} to 1×10^{-6} was considered acceptable for regulatory purposes in protecting human health (USEPA). The estimated inhalation cancer risks of POPs (including DDT, heptachlor, HCB, PCBs and dioxins/furans) all fell at the lower end of the 1×10^{-4} to 1×10^{-6} range, indicating there was no unacceptable inhalation cancer risk of toxicological significance to the Hong Kong population.

2.5.3.3.2 Dietary Carcinogenic Risk Assessment

The potential for carcinogenic health effects associated with exposure to POPs contamination of the locally consumed food items was calculated by multiplying the LADD of chemical exposure from consumption of local food items by its carcinogenic slope factor. Excess lifetime cancer risk in the range of 1×10^{-4} to 1×10^{-6} was considered acceptable for regulatory purposes in protecting human health (USEPA). The calculated dietary cancer risks of POPs (DDT, HCB, PCBs and dioxins/furans) all fell well within the 1×10^{-4} to 1×10^{-6} range, indicating there was no dietary cancer risk of toxicological concern associated with a lifetime exposure of local residents to current levels of POPs contamination in the locally consumed foods.

2.5.3.4 Levels of POPs Contamination in Local Marine Biota

In the absence of Food Safety Standards on POPs in Hong Kong, the levels of POPs contamination in marine fish and shellfish sampled in the local waters were examined against published national and overseas Food Safety Standards/Action Levels. The levels of POPs in local marine fish and shellfish were well below the standards/action levels set by the Mainland, the US and the EC.

2.5.3.5 Human Incremental Risk Assessment on POPs in Local Marine Environment

2.5.3.5.1 Incremental Non-Carcinogenic Risk Assessment

The potential for incremental non-carcinogenic health effects associated with exposure to POPs contamination in the local marine environment was evaluated by calculating the HQ which was defined as the ratio of the LADD from consumption of locally-caught seafood and incidental ingestion of marine water (during recreational activities) to the RfD (USEPA) or ADI (WHO). Exposure levels below the RfD or ADI would be considered unlikely to elicit adverse health effects. The calculated HQs for all 12 Convention POPs were well below unity, indicating there was no incremental non-carcinogenic risk of toxicological concern associated with a lifetime exposure of Hong Kong residents to current levels of POPs contamination in locally caught marine fish and shellfish. It should be noted, however, that exposure to POPs from sources other than locally caught seafoods (and incidental ingestion of seawater during recreational activities) had not been taken into account in the incremental risk assessment.

2.5.3.5.2 Incremental Carcinogenic Risk Assessment

The potential for incremental carcinogenic health effects associated with exposure to POPs contamination in the local marine environment was calculated by multiplying the LADD of chemical exposure from consumption of locally-caught seafood and incidental ingestion of marine water (during recreational activities) by its carcinogenic slope factor. Excess lifetime cancer risk in the range of 1×10^{-4} to 1×10^{-6} was considered acceptable for regulatory purposes in protecting human health (USEPA). The calculated cancer risks of POPs all fell well within the 1×10^{-4} to 1×10^{-6} range, indicating there was no incremental cancer risk of toxicological concern associated with a lifetime exposure of Hong Kong residents to current levels of POPs contamination in locally caught marine fish and shellfish.

3. STRATEGIES, PRIORITIES AND ACTION PLANS OF THE HONG KONG IMPLEMENTATION PLAN (HKIP)

3.1 POPs Management Framework and Implementation Strategy

- Develop an integrated and transparent legislative framework and institutional system to effectively control, minimize and prevent the potentially adverse impact of POPs on human health and the environment.
- Uphold the principle of environmental sustainability in pursuing community development, and apply Best Available Techniques (BAT) / Best Environmental Practices (BEP) to reduce environmental pollution by POPs.
- Conduct a structured monitoring programme to better characterize and quantify the local POPs emission profile which is vital to the planning and development of a practical and successful action plan to reduce or ultimately eliminate POPs.

3.2 Overall Assessment of Current POPs Pollution in Hong Kong

- On a “per capita” basis, the current (2003) annual dioxin/furan release in Hong Kong was generally similar to that of Asian countries, Canada, the US and Australia, and was the 2nd lowest in air emission.
- The level of POPs contamination in the local environment (ambient air, marine water,

marine sediment, marine fish and shellfish) was generally comparable to the range reported in most other urban locations in Asia Pacific, Europe, the US and Australia.

- Assessment based on available data indicated that overall, there was unlikely to be any ecological risk of toxicological significance associated with exposure of local marine life to the current level of POPs contamination in the marine environment of Hong Kong.
- Total daily exposure of local residents to dioxins/furans was estimated to be 0.927 pg TEQ/kg bw/day, a value falling at the lower end of WHO's Tolerable Daily Intake of 1-4 pg TEQ/kg bw/day. Dietary intake was the major route, accounting for 98.2% of total exposure of local residents to dioxins/furans.
- Results of human health risk assessment indicated that there was no inhalation nor dietary chronic/carcinogenic risk of toxicological concern associated with a lifetime exposure of Hong Kong residents to current levels of POPs contamination in the local environment and locally consumed foods.
- Levels of POPs in local marine biota were found to be well below national and overseas Food Safety Standards/Action Levels of the Mainland, the US and the EC.

3.3 Action Plans

3.3.1 Strengthening of the Institutional and Regulatory Systems

A summary of identified legislative gaps and proposed action items to meet the Stockholm Convention requirements is presented in Action Plan 1.

Action Plan 1 Legislative Framework for POPs Management and Control

Action Item	Anticipated Outcome	Responsible Party	Priority/ Target Term
POPs Pesticides			
To consider a review of the overall pesticide control system in Hong Kong.	Ensure full compliance of the requirements under the Stockholm Convention on control of POPs pesticides.	AFCD	High/ Short-term (<5 yr)
Non-Pesticide POPs			
To enact new legislation to effect control and regulation of the import, export, domestic production and use of non-pesticide hazardous chemicals in Hong Kong.	Put in place a single piece of legislation to control and regulate the import, export, domestic production and use of non-pesticide hazardous chemicals in Hong Kong.	EPD	High/ Short-term (<5 yr)

3.3.2 Validation and Refinement of the POPs Inventories

The compilation of a robust and reliable POPs inventory is vital to the planning and development of practical and relevant action plans to effectively reduce and ultimately eliminate POPs in Hong Kong. Action Plan 2 summarizes the list of proposed action items to fill critical data gaps identified in the current POPs inventories, including the dioxin/furan source inventory, environmental levels of POPs contamination, dietary exposure to POPs and human body burden of POPs.

Action Plan 2 Validation and Refinement of the POPs Inventories

Action Item	Anticipated Outcome	Responsible Party	Priority/ Target Term
Source Inventories on POPs - Release of Unintentional POPs as by-Products			
To establish a more representative local annual activity and emission level of the "aluminium production" process.	Better assessment of the industry performance and its contribution to local annual dioxin/furan emission profile.	EPD	High/ Short-term (<5 yr)
To further analyze sewage effluent and sewage sludge at source.	Achieving better estimate of local annual dioxin/furan release from sewage and sludge disposal.	EPD	High/ Short-term (<5 yr)
To collate information on local annual stormwater production and analyze the stormwater for level of dioxin/furan contamination.	Assessment of the contribution of stormwater discharge to local annual dioxin/furan emission profile.	EPD	Medium/ Med - term (5-10 yr)
To analyze local livestock waste composting and establish a local dioxin/furan emission factor specific to the trade.	Better estimate of local annual dioxin/furan emission from the livestock waste composting activity.	EPD	High/ Short-term (<5 yr)
To further study the composition and fate of boiler ash residues generated from coal fired power boilers plants.	Characterization of this potential emission source "in residue" and "in product", and better assessment of its contribution to the local dioxin/furan emission profile.	EPD	High/ Short-term (<5 yr)
Environmental Levels of POPs - POPs in Local Environmental Media and Aquatic Biota			
To include all 12 Convention POPs in the routine monitoring programme for local ambient air.	Improved environmental POPs inventory for the effectiveness evaluation of the HKIP.	EPD	High/ Short-term (<5 yr)
To include all 12 Convention POPs (dioxins/furans in particular) in the routine monitoring programme for local marine water, sediment and biota.	Improved environmental POPs inventory for the effectiveness evaluation of the HKIP.	EPD	High/ Short-term (<5 yr)
To conduct further studies of POPs in local water birds on a project basis, with possible collaboration with local academia.	Improved environmental POPs inventory for the effectiveness evaluation of the HKIP.	AFCD	High/ Short-term (<5 yr)

Action Item	Anticipated Outcome	Responsible Party	Priority/ Target Term
To conduct further studies of POPs in local marine mammals on a project basis whenever opportunities arise, with possible collaboration with local academia.	Improved environmental POPs inventory for the effectiveness evaluation of the HKIP.	AFCD	High/ Short-term (<5 yr)
To monitor the level of POPs contamination in local inland water and river sediment on a project basis.	Improved environmental POPs inventory for the effectiveness evaluation of the HKIP.	EPD	Medium/ Med-term (5-10 yr)
To monitor the level of POPs contamination in local surface soil and vegetation on a project basis, with possible collaboration with local academia.	Improved environmental POPs inventory for the effectiveness evaluation of the HKIP.	EPD	Low/ Long-term (>10 yr)
Dietary Exposure to POPs – POPs Contamination in Locally Consumed Foods and Drinking Water, Food Consumption Patterns and Food Safety Standards/Action Levels			
To include all 12 Convention POPs for analysis in all main locally consumed food groups in the routine food surveillance programme.	Improved dietary POPs inventory for better assessment of the local situation	FEHD	High/ Short-term (<5 yr)
To consider including all 12 Convention POPs in the routine drinking water surveillance programme.	Improved dietary POPs inventory for better dietary risk assessment and the effectiveness evaluation of the HKIP.	WSD	High/ Short-term (<5 yr)
A population-based local food consumption survey commissioned by FEHD; To conduct Total Diet Studies in the future when additional resources are made available.	Better estimate of dietary exposure of local residents to POPs.	FEHD	Medium - High/ Short - Med-term (<5 -10 yr)
To consider setting Food Safety Action Levels on POPs specific to Hong Kong by taking reference from national and international food safety authorities.	Effective control and management of POPs contamination of locally consumed foods.	FEHD	Medium/ Med-term (5 - 10 yr)
Human Body Burden of POPs - Human Breast Milk and Blood/Serum			
To participate in the 4th and subsequent WHO-Coordinated Survey of Human Milk for the 12 Convention POPs, with possible collaboration with local academia.	Improved human body burden POPs inventory for better health risk assessment and the effectiveness evaluation of the HKIP.	DH	High/ Short-term (<5 yr)
To consider, taking into account international best practices, initiating measurements of POPs in the blood/serum of local residents on a project basis, with possible collaboration with local academia.	Improved human body burden POPs inventory for better health risk assessment and the effectiveness evaluation of the HKIP.	DH	Medium/ Med-term (5 - 10 yr)

3.3.3 Measures to Reduce Emission of Unintentionally Produced POPs

Proposed measures to reduce emissions of unintentionally produced POPs, i.e. dioxins/furans, are summarized in Action Plan 3. These measures are being pursued as part of the HKSARG's environmental portfolio in accordance with the established timetable.

Action Plan 3 Measures to Reduce Emission of Unintentionally Produced POPs

Action Item	Anticipated Outcome	Responsible Party	Target Term
Emission of Dioxins/Furans to Air			
To optimize the use of existing generating capacity of gas-fired power plants and to progressively phase out old coal-fired generation units and replace with gas-fired plants, subject to energy policy, economic considerations and technical feasibility, and timing of adjusting the fuel mix to meet the local power demand.	Reduced dioxin/furan emission to the local atmosphere.	EPD	Short to Long-term (<5 - >10 yr)
To tighten dioxin emission standards for crematoria under Best Practicable Means and progressively phase out or replace old cremation units.	Reduced dioxin/furan emission to the local atmosphere.	EPD	Short to Medium-term (<5 – 10 yr)
To introduce more stringent motor vehicle emission standards.	Reduced emission of respirable suspended particulate (RSP), nitrogen oxide (NOx) and vehicular dioxins/ furans to the local atmosphere.	EPD	Short-term (<5 yr)
Emission of Dioxins/Furans to the Marine Environment			
To implement a territory-wide sewage improvement programme, including the Harbour Area Treatment Scheme Stage 2A and upgrading of sewage treatment works, subject to the acceptance by the community of the need for the full recurrent costs to be recovered through the sewage services charging scheme.	Reduced dioxin/furan release to the local marine environment from sewage effluent discharge.	EPD	Short to Medium-term (<5 – 10 yr)
Integrated Environmental Waste Management			
To implement integrated waste management in a sustainable and environmentally sound manner, including waste prevention and recycling as top priority and adoption of BAT and BEP to treat clinical waste, sewage sludge and unavoidable municipal solid waste, subject to the implementation of the "polluter-pays" principle.	Reduced overall local annual dioxin/furan emission via all vectors.	EPD	Short to Medium-term (<5 – 10 yr)

3.3.4 Public Awareness Campaign

A summary of the proposed action items to raise local public awareness of POPs-related issues is presented in Action Plan 4.

Action Plan 4 Public Awareness Campaign

Action Item	Anticipated Outcome	Responsible Party	Target Term
To develop a dedicated POPs webpage under EPD's homepage.	Effective dissemination of science-based facts on POPs and POPs-related issues to the public, and enhanced local community participation in the global effort to reduce and eliminate POPs in the environment.	EPD	Short-term (<5 yr)
To produce POPs information pamphlets for distribution to the public, and to design exhibition panels for display in EPD's Environment Resource Centres and other appropriate venues.	Effective dissemination of science-based facts on POPs and POPs-related issues to the public, and enhanced local community participation in the global effort to reduce and eliminate POPs in the environment.	EPD	Short-term (<5 yr)
To organize publicity events, education/training programmes and visits to various target groups (school students, professionals, NGOs and the public at large) on POPs-related themes and topics.	Effective dissemination of science-based facts on POPs and POPs-related issues to the public, and enhanced local community participation in the global effort to reduce and eliminate POPs in the environment.	EPD	Short-term (<5 yr)

3.3.5 Regional Collaboration with the Mainland

Hong Kong, because of its geographical location at the Pearl River Estuary, is significantly influenced by the movement of toxic pollutants, POPs in particular, within the PRD Region via both the atmospheric and water pathways. The common occurrence of POPs pesticides which are not registered or have been banned from all uses for many years in the local environment is evident of long range transport of these POPs within the region. Therefore, sound and effective environmental management of environmental pollution of POPs must encompass the PRD Region as a whole. Action Plan 5 presents the proposed action items for strengthening regional collaboration with the Mainland especially the PRD.

Action Plan 5 Regional Collaboration with the Mainland

Action Item	Anticipated Outcome	Responsible Party	Target Term
To organize regional technical workshops and training seminars on POPs monitoring and analytical protocols, and risk assessment methodologies.	Enhanced information exchange and knowledge sharing, harmonization of POPs monitoring approaches, and improved data comparability within the region.	EPD	Short-term (<5 yr)
To conduct joint regional POPs monitoring programme on a project basis.	Contribution to the development of a regional overall picture of POPs and to the effective control and environmental management of POPs in the PRD.	EPD	Medium-term (5 - 10 yr)

3.3.6 Capacity Building

To achieve the objectives of the HKIP, the following capacities would need to be built up and/or strengthened within the HKSAR. The proposed action items are summarized in Action Plan 6.

Action Plan 6 Capacity Building

Action Item	Responsible Party	Target Term
To improve legislative and management systems for comprehensive and effective POPs control in Hong Kong.	EPD	Short-term (<5 yr)
To promote BAT/BEP in local community activities, industrial processes and public utilities.	EPD	Short to Long-term (<5 - >10 yr)
To enhance local POPs monitoring and analytical capabilities, in close collaboration with the local academia and commercial laboratories.	EPD	Short to Long-term (<5 - >10 yr)
To update the POPs database and refine the POPs inventories.	EPD	Short-term (<5 yr)

3.3.7 Implementation Plan Review and Effectiveness Evaluation

Article 16 of the Stockholm Convention calls for periodic progress/effectiveness review of a National Implementation Plan. Regarding the HKIP, the review can be on a 5-year basis or at intervals as determined by the CPG and in accordance with decisions of the Conference of the Parties to the Stockholm Convention. The implementation of the HKIP and effectiveness of implementing the action plans to reduce dioxin/furan emission and improve local and regional control and management of POPs will be evaluated through reports of routine monitoring and *ad hoc* studies of POPs in the local environment and foods, and human body exposure. The monitoring data generated will be used to update and refine the HKSAR's POPs inventories which are instrumental to a science-based re-assessment of our local POPs situation prior to the next review year.

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